Electricity Report 2019

Contents

Consumption

Trend in consumption

473 TWh

Consumption adjusted for weather

- 0,5 %

Slight decline vs. 2018

Consumption down slightly for the year

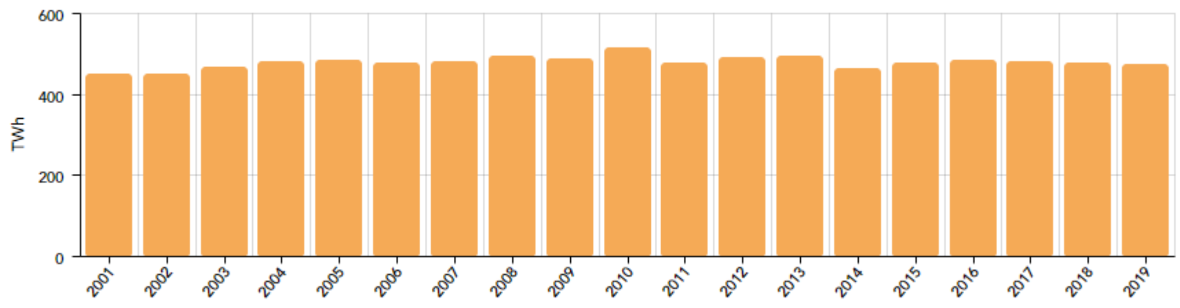
Total electricity demand had been stabilising for several years, thanks to generally improved demand-side management and despite increased use of electric appliances.

Consumption nonetheless declined slightly year-on-year in 2019, due to generally warmer weather early in the year and to economic growth that was not as robust in 2018, falling to its lowest level in ten years.

Gross consumption

Gross consumption ended the year at about 474 TWh, down 1% from a year earlier. This slight decrease was driven by generally milder weather in the early months of the year and economic growth that was not as robust as in 2018.

Trend in gross consumption



For a better understanding

Why are adjustments made to gross consumption?

To better identify structural trends

When it is very cold outside, electricity is used for heating. When the weather is very hot, people use power for cooling. To better analyse structural trends from one year to the next, power consumption data is adjusted to strip out "weather effects". Once this is done, electricity demand corresponds to what would have been consumed if temperatures had been the same as reference temperatures.

Adjustments can be made for other factors as well. For instance, February has an extra day in leap years. To strip out this calendar effect, consumption is adjusted in such a way as to count only 365 days.

Adjusted consumption

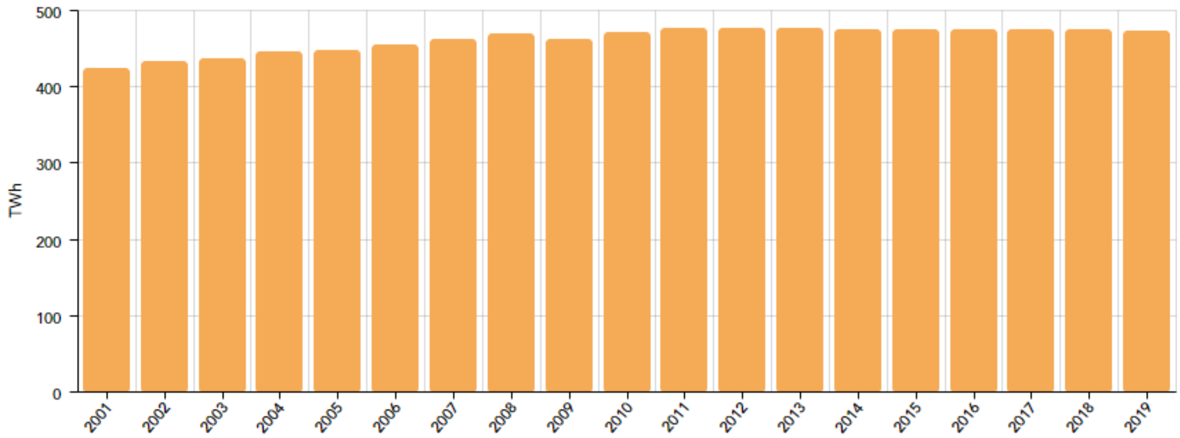
Excluding the energy sector from the calculation, adjusted consumption (adjusted for weather and calendar effects) ended 2019 at 473 TWh, down slightly (-0.5%) from 2018 and broadly in line with the average for the past ten years.

Power demand in France entered a period of relative stability in 2010. The trend reflects a gradual slowing of demand growth observed over several decades: growth rates declined steadily and approached zero in 2010.

This structural slowing of electricity demand growth in France, also observed in most European countries, is chiefly attributable to:

- More widespread and stronger energy efficiency measures in buildings and for appliance efficiency, allowing the same needs to be met with less electricity;
- A long-term slowing of economic and demographic growth over several decades;
- A structural change in economic activity with a shift toward the service industry, knowing that services consume four to five times less electricity than the industrial sector for the same level of production.

Consumption adjusted for weather



Note: To calculate adjusted consumption, it is necessary to exclude the energy sector because the adoption of a new uranium enrichment process in 2012 severely impacted the sector and caused a steep decline in consumption.

Temperature trends relative to reference temperatures

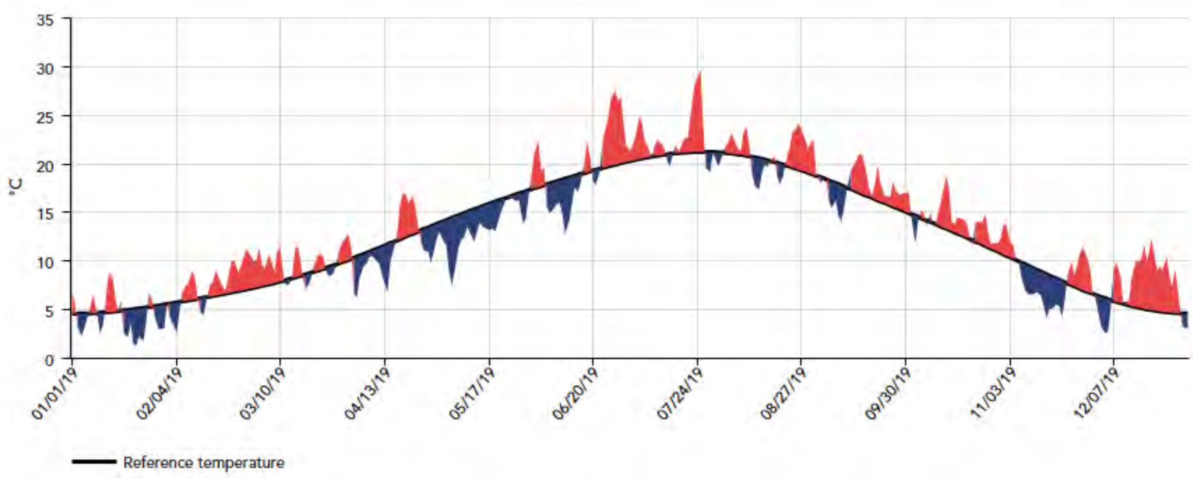
2019 was one of the warmest years on record (average temperature 0.5°C above the reference temperature), matching the 2014 level but slightly cooler than 2018.

An analysis of daily data (source: Météo France) nevertheless reveals some contrasting trends:

- Temperatures were 0.3°C below average in January 2019, but rose sharply after that (between 0.6°C and 2.2°C above the average);
- Temperatures were below normal most of the time in May 2019 (-1.1°C);
- June 2019 was the fifth hottest month of June on record since 1900, with temperatures climbing above 46°C in Occitanie;
- Temperatures were also above average for most of the summer of 2019. July saw an exceptional heatwave in the northern half of the country with temperatures exceeding 40°C, making it the fourth hottest month of July since 1900.
- In the latter months of the year, temperatures were also generally above average (+2°C in October and December).

Adjustments are made for these changes in consumption analyses in order to better identify underlying trends.

Temperature trends in France relative to reference temperatures



A closer look

éCO2mix: Everything you want to know about electricity in France and your region or city

éCO_2mix is an educational tool designed to promote transparency.
Whether you are an ordinary citizen trying to better understand electricity to become a more responsible consumer, a knowledgeable amateur or an energy professional, you can use éCO_2mix in a fun or expert manner to monitor power system data at the national, regional or city level. It can also be used to understand your power consumption and get advice on how to reduce it and take simple actions to prevent or reduce the risk of a system imbalance if a power warning is issued.

https://www.rte-france.com/eco2mix

Breakdown of consumption by sector

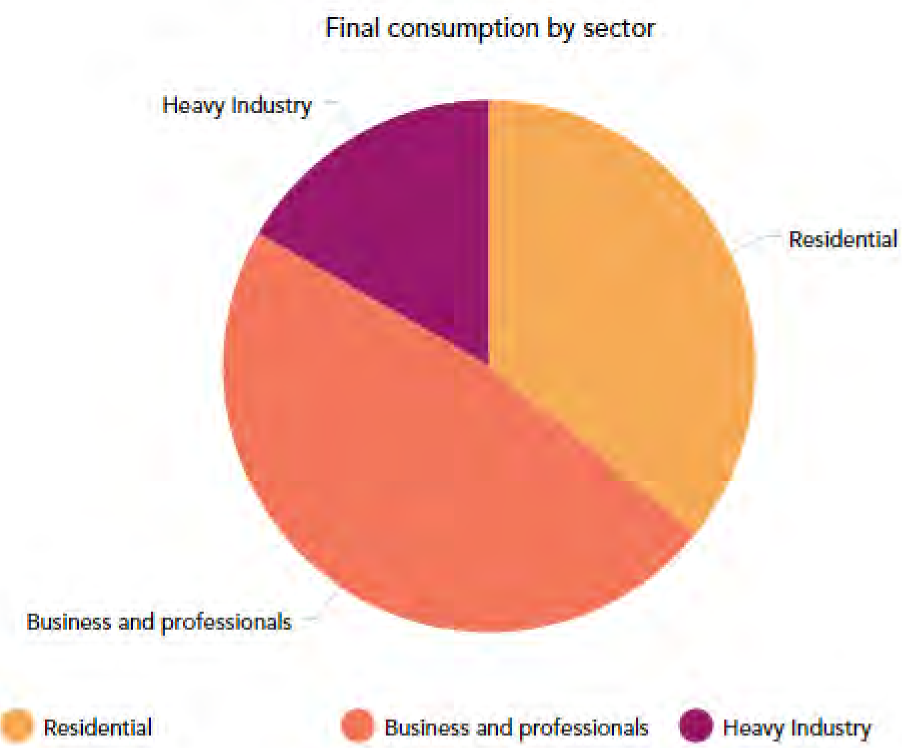
- 3 %

Decline in consumption in heavy industry

No change in breakdown by sector

The breakdown of consumption by sector on RTE's transmission networks (excluding EDF-SEI and LDCs) and the Enedis distribution network was comparable to 2018.

Final electricity consumption was highest in the business and professionals segment (47%), followed by residential (nearly 36%) and then heavy industry (17%).



For a better understanding

Who are RTE's customers?

RTE works on behalf of society and its own customers – producers and distributors of electricity, industrial firms and traders – to offer solutions that help keep power system costs in check and thus preserve economic activity.

As the transmission system operator, RTE plays a central role in the power system and is responsible for ensuring that generation always matches demand. It works around the clock, seven days a week, to direct electricity flows and optimise the functioning of the power system for its customers and society at large. RTE carries electricity to all parts of France, from generation sites to the industrial sites that are directly connected to its network and to the distribution grids that deliver it to final consumers.

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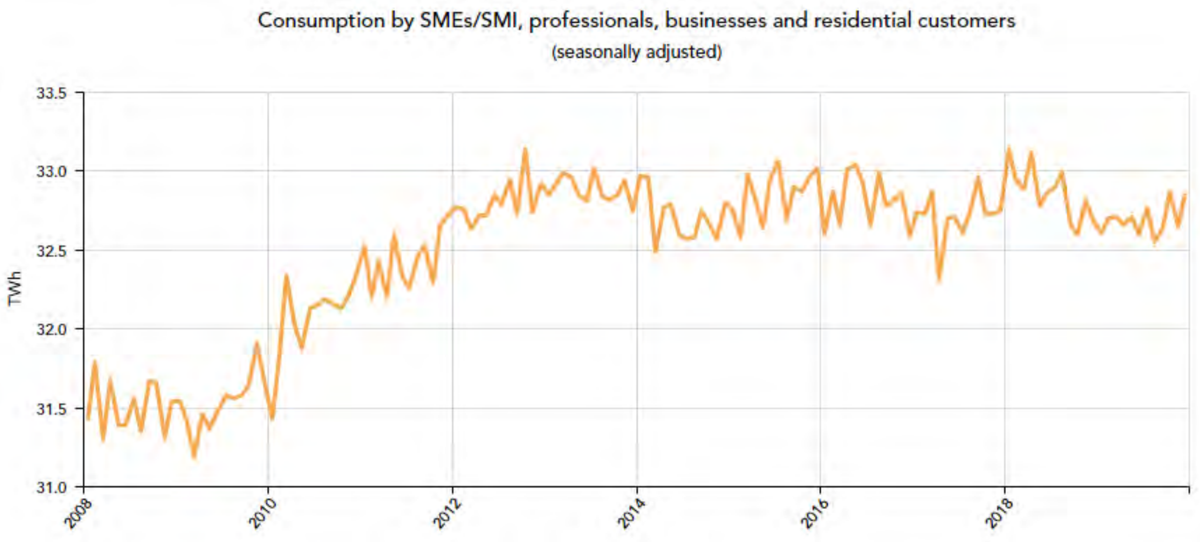
Slight decline in consumption on the distribution networks

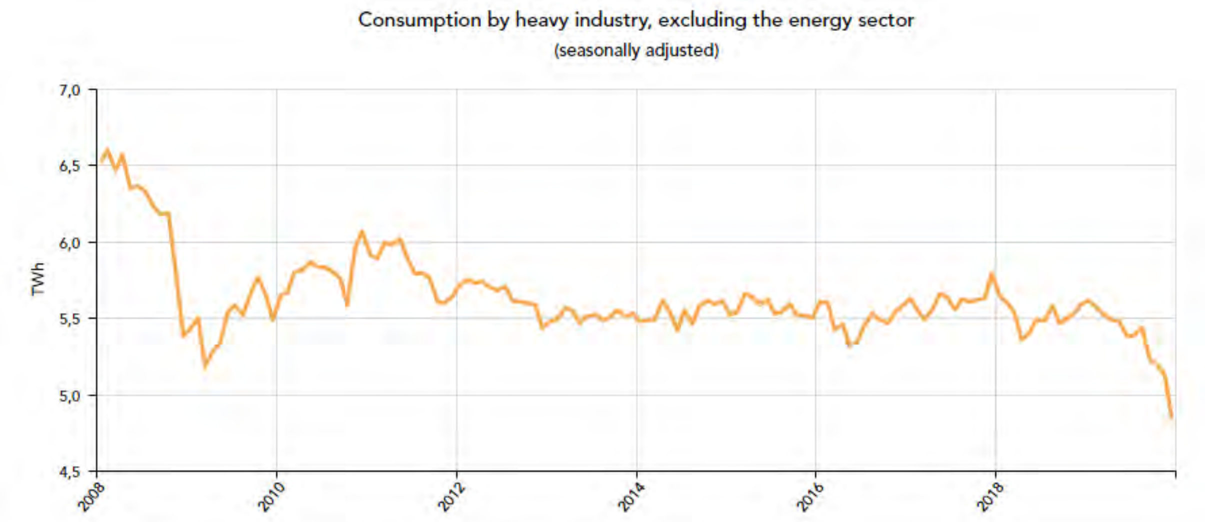
Adjusted consumption (adjusted for weather), including losses, has been stable for the past seven years for SME/SMIs, professionals, businesses and residential customers connected to the distribution grid, albeit with a 0.5% decline between 2018 and 2019.



The application of directives and regulations on the energy efficiency of equipment contributed to this trend. Another factor was slower growth in the share of new buildings heated with electricity following the application of the 2012 Building Energy Regulation.

Contraction in demand in heavy industry

Electricity consumption by industrial users* directly connected to the public transmission network reached 64.3 TWh*, which was 3% lower than in 2018. This decrease was driven by the steel, paperboard, car manufacturing and rail transport segments.



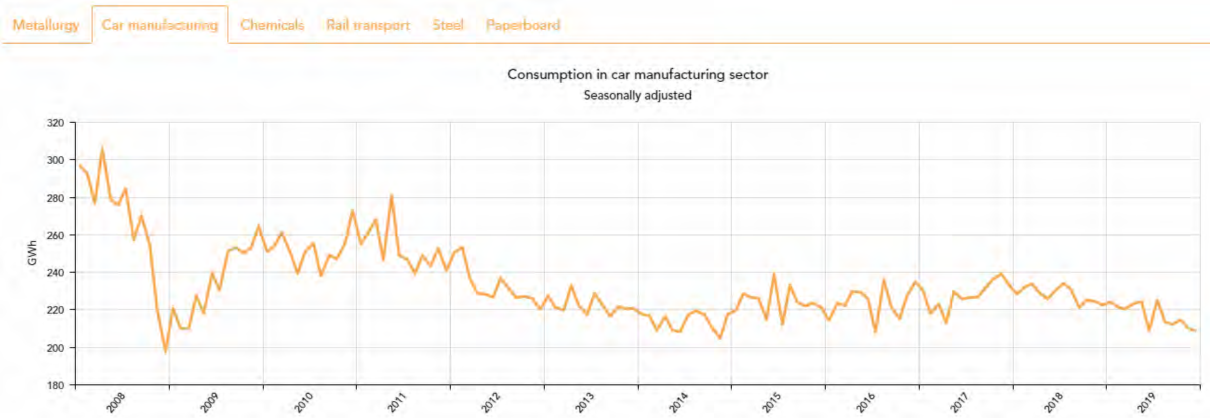
* including own consumption but excluding losses and the energy sector, seasonally adjusted

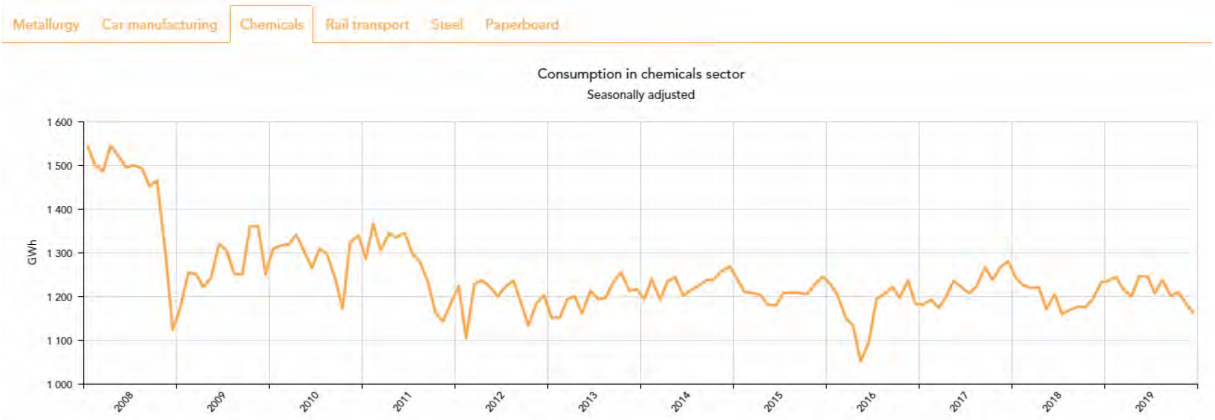
Uneven trends in different segments of heavy industry

On a seasonally adjusted basis, consumption trends were uneven across the different segments of industry.

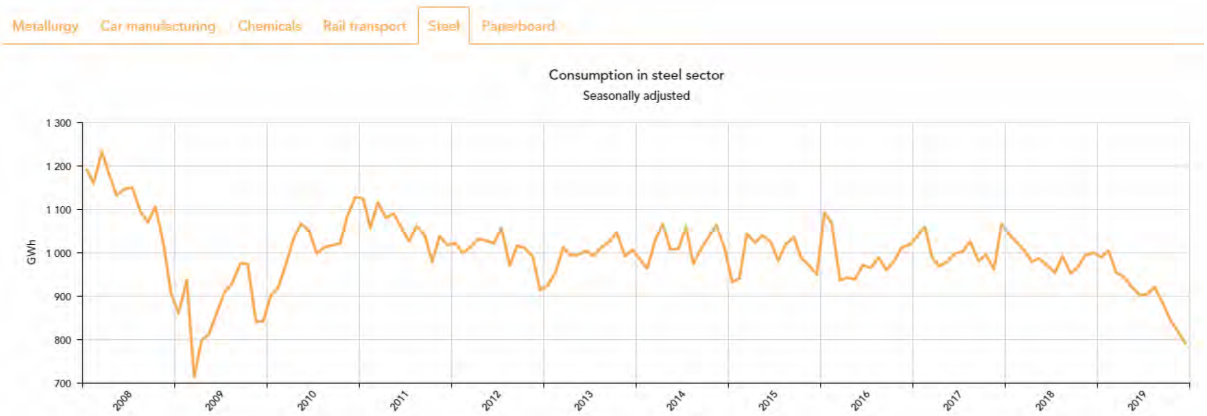
The metallurgy, energy and chemicals segments saw year-on-year increases of 4.8%, 1.5% and 1.4%, respectively.

Demand decreased in other segments, with the sharpest decline recorded by steel (-9.1%), followed by paperboard (-7.2%), car manufacturing (-5%) and rail transport (-1.3%), the latter having been affected by major social movements in December.




Metallurgy
Car manufacturing
Chemicals
Rail transport
Steel
Paperboard
Consumption in chemicals sector
Seasonally adjusted
GWh
1 600
1 500
1 400
1 300
1 200
1 100
1 000
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019


Metallurgy
Car manufacturing
Chemicals
Rail transport
Steel
Paperboard
Consumption in rail transport sector
Seasonally adjusted
GWh
750
700
650
600
550
500
450
400
350
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019


Metallurgy
Car manufacturing
Chemicals
Rail transport
Steel
Paperboard
Consumption in steel sector
Seasonally adjusted
GWh
1 300
1 200
1 100
1 000
900
800
700
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019


Metallurgy
Car manufacturing
Chemicals
Rail transport
Steel
Paperboard
Consumption in paperboard sector
Seasonally adjusted
GWh
800
700
600
500
400
300
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019

A closer look

Supply to industrial users interrupted twice in 2019 via interruptibility programme

Since electricity is difficult to store, the transmission network must ensure that supply and demand are balanced at all times. Network frequency is a reflection of this balance. If demand exceeds supply, frequency decreases. Conversely, when generation outpaces demand, frequency increases.

France's interruptible load programme, defined by law and implemented by RTE in 2014, makes it possible to immediately interrupt participating large power customers, which participate voluntarily and are compensated for this service. Automatically activated when system frequency falls below a certain threshold, the programme helps restore frequency balance by reducing consumption. Twenty-two industrials sites currently participate in the programme, representing a reserve of 1,500 MW that can be interrupted in under 30 seconds.

The mechanism was activated for the first time at the national level on Thursday 10 January, 2019, at 9:00 pm, and then for a second time on 7 October, also at 9:00 pm on the hour. Cross-border exchange schedules between European countries change on the hour, making this the most complex time for grid management as generation at power plants across Europe is stopping, starting and changing all at the same time.
Other events that occurred on the two days in question (false measurement data on the line between Germany and Austria on 10 January, loss of a generating unit on 7 October) accentuated the drop in frequency normally seen during schedule changes, causing it to dip below the load interruption programme activation threshold. Note that this activation was not related to the variability of renewable energy sources.

It is important to understand that such a variation in frequency is not enough to create a risk of blackout across the European system. Yet it does make it necessary to mobilise resources to quickly restore frequency to 50 Hz. The activation of the interruptibility programme in France showed that the mechanism can provide an adequate response in real time to help support frequency when necessary.

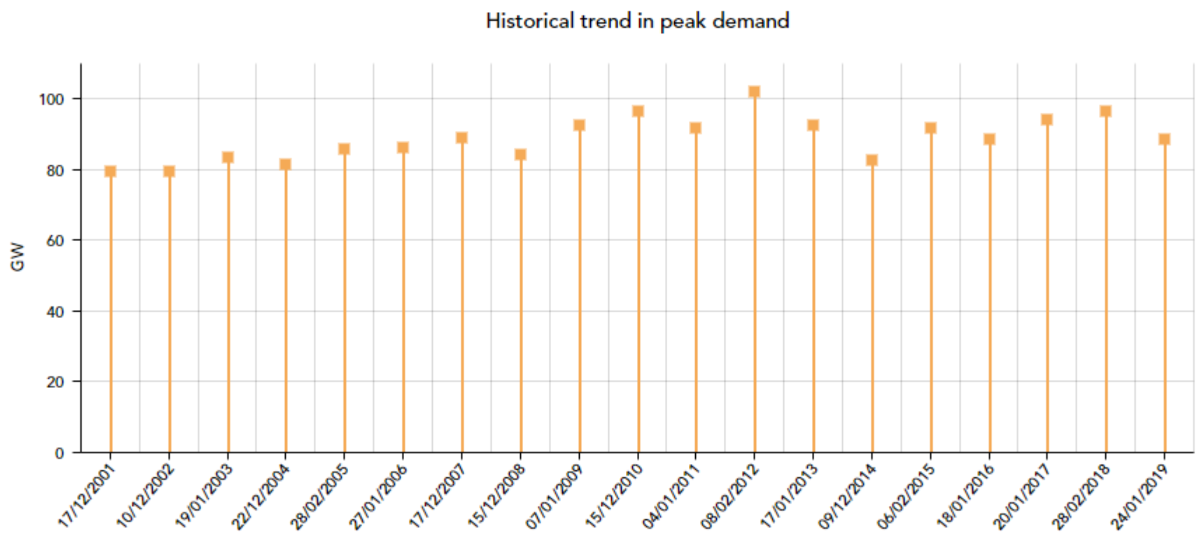
Sensitivity to temperatures and end-uses

88,5 GW

Peak demand in winter

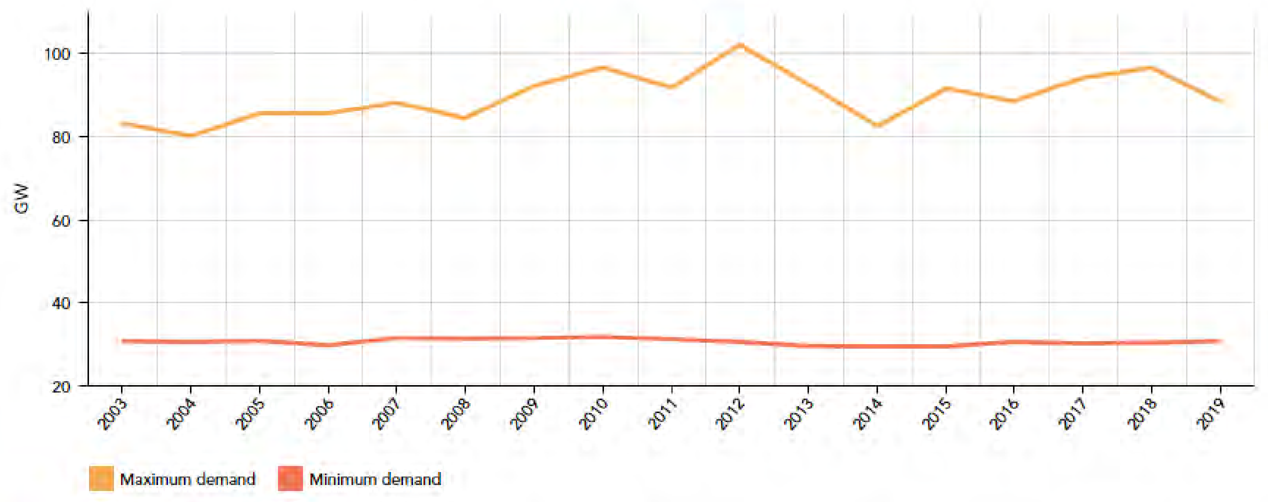
Peak demand

Electricity consumption peaked for the year at 88.5 GW on Thursday, 24 January 2019, at 7:00 pm, during a period when lower elevations were seeing heavy snowfall. The peak was within the average for the past 20 years in France.
The summer peak was reached on 25 July 2019, at 59.1 GW, not far from the historic high of 59.5 GW recorded in June 2017. Demand was driven up by a heatwave and economic activity that remained robust.



Demand reached its lowest point for the year on Sunday 11 August, falling to 30.8 GW.

Trends in annual maximum and minimum demand



For a better understanding

What drives peaks and valleys in demand?

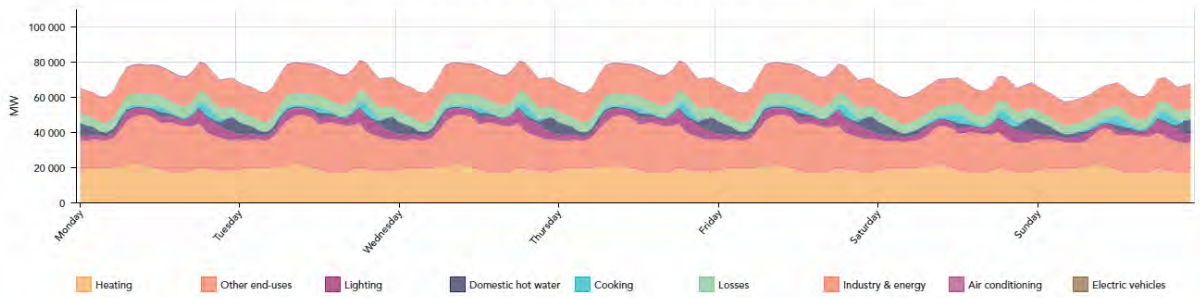
Consumption in France varies greatly depending on the season, the day of the week and the time of day

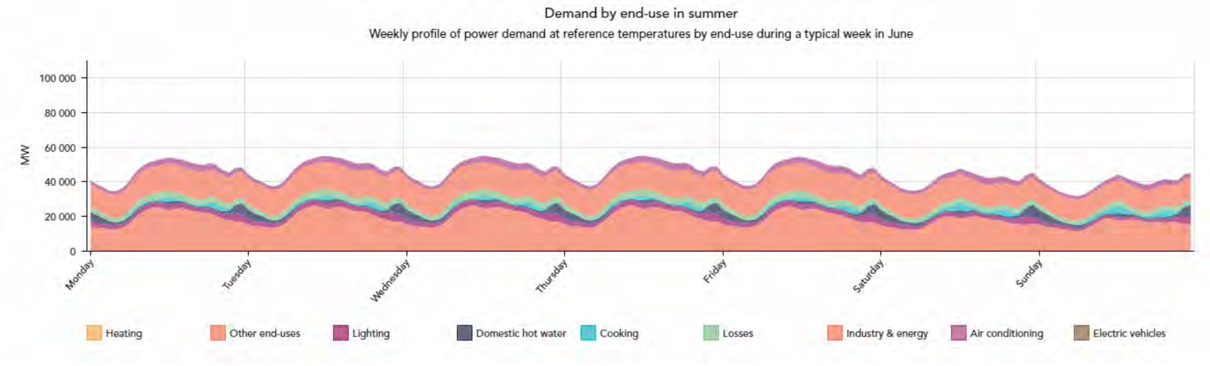
Electric heating causes demand to reach higher levels in winter than in summer. Similarly, people are more active during the week than on weekends, so demand is higher on weekdays.
Over the course of a day, the use of lighting and cooking for example, particularly in the evening, when people tend to return home, explains the spike observed at around 7:00 pm.

Demand by end-use

Hourly loads* on the two charts below show substantial seasonal variability. This is due in large part to the use of heating in winter.

Demand by end-use in winter
Weekly profile of power demand at reference temperatures by end-use during a typical week in January



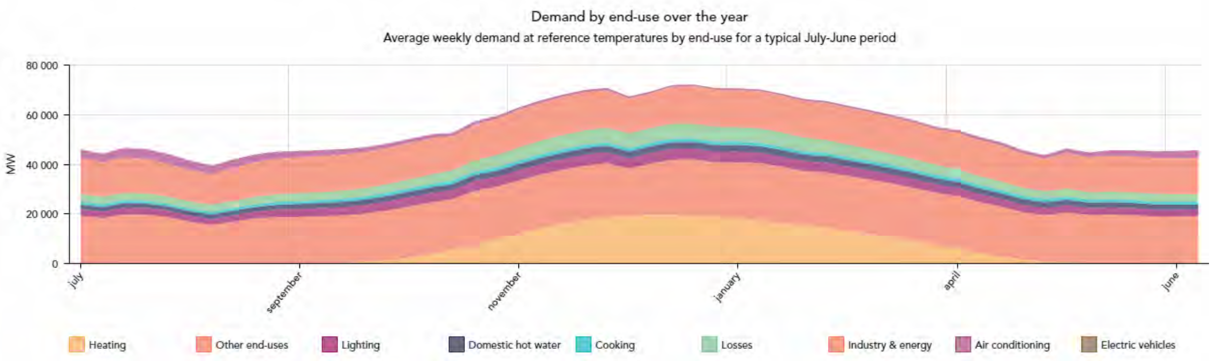


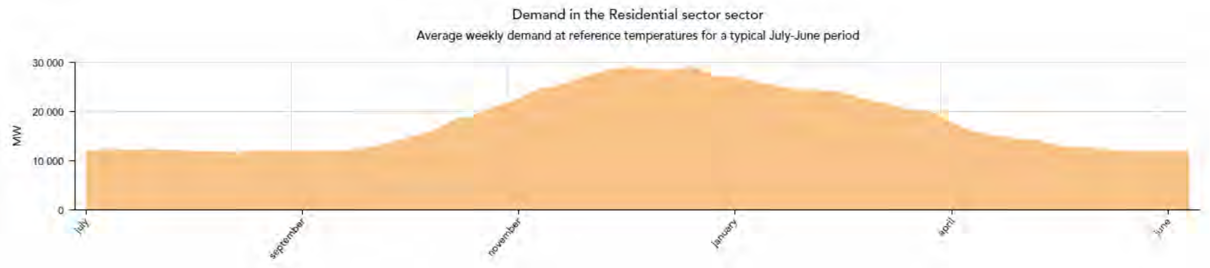
*Note that these charts show power demand at reference temperatures. Actual demand may be much more variable.

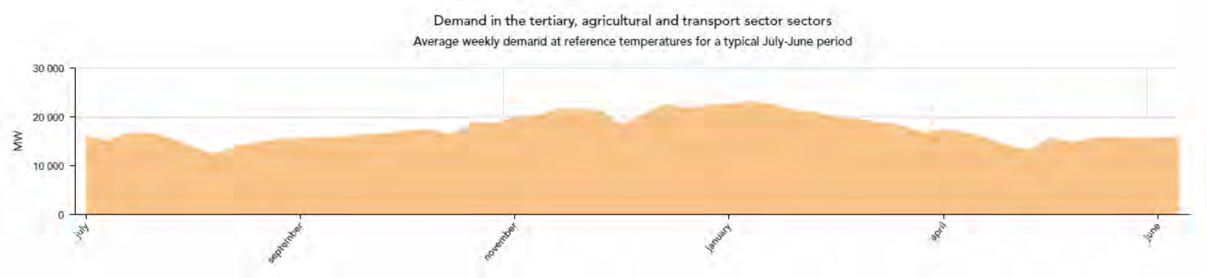
Demand by sector

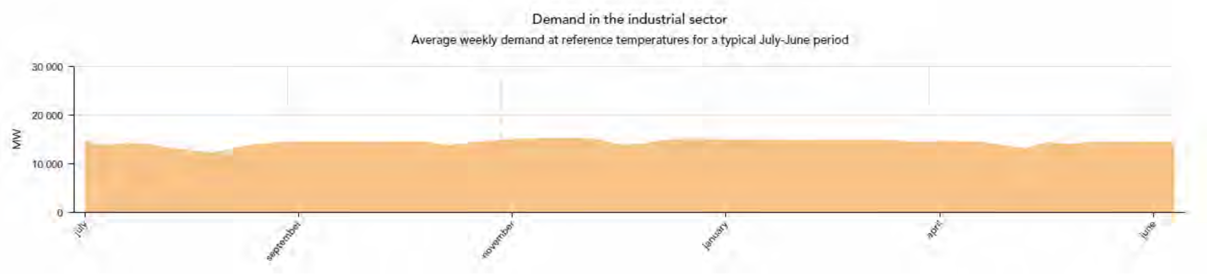
Analysis of the breakdown of demand by sector over one year reveals:

- Significant reliance on electric heating in winter, reflected in power demand in the residential sector and, to a lesser degree, in the tertiary sector;
- A brief dip in demand in the tertiary sector and industry late in December, when economic activity slows due to the year-end holidays. Decreases are also seen in both sectors during school holidays (in August, for example).



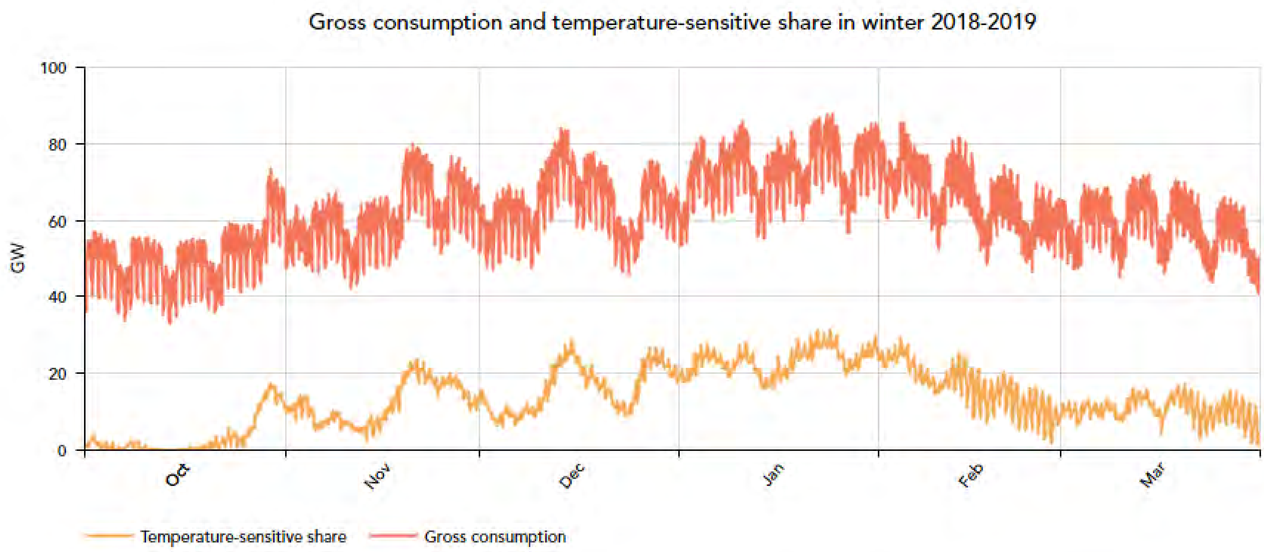



Demand in the tertiary, agricultural and transport sector sectors
Average weekly demand at reference temperatures for a typical July-June period
30 000
20 000
10 000
0
MW
july
september
november
january
april
june


Demand in the industrial sector
Average weekly demand at reference temperatures for a typical July-June period
30 000
20 000
10 000
0
MW
july
september
november
january
april
june

In winter, demand increases by 2,400 MW with each degree Celsius drop in temperatures

Power demand in France is very sensitive to temperatures, particularly in the winter months, due to the widespread use of electric heating.
RTE uses a model that distinguishes between temperature-sensitive and non-temperature-sensitive demand to calculate consumption adjusted for weather. It is the temperature-sensitive share that determines the shape of the overall demand curve.



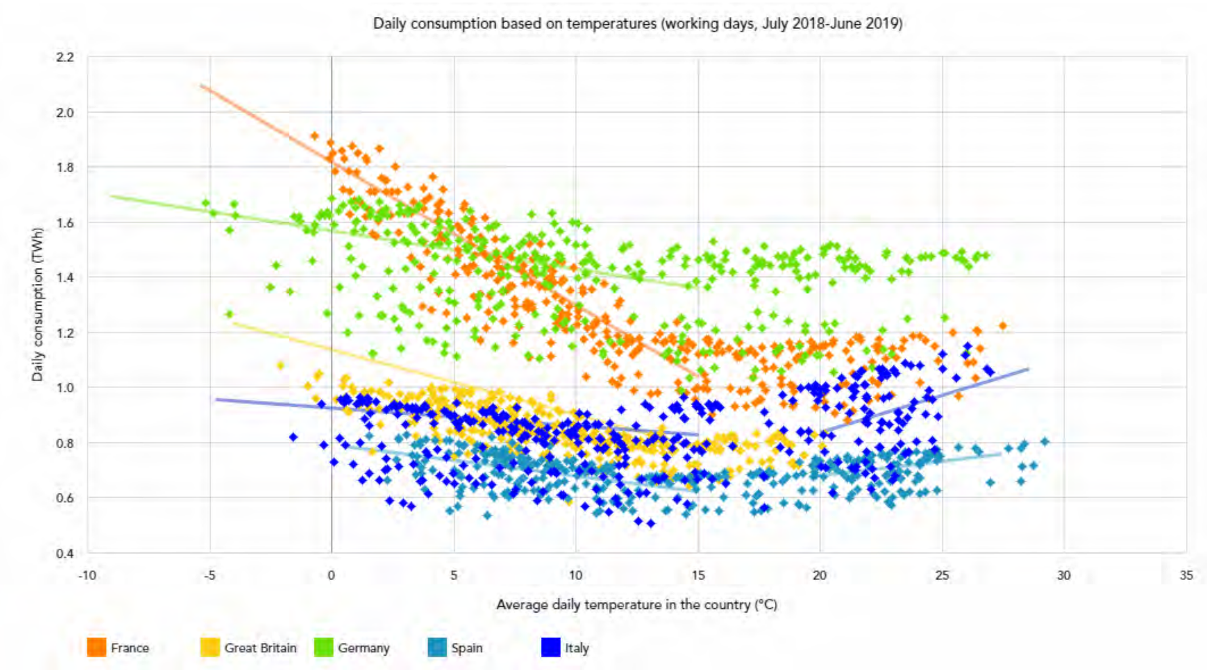
The temperature sensitivity of power demand varies over the course of the day. It is estimated at about 2,400 MW per degree Celsius in winter on average.

Temperature sensitivity varies across Europe

A country's electricity consumption is sensitive to temperatures. Demand increases with colder weather, notably due to the use of electric heating. Known as temperature sensitivity, this phenomenon is observed in all European countries, but it is by far the most pronounced in France.

The chart below helps illustrate the existence of this temperature sensitivity: it traces daily consumption in a given country based on the average temperature in that country. Bank holidays, the year-end holidays and the month of August are not represented since demand is so much lower than normal during these periods.

Below 15°C, consumption begins to increase as the temperature decreases. The curve is three to five times steeper in France than elsewhere. In some countries, temperature sensitivity is observed in summer when temperatures climb above 20°C. Consumption increases with temperatures in Spain, and even more so in Italy, notably due to the use of air conditioning.



Energy efficiency: Households are consuming less energy

Household appliances are increasingly efficient, and this efficiency is helping households save on their energy bills.

It was estimated in 2017 that households consumed an average 2,350 kWh a year for domestic electricity uses. This consumption would be halved if households were equipped exclusively with efficient appliances (A+++).

	Average unit consumption per household	2007 2550 kWh	2012 2500 kWh	2017 2350 kWh	2018 Best Technology
White goods	Refrigerator	380 kWh	330 kWh	270 kWh	130 kWh
	Standalone freezer	440 kWh	390 kWh	340 kWh	140 kWh
	Washing machine	190 kWh	180 kWh	160 kWh	130 kWh
	Clothes dryer	410 kWh	400 kWh	370 kWh	130 kWh
	Dishwasher	250 kWh	230 kWh	200 kWh	140 kWh
ICT	Primary television	220 kWh	230 kWh	200 kWh	70 kWh
	Set-top box/Internet	190 kWh	190 kWh	2200 kWh	110 kWh
Cooking	Electric cooktop	260 kWh	230 kWh	210 kWh	160 kWh
	Oven	160 kWh	150 kWh	150 kWh	100 kWh
Lightning	Lamp	16 kWh	13 kWh	11 kWh	3 kWh

A closer look

Impacts of e-mobility on the power system

The transport sector accounts for nearly 30% of final energy consumption and close to 40% of greenhouse gas emissions. At the local level, it affects the quality of life of those who live in France. With this in mind, public authorities at the national, European and local levels are adopting policies to encourage the development of cleaner transport options. While electric vehicles are not the only way to decarbonise the transport sector, there is no question that e-mobility will take off thanks to the measures adopted by actors across the industry. RTE has consequently been regularly called upon by stakeholders to continue the initiatives announced in the 2017 Generation Adequacy Report. It set up a working group, led jointly with AVERE, that will consult with all interested parties and use the results as the basis for scenarios and analyses looking at all the ways the development of e-mobility will impact the French power system. This working group's report was published on 15 May 2019.

The power system can accommodate the development of e-mobility

• In 2035, e-mobility would account for an estimated 10% of total electricity demand at the most. The generation mix described in the Multiannual Energy Programme is more than sufficient to accommodate this new electricity use. Load scenarios vary greatly depending on assumptions about the degree to which charging will be controlled and other general characteristics: between +8 GW under the worst-case scenario for the power system and -5.2 GW under a very favourable scenario, with the winter peak reaching around 100 GW.

• Long-distance journeys account for a small share of total distance travelled every year, and become a bigger factor at times (summer, weekends) when the power system has abundant surpluses. Vigilance would nonetheless be required if there was a cold spell during the year-end holiday period. In other words, day-to-day travel will be the biggest challenge for the power system, as demand could be concentrated around the 7:00 pm to 9:00 pm peak period if charging is not controlled.

• Though not a technical prerequisite to accommodating e-mobility, smart charging has no downside for the power system. In addition to smoothing charging-related demand, based on the generating mix described in the Multiannual Energy Programme, it would make it possible to adjust demand to a considerable degree on a daily and weekly basis to reflect variations in renewable generation.

Relation between the electricity mix and transport electrification: Significant economic gains

• Generating the power to charge electric vehicles represents a very small percentage of the full cost of mobility and will only make up 5% of the full cost of the power system in 2035. Actual costs will depend on the degree of smart charging.

• Widespread adoption of smart charging leads to collective savings of close to €1 million a year with, in the short term, less curtailment of renewable energy production and less adjustment of nuclear production and, over the medium term, a reduction in the need to develop or maintain peak capacities.

• Based on targets set for the electricity mix, the development of e-mobility will mean:

– Less need to subsidise renewable energy sources,

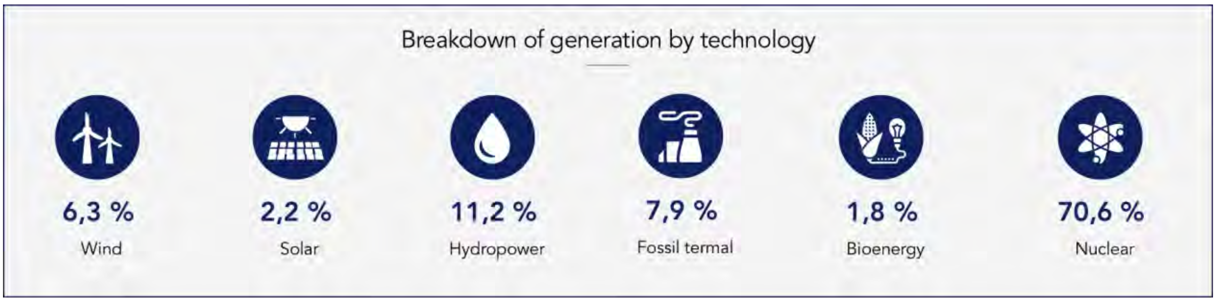
– More electricity price stability and fewer instances of low or negative prices,
– The ability to charge vehicles at times when electricity prices are lowest.

See the Generation Adequacy Report

Detailed consumption forecasts and projected trends linked to end-uses can be found in this year's edition of the RTE Generation Adequacy Report.

Generation

Total generation



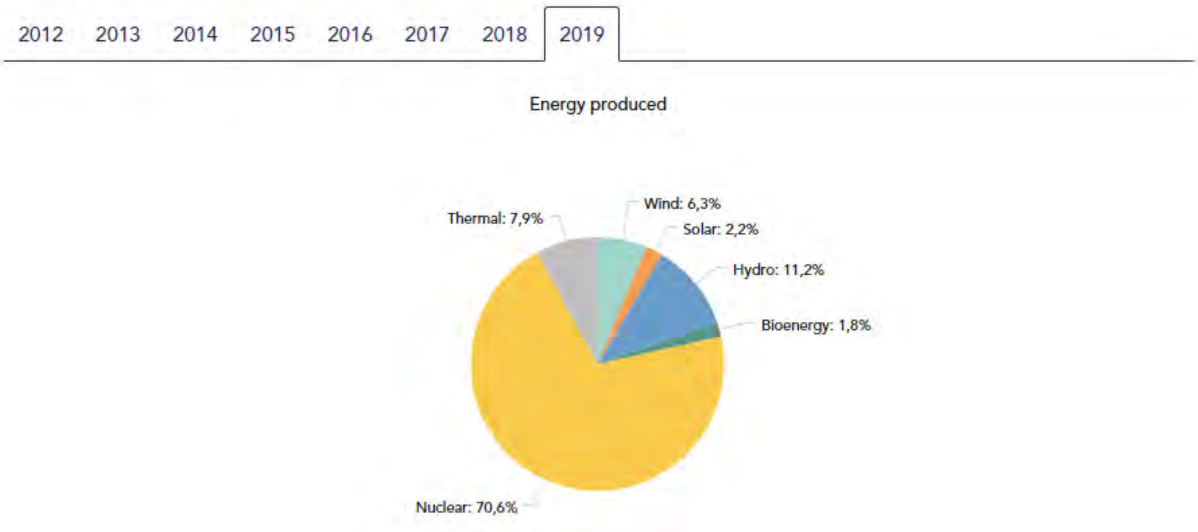
Electricity generation down, decarbonised production up thanks to coal's decline

Total power generation in France reached 537.7 TWh in 2019, which was 2% (11 TWh) lower than in 2018. Renewable energy sources accounted for more than 21% of total electricity production, despite a more than 12% year-on-year decline in hydropower generation. Wind power output increased sharply from 2018 (+21.2%), as did solar power generation, which rose 7.8%.

Because hydropower generation and nuclear generation were lower, fossil-fired thermal generation increased (+9.8%) even as production at coal plants plummeted.

The rise in generation at oil-fired plants, which was significant this year on the distribution grid, was mainly attributable to a sharp drop in hydropower generation in Corsica. In fact, output at the oil-fired plants in Corsica doubled year-on-year, to 1 TWh from 0.5 TWh in 2018.

Energy produced	TWh	2019/2018	Share of generation
Net generation	537,7	-2%	100%
Nuclear	379,5	-3,5%	70,6%
Fossil-fired thermal	42,6	+9,8%	7,9%
of which coal	*1,6*	*-71,9%*	*0,3%*
of which oil	*2,3*	*+26,5%*	*0,4%*
of which gas	*38,6*	*+23,8%*	*7,2%*
Hydropower	60,0	-12,1%	11,2%
*of which renewable**	*55,5*	*-12%*	*10,3%*
Wind	34,1	+21,2%	6,3%
Solar	11,6	+7,8%	2,2%
Bioenergy	**9,9**	**+3,6%**	**1,8%**
of which biogas	*2,6*	*+8,5%*	*0,5%*
of which biomass	*2,7*	*-0,8%*	*0,5%*
of which paper waste	*0,2*	*-9,3%*	*0,0%*
of which non-renewable municipal waste	*2,2*	*+4,8%*	*0,4%*
of which renewable municipal waste	*2,2*	*+4,8%*	*0,4%*



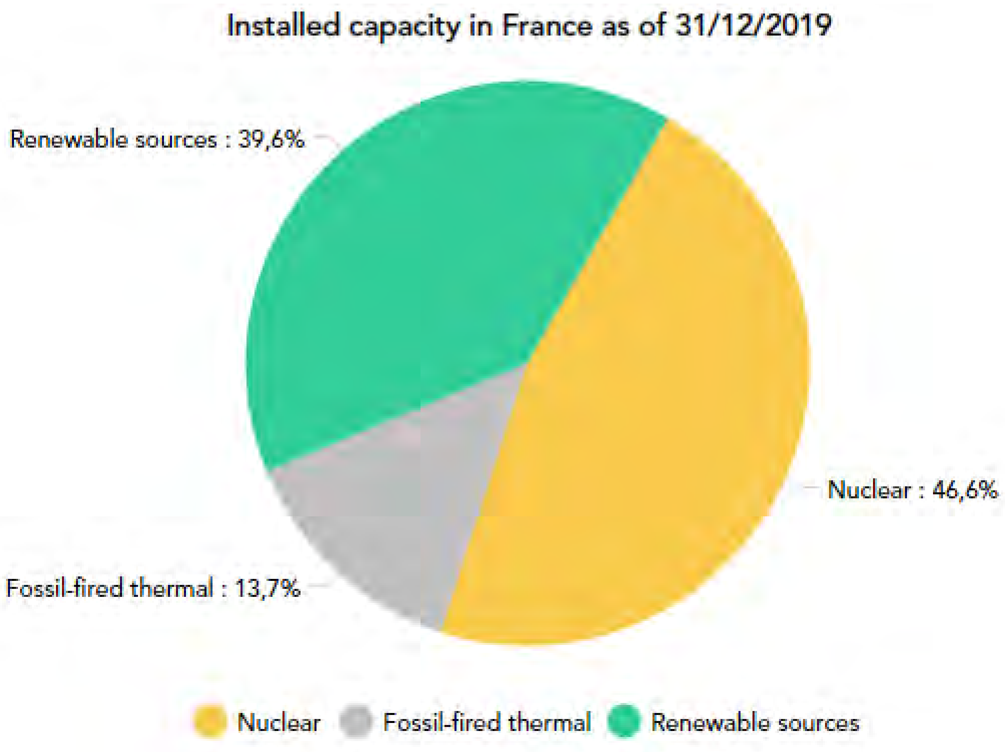
Fossil-fired thermal capacity by technology

Energy produced	TWh	Change 2019/2018	Share of generation
Net fossil-fired thermal generation	42.6	+9.8%	7.9%
Coal	1.6	-71.9%	0.3%
Oil	2.3	+26.5%	0.4%
Combustion turbines	*0.2*	*-17.4%*	*0.04%*
Co-generation	*0.7*	*-14.6%*	*0.1%*
Other*	*1.4*	*+47.6%*	*0.3%*
Gas	38.6	+23.8%	7.2%
Combustion turbines	*0.1*	*+53%*	*0.02%*
Combined-cycle gas	*23.6*	*+35.2%*	*4.4%*
Co-generation	*12.1*	*+5.2%*	*2.3%*
Other*	*2.8*	*+29.2%*	*0.5%*

Installed capacity: Renewable energy sources continued to gain ground

Generation capacity in mainland France ended the year at 135.3 GW, up 2.3 GW (+1.7%) from the end of 2018. Wind and solar power accounted for the lion's share of this increase, in keeping with the objectives of the Multiannual Energy Programme.

Installed capacity at 31/12/2019	Capacity in MW	Change relative to 31/12/2018	Change in MW	Share of capacity
Nuclear	63,130	0%	0	46.6%
Fossil-fired thermal	18,589	-0.3%	-51.8	13.7%
of which coal	*2,997*	*0%*	*0*	*2.2%*
of which oil	*3,401*	*-2.8%*	*-96.6*	*2.5%*
of which gas	*12,191*	*+0.4%*	*+44.8*	*9.0%*
Hydropower	25,557	+0.1%	+21	18.9%
Wind	16,494	+9%	+1,360	12.2%
Solar	9,435	+10.4%	+890	7%
Bioenergy	2,122	+3.7%	+75	1.6%
of which biogas	*499*	*+8.4%*	*+38.6*	*0.4%*
of which biomass	*674*	*+3.5%*	*+22.8*	*0.5%*
of which paper waste	*51*	*-10.6%*	*-6*	*0.04%*
of which municipal waste	*897*	*+2.2%*	*+19.5*	*0.7%*
Total	135,328	+1.7%	+2,295	100%

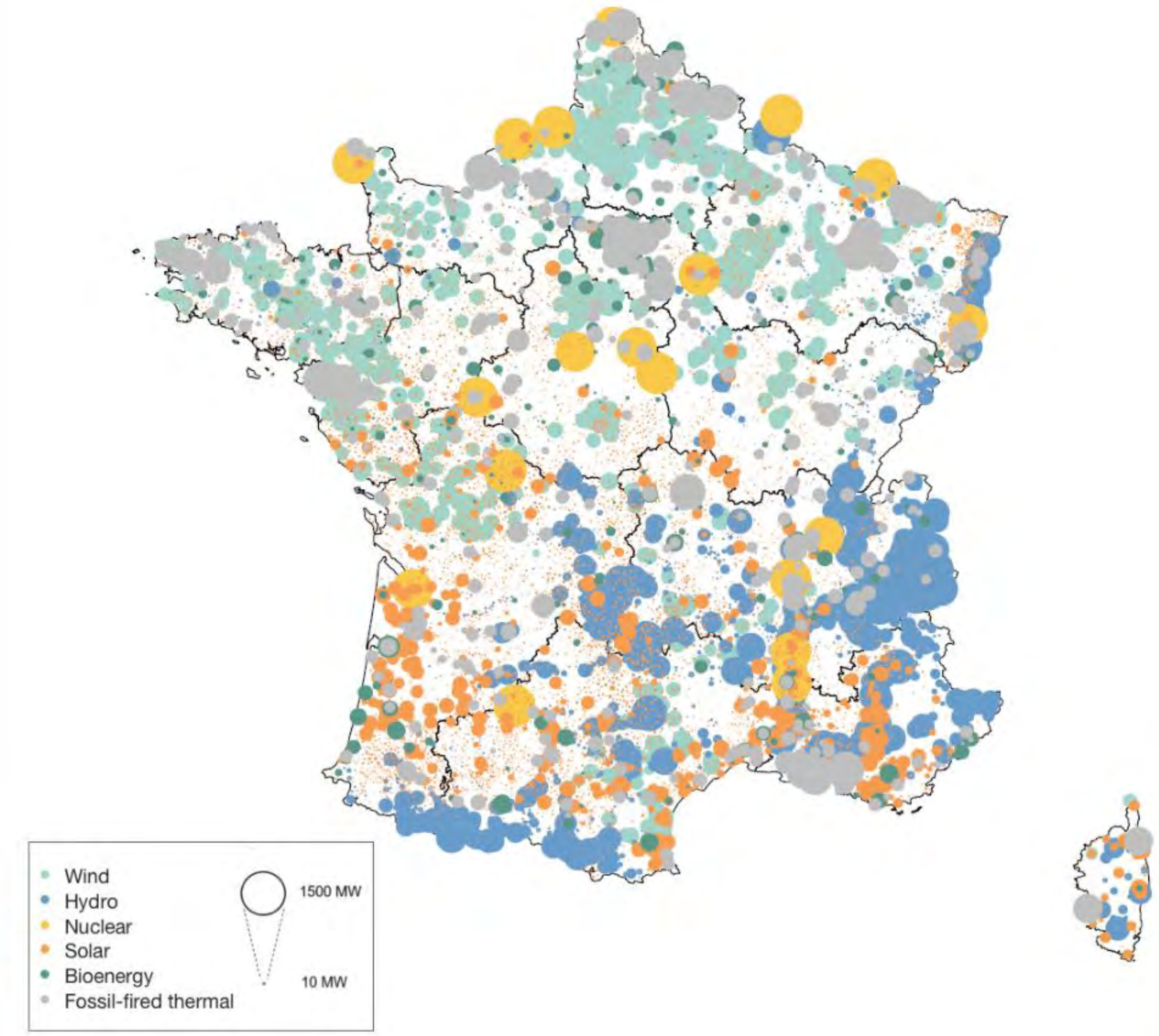


Fossil-fired thermal capacity by technology

Installed capacity at 31/12/2019	Power MW	Change relative to 30/12/2018	Change in MW	Share of capacity
Coal	2,997	0%	0	2.2%
Oil	3,401	-2.8%	-97	2.5%
Combustion turbines	*1,402*	*0%*	*0*	*1%*
Co-generation	*492*	*0%*	*0*	*0.4%*
Other*	*1,507*	*-6.0%*	*-97*	*1.1%*
Gas	12,191	+0.4%	+45	9.0%
Combustion turbines	*703*	*0%*	*0*	*0.5%*
Combined-cycle gas	*6,258*	*0%*	*0*	*4.6%*
Co-generation	*4,903*	*+0.9%*	45	*3.6%*
Other*	*327*	*+0.1%*	+0.2	*0.2%*
Total	18,589	-0.3%	-51	13.7%

Map of generation capacity in France

Capacity and location



For a better understanding

Energy and power

Understanding the difference between power and energy

Power (measured in watts, symbol W) represents a generation resource's ability to deliver a quantity of energy per unit of time. A watt-hour (Wh) quantifies the energy delivered: 1 Wh is the energy produced by a 1 W generation facility over a one-hour period (1 W × 1h).
In addition to kilowatt-hours (kWh = 10^3 Wh), larger multiples of watt-hours are often used to describe electricity generation: megawatt-hours (MWh = 10^6 Wh), gigawatt-hours (GWh = 10^9 Wh) and terawatt-hours (TWh = 10^{12} Wh). The energy consumed in one hour corresponds to power delivered to meet demand during that hour.

A closer look

View the national registry of power generation and storage facilities

Since 2017, RTE has been listing the main characteristics of French power generation and storage facilities on OpenData Réseaux Energie, which is updated every month. Information provided includes the location of facilities, the type of technology and fuel used, capacity and annual output.

The data comes from all system operators in mainland France and the overseas territories. It can be found here.

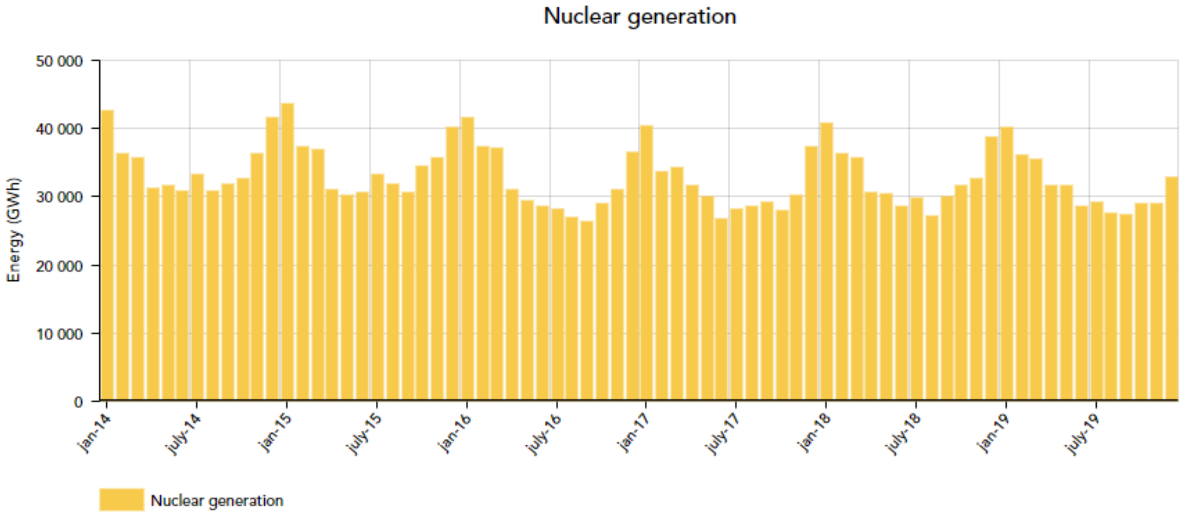
Nuclear generation

- 3,5 %

Nuclear generation

Nuclear generation down slightly

Installed nuclear capacity ended the year unchanged at 63.1 GW, which represents about 47% of total French capacity (135.3 GW). Output from nuclear plants contracted by 3.5% (13.7 TWh) and accounted for 70.6% of total power production in France, the lowest level since 1989. This decrease in output was attributable chiefly to lower nuclear plant availability.



Map of nuclear power plants in France

Nuclear plant unavailability increased

Average nuclear power plant unavailability rose slightly in 2019, to **17.7 GW** compared with **16.3 GW** in **2018.**

A closer look

Nuclear plant unavailability in 2019

Nuclear power accounts for a large share of electricity generation in France (more than 70% of the total in 2019). Specific factors must therefore be taken into account in operating the power system, including a real dependence on the performances of the nuclear fleet. Not counting unavailability for technical or regulatory reasons, France’s nuclear power plants generate “base-load” electricity, meaning they run year-round and produce a fairly stable quantity of electricity.

Since 2015, the EU transparency regulation has required that operators of any type of generating unit report the unavailability of 100 MW or more, once it is known or scheduled, up to three years ahead of time.

French nuclear power plants are designed to remain in service for at least 40 years. Maintenance is scheduled over this period with stoppages of reactors at regular intervals. Two types of unavailability must be reported to the EU transparency platform.

Planned

Approximately every 12 or 18 months, depending on the technical series, each reactor is shut down for around a month to replace the fuel in the core, or for several months to replace all the fuel and conduct heavier maintenance. And every ten years, reactors undergo detailed and in-depth ten-year inspections, notably to inspect key components (reactor vessel, primary circuit, steam generators, containment building, etc.).

Operators do their best to schedule these shutdowns outside the winter months, but given the size of the fleet and the heavy constraints that exist (notably regulatory and industrial), outages must be spread out over time with some occurring in winter.

Unavailability forecasts may be adjusted, usually extended, due to complications or events that arise during the outage. Another type of planned unavailability occurs when maximum power available is lowered temporarily (typically after a long outage when the ramp-up takes several days).

Unplanned

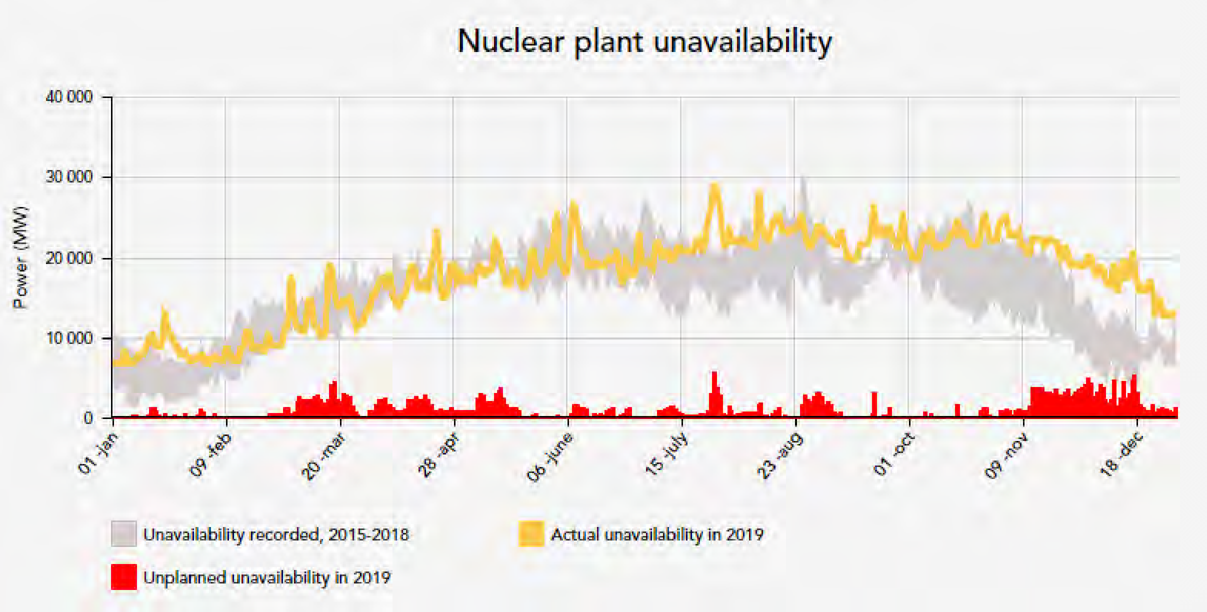
Unplanned unavailability usually occurs following a technical failure or due to regulatory constraints that force the reactor to reduce power or even shut down.

In such instances, the supply-demand balance (mainly in winter) may be affected by the nuclear plant maintenance schedule set by the operator, but more often it will be by unplanned outages resulting from the extension of planned outages, specific weather or environmental conditions, social movements, or decisions taken by the Nuclear Safety Authority (*Autorité de Sureté nucléaire* – ASN).

Nuclear power plant unavailability increased in 2019

In 2019, the average availability of the nuclear fleet decreased slightly to **45.4 GW** from **46.8 GW** in 2018.

The grey on the graph below shows unavailability between 2015 and 2018. The yellow corresponds to actual unavailability in 2019 that was planned and the red to unplanned unavailability, also in 2019.



Most of the unavailability reported corresponded to planned outages. It is naturally higher during the months when weather is mildest, this to ensure higher availability in winter, when demand for electricity increases.

Highlights of 2019 included:

18 to 21 January:

A number of technical difficulties affected the nuclear fleet in the second half of January, driving availability down well below historical averages. This put the system on high alert, notably regarding supply to the Grand Ouest region in France.

24 and 25 July:

On 24 and 25 July, during the second heatwave period in France, six nuclear power plants lowered their power to comply with environmental restrictions (Saint-Alban, Bugey, Dampierre, Golfech, Tricastin and Blayais).
The first round of feedback on periods of heatwaves allowed RTE to show that output declines at all types of generation plants (nuclear, hydropower, wind, solar, gas) during heatwaves. This is the case for nuclear power plants, as the operator may be required,

for environmental reasons, to stop or reduce production at certain sites to prevent excessively high water temperatures in rivers. When a nuclear plant is next to a river, it draws water to cool the steam in the secondary loop that drives the turbines, and then releases it back into the river (unless the plant has a cooling tower). The water discharged must be below a certain temperature to avoid altering the ecological balance of the river. Water intake may also be constrained by minimum flows. In sum, nuclear power plants have a set of limitations that reflect their specific geographic, technical and environmental characteristics.
It should be noted that in 2018, four reactors on the Rhône river had to be shut down for short periods.

11 November:

A 5.4-magnitude earthquake was recorded in the Ardèche region, near the city of Teil. In the wake of that event, the Cruas nuclear power plant stopped production at reactors 2, 3 and 4 for inspections. This outage reduced available capacity by 2,700 MW. Operators will typically stop reactors when an earthquake of this magnitude occurs to determine whether the event had any impact on the equipment.

Month of December:

Unavailability increased in December 2019, and was on average 6 GW higher than the average for the past four years.

Though three generating units at Cruas were brought back online in the second week of December, several sites were affected by strikes and technical difficulties.

At many facilities, resumption of production was pushed back to 2020, later than the initially planned date.

As was reported in additional analyses conducted and published following RTE’s 2018 Generation Adequacy Report and forecasts for the winter of 2019, the risk of voltage collapse in the North-Western quarter of France does exist. In the absence of sufficient local generation capacity, the routing of electricity over long distances causes voltage to decrease, at times steeply if consumption in the region is high.
RTE remains particularly vigilant with regard to the availability of all generation capacity during the 2019 winter to limit the risk of voltage collapse, especially with the delayed restart of the Flamanville reactors.

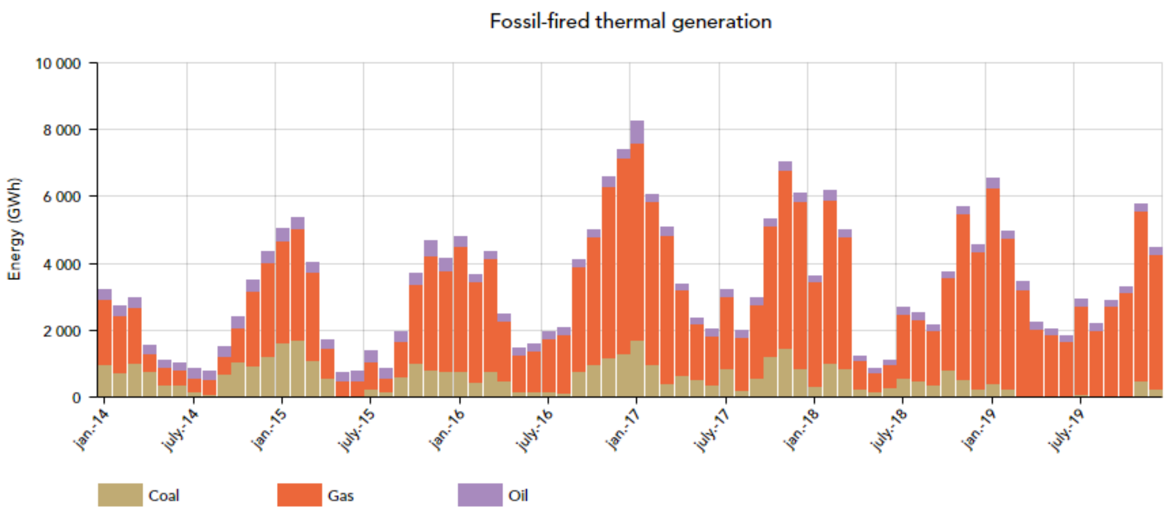
Fossil-fired thermal generation

- 72 %

Coal plant output

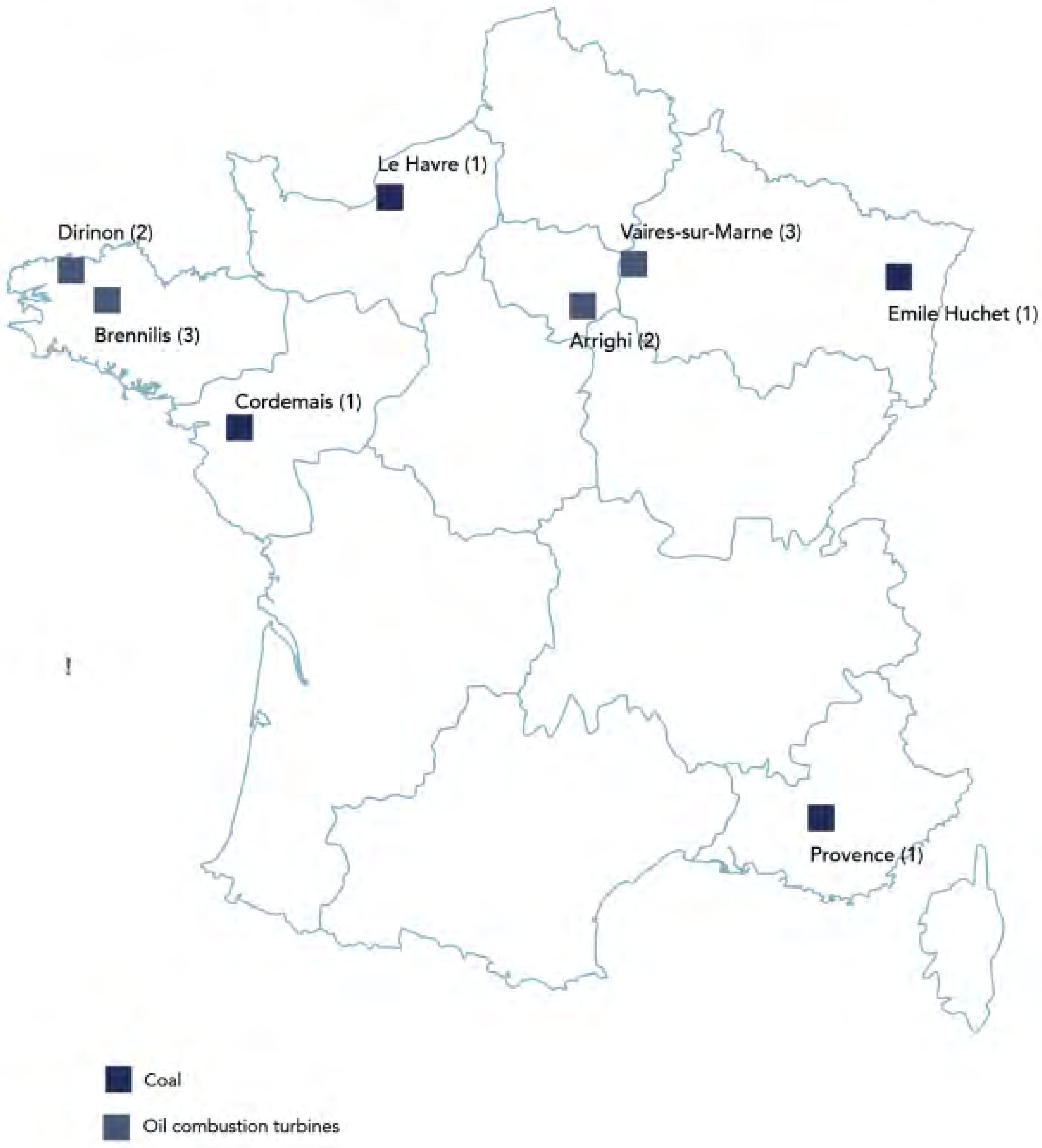
Increase in fossil-fired thermal generation

Subsequent to declines in hydropower and nuclear generation in 2019, fossil-fired thermal power plants were run more often, and output increased by 9.8% year-on-year. Production at gas-fired thermal power plants surged (+23.8%) and accounted for the lion’s share of the increase, while coal-fired generation plummeted (-71.9%). Oil-fired generation rose (+26.5%) chiefly at facilities connected to the distribution grids, notably in Corsica, where hydropower generation decreased sharply due to low water reserves.

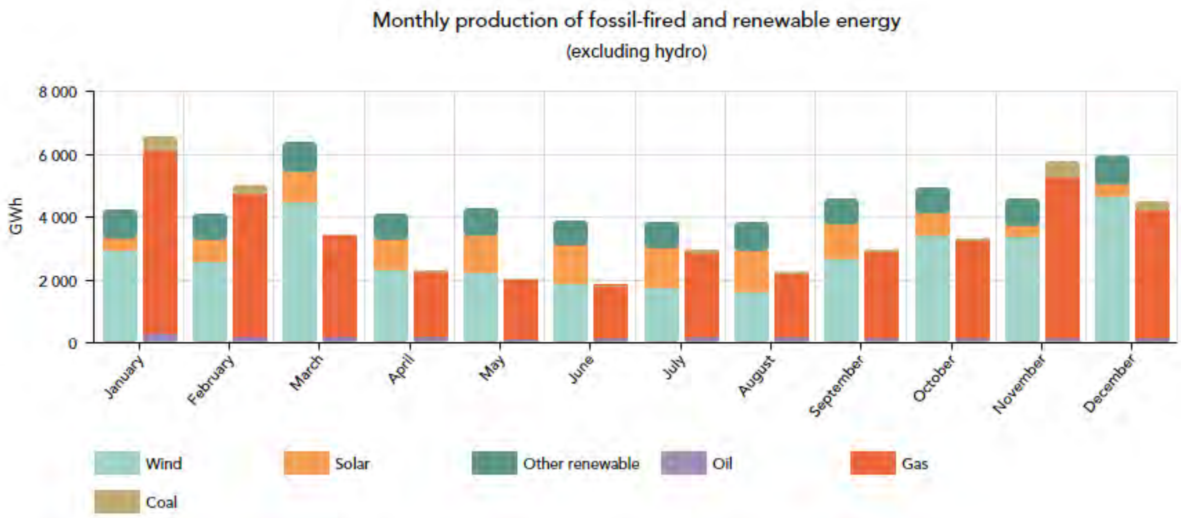


Map of fossil-fired power plants in France

Coal- and oil-fired plants (combustion turbines)



Fossil-fired and renewable generation in 2019



Fossil-fired thermal generation was highest in January, February and November. These plants were fired up less often in December, notably because wind power output was high (more than 4.7 TWh).

Gas-fired plants accounted for the majority of fossil fuel thermal generation, producing more than 5.8 TWh in January, 4.5 TWh in February and 5.1 TWh in November. Output from fossil-fired plants was also significant during the summer peak in July.

Coal generation was much lower than in 2018, and concentrated in January (426 GWh), November (474 GWh) and December (253 GWh). There was a direct correlation between this decline and the sharp drop in the gas price over the year, which favoured gas-fired plants, and a rise in the price of EU emissions allowances.

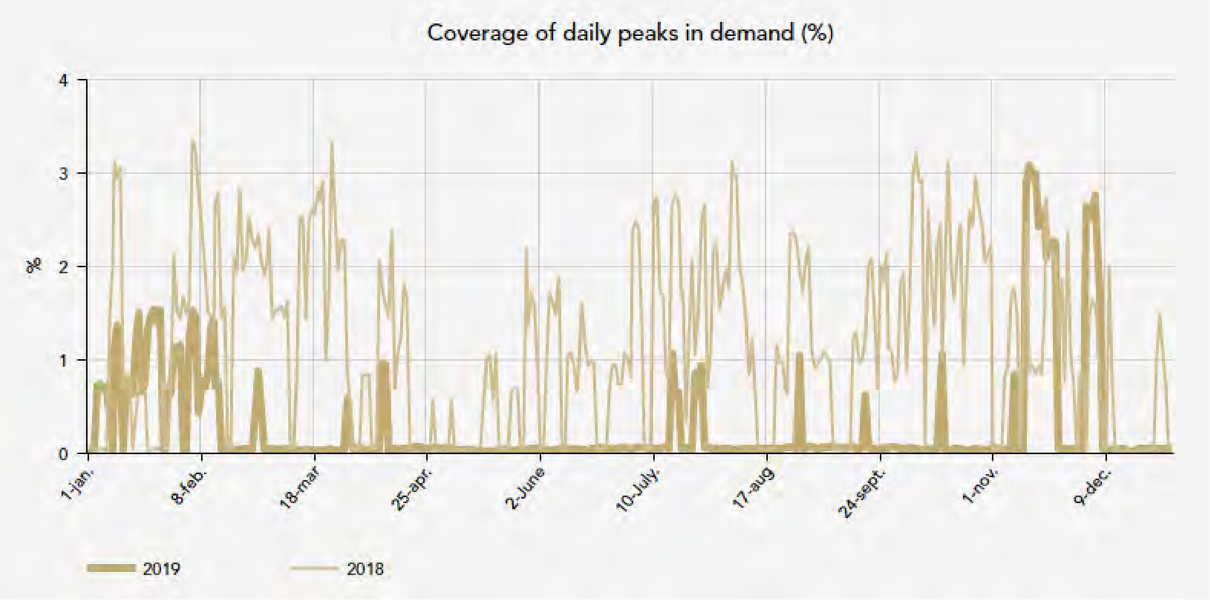
A closer look

Coal-fired power plants in 2019

In 2017, the French government announced that it would shut down the country's last coal-fired plants by 2022. Article 3 of the energy-climate law introduced a mechanism that caps emissions and thus the amount of time coal-fired plants can operate in mainland France after 1st January 2022. This was one of the targets set out in the Multiannual Energy Programme unveiled early in 2019.
The four coal-fired plants in question, the ones still in service in France, are the Cordemais, Le Havre, Saint-Avold and Gardanne facilities.
They represent installed capacity (five generating units) of 3 GW, or about 2.2% of total installed capacity in France.

The hours of operation of coal-fired plants decreased sharply in 2019. Output fell to 1.6 TWh, about 3.5 times below the 2018 level, and capacity availability decreased from an average 1,815 MW in 2018 to 1,674 MW in 2019. This decline was primarily a reflection of a contraction in the economic space for the technology (see below) and, to a lesser degree, of strikes that affected production at the different coal plants in France.

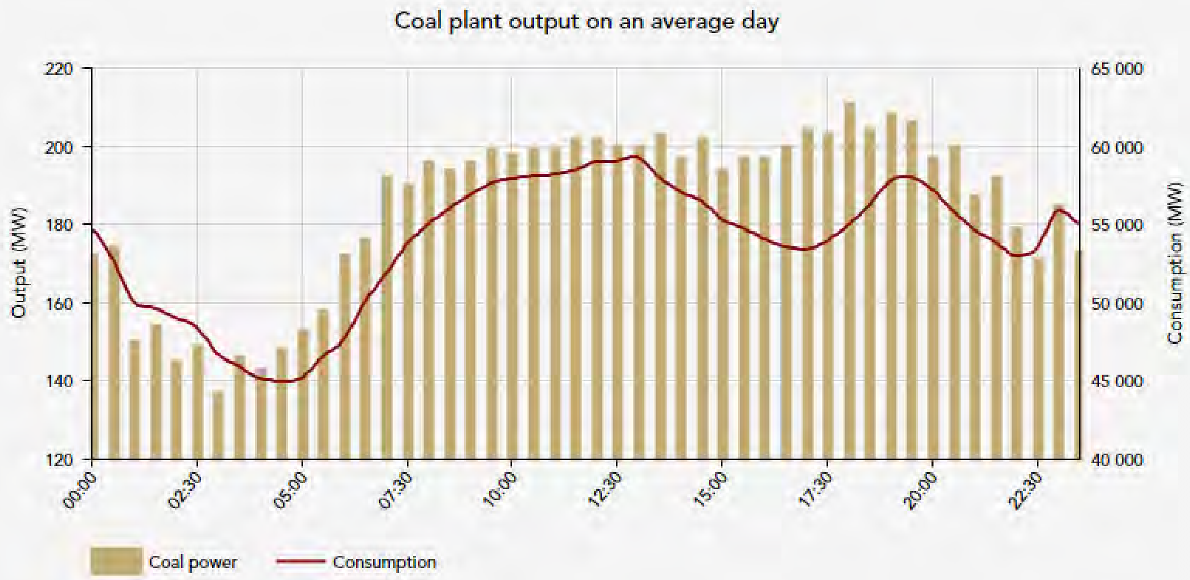
Output from coal-fired plants:



From February on, coal plants were fired up much more infrequently, though production resumed temporarily during heatwave periods in the second half of July, partly to make up for a drop in nuclear generation linked to maintenance schedules and environmental restrictions that kicked in due to high temperatures and drought conditions. The coal plants were once again fired up in late November and early December, in response to a rise in demand and a nuclear plant availability rate that remained low at the beginning of winter, notably when the reactors at Cruas were unexpectedly unavailable.

Coverage of demand during peak periods declined sharply between 2018 and 2019. Coal plants contributed much less to meeting peak needs during the year, with an average coverage rate of 0.20% in 2019 compared with 1.18% in 2018.

On a typical day in 2019, coal plant output reached an average low of 137 MW at 3:00 am and a high of 211 MW at 6:00 pm, when demand increases around the evening peak. Generally speaking, the plants do not totally stop production when demand slumps, in order to be available for the morning ramp and the evening peak.



Operations:

Producers of electricity strive to cover their fixed and variable costs. Consequently, a coal plant is typically not run unless it can at least cover its variable costs, which depend mainly on how much it pays for fuel and emissions allowances. Under current market conditions, the variable costs of a coal power producer in France seem high in terms of the European economic dispatch order (base-load, then semi-base load then peak). Coal plants are semi-base load resources designed to operate for a fairly long period in order to cover their relatively high fixed costs. As the carbon price increases, they gradually become the most expensive semi-base load plants to operate within the merit order. The shorter the amount of time they operate, the more difficult it becomes for them to cover their fixed costs.

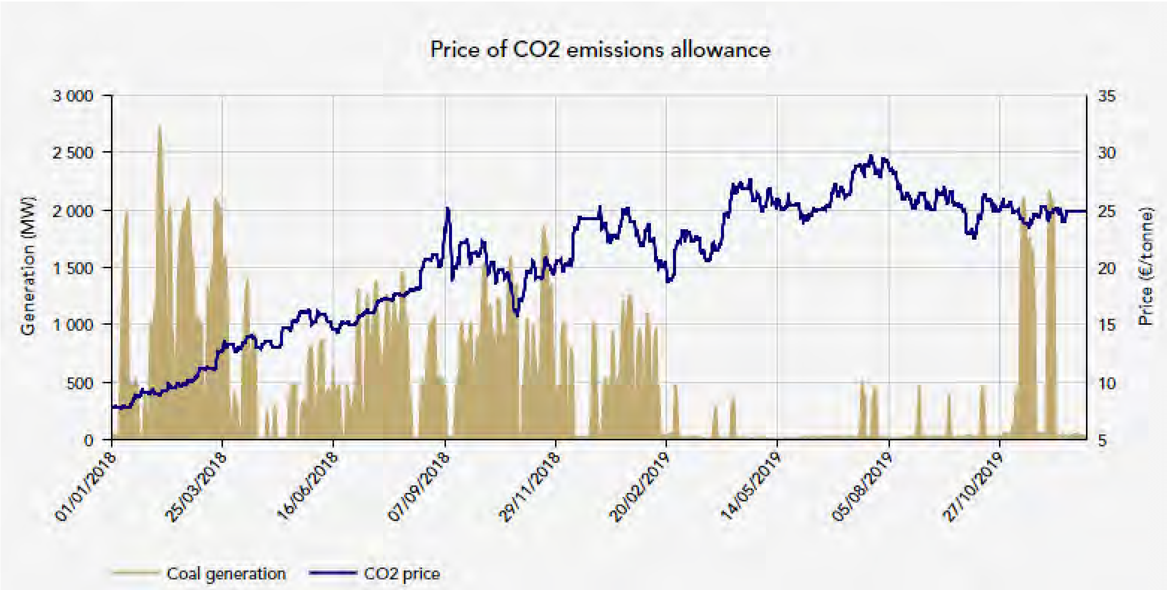
Influencing factors

Various technical and economic factors determine when coal plants are used: the coal price, the price of carbon emissions credits, and the euro/dollar exchange rate.

- **Price of emissions allowances up sharply**

Generators that produce CO_2, are required to purchase permits to offset those emissions. Because coal gives off large quantities of CO_2, the price of permits is a key determinant in the operation of a coal plant. In July 2019, the price of an emissions allowance reached a record high of €29.8 per tonne. If a generator fails to cover its production, each tonne of CO_2 emitted but not covered by equivalent allowances costs, in addition to the coverage requirement, a penalty of at least €100 per tonne. The steady increase in the carbon price in 2018 and 2019 has caused a dramatic surge in the variable costs of coal plants.

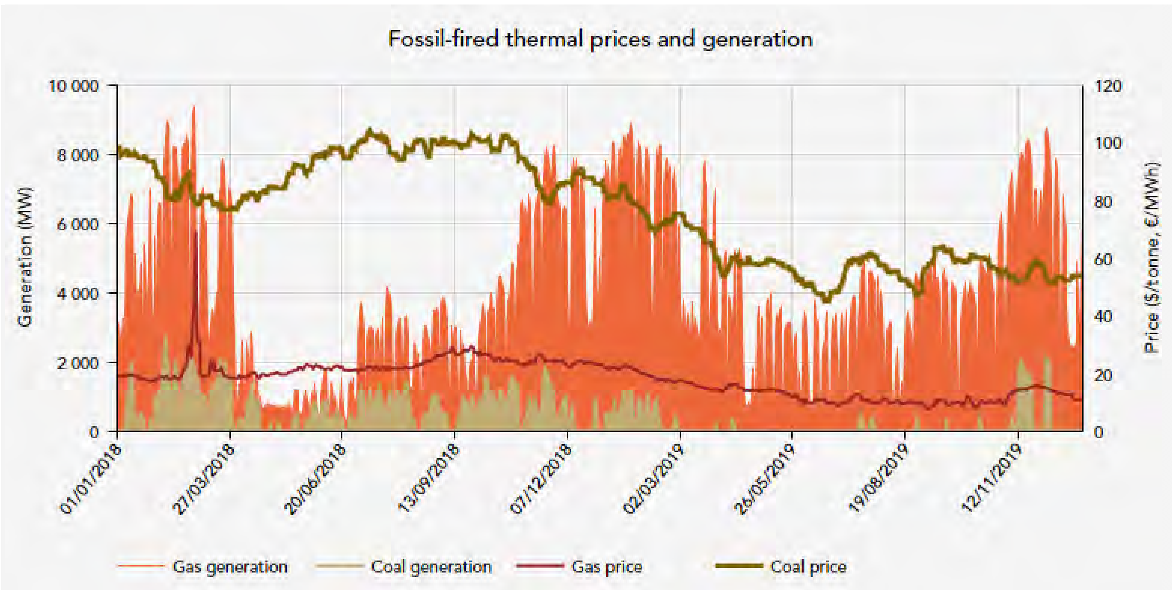
Platts data



- **Gas price down sharply**

The CO_2 emission factor is almost twice as high for coal as for gas plants (0.986 t/MWh for coal units vs. between 0.352 t/MWh and 0.583 t/MWh for various gas-fired generation technologies, according to Ademe data). Though the coal price did decline in 2019, the gas price fell even more sharply, making gas more competitive than coal for an equivalent level of service in terms of generating flexibility. Electricity production from natural gas thus increased by more than 22% relative to 2018.

Platts data



- **€/$ exchange rate**

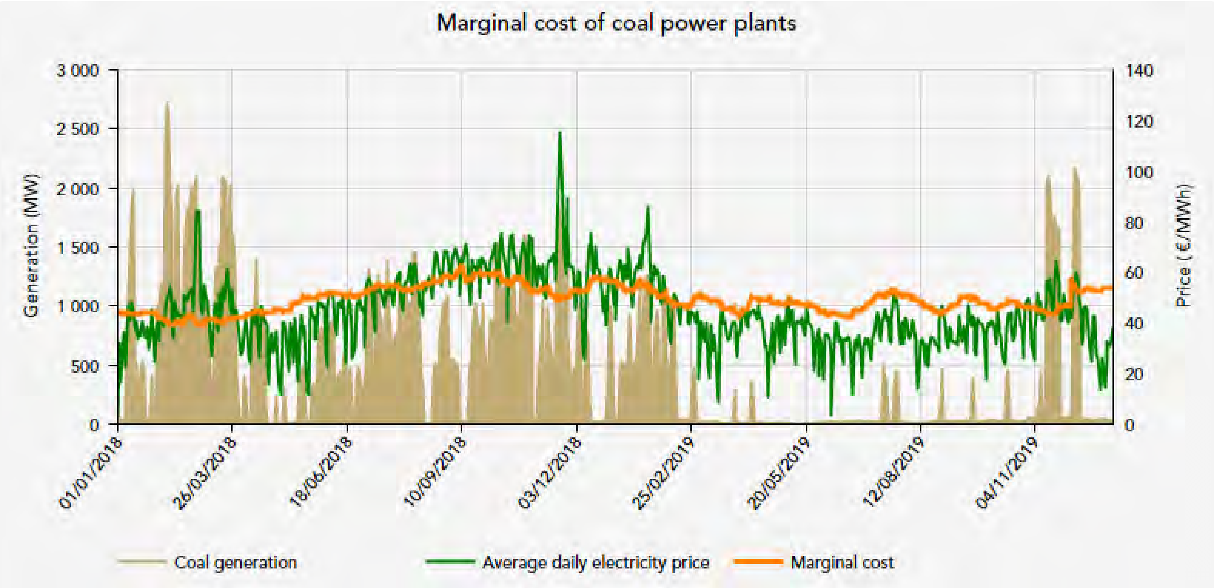
The €/$ exchange is another economic factor that determines whether coal plants run. Coal is purchased in dollars but electricity is sold in euros. The ratio has been trending lower since the second half of 2018, making coal even less competitive relative to other generation resources.

Marginal costs of coal plants

In theory, prices on the day-ahead market are set for a given time of day, based on the variable cost of the marginal technology (i.e. the one supplying the last MW).

Every time the average marginal cost is below or close to the day-ahead price, it corresponds to when coal power plants are operating. This is when producers can generate a profit on electricity sales.

The chart below shows the average marginal cost of coal power plants in France:



Coal power plants in 2019

After the government announced that the last five coal-fired plants would be shut down by 2022, RTE, through its Generation Adequacy Report, set out the conditions that would have to be met to maintain the same level of security of supply in France.
The coal power plants at Le **Havre** and **Cordemais** are currently being operated by the incumbent utility, **EDF**.
EDF has indicated that it will close the Le Havre plant on 1st April 2021. It added that Cordemais could be operated at 10% of the current level (between 200 and 500 hours a year) between 2022 and 2024, and possibly until 2026, but not beyond that year. EDF intends to gradually convert it to a coal and biomass facility.
In July 2019, Uniper sold the **Saint-Avold** and **Gardanne** plants to **EPH**.

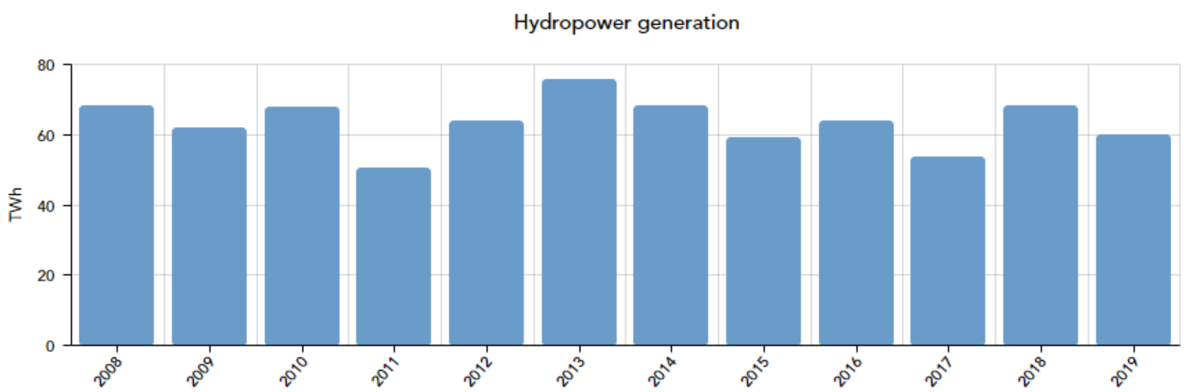
Hydropower generation

- 12,1 %

Hydropower output

Sharp decrease in hydropower generation

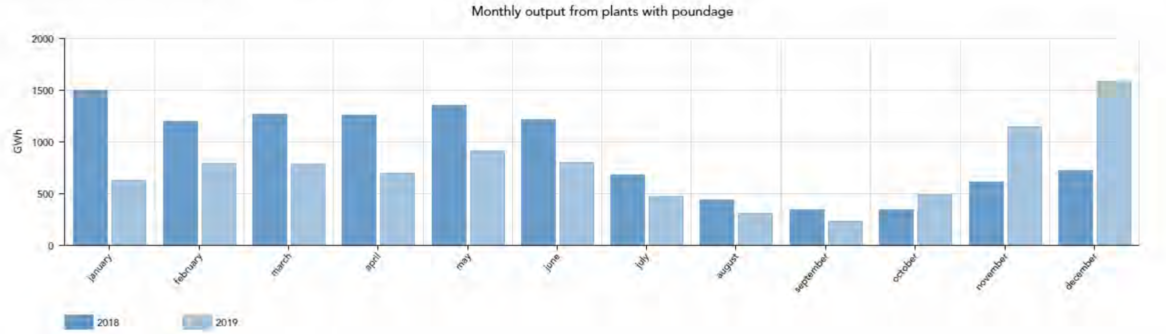
Hydropower generation was lower than in 2018, when weather conditions had been particularly favourable for this technology. The year-on-year decrease in hydropower generation between 2018 and 2019 was 12.1%.



Hydropower generation by type of plant

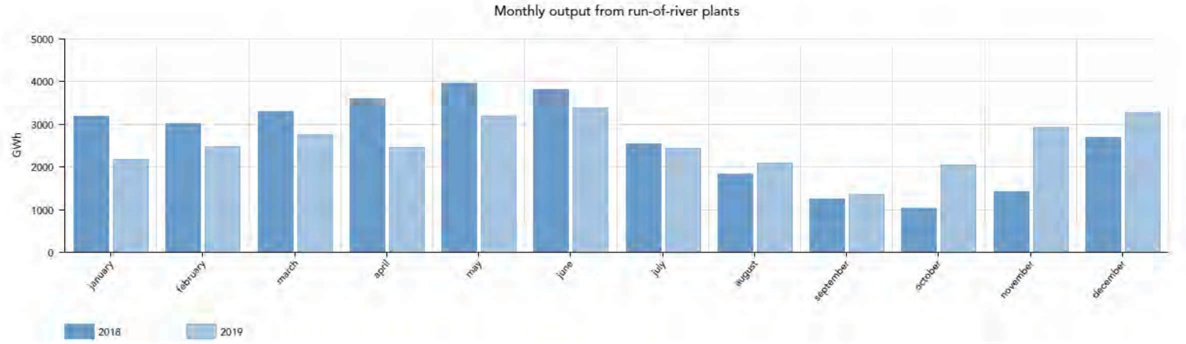
Poundage | Run-of-river | Reservoir | Other

The reservoirs of plants with poundage, usually located in lakes below midsized mountains, can be filled in 2 to 400 hours. They are used for daily, and even weekly modulation (daily peaks in demand, between business and nonworking days, etc.).



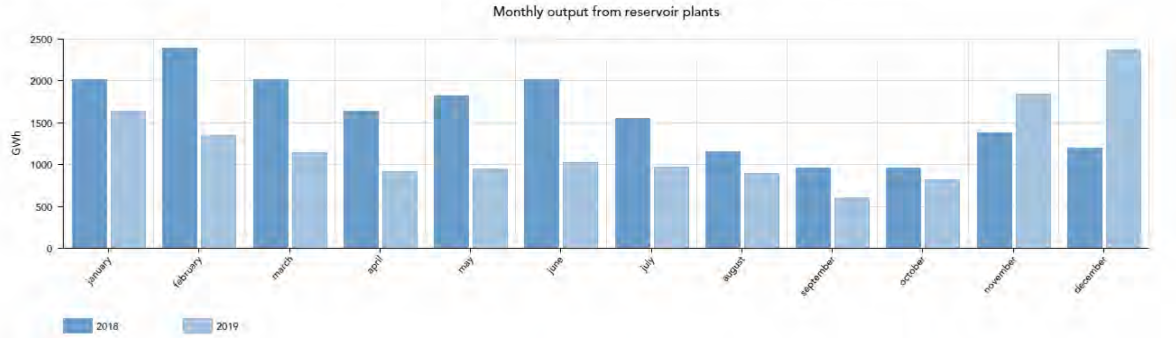
Poundage | Run-of-river | Reservoir | Other

Run-of-river plants are primarily located on plains and have small reservoirs that can be filled in less than two hours. They thus have little capacity for modulation through storage, and their production depends on water flows.



Poundage | Run-of-river | Reservoir | Other

Reservoir plants are built at the foot of midsized and tall mountains and have a filling period of more than 400 hours. They are used for seasonal storage.

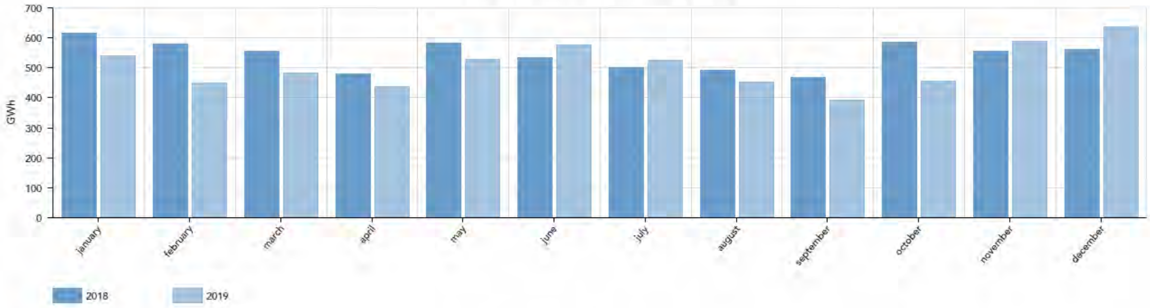


Poundage | Run-of-river | Reservoir | Other

"Other" hydropower plants are tidal and pumped storage plants (*Station de Transfert d'Energie par Pompage* – STEP). Tidal power plants harness energy from tides in coastal areas with strong tidal currents (difference in water levels between successive high and low tides). These plants harness tidal ranges to produce electricity, making use of the difference in heights between two basins separated by a dam.

STEP plants operate in pumping-turbining cycles between a lower and an upper reservoir, using reversible pump-turbines. They are an efficient storage tool and help ensure the balance of the power system. If the reservoirs have natural inflows, the turbines fall into the "mixed pumped storage" category. Otherwise they are considered "pure pumped storage".

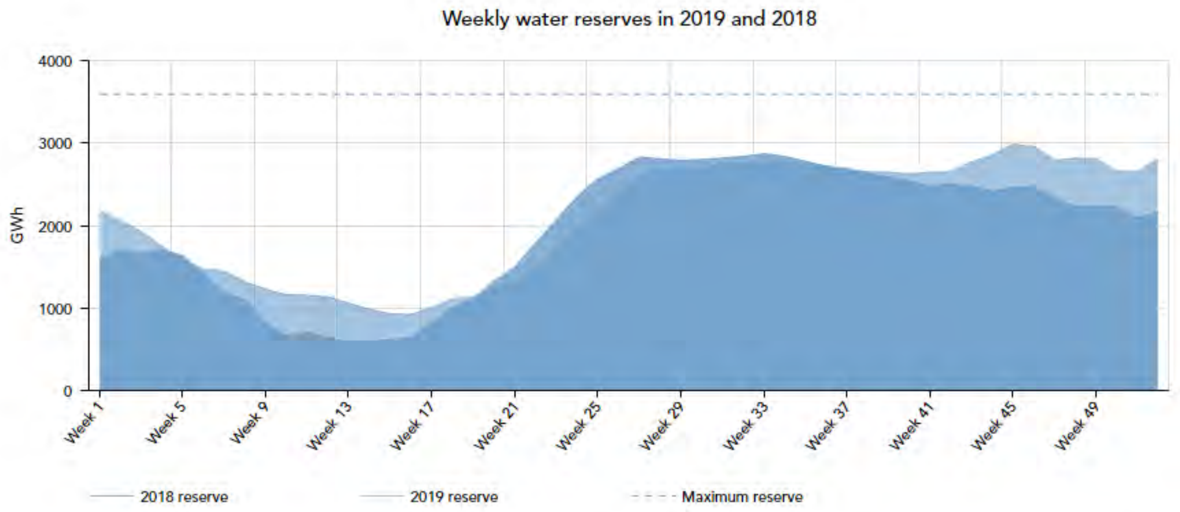
Monthly output from "other" hydro plants



Water reserves

Water reserves (hydraulic stock) are associated with reservoir-type hydropower plants that take a long time to fill and are managed seasonally. Reserves decline in winter, when these plants run often, and are then restored in spring, when the snow is melting.

Rainfall conditions were good in 2018, so water reserves were high at the start of January 2019. Reserves were close to the 2018 level early in February, but subsequently remained higher than a year earlier as reservoir plants are not heavily used until the spring. It took longer to restore reserves than in 2018, but they exceeded the year-earlier level by September and were 30% higher at the end of the year, when precipitation is significant.



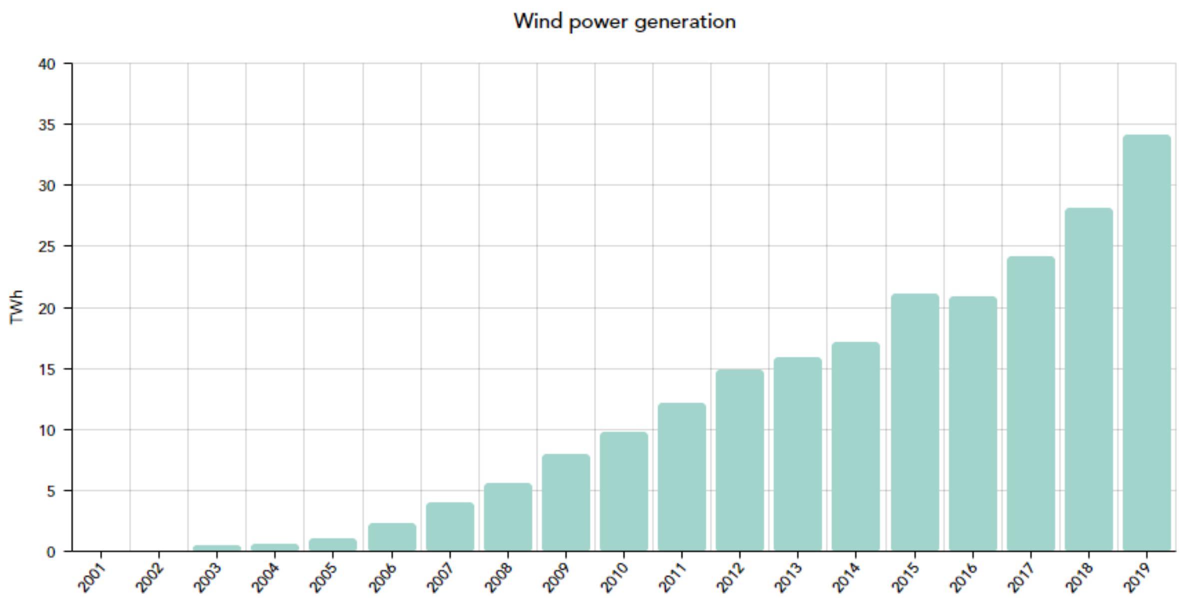
Wind power

+ 1,360 MW

Increase in installed capacity

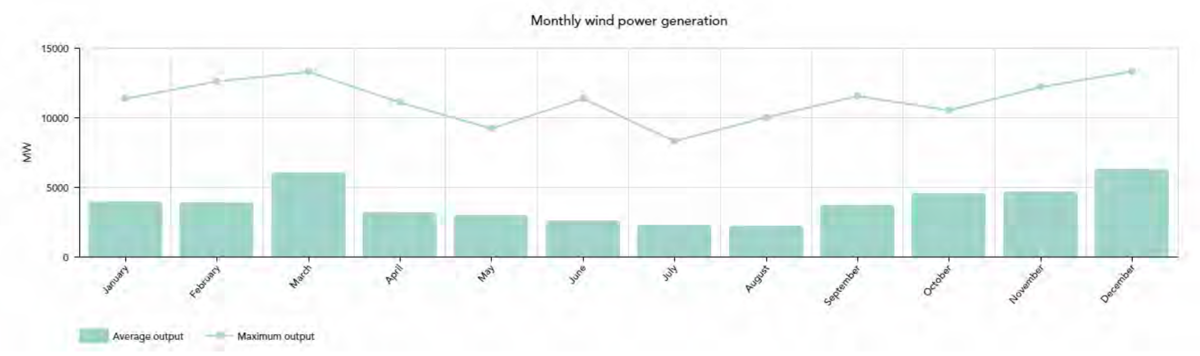
Wind power output rose

Wind power generation rose 21.2% relative to 2018, driven not only by an increase in installed capacity, but also by particularly favourable weather conditions during the year.



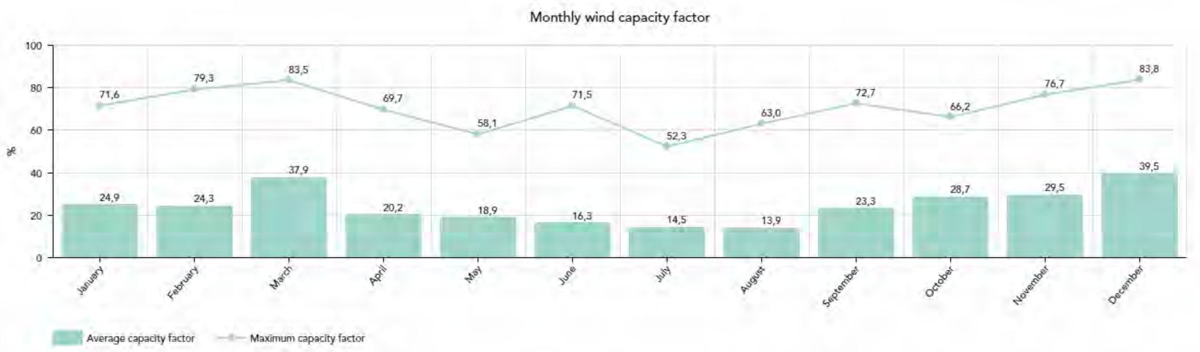
Monthly wind power generation

Wind power production peaked for the year on 13 December 2019, with generation reaching 13,330 MW, representing a wind capacity factor of 80.8%.



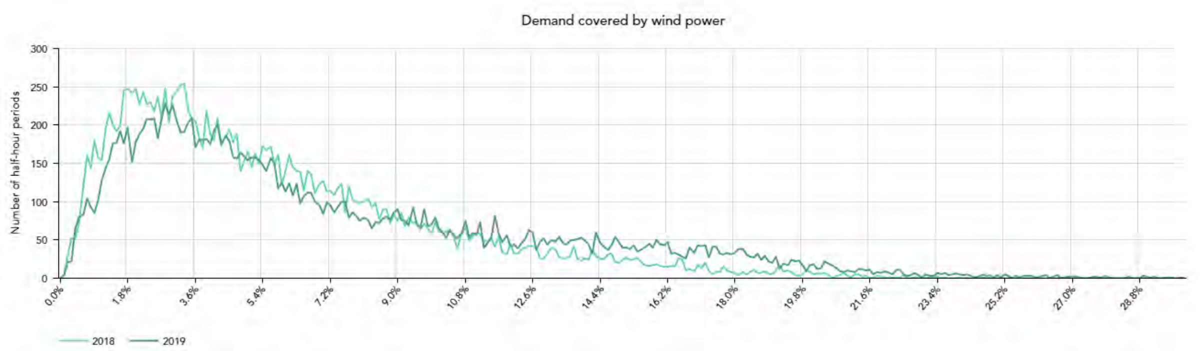
Monthly wind capacity factor

The monthly wind power capacity factor averaged 24.7%, which was higher than in 2018 (22.8%).



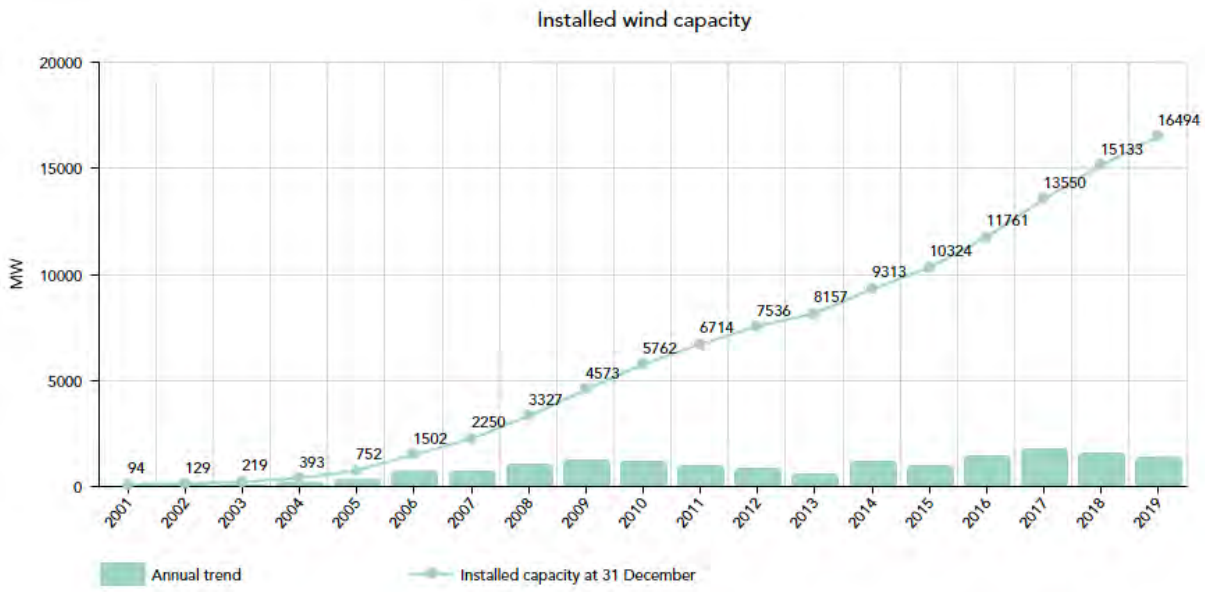
Coverage of demand by wind power

Coverage of demand by wind power reached 7.2% in 2019, up from 5.9% in 2018.



16.5 GW of installed capacity

As of 31 December 2019, France was home to 16,494 MW of installed wind power capacity after 1,361 MW of new capacity was added during the year. Of this total, 1,106 MW was connected to the RTE network and 15,388 MW to the grids of Enedis, LDCs and EDF-SEI for Corsica. The 2019 total was 9% higher than at end-2018. The Multiannual Energy Programme set installed capacity targets for 2023 of 21.8 GW under the low scenario and 26 GW under the high scenario. Therefore, France is 75% of the way toward meeting the Multiannual Energy Programme target for 2023 (low scenario).



Solar power

11.6 TWh

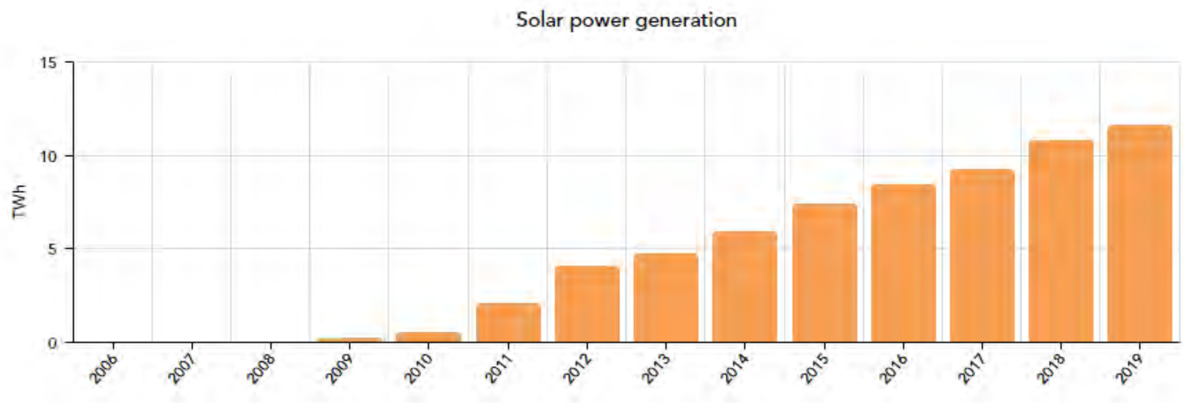
Solar power generation

Trend

+ 7,8 %

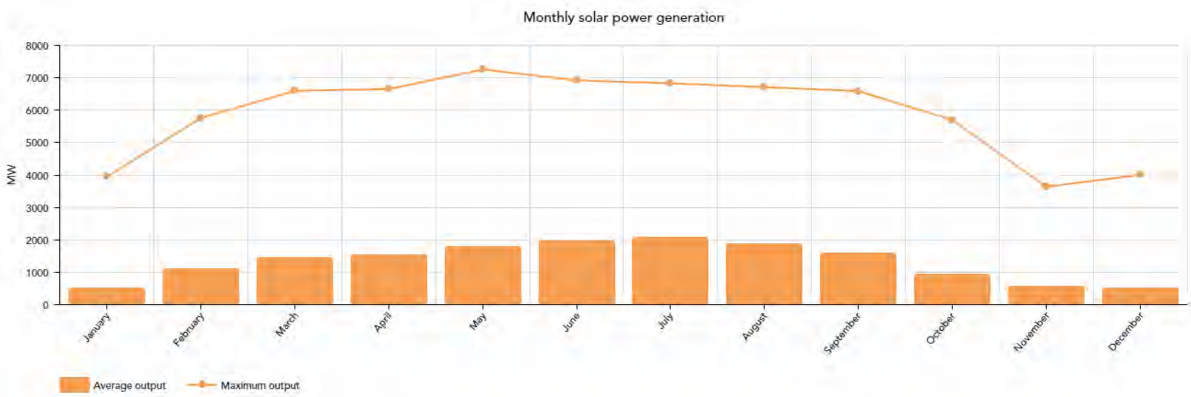
Output rose during the year

Solar power output rose by 7.8% in 2019, to 11.6 TWh.



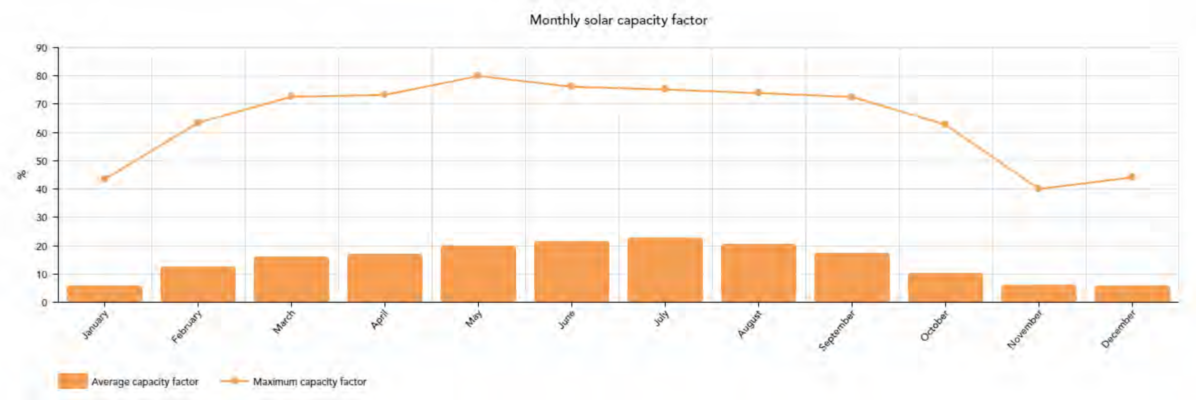
Monthly solar power generation

On 13 May 2019, at 2:00 pm, solar power generation reached a record high of 7,379 MW, with a capacity factor of 83.3%. Output is at its highest between May and August.



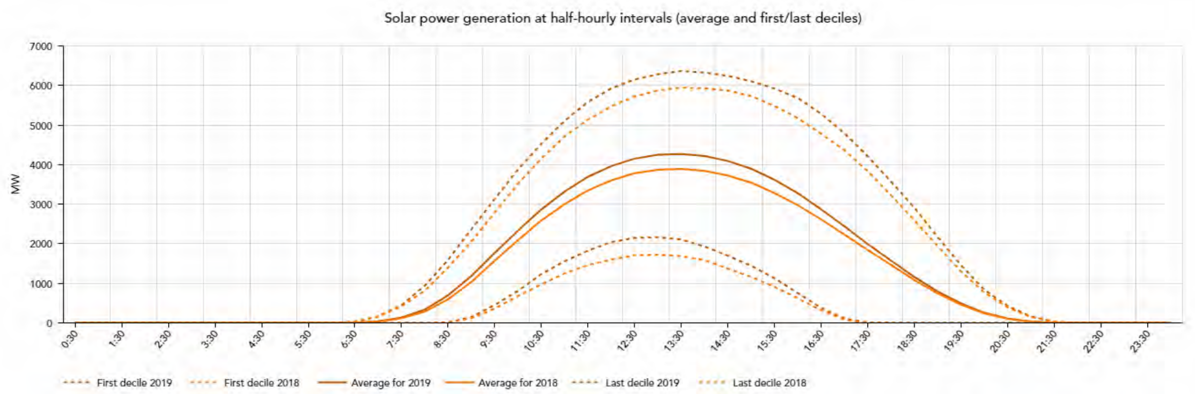
Monthly solar capacity factor

The average solar capacity factor was 13.5% in 2019, compared with 15% in 2018.



Solar power output at half-hourly intervals

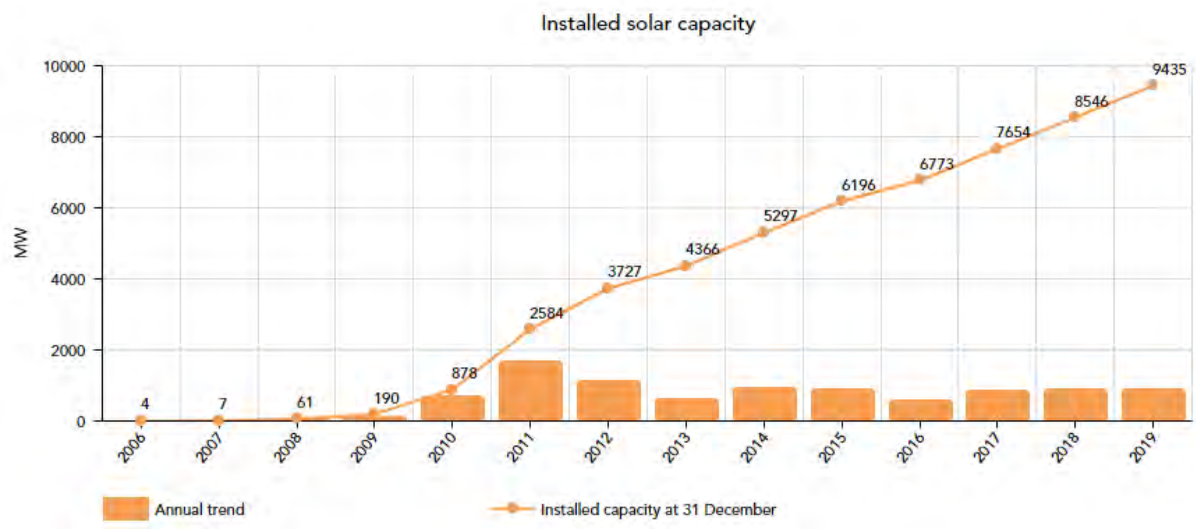
Solar power covered an average 2.2% of demand in 2019 compared with 2.3% in 2018.



9.4 GW of installed capacity

Installed solar capacity in France ended 2019 at 9,435 MW. Of this, 8,793 MW was connected to the grids of Enedis, LDCs and EDF-SEI for Corsica, and 643 MW to the transmission network. The increase in capacity relative to 2018 was 10.4%. At 889 MW, capacity additions were within the average range for recent years.

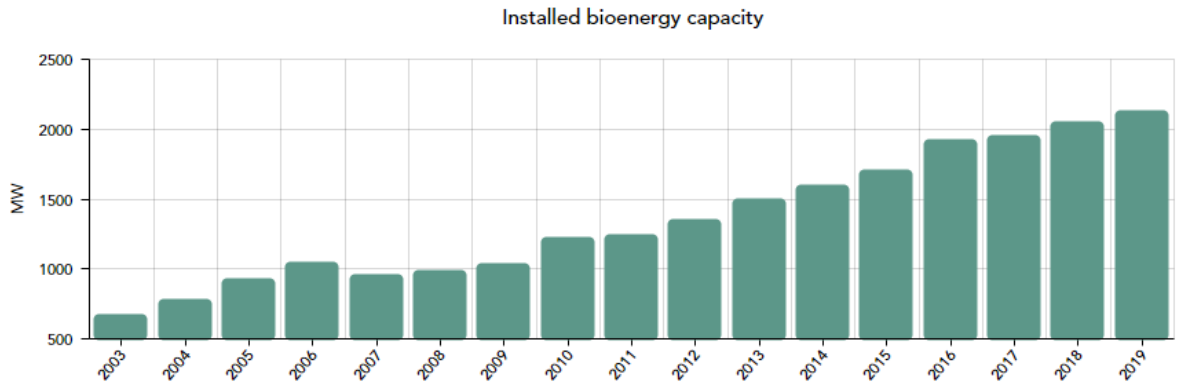
The Multiannual Energy Programme set a target of lifting installed solar capacity to 18.2 GW by 2023 under the low scenario and to 20.2 GW under the high scenario. France is thus 51% of the way toward achieving the target for 2023 (low scenario).



Renewable thermal generation

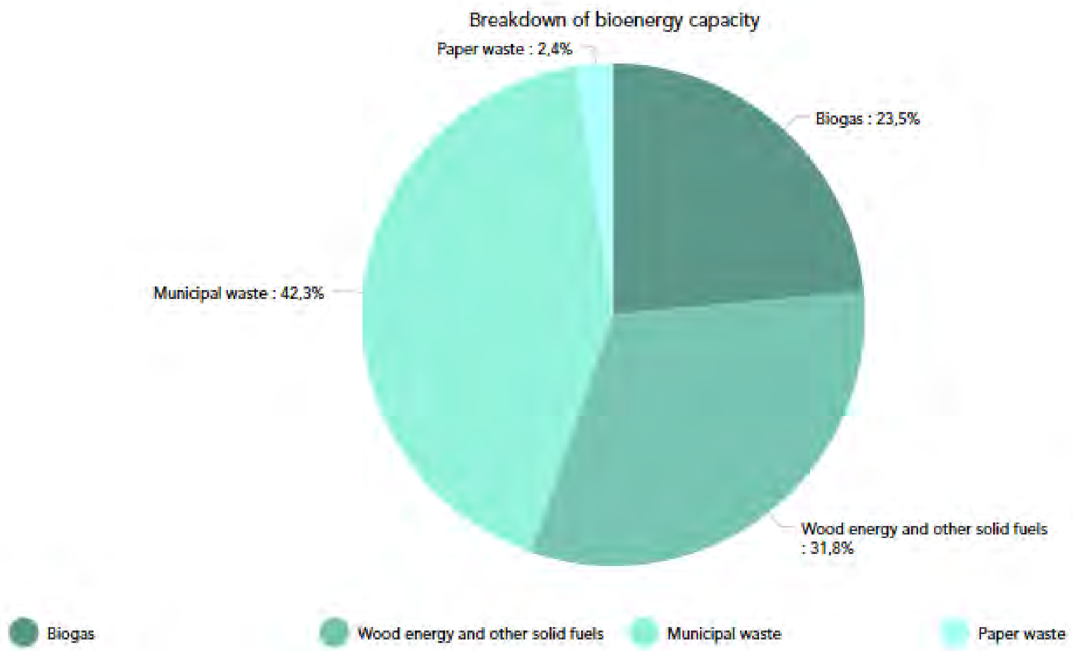
Moderate increase in installed capacity

Installed bioenergy capacity stood at 2.1 GW at end-December 2019 (+3.7% vs. end-2018).



Breakdown of capacity

Municipal waste incineration plants still account for the lion's share of bioenergy capacity.



Renewable energy generation

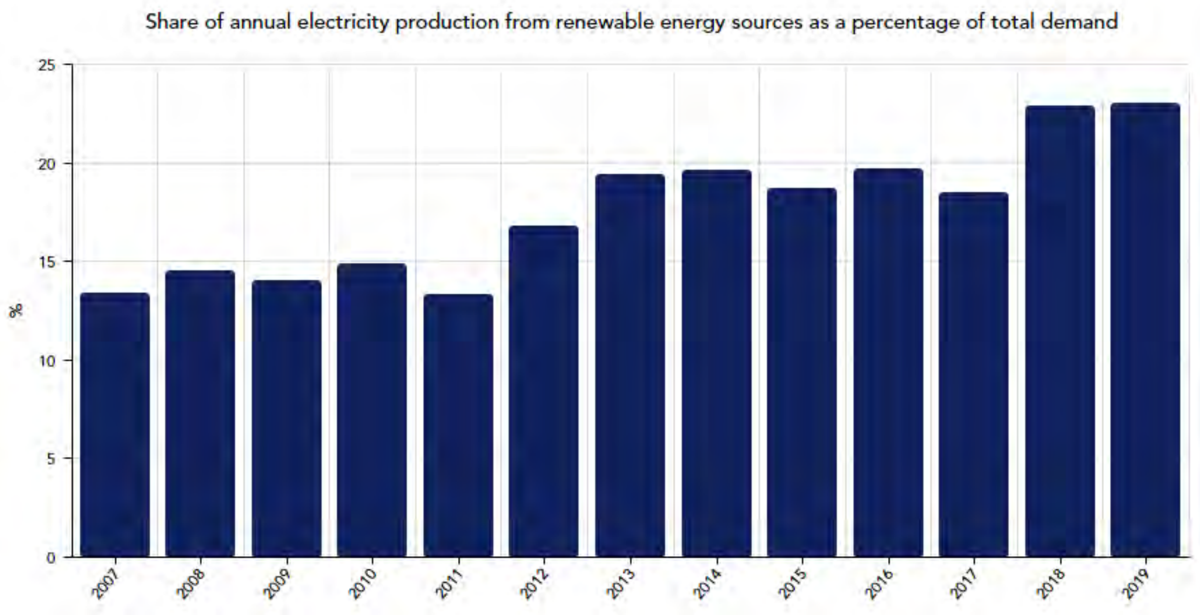
23.0 %

Power demand covered by
renewable energy sources

Renewable coverage of demand was high in 2019

Renewable coverage of power demand remained high in 2019, ending the year at 23%. A year-on-year decrease in hydropower generation was offset in part by rises in wind and solar power generation, made possible by favourable weather conditions and a further increase in installed capacity.
Hydropower accounted for 51.9% of renewable coverage, wind power for 29.5%, solar power for 10% and bioenergy for 8.6%.

Renewable electricity generation was flat in 2019, and again helped keep CO_2 emissions in check. Renewable generation has a variable production cost of zero, and it is usually substituted for fossil-fired thermal technologies that are costlier to operate and emit significant carbon, coal-fired plants being an example. However, even though very few coal power plants were fired up in France in 2019 (see section on coal in the 2019 Electricity Report), given the level of interconnection between European grids, the renewable energy produced in France was in most cases substituted for generation from coal-fired plants in other countries like Poland and Germany.
In other words, higher renewable electricity output in France contributed to the collective goal, notably in Europe, of reducing CO_2 emissions. It is estimated that French renewable electricity production avoided 5 million tonnes of CO_2 in France and 15 million tonnes in Europe excluding France.



Method of calculating renewable generation

The calculation method used is drawn from EU Directive 2009/28/EC. Seventy percent of consumption for pumping is deducted from production at pumped storage stations. Municipal waste incineration plant output is counted at 50%. The methodology used here does not make adjustments for weather conditions.

CO_2 emissions

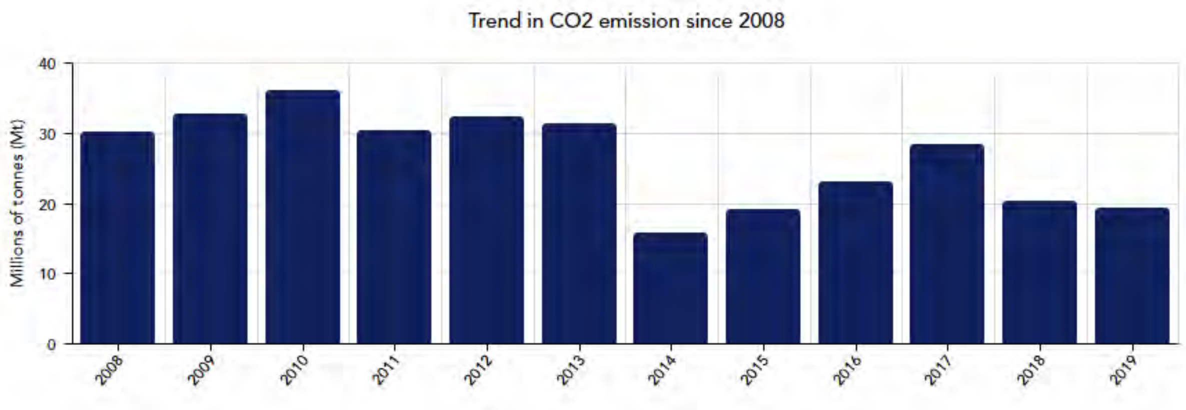
	- 6 %
CO_2	Decline in CO2 emissions from electricity generation in France

CO_2 emissions were lower

CO_2 emissions fell by nearly 6% year-on-year in 2019. Despite an increase in fossil-fired thermal generation over the period, related emissions declined, reflecting the marked shift from coal- to gas-fired generation, which emits significantly less carbon.

CO_2 emissions from own consumption reached an estimated 2.8 million tonnes (+7% relative to 2018). They are included in the carbon footprint assessments of the industrial sites in question.

CO_2 emissions excluding own consumption (millions of tonnes)	2019	2018
Net production	19.2	20.4
Nuclear	–	–
Fossil-fired thermal	17.5	18.7
of which coal	*1.5*	*5.6*
of which oil	*1.2*	*1.1*
of which gas	14.8	12
Hydropower	–	–
Wind power	–	–
Solar power	–	–
Municipal waste (incineration)	1.7	1.7



Calculating CO_2 emissions

The CO_2 emission factors shown here only represent CO_2 emissions generated by consumption of the primary fuel source. Different generation technologies contributed to CO_2 emissions as follows:
– 0.986 t/MWh for coal-fired units
– 0.777 t/MWh for oil-fired units
– 0.486 t/MWh for newer gas combustion turbines
– 0.352 t/MWh for combined-cycle gas turbines
– 0.583 t/MWh for older gas combustion turbines and other gas-fired plants
– 0.988 t/MWh for municipal waste incineration (only the non-renewable share, or 50% of generation, counts towards emissions)
These rates are calculated based on emission factors published by Ademe and plant efficiencies based on ENTSO-E recommendations.

Territories and Regions

The generation/consumption balance

The transmission grid helps ensure inter-regional solidarity

Electricity generated in the regions not only meets local needs but also helps cover demand in neighbouring areas and beyond. The transmission grid helps ensure inter-regional solidarity in two ways.

- First, geographically: The Centre-Val de Loire and Grand Est regions, for instance, produce much more electricity than they consume and thus make a great contribution to solidarity. Regions that rely heavily on imports from neighbours, such as Ile-de-France, Bourgogne-Franche-Comté and Brittany, know that they will have enough supply to keep up with demand.
- Second, in terms of timing: Each region must rely at certain times on generation from other areas.

Most of these exchanges flow over the public transmission grid.

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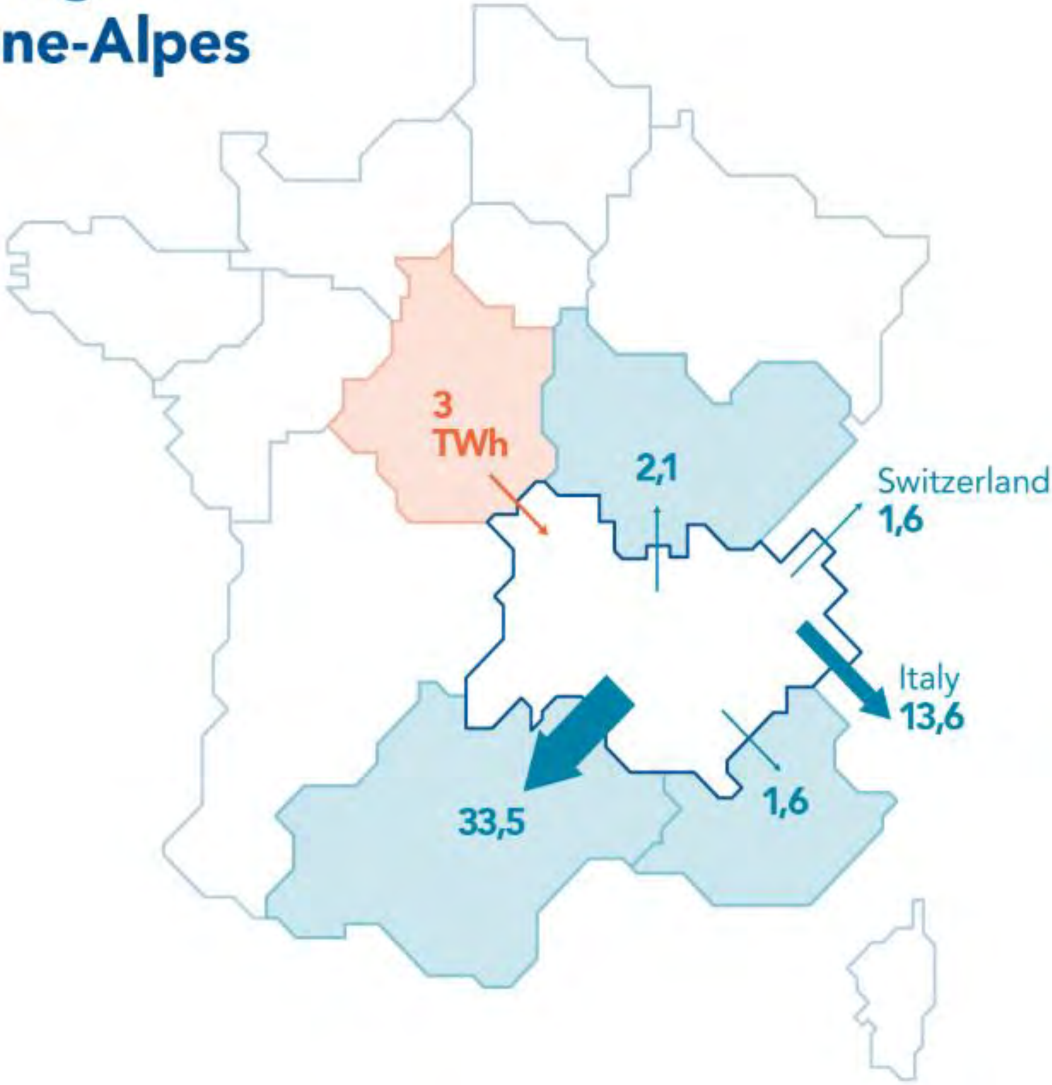
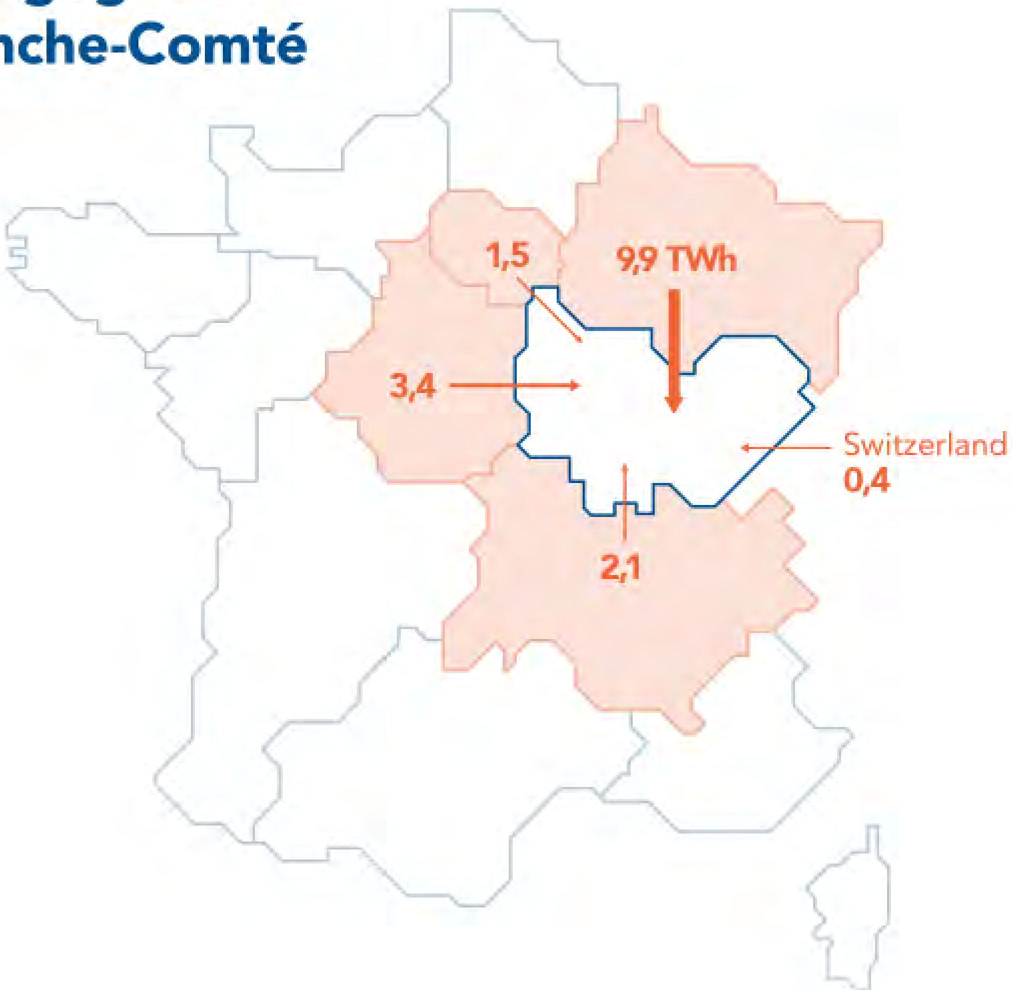
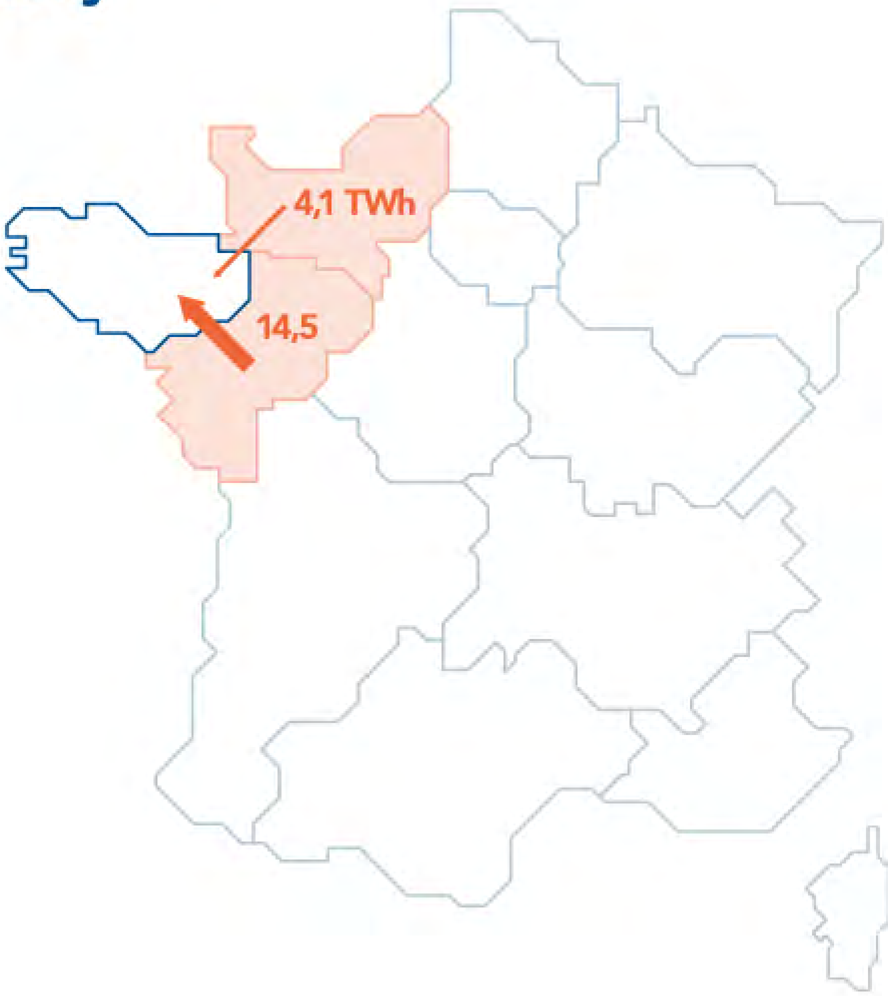
Auvergne Rhône-Alpes



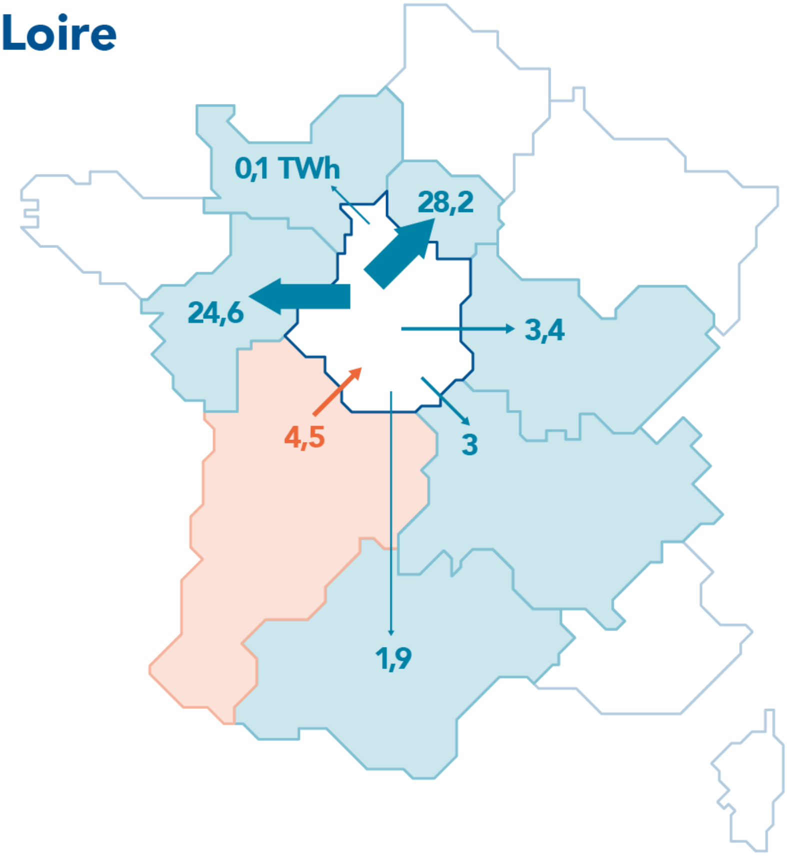
Bourgogne-Franche-Comté



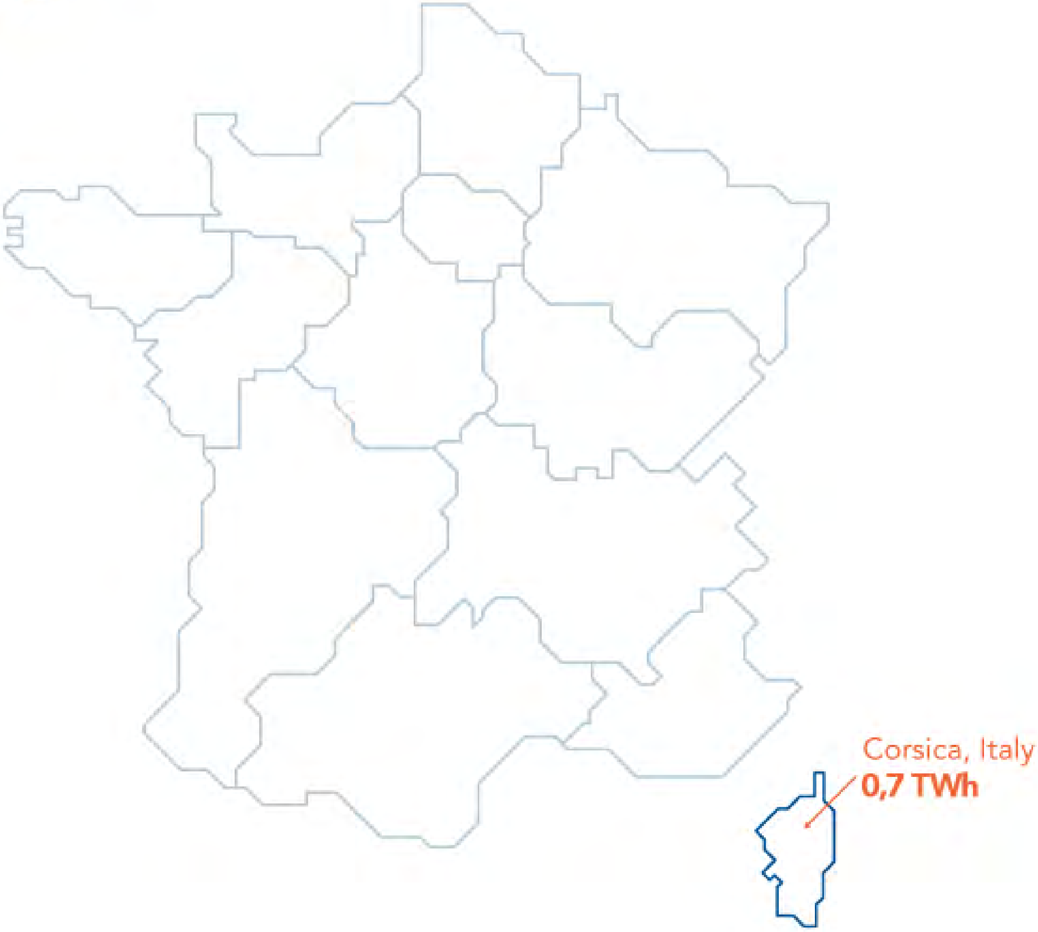
Brittany



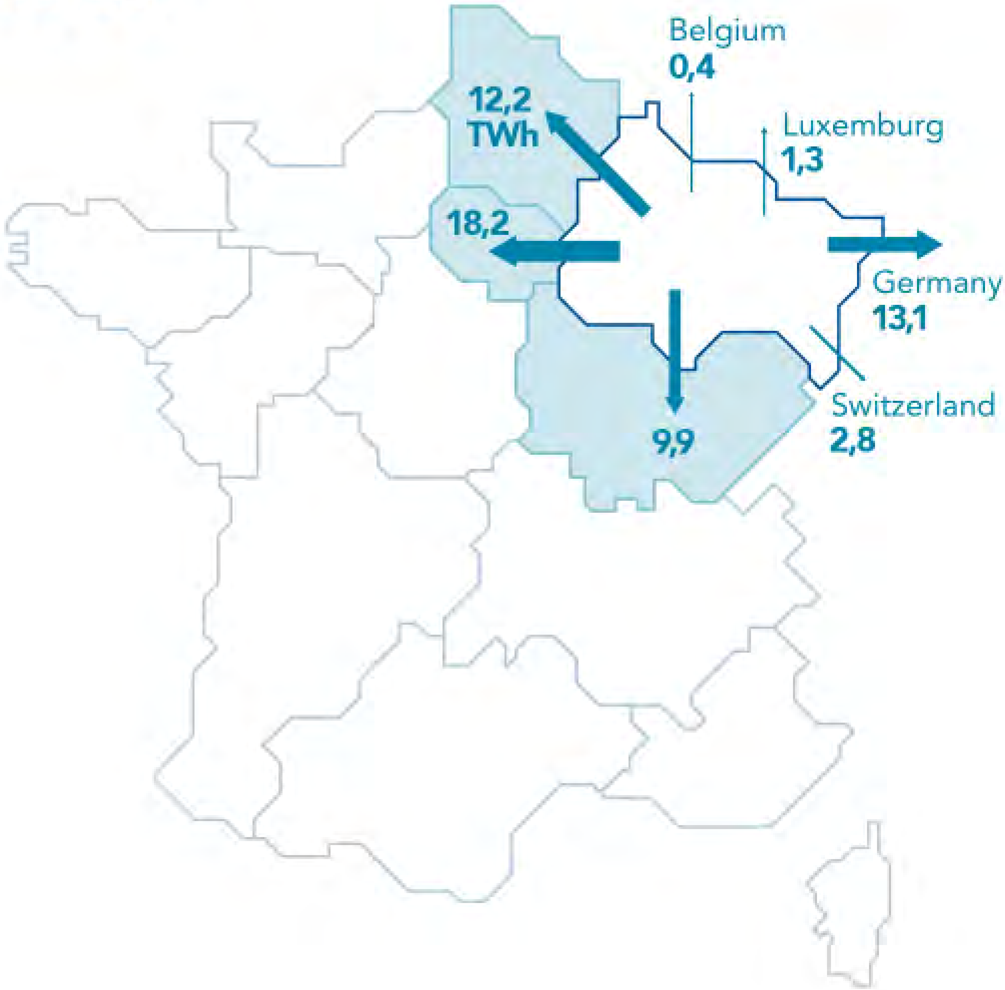
Centre-Val de Loire



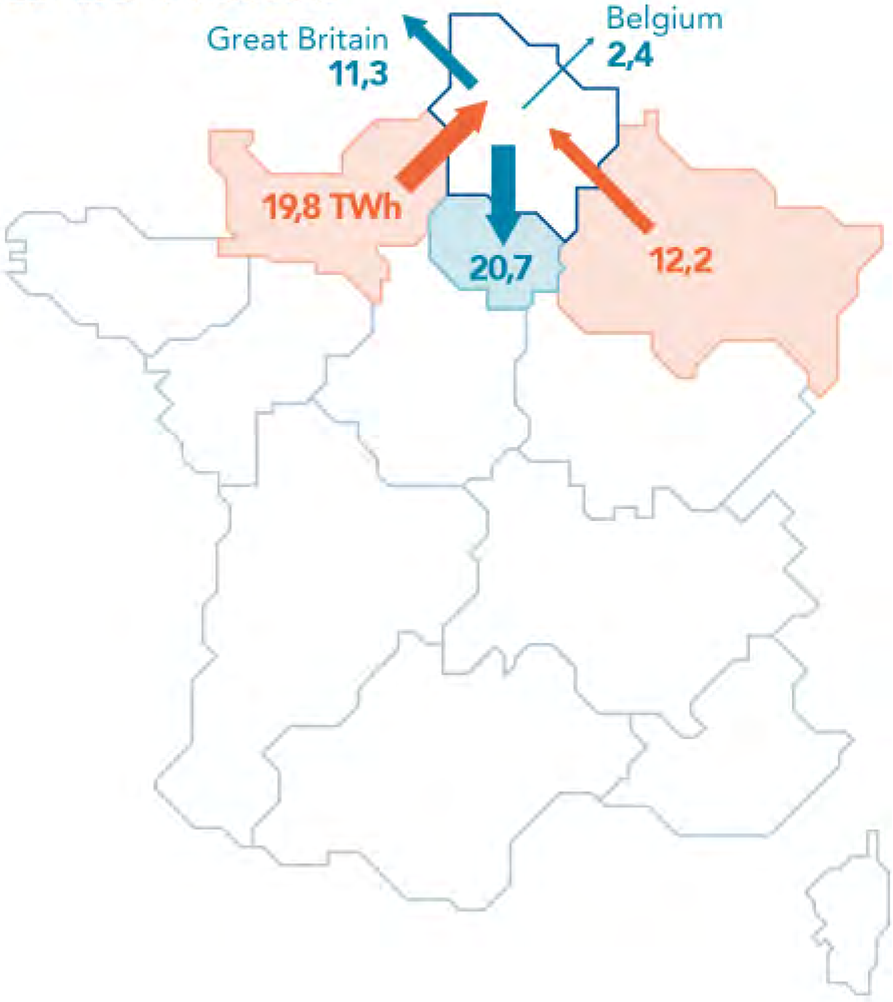
Corse



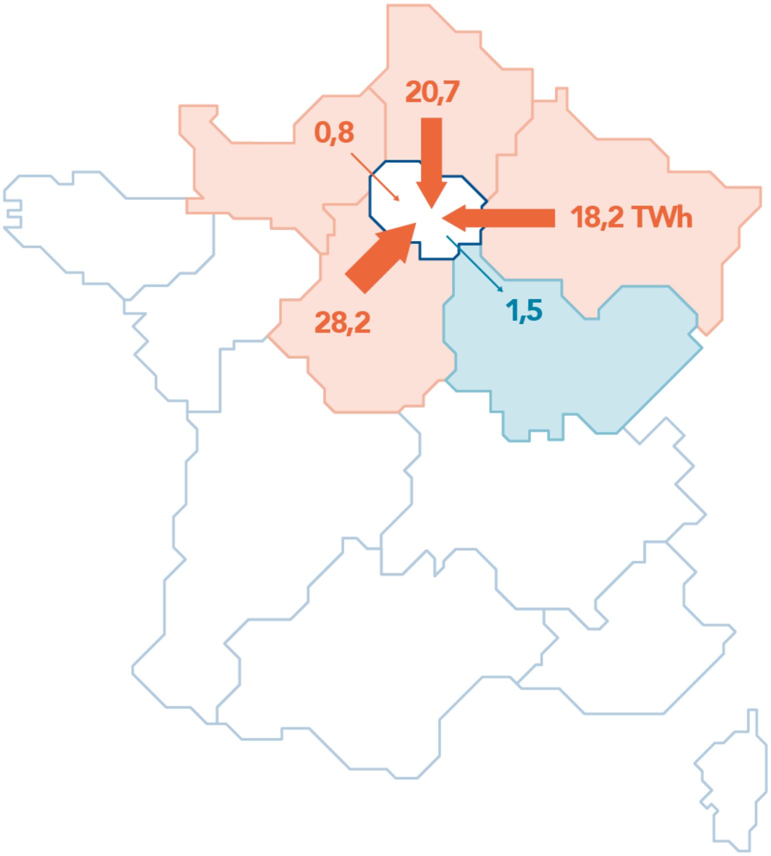
Grand-Est


Belgium
0,4
Luxemburg
1,3
12,2
TWh
18,2
Germany
13,1
Switzerland
2,8
9,9

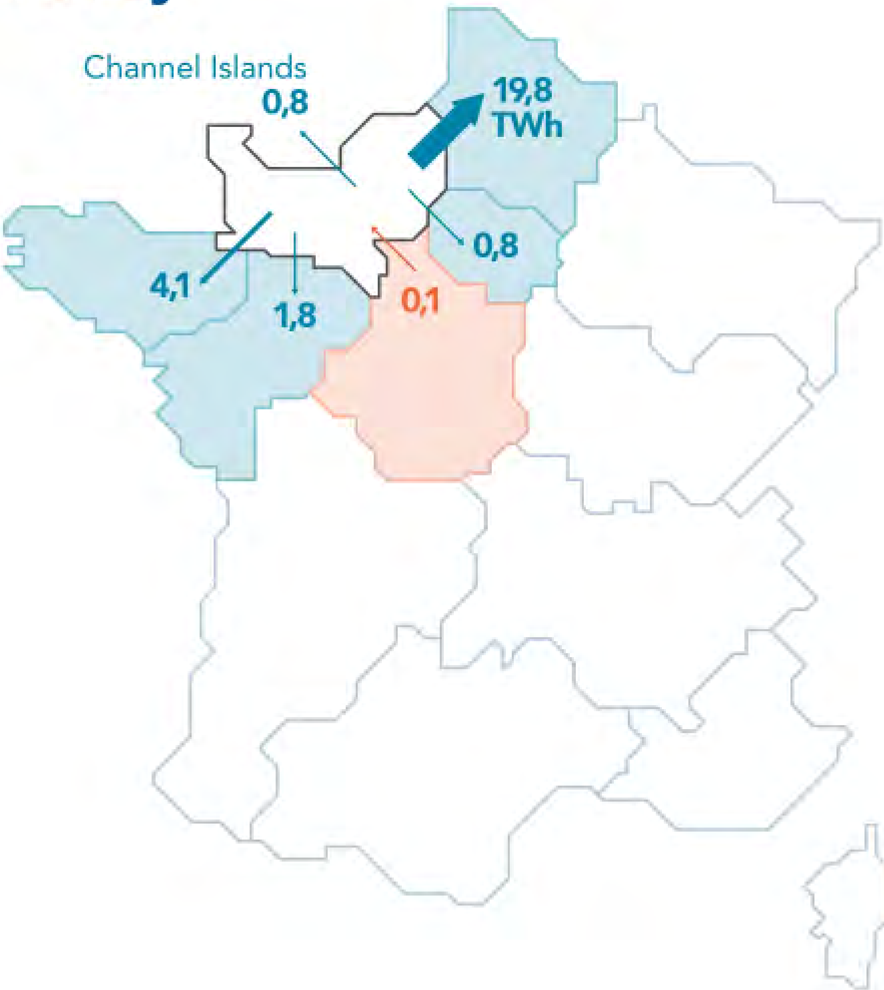
Hauts de France



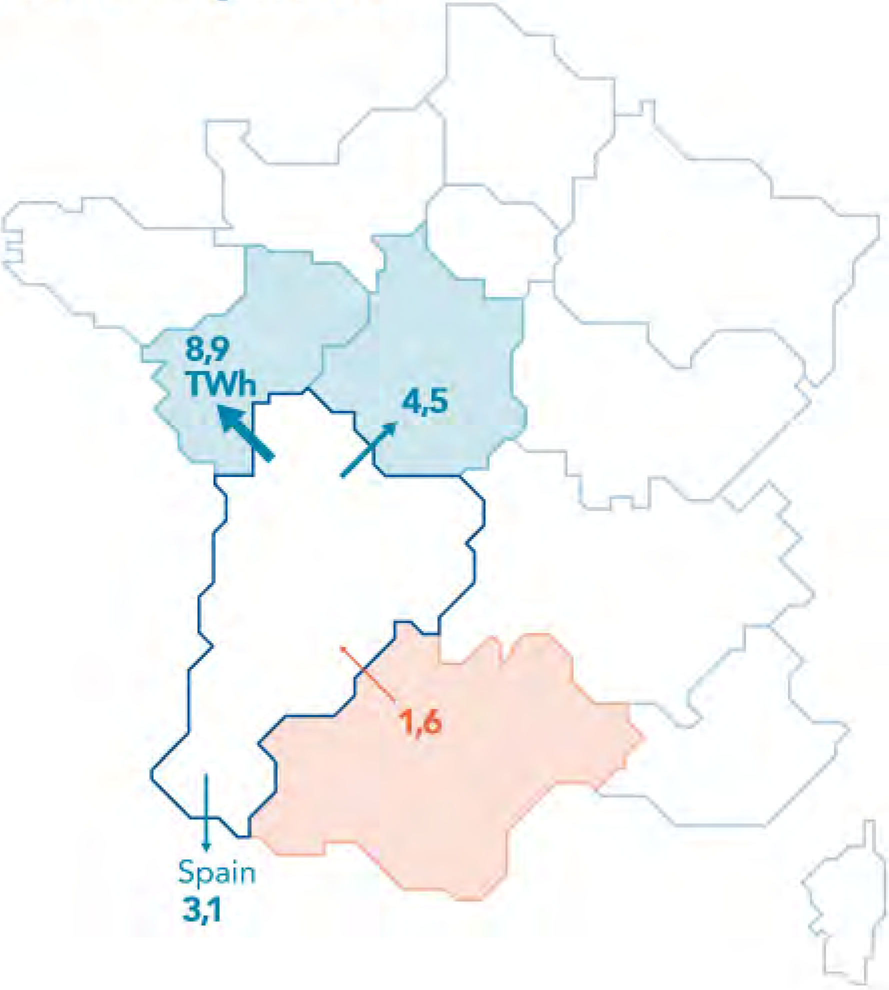
Île-de-France



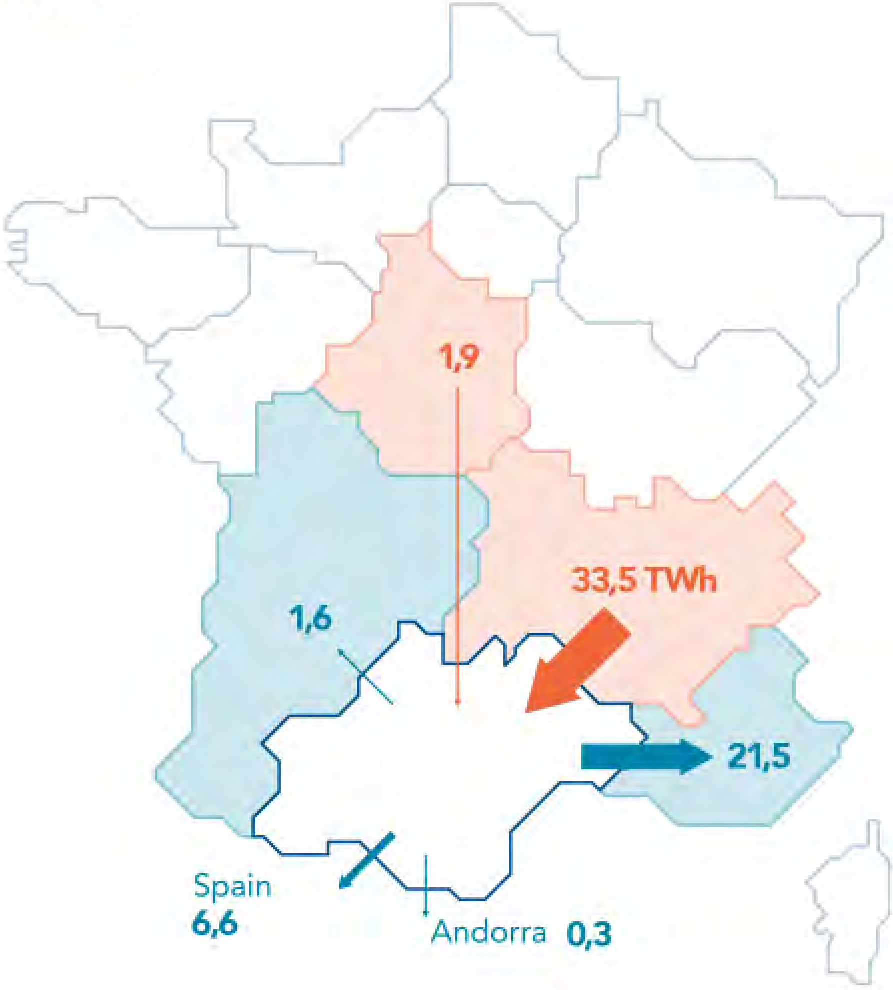
Normandy



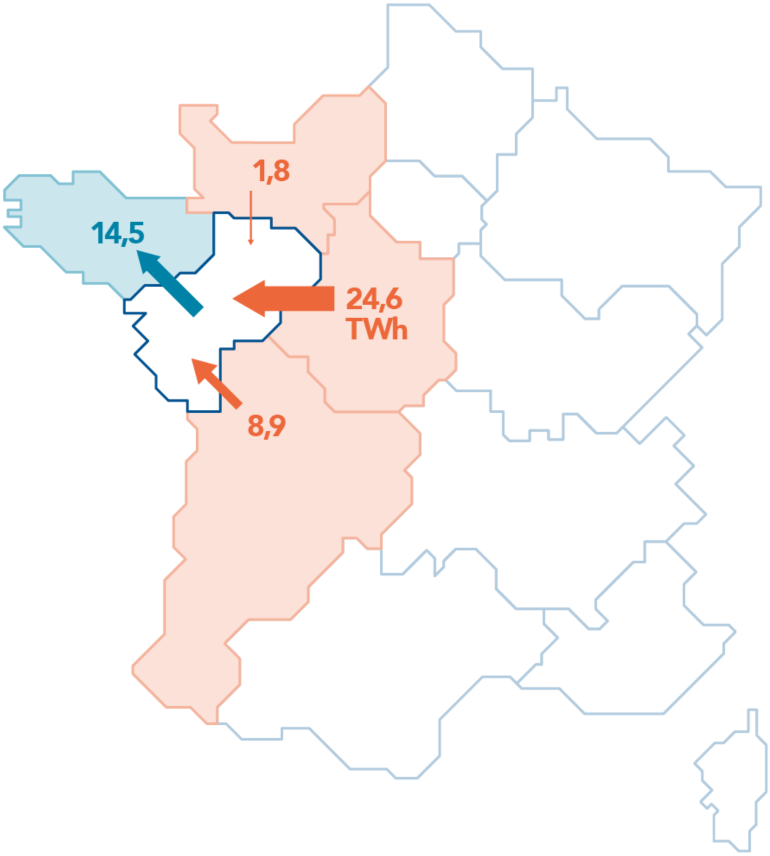
Nouvelle-Aquitaine



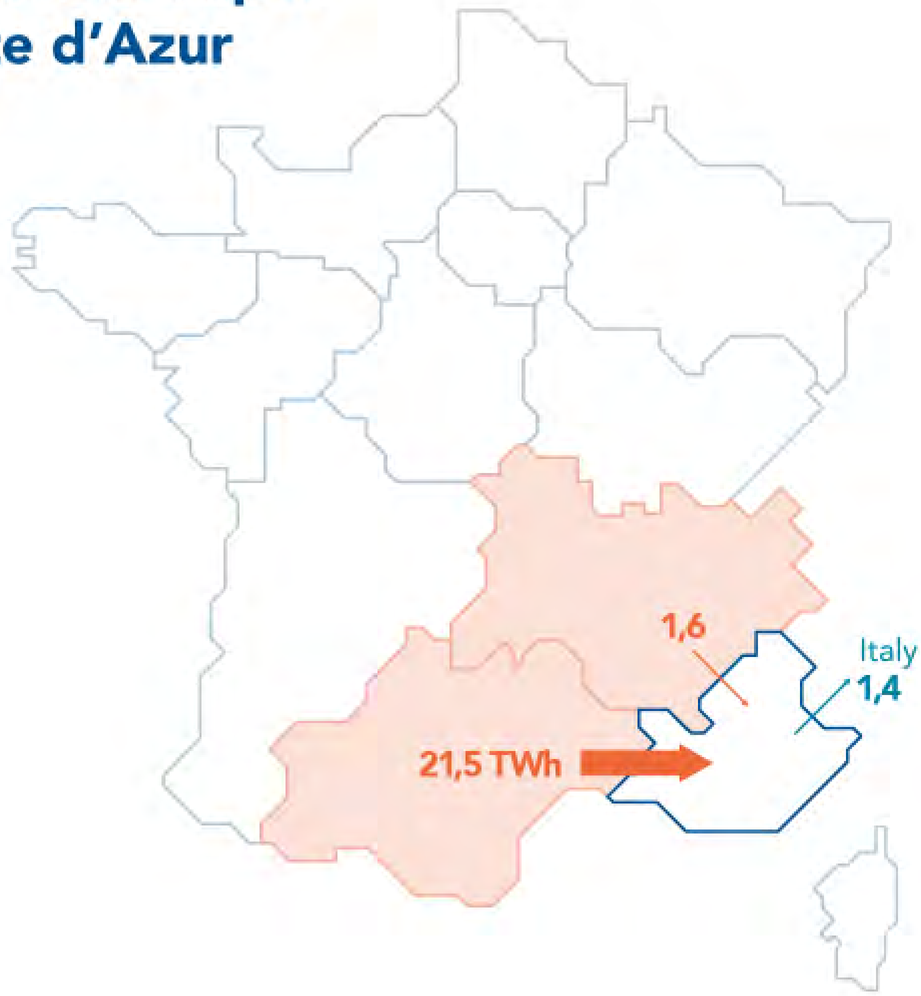
Occitanie



Pays de la Loire



Provence-Alpes-Côte d'Azur

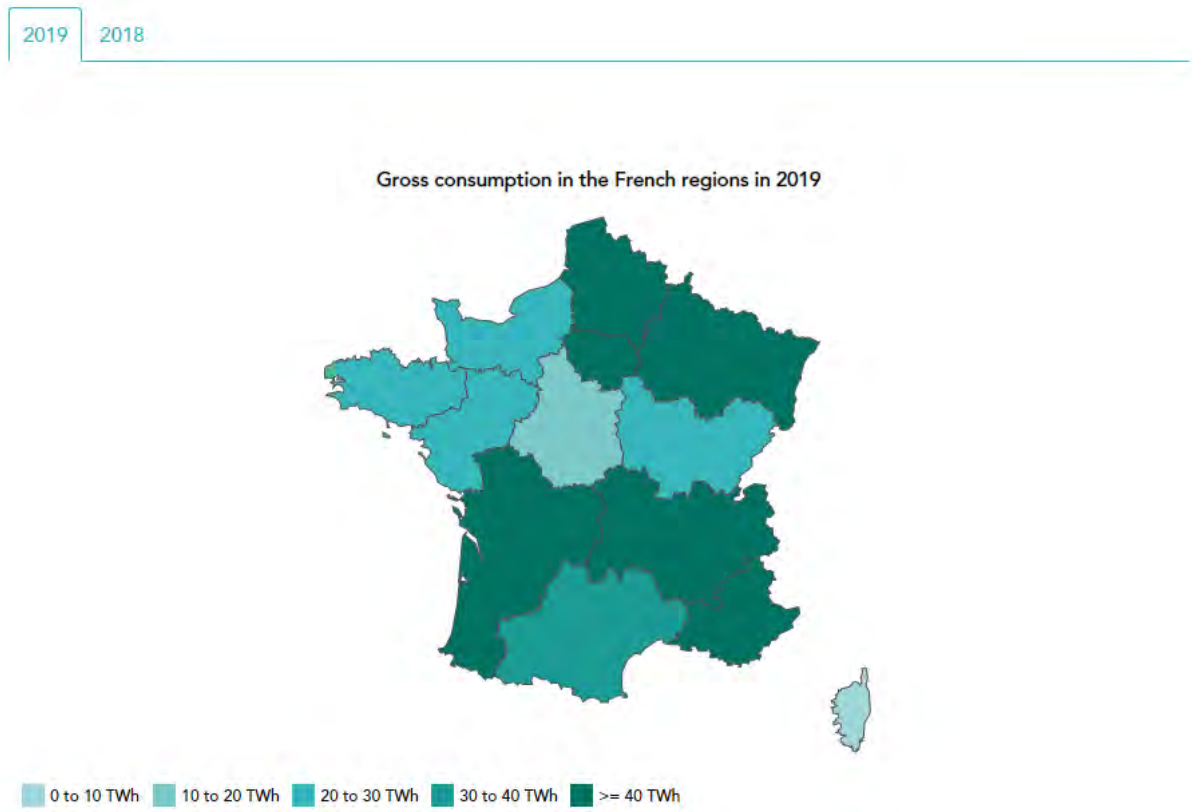


Electricity exports and imports between the French regions in 2019

Consumption in the French regions

Gross consumption down slightly

Gross consumption in the French regions declined relative to 2018 in all regions except Centre-Val de Loire and Corsica, which saw increases of 0.7% and 1.8%, respectively. The steepest decline was recorded in Auvergne-Rhône-Alpes (-2.6%).



A closer look

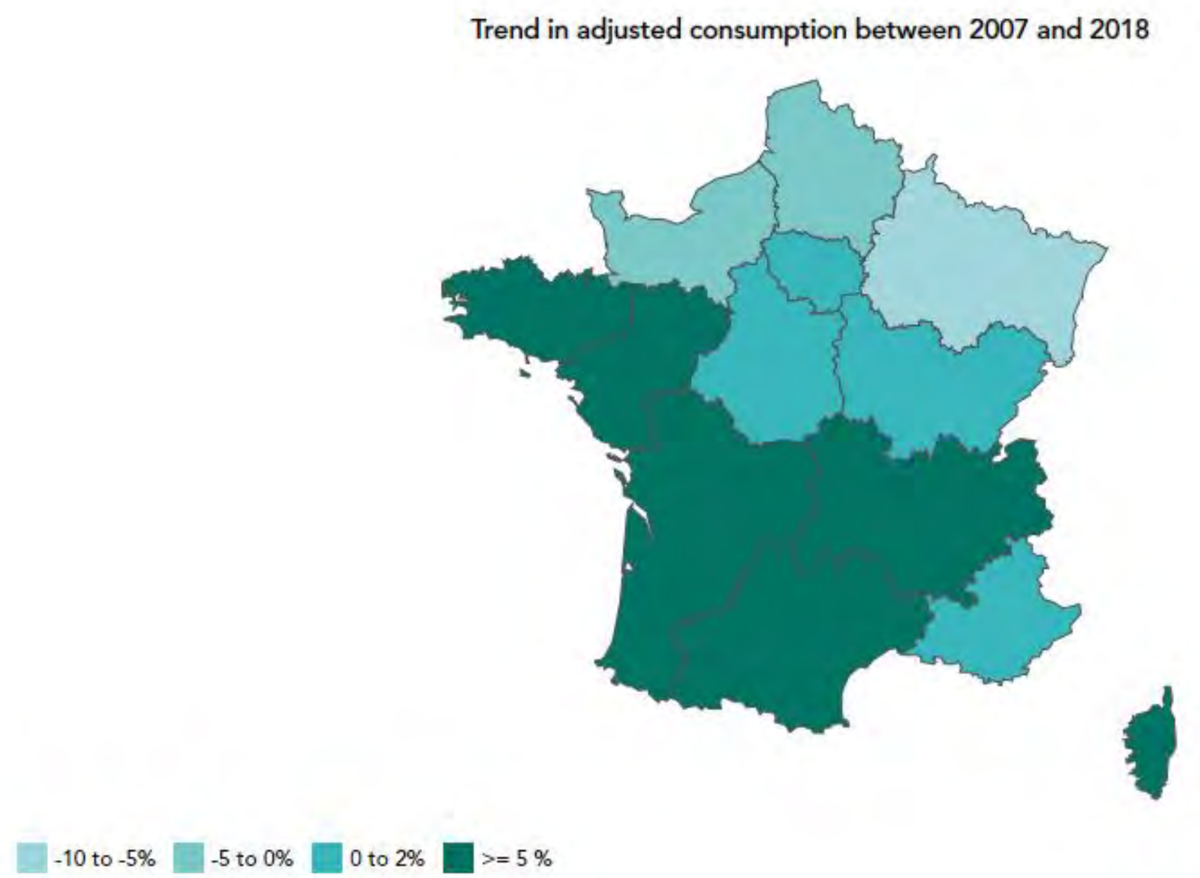
Regional electricity data with éco2mix

To get real-time information about electricity in each region, go to the éco2mix website. City-specific versions of the app are also available.

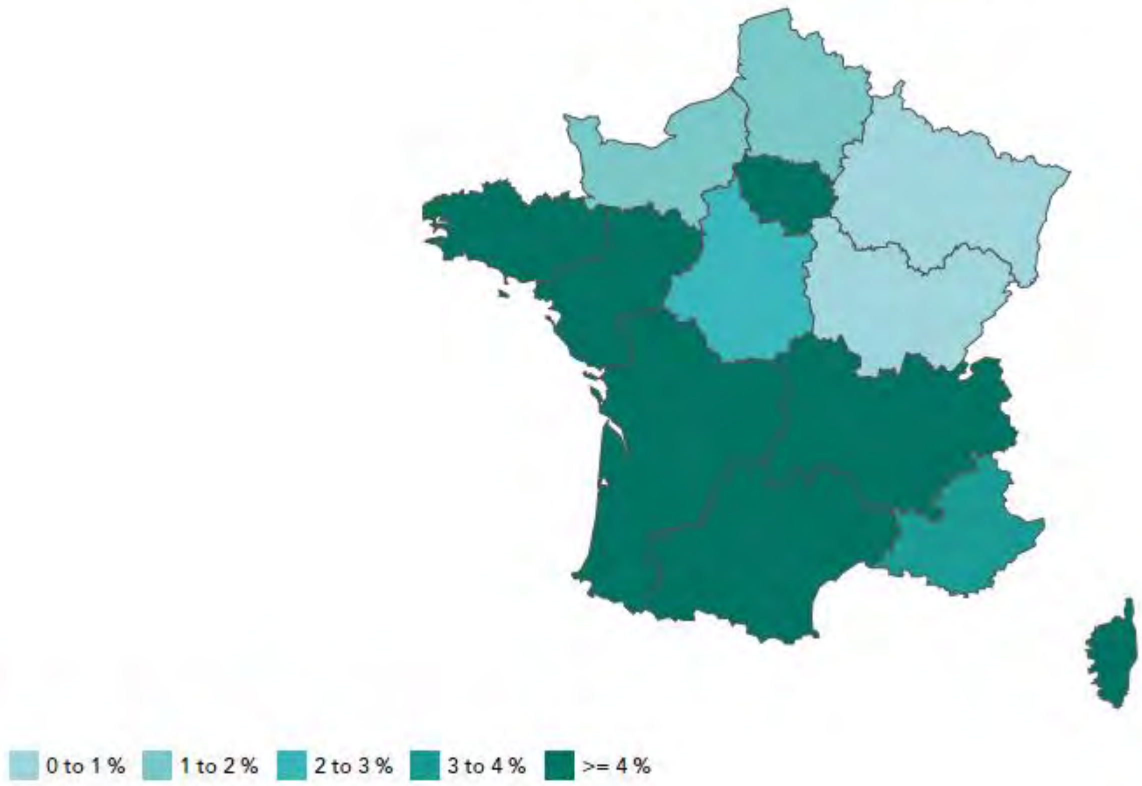
Adjusted consumption: Trends shaped in part by demographics

Between 2007 and 2018, trends in adjusted consumption in France were mixed due to a variety of factors, one of which was demographics. This was the case in Corsica, where electricity consumption rose by almost 22.7% while the population grew by more than 11.7% between 2007 and 2017 (Insee figures).

The Grand Est region saw the steepest decrease in adjusted consumption in France (-9.2%) due to its deindustrialisation.



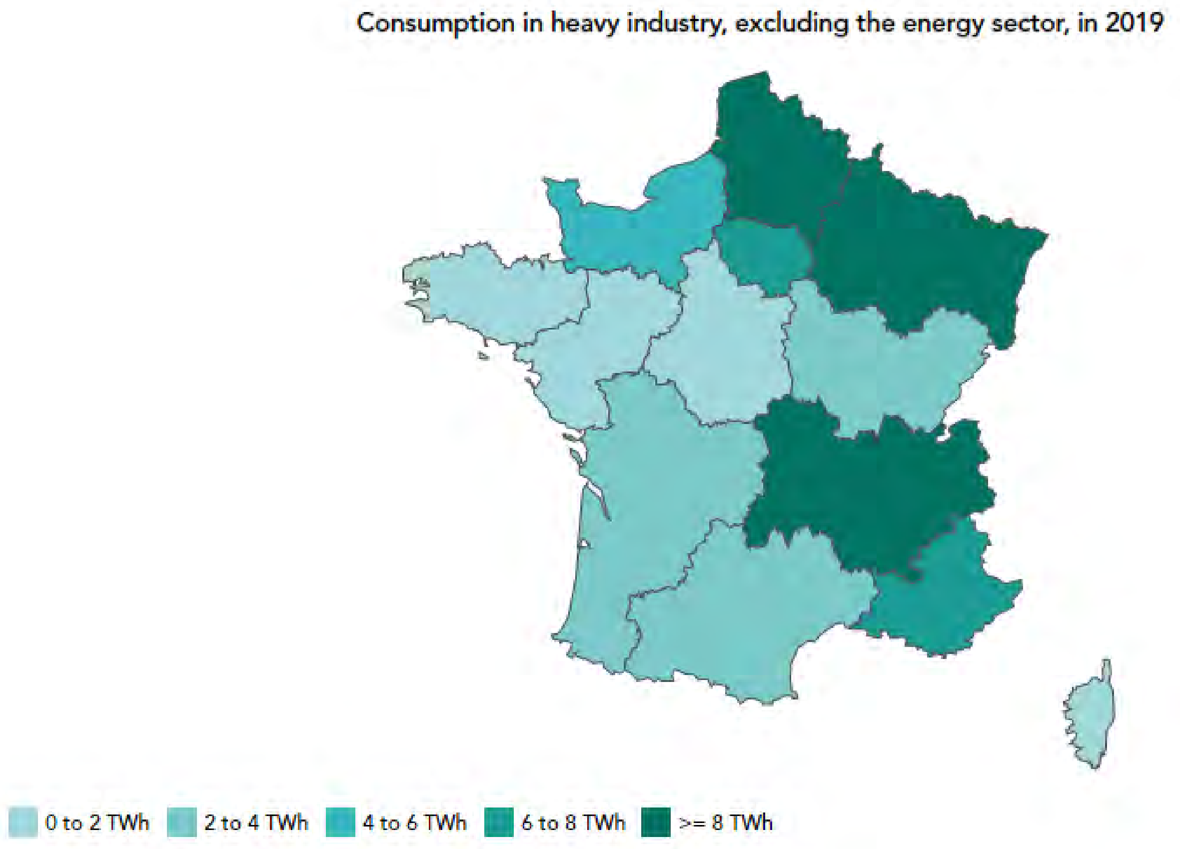
Population growth between 2007 and 2017



Consumption in heavy industry declined

The Hauts-de-France, Grand Est and Auvergne-Rhône-Alpes regions are home to the largest number of industrial sites connected to the transmission grid. Consumption declined relative to 2018 in all regions except Normandy (+2%) and Provence-Alpes-Côte d'Azur (+2.4%).
The sharpest decrease was seen in Pays de la Loire (-10.9%).

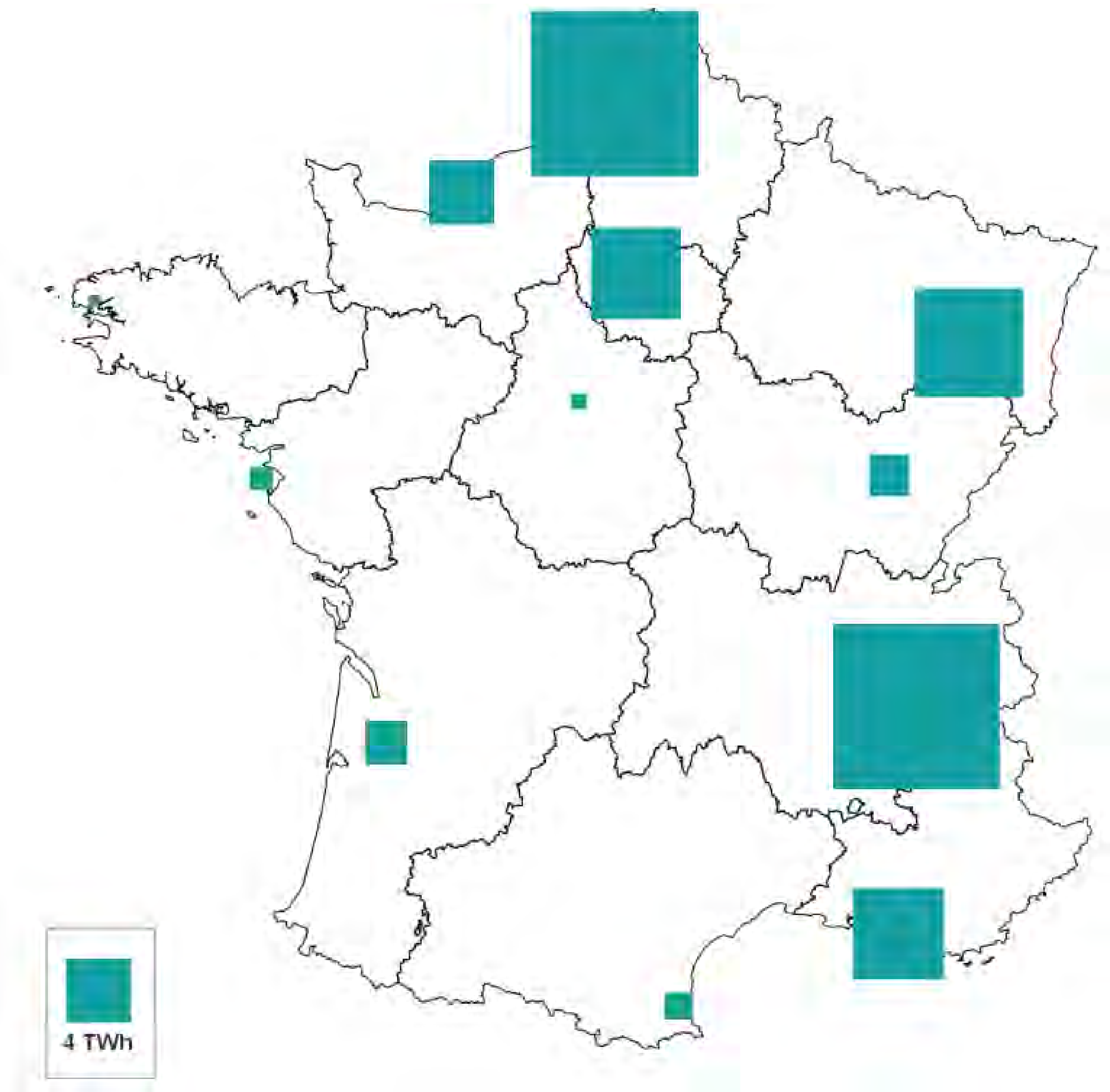
2019 2018



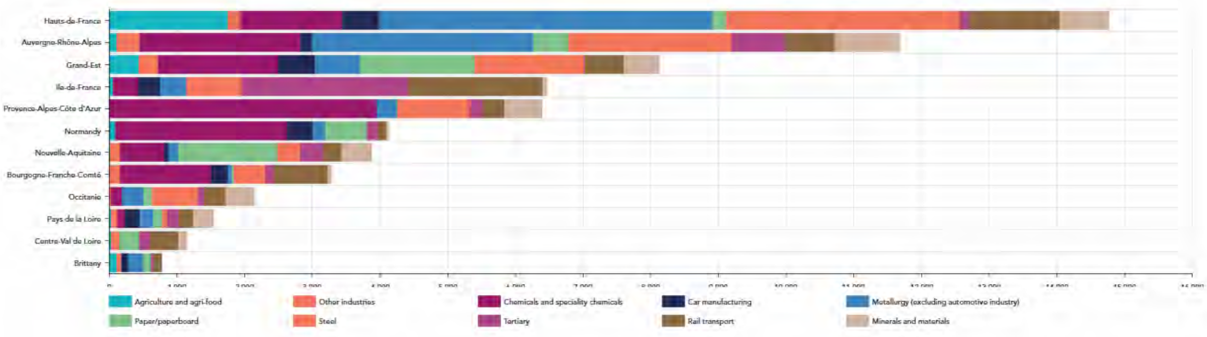
SEI data can be found in: [Electricity Report for SEI, Corsica and Overseas Territories]

Map of heavy industry withdrawal points

Energy volumes withdrawn and location of sites in France



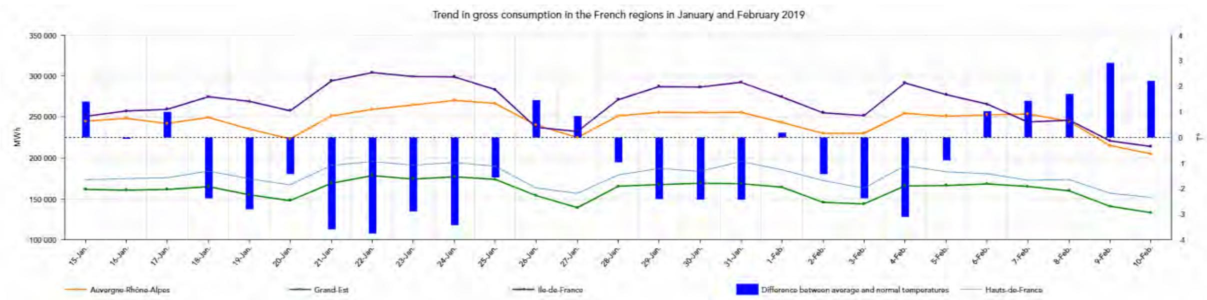
Breakdown of heavy industry consumption by sector in the French regions



Impact of cold spells on consumption

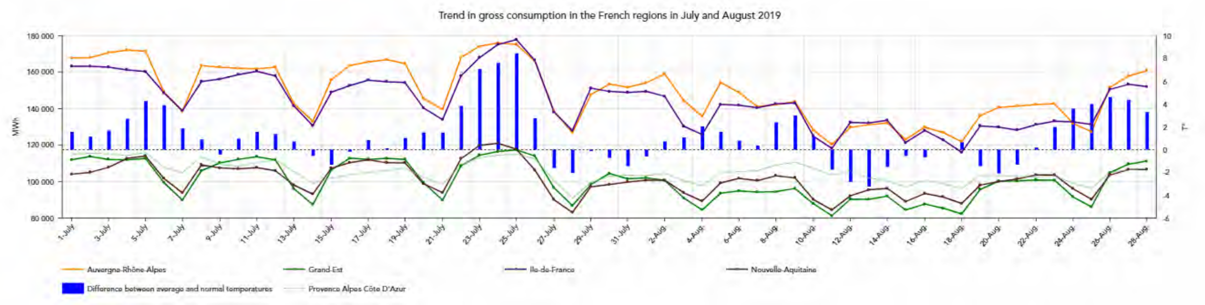
In January of 2019, the average temperature observed was at times almost 4°C below normal. Electricity demand rises on some days when temperatures are well below normal due to the large share of electric heating in France.

Fluctuations in demand are greater in very temperature-sensitive regions like Ile-de-France and Hauts-de-France.



Impact of heatwaves on consumption

July 2019 was one of the hottest months of July on record since 1900. Widespread use of air conditioning was reflected in higher power consumption on particularly hot days. Fluctuations in demand were significant in the Ile de France and Nouvelle Aquitaine regions, with temperatures peaking on 25 July at more than 8°C above normal.



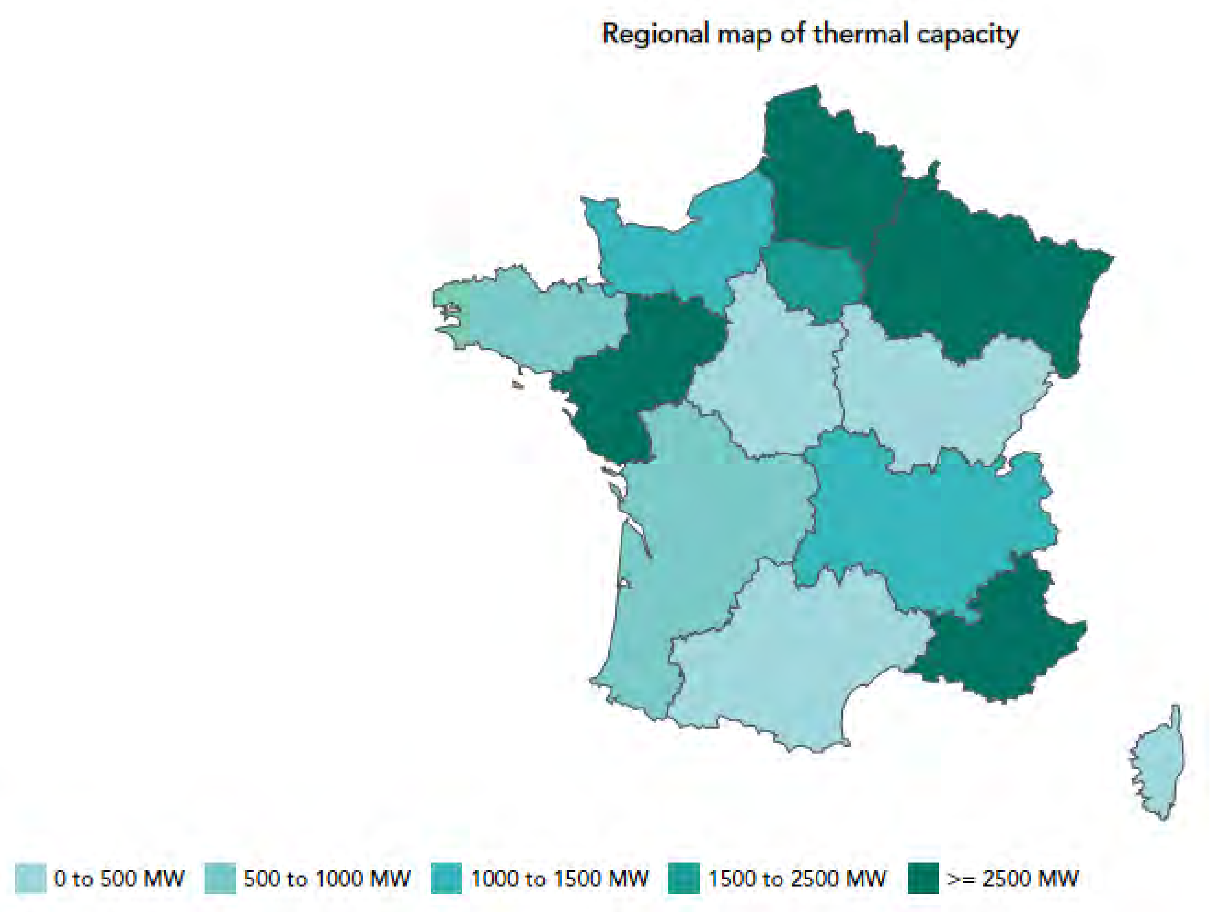
Generation in the French regions

Generating technologies

Fossil-fired thermal | Nuclear | Hydro | Wind | Solar | Bioenergy

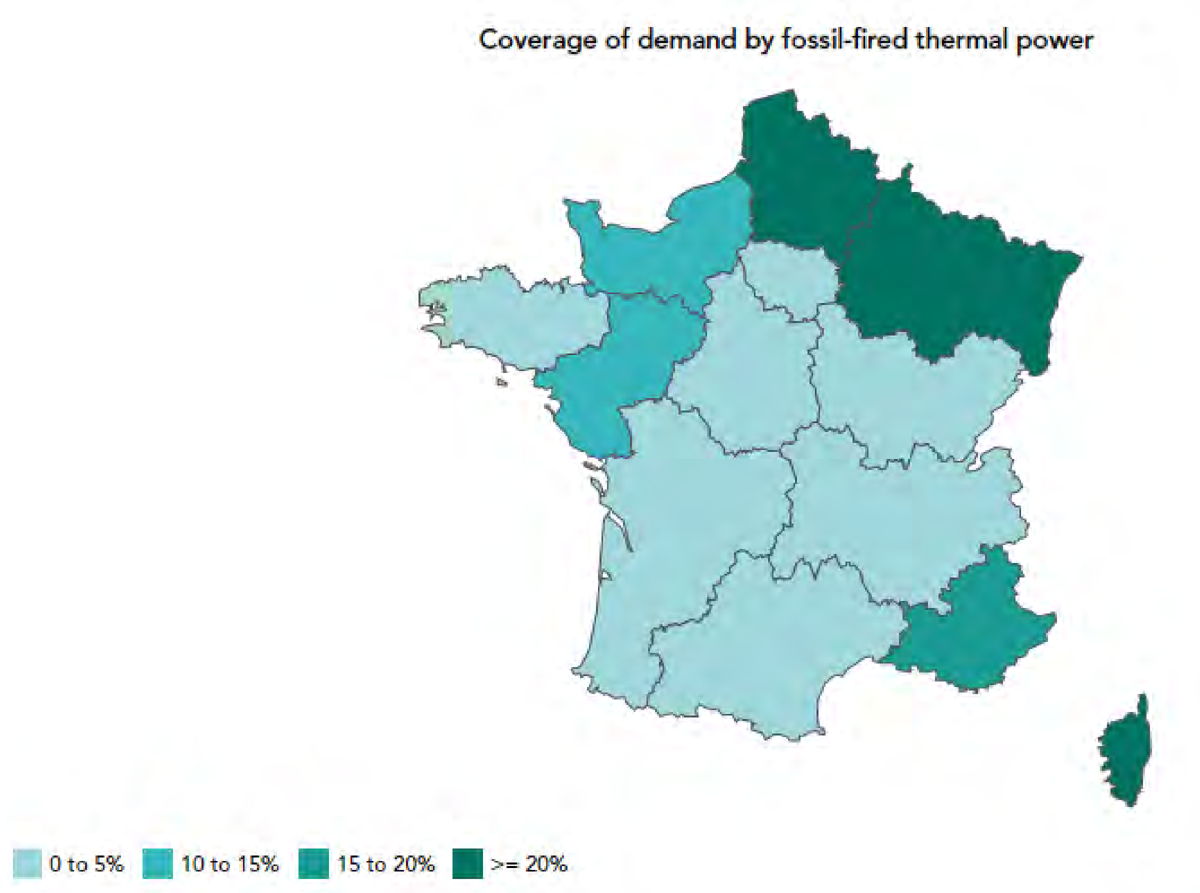
Fossil-fired thermal (breakdown in MW)

Fossil-fired thermal plants can be found throughout the French regions. Most capacity is in the Hauts-de-France, Pays de la Loire, Grand Est and Provence-Alpes-Côte d'Azur regions, which together are home to around 60% of total fossil-fired thermal capacity. Because they require water for system cooling, these plants are located near water points (e.g. Cordemais on the Loire River).



Coverage of demand (%) by fossil-fired thermal

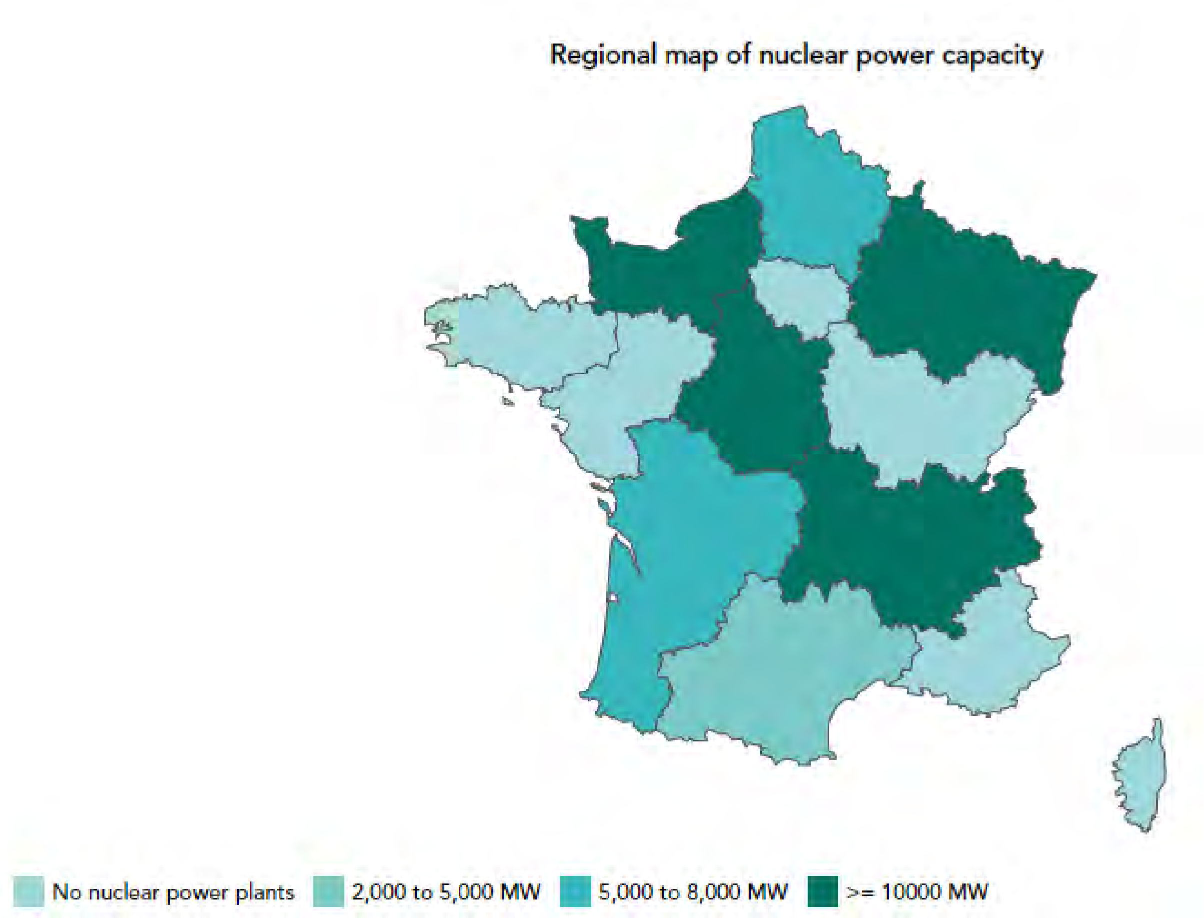
[Fossil-fired thermal generation] covers more than 40% of demand in Corsica and more than 20% in the Grand Est and Hauts-de-France regions.



SEI data can be found in: Electricity Report for SEI, Corsica and Overseas Territories

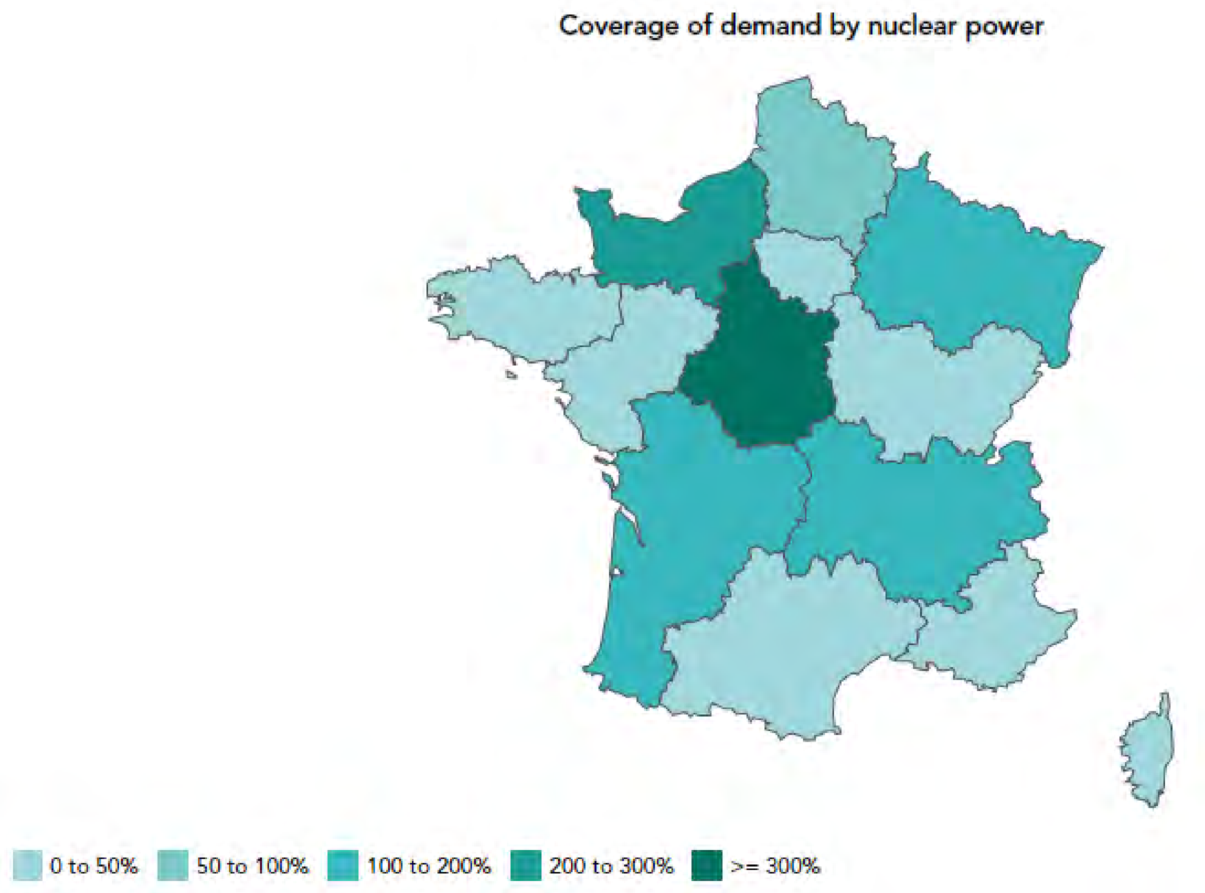
Nuclear power (breakdown in MW)

Most of the nuclear reactors in France are in the Normandy, Grand Est, Centre-Val de Loire and Auvergne-Rhône-Alpes regions, which are together home to 77% of the nuclear plants in service. Because of their cooling requirements, the plants are located near water points: along the coast (e.g. Paluel and Flamanville, on the English Channel) or waterways (e.g. Tricastin and Cruas on the Rhône). Nuclear generation was unchanged in 2019 (63.1 GW).



Coverage of demand (%) by nuclear power

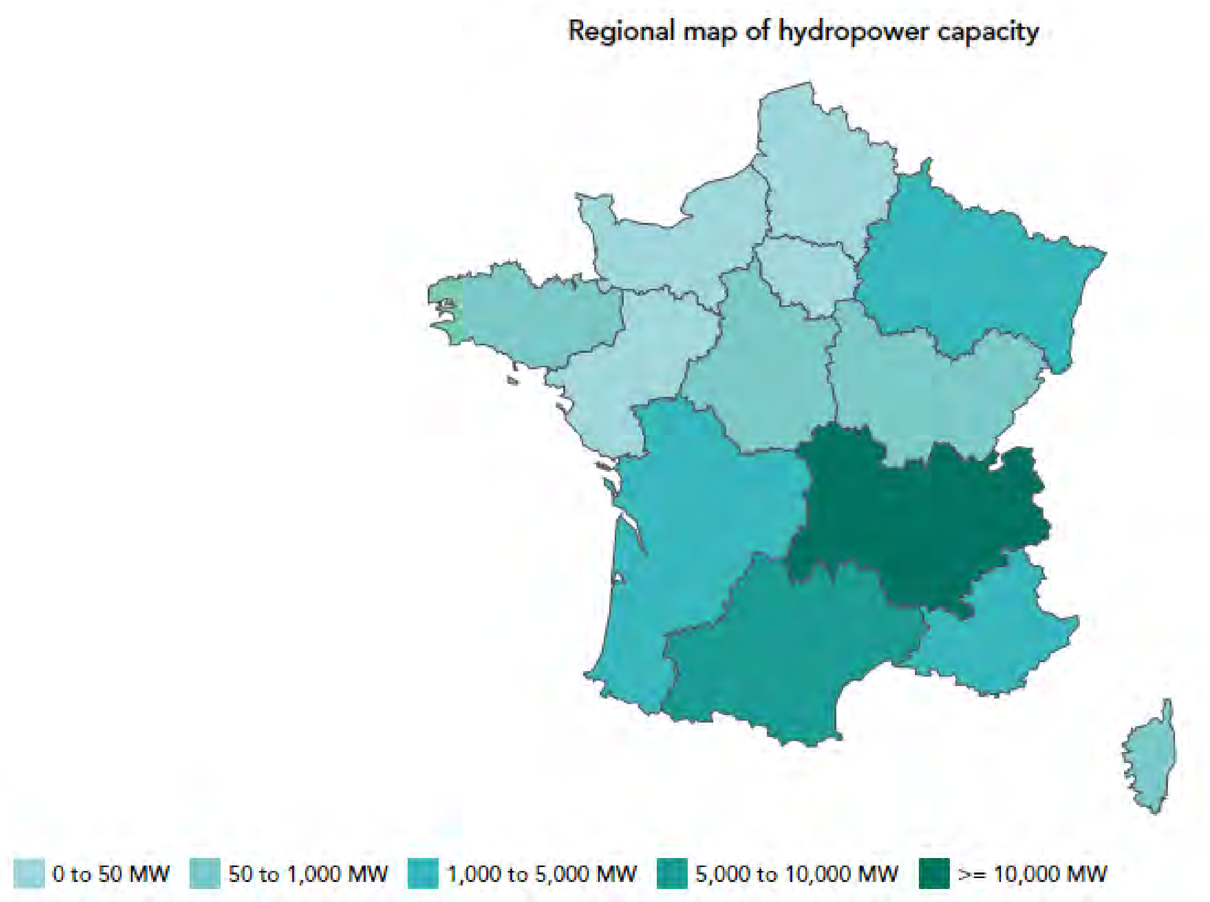
Nuclear generation covers demand in the Centre-Val de Loire nearly four times.



See additional SEI data in: Electricity Report for SEI, Corsica and Overseas Territories

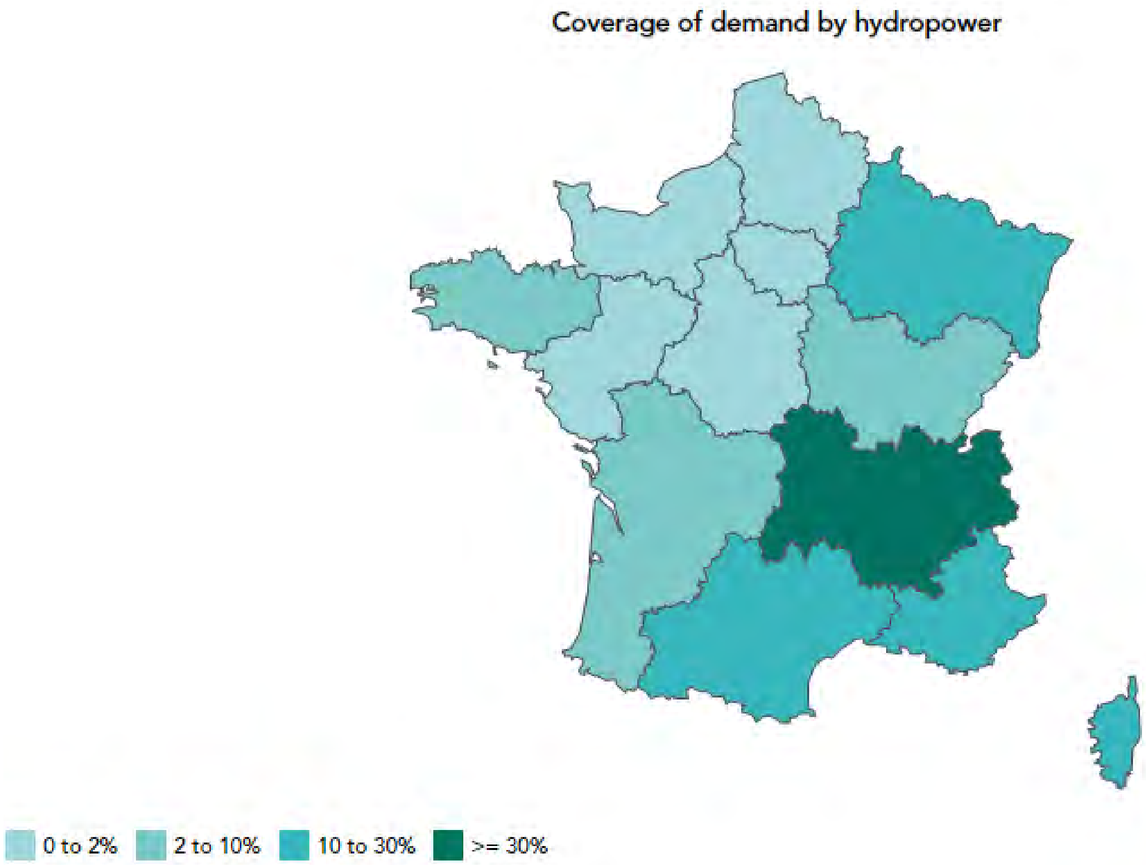
Hydropower (breakdown in MW)

With 25.5 GW of installed capacity, hydropower generation in France is divided unevenly across the country.
Regions with large mountainous areas (Auvergne-Rhône-Alpes, Occitanie and Provence-Alpes-Côte d'Azur) are home to more than 79% of total French hydropower capacity. Most of the facilities are hydroelectric dams, notably with water reservoirs and poundage. Hydropower generation capacity in other regions is less significant and often relies on run-of-river plants or those with poundage.



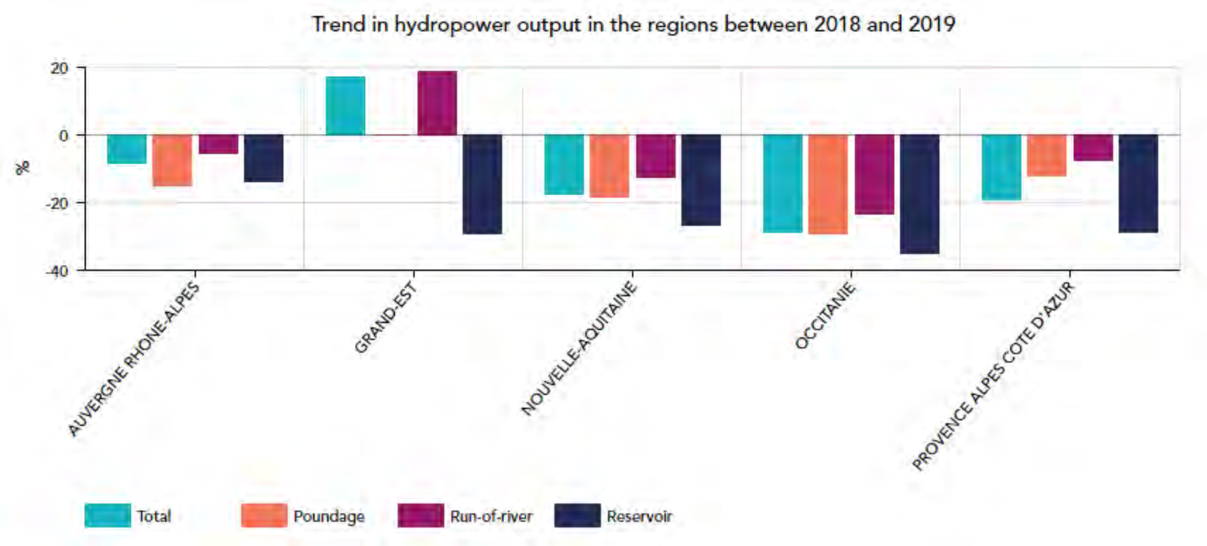
Coverage of demand (%) by hydropower

Coverage of demand by hydropower generation is highest in the Auvergne-Rhône-Alpes, where it exceeds 40%.



Impact of rainfall on hydropower output

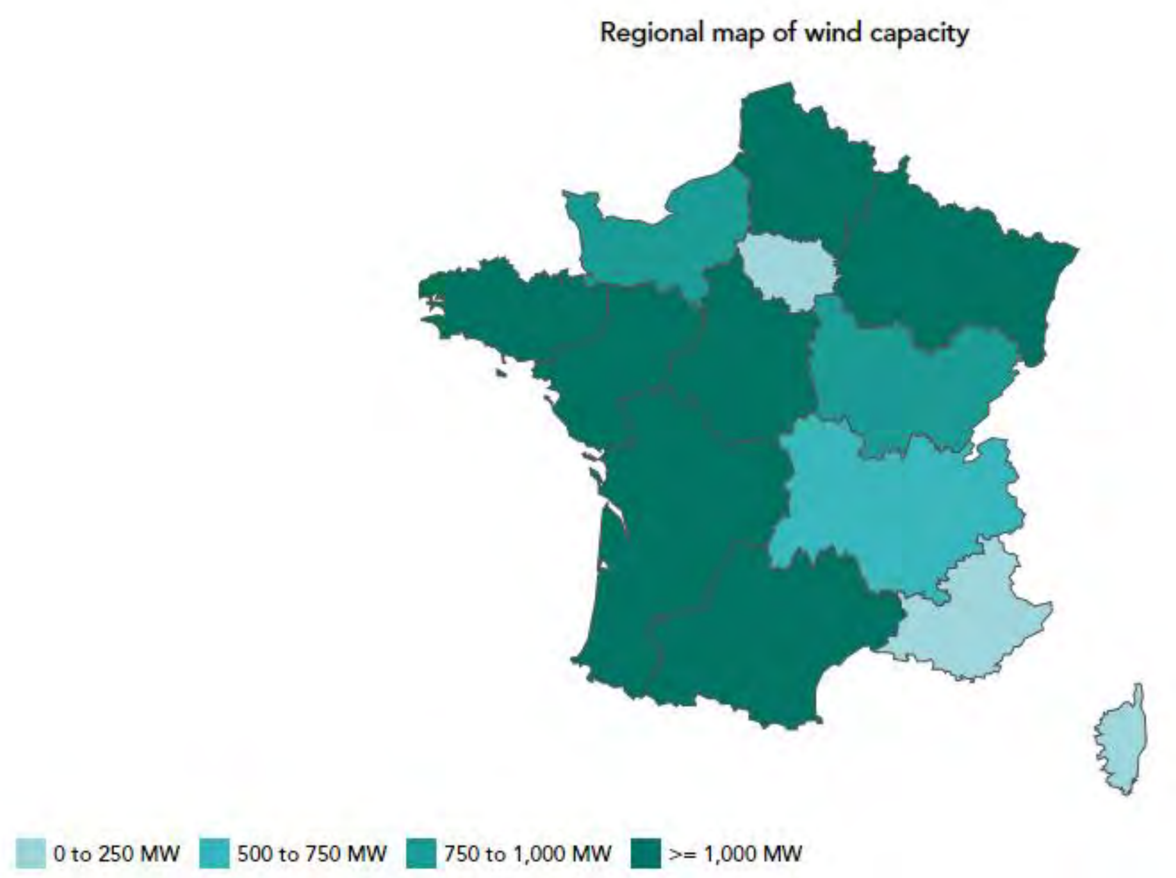
Annual fluctuations in hydropower generation are closely correlated to precipitation. As France saw significantly less rainfall in 2019 than in 2018, hydropower generation declined across all regions except Grand Est.



SEI data can be found in: Electricity Report for SEI, Corsica and Overseas Territories

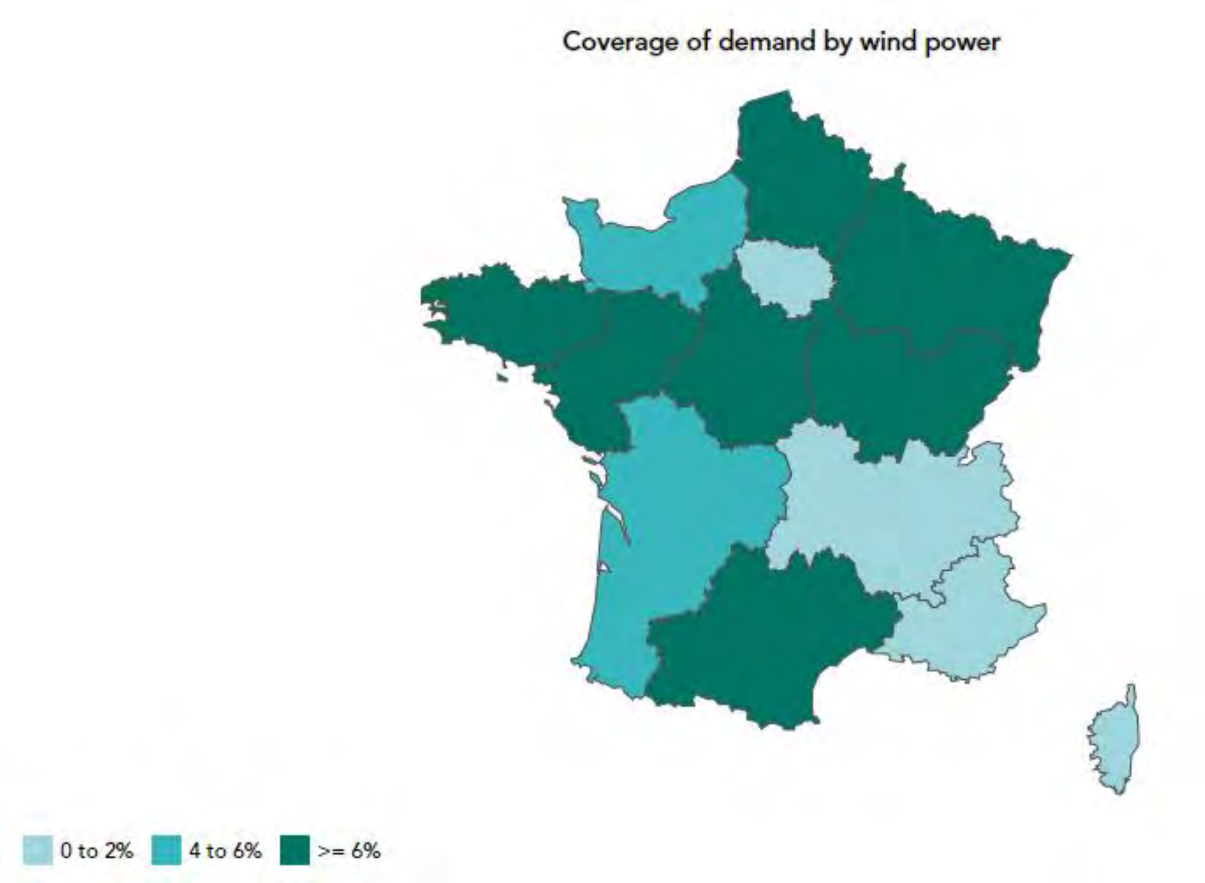
Wind power (breakdown in MW)

Climate conditions (wind regimes), environmental constraints and local political priorities explain the differences between wind power development rates. The two regions that have the most wind capacity installed are Hauts-de-France (4.5 GW) and Grand Est (3.6 GW). Capacity increased by more than 10% in these regions between 2018 and 2019.



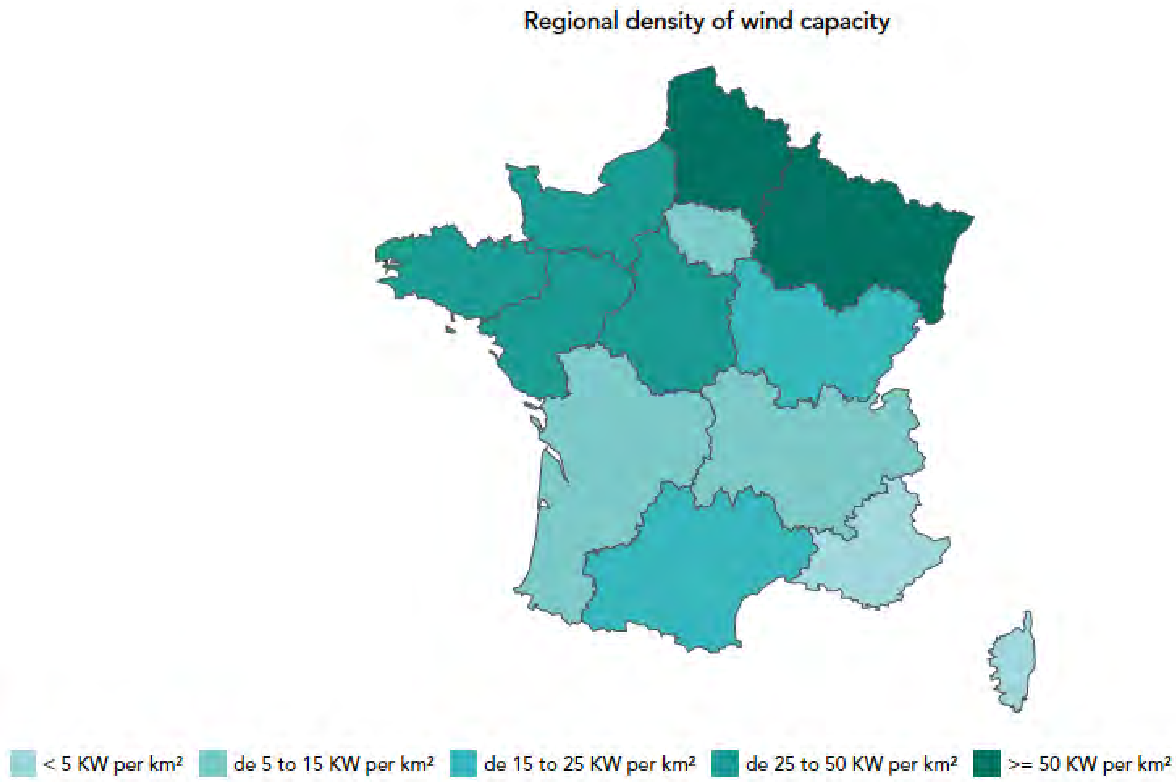
Coverage of demand (%) by wind power

Coverage of demand by wind power reached 7.5% in the French regions and exceeded 14% in the Hauts-de-France, Grand Est and Centre-Val de Loire regions.



Regional density of wind capacity

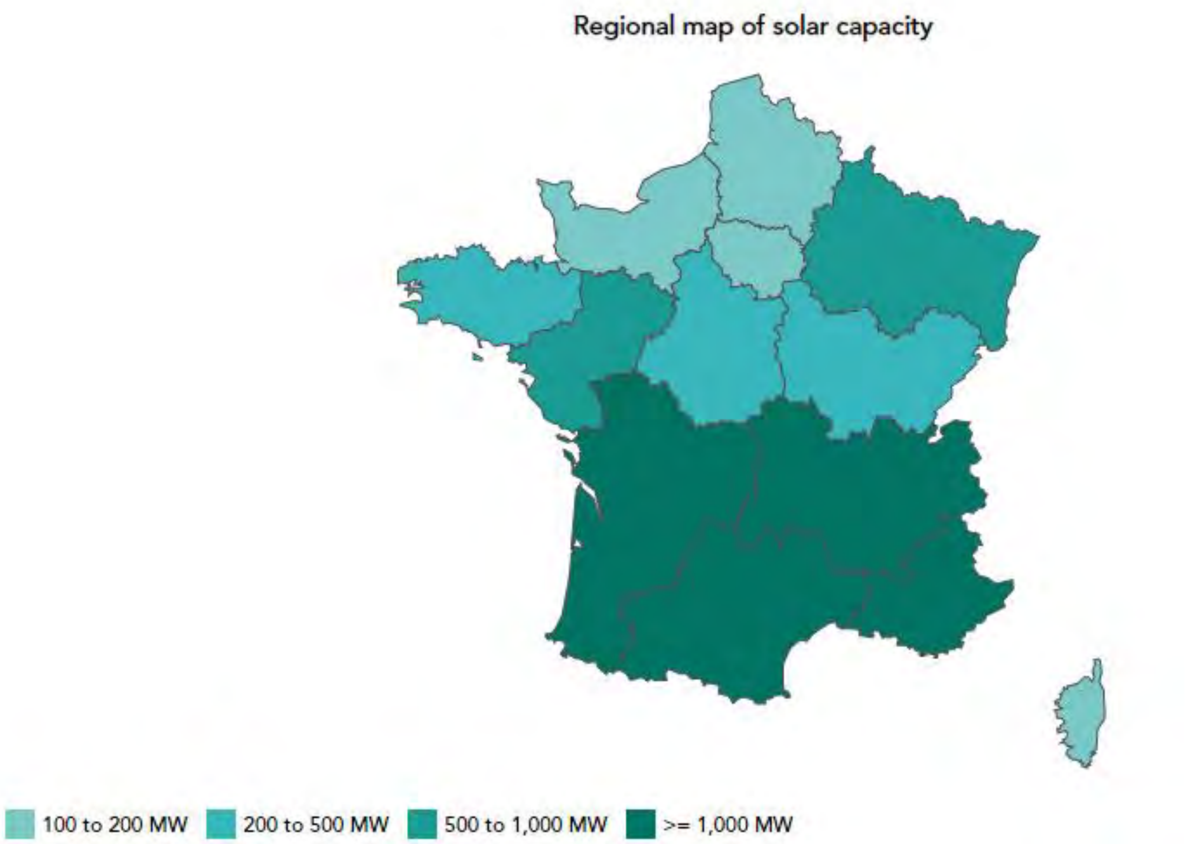
Density is a calculation of wind capacity per square kilometre in each region. The Hauts-de-France region has the most installed capacity and the highest density. Occitanie ranks third in terms of capacity but seventh in terms of density, below the national average of 22.4 kW per square kilometre.



See additional SEI data in: [Electricity Report for SEI, Corsica and Overseas Territories]

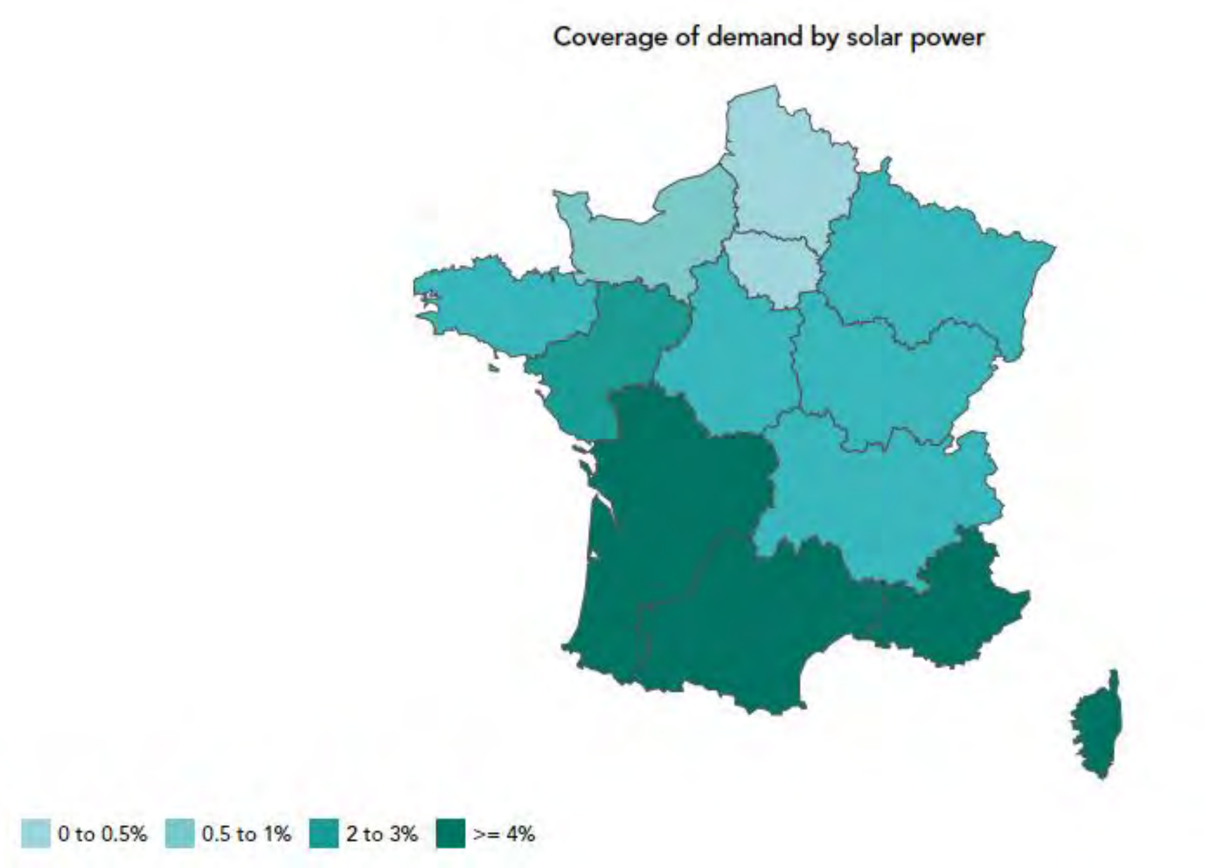
Solar power (breakdown in MW)

Four regions have more than 1 GW of installed solar capacity: Nouvelle-Aquitaine, Occitanie, Auvergne-Rhône-Alpes and Provence-Alpes-Côte d'Azur. These regions account for more than 73% of installed solar capacity in France, due to their geographic location in the southernmost part of the country, where conditions are favourable for solar power development. The Auvergne-Rhône-Alpes region saw the sharpest increase in capacity during the year (more than 19%).



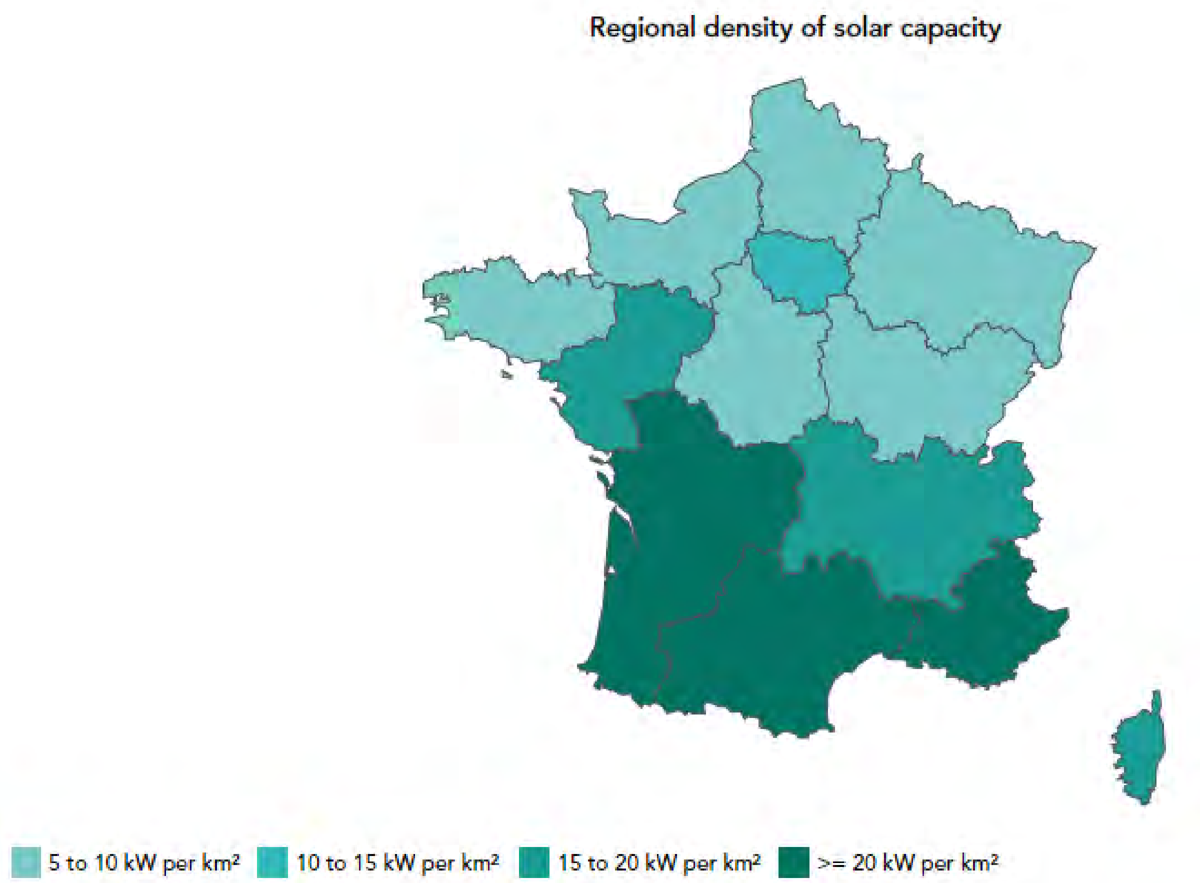
Coverage of demand (%) by solar power

Coverage of demand by solar power exceeded 5% in Corsica, Occitanie and Nouvelle-Aquitaine.



Regional density of solar capacity

Density is a calculation of installed solar capacity per square kilometre in each region. Provence-Alpes-Côte d'Azur has the highest density, but ranks third nationally in terms of capacity. Conversely, the Auvergne-Rhône-Alpes region ranks fourth in terms of capacity but its density is below the national average of 15.3 kW per square kilometre.

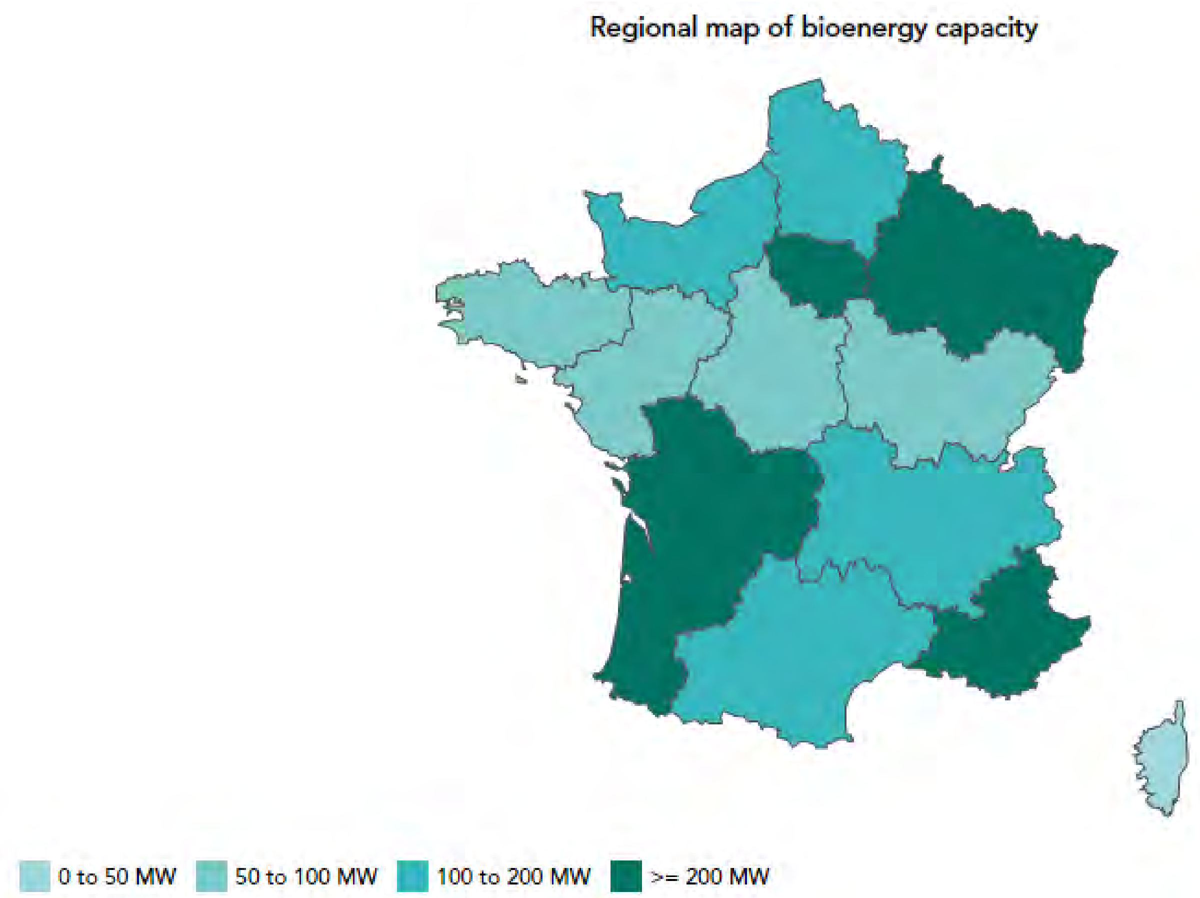


See additional SEI data in: [Electricity Report for SEI, Corsica and Overseas Territories]

Fossil-fired thermal | Nuclear | Hydro | Wind | Solar | Bioenergy

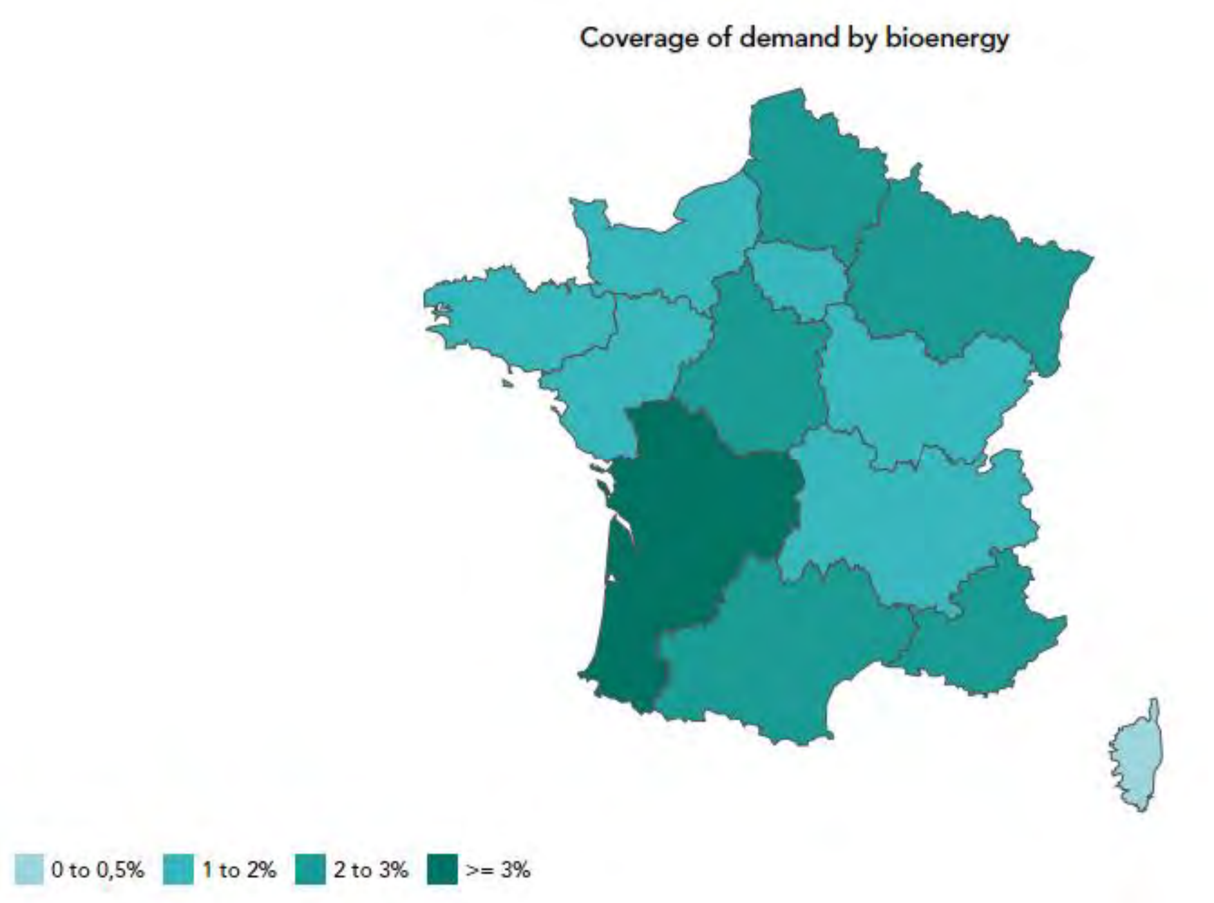
Bioenergy (breakdown by MW)

Bioenergy plants are found throughout France. The Ile-de-France, Nouvelle-Aquitaine and Provence-Alpes Côte d’Azur regions are each home to more than 14% of the country’s total bioenergy capacity.



Coverage of demand (%) by bioenergy

Coverage of demand in the French regions by bioenergy generation is highest in Nouvelle-Aquitaine, where it exceeds 3%.



See additional SEI data in: Electricity Report for SEI, Corsica and Overseas Territories

The transmission network

How the network evolved in 2019

105 942 km

Total length of lines in service

6.415 km
Underground lines

99.527 km
Overhead lines

Length of lines

RTE is the largest transmission system operator in Europe with 105,942 km of lines in service. As the operator of the French power system, its mission is to offer customers access to an affordable, safe, clean electricity supply today and tomorrow. This notably requires investing steadily to build a transmission network that can support the economy and energies of the future.

Highlights of 2019 included:

The inauguration of the new Quatre Seigneurs–Saumade underground 225 kV cable in the Hérault region;

The replacement of the Argia–Mouguerre underground 225 kV cable with an underground cable equipped with smart sensors in Pyrénées-Atlantiques;

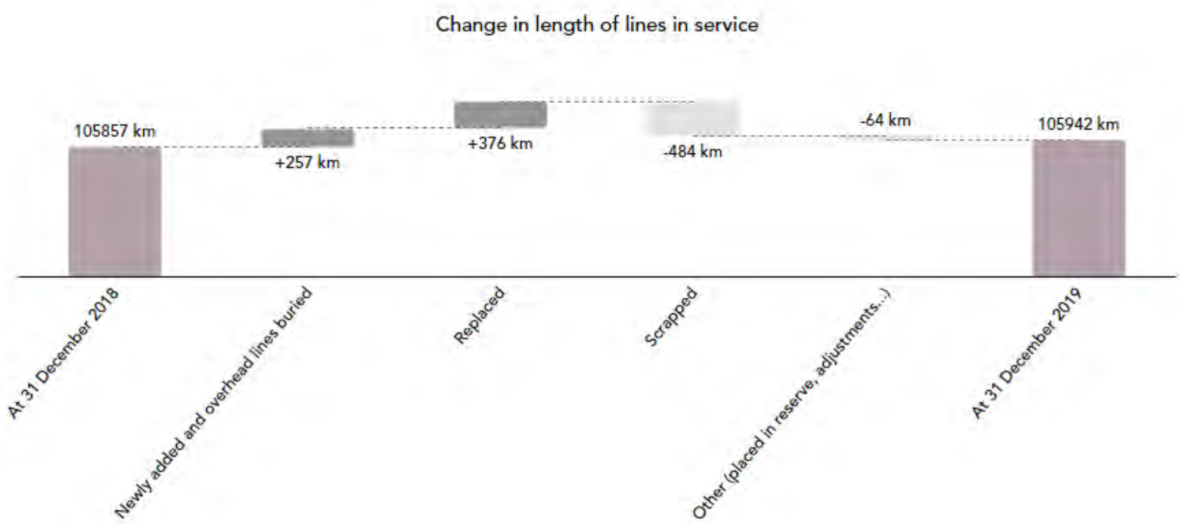
The undergrounding of the Castelnau–Fréjorgues–Montpellier–Pastourel 63 kV link around Montpellier as part of a "MESIL" project (undergrounding by local initiative);

The commissioning of the l'Argentière–Serre-Barbin underground 63 kV line in Hautes-Alpes as part of the plan to upgrade the power system in Haute-Durance.

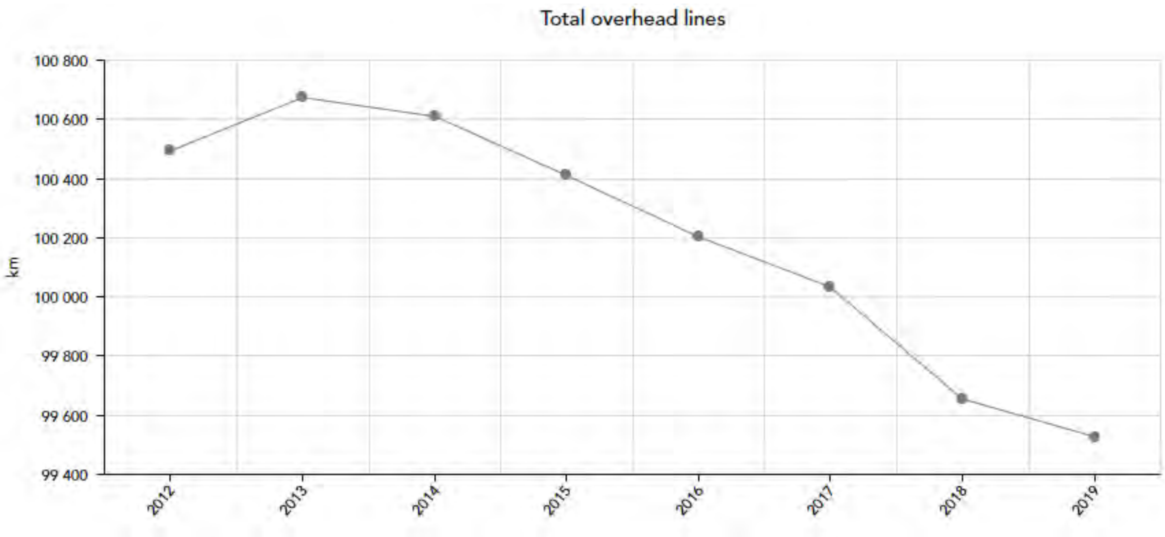
New underground cables (newly created or overhead lines newly undergrounded) totalled 219 km, while 477 km of overhead lines were taken down (permanently or to be replaced) during the year.

The length of the network increased by 85 km year-on-year in 2019.

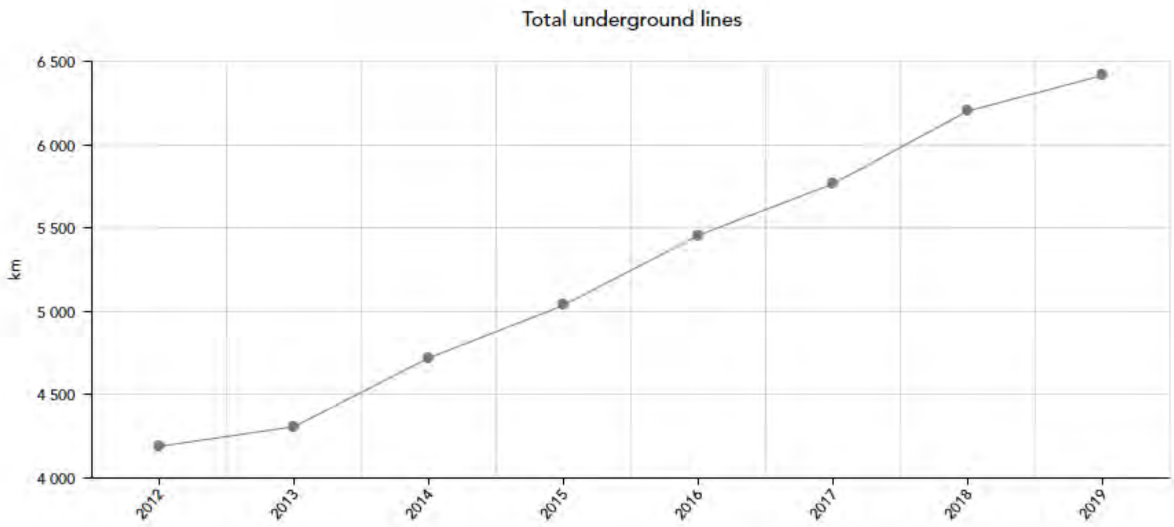
Length of lines in service (km)	Overhead	Underground	Total
At 31 December 2018	99,655	6,202	105,857
New	401	232	633
Newly added	*38*	*160*	*198*
Replaced	*363*	*13*	*376*
Overhead lines buried	*0*	*59*	*59*
Scrapped	-477	-7	-484
Other *(placed in reserve, length adjusted, etc.)*	-52	-12	-64
At 31 December 2019	**99,527**	**6,415**	**105,942**
Change 2018 to 2019	-128	213	85



The total length of overhead lines on the transmission network continued to decrease, falling to 99,527 km.



The total length of underground lines in service rose further, to 6,415 km.



Substation connections

Along with power lines, substations play an important role in keeping the grid operating smoothly as they receive electrical energy and then transform and distribute it. They too require continued investment.

Sixteen new substations were connected to the transmission system in 2019, including **nine** that are 225 kV.

Two inaugurations were particularly worthy of note:

- Montgros, 225 kV, in Lozère (to improve quality of supply in that department and to support the energy transition);
- Saverdun, 63 kV, in Ariège (to increase the region's power of attraction with the connection of an SNCF traction substation).

New and replaced lines

633 km

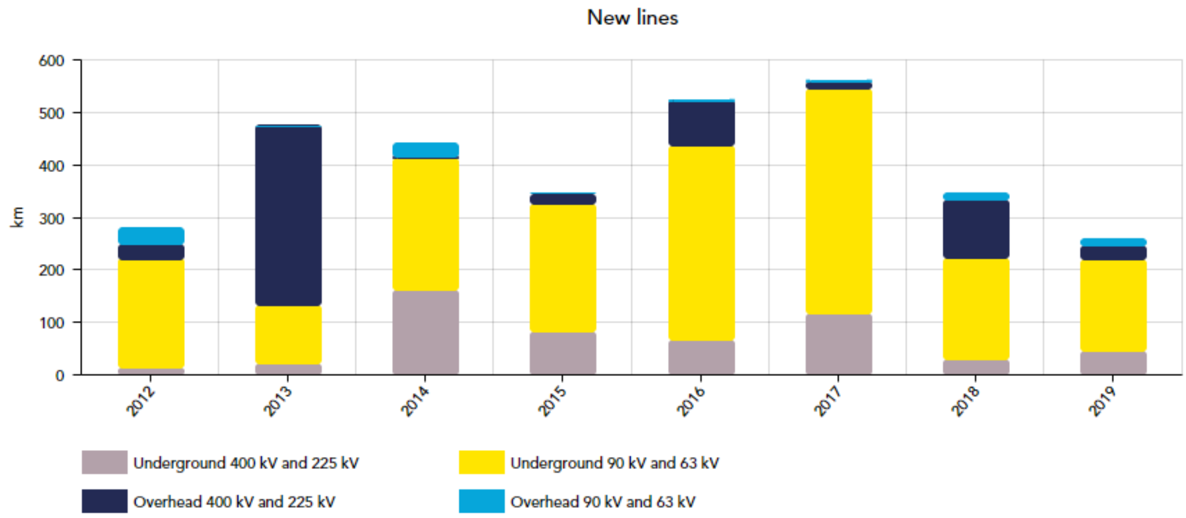
Length of new power lines added in 2019

257 km
New lines added

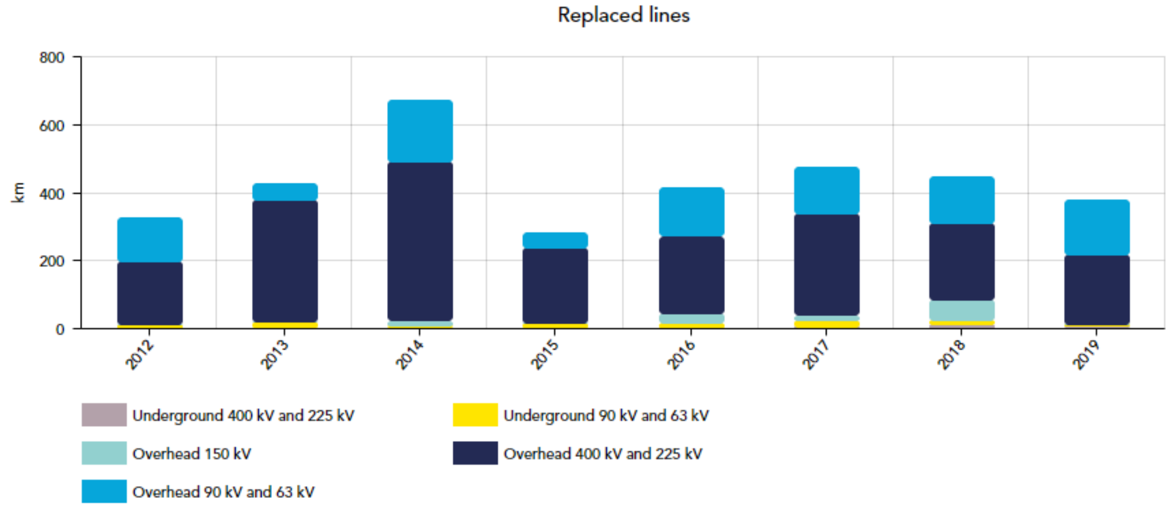
376 km
Lines replaced

The underground network continued to expand

More than 257 km of new lines were added to the public transmission network in 2019 (including overhead lines that were undergrounded).



RTE also replaced more than 376 km of overhead and underground lines on its network.



A closer look

As part of its public service contract with the French state, signed in May 2017, RTE committed to not increase, and even to decrease, the total length of overhead lines on its network (see chart, total overhead lines).

Since 2017, 95.5% of the new 90 kV and 63 kV lines brought into service have been underground. RTE is also working to “take down” existing overhead lines. As technologies evolve, RTE is burying high-voltage lines more and more often.

Underground lines current represent:

- 8.6% of all 63/90 kV lines;
- 5.6% of all 225 kV lines;
- a negligible share of 400 kV lines (0.03%).

400 kV and 225 kV Voltages

Underground

A total of 45 km of new 225 kV underground lines were brought into service in 2019. The main completions were:

- The 225 kV *Quatre Seigneurs–Saumade* underground line in the Hérault, to enhance security of supply in the Montpellier metropolitan area;
- The commissioning of the 225 kV *Béziers-Est-St-Vincent* double-circuit line in the Hérault, to increase security of supply in the Béziers metropolitan area;
- The inauguration of the 225 kV *Grimaud–Trans* line in the Var, to enhance security of supply in that department;
- The commissioning of the 225 kV *Saclay–St-Aubin* and *Saclay–Villeras* lines in the Essonne, to connect a substation.

Overhead

RTE replaced conductors on nearly 205 km of overhead lines operated at voltages of 400 kV and 225 kV in 2019, primarily as part of:

- The replacement of the 225 kV *Châtillon-sur-Seine – Darcey – Rosières* line in Côte-d'Or;
- The replacement of the 400 kV *Chesnoy – Cirolliers* line in Essonne and Seine-et-Marne;
- The inauguration of the 225 kV *Grimaud – Trans* line in the Var, to enhance security of supply in that department;
- The replacement of the 225 kV *Carrières – Roye – Valescourt* line in the Oise.

63 kV and 90 kV Voltages

Underground

The length of underground lines operated at voltages of 63 kV and 90 kV increased in 2019, as 175 km of new lines were added. RTE notably brought into service:

- The *Gourdan – Lestelle* 63 kV line in the Haute-Garonne;
- The *l'Argentière – Serre-Barbin* 63 kV line in the Hautes-Alpes;
- The *Bains-les-Bains – Pouxeux* 63 kV line in the Vosges;
- The *Langogne – Montgros* 63 kV line in the Lozère.

Overhead

Conductors were replaced on certain 63 kV and 90 kV overhead lines representing 159 km in all. Examples included:

- The *Grisolles – Montdauphin* 63 kV line in the Hautes-Alpes;
- The *Baraqueville – Thuries – Pré-Grand* 63 kV line in the Tarn;
- The *Armonville – Thionville* 90 kV line in the Loiret;
- The *Changy – Riorges* 63 kV line in the Loire.

2019 highlights

Commissioning of the 225 kV Montgros substation in the Lozère

Located at an historic crossroads of power lines, this new substation will improve the quality of electricity supply and facilitate the energy transition in the department.

The network in the upper Allier valley was built in the 1930s. One of the first to have electricity in France, the area is at the crossroads between the Lozère, Ardèche, Haute-Loire and Cantal departments. The construction by RTE of the *Montgros* substation and its connection to the existing substation in Langogne will start a new chapter in this story. Thanks to RTE's €30 million investment, the electricity network in the Lozère will be stronger thanks to the existence of two 225 kV substations.

RTE notably went out of its way to protect the local landscapes and environment. All new lines were built underground, so no new towers were added.

A total of 14 km of underground cables were also added between *Montgros* and *Langogne*.

To learn more, see the report on this project in RTE's magazine, MAG RTE&Vous.

Inauguration of the new 225 kV Quatre Seigneurs – Saumade underground line

To sustainably increase security of supply to the northern part of the Montpellier metropolitan area, RTE built a new underground line between the Quatre Seigneurs and Saumade substations. Work began on this 7.8 km link late in November 2017 and was completed in 2019. This new underground line, a project undertaken by RTE for the benefit of the local community, gave the Montpellier metropolitan area a network connecting five substations capable of backing one another up starting in the winter of 2018. This will secure safe and quality electricity for a metropolitan area that will see a rise in power demand over the coming decades as it expands.

“MESIL” (local undergrounding initiative project) in Montpellier

In 2018, RTE began work to bury three power lines in the eastern part of the Montpelier metropolitan area as part of a local undergrounding initiative (MESIL) project. By the end of 2020, RTE will remove 36 towers between the A709 motorway and Domaine de Verchant, passing through the Port-Marianne districts, eliminating a total of 13 km of overhead lines. This project is part of the plan to encourage economic development in the eastern part of the metropolitan area. Work is scheduled to be completed by the end of 2020, when the new underground lines will be commissioned.

The three lines in question are the 225 kV *Saumade – Tamareau* link, the 225 kV *Montpellier – Pont Trinquat – Saint-Christol* link and the 63 kV *Castelnau – Fréjorgues – Montpellier – Pastourel* link.

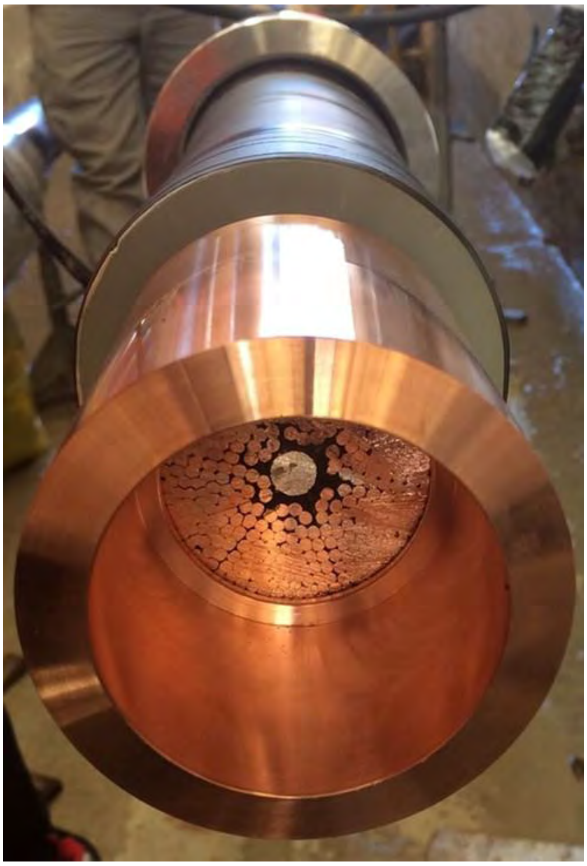
Upgrading the electricity network in Haute-Durance

A new 63 kV overhead/underground power line between l’Argentière and Monêtier-les-Bains was brought into service as part of the plan to upgrade the electricity network in the Haute-Durance. The new line will strengthen the existing network, which was built in the 1930s and recently weakened by sticky snow.

Inauguration of the Saverdun 63 kV substation in Ariège

This substation is supporting the region’s economic development, making it possible for a titanium investment casting foundry that supplies aerospace parts to move into Mazères and for an SNCF traction substation to be connected. It is facilitating the energy transition in Ariège by allowing the accommodation of renewable energies: two photovoltaic plant projects under review could feed local distribution networks alongside existing hydropower generation. It is also helping to improve quality of supply for the 5,000 residential and business customers in the region, a number that has been rising steadily due to the region’s demographic growth.

Replacement of the 225 kV Argia – Mouguerre underground cable with an underground line equipped with smart sensors



This underground line is improving security of supply to the Basque Country and is a first in terms of combining electricity and digital technologies.

With a budget of €10 million, the objectives of the project are twofold:

- Strengthen the link between Villefranque and Mouguerre, with additional support from the installation of two new transformers (400 kV and 225 kV) at the Argia substation (Villefranque);
- Install optical fibre directly inside the cables and sensors on the outside. With this technological first, RTE will be able to gather data in real time (temperature, vibrations, etc.) and thus optimise management of the cables while preventing and anticipating potential failures. The vibration sensors will also improve security around RTE infrastructure.

RTE investments

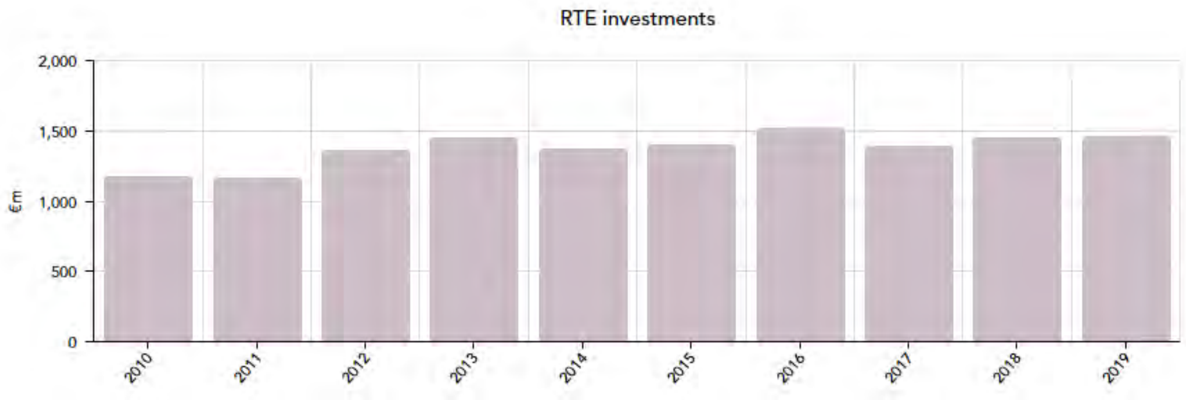
1 456 M€	1 161 hectares
RTE investments in 2019	Developed as biodiversity-friendly areas

RTE invested €1,456 million in 2019

RTE’s investments within the scope of businesses regulated by the CRE (Energy Regulatory Commission) totalled €1,456 million in 2019. Investments were concentrated mainly on continuing work on the new interconnector with England (IFA2), the DC interconnection between France and Italy passing through the Fréjus safety tunnel (“Savoy – Piedmont”), and the restructuring of the 225 kV network in Haute-Durance.

Work also continued during the year on the Avelin – Gavrelle and Carrières – Breteuil – Valescourt projects, and initial investments were made in the Saint-Nazaire project.

The RTE investment programme approved by the regulator for 2020 totals €1,808 million. The increase relative to 2019 is explained by a combination of projects: completion of work on the Savoy – Piedmont interconnection, continuation of work on the IFA2 interconnection and Haute-Durance project, and the ramp-up of work on connections for offshore wind farms, the Avelin – Gavrelle project, and local undergrounding initiatives related to the 2024 Olympic Games. Lastly, the budget includes investments relating to the connection of the CCGT plant in Landivisiau.



RTE is standing up for the environment and biodiversity

RTE is taking action to reduce the environmental impact of its activities by utilising resources and energy more efficiently. For instance, in 2004, RTE launched an initiative to reduce leakage of SF6, which has a strong greenhouse gas effect. SF6 is currently used to insulate high-voltage equipment. It can be found in SF6 circuit breakers (present in most overhead transformers) and gas-insulated substations, whether inside buildings or outdoors. SF6 emissions reached 4.9 tonnes in 2019. Implementation of a leak recovery solution is expected to translate into further improvement.

RTE is also forging partnerships to turn its power line corridors into corridors of biodiversity. Nearly all of RTE's infrastructure is located in agricultural areas (70%) or wooded regions (20%), and some 23,000 km of power line corridors cross through protected natural areas.

Protecting and encouraging the development of biodiversity are cornerstones of RTE's environmental policy. Its commitment is recognised as part of the "2011-2020 National Strategy for Biodiversity" by the Ministry of Ecology.

In 2019, RTE developed a total of 1,161 hectares as biodiversity-friendly areas through partnerships with local players, strengthening the company's roots in the French regions.

Detailed sustainable development information can be found in RTE's Management Report, published in March.

Map of main projects under way

A closer look

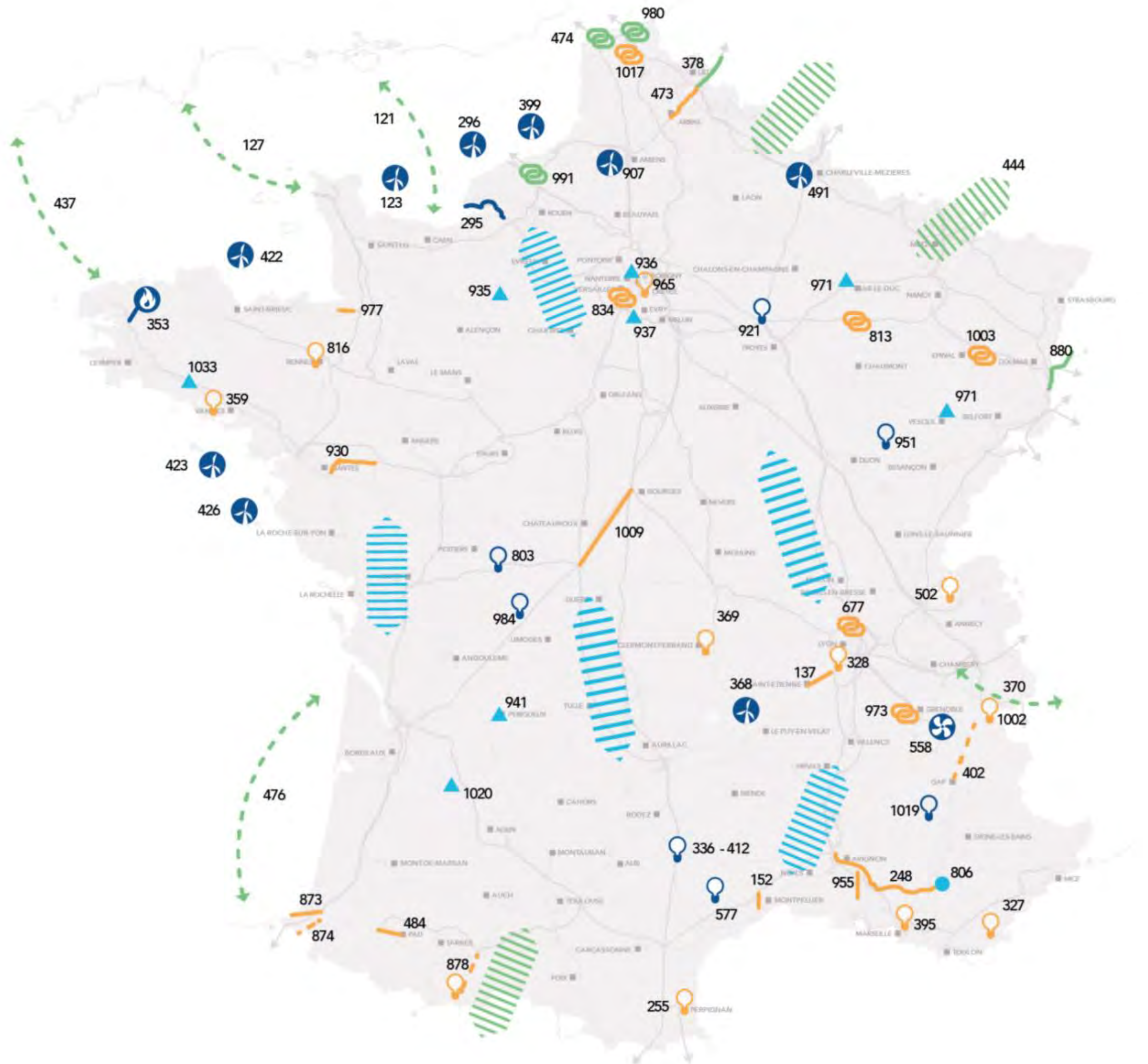
Ten-year Network Development Plan

For the 2019 edition of its Electricity Report, RTE is presenting a new Ten-Year Network Development Plan, expanded and reorganised to highlight how the energy transition will force networks to evolve. It contains operational recommendations for implementing the Multiannual Energy Programme and was drafted based on broad public consultation with stakeholders. The plan covers all the issues the transmission network must address – industrial, societal, environment and financial (capital expenditure and operating expenses), and sets forth detailed financial trajectories. The time horizon is 15 years (2021-2035), comparable to the general timeframe for the Multiannual Energy Programme and the scenarios in the Generation Adequacy Report published in November 2017. Lastly, the plan was voluntarily subjected to a strategic environmental assessment with assistance from a specialised consultancy.

To find out more about network development, see the Ten-Year Network Development Plan.

Map of main projects under way and planned

The scope and nature of the projects undertaken or scheduled to be brought into service over the coming years reflect the changes taking place in the energy sector, including the stabilisation of electricity consumption and growth in renewable energy sources.



Key infrastructure brought into service in 2018

RTE INFRASTRUCTURE
- Strengthening of existing line
- Creation of new line
- Strengthening being studied (need, type and location to be determined)
- Creation or strengthening of substation

CONNECTION
- Combined-cycle gas, nuclear
- Wind/Solar
- Marine/Hydro
- Consumption/Interconnection

MAIN GOAL OF PROJECTS
- Security of supply and easier assistance between regions
- Preparation for new energy mix
- Preservation of the power system
- Increase in exchange capacity at interconnections

GOAL : POWER SYSTEM SECURITY
- High voltage management
- Management of short-circuit intensity
- Grid stability

Celtic project

The aim of the Celtic Interconnector project, led by RTE and its counterpart EirGrid, is to create a high voltage direct current (HVDC) line, spanning about 575 km (of which about 500 km subsea), allowing direct electricity exchanges between France and Ireland. With a capacity of 700 MW, the cable will be routed between the northern coast of Brittany and the southern coast of Ireland.

This France-Ireland interconnection project will help further the European Union’s energy transition and climate change goals by favouring the development of renewable energies and the shift toward a low-carbon electricity mix. It will also strengthen energy solidarity between the two countries.

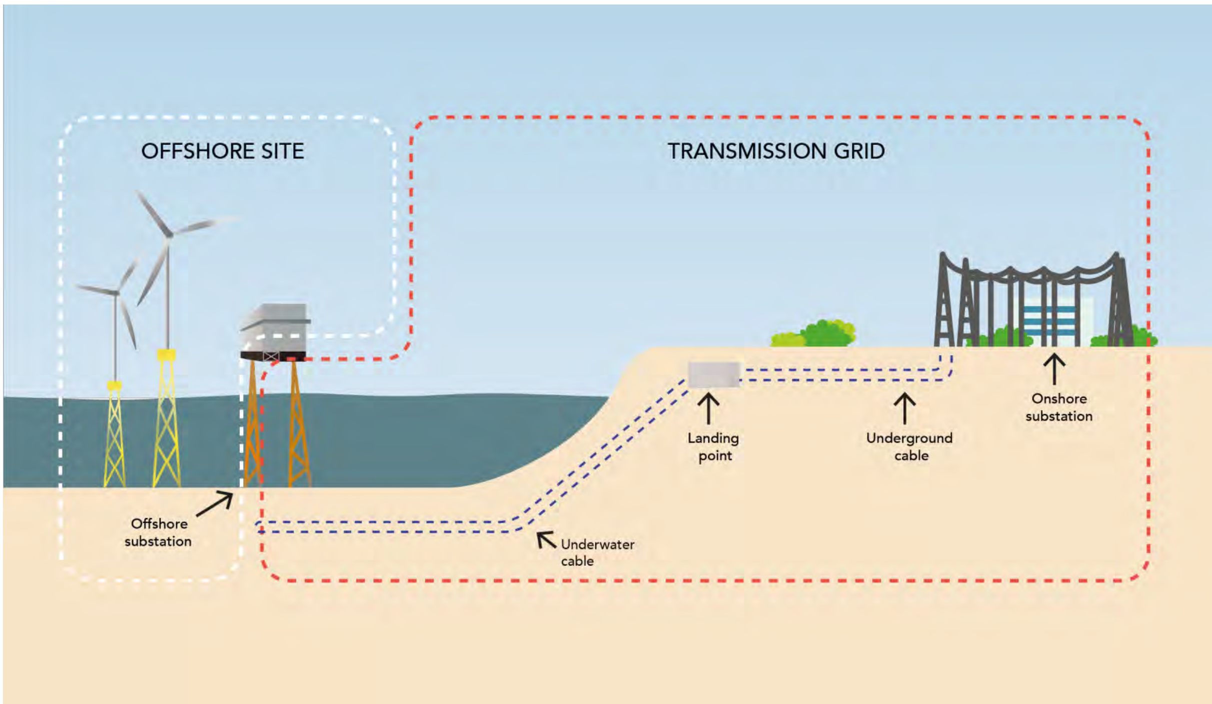
More information can be found here.

Haute-Durance project

Power is supplied to Haute-Durance primarily via a single 150 kV line built in 1936. The region now finds itself in a vulnerable position, particularly when demand peaks in winter. The programme RTE designed for the department is divided into six projects. It involves replacing the existing 150 kV network with a 225 kV network, and upgrading the 63 kV network (undergrounding, reconstruction or strengthening) all while protecting the local environment. The programme is being carried out through 18 work projects that will be staggered over time until the last step is completed in 2020.

Connecting offshore windfarms

France's Multiannual Energy Programme calls for the installation of 3,000 MW of offshore wind capacity by 2023. Offshore development offers significant power generation potential given the country's natural assets (11 million km^2 of water in its jurisdiction). The highest-potential areas are concentrated off the coasts of Normandy, Brittany and Pays de la Loire. The government launched two tenders for the construction of offshore windfarms in these areas, followed by a third late in 2018 for a project off the coast of Dunkirk. RTE is in charge of studies and connecting these farms to the grid. The solution being considered involves creating 225 kV double-circuit lines, starting out underwater between the windfarm connected to the offshore substation and the landing point and then running underground between the landing point and the 225 kV substation where they are earthed.



The sites selected through the first call for tenders have already been the subject of consultations with local stakeholders, government services and infrastructure operators to determine the best possible path for the lines from a technical, economic and environmental standpoint. Late in 2015, public inquiries were launched for the projects in the towns that will be affected by the future Fécamp, Courseulles-sur-Mer, Saint-Nazaire and Saint-Brieuc windfarms. Production is not scheduled to start at these sites until 2021.

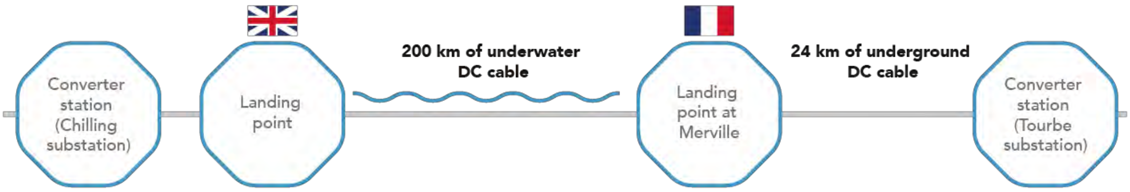
Bay of Biscay

The Bay of Biscay project involves creating a new interconnection between France and Spain. Scheduled to go into service in 2025, it will boost exchange capacity between the two countries to almost 5,000 MW. This new 370 km link will run from the substation in *Cubnezais* (near Bordeaux) to the one in *Gatika* (near Bilbao), and will be the first France-Spain interconnection that is partially underwater.

The France-Spain electricity interconnection across the Bay of Biscay, which Europe has declared a Project of Common Interest, is being carried out by INELFE, the company set up by RTE and its Spanish counterpart REE (Red Eléctrica de España). More information about the project is available [here.]

IFA2

Conducted in cooperation with UK transmission system operator National Grid, the IFA2 project (construction of a new France-England interconnection) is part of the plan to support the energy transition and enhance security of electricity supply in both countries.



The project involves creating a DC line around 225 km long between Tourbe, which is located south of Caen, and Fareham in England. Converter stations at both ends will transform the DC into AC so the line can be connected to the transmission grid. The future interconnector will have transmission capacity of 1 GW.

Savoy-Piedmont project

Launched in the spring of 2015 and conducted in partnership with RTE's Italian counterpart TERNA, this project involves building a new France-Italy interconnector between the substations at *Grande-Ile* (Sainte-Hélène du Lac) and *Piossasco* (Turin), an underground DC line almost 190 km long. The new line will represent a bona fide technological feat and help increase mutual assistance possibilities in Europe by boosting exchange capacity between these two countries by 60%.

More information about this project can be found on the RTE website.

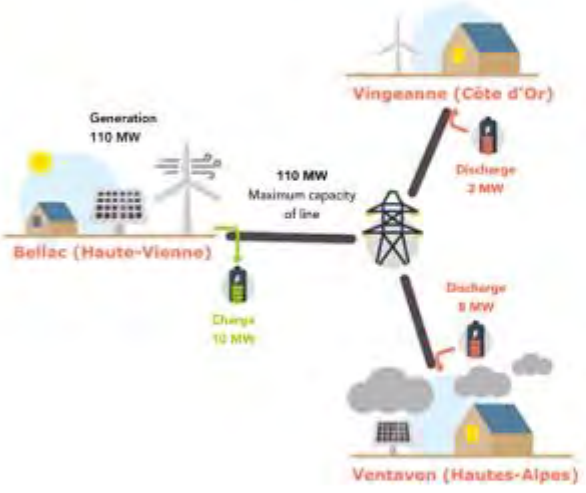
More flexibilities will be vital for the electric grid

Based on the targets the European Commission and French government have set for the energy transition, RTE estimates that the electric grid will require significant additional flexibilities starting in 2030. RTE has begun launching experiments in France so the flexibilities needed can be identified and deployed.

The power system can absorb the level of renewable energy development called for in the Multiannual Energy Programme, which was open to public consultation. With its current scale, the existing grid, combined with the deployment of automated machines and digital technologies, will be able to integrate the new generation capacity planned over the period.

Beyond the timeframe of the Multiannual Energy Programme, the grid will require additional flexibilities, whether in the form of increased demand-side management, mobilisation of different forms of storage (distributed or large-volume) and hydrogen, depending on the energy mix scenario.
RTE has launched an experiment called “RINGO” to test electricity storage on its grid at three sites in France.
RTE selected three sites and three different consortia for this experiment: the test at Vingeanne (Côte d’Or) will be handled by Nidec Asi, the one at Bellac (Haute-Vienne) by Saft/Schneider, and the one at Ventavon (Hautes-Alpes) by Blue Solutions/Engie Solutions/SCLE INEO.

Work on these projects will get under way in 2020.



Electricity quality

3 min 25s
Equivalent outage time in 2019

0,37
Outage frequency per site in 2019

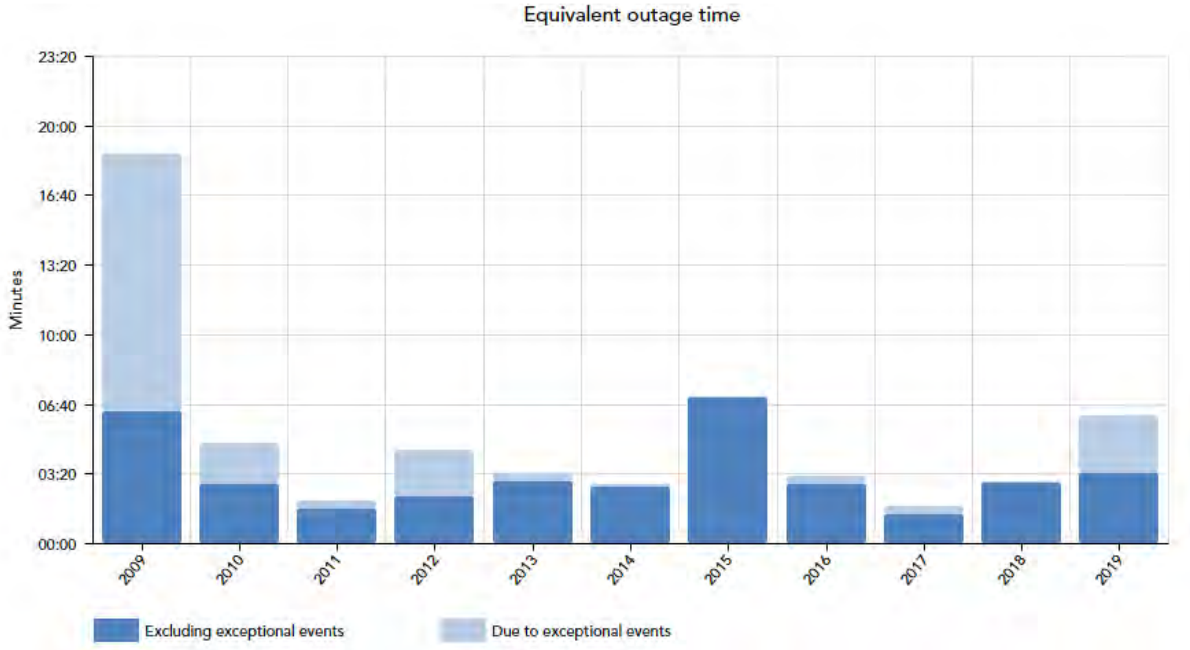
Electricity quality reflects two complementary measurements: the quality of voltage and continuity of supply.

Voltage quality can be affected by different types of disruption. It is important to draw a distinction between disruptions that are momentary, resulting from a one-time event (events affecting grid components, weather conditions, equipment damage, actions of third parties, etc.), and phenomena that continuously affect the nominal characteristics of the voltage wave, related to the operations of facilities connected to the grid or fluctuations in consumption and generation.

Continuity of supply is the grid's ability to continuously supply power to all customer points of delivery. It may be affected by interruptions in supply or outages (for instance a lightning-related weather event). Continuity of supply is estimated based on equivalent outage time and outage frequency.

Equivalent outage time

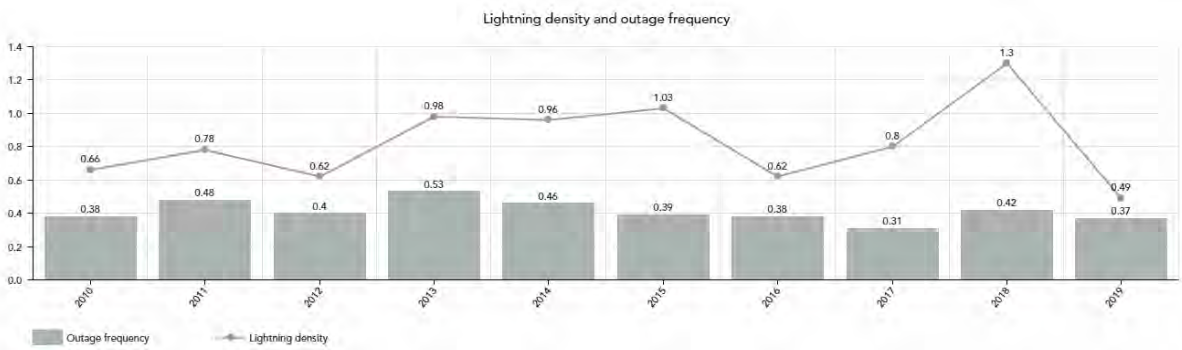
In 2019, equivalent outage time was 3 minutes 25 seconds, excluding exceptional events.



Lightning density: A calmer year

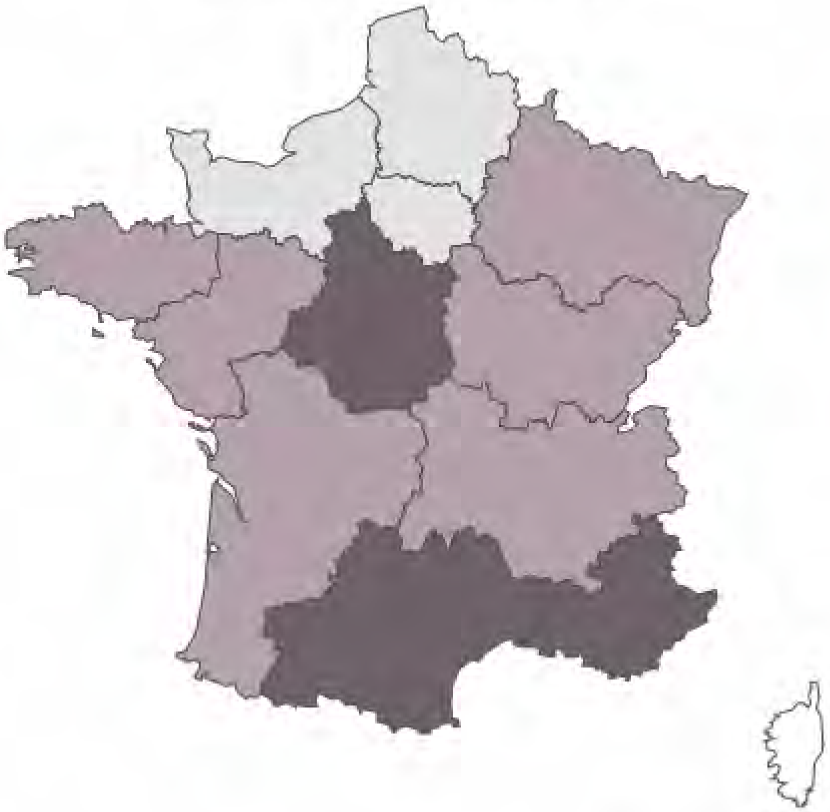
Lighting density is a leading cause of the brief outages observed during the year, so it has a non-negligible impact on the outage frequency indicator.

2018 was an exceptional year in terms of storms, but 2019 was calmer. With close to 280,000 cloud-to-ground lightning strikes and 267 days of storms, lightning density ended the year at 0.5 strike per km². The transmission network proved robust, as outage frequency was below the average for the past ten years.

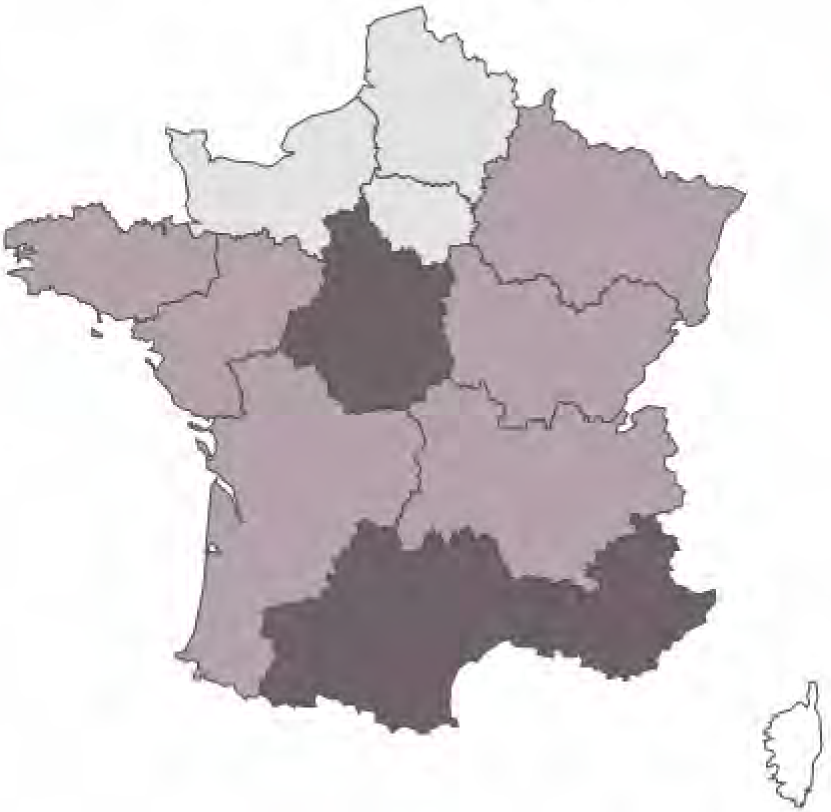


The regional figures below also show that outage frequency was above average in the regions the most impacted by lightning, particularly the southeast.

Short outage frequency by region



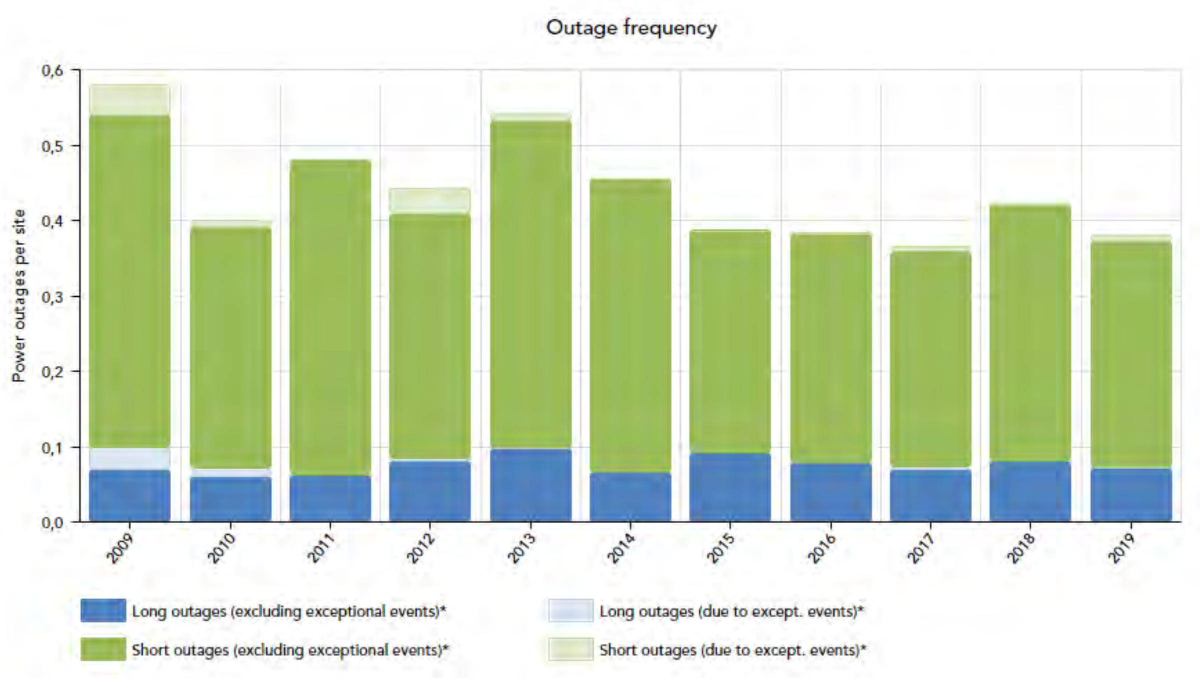
Short outage frequency by region



Densité de foudroiement (par région)

Outage frequency

Outage frequency was 0.37 outage/site in 2019, excluding exceptional events.



∗ Short outages last between 1 second and 3 minutes and long outages more than 3 minutes.

Loss rate

2,22 %

Loss rate on the public transmission system in 2019

Line losses mainly correspond to energy lost through the Joule effect during transmission over high and very high voltage lines. Loss levels depend primarily on consumption, generation schedules and cross-border exchanges. RTE works to offset these losses.

There are different ways RTE can reduce losses during grid operations:

Maintaining voltage at the highest values allowed by technical reference standards,

Optimising the operational scheme of the network.

Losses on the transmission system represent between 2% and 3.5% of consumption, depending on the season and time of day. In 2019, the loss rate was 2.22%, which corresponded to about 11 TWh.

As the transmission system operator, RTE must ensure that electricity losses are offset. This involves purchasing electricity from suppliers.

Prices and exchanges

Market prices in Europe

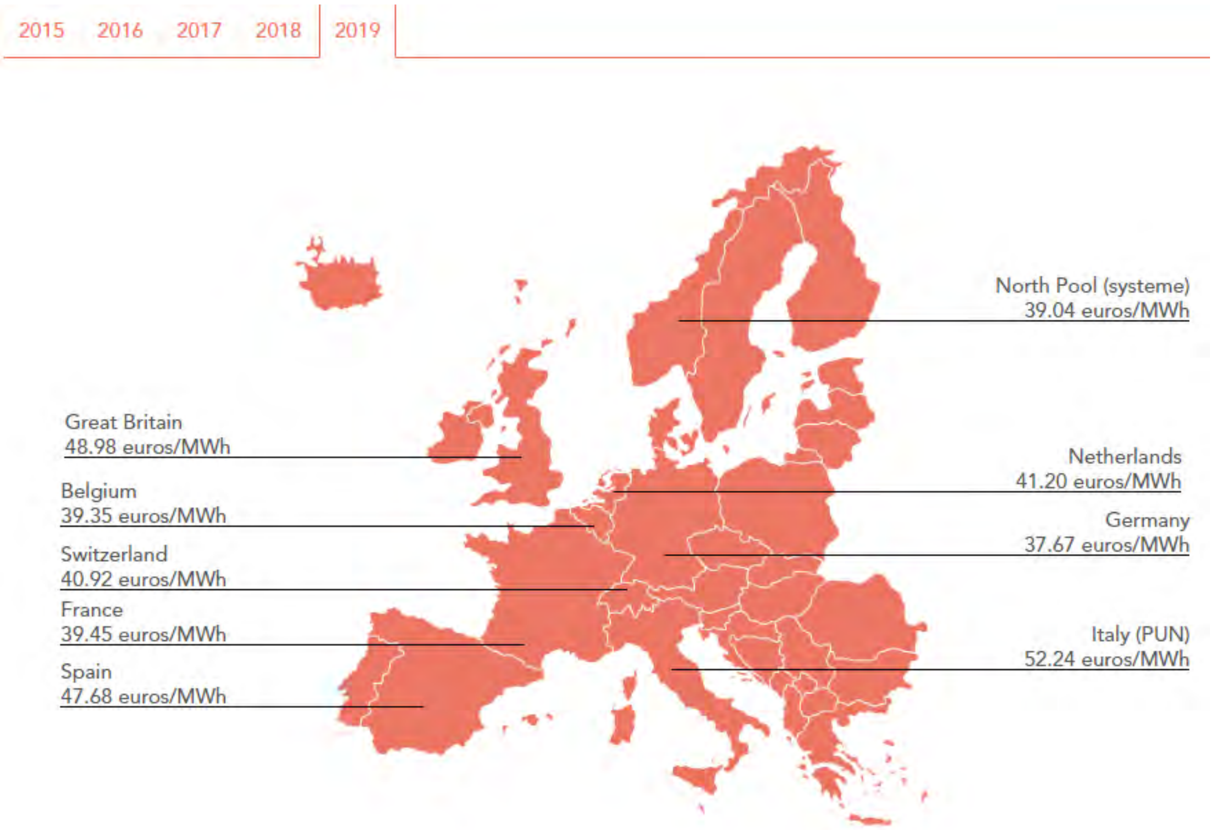
€39.45 /MWh

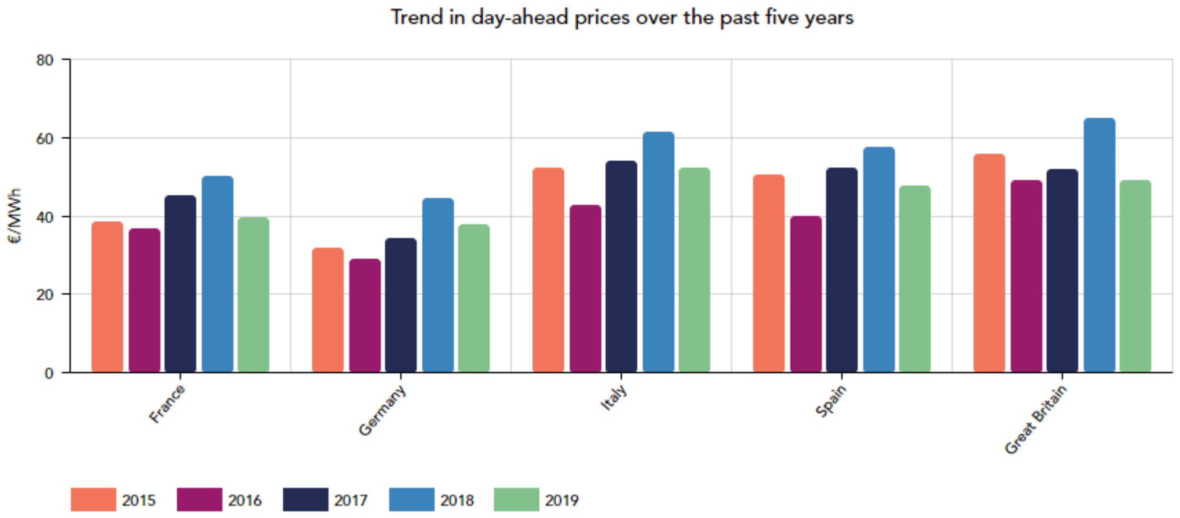
Average day-ahead electricity price in France

- 21 %
Relative to 2018

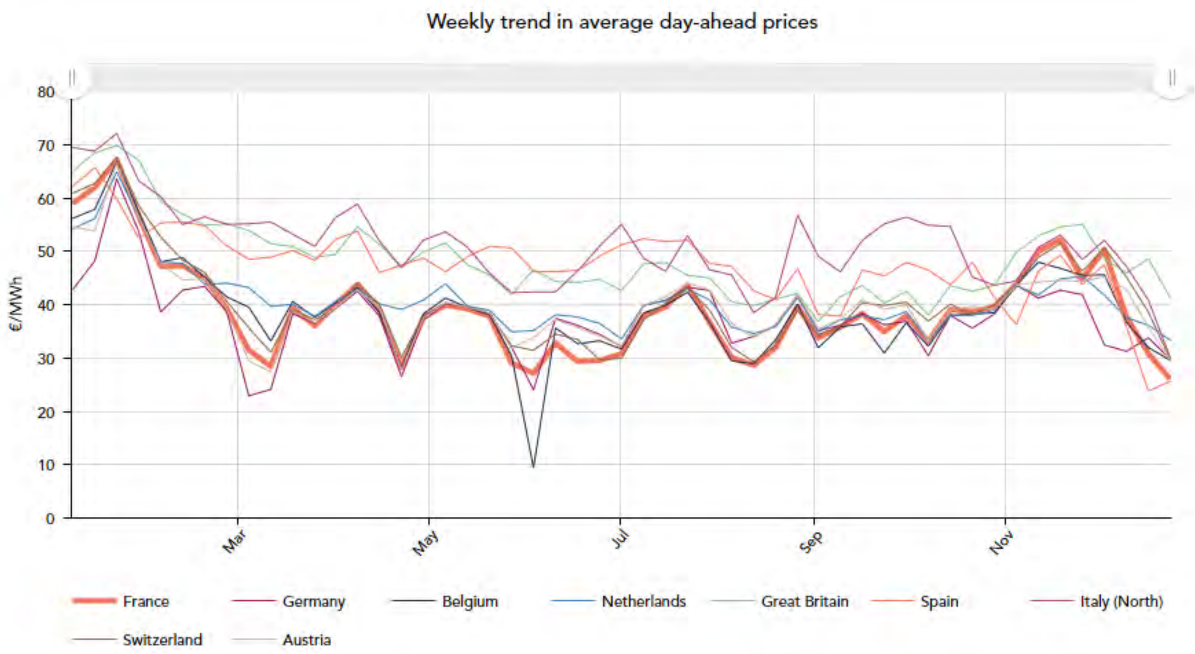
Prices on the day-ahead market declined in Europe

Prices on the day-ahead market declined across Europe in 2019. In France, the average price for the year was €39.45/MWh, down from €50.2/MWh in 2018, the lowest level since 2016.



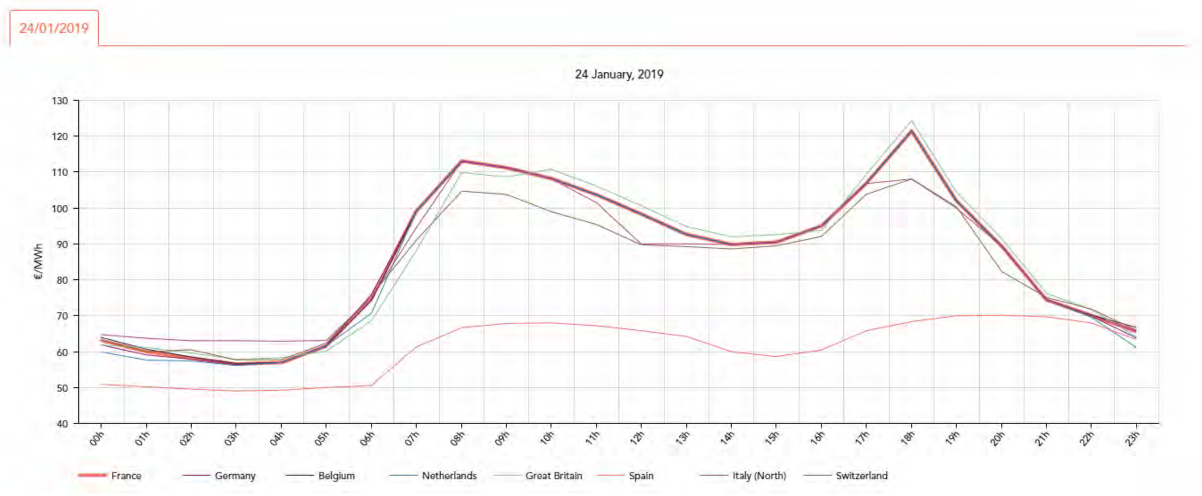


The downtrend in European electricity prices notably reflected the sharp drop in fuel prices (coal and especially gas). Moreover, temperatures remained mild overall early and late in the year in France. As a result, price spikes were fewer in number and less intense, dragging the average price down.



Prices in France were at their highest of the year during the cold spell late in January. On Thursday 24 January, when electricity demand peaked for the year, the price rose above €100/MWh over seven one-hour time steps and reached €121.5/MWh between 6:00 pm and 7:00 pm. This peak price was nonetheless well below those seen in past years, proof that there was less tension in terms of maintaining the supply-demand balance.

Details of hourly prices in Europe on 24 January

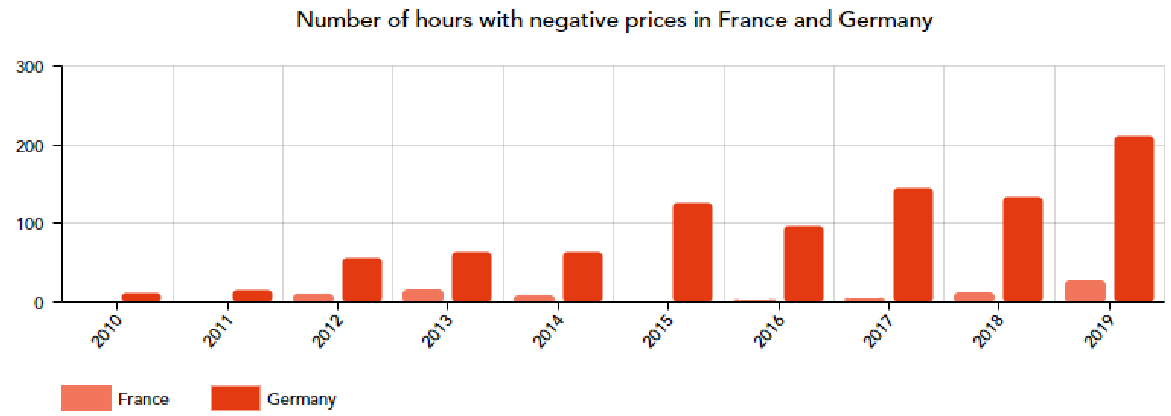


For a better understanding

Negative prices are increasingly common

Negative price periods are rare but do occur, notably when demand is low (overnight, bank holidays, weekends, etc.) and generation capacity is difficult to modulate. The fact is that it may be more expensive for a producer to stop and then restart facilities with little flexibility than to have prices be negative for a time. Most instances are when wind and solar power cover a large share of demand, which is most often seen in Germany. As renewable energies become more widely used, negative price periods will increase.

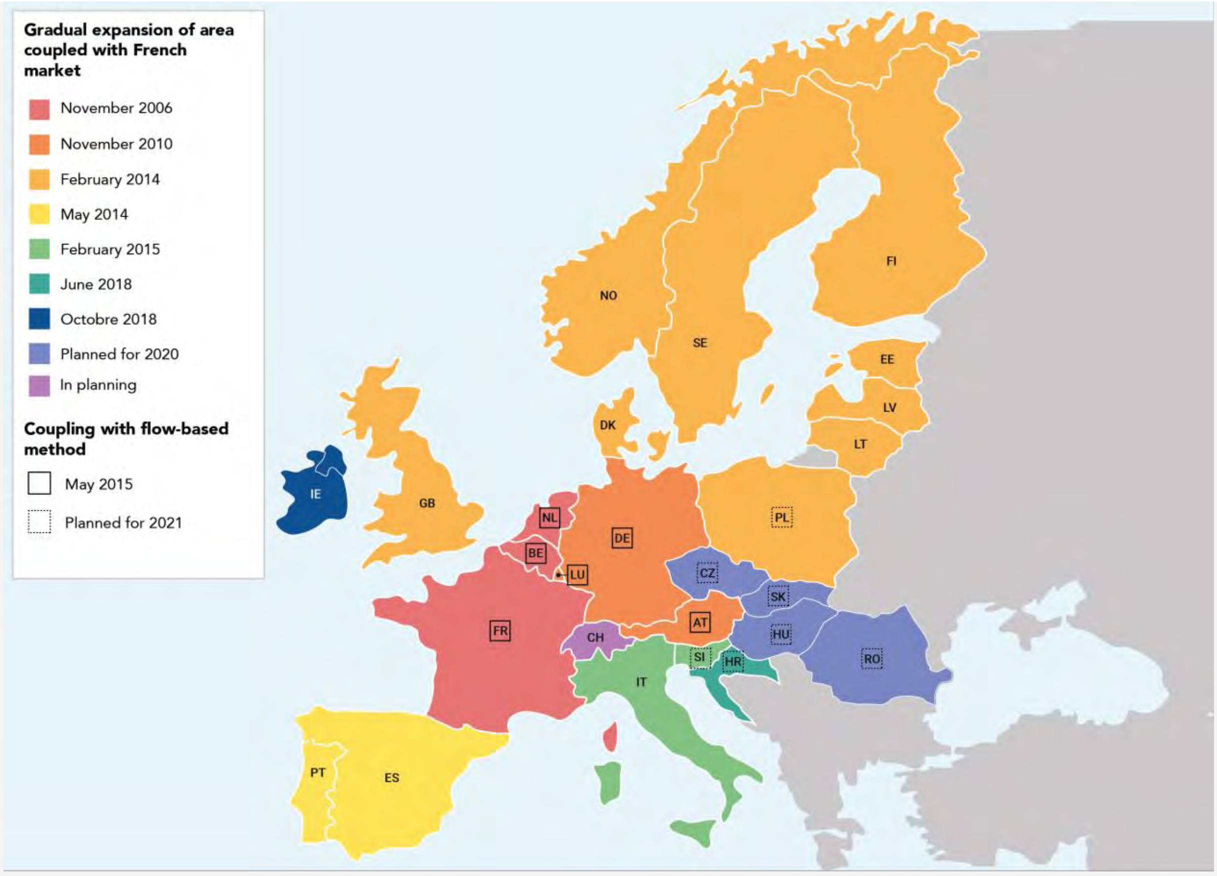
In 2019, the number of hours with negative prices in France rose further to a record high of 27. French prices fell as low as -€24.9/MWh on Saturday 8 June. Demand was low that day (it was the weekend of the Pentecost holiday) and wind power output was high due to the arrival of Storm Miguel.
Germany also saw more hours with negative prices during the year.



A closer look

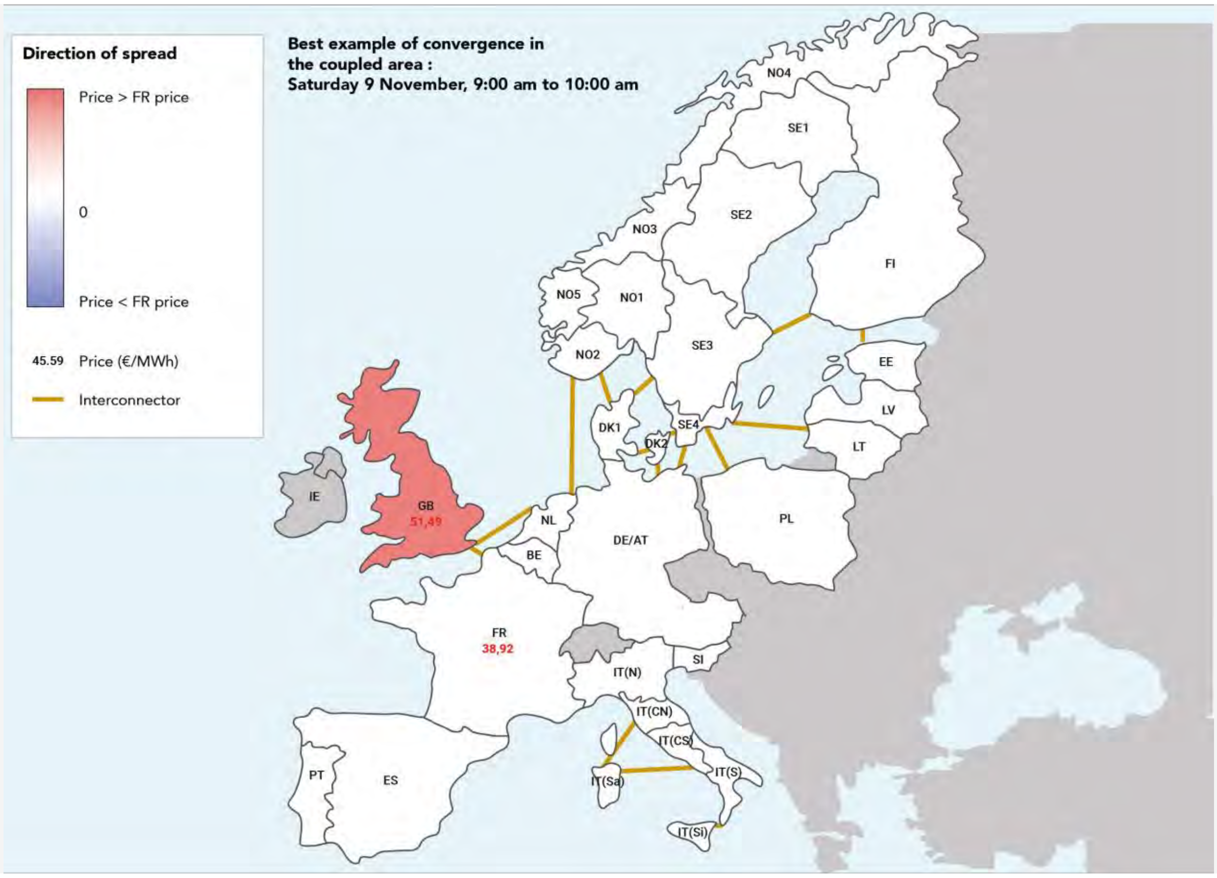
Market coupling guarantees optimal use of cross-border capacities

Day-ahead price coupling makes the European market more economically efficient by allowing market actors to buy and sell electricity through exchanges on a day-ahead basis in participating countries, taking into account the physical dimensions of the networks. Trading between France and neighbouring countries thus depends directly on day-ahead prices, which are identical when interconnection capacities do not limit cross-border exchanges. The French market has gradually been coupled with most European market starting in 2006.



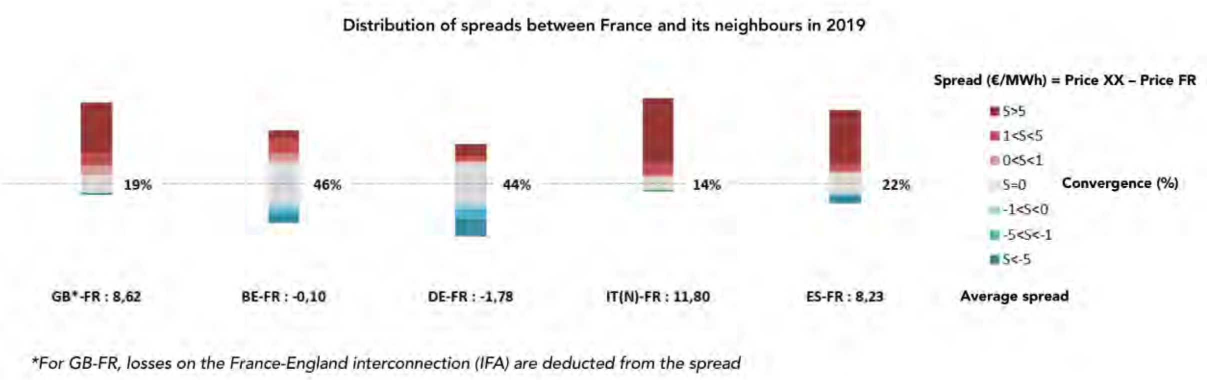
Note: Germany and Luxemburg form a single bidding zone. Coupling with Poland is exclusively via Sweden (SwePol subsea cable).

A remarkable example of convergence occurred on Saturday 9 November, between 9:00 am and 10:00 am, when prices were identical across the entire coupled area except in Great Britain, Ireland and Poland. Prices in 30 zones converged at €44.57/MWh from Portugal all the way to Finland. Such an occurrence requires similar market conditions in all countries and interconnection capacity that does not limit trading across borders.



Direction of spread
Price > FR price
0
Price < FR price
45.59 Price (€/MWh)
Interconnector
Best example of convergence in the coupled area :
Saturday 9 November, 9:00 am to 10:00 am
NO4
SE1
SE2
NO3
FI
NO5
NO1
SE3
NO2
EE
LV
DK1
SE4
DK2
LT
IE
GB
51,49
NL
DE/AT
PL
BE
FR
38,92
SI
IT(N)
IT(CN)
IT(CS)
PT
ES
IT(S)
IT(Sa)
IT(Si)

Additional indicators relating to price convergence



It should be noted that the French prices shown on this page correspond to day-ahead prices on the wholesale electricity market, and are only one component of end-consumers' bills, which also include taxes, contributions and network costs.

For a better understanding

A new power exchange in France

For the first time since the electricity market was opened to competition, two different power exchanges now operate in France's day-ahead market: Nord Pool has joined EPEX SPOT, the incumbent in the French electricity market.

As of 2 July 2019, market actors that want to sell or buy energy on the day-ahead market in France can submit bids via EPEX SPOT or Nord Pool. It should be noted that Nord Pool has been active in the intraday market in France since June of 2018, when the XBID European platform was launched.

Trading via Nord Pool in France has made up 1.4% of total exchange volumes on day-ahead markets in France since early July and 5.6% of the total on intraday markets.

Net commercial exchanges

55.7 TWh

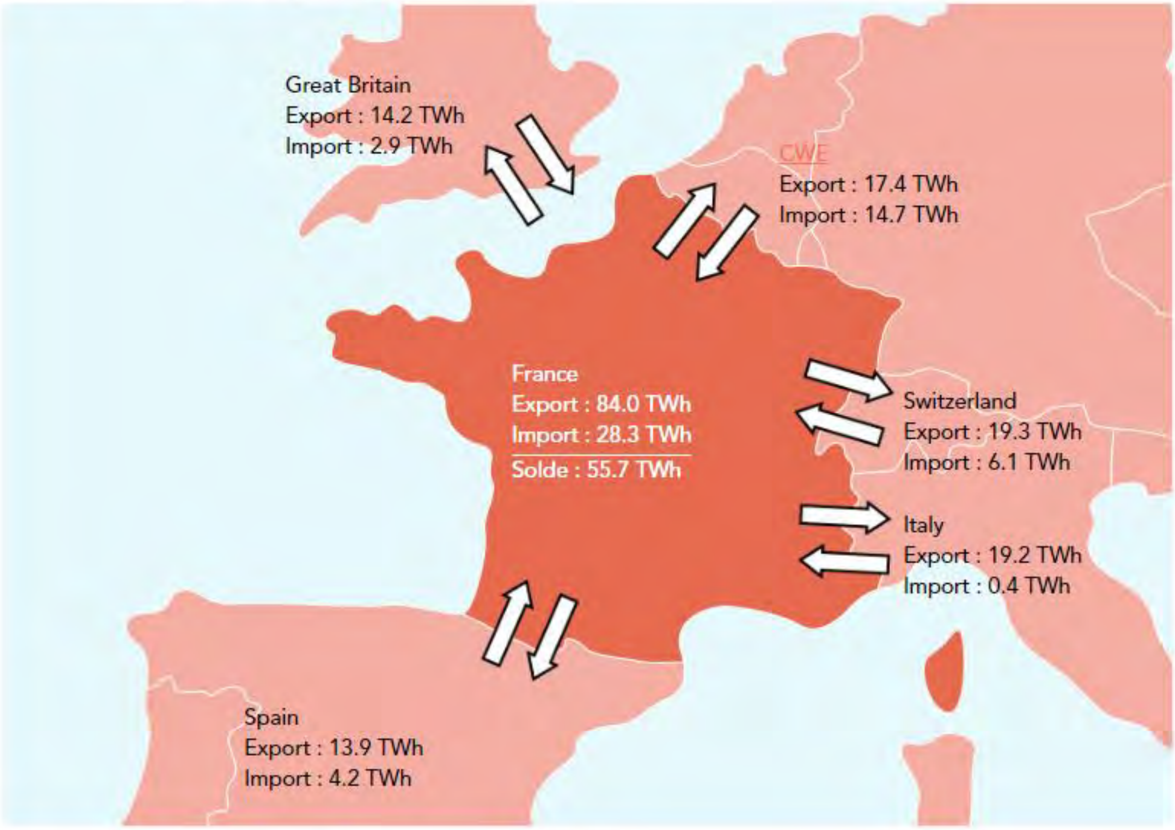
France's electricity trade balance

84.0 TWh
Exports

28.3 TWh
Impots

France was once again the biggest exporter in Europe

2015 2016 2017 2018 2019



France's electricity trade balance was 55.7 TWh in 2019, a slight decrease from a year earlier. Export volumes declined slightly to 84 TWh, whereas import volumes rose to 28.3 TWh.
France nonetheless remained the biggest electricity exporter in Europe.

Trade balances were positive every month, though the January figure was the lowest observed since December 2017.

Trading remained very volatile throughout the year, ranging from a net import balance of 9.3 GW at 9:00 am on 19 November to a 17.4 GW net export balance on 22 February at 4:00 pm, a new record. These fluctuations represent nearly 27 GW of flexibility for the

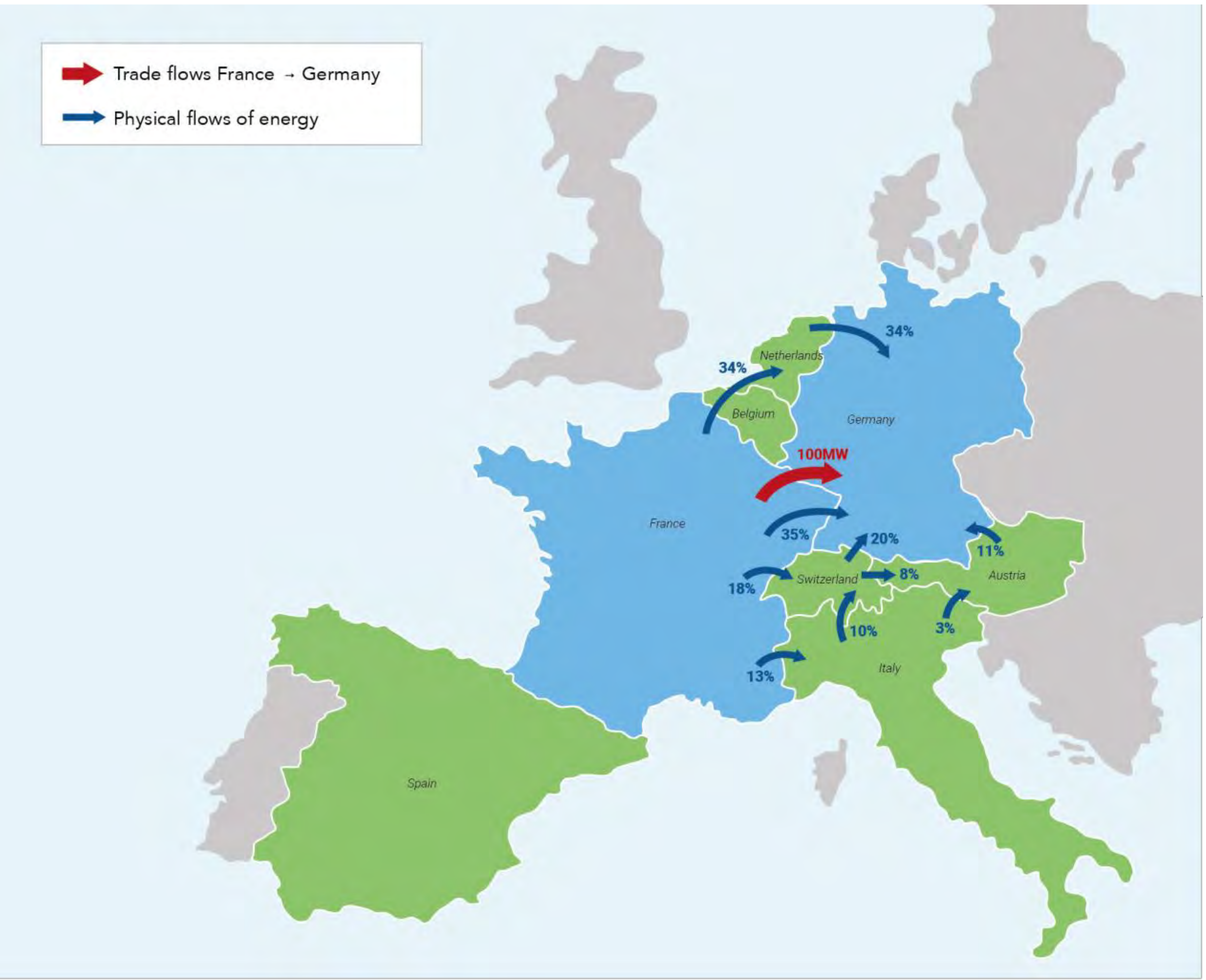
French power system, which also illustrates the level of European solidarity made possible by interconnections.

For a better understanding

What is the difference between physical and scheduled commercial exchanges?

Scheduled exchanges between countries are the result of commercial transactions between market participants. Physical flows correspond to the electricity actually carried over interconnector lines directly linking countries. For instance, a 100 MW commercial export programme for the Franco-German border could involve power transiting through other countries.

For a given country, the balance of physical flows across all borders and the balance of scheduled commercial exchanges with all neighbours are identical.

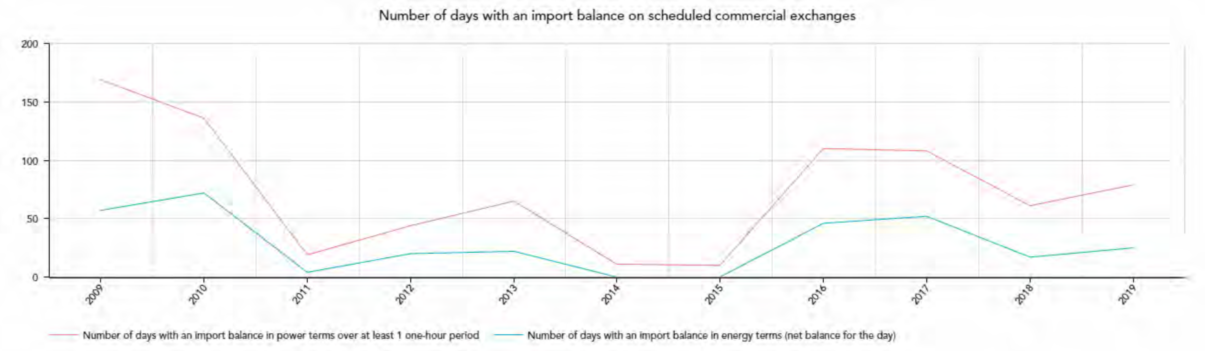


Number of days of net imports up slightly

France was a net importer of energy on 25 days in 2019, eight days more than in 2018. Most of these days were in January, November and December, when temperatures were below normal for the season.

It should be noted that there is a direct correlation between France's electricity trading and price differences with its neighbouring countries. At times, it may make sense economically for France to import energy rather than firing up costly generation assets within its borders. In other words, France may import electricity even when there is no shortage of generation capacity.

Number of days with an import balance on scheduled commercial exchanges



CWE region

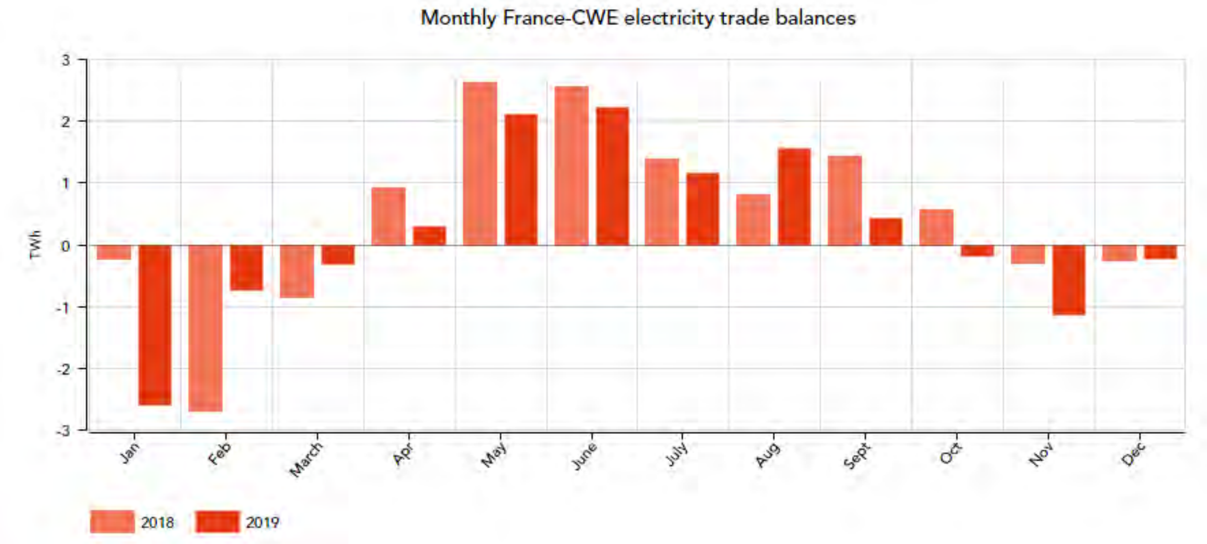
For a better understanding

The flow-based coupling method

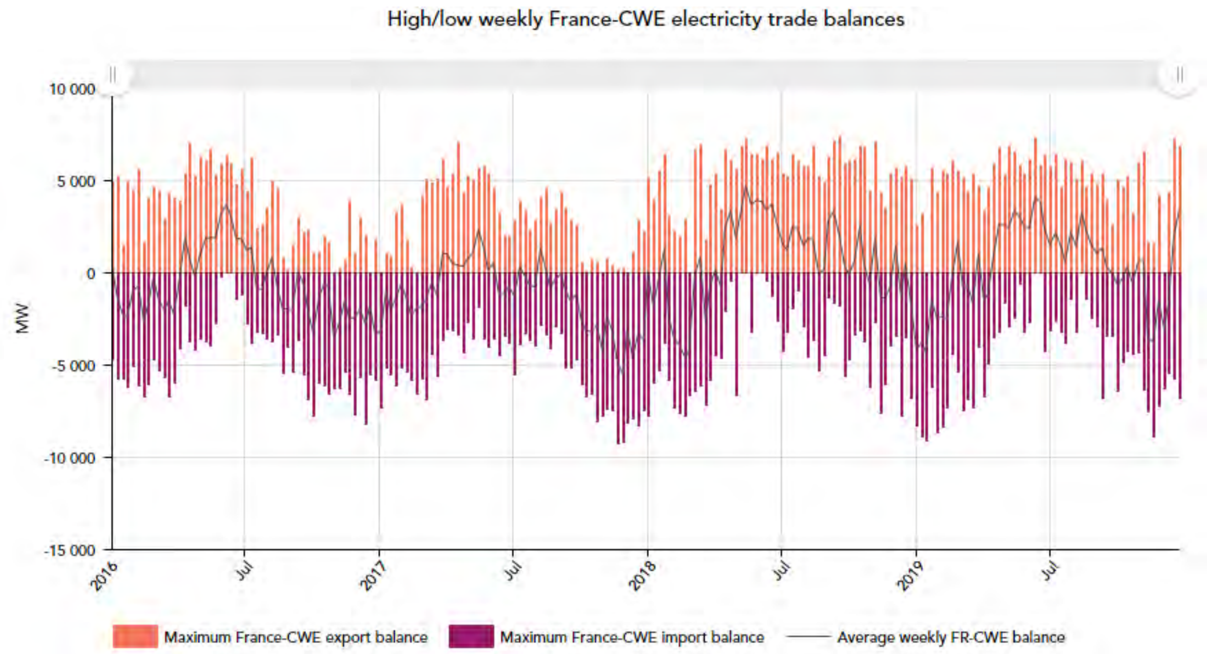
Flow-based coupling within the CWE region went live on 21 May 2015.

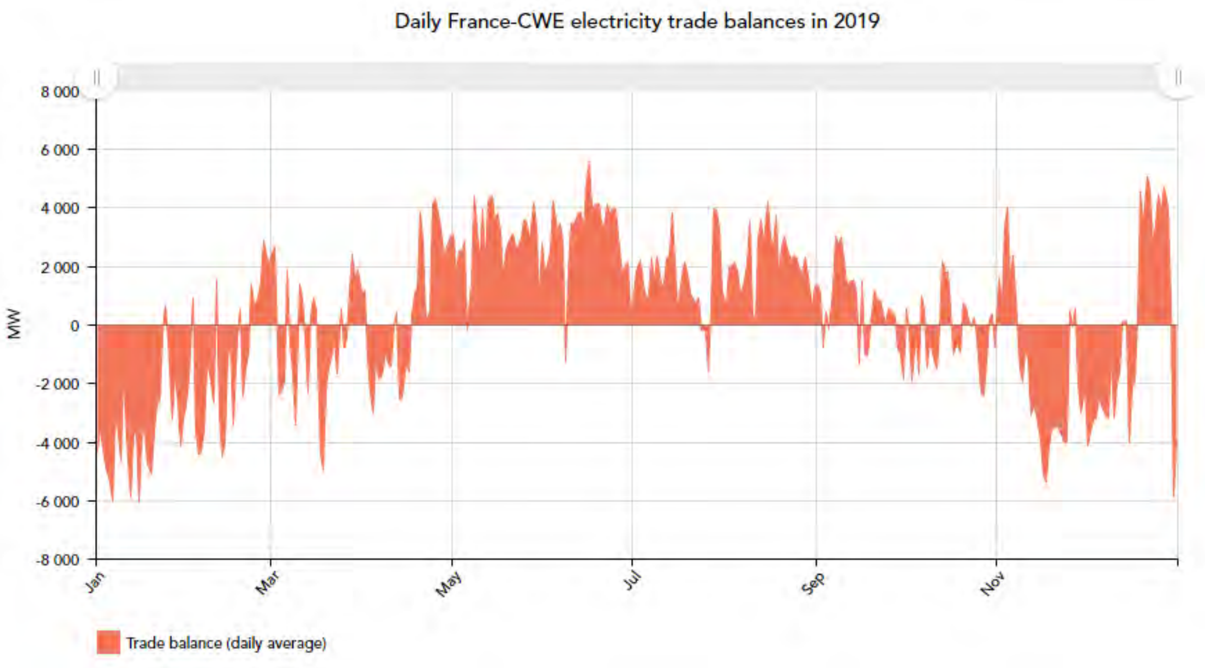
Prior to that, these four bidding zones were coupled on a Net Transfer Capacities (NTC) basis, meaning that limitations on exchanges were set bilaterally for each border (one constraint per border and per direction, implicitly taking into account the state of the network).
Constraints now explicitly take into account the physical network infrastructure in the five countries. Cross-border exchanges are thus optimised to reflect the actual physical capacities of networks as accurately as possible. This requires very close coordination between transmission system operators in CWE countries.
In sum, it is no longer possible to consider borders separately, and indicators previously used for the France-Belgium and France-Germany borders have been replaced by France-CWE region indicators.

France was once again a net exporter to CWE



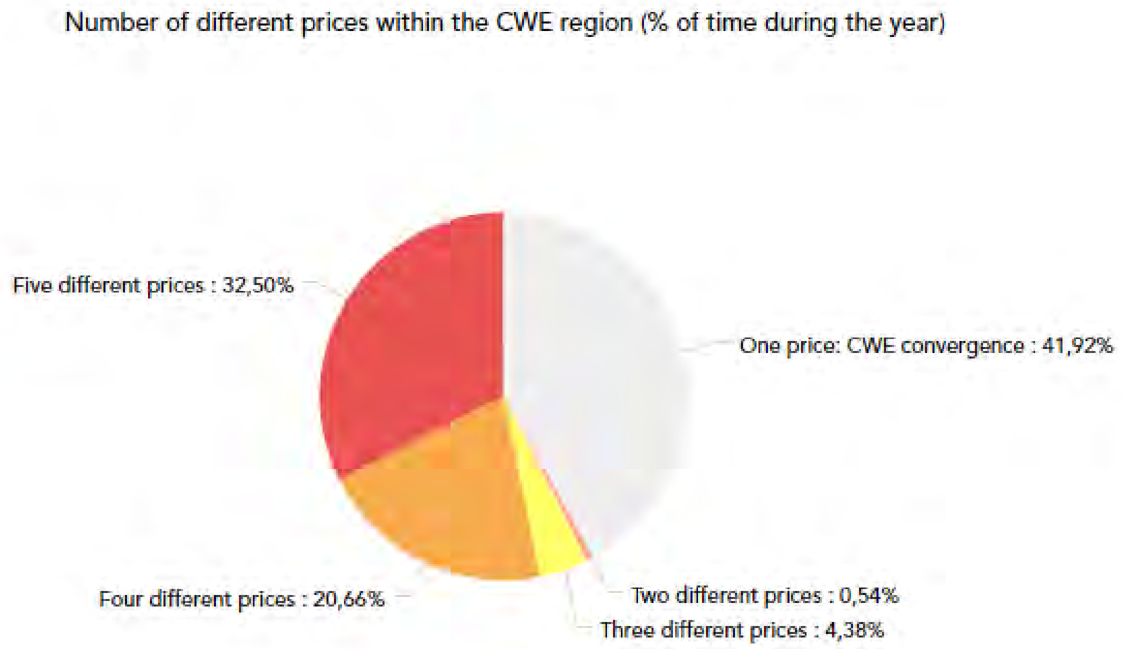
France was once again a net exporter to CWE, with a balance of 2.7 TWh. The balance was nonetheless lower than in 2018, chiefly owing to increased availability of nuclear power plants in Belgium, leading that country to import less electricity from France. Belgium ended the year with a net export balance (taking all borders together).




Daily France-CWE electricity trade balances in 2019
8 000
6 000
4 000
2 000
0
-2 000
-4 000
-6 000
-8 000
MW
Jan
Mar
May
Jul
Sep
Nov
Trade balance (daily average)

Rise in price convergence within the CWE region

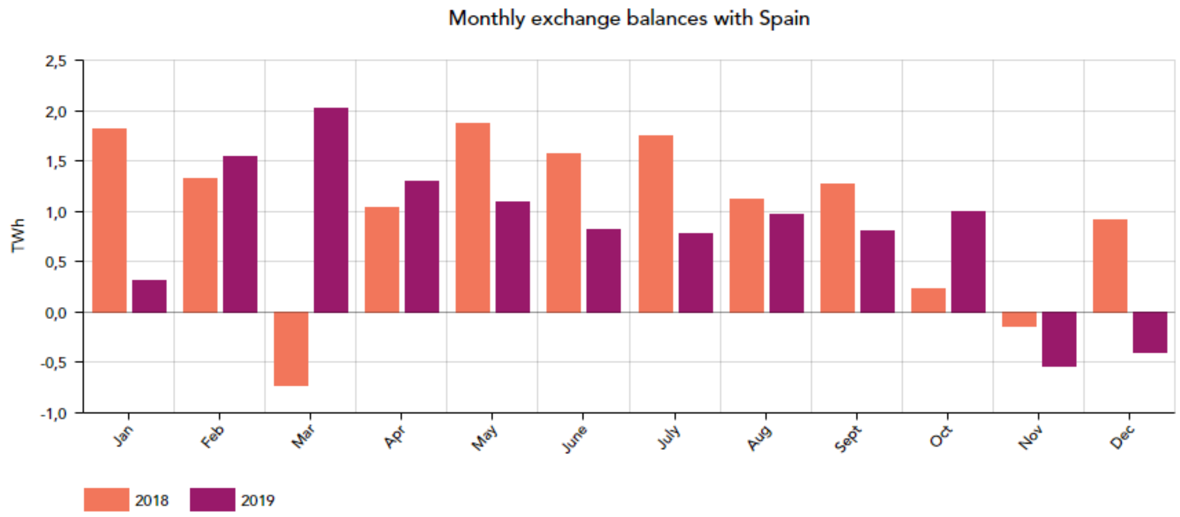
Cases of price convergence within the CWE rose sharply to 42% from 33% in 2018. This was the highest level on record since markets were first coupled. The rise was driven by much more homogeneous market conditions in the different CWE countries and by the additional interconnection capacity available.



Spain

France a net exporter to Spain

France's export balance with Spain remained significant at 9.7 TWh. It was nonetheless 19% lower than in 2018, notably due to a limitation of exchange capacities between April and early December. For the first time, France posted a monthly export balance of more than 2 TWh in March.



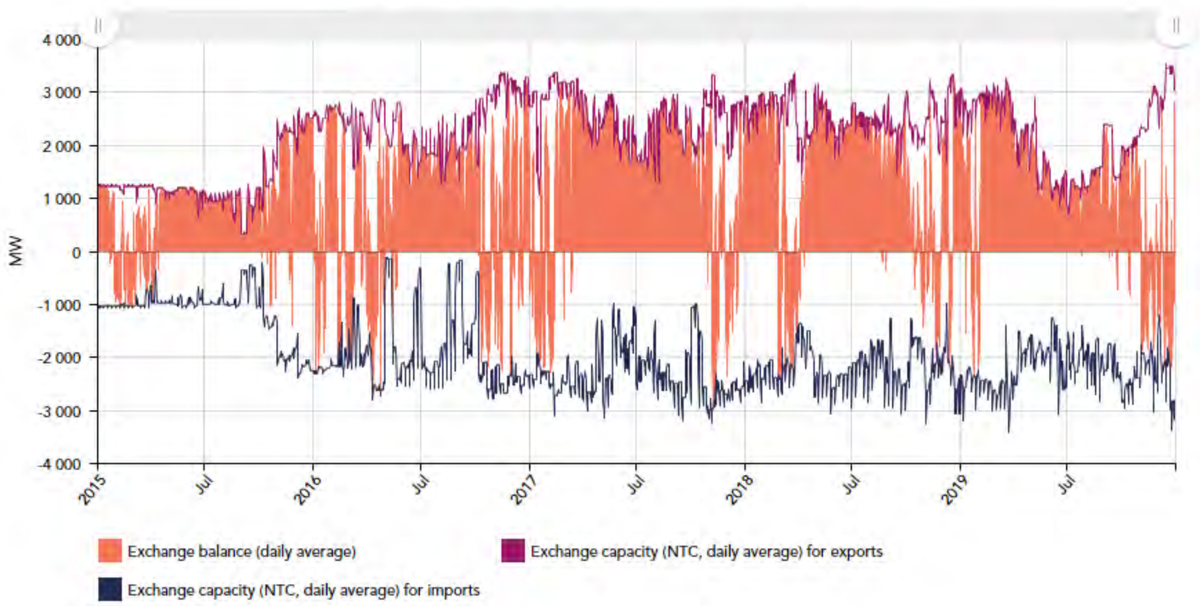
France-Spain exchange capacities

A technical problem on the 400 kV Argia-Cantegrit interconnector limited exchanges between the countries starting in April, notably for exports.

Maintenance was done on the line between April and early December to protect the physical integrity of the line and guarantee interconnection capacity. Capacity was reduced to about a third of its normal level in both directions during this period. Available capacity rose sharply when the work was completed.

The availability of capacity at the France-Spain border was lower on average, reaching 2,152 MW for exports and 2,224 MW for imports. The interconnector was saturated 78% of the time (68% for exports and 10% for imports).

Capacity and daily exchanges between France and Spain, 2015 to 2019

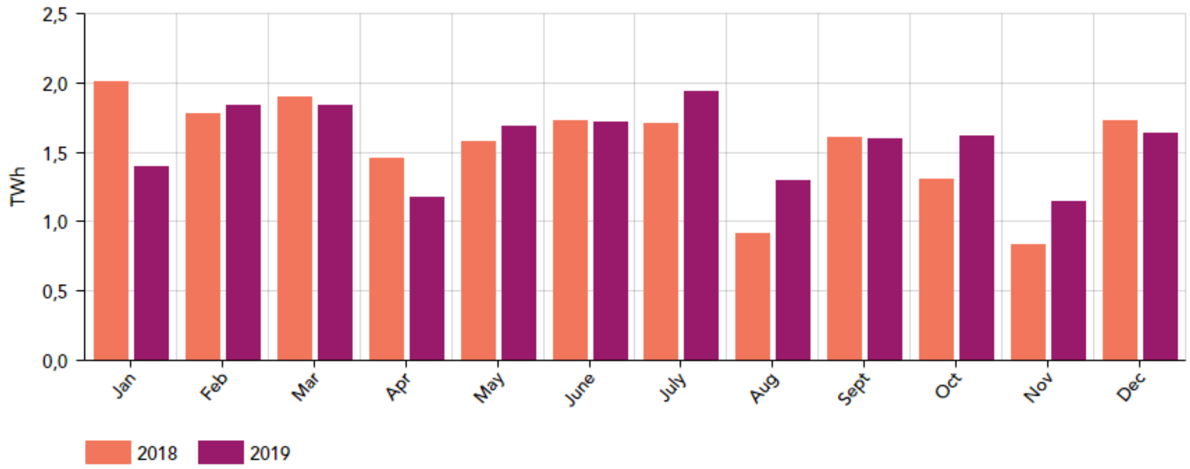


Italy

France's export balance with Italy remained high at 18.8 TWh, unchanged from 2018. The interconnection was mostly used for exports: there were only 247 one-hour periods with net imports (less than 3% of the time), down from 330 in 2018.

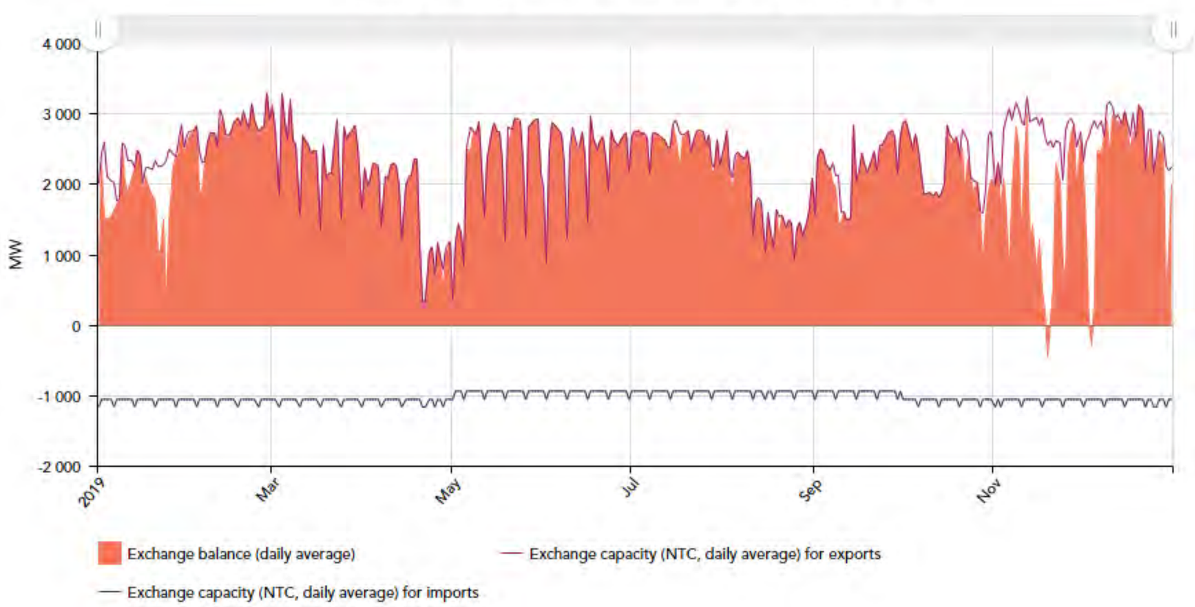
The upcoming commissioning of the new Savoy-Piedmont interconnection will help boost exchange capacities and opportunities for mutual electricity assistance between France and Italy.

Monthly exchange balances with Italy



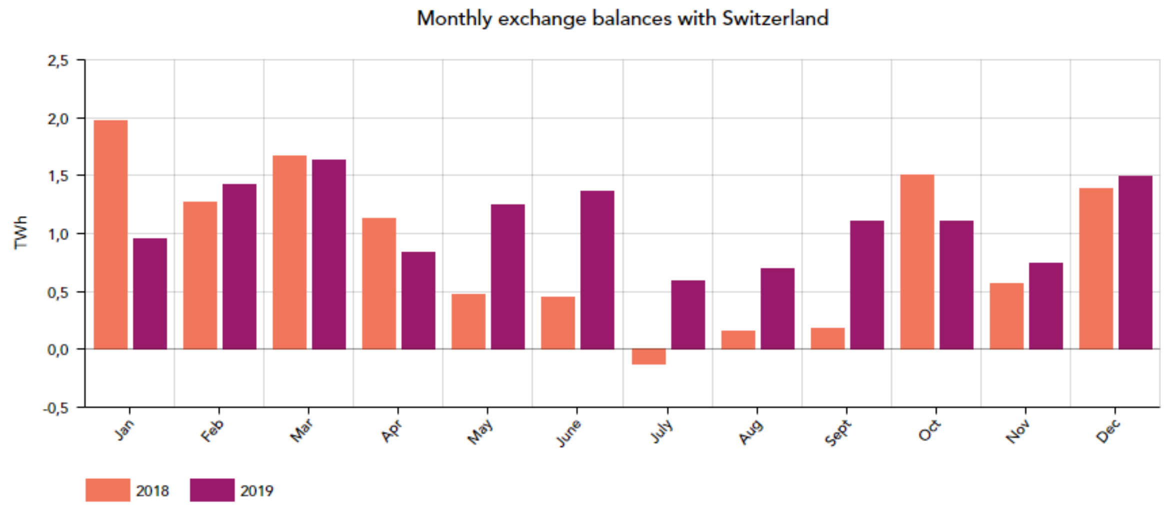
Italy caps imports on days when demand is low, especially weekends in the spring and summer, as it must keep in service enough thermal power plants that can adjust their output to ensure the stability of the power system. On days when solar seems likely to cover a large share of demand, import capacity at interconnections is reduced.

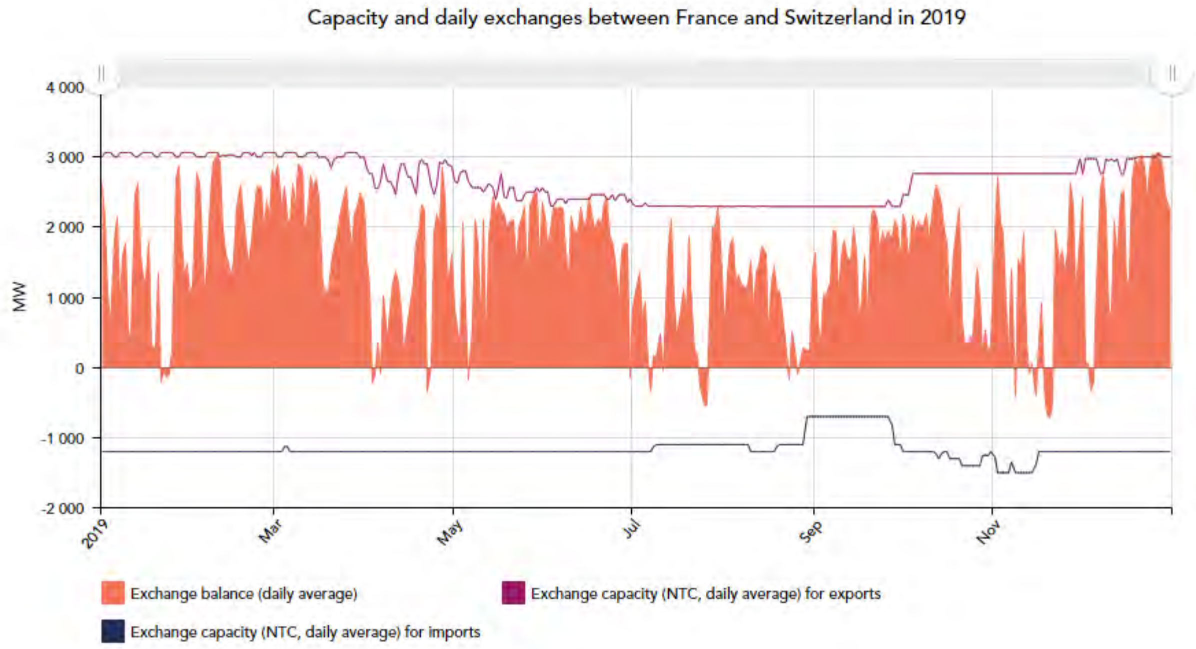
Capacity and daily exchanges between France and Italy in 2019



Switzerland

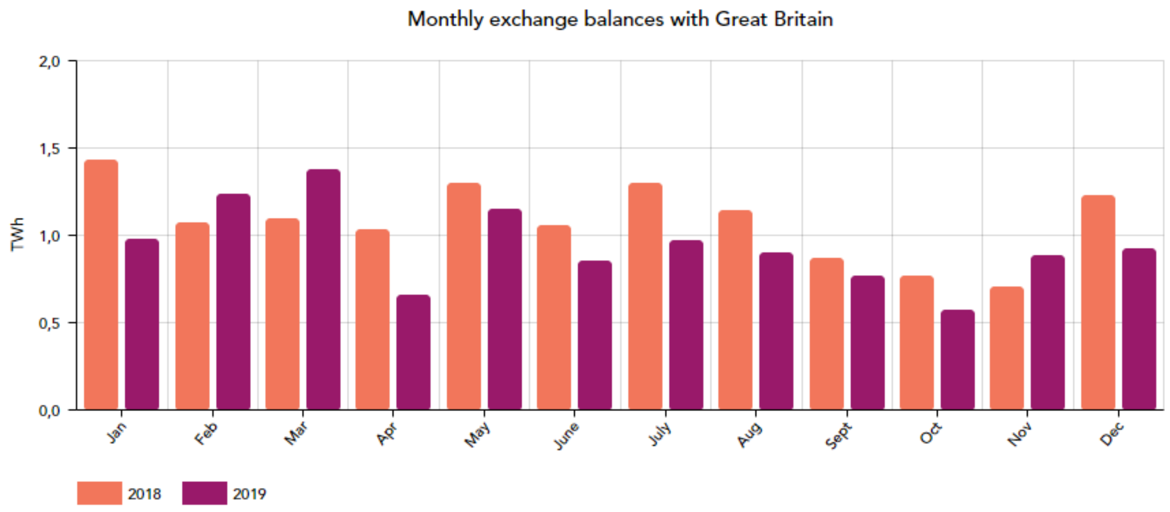
France’s export balance with Switzerland surged from 10.6 TWh in 2018 to 13.2 TWh, for a 25% year-on-year increase. Trading was much more geared to exports than a year earlier starting in May (with the exception of October), and France was not a net importer any month of the year.



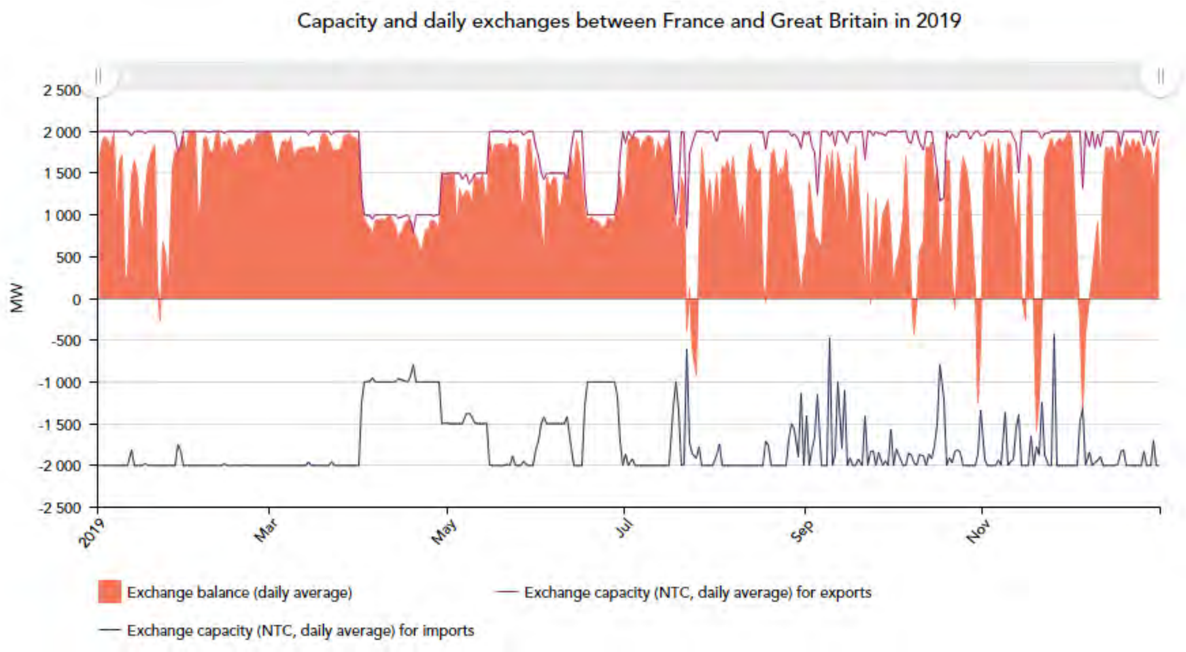


Great Britain

France was once again a net exporter to Great Britain in 2019. Its balance for the year of 11.3 TWh was lower than in 2018, notably because capacity was limited between April and June due to maintenance on the IFA interconnection with England. Capacity was reduced by as much as 1,000 MW, to about half the normal level, throughout almost all of April.



The interconnector was once again used for exports a large majority of the time. However, France was a net importer from Great Britain when temperatures were low in France and during the heatwave late in July. Over 2019 as a whole, France was a net importer for 860 one-hour periods, or about 10% of the time.



Evolution of cross-border exchange mechanisms

RTE is supporting the evolution of cross-border mechanisms

From the beginning, RTE has been working with market participants, in accordance with the principles set forth in European network codes, to develop mechanisms that encourage the opening of the French electricity market and its integration within Europe.

- To integrate the changes resulting from the EU's Electricity Balancing (EB) regulation, the TERRE (Trans European Replacement Reserve Exchange) project will include a common platform over which several European countries can trade balancing energy with an activation time of under 30 minutes. RTE will participate in it starting in the second half of 2020.
- A coordinated capacity calculation process that complies with the EU's Capacity Allocation and Congestion Management (CACM) regulation, already performed in parallel to the existing weekly calculation method since July 2019, will also apply to day-ahead trading at the France-Spain border in the first quarter of 2020.
- On 30 November 2016, the European Commission unveiled its Clean Energy Package, or CEP, with a series of measures designed to address changes in energy markets arising from the transition to clean energies. The CEP stipulates that a minimum of 70% of infrastructure capacity must be made available for cross-border trade by 1st January 2020. The floor will become mandatory in 2025. In the meantime, TSOs may seek derogations or implement action plans.

Market mechanisms

Role of the balance responsible parties

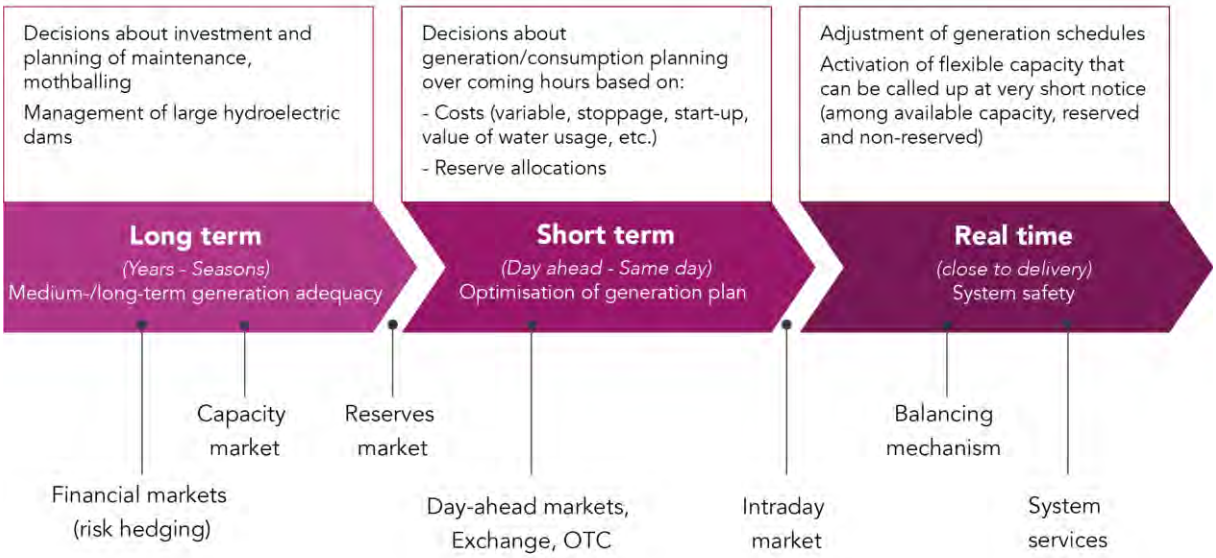
182
Number of balance responsible parties

145
Active balance responsible parties
45
Physical balance responsible parties

Markets are tools for optimising the power system

RTE works around the clock, seven days a week, directing electricity flows over its lines to ensure that generation and consumption are always balanced at the least possible cost to society. This balance is achieved through a series of decisions aimed at optimising the power system, from the long term down to real time. These decisions are taken by private actors, whose actions are coordinated thanks to the market mechanisms through which their activities are rewarded.

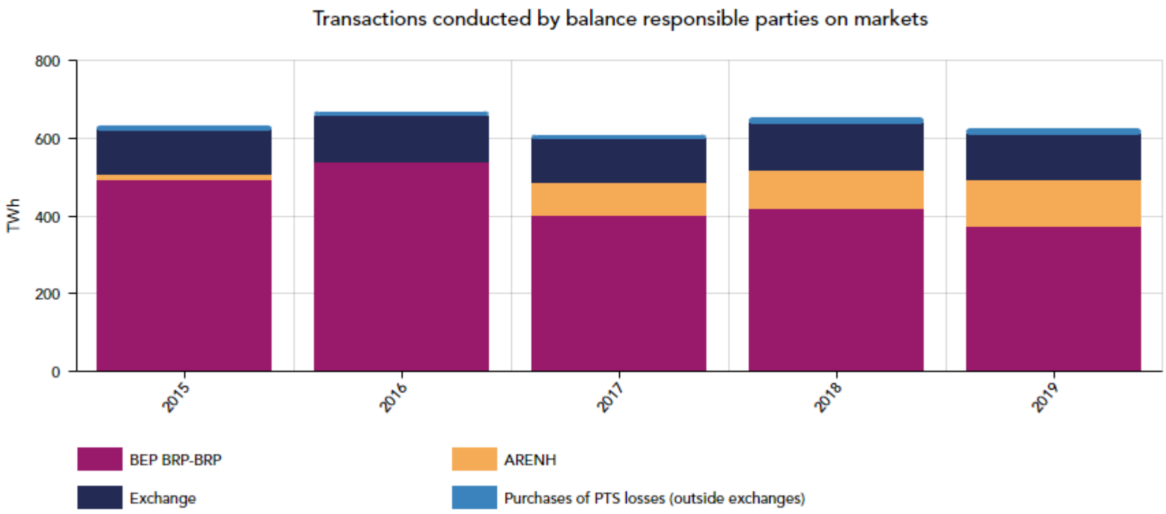
Increasing the flexibility of the power system is also clearly identified as key to a successful energy transition, notably given the intermittent nature of renewable sources. RTE's market rules are well-suited to allow the participation of new, flexible capacities, as they allow all operators to be rewarded for their capacity and energy via markets (demand response, storage, renewable energy sources, etc.).



The role of balance responsible parties

A closer look

The balance responsible party system allows consumers, producers, suppliers and traders to conduct all types of commercial transactions in electricity markets, on timeframes ranging from several years ahead to almost real time. Thanks to the flexibility this system provides, market participants can respond to a wide variety of contingencies and uncertainties. Each balance responsible party creates an activity portfolio and agrees to settle the costs resulting from imbalances between generation and consumption within that portfolio, as recorded after the fact. The parties have a financial incentive to maintain a balance within their portfolios and thus contribute to the balance of the French power system.
As of 31 December 2019, there were 182 balance responsible parties with valid contracts. Of these, 145 were active during the year and 45 made significant injections or withdrawals.



Transactions between balance responsible parties were about 5% lower than in 2018. Purchases of ARENH power nonetheless rose by 25%. This increase partly explains the decline in OTC transactions between balance responsible parties (block exchange programmes, or BEP). Indeed, market participants that hedged their purchases (at least partially) with ARENH had less need to engage in other types of transactions.

Record ARENH purchase volumes

In 2019, demand for ARENH among alternative suppliers reached an all-time high of 132.98 TWh, exceeding the 100 TWh cap for the first time. This record demand reflected market prices that were well above the ARENH price of €42/MWh during the ARENH gate at the end of 2018. The Energy Regulatory Commission (CRE) allocated the 100 TWh in proportion to the demand expressed by suppliers with the exception of EDF subsidiaries, which received none of it.
In addition to this 100 TWh, 20.4 TWh were allocated to system operators to cover their losses.

The ARENH mechanism

The Regulated Access to Historical Nuclear Electricity scheme (*Accès Régulé à l'Electricité Nucléaire Historique* – ARENH) was established by the NOME Act on the new organisation of the electricity market.

To guarantee fair competition in the power market, alternative suppliers have the opportunity to buy a portion of EDF's nuclear generation at the ARENH rate. The rate was set by the government at €40/MWh between 1st July and 31st December 2011 and then at €42/MWh since 1st January 2012. Effective 1st January 2017, the price also includes the related capacity certificates for each delivery year (see page on the capacity mechanism).
The Energy Code stipulates that suppliers' total demand for ARENH electricity cannot exceed 100 TWh a year (excluding supply of losses by system operators), which represents about a quarter of EDF's total nuclear power production in France. Electricity suppliers seeking to exercise their "ARENH rights" must submit requests to the CRE.

It should be noted that the mechanism evolved during the year following the adoption of the energy-climate bill, which would allow the government to raise the ceiling on nuclear power made available to alternative suppliers at annual gates to 150 TWh and to modify the ARENH rate by decree. This option was not exercised for the 2020 delivery year, so the ceiling and ARENH price remain the same.

Intraday trading volumes

Though the number of transactions declined, intraday trading volume continued to rise, ending the year about 13% higher. These mechanisms give balance responsible parties flexibility to operate as close as possible to real time. Their need for flexibility is notably increasing as renewable energies come to account for a larger share of the energy mix, since generation from these sources is more difficult to forecast.

Balancing mechanism

8.1 TWh

RTE's total balancing needs

1.7 %

of consumption in France

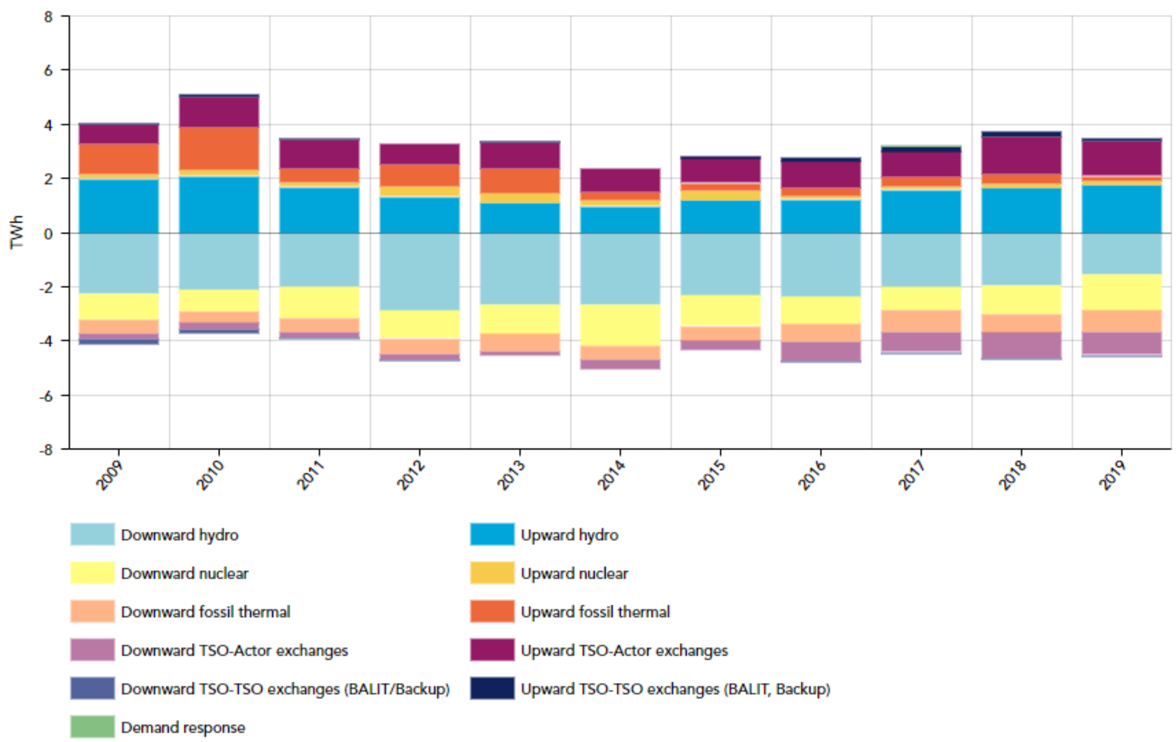
For a better understanding

The balancing mechanism allows RTE to modulate generation, consumption and trading to ensure that electricity supply and demand are always balanced. The mechanism involves the selection of bids submitted by balancing service providers based on the merit order and identified needs.

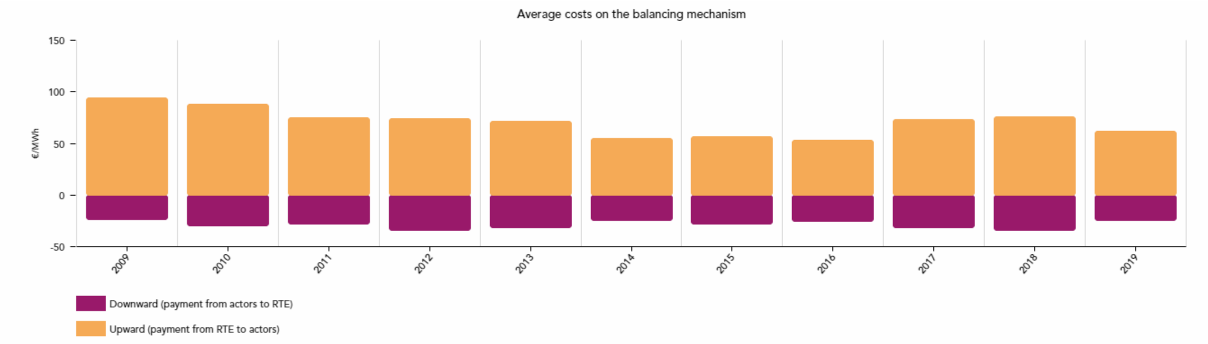
Slight decrease in overall balancing volumes

Total balancing volumes decreased slightly year-on-year to 8.1 TWh, equivalent to 1.7% of gross annual consumption. Hydropower once again accounted for the majority of upward and downward balancing.
Cross-border balancing volumes, notably from Germany and Switzerland, remained high (40% of total upward balancing and 19% of downward balancing), but were lower than in 2018.

Volumes activated on the balancing mechanism



Average costs on the balancing mechanism

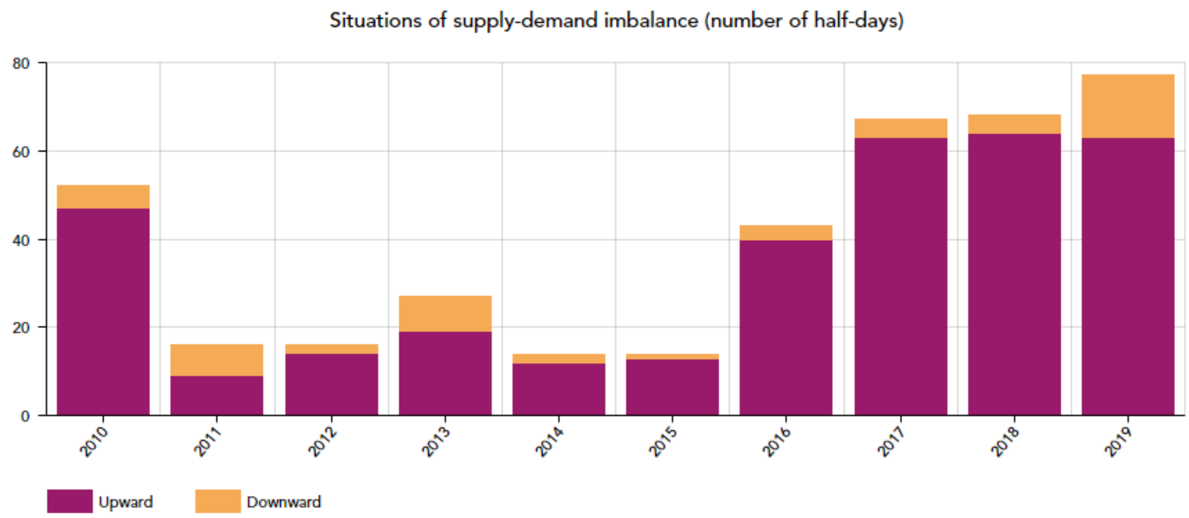


Tight situations on the balancing mechanism

A supply-demand imbalance is considered to exist when RTE generates one or more messages about insufficient offers on the balancing mechanism (alerts or degraded modes) to encourage participants to submit additional offers.

The number of instances where supply was tight on the balancing mechanism (i.e. where demand exceeded supply) was comparable to 2018, at 63 half-days. The factors that can cause such imbalances include social movements at generation plants, heatwaves, environmental constraints and cold spells. The month of December alone, when significant social movements occurred, accounted for 23 half-days.

The number of instances of tight situations due to supply exceeding demand increased to 14 half-days (see box below, For a better understanding).



For a better understanding

Tight situations due to excess supply

It is easy to imagine tight situations arising when electricity demand exceeds supply, but the transmission system can also find itself in a tight situation due to surplus supply, when demand is low (decline in activity due to holidays, weekends or bank holidays). These situations occur more often in summer, when consumption is lower, but also on weekends in the spring, particularly when wind and solar output are high and consumption is low in Europe.

In these instances, France may need to export large quantities of energy to avoid finding itself with too much supply. When the limits of export capacity are reached, RTE may request that generating units reduce or stop their production temporarily. Because wind and solar generation are given priority, fossil-fired thermal and nuclear generation in particular may decrease sharply.
Instances of surplus generation have been occurring more frequently in recent years, notably because of the continued development of renewable energy sources and the increase in minimum production requirements for nuclear reactors (technical constraints declared by the plant operators).

Demand response

29.8 GWh

Total demand response

Balancing mechanism + NEBEF

For a better understanding

Demand response is defined as an action intended to temporarily reduce, in response to a one-time request sent to one or more consumers by a demand response operator or electricity supplier, the electricity effectively withdrawn from the public transmission or distribution network at one or more consumption sites, relative to a consumption plan or consumption estimate (article L 271-1 of the energy code).

Market players can use demand response to optimise their own portfolios or to sell energy directly to other users or to RTE. There are two main categories of demand response that contribute to the supply-demand balance:

- Industrial demand response, when consumption is reduced at one or more industrial sites (either by shutting down processes or by switching over to own consumption). This type of demand response can be proposed either directly by the industrial user or through an aggregator or supplier.

- Distributed demand response, or the aggregation through an aggregator or supplier of individual demand response actions involving smaller volumes, all carried out at the same time by residential or professional customers.

Demand response is remunerated through a variety of mechanisms

France was the first country in Europe to open all parts of its national market to all consumers, including those connected to the distribution networks:

- Since 2003, it has been possible to offer industrial demand response on the balancing mechanism.

- Since 2008, RTE has been contracting with BRPs for demand response capacity to guarantee the availability of their capacity to the balancing mechanism.

- Since 2011, RTE has been contracting demand response capacity that can be activated on very short notice for the mFRR (manual frequency restoration reserves). In 2019, demand response capacity made up half of the mFRR.

- Since January 2014, it has been possible to sell demand response energy directly on energy markets through the NEBEF mechanism.

- Since July 2014, industrial customers have been able to participate in frequency ancillary services by offering demand response (1 MW minimum). These reserves, which can be automatically activated in timeframes ranging from a few seconds to a few minutes, are critical to keeping supply and demand balanced. Previously, only generation facilities could participate. In 2019, demand response capacity contributed 10% of the frequency containment reserve.

- In 2018, demand response tenders became a support mechanism for the demand response sector. Organised by the Ministry of Energy, the tenders encourage the development of demand response capacity to meet the targets set forth in the Multiannual Energy Programme.

EcoWatt, a voluntary scheme available in the French regions

EcoWatt is a voluntary scheme introduced in Provence-Alpes-Côte d'Azur and Brittany in the late 2000s to address the specific problems faced by local power systems. Since "safety nets" were introduced and the SMILE (Bretagne-Pays de la Loire) and FLEXGRID (PACA) smart electric grids were rolled out, the EcoWatt scheme has become a tool for supporting the energy transition and the French regions. Conducted in partnership with the French government, Ademe, Enedis and local governments, the EcoWatt scheme now counts close to 90,000 subscribers in the two regions.

EcoWatt provides citizens with an electricity barometer they can use to check local consumption forecasts at any time of the day. These forecasts are provided with colour-coded signals: green if demand is reasonable, orange if it is high and red if it is very high. Users then have a fun way to help tackle the challenge by taking actions that reduce their electricity consumption.

Learn more about the scheme here: www.monecowatt.fr.

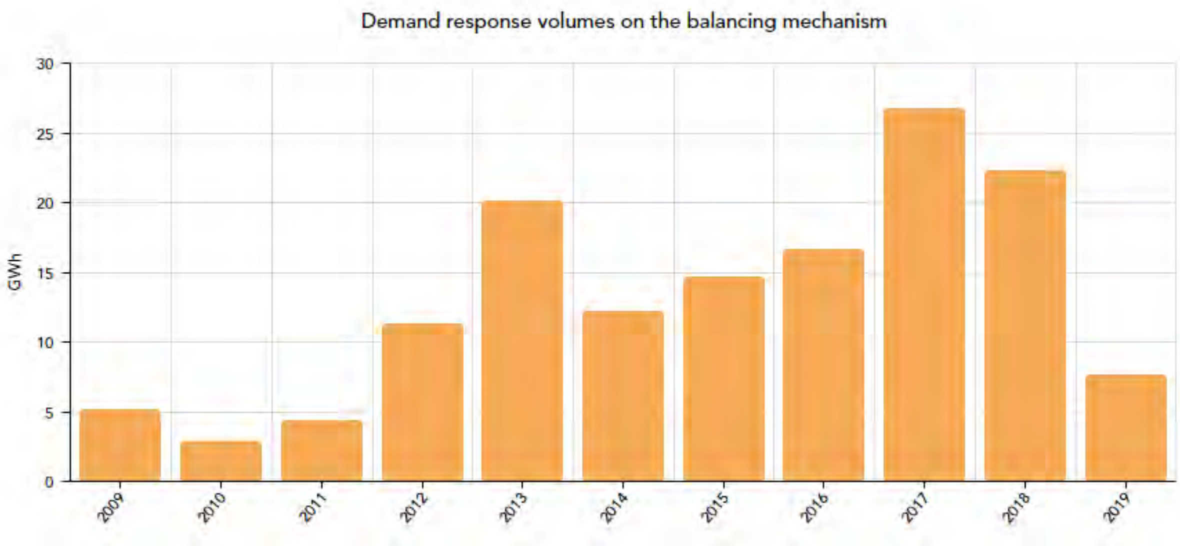
A closer look

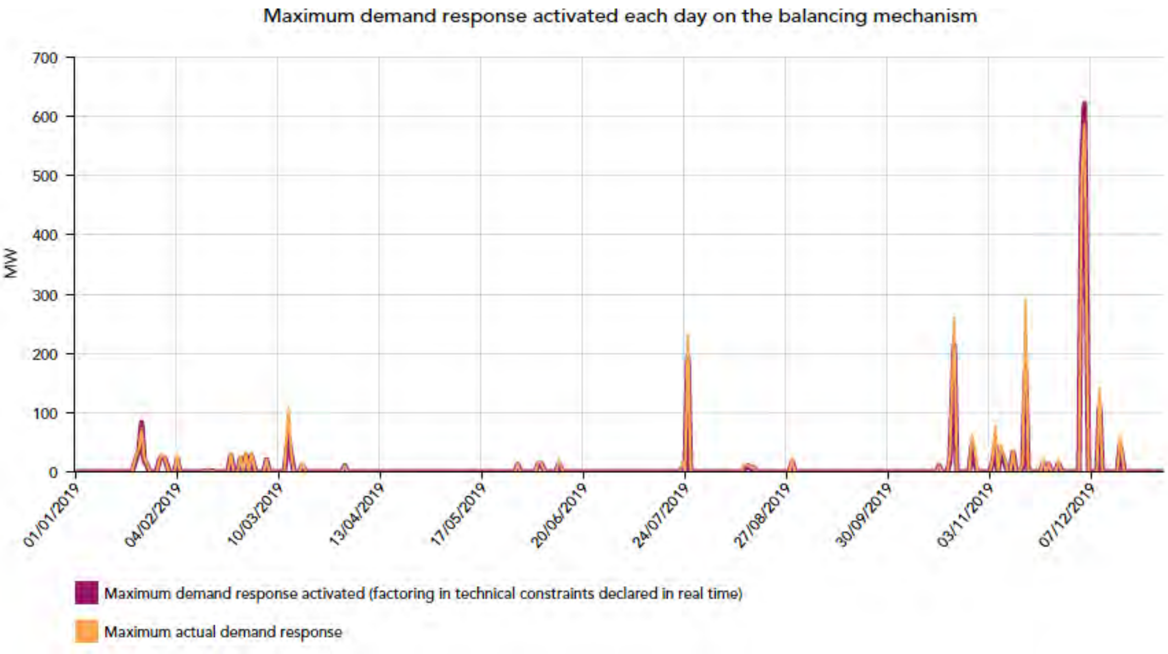
Demand response tenders in 2019

For the third demand response tender organised since the mechanism was overhauled, the volume selected was 31% (770 MW) higher than a year earlier. This increase was particularly noteworthy since participation criteria were tightened: load reductions achieved by switching to self-generation (diesel) are no longer eligible. All of the demand response capacity selected in 2020 was thus 100% “green”. For the second year in a row, “green” demand response volumes surged, with increases of 34% between 2018 and 2019 and 43% between 2019 and 2020. Over two years, even as self-generation (diesel) was gradually excluded from the tender process, “green” demand response volumes accepted doubled.

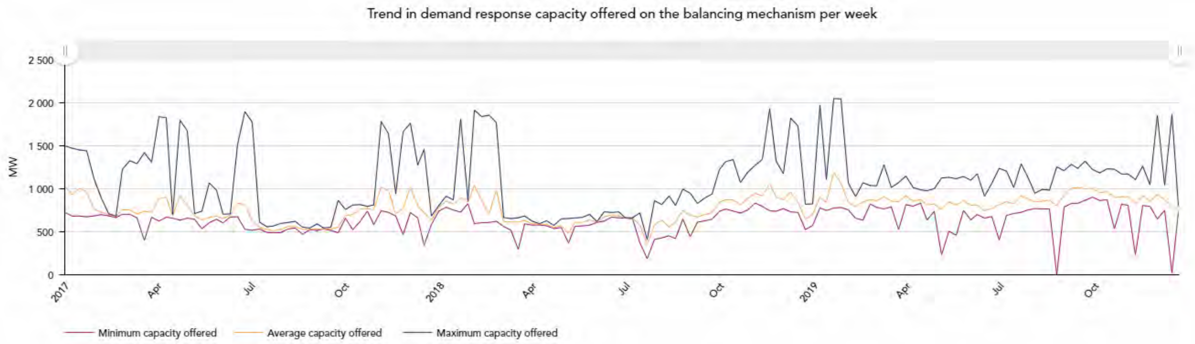
Demand response on the balancing mechanism

The average demand response volume offered on the balancing mechanism was 878 MW, higher than the average for 2018 (727 MW).
A total of 7.6 GWh of demand response was activated, down from 22.3 GWh in 2018. The fact is that most demand response has a capacity value, meaning it as a high price and is activated in real time by RTE in times of significant stress on the power system, notably during cold spells. In 2019, there were fewer instances where the price of the last offers activated on the balancing mechanism matched or exceeded the high price of the demand response capacity offered.





Trend in demand response capacity

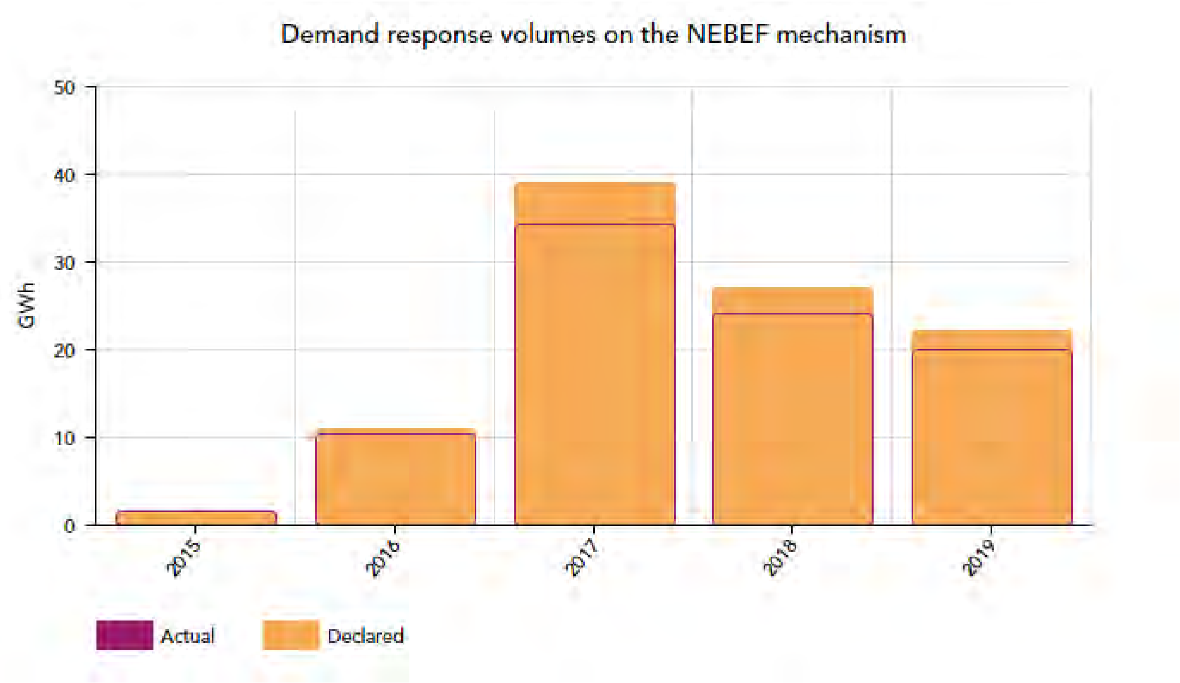


The NEBEF mechanism

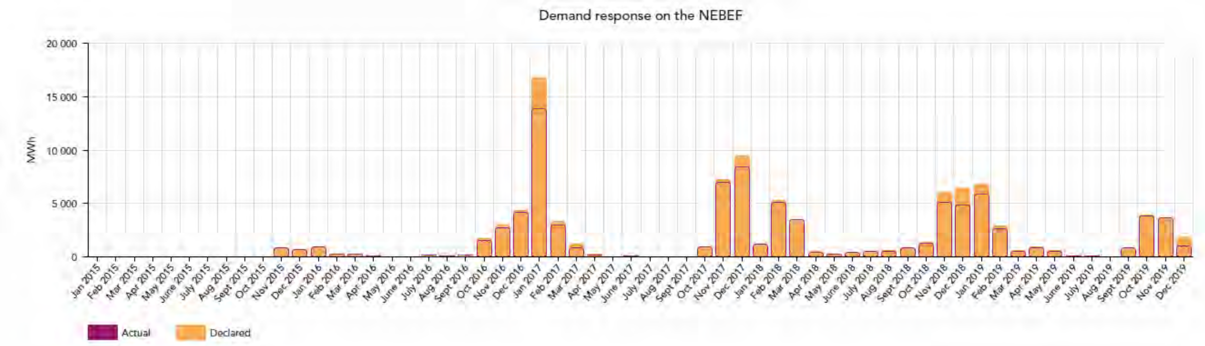
For a better understanding

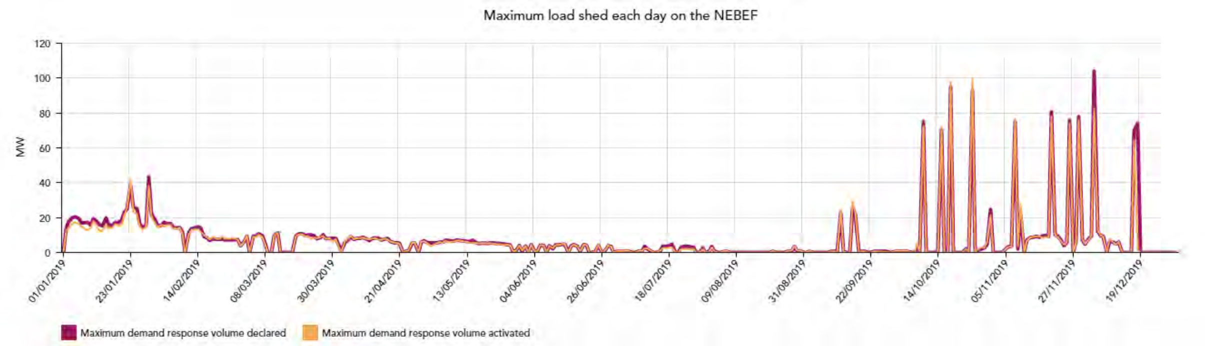
The NEBEF mechanism (Demand Response Block Exchange Notification) allows market actors to realise value on demand response directly through the market. They inform RTE of the demand response they plan to activate the next day and can now re-declare schedules at the intraday scale. RTE verifies afterward that actual volumes correspond to the schedules submitted by participants.
As of today, 21 demand response operators have contracts with RTE to participate in the mechanism.

Demand response volumes selected through the NEBEF mechanism reached 22.2 GWh in 2019, in line with 2018. Distributed demand response accounted for the lion's share of volumes exchanged via the NEBEF. Instances of significant demand response volumes being activated were concentrated in the last quarter.



Detailed NEBEF indicators





Capacity mechanism

90.5 GW Total capacity certified	6.3 GW Cross-border capacity certified for 2019

The capacity mechanism in France

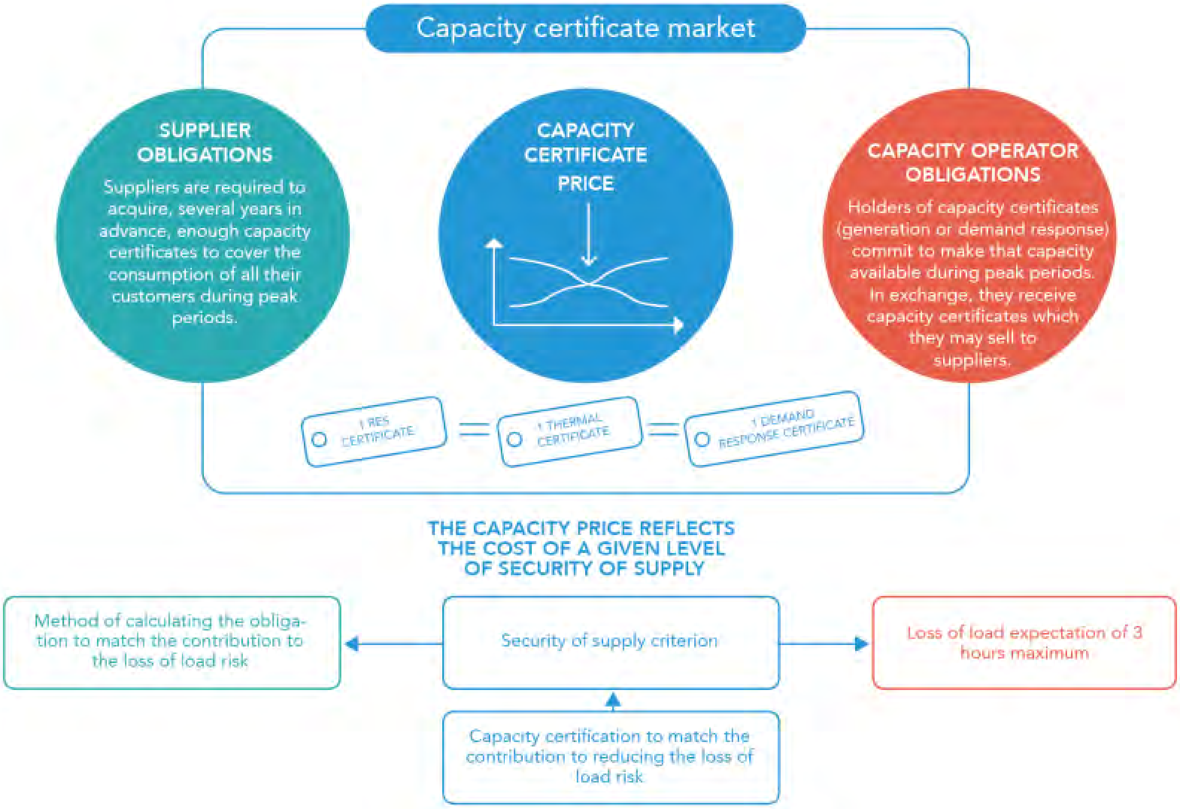
The goal in implementing a capacity mechanism in France is to guarantee security of supply over the medium term by covering risks during peak periods in winter. It was approved with conditions by the European Commission on 8 November 2016, and the market rules drafted for it were approved by the French Ministry of Energy and Energy Regulatory Commission on 29 November 2016.

For a better understanding

How the capacity mechanism works

The capacity mechanism rests on two pillars. First, it creates a requirement for obligated parties – mostly electricity suppliers – to obtain capacity certificates to contribute to the security of supply of their customers. Holding suppliers responsible in this way is notably a means of containing peak demand growth by creating an economic incentive to limit their customers' consumption.
Second, RTE certifies the capacity of operators that agree to make their capacity available when demand peaks in winter. The capacity mechanism allows them to realise value on the availability of generation and demand response capacity by selling capacity certificates.

Actors trade capacity certificates through organised market sessions or OTC transactions. During the delivery year, RTE notifies them of the peak days when they must uphold their individual commitments (“PP1” days for suppliers, “PP2” days for generators and other capacity operators). The calendar of these days can be found here. After the delivery year, RTE informs suppliers of their final obligation level and calculates the actual availability of their capacity. Differences result in financial payments.


Capacity certificate market
SUPPLIER OBLIGATIONS
Suppliers are required to acquire, several years in advance, enough capacity certificates to cover the consumption of all their customers during peak periods.
CAPACITY CERTIFICATE PRICE
CAPACITY OPERATOR OBLIGATIONS
Holders of capacity certificates (generation or demand response) commit to make that capacity available during peak periods. In exchange, they receive capacity certificates which they may sell to suppliers.
1 RES CERTIFICATE
1 THERMAL CERTIFICATE
1 DEMAND RESPONSE CERTIFICATE
THE CAPACITY PRICE REFLECTS THE COST OF A GIVEN LEVEL OF SECURITY OF SUPPLY
Method of calculating the obligation to match the contribution to the loss of load risk
Security of supply criterion
Loss of load expectation of 3 hours maximum
Capacity certification to match the contribution to reducing the loss of load risk

Forward indicators for the capacity obligation

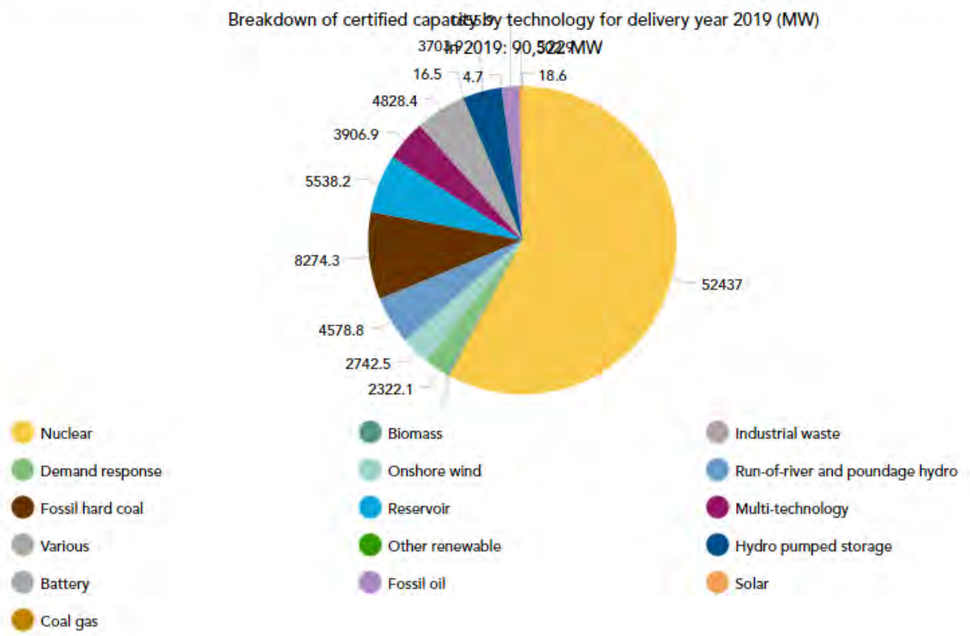
Forward indicators for the capacity obligation are based on the reference trajectory and alternative consumption trajectories in the sensitivity analyses presented in the 2019 Generation Adequacy Report.

Trajectory	Forecast total capacity obligation for France in 2020 (GW)	Forecast total capacity obligation for France in 2021 (GW)
Trajectory 3	93.7	93.2
Trajectory 4	94.0	93.9
Base case: flat consumption	94.3	94.3
Trajectory 5	94.5	94.6

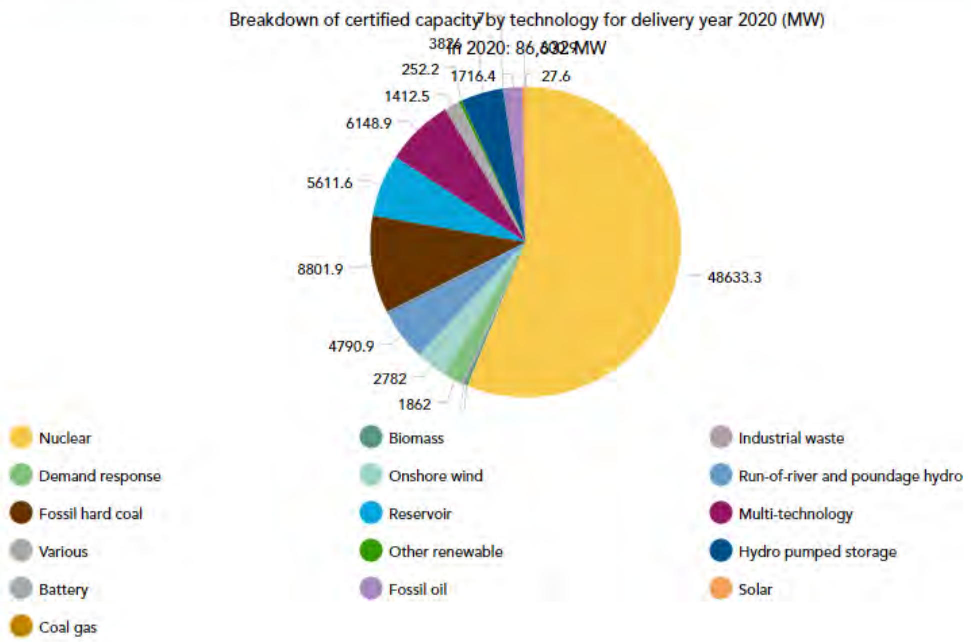
Suppliers can take measures to reduce their customers' consumption. Such measures to limit consumption at peak times must be subtracted from the forecast capacity obligation published by RTE. Total demand response measures are published in the Registry of Consumption Control Measures. In 2019, they amounted to 632 MW.

Breakdown of certified capacity

In 2019 | In 2020



In 2019 | In 2020



Certified entities and their technology are defined at the site level. They may be generation or demand response capacities. Certified volumes total 90.5 GW for 2019 and 86.6 GW for 2020.

This does not include capacity certified by RTE at interconnections: 6,319 MW for 2019 and 6,760 MW for 2020.

For a better understanding

Explicit participation of cross-border capacities

From the beginning, the French capacity mechanism was designed to take into account the interconnection between the country’s power system and those of other European countries, and the contribution the latter can make to security of supply in France. Initially, for delivery years 2017 and 2018, this contribution was accounted for implicitly, by deducting it from the capacity requirements of suppliers via the so-called security factor, but it was not explicitly valued. The security factor was 0.93 in 2017 and 2018.

Since 2019, contributions from EU Member States directly interconnected with France have been accounted for explicitly. A country’s contribution is based on the electricity France can expect to import from it when a shortfall is identified in the Generation Adequacy Report scenarios.

For delivery year 2019, the contribution of the five countries explicitly taken into account was 6,319 MW, and the security factor was 0.99.

Capacity price

Capacity certificates can be exchanged over-the-counter or through auctions.

Details of these transactions are published in the capacity certificates register. When auctions are involved, in the interest of transparency, exchange volumes and prices (€/certificate) are published on the EPEX SPOT website.

The imbalance settlement price (formerly the reference market price) is then calculated using a methodology defined by the CRE.

Delivery year	Reference market price, or imbalance settlement price
2017	€9,999.8/MW
2018	€9,342.7/MW
2019	€17,365.3/MW
2020	€16,583.9/MW

Change in calculation of the imbalance settlement price

The methodology for calculating the imbalance settlement price changed in 2019 (changes applicable in 2020).

For each delivery year (DY) between 2017 and 2019, the reference market price is calculated as the arithmetic average of prices revealed by auctions on organised exchange platforms between the 1st of January DY-4 and the 31st of December DY-1.

Starting in delivery year 2020, the imbalance settlement price is defined as the price revealed by the last auction conducted on organised exchange platforms in the year preceding the delivery year.

Long-term tenders

A long-term tender (*appel d'offres long terme* - AOLT) is a tender for new capacity compatible with the Multiannual Energy Programme (meaning capacity relying on fossil fuels are not eligible). Tenders are organised four years prior to each delivery year by the Ministry of Energy if a benefit for society is identified. The goal is to offer visibility on stable revenue from capacity, and thus encourage new investments that will boost security of supply.

A guaranteed price is set at the conclusion of each tender. Candidates whose offers are below the guaranteed price are selected and awarded contracts for difference, ensuring they receive steady remuneration equal to the guaranteed price for a period of seven years. If the guaranteed price is above the market price over the course of the period covered by a contract, the selected party will obtain the difference. If it is below the market price, the party will pay the difference into a dedicated fund.

Once the scheme is fully established, each tender will be organised four years ahead of the delivery period and remain open for a period of six months.

The first tenders were conducted in 2019. Transitional measures were put into place for their organisation, to secure capacity for periods starting over the next four years. As such, four tenders were organised late in 2019, for the following periods:

- 2020-2026
- 2021-2027
- 2022-2028
- 2023-2029

Results were not yet available for these tenders as this report was being prepared. Winners are expected to be notified by the Ministry of Energy in the near future.

Glossary

A

ADEeF
Association of Electricity Distributors in France

Adjusted consumption
Power that would have been consumed if temperatures had been the same as reference temperatures, and if there was no 29th day in February for leap years

ARENH
Accès Régulé à l'Electricité Nucléaire Historique, or Regulated Access to Incumbent Nuclear Electricity: Refers to suppliers' right to buy electricity from EDF at a regulated price, in quantities determined by French energy regulator CRE

B

Balance responsible party
An electricity market player that has a contract with RTE under which it must settle the cost of any differences between energy injected and withdrawn, as recorded after the fact, across the entire portfolio for which it is responsible

Balancing mechanism
Mechanism designed to ensure that, at any given time, RTE has sufficient power reserves it can activate if supply and demand do not balance

BALIT
Balancing Inter TSO: Mechanism through which transmission system operators exchange balancing energy for system balancing. It is available for France-Spain and France-UK exchanges.

Business customers
Customers getting power from the public distribution grid with contracted power of 250 kVA or more

C

Capacity factor
Ratio between the electrical energy effectively generated over a given period and the energy that would have been produced at nameplate capacity over the same period

CCGT
Combined-cycle gas turbine

Converter station
Converter stations can convert DC to AC and thus enable its integration into the power system

Corona effect
Physical phenomenon occurring when the conductor is exposed to high voltage

Coverage rate
Ratio between power generated and gross domestic consumption at a given time

CWE
Central West Europe, region including France, Belgium, Germany, Luxembourg and the Netherlands within which electricity market prices have been coupled since 2010

E

EDF-SEI
EDF-SEI is an integrated operator that generates, purchases, transmits, distributes and supplies electricity in non-interconnected island territories

Enedis
A distribution system operator in France

ENTSO-E
European Network of Transmission System Operators for Electricity, which has 34 member countries and 41 transmission system operator (TSO) members. Its purpose is to promote important aspects of electricity policy such as security, renewable energy development and the power market. ENTSO-E works closely with the European Commission and is the backbone of the European electricity market

Equivalent outage time
Energy not supplied as a result of customer power cuts, expressed as a ratio to total annual power supplied by RTE to its customers

Exceptional events
High impact, low probability atmospheric phenomena as well as cases of force majeure

G

Generation: Bioenergy
“Bioenergy” includes biogas, paper/paperboard waste, municipal waste, wood-energy and other solid biofuels

Generation: Fossil-fired thermal
“Fossil-fired thermal” includes fuels like coal, oil and gas

Generation: Hydropower
“Hydropower” includes all types of hydropower facilities (pondage facilities, run-of-river, etc.). Consumption resulting from pumping at “STEP” (pumped storage stations) is not deducted from total output

Generation: Nuclear
“Nuclear” includes all nuclear power plants. Consumption by auxiliary generator sets is deducted from generation

Generation: Renewable
“Renewable” includes all electricity generated from renewable sources (hydro, wind, solar, bioenergy)

Gross consumption
Power consumed across France, including Corsica and factoring in losses

H

Heavy industry
Final customers getting electricity directly from the transmission system operator

I

Industrial output
The indicator used is based on Insee's industrial output indices, weighted to reflect power demand in the different segments of each sector

Intraday
Refers to electricity trades conducted on very short notice, almost in real time

ITER
International Thermonuclear Experimental Reactor

J

Joule effect
Heating of the conductor when an electric current flows through it

L

LDCs
Local Distribution Companies. These are, along with Enedis, the operators of the distribution system, intermediaries between the transmission grid and final customers. There are approximately 150 LDCs across France

Lightning density
Number of times lighting strikes per year and per km2 in a given region

Demand response
Mechanism by which consumers cancel or postpone all or part of their power consumption in response to a signal

M

Market coupling
Process by which electricity supply and demand are matched across different markets, within the limits of the interconnection capacity between these markets. An algorithm simultaneously determines prices and implicitly allocates available cross-border capacities, resulting in identical price zones when interconnection capacities do not limit cross-border trades

Multiannual Energy Programmes
Multiannual Energy Programmes (*Programmation Pluriannuelle de l'Energie* – PPE) are a new tool used to set priorities to guide the actions of public authorities as they relate to the energy transition, in accordance with the commitments outlined in the energy transition law for green growth

MWp
Megawatt peak corresponds to 1 million Watt-peak units. A Watt-peak is a measuring unit for the output of photovoltaic panels, corresponding to the production of 1 Watt of electricity under normal conditions for 1,000 Watts of solar radiation per square metre at an ambient temperature of 25°C

N

NEB
Block Exchange Notification (*Notification d'Echanges de Blocs*): Service allowing balance responsible parties to exchange energy blocks with other balance responsible parties and/or to supply electricity to consumption sites connected to the transmission or distribution grid outside their balancing perimeter

NTC
Net Transfer Capacity, the transfer capacity made available to the market for imports and exports, calculated and published jointly by the system operators. Transfer capacity depends on the characteristics and availability of interconnection lines and internal constraints on individual countries' power grids

O

Outage frequency
Ratio between the number of short or long outages and the number of distributors and industrial customer sites supplied by RTE. An outage is considered short if it lasts between 1 sec and 3 min and long if it lasts more than 3 min

P

Power line circuit length
Actual length of one of the conductors that form a power line or the average length of the conductors if they differ substantially

Professional customers
Customers getting power from the public distribution network for professional use with contracted power of 36 kVA or less

PTS
Public Transmission System, over which electrical energy is carried and transformed, linking generation sites to consumption sites. It includes the primary transmission and interconnection grid (400 kV and 225 kV) as well as the regional distribution networks (225 kV, 90 kV and 63 kV). This very high voltage and high voltage grid provides electricity to heavy industry and the main distribution system operators

R

Reference temperatures
Averages of past temperature series considered to be representative of the current decade. Based on Météo France data, the temperatures are calculated by RTE for France as a whole thanks to 32 weather stations throughout the country

Residential customers
Customers getting power from the public distribution network for residential use with contracted power of 36 kVA or less

Residual demand
Residual demand corresponds to demand from which must-run generation has been subtracted

Retail customers
This is another name for the residential sector, which includes customers that get power from the public distribution network for residential use with contracted power of 36 kVA or less

S

Seasonal adjustments

Chronological series from which the seasonal component has been removed. Changes in statistical series can usually be characterised as reflections of trends, seasonal components, or irregular components. Adjusting for seasonal variations is a technique used by statisticians to eliminate the effects of seasonal fluctuations on data, thereby revealing fundamental trends

SER
“Syndicat des Énergies Renouvelables”, France’s renewable energy association

SMEs/SMI
Final customers to which distribution system operators provide medium- and low-voltage power, with contracted power of 36 kVA or more

Spot price
Average electricity price negotiated for delivery the following day in 24 one-hour timeslots

T

TSO
Transmission System Operator

V

VPP
Virtual Power Plants: A mechanism that was phased out in the first half of 2015

W

Water reserve
The water reserve in France is the weekly average aggregate filling rate of all water reservoir and hydro storage plants. The upper energy is energy that can be generated from the (only) production unit directly connected to the reservoir, depending on its filling rate. The data published constitutes only the reserves related to upper energy and is expressed in MWh.

Le réseau
de transport
d'électricité

RTE - Direction innovation et données – Janvier 2020