Le réseau
de transport
d'électricité





SAFETY REPORT

2025



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Summary

The operational safety of the electricity system

RTE is responsible for continuously maintaining the balance between electricity generation and consumption, transmitting electricity from generation to consumption, and managing exchanges between France and neighbouring countries. Ensuring operational safety means controlling how the electricity system evolves and responds to the various contingencies it may encounter (short circuits, unexpected changes in consumption or generation, unforeseen unavailability of generation or network assets, etc.). This involves, in particular, anticipating the measures to be implemented in response to these possible contingencies and reducing, as far as possible, the risk of the physical parameters governing the operation of the electricity system (frequency, current and voltage) moving outside the operating ranges considered safe, thereby creating a risk of interruptions to electricity supply.

The management of the electricity system is governed by a body of French and European rules.

System safety is defined as the ability to:

- Ensure normal system operation (normal ranges for frequency, voltage, current and short-circuit power) under normal operating conditions and in the event of a standard hazard conditions,
- Limit the number of incidents and prevent major incidents in the event of adverse hazard conditions,
- Limit the consequences of major incidents when they occur, particularly in the event of highly adverse hazard conditions.

Many of the actions described in the Safety Report form part of the principles set out in RTE's Ten-Year Network Development Plan (SDDR) and System Operation Transformation Plan (STES).

The safety report is published annually by RTE pursuant to Article 28 of the specifications for public transmission system grid-concession (RPT) (approved by decree of 23 December 2006).

This report of the operational safety of the electricity system is based on an analysis of:

- Significant System Events (SSEs) that occurred during the year and reflect the operational safety of the system,
- Management of operating parameters:
  - Management of the supply-demand balance (SDB) and its impact on frequency,
  - Management of network flows and compliance with the permissible current ratings of network assets,
  - Management of voltage levels at all points on the network,
  - Management of transient phenomena, operation of the safeguard and defence plans, and the system restoration plan,
- Operation of the information and telecommunications systems required for system operation,
- The company's organisation for ensuring system safety.

IN 2025, OPERATIONAL SECURITY REMAINED GENERALLY SATISFACTORY, WITH THE LEVEL OF SSES REMAINING STABLE OVER THE PAST THREE YEARS, ALTHOUGH THEIR CAUSES ARE EVOLVING, REFLECTING STRUCTURAL CHANGES IN THE SYSTEM.

To better reflect the risks observed in recent years and facilitate their analysis, **the SSE classification framework was updated on 1 January 2025,** while ensuring comparability with previous years. The main change concerns **the explicit inclusion of significant variations in renewable energy generation during periods of negative spot prices (PSN).**

Analysis of the key indicators for the year confirms a satisfactory level of electricity system operational safety:

- The total number of SSEs rated ≥ A increased slightly and remained in line with 2023-2024.
- The increase in SSE A is primarily due to short-term factors; it reflects the French electricity system's current production overcapacity but does not indicate any underlying deterioration in operational safety.
- SSE B recorded in relation to network flow management decreased significantly. They are slightly more numerous than before 2024 due to isolated incidents affecting IT and telecommunications infrastructure and measures to improve the detection of risks to system stability.
- An event rated D was recorded in connection with the Iberian Peninsula blackout of 28 April 2025: the French defence plan was activated and helped preserve the integrity of the European electricity system.

MANAGEMENT OF THE SUPPLY-DEMAND BALANCE (FROM A MARKET PERSPECTIVE) AND FREQUENCY (FROM AN OPERATIONAL SAFETY PERSPECTIVE) BENEFITED FROM FAVOURABLE TRENDS IN 2025, WITH A SIGNIFICANT INCREASE IN THE PARTICIPATION OF VARIABLE RENEWABLE ENERGY (ENR) IN THE BALANCING MECHANISM. HOWEVER, THE MANAGEMENT OF SPECIFIC PRODUCTION SITUATIONS THAT RESULT IN PERIODS OF NEGATIVE SPOT PRICES IN THE MARKETS REMAINS AN AREA REQUIRING CLOSE ATTENTION, BOTH FOR SUPPLY-DEMAND BALANCE MANAGEMENT AND FOR THE NETWORK.

From a balancing perspective, **the abundant generation situation in which the electricity system currently finds itself is leading to a reduction in situations involving insufficient upward margins.** These are primarily associated with industrial action that temporarily affects the availability of the generating fleet.

Conversely, for the third consecutive year, **situations involving insufficient downward margins** – associated with very high generation levels – **continued to increase sharply.** The number of SSE A recorded due to insufficient downward margins doubled again in 2025.

To address these situations, RTE has two complementary levers:

- issuing real-time orders to reduce renewable generation outside the balancing mechanism when available market depth remains insufficient. First implemented in 2024, this lever was activated 29 times in 2025. This mechanism is gradually disappearing thanks to the second lever;
- **activating renewable energy balancing offers through the balancing mechanism,** which are particularly useful for managing high frequencies. **The volumes offered rose sharply in 2025 in anticipation of the regulatory change that came into force on**

1 January 2026, extending the obligation to participate in the balancing mechanism to all generating facilities with a capacity of more than 10 MW.

Developing levers to control low-voltage photovoltaic generation remains a key challenge for the coming years. This type of generation is developing rapidly, with installed capacity now exceeding that connected to the medium-voltage network (HTA).

In terms of frequency, 2025 was marked by a significant improvement at the France-wide level, as a result of several measures:

- new settings for France's contribution to primary frequency control, now fixed, which prevent excessive contributions during major frequency deviations;
- connection to the European PICASSO platform for secondary reserve (aFRR) in April 2025, enabling reserves to be exchanged more efficiently between countries.

AS IN 2024, THE EXISTING INFRASTRUCTURE ENABLED OVERALL CONTROL OF THE ELECTRICAL OPERATING PARAMETERS AND THE STABILITY OF THE ELECTRICITY SYSTEM, WHICH STILL REQUIRES PARTICULAR ATTENTION TO THE MANAGEMENT OF HIGH VOLTAGES. POWER FLOW MANAGEMENT AS REAL TIME APPROACHES IS BECOMING MORE COMPLEX, NOW SIMULTANEOUSLY INVOLVING THE NEED TO MAINTAIN THE INSTANTANEOUS BALANCE BETWEEN GENERATION AND CONSUMPTION, CONTROL POWER FLOWS ON THE NETWORK, AND MANAGE VOLTAGE. THIS INCREASES THE NEED FOR RTE TO ANTICIPATE DEVELOPMENTS, WHICH MUST BE BASED ON RELIABLE INFORMATION FROM MARKET PARTICIPANTS, MAKING IT NOW ESSENTIAL FOR MARKET PARTICIPANTS TO EFFECTIVELY AND RELIABLY PROVIDE RTE WITH THEIR OPERATING SCHEDULES.

Management of power transfers and compliance with permissible current ratings

Changes in the French and European energy mix are leading to **greater variability in network flows, in terms of their geographical distribution, direction and magnitude.** This is resulting, in particular, in the maximum permissible current ratings of certain network assets being approached, potentially creating network flow constraints. In 2025, the number of temporary exceedances of the permissible current ratings on RTE's network assets remained in line with the average for previous years (2017-2024).

Although the increase in south-to-north network flows observed in 2024 was confirmed in 2025, with the network remaining heavily loaded, **the measures implemented have produced results, with improved control of power transfers,** particularly at the Italian border: the number of SSEs caused by power transfers decreased considerably compared with 2024.

The Spanish border continues to receive particular attention: exchanges between France and the Iberian Peninsula remain high. The loading of network assets in the area, including the interconnection and the upstream 400 kV and 225 kV network, is often close to operating limits, but the number of temporary exceedances of permissible network flows remains under control.

Voltage management

Low-voltage management, which has historically been an area of concern in western France (particularly Brittany) during the winter period, has no longer presented any major difficulties for several years, against a backdrop of changes in the national consumption and generation profile. The two defence automation protection schemes installed in the 2010s were not activated in 2025. Nevertheless, **new low-voltage phenomena have emerged in recent years, associated with high local power**

transfers or the end of periods of negative spot prices, when conditions can change very rapidly.

High voltages remain under enhanced monitoring against a backdrop of relatively low consumption combined with structural changes in the electricity system (development of underground distribution and transmission systems, growth in decentralised generation, and changes in the technical characteristics of electricity uses). **The number of hours during which authorised thresholds are exceeded has continued to decrease over the past two years, reflecting the efforts made by RTE to deploy compensation equipment,** with 14 inductors installed in 2025 ahead of an acceleration in deployment by 2030, in accordance with the strategy set out in the 2025 SDDR.

Other levers were strengthened in 2025 to improve control of high voltages: continued deployment of automation systems to control the switching of static compensation equipment and securing of the process for imposing nuclear generation levels in south-western France. From 2026, the extension of participation in voltage ancillary services to renewable energy producers and storage operators connected to the HTB network will enable these parties, through static compensation, to provide voltage control services even when they are not operating.

To limit the reactive power fed back into the transmission system, which continues to increase every year, as it does in all countries, the approach pursued for several years with distribution system operators to increase the contribution of producers connected to the HTA network to reactive power absorption is continuing. In addition, the participation of these HTA-connected parties in voltage control is a lever being considered to contribute to electricity system operational safety.

These actions are governed by a demanding programme for contracting system services, regular performance monitoring of market participants, and new remuneration rules, agreed in 2025 and applicable from 2027.

System stability and dynamic phenomena

Within the framework of the existing operating rules, certain specific situations have led RTE to reduce the output of certain nuclear reactors or modify the cross-border trading schedule (countertrading) in order to prevent dynamic phenomena from occurring (local stability issues and inter-zone frequency oscillations at European level).

RTE IS DEVELOPING ITS TOOLS AND REFINING THE STRUCTURE AND ORGANISATION OF ITS OPERATIONAL ACTIVITIES IN ORDER TO MAINTAIN AND IMPROVE THE SYSTEM SAFETY.

The number of SSEs related to information systems and telecommunications infrastructure increased very slightly in 2025 (25 SSEs compared with 23 in 2024), with a significant proportion of SSE B associated with telecommunications equipment failures or interventions affecting the environment of the StanWay control system. Although these events were managed successfully, they confirm the need to continue renewing and developing telecommunications networks and securing critical application chains.

Lastly, RTE's target organisation for electricity system operation is now operational following the opening of the third Electricity System Operations Centre (COSE) in Marseille. The creation of the COSEs, which replace the eight original dispatching centres, is intended to streamline RTE's organisation while improving its capacity to anticipate and act in real time and simplifying interactions between operational areas.

RTE IS CONTINUING AND DEVELOPING ITS COOPERATION WITH ITS EUROPEAN COUNTERPARTS IN SUPPORT OF SYSTEM SAFETY.

Cooperation between transmission system operators and coordination centres in Europe is continuing, based on the implementation of the services provided for under European legislation.

The Baltic countries – Lithuania, Latvia and Estonia – were successfully connected to continental Europe on 9 February 2025. In addition, throughout 2025, RTE and its European partners continued their analyses of the compliance of the Moldovan TSO (Moldelectrica[1]) with European rules.

Cooperation work is continuing at European level, with strong expectations in terms of system safety, including for the network code aimed at establishing a European regulatory framework for the development of flexibility markets in the Member States. The revision of the Capacity Allocation and Congestion Management (CACM) network code was also initiated in 2025.

THE BLACKOUT THAT OCCURRED IN THE IBERIAN PENINSULA ON 28 APRIL 2025 AND THE INCREASE IN PERIODS OF NEGATIVE SPOT PRICES WERE THE TWO MOST SIGNIFICANT EVENTS OF 2025.

The blackout that occurred on 28 April 2025 was classified at the highest level under European regulations and as the most serious incident in Europe in more than 20 years.

According to the report published on 20 March 2026 by the Expert Panel established by ENTSO-E, the root causes of the incident were related to: i) the definition and monitoring of requirements for the setting of protection systems against high voltages, ii) the definition and monitoring of voltage control requirements, iii) voltage control capabilities, and iv) security margins. **The combination of these factors** generated unstable voltage and **a rapid increase in voltage, which led to cascading trips and resulted in the blackout.**

France is less exposed to voltage instability phenomena and is better protected against them thanks to more stringent operating rules and conditions. As a result, many of the recommendations made in the report are already applied in France, such as real-time secondary voltage control, automation systems for controlling static compensation equipment, monitoring of the requirements applicable to producers, and the use of stricter security margins (normal operating voltage is limited to 420 kV in France, compared with 435 kV in Spain).

Other recommendations, already being implemented by RTE, require further work to strengthen the resilience of the French electricity system: extending voltage control requirements to renewable energy producers connected to the HTB network and storage operators through static compensation, and improving network observability for rapidly changing phenomena through the installation of dedicated sensors, the deployment of which needs to be accelerated in the coming years.

Lastly, work is also under way with Enedis to adapt the frequency-based load-shedding plan to decentralised generation and develop dynamic voltage control for producers connected to the distribution system.

1. At the end of 2023, Moldelectrica joined ENTSO-E as an observer member.

Periods of negative spot prices, now monitored through specific SSEs, continue to increase in number and in their impact on the network.

The continued development of low-carbon generation and the maintenance of stable electricity consumption following the health and energy crises have led to an increase in the number of periods and hours of negative spot prices since 2022.

The volumes of generation shutdowns and restarts at the beginning and end of these periods have been steadily increasing for several years. These periods can indeed lead to large volumes of renewable generation being shut down within a matter of minutes, which can significantly disrupt the supply-demand balance and frequency management, particularly since RTE currently does not have **sufficient visibility of the operating schedules of producers connected to the RPD** (and therefore of generation shutdown and restart volumes). Given the rapid dynamics of these phenomena, this complexity also extends to the management of network flows and the voltage plan.

To ensure system safety, the DDADUE law of 30 April 2025 extended to all generating facilities – including renewable facilities – with an installed capacity of more than 10 MW the obligation to make their technically available capacity available to RTE (through the balancing mechanism), both upwards and downwards. RTE's market rules set out the practical arrangements for this obligation and were approved by the CRE on 2 December; the obligation came into force on 1 January 2026. In addition, the 2025 Finance Law, supplemented by an order dated 8 September 2025, also introduced the possibility for all sites subject to a purchase obligation (OA) to participate in the balancing mechanism. As some market participants anticipated the implementation of these provisions, the renewable capacity that RTE could mobilise through the balancing mechanism increased tenfold between December 2024 and December 2025, reaching 5.6 GW.

Extending scheduling obligations to new market participants is therefore intended to improve predictability and, consequently, optimise supply-demand balance management. In addition, implementing technical arrangements for staggering generation shutdowns and restarts during periods of negative spot prices should help facilitate control of the system's electrical parameters (frequency, current and voltage).

2 Operational safety of the electricity system

A MODERNISED FRAMEWORK FOR ASSESSING SIGNIFICANT SYSTEM EVENTS (SSES)

RTE assesses the operational safety of the electricity system each year by compiling **Significant System Events (SSEs).** They are classified according to a severity scale ranging from 0 and A to F. These events reflect the occurrence of incidents that may have multiple causes. RTE's classification can be mapped onto ENTSO-E's four-level ICS (Incident Classification Scale).

Monitoring SSEs over several years makes it possible to detect low-level events (severity 0) and events that have an impact on operational safety (from severity A = localised, single and controlled incident to F = widespread incident), and to measure, over time, the effectiveness of all the actions undertaken to ensure the operational safety of the electricity system.

The framework for events affecting System Safety was revised on 1 January 2025 to adapt to the changes in risks observed in recent years. This new framework clarifies the criteria defining an SSE, facilitates the analysis and monitoring of causes, and strengthens the effectiveness of the actions implemented to improve system safety. As a result, **particular attention was paid in this edition of the Safety Report to ensuring continuity in the analysis of events identified as critical** with regard to the operational safety of the electricity system.

The main change concerns the broadening of the criteria relating to unexpected variations in a volume of generation, to now include variations in renewable generation volumes observed during periods of negative spot prices. Indeed, although the time periods affected by negative spot prices are known in advance, the difficulty of predicting the volumes and dynamics of renewable generation shutdowns and restarts can affect the supply-demand balance when variations of several gigawatts occur both at the beginning and at the end of a period of negative spot prices. To ensure continuity in monitoring the development of significant events over several years, these events related to negative spot prices will be presented separately in the remainder of the document, particularly in Chapter 8.2.

In this new framework, the number of criteria remains broadly unchanged. Previously classified under five main themes (system operation, network, control systems, generation, distribution), they are now grouped together in order to better distinguish

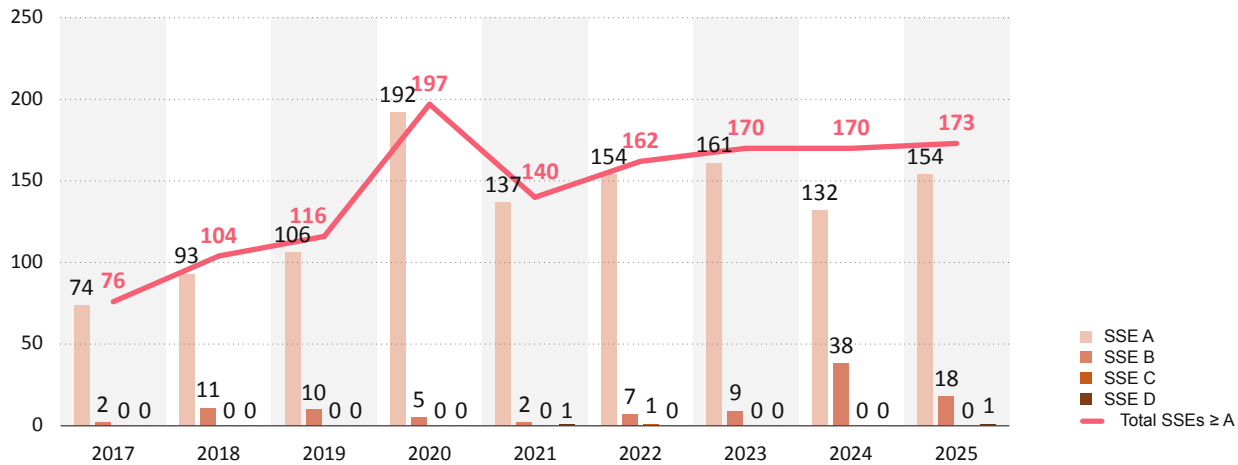
the physical parameter or safety issue concerned.

- Supply-Demand Balance (SDB):
  - Frequency
  - Consumption
  - Production
- Physical parameters:
  - Voltage
  - Load flow
  - Stability
  - Short-circuit current
- Network events
- Incident prevention:
  - System restoration
  - Safeguard plan – Defence plan
- IT and telecommunications:
  - Application and telecommunications network tools
  - Telephony

AN UPWARD TREND IN SIGNIFICANT SYSTEM EVENTS (SSES) SINCE 2017, BUT RELATIVE STABILITY OVER THE PAST THREE YEARS.

With 172 events classified A or B and one event classified D, 2025 confirms the trend towards stability seen over the past three years, despite a very slight increase (+3) in the number of Significant System Events (SSEs) compared with 2024. The period experienced by the French electricity system since the health and energy crises of 2020 and 2022-2023 continues to be marked by a higher number of SSEs than in the preceding period:

FIGURE 1 – EVOLUTION OF SSES OF SEVERITY ≥ A



- The event classified D corresponds to the activation of the French defence plan and the automatic activation of measures to disconnect the network in response to loss of synchronism (DRS), following the Iberian blackout of 28 April 2025. A focus on this event is presented in Chapter 8.1.
- The number of SSE B decreased compared with 2024. RTE's actions to strengthen risk anticipation and control have enabled better control of network flows, particularly near the Italian border. These actions, described in Chapter 4, reduced the number of SSE B related to network flow management from 24 in 2024 to just one in 2025.
- Excluding 2024, however, the total number of SSE B remains higher than in previous years, due to isolated incidents affecting the information system or failures on RTE's telecommunications network (see Chapter 7).
- The increase in the number of SSE A between 2024 and 2025 remains a short-term development and is not linked to any particular factor, with the final figure being equivalent to that of previous years.

MONITORING OF SSES NOW ALSO INCORPORATES VARIATIONS IN RENEWABLE GENERATION DURING PERIODS OF NEGATIVE SPOT PRICES.

Since 1 January 2025, variations in renewable generation observed during periods of negative spot prices have been recorded as SSE 0, A or B, depending on the volume of generation affected by a shutdown at the beginning of the period. These events are subject to specific analysis (see Chapter 8.2), which will be repeated in future assessments.

SSES ABOVE SEVERITY A REMAIN STABLE IN VOLUME BETWEEN 2024 AND 2025, BUT THEIR CAUSES ARE CHANGING SIGNIFICANTLY.

The following graph shows the distribution of SSEs ≥ A according to the different categories: Supply-Demand Balance (SDB), Power Flows, Voltage, Prevention of Major Incidents (IGA), IT and Telecommunications. These categories are analysed in detail in the remainder of the document.

FIGURE 2 – DISTRIBUTION OF SSES OF SEVERITY A AND ≥ B BY CATEGORY IN 2025

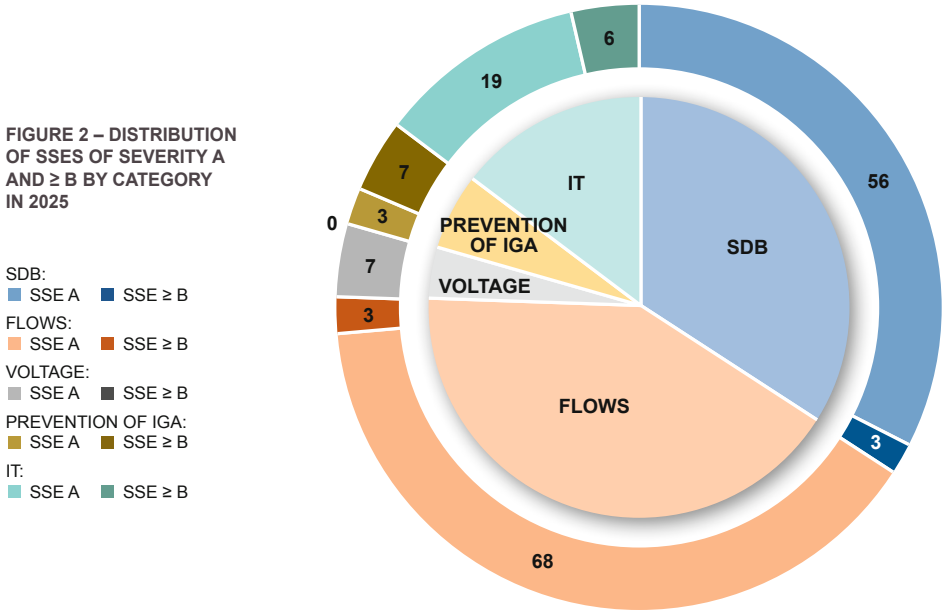
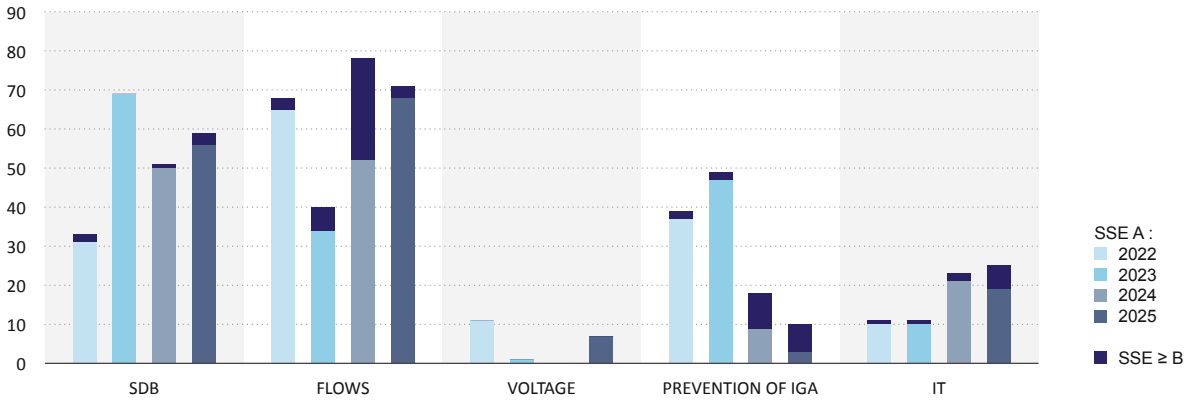


FIGURE 3 – HISTORY OF SSES OF SEVERITY A AND ≥ B BY CATEGORY



Although the total number of SSEs remained stable between 2024 and 2025, their classification by category (SDB, Power flows, Voltage, Prevention of IGA, IT and Telecommunications) in 2025 shows significant differences compared with previous years.

For 2025, the following specific points can be highlighted:

- For SDB, the factors explaining this increase are as follows:
  - The request to shut down renewable generation in the event of insufficient supply on the balancing mechanism (29 SSEs A compared with 9 in the second half of 2024).
  - As in 2023, industrial action at the end of 2025 affected the availability of the generating fleet and SDB management (8 SSEs A due to insufficient upward margins).
  - The introduction of new criteria for measuring the quality of intraday forecasts, rather than only day-ahead forecasts (4 SSEs A).
  - However, better frequency control helped mitigate this increase (6 SSEs A compared with 16 in 2024).
- The number of SSEs related to network flow management remained stable, with the number of SSE B at a similar level to 2022 and 2023 and below the levels of criticality observed in 2024.
- Regarding events identified in the Prevention of IGA category, the high number observed in 2022 and 2023 was essentially related to the use of the SAS communication tool (Alert and Safeguard System) by producers and the carrying out of acknowledgement actions. Their decrease is explained by awareness-raising activities carried out with market participants and by a lower number of SAS messages sent over the past two years. The apparent increase in the number of SSE B in 2024 and 2025 compared with previous years is not due to an increase in risk situations, but to the use of the Stabsys tool, which strengthens the monitoring and detection of situations that may pose a risk to network stability (see Chapter 6.1).
- The number of SSEs related to IT tools and telecommunications networks increased slightly (25 SSEs in 2025 compared with 23 in 2024 and around ten per year on average since 2021). This is partly explained by the clarification of these criteria in the new framework, but also by difficulties encountered with the tools associated with the network studies process and by the impacts observed during interventions in the environment of the control system tool (Stanway). Of these 25 SSEs, 6 were SSE B, 5 of which occurred in connection with failures affecting components of the telecommunications network.

Frequency: supply-demand balance management

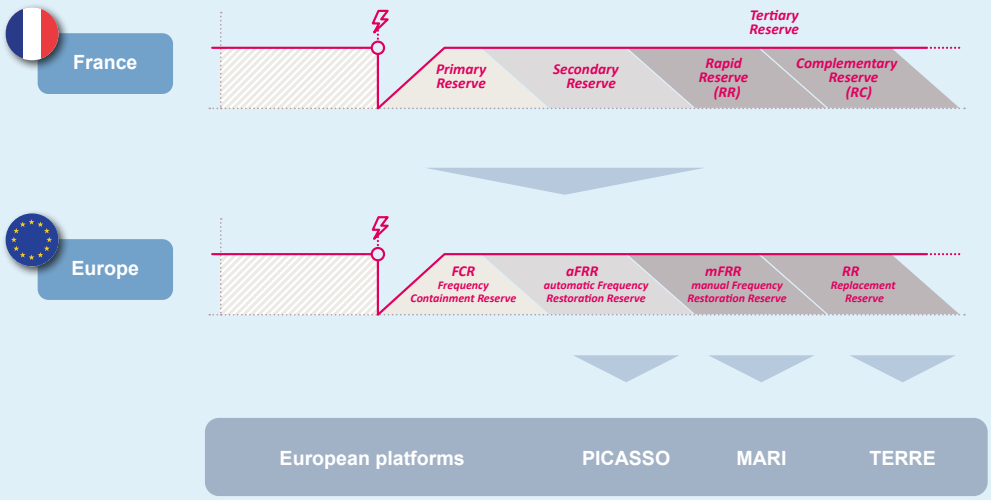
THE MAIN PRINCIPLES OF BALANCING AND MARGINS

The network frequency corresponds to the rotational speed of the alternators of the generating units. By convention, the frequency is 50 Hz across the synchronous area of continental Europe. Maintaining the frequency at 50 Hz requires maintaining the balance between consumption (demand) and the amount of electricity generated (supply).

Each country must maintain the balance of its own national network by monitoring at all times what is being consumed or generated, while taking into account electricity exchanges with neighbouring interconnected countries. Thus, an import is considered to be supply and an export to be demand.

To ensure the supply-demand balance of the electricity system and regulate frequency at all times, RTE has the following levers:

- **The automatic primary (FCR) and secondary (aFRR) reserves provided by the modulation capacities of generating or storage facilities,** also known as frequency-electricity system services, are used first to respond to generation or consumption contingencies occurring on the network;



- **The tertiary reserve** (mFRR) is intended to restore the supply-demand balance in terms of both depth and duration, as well as to restore system services when these have been used during the contingency.

For these various reserves, **operating margins** are calculated, both upwards and downwards, to be able to respond to technical contingencies occurring on the electricity system (loss of a generating unit), or to differences between weather forecasts and actual conditions (temperature, sunshine, cloud cover and wind).

These margins consist of contracted reserves and freely offered capacity on the balancing mechanism, as well as capacity available on the European TERRE platform for the complementary reserve.

The level of these margins must comply with required minimum levels, which depend on the time horizon, and is governed by a European framework:

- The **fast margin** is sized to deal, at any time and within less than 15 minutes, with the loss of the largest generating unit connected to the network (upward margin), or with the loss of the largest withdrawal or an export on a direct-current link (downward margin);
- The **margin for the relevant time horizon,** meanwhile, is intended to cover contingencies that may occur over the coming hours: deviations in the consumption forecast, a technical contingency affecting generation, deviations in the forecast for wind and photovoltaic generation, etc.

When these conditions are not met, RTE issues an information message (day-ahead or intraday), followed by a degraded operating mode (near real-time) and, where applicable, a safeguard message (in real time).

RTE publishes the forecast level of upward and downward margins on its website[2]. These publications are initiated from day-ahead and then updated throughout the day, based on the latest information available.

As the entity responsible for maintaining the balance between electricity supply and demand in real time, RTE can request generation adjustments as close as possible to real time to ensure electricity system operational safety. The balancing mechanism makes it possible to balance the system in compliance with technical and economic precedence criteria. In particular, when supply exceeds demand, these adjustments are prioritised for the generation schedules with the highest variable costs, provided that this does not create network constraints.

Also, when the decisions taken by market players result in surplus power generation, RTE can order cuts in output when normal market operation has not resulted in a balance being achieved. As such, solar and wind capacity can be called on to adjust their output downwards in order to guarantee the balance of the electricity system. This lever is presented in Chapter 3.4, together with the regulatory developments aimed at incorporating these capacities into the balancing mechanism.

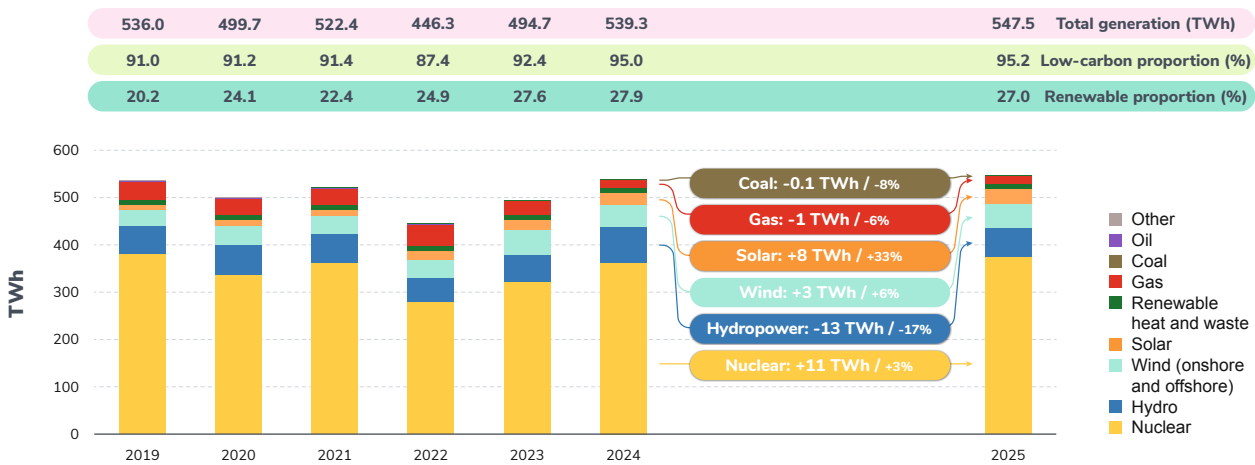
2. Balancing Capacity – RTE Services Portal (services-rte.com)

3.1 Production

A SLIGHT INCREASE IN PRODUCTION IN 2025...

Electricity generation in mainland France reached 547.5 TWh in 2025[3]**.** After two years of strong growth in 2023 and 2024, due mainly to the renewed availability of the nuclear fleet and improved hydropower output resulting from more favourable weather conditions, **the volume of electricity generated in mainland France grew very slightly in 2025** (+8.2 TWh, or +1.5% compared with the 2024 level).

FIGURE 4 – ANNUAL ELECTRICITY GENERATION BY ENERGY SOURCE BETWEEN 2019 AND 2025



* *Power generated from household waste is considered 50% renewable. Seventy percent of PSH pump consumption is deducted from hydropower generation in accordance with European Directive 2009/28/EC*

3. Data from the 2025 Electricity Report published by RTE in February 2026

DRIVEN BY THE INCREASE IN NUCLEAR AND RENEWABLE GENERATION

Nuclear generation increased (373.0 TWh, +11.3 TWh compared with 2024) to a level close to where it was in 2019, thanks to improved availability of the generating fleet. Modulation (across all types) represented around 30 TWh in 2025, a relatively stable volume compared with the previous year. This is not a new phenomenon. For example, comparable or even higher levels were reached in the 1990s and early 2000s, in a context where generation capacity exceeded consumption. Over the last few years, while the volumes have been comparable, the modulation profile has changed, and the amount due to a lack of economic outlets has increased.

In 2025, the Flamanville EPR (1.6 GW) continued to ramp up following its connection to the grid at the end of 2024. The EPR reached full power for the first time on 14 December 2025. It underwent a new series of tests at 100% in early 2026.



Hydropower generation fell sharply compared with 2024 (62.4 TWh, or -12.9 TWh), a year in which it benefited from exceptional rainfall, while remaining at a level in line with historical averages (62.4 TWh).

Generation from solar (32.9 TWh, or +8.1 TWh) and wind (49.6 TWh, or +2.8 TWh) continued to increase, mainly as a result of the development of the solar generating fleet (+5.9 GW, bringing total capacity to 30.4 GW at year-end, now exceeding the capacity of France's hydro installations, which stands at 25.7 GW) and the wind fleet (+0.9 GW for onshore wind and +0.4 GW for offshore wind, with the gradual commissioning of France's fourth offshore wind farm, at Yeu-Noirmoutier), supported by improved sunshine conditions.

Fossil-fired generation continued its decline in 2025 (18.7 TWh, or -1.3 TWh compared with 2024). Generation from this source was at its lowest level for almost 75 years.



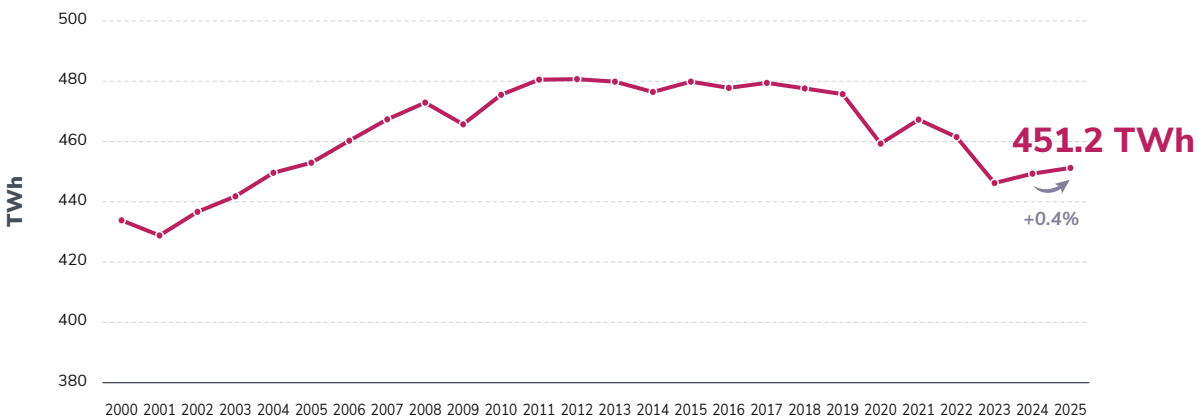
3.2 Consumption

ENERGY ANALYSIS: STABLE ANNUAL CONSUMPTION

Electricity consumption in mainland France in 2025 (adjusted for weather and calendar effects) remained stable in comparison with the previous year, reaching 451 TWh (+0.4% compared with 2024).

Consumption therefore remained significantly lower in 2025, by around 6%, than during the 2014-2019 period (before the health and energy crises), a sign that at least some of the measures taken to reduce consumption and reorganise economic activity in response to these shocks have become established, and that the drive to electrify energy use is still insufficient to reverse the trend.

FIGURE 5 – CONSUMPTION ADJUSTED FOR WEATHER AND CALENDAR EFFECTS BETWEEN 2000 AND 2025

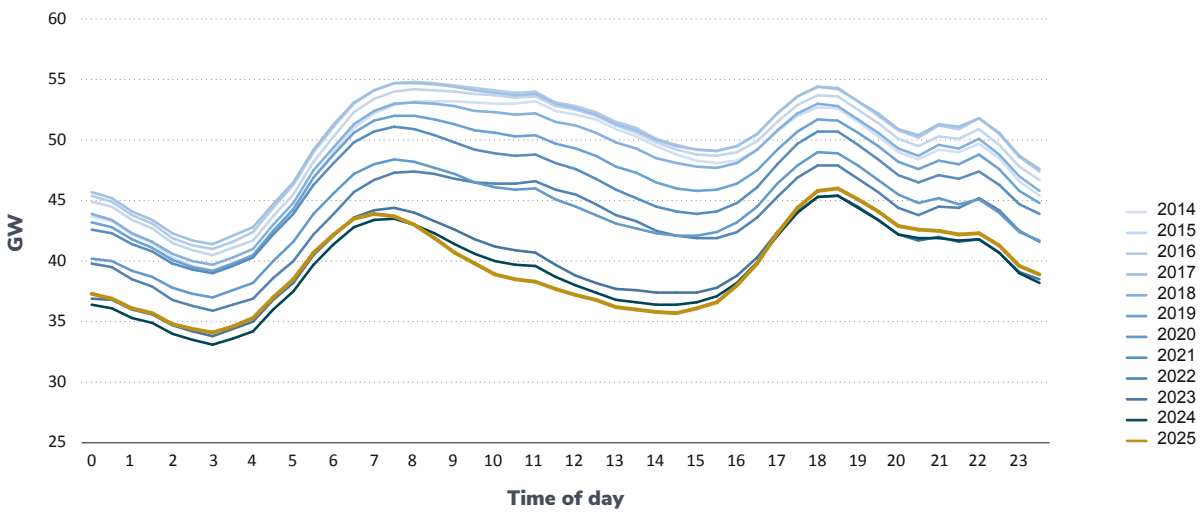


POWER ANALYSIS: RESIDUAL CONSUMPTION WHOSE DAILY PROFILE CONTINUES TO EVOLVE, WITH A DEEPER AFTERNOON THROUGH DRIVEN BY THE GROWTH OF PHOTOVOLTAIC GENERATION

In addition to the annual representation in terms of energy, electricity consumption can also be presented in terms of changes in residual consumption[4] in power terms, which is more representative of the need for instantaneous balancing. Residual consumption corresponds to the consumption that remains to be met by dispatchable generation resources once the volumes of non-dispatchable renewable generation, with zero variable cost, have been taken into account.

The graph below illustrates, firstly, the downward trend in residual consumption since 2014 and, secondly, the evolution of its profile over the course of the day, which is shifting downwards as a result of the combined effect of lower total consumption and increased wind generation (around 7 GW over the 2014-2025 period). This daily profile continues to deepen in the middle of the day as solar generation continues to increase, bringing the decrease to an additional 8 GW at 2 pm between 2014 and 2025.

FIGURE 6 – EVOLUTION OF RESIDUAL CONSUMPTION IN GW (DAILY AVERAGE OVER THE YEAR)



4. Residual consumption corresponds to consumption minus variable solar, wind and hydro generation (run-of-river and pondage). Hydro generation varies relatively little over the course of a day or week.

3.3 Exchanges

A HISTORIC NET EXPORT BALANCE, CONFIRMING THE 2024 TREND.

France's net balance in 2025 was 92.3 TWh[5] of exports. For the second consecutive year, it was the highest in its history, exceeding the 2024 balance (89 TWh).

The balance of physical exchanges was very positive across all borders, with the exception of Spain, with which the annual balance remained balanced (0.2 TWh).

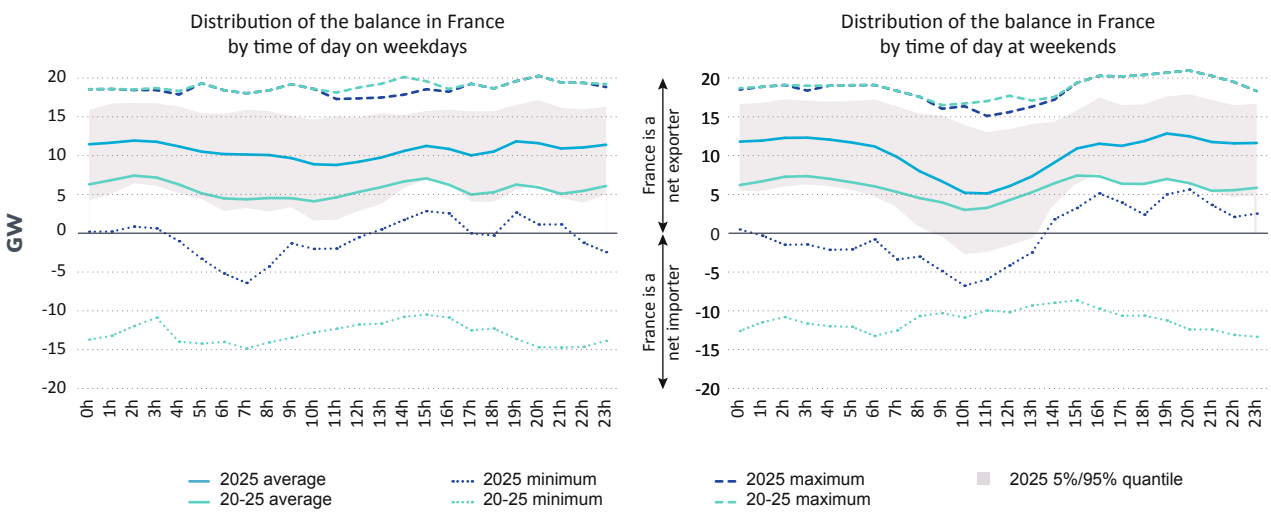
The distribution of exchange volumes by time of day illustrates the significant changes in exchange flows in recent years, notably the fact that in 2025, the minimum exchange levels, which historically and exclusively corresponded to import situations, now partly correspond to export situations. The average value of exchanges increased by around 5 GW.

This growth in exports was notably supported by RTE's optimisation of exchange capacities and coordination of flows at the borders.

Capacity calculations carried out from the annual time horizon through to the intraday time horizon make it possible to optimise the capacities offered while ensuring that commercial exchanges are compatible with the distribution of physical flows on the networks (a distribution that depends on the electrotechnical characteristics of network assets) and compliance with the operating rules common to and specific to each TSO.

These physical electricity flows between countries are mainly the result of commercial exchanges between market participants. The European regulatory framework established by the *Capacity Allocation & Congestion Management* (CACM) and *System Operation Guidelines* (SOGL) regulations defines the safety and operating rules for the interconnected electricity network.

FIGURE 7 – DISTRIBUTION OF THE BALANCE IN FRANCE BY TIME OF DAY ON WEEKDAYS AND AT WEEKENDS



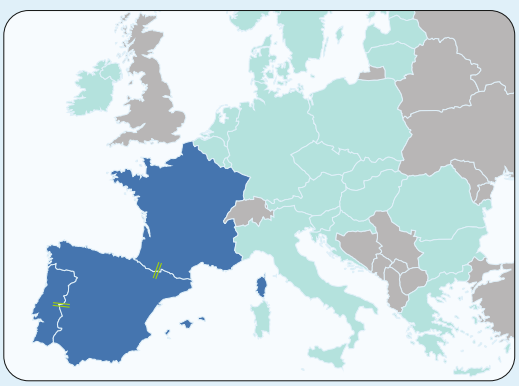
5. 2025 Electricity Report published by RTE in February 2026

Capacity calculations are based on methodologies aimed at calculating, in a coordinated manner, optimised cross-border capacity for the market while complying with the operational security rules imposed by TSOs.

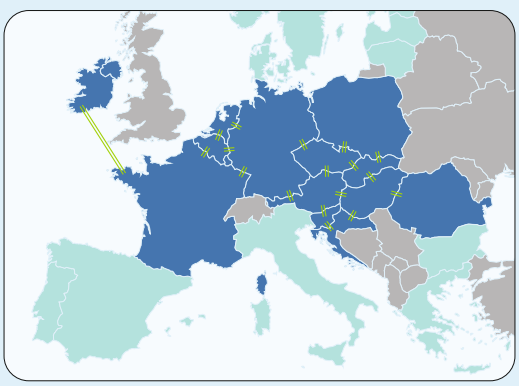
Maximising exchange capacities contributes to supply-demand balance management, particularly in situations of imbalance, and therefore to operational safety of the electricity system. It also meets the requirements imposed by European regulations, particularly those set out in the “Clean Energy Package” (CEP).

These calculations are carried out across several geographical areas and for several time horizons, ranging from the long term (annual and monthly) to the intraday time horizon, with a day-ahead update (D-1) in between. By 2030, capacity calculations for the balancing time horizon (close to real time) are planned. They will provide balancing platforms with capacity values updated as close as possible to the relevant time horizon.

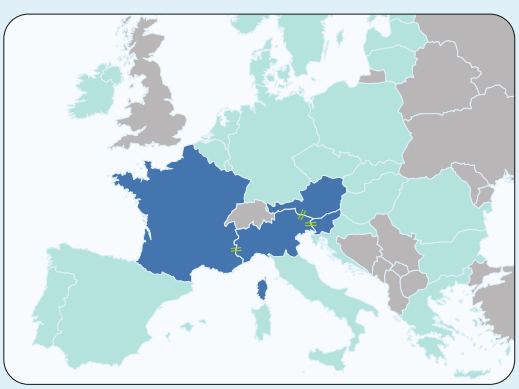
RTE is part of three capacity calculation regions, also known as “CCRs” (Capacity Calculation Regions): South West Europe CCR, Core CCR and Italy North CCR. In the coming years, the Core and Italy North regions will merge to create a new Central Europe region.



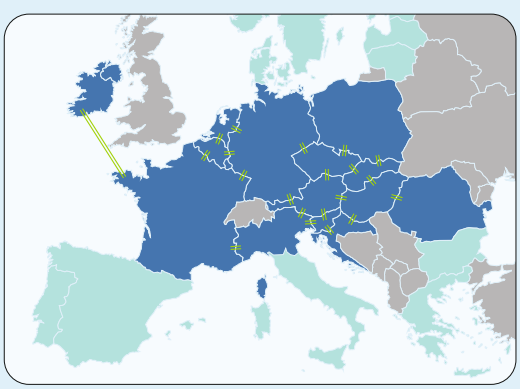
South West Europe



Core



Italy North



Central Europe

EUROPEAN COORDINATION WORK MARKED BY NEW MILESTONES IN 2025.

The 2020-2025 period saw an acceleration in the implementation of European regulations relating to interconnections (the CACM[6], SOGL, FCA[7], and EBGL[8] regulations and texts arising from the Clean Energy Package). The year 2025 marked the start of the cycle for revising these regulations, beginning with the CACM regulation, for which the entry into force of its new version (CACM 2.0), initially planned for early 2026, will probably be postponed to a later date in 2026.

The "Clean Energy Package" sets a minimum threshold of 70% of the capacity of interconnection assets to be made available for cross-border electricity trading, with this threshold required to be reached by the end of 2025. The expected increase in cross-border trading requires greater coordination between European TSOs in order to comply with the operational limits of the European electricity system and manage the associated congestion. In France, compliance with the 70% rule is encouraged through an incentive-based regulatory mechanism introduced by the CRE as part of the TURPE 7 tariff period (2025-2028).

Several new milestones reached in 2025 have helped optimise capacity at the borders:

- On 25 June 2025, a new capacity calculation for the intraday time horizon was launched for the Core region, known as the "Core IDCC[9] (c)" calculation. This is the third intraday capacity calculation for the Core region, following IDCC(a) and IDCC(b), coordinated using a flow-based approach for the Core region. Every day at 4 a.m., it determines the intraday capacities of the borders in the Core region, particularly the French-Belgian and French-German borders, for the [6 a.m.-midnight] period of the current day. The capacities calculated by Core IDCC(c) are offered directly for continuous trading, unlike the IDCC(a) and IDCC(b) calculations, which determine capacities that are then offered in the intraday auctions (Intraday Auctions), respectively IDA 1 and IDA 2, before being offered for continuous trading. Two further calculations are planned for 2026 (IDCC(d) and IDCC(e)) to finalise the overall design envisaged for the Core region, with capacity calculations directly linked to coordinated security analyses.
- Also on 25 June, RTE successfully connected to the European exchange capacity management module for the balancing time horizon, known as CMM Balancing (CMM: Capacity Management Module). This is a centralised European module supplied by RTE with raw exchange data (NTC, exchange schedules on all of RTE's borders), whose main function is to determine the residual capacity at the borders (Available Transfer Capacity or ATC) and communicate it directly to the European balancing platforms.
- The effective launch of 15-minute MTU (Market Time Unit) products took place on the intraday coupling platform on 22 January in the French bidding zone and on the France-Italy, France-Belgium and France-Germany borders, followed by the France-Spain border on 18 March, and on the day-ahead coupling platform on 30 September for the delivery day of 1 October 2025. These developments are intended to improve the accuracy of price signals and increase market flexibility. They represent a key step in the development of coupling platforms towards better integration of renewable energy and more refined congestion management.
- On 22 September 2025, EXAA, the Austrian electricity exchange, entered the French market by launching its local auction at 10.15 am for the delivery day of 23 September 2025.

6. CACM: Capacity Allocation and Congestion Management. Allocation of capacity at interconnections and congestion management.
7. FCA: Forward Capacity Allocation. Long-term allocation of capacity at interconnections.
8. EBGL: Electricity Balancing Guidelines. Electricity system balancing
9. IDCC: Intraday Capacity Calculation

3.4 Supply-demand balance and margins

Overall, managing the supply-demand balance in 2025 did not present any particular difficulties, particularly during the winter period. The Ecowatt alert system, which can be used by RTE in the event of significant difficulties in maintaining the supply-demand balance and was, for this reason, extensively developed during the 2022-2023 energy crisis, was not activated. The fundamentals of the electricity system have changed very significantly in the space of three years. France has therefore moved from a situation of risk of shortages to a situation of abundant electricity generation in the face of consumption below historical levels. This situation also presents technical challenges for electricity system operation, but they are very different from those France faced during the energy crisis.

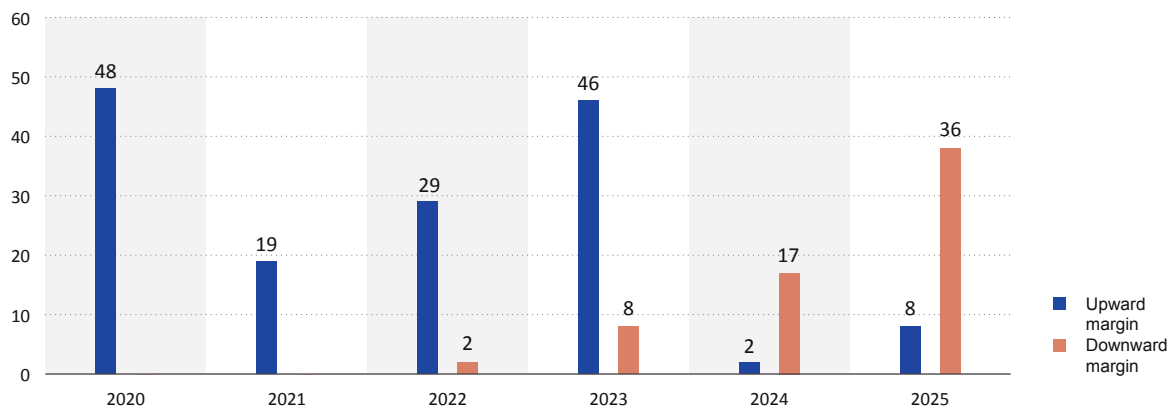
As in 2024, 2025 therefore saw **continued growth in the periods during which RTE faced insufficient downward margin offers.** This led to generation reduction orders being issued to renewable generation fleets connected to the transmission system before they were able to participate in the balancing mechanism.

Managing the supply-demand balance requires production margins to be available ahead of real time, either "upward" margins (in anticipation of a generation shortfall) or "downward" margins (in anticipation of a generation surplus).

- Between 2020 and 2023, many Significant System Events (SSEs) involved situations in which RTE did not have sufficient "upward" margins, particularly due to reduced availability of the nuclear fleet. Thanks to improved availability of the generating fleet and the development of installed renewable generating fleets, these situations were no longer encountered in 2025, with the exception of periods associated with industrial action affecting the availability of the generating fleet, particularly the nuclear fleet (8 events between September and early December 2025).

- **Conversely, since 2022, there has been a very strong increase in situations in which RTE does not have sufficient "downward" margins,** *i.e.* situations in which generation is very abundant. These situations doubled again in 2025 (36 SSEs over the year). It will be necessary to monitor whether the number of these situations decreases in the coming years as renewable energy market participants increasingly participate in the balancing mechanism.

FIGURE 8 – SSE A DUE TO INSUFFICIENT MARGIN



SPECIFIC ACTIONS INITIATED SEVERAL YEARS AGO, FOLLOWED BY REGULATORY AND LEGISLATIVE WORK IN 2025 WITH HTB AND HTA RENEWABLE ENERGY PRODUCERS.

Since 2024, in addition to activating offers submitted by renewable energy market participants through the balancing mechanism, RTE has had the option of activating an additional lever to reduce renewable generation in real time. Implemented since July 2024 (9 activations in the second half of 2024), this lever was activated 29 times in 2025 (SSE A) by issuing safeguard orders.

During 2025, RTE carried out 100 GWh (compared with 18 GWh in 2024) of downward adjustments to wind and solar generation (to a lesser extent). Although these volumes are still small compared with the total volume of downward adjustments made to maintain the supply-demand balance, the volumes of solar and wind generation adjusted are increasing sharply.

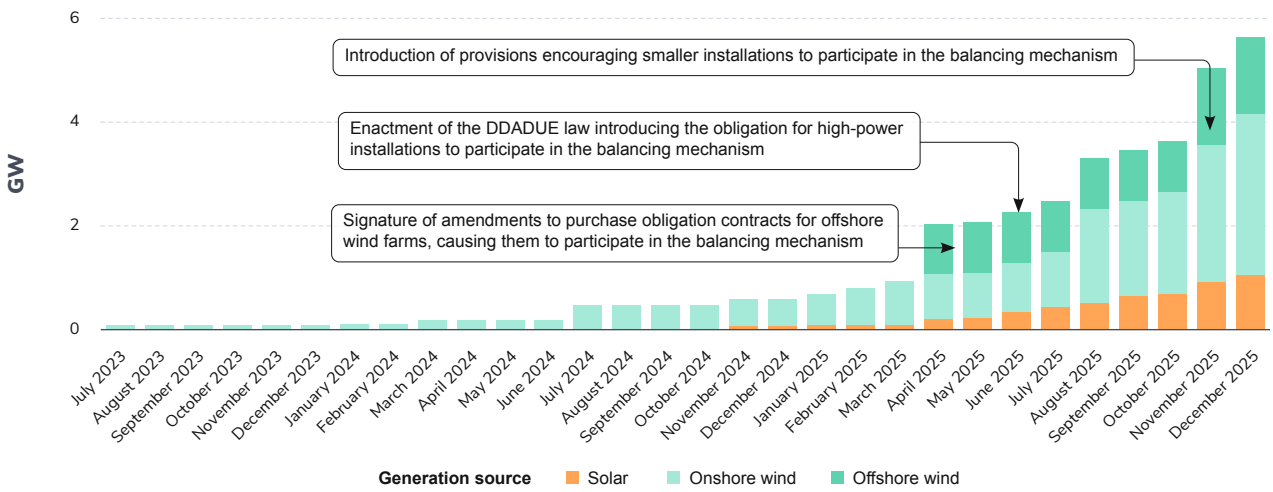
As part of the work carried out in 2024 and 2025 and led by RTE, Law No. 2025-391 of 30 April 2025 (known as “DDADUE 2”) extended the obligation to participate in the balancing mechanism to all generation facilities above a certain threshold, both downwards and upwards. This will provide more levers for balancing the system. The threshold was set at 10 MW in the new version of the RTE market rules that entered into force on 1 January 2026, in accordance with CRE deliberation No. 2025-266.

The wind and solar capacities participating in the balancing mechanism almost increased tenfold during 2025, reaching 5.6 GW at the end of 2025.

Despite these very favourable developments, the installed photovoltaic fleet is still today predominantly connected to the low-voltage network (around 16 GW, compared with 13 GW connected to the medium-voltage network (HTA). This low-voltage fleet consists of a very large number of small, low-capacity generation units whose generation cannot currently be controlled.

Among the other means available to balance the system, RTE can also activate demand response through the balancing mechanism. **In 2025, these demand response activations amounted to 5 GWh over the year, with an average power of 14 MW, while the maximum volume activated simultaneously was 694 MW.**

FIGURE 9 – WIND AND SOLAR CAPACITY PARTICIPATING IN THE REAL-TIME BALANCING MECHANISM



3.5 Frequency control

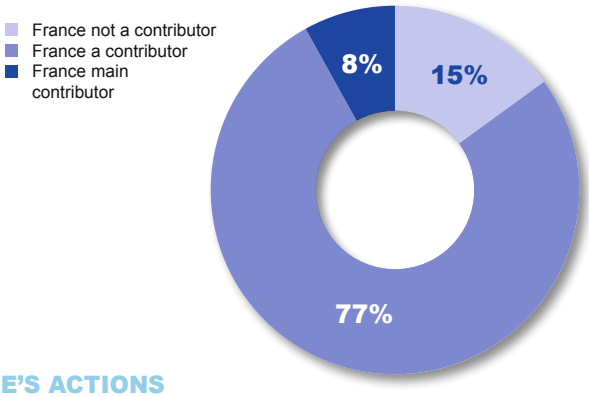
FREQUENCY CONTROL SHOWED A MARKED IMPROVEMENT AT THE FRANCE-WIDE LEVEL, BUT A≈DETERIORATION AT EUROPEAN LEVEL...

In 2025, the duration for which the European frequency deviated from the standard range (±50 mHz) amounted to 232 hours, below the threshold of 250 hours defined by the European SOGL code as the frequency quality criterion for the synchronous area. This threshold was exceeded for the first time in 2023 and again in 2024. The actions implemented since then confirm the improvement already observed in 2024.

The good performance of the European electricity system against this criterion nevertheless masks an upward trend in deeper and more sustained frequency deviations since 2022 (31 in 2022, 67 in 2023, 54 in 2024 and 80 in 2025). In 2025, as in 2024, the deviations were predominantly low-frequency deviations (62% of them).

France was a contributor, to varying degrees, to 68 of these 80 deviations. For 6 of them, it was the main contributor.

FIGURE 10 – DEEP AND SUSTAINED FREQUENCY DEVIATIONS



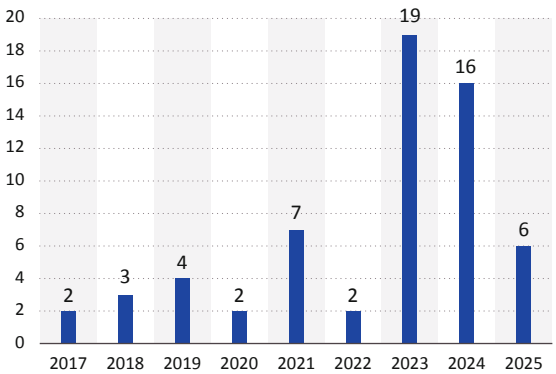
A DECREASE IN SSES IN 2025 THANKS TO RTE'S ACTIONS TO IMPROVE ANTICIPATION AND STRENGTHENED CONTROLS.

Despite the higher number of deviations, **the number of events for which the SSE eligibility threshold was reached decreased significantly in 2025.**

Of these 6 SSEs, the French frequency control was the main contributor for four of them: the first occurred when two generating units tripped within a three-minute period, and the second when an episode of negative spot prices ended. For the other two, the events were isolated consumption contingencies (consumption lower than forecast).

In 2025, RTE continuously monitored the performance of 253 frequency[10] control entities (generators, consumers, storage facilities and distributed resources). **Over 2025, the number of deviations from system services decreased significantly compared with 2024,** particularly in relation to participation in secondary frequency control, mainly due to the resolution of the deviation affecting generating units.

FIGURE 11 – NUMBER OF SSE A: FREQUENCY DEVIATIONS

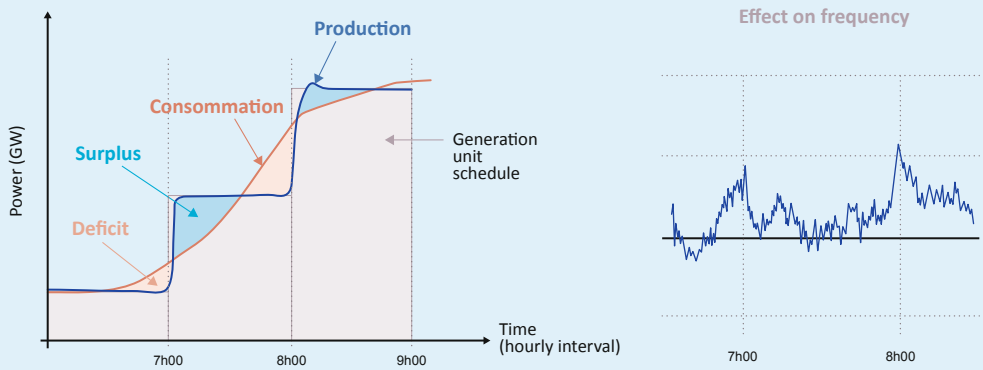


10. The decrease compared with 2024 is explained by the grouping of certain entities.

FREQUENCY DEVIATIONS AT THE HOUR MARK: A EUROPEAN ISSUE REQUIRING SPECIFIC MONITORING AS THE SPOT MARKET MOVED TO 15-MINUTE INTERVALS IN OCTOBER 2025

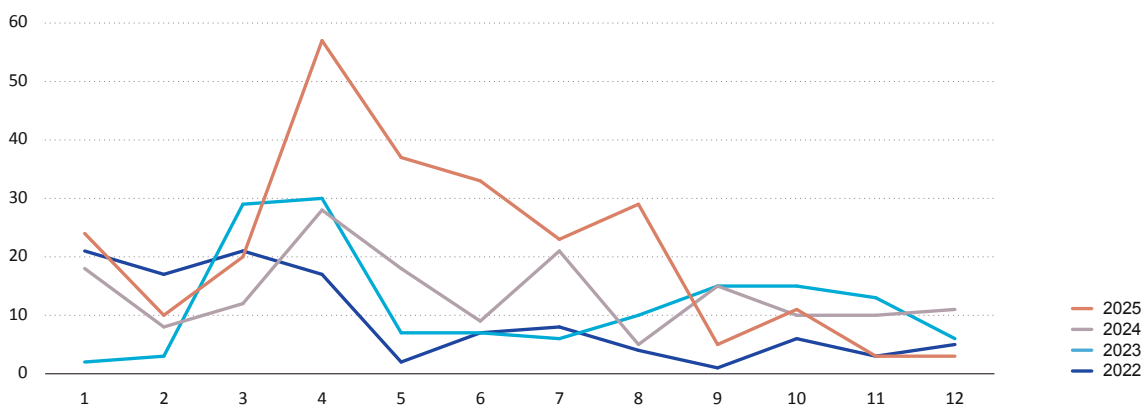
"Frequency deviations **at the hour mark"** result from changes to generation schedules and cross-border trading schedules grouped at the hour mark, due to the hourly structure of the market products traded by participants in the European electricity market.

At the hour mark, the generation of certain European generating units can change very rapidly: frequency varies significantly while the automatic control mechanisms take effect, resulting in the mobilisation of all or part of the primary and secondary reserves.



This phenomenon, characterised by frequency variations of more than 75 mHz over short periods when generation schedules in Europe are changed, is increasing sharply (255 deviations of more than 100 mHz were observed in 2025, compared with 165 in 2024, 143 in 2023 and 112 in 2022), particularly from **April to August. Conversely, these deviations decreased during the final months of the year, returning to levels observed in previous years.**

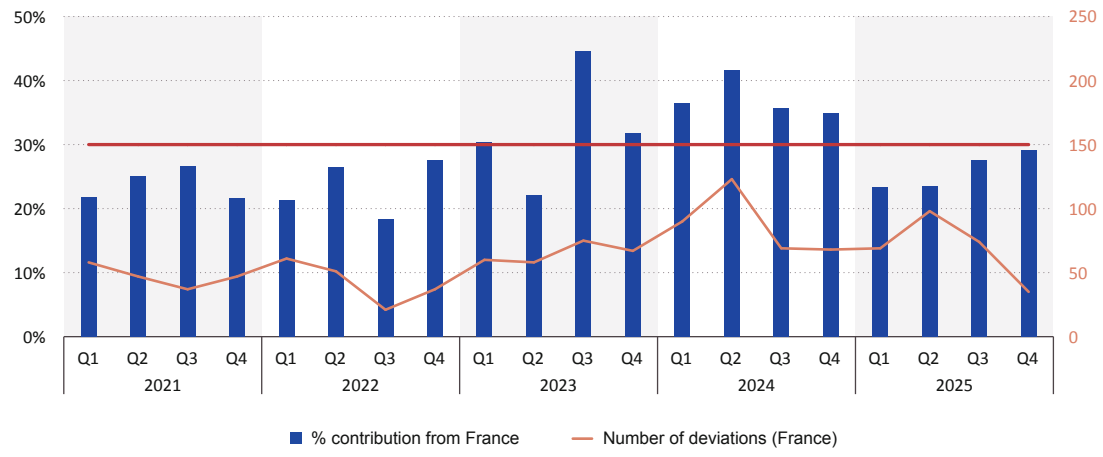
FIGURE 12 – MONTHLY FREQUENCY DEVIATIONS OF MORE THAN 100 MHZ



Since 2021, following a joint decision by the European TSOs, enhanced monitoring of each TSO's contribution to frequency control during changes in cross-border trading at the hour mark has been implemented. After a year in 2024 during which RTE exceeded the 30% contribution threshold for deterministic frequency deviations in each quarter, **RTE complied with the criterion in every quarter of 2025.**

In addition, the time interval at which market products can be traded on the spot market, which takes place the day before for the following day, was reduced from one hour to 15 minutes in October 2025. In practice, the initial observations show a degree of "smoothing" of frequency deviations, but it is still too early to draw firm conclusions.

FIGURE 13 – FRANCE'S CONTRIBUTION TO FREQUENCY DEVIATIONS AT THE HOUR MARK



	2022				2023				2024				2025			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
% contribution from France	21%	26%	18%	28%	30%	22%	**45%**	**32%**	**36%**	**42%**	**36%**	**35%**	23%	24%	28%	29%
Number of deviations (France)	61	51	21	37	60	58	75	67	90	123	69	68	69	98	74	35
Total deviations	**287**	**193**	**114**	**134**	**198**	**263**	**168**	**211**	**247**	**296**	**193**	**195**	**295**	**416**	**269**	**120**

In 2025, as in previous years, France met the two criteria set out in the European SOGL code, which define the frequency control quality of each control block in the synchronous area. Based on the control deviation calculated over a 15-minute moving average, they must not exceed a power threshold or exceed 5% or 30% of the time, respectively, on an annual average.

Year	2021	2022	2023		2024	2025	
Level 1 threshold (<30%)	Threshold: 238 MW	Threshold: 231 MW		Threshold: 205 MW	Threshold: 185 MW	Threshold: 173 MW	Threshold: 157 MW
	9,20 %	7,40 %	10,80 %		11,70 %	10,30 %	
Level 2 threshold (<5%)	Threshold: 450 MW	Threshold: 436 MW		Threshold: 387 MW	Threshold: 349 MW	Threshold: 334 MW	Threshold: 311 MW
	3,40 %	2,30 %	4,50 %		4,50 %	2,90 %	

These frequency quality indicators actually improved further in 2025, reflecting better frequency control in France, as a result of:

- the change to the dynamic settings governing France's contribution to primary frequency control in Europe, which had put RTE at a disadvantage during major frequency deviations. Following an experimental phase conducted in the second quarter of 2025, RTE now uses a fixed control mode, enabling a more appropriate contribution to frequency control in 2025.
- connection to PICASSO, the European platform for sharing secondary reserves, in April 2025.
- growth in the volume of renewable energy offered on the Balancing Market (BM), which is a valuable lever for controlling high frequencies.
- implementation of renewable generation shutdowns outside the Balancing Market, in application of the Energy Code (29 generation shutdowns in 2025, including 17 in March and April).

As detailed in Chapter *3.4, SDB and Margins,* RTE worked with renewable energy producers to encourage them to participate voluntarily in the balancing mechanism, with a view to increasing the volume of offers that can be activated. Indeed, the emergence of offers with short activation lead times and periods constitutes an effective lever for mitigating and limiting deterministic frequency deviations. In addition, if the trend reverses, the absence of a technical threshold in this sector makes it possible to lift the limitation order very quickly and thus restore available capacity without having to start up other generation facilities.

INCREASING PARTICIPATION BY STORAGE UNITS IN PRIMARY AND SECONDARY RESERVES.

For primary reserve, the total volume of certified batteries at the end of 2025 amounted to 900 MW (compared with 600 MW in 2024), for a primary reserve sizing requirement in France of 516 MW.

For secondary reserve, 2025 also saw a sharp increase in battery participation, with an increase in the number of certifications: 345 MW at the end of 2025, representing an increase of 275 MW compared with 2024. At the same time, the need for upward secondary reserve reached a record level in 2025 since the probabilistic sizing method was introduced in 2021 (up to 1.3 GW during the 4 p.m.-6 p.m. period on non-working days in the second quarter of 2025). These peaks in demand are linked to significant generation shortfalls observed at the end of periods of negative spot prices, caused by a mismatch between changes in exchange schedules at the borders (starting as early as five minutes before the change in the spot price value) and the resumption of renewable generation (starting several minutes later).

AN INTERRUPTIBILITY SCHEME ACTIVATED ONLY ONCE IN 2025.

The interruptibility scheme governs the participation of consumer sites in the actions of the defence plan. The 2025 annual tender, opened for 1,200 MW, resulted in 878 MW being contracted for 2025 (compared with 756 MW in 2024). The scheme was activated on 3 April 2025 at 9:01 a.m. following a frequency drop of more than 180 mHz lasting more than 3 seconds. The automatic system sent an interruption order to all contracted sites, enabling 854 MW to be interrupted in less than 5 seconds.

MODERATE CONTRIBUTION FROM EUROPEAN PLATFORMS TO FRENCH BALANCING.

RTE participates in the two projects to create European platforms, namely “MARI” (Manually Activated Reserves Initiative) for managing the fast reserve (15’) or mFRR, and “PICASSO” (Platform for the International Coordination of the Automatic Frequency Restoration Process and Stable System Operation) for managing the automatic secondary reserve or aFRR.

Since 21 November 2023, in preparation for connection to the PICASSO platform, the secondary reserve has been activated according to economic merit order (France), rather than in proportion to the operating schedule. RTE connected to PICASSO on 2 April 2025 and to the MARI platform at the end of April 2026.

4 Power flow management

THE PHENOMENON OF CASCADING OVERLOADS

Maintaining an excessively high current in a connection causes heating which, if not controlled, can:

- damage the components of the connection, potentially leading to conductor breakage;
- create risks to people and property by causing cables to expand and lengthen, bringing them closer to the ground beyond the safety distances between the line and its surroundings, potentially resulting in a short circuit.

Maximum values are therefore defined for each network asset:

- a temporary emergency current rating (IST), corresponding to the maximum permissible current without a time limit;
- transient overcurrent thresholds (TOC), which are higher than the IST but apply for limited periods (less than 20 minutes).

To guard against the risk of exceeding these current ratings, so-called overload protection is used in France on the 225 kV and 400 kV networks. If the current overload is not cleared within a given period after it occurs (between a few seconds and 20 minutes, depending on the extent of the exceedance), the network asset concerned is automatically disconnected from the network by this overload protection.

The power transfer carried by this asset before it trips is then transferred to neighbouring assets. Depending on the severity of the phenomena, further overloads may occur, followed by further disconnections. Successive and cumulative load transfers can, through a cascading effect, lead to the loss of a significant part of the network.

The doctrine for managing power transfer risks established by the SOGL code and applied by RTE ensures that such a cumulative effect does not occur as a result of a single contingency.



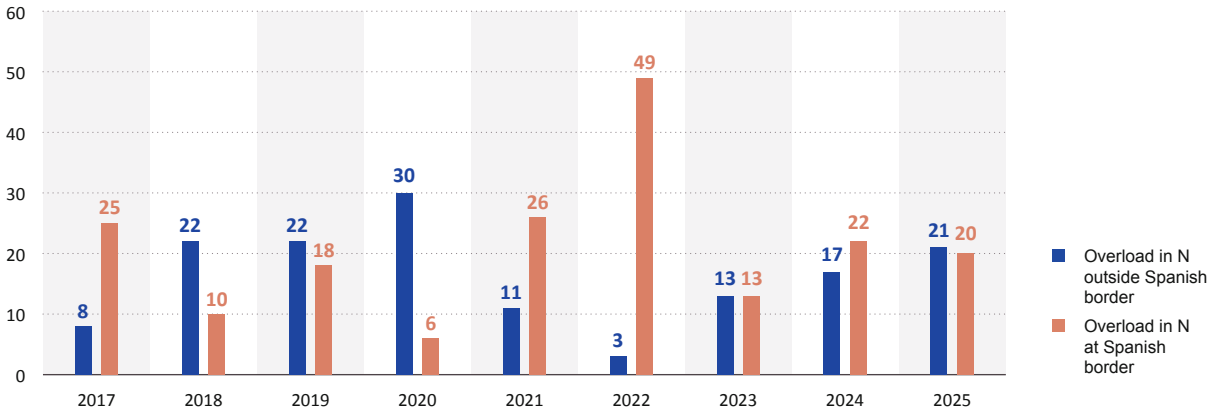
EXCLUDING THE SPANISH BORDER, IST EXCEEDANCES HAVE BEEN INCREASING SINCE 2022...

In 2025, the number of isolated 225 kV and 400 kV overload situations, outside incident conditions, remained in line with the average for recent years. **These current exceedances were systematically dealt with before the automatic tripping of the network assets concerned and did not present any difficulty for electricity system operational safety.**

Although IST exceedances outside the Spanish border have increased as a result of the increase in network flows across the network in recent years, they remain below 30 overloads per year.

A significant proportion of exceedances of power transfer capacities regularly occurs on network assets

FIGURE 14 – IST EXCEEDANCES OUTSIDE INCIDENT CONDITIONS





affected by exchanges with Spain. 20 exceedances were recorded there in 2025, a decrease compared with 2024 but in line with the average for the past eight years. 13 of these occurred between mid-April and mid-May, a period during which work was under way in the area.

Managing the current flowing through these network assets has historically been complex, due to the difficulty of estimating in advance the east-west distribution of flows along the border and the high sensitivity of these flows to supply-demand balance deviations that may occur within the Iberian Peninsula. The network assets in the area (interconnections and the upstream 400 kV and 225 kV network) are also often operated at levels close to their operating limits in order to optimise the exchange capacities offered upstream at this border. Consequently, exchanges between France and the Iberian Peninsula remain high and regularly need to be limited in real time through countertrading operations[11] in order to comply with the operating rules.

To illustrate the variability of flows at the borders, in 2025, the average of the daily standard deviations of active power exchanges with Spain was 1.5 times higher than that with Germany and Switzerland and 2.5 times higher than that with Italy.

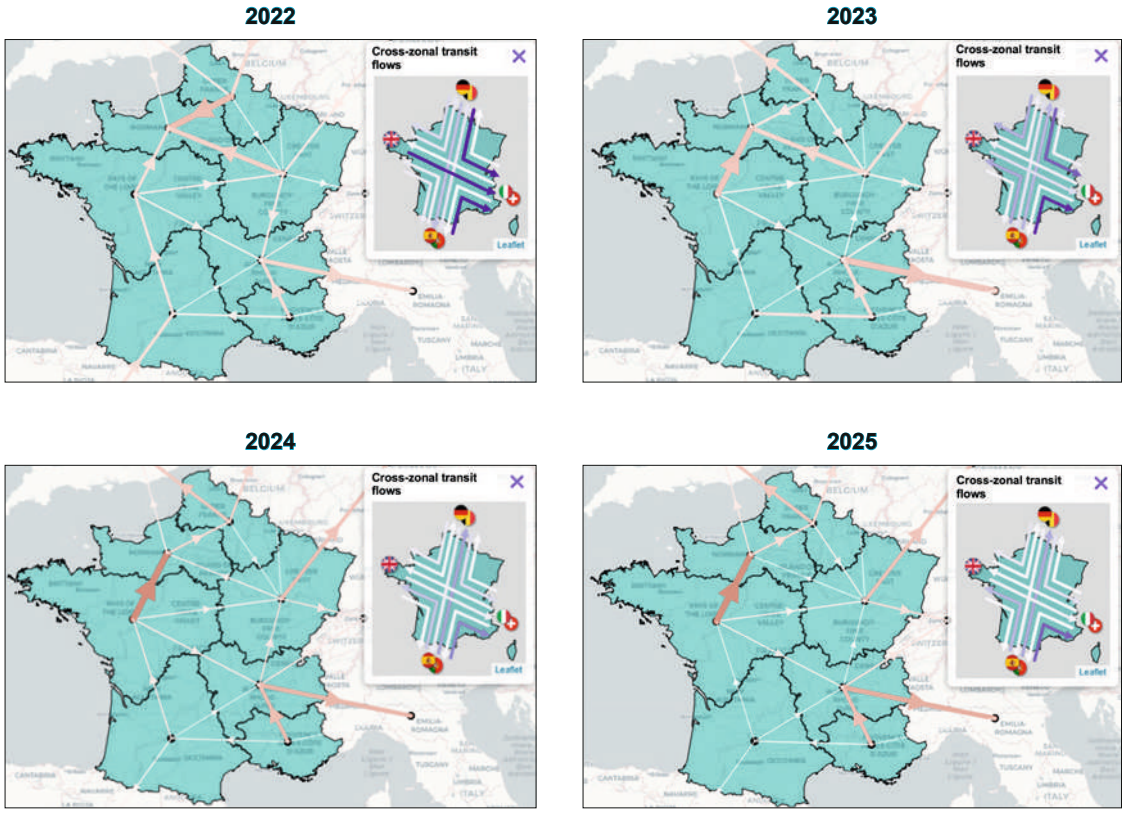
11. Countertrading: modification of the exchange schedule intended to generate a flow in the opposite direction to the congestion.

...IN A CONTEXT OF CROSS-ZONAL TRANSIT FLOWS IN 2025 SIMILAR TO THOSE IN 2024, BUT BETTER CONTROLLED IN 2025

The year 2024 was marked by the continued increase in south-to-north flows, both in the east and west of the country, caused by the combination of high imports from Spain and high levels of nuclear and solar generation in the south-west. Significant constraints were also observed on the Italian border during work on 400 kV lines.

In 2025, flows were **comparable** to those in 2024 (see the maps of interregional flows below). Nevertheless, the number of SSE B decreased compared with 2024 (24 SSE B related to network flow management were recorded in 2024, compared with just one in 2025). This improvement resulted from the action plan implemented by RTE following the complex operating situations encountered in spring 2024[12]. These actions, aimed at strengthening risk anticipation and control in the context of works, resulted in better control of network flows, particularly at the Italian border.

FIGURE 15 – EVOLUTION OF INTERREGIONAL FLOWS AND CROSS-ZONAL TRANSIT FLOWS FROM 2022 TO 2025



12. See Chapter 6.1 of the 2024 Safety Report.

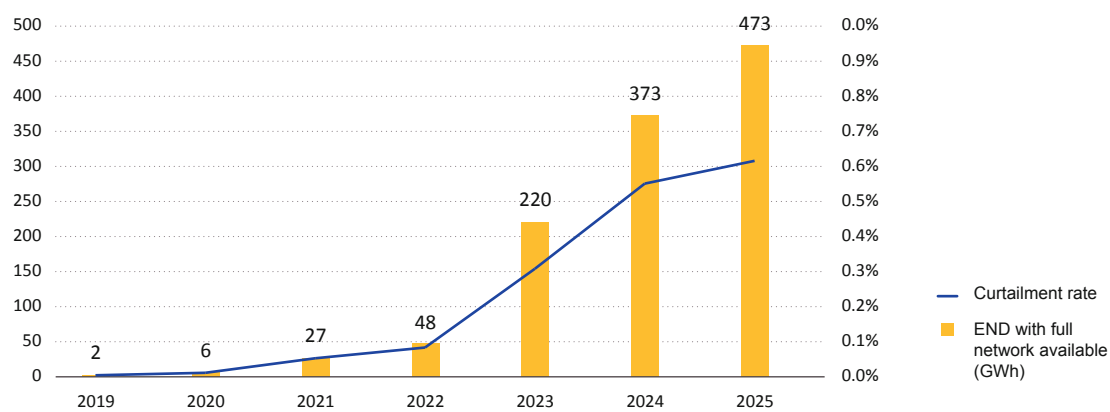
THE GROWING CHALLENGE OF EVACUATING RENEWABLE GENERATION IN CONNECTION WITH OPTIMAL NETWORK SIZING, AND THE DEVELOPMENT OF NAZA AUTOMATION SYSTEMS.

The increasing connection of renewable generation to the HTA and HTB1 networks (63 or 90 kV) can give rise to local power transfer constraints, which must be managed by RTE in conjunction with DSOs. It is therefore sometimes necessary to temporarily and selectively limit the generation of certain facilities in order to comply with operating rules and thus avoid additional investment, in line with RTE's approach of ensuring economically optimal sizing of the electricity transmission system.

The volume of Energy Not Dispatched (END) associated with these generation curtailments has been steadily increasing since 2019, as can be seen in the figure below, which shows an estimate of END with the full network available and the curtailment rate (the share of END with the full network available relative to total onshore wind and solar generation). The END data for recent years are not final, as they are still being validated with local distribution companies (LDCs). This increase is linked to the rate at which onshore renewable generation has been connected (54 GW at the end of 2025, compared with 27 GW at the end of 2019) and to limitations that are still carried out manually and preventively in certain areas. This increase in END was expected and is indeed materialising.

Since 2019, RTE has been installing specific automation systems known as "NAZA" (New Adaptive Zone Automation systems). They make it possible to limit wind and solar generation locally in real time and avoid reinforcing or building infrastructure whose usefulness would only be demonstrated for a few hours a year. The actual deployment of these automation systems is a necessary condition for capturing the benefits associated with implementing the optimal sizing principle set out in the 2019 SDDR. RTE is continuing its NAZA installation programme, with 31 systems in operation in 2025 (+13 compared with 2024). These automation systems, installed and interfaced with the control systems used by DSOs, are intended to improve the management of constraints and contain END by reducing the volumes curtailed preventively.

FIGURE 16 – EVOLUTION OF END AND THE CURTAILMENT RATE WITH THE FULL NETWORK AVAILABLE



5 Voltage control

5.1 Managing the risk of voltage collapse

The reactive network flowing through the network is directly related to the inductive or capacitive nature of the components of the electricity network (generating units, overhead lines, underground cables, compensation equipment such as inductors or capacitors, etc.). According to the laws of electrical engineering, this reactive power affects voltage locally: inductive loads cause voltage drops, while capacitive loads have the opposite effect and increase voltage. When the network is heavily loaded, it therefore behaves primarily as an inductance, with a lower voltage plan than when it is lightly loaded (capacitive behaviour).

Network voltage is controlled using multiple sources of reactive power (generating units, capacitors, reactors, electronic power-based reactive power compensators (SVCs), etc.) distributed throughout the network.

In a given area, reactive power sources may no longer be sufficient to meet requirements, for example in the event of the loss of network assets or generating units, particularly when consumption is high.

Importing the missing power from neighbouring areas then causes significant voltage drops on the network. Automatic on-load tap changers installed on transformers in networks supplying consumers make it possible to compensate for these voltage drops locally. However, this has the effect of increasing the current demand and therefore lowering the voltage in the area slightly further overall.

Below a certain low-voltage level known as the critical voltage, the maximum transferable power is reached.

As part of the voltage defence plan, RTE has installed two automation systems on the network (ADO since 2009 and ADN since 2015 which is currently undergoing technical renovation) which protect against the risk of voltage collapse in Brittany (ADO) and in the Ile-de-France and Normandy regions (ADN), given the specific characteristics of the network in these regions. In the event of a network incident resulting in a significant voltage drop, these automation systems activate a localised volume of load shedding that is just sufficient to prevent an uncontrolled spread of the network collapse, thereby avoiding a much larger volume of consumption being disconnected. These two automation systems complement the TC-BS automation system deployed nationally following the incident of 12 January 1987. This automation system, refurbished in 2023, provides for the automatic blocking of tap changers on transformers installed on both the RPT and the RPD. The area in which this automation system operates is limited to a given geographical zone associated with a voltage measurement pilot point. Depending on the severity of the incident, several zones may be affected.

The management of low voltages during the winter of 2024/2025 did not present any major difficulties. No safeguard order for low voltages has been issued since 2021.

The arming threshold of the Western and Northern Defence Automation systems (ADO and ADN) **was never reached** (the last arming events date back to March 2020).

The availability of generating units in western and north-western France during the winter, together with lower levels of consumption, largely explains this situation. The risk of voltage collapse is therefore now lower due to structural changes in the electricity system (stagnating consumption, reduced withdrawals from the transmission system, and the development of distributed renewable generation).

In 2025, however, low voltages were encountered on the transmission system (400 and 225 kV), either during periods of high power transfers or during the rapid resumption of generation following a period of negative spot prices. These situations did not present any risk of voltage collapse, but on four occasions they resulted in the activation thresholds of the transformer tap-changer blocking automation systems being exceeded:

- On 8 January and 31 March in the Marmagne area (Cher), in connection with significant power transfers;
- On 1 April in the Revigny area (Meuse), in the context of the resumption of generation at the end of a period of negative spot prices;
- On 3 May in the La Chaussée area (Marne), for the same reason.

The various measures already in force or currently being implemented in conjunction with DSOs to facilitate electricity system operation during periods of negative spot prices (improved visibility of renewable energy producers' operating schedules and staggered shutdowns and restarts, see Chapter 8.2 dedicated to negative spot prices) should help improve the management of this low-voltage phenomenon, particularly in areas where consumption is expected to increase.

5.2 Management of high voltages

Operational challenges are gradually shifting towards managing high voltages, the risk of voltage escalation, and operating situations involving rapid changes in voltage.

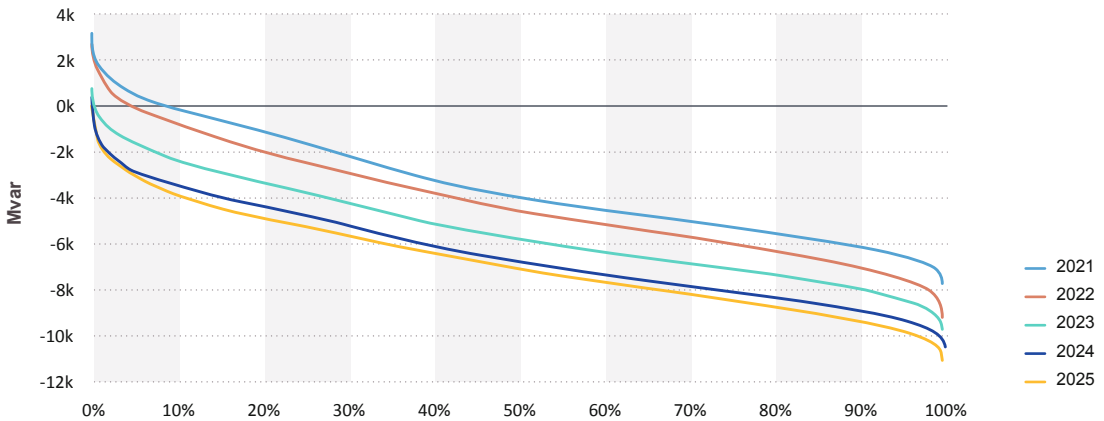
High voltages occur when the equipment used to control reactive power (generating units, SVCs and inductors) is no longer sufficient to absorb the reactive power generated by the network (capacitors, lightly loaded lines, underground cables, reactive power generated by customers, etc.). These phenomena, which historically occurred during periods of low consumption on summer weekends, are now becoming more frequent throughout the year, including on weekdays in the afternoons when high levels of distributed generation coincide with low consumption. Prolonged high-voltage conditions can reduce equipment service life and cause damage to RPT assets, affecting electricity quality.

These findings are widely shared by European TSOs, and the difficulty of managing such high-voltage situations was one of the root causes of the blackout that occurred in the Iberian Peninsula on 28 April 2025. In this context, France has already implemented most of the adaptations recommended in the ENTSO-E report on the incident, published in March 2026, whether relating to real-time voltage control (software and hardware), market participants' participation in voltage control, or system service requirements and checks.

High-voltage phenomena can result from a combination of several factors:

- Relatively low electricity consumption compared with the system's design capacity;
- Changes in the nature of transmission and distribution systems, where underground technology, which generates reactive power, is increasingly used to improve the acceptability of infrastructure;
- Increased generation connected to the HTA network, reducing the share of generation carried by the public transmission system, but also reducing the share of HTB generation providing dynamic voltage control.

FIGURE 17 – REACTIVE POWER TRENDS AT THE RPT/RPD INTERFACE



Changes in the technical characteristics of electricity uses therefore play an important role in the occurrence of these phenomena. New electricity uses consume less reactive power, and some even generate it: reactive power fed into the public distribution system has been steadily increasing for several years.

This finding is shared by all European TSOs.

The curves in Figure 17 show reactive power exchanges at the interface, from the distribution system to the transmission system, taking into account transformer reactive power losses.

Since 2023, distribution systems have been feeding reactive power into the RPT throughout the year. Although the increase in reactive power fed in from the RPD continued in 2025, its rate of growth has slowed thanks to the actions implemented with distribution system operators.

BETTER CONTROL OF VOLTAGE THRESHOLD EXCEEDANCES IN 2025

Voltage threshold exceedances show contrasting trends depending on the voltage level at which they occur.

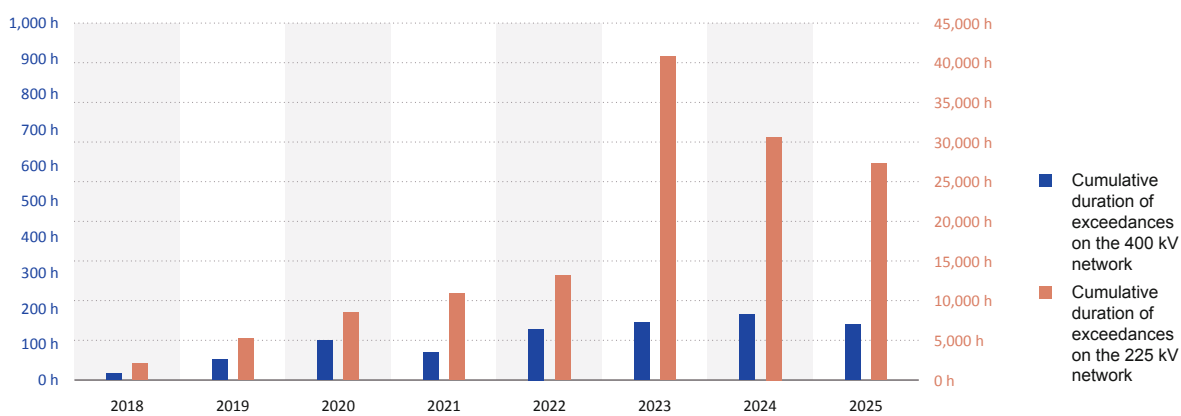
On the 400 kV network, voltage threshold exceedances have remained low and stable for four years, and 2025 continued this trend.

On the 225 kV network, **the number of exceedances decreased in 2025 compared with the previous year, notably as a result of** the commissioning of 14 new inductors in 2025 and the contracting of generating units for high-voltage management. However, the number remained high compared with the 2018-2022 period, particularly due to the unavailability, in spring 2025, of RTE assets or generating units operating in synchronous compensation mode.

In an exceptional case, the Iberian blackout of 28 April 2025 (see Chapter 8.1) resulted in approximately 300 hours of exceedances of the 245 kV threshold on the 225 kV network in south-western France.

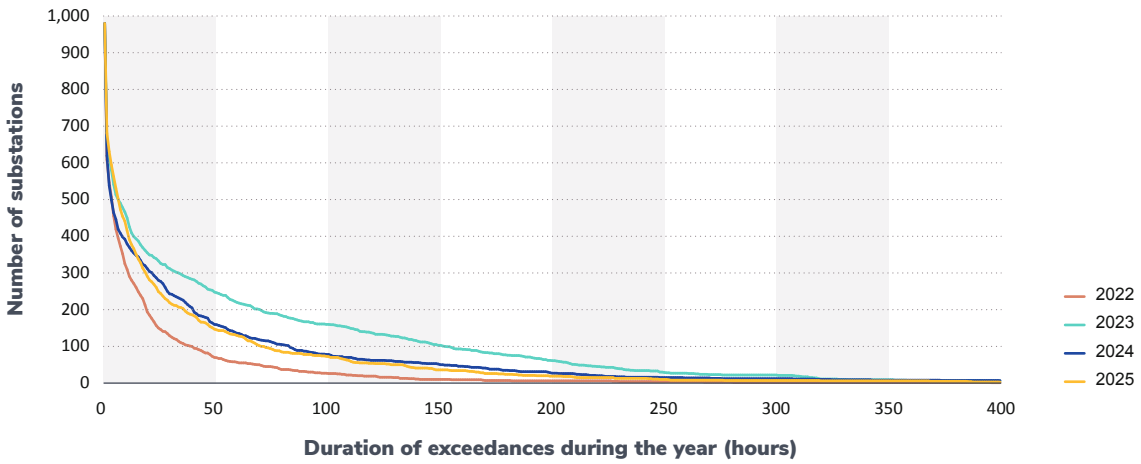
The change in the number of substations affected by voltage threshold exceedances on the 225 kV

FIGURE 18 – VOLTAGE THRESHOLD EXCEEDANCES



network, shown in the graph below, confirms that the situation improved in 2025 compared with 2024 and, in particular, 2023, although it did not return to the same level as in 2022.

FIGURE 19 – NUMBER OF 225 KV SUBSTATIONS AFFECTED BY VOLTAGE THRESHOLD EXCEEDANCES



IMPROVED CONTROL SUPPORTED BY STRONGER HIGH-VOLTAGE MANAGEMENT MEASURES IN 2025.

Maintaining voltage within safe ranges, particularly during high-voltage episodes, relies on several measures:

- The manual or automatic switching-in of reactive power compensation equipment connected to the RPT, particularly inductors (that lower voltage by absorbing reactive power), whose utilisation rate is increasing year on year. The deployment of dedicated automation systems to switch in this compensation equipment is continuing, covering both existing and newly installed equipment, with the aim of improving response dynamics during high-voltage episodes.
- The participation of generating facilities connected to the RPT in voltage control under the voltage system services contract. This participation is mandatory for all generating facilities connected to the RPT, without exception (primary voltage control on the HTB1 network, primary and secondary voltage control on the HTB2 and HTB3 networks[13]);
- Contribution from renewable generation facilities connected to distribution systems at HTA level, using a control setting that enables reactive power absorption whenever these facilities inject active power (fixed power factor setting);

13. HTB1 (90 kV – 63 kV) – HTB2 (225 kV – 150 kV) – HTB3 (400 kV)

- Temporary decommissioning of transmission system assets to relieve loading on the network and reduce the capacitive effect that raises voltage;

- Use of generating facilities connected to the RPT that have a “synchronous compensation” function for rotating machines or a “static compensation” function for renewable energy facilities, enabling these generating facilities to absorb or supply reactive power without injecting active power into the network;

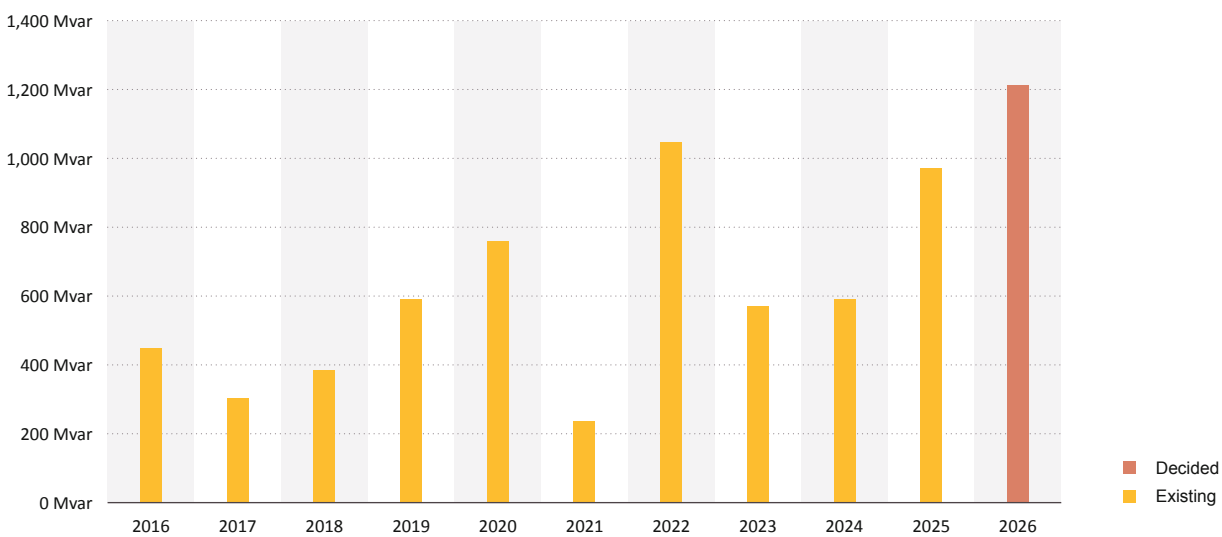
- RTE’s ability to contract the targeted start-up of generating facilities so that they can participate in voltage control.

In addition to contractual agreements concluded in advance with producers to guarantee the availability of targeted generating units, the facilities called upon by RTE through the balancing mechanism so that they can participate in voltage control represented a cost similar to that of 2024, following a sharp increase in 2023: €2.9 million in 2025 for a volume of 35.8 GWh (€3 million in 2024 for a volume of 11.3 GWh, compared with €22 million in 2023 for a volume of 112 GWh).

The use of generating units as synchronous compensators represented a cost of €8.8 million in 2025 for 10,000 operating hours, a significant decrease compared with 2024 (€11.4 million for 15,000 hours), and an even more significant decrease compared with 2023 (€32.1 million for 26,000 hours).

Against this backdrop, **RTE is accelerating its programme to install compensation equipment** in order to improve control of high voltages. In 2025, 14 inductors were therefore connected, for a total capacity of 973 Mvar[14].

FIGURE 20 – INDUCTOR PROJECTS BY YEAR OF COMMISSIONING



14. This figure corresponds to the new equipment identified in studies dedicated to maintaining the voltage plan. It does not include inductors associated with new connections (particularly for offshore wind), studies carried out as part of the S3REnR schemes, or the replacement of existing equipment. It should also be noted that, for new connections and requirements related to S3REnR schemes, the financing of compensation equipment is borne by the parties concerned.

For 2026, a total of approximately 1,200 Mvar is planned, with 17 new inductors to be installed.

Over the 2028-2030 period, a national study identified a need to install 34 pieces of equipment to manage N-state constraints, in addition to other levers such as the use of voltage system services from facilities connected to the RPT.

In 2025, RTE decided to accelerate this 2028-2030 programme by adding 14 further reactors, including very high-capacity inductors (250 Mvar) on the 400 kV network.

RTE also continued in 2025 the initiative launched in 2023 with Enedis concerning changes to the voltage setpoint for renewable energy facilities connected to distribution systems.

Further work is under way to identify the levers to be deployed to manage voltage under normal or exceptional conditions, with the aim of successfully activating all available reactive power absorption or supply capabilities in the event of a voltage incident. The new framework for billing reactive power introduced with the entry into force of TURPE 7 should also encourage distribution system operators to use various levers to manage their supply of reactive power. By way of illustration, reactive power charges for distribution system operators during the first nine months of TURPE 7 amounted to €7.5 million, compared with less than €1 million over the same period the previous year.

The trial of static compensation in south-western France (photovoltaic plant), which began in 2023, continued in 2025. The technical feasibility and contractual and financial framework were defined. At this stage, the trial involves six renewable energy producers (three wind producers and three photovoltaic producers), with the static compensation service scheduled to start in spring 2026.

The mechanism introduced in July 2025 to secure the process for imposing nuclear generation levels required to control high voltages in south-western France will be extended to the entire network in 2026. It should help improve overall voltage management in the coming years, with operational management made easier.

As regards voltage system services, 2025 also saw a continued increase in the number of participants involved in voltage control (+13 new participants), while continuous performance monitoring continued for 336 voltage control entities (generators, including renewable energy facilities, consumers, storage facilities and HVDC). This monitoring resulted in a slight increase in the volume of residual reactive power deviations (more than 400 Mvar), mainly due to a control deviation at one generating facility, and penalties totalling €16 million.

Lastly, a new remuneration and penalty framework for voltage system services was agreed with stakeholders and approved by the CRE in its deliberation of 9 April 2026, for implementation in early 2027. Its aim is to remunerate services based on the reactive power actually supplied to the network, adjust remuneration according to the actual availability rate of facilities, establish a framework for static compensation (renewable energy facilities) and synchronous compensation (rotating machines), and strengthen penalties for participants that do not provide the expected service.

6 Prevention of major incidents

6.1 Network stability

LOSS OF SYNCHRONISM (LOCAL FREQUENCY OSCILLATIONS)

Under normal operating conditions, the alternators of generating plants interconnected across Europe operate at the same frequency, around 50 Hz. This is referred to as synchronous operation of the electricity system, with the network acting as the “synchronising link” between the electrical machines.

This balance can be disrupted by short circuits, which cause the rotational speed of the alternators to increase. If the short circuit is not cleared quickly enough, or if the generating unit was not initially in a sufficiently stable state, the alternators may be unable to resynchronise with the frequency of the overall network. This is known as loss of synchronism. If the phenomenon persists, it can then spread to other generating units. To prevent this propagation, protection systems against loss of synchronism, which form part of the defence plan, come into action by splitting the network into predefined zones in order to isolate the affected area.

To ensure the stability of interconnected generating units, RTE carries out specific studies over various time horizons and takes the necessary preventive actions:

- Determining and complying with the maximum fault-clearing times for short circuits;
- Limiting the operating range of generating units in terms of active and reactive power to ensure greater initial stability;
- Adapting operating configurations and optimising the positioning of network asset outages;
- Monitoring the performance of generating unit control systems and protection systems.

SITUATIONS MORE CLOSELY MONITORED BY RTE IN REAL TIME

In 2025, RTE introduced a new tool, Stabsys, enabling it to better monitor in real time events that could lead to electricity system instability and to detect such situations more accurately.

In 2025, several events affecting the local stability of the transmission system were recorded:

- 2 SSE B, on 5 March and 27 May 2025, detected through analysis of the stability criteria of the Stabsys tool.
- 3 SSE B, on 11 June, 4 September and 24 December, due to the unavailability of a protection system which, if an incident were to occur, would create risks of generating unit loss and operation of the protection systems against loss of synchronism.

More specifically, one SSE D was recorded for the activation of the loss-of-synchronism network splitting protections (DRS) during the blackout that occurred in the Iberian Peninsula on 28 April (normal and expected operation in such a situation, see further details in Chapter 8.1).



EUROPEAN SYNCHRONISATION AND OSCILLATION EVENTS

On 9 February 2025, the Baltic countries were synchronised with the Continental European synchronous area. This change resulted in a slight modification of the known inter-zone modes, with these countries participating in these modes, without adversely affecting damping.

In 2025, several other oscillatory events involving the East-Centre-West mode were observed, some of which required countertrading to reduce the power exported from Spain to France. This was notably the case on 16, 23 and 24 February, 24 March, 28 April (see Iberian blackout), 7, 21 and 22 May, 23 August, 8 September and 8 October, *i.e.* 11 occurrences (8 in 2022, 3 in 2023 and 7 in 2024).

INTER-ZONE OSCILLATIONS

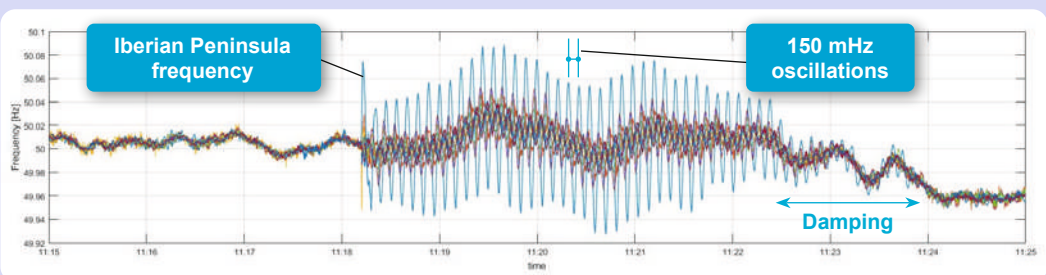
Inter-zone oscillations (or inter-zone modes) are complex electrical phenomena that can occur between two or more parts of an interconnected electricity system. They occur when exchanges are high or when the boundaries between these areas are less strongly meshed. In this configuration, when an imbalance occurs, for example a change in load or a disturbance, synchronous generating units located in different geographical areas of the network may begin to oscillate relative to one another at a low frequency (between 100 mHz and 1 Hz) in opposite phase. This dynamic causes oscillations in all electrical parameters, particularly active power on the lines interconnecting the different areas. The least damped inter-zone mode currently observed in Europe is the East-Centre-West mode, involving oscillations of the Iberian Peninsula and Turkey in opposition to central Europe, at a frequency of around 200 mHz. As the Iberian Peninsula is at the end of the European network and the France-Spain border is relatively weakly meshed, management of this border has a significant impact on this mode.

To illustrate this phenomenon, the graph below shows the frequency variations during the event of 1 December 2016:

The frequency remains around 50 Hz but shows significant variations at different points in the interconnected European network.

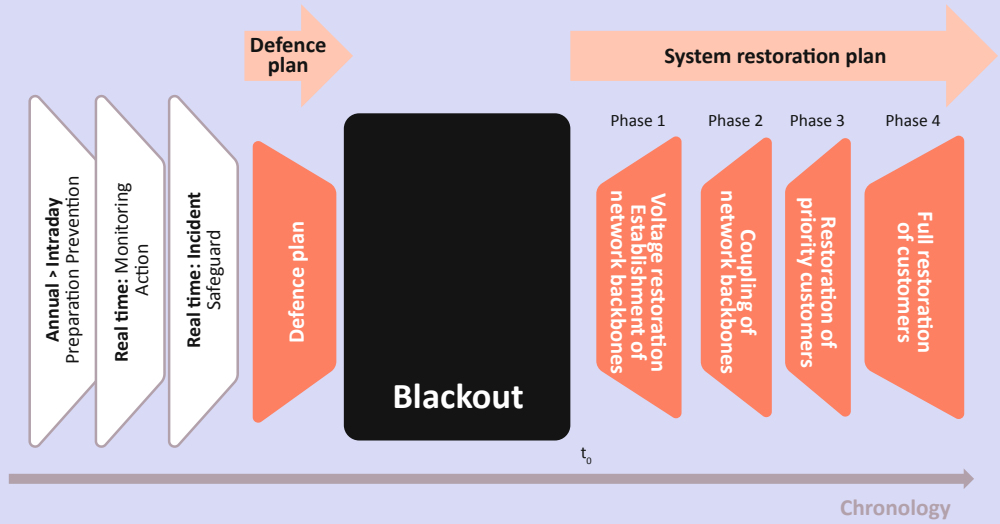
This phenomenon affects the stability of the electricity system and must be damped to prevent safety risks that could potentially result in generating units tripping and separation of the European network.

The deployment of measurement equipment at numerous points across the European network, namely Phasor Measurement Units (PMUs), whose data are shared between European network operators, makes it possible to monitor the phenomenon and mitigate its consequences.



6.2 Defence in depth of the electricity system

Map of defence layers



Defence plan

The Defence Plan brings together all the automatic systems that perform remedial actions to counter electrical phenomena that could lead to the collapse of the network and whose rapid onset and development rule out any possibility of human intervention. The Defence Plan notably includes the following actions:

- Automatic separation of regions that have lost synchronism (DRS);
- Automatic disconnection of non-priority consumption following a frequency drop (frequency-based load shedding);
- RTE's specific Defence Plan automation systems (ADO/ADN, etc.);
- Automatic blocking of transformer on-load tap changers.

FREQUENCY-BASED LOAD SHEDDING

In France, since 2023, frequency-based load shedding, shared between RTE and DSOs, has been based on a six-stage principle distributed between 49 Hz and 48 Hz, in accordance with the European network code on emergency and restoration procedures for the electricity system (Emergency and Restoration code).

Changes in the energy mix on distribution systems are leading to a high degree of interconnection between consumption and generation, particularly as a result of the significant growth in photovoltaic generation connected to the low-voltage network within consumption areas themselves. This mix makes it more difficult to assess gross consumption because, depending on the level of generation located at the same electrical point as the consumption, this electrical point can switch from consumption to generation depending on the time of year and time of day.

This raises questions about the arrangements for allocating and managing frequency-based load shedding, as the current organisation could result in consumption being shed while also shedding generating facilities, producing the opposite effect to that intended. Discussions have been initiated, particularly with Enedis, to examine the need to adapt the arrangements for implementing frequency-based load shedding.

The System Restoration Plan (PRR)

An exceptional combination of adverse events can lead, despite all the precautions taken, to a total collapse of the network (blackout) in one region, across the entire country or even beyond.

RTE must then restore the system to normal operation (the “system restoration” action), with the aim of acting as quickly as possible in order to minimise the duration of the impact of the blackout as far as possible, in a controlled manner, while ensuring the safety of people and property, and in particular avoiding any further network collapse.

RTE’s strategy for restoring all or part of the network following a widespread incident, in the absence of any possible support from a network that has remained energised, in France or abroad, is based on islanded nuclear generating units. The network would then be progressively restored from predefined network backbones, making it possible to progressively restore priority customers and then the rest of consumption.

Implementing this strategy obviously depends on the availability of a remote-control system that is itself resilient to the blackout.

SPECIFIC COOPERATION WITH EDF TO JOINTLY ENSURE NUCLEAR SAFETY AND ELECTRICITY SYSTEM SAFETY...

Islanding of nuclear generating units, network backbones and voltage restoration

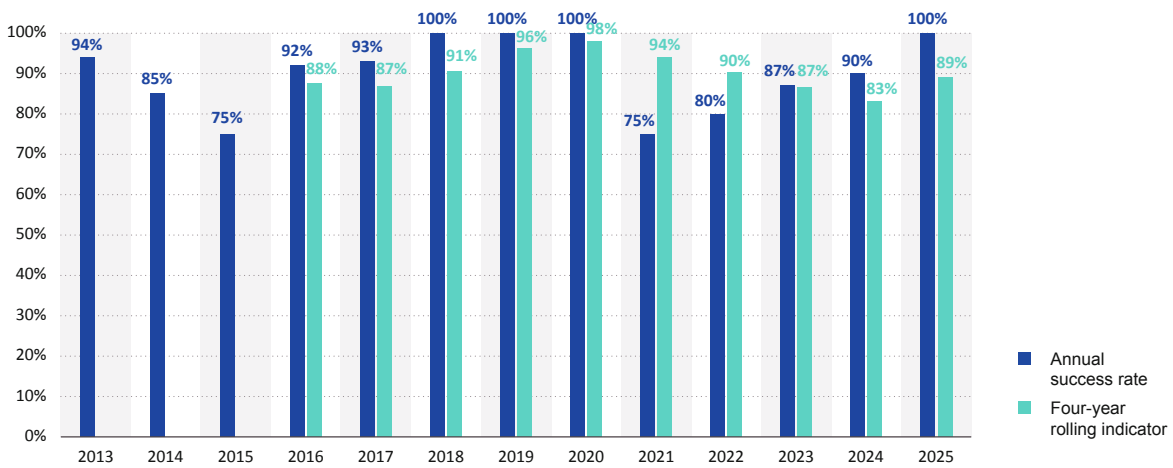
For a nuclear reactor, islanding means switching from normal operation, with its full power being delivered to the network, to a state in which it is isolated from the electricity system, with the reactor then producing only the electrical energy required for its own operation.

Beyond nuclear safety, the successful islanding of nuclear generating units in the event of a widespread incident is essential to enable the network to be restored. Reactors that have successfully islanded can be used to restore the auxiliary systems of nuclear generating units that have not managed to island, which in this case have other autonomous means of power supply, and also to restore supply to consumers as quickly as possible.

Network restoration then relies on the step-by-step energisation of 400 kV structures and substations at lower voltage levels, known as regional network backbones, which connect the nuclear sites to one another in order to restore supply to substations serving major consumption areas.

In 2025, **9** nuclear generating units successfully **islanded,** either as part of planned tests or following unforeseen events, with a 100% success rate (89% over four rolling years). This rate is satisfactory compared with the multi-year target of 60%.

FIGURE 21 – ISLANDING SUCCESS RATE



REFLECTING A SHARED RESPONSIBILITY BETWEEN EDF AND RTE.

FIGURE 22 – SIMULATOR TESTS

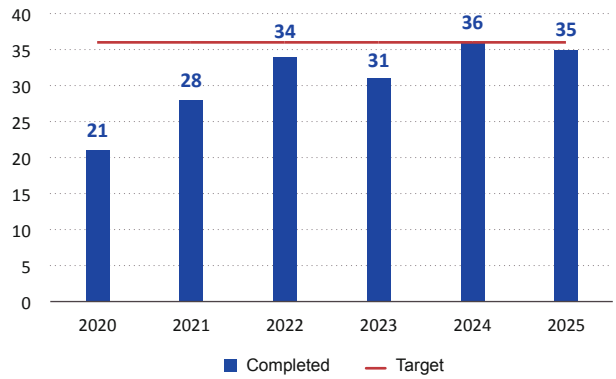
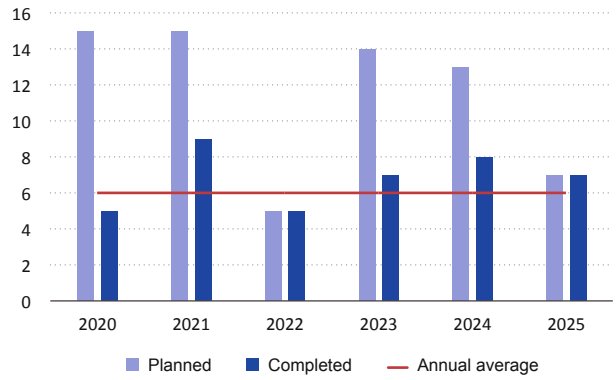


FIGURE 23 – EXTERNAL RVU TESTS



In the event of a blackout, the System Restoration Plan is essential to ensuring both nuclear safety and the ability to rapidly restore the system to normal operation.

Nuclear power plants (CNPEs) have been designated as high-priority significant network users to be re-energised at the beginning of the system restoration process, both for nuclear safety reasons and because of their ability to ensure rapid restoration of consumption. The establishment of the seven regional frameworks meets this regulatory requirement.

This framework requires RTE and EDF to carry out tests on simulators and in real conditions, in order to ensure that, if required, the equipment, incident procedures, organisation and operators will meet the expectations of both companies. In 2025, the rate at which these tests were carried out was satisfactory.

These results confirm the operational status of 95% of the scenarios for restoring supply to the auxiliary systems of nuclear generating units (tested over the past 6 years). 5% of the scenarios are still considered “usable”, insofar as they were tested between 6 and 12 years ago.

7 Information and telecommunications systems

7.1 Control room tools

In 2025, the availability of critical applications in the tertiary sector was 99.43%. The availability of applications in the industrial sector was 99.19%. The availability of tools contributing to secure network operation was at the same level as in previous years.

Following the increase observed in 2024, the number of significant severity A events fell slightly in 2025, with 19 SSEs (21 in 2024 and around ten in previous years). Conversely, six SSEs of severity B were recorded in 2025 (compared with an average of one SSE B per year in previous years). Of these six events, five were related to a failure affecting an optical transmission medium or equipment failure. The inclusion of the new criteria in the classification framework only partly explains this increase.

5 SSEs (4 SSE A and 1 SSE B) were related to incidents or interventions involving RTE's control system.

Each of these events was subject to an in-depth analysis, with the associated actions aimed primarily at facilitating the detection of a malfunction in order to speed up incident resolution.

SAS is the secure system for transmitting alerts and actions to be carried out by the parties responsible for system safety, thereby enabling degraded or at-risk situations to be managed.

Safeguarding the system requires coordination and rapid action between the dispatching centres and:

- the control centres of distributors and producers;
- RTE's operational teams.

Using SAS, RTE dispatching centre operators securely, accurately and rapidly transmit predefined orders and messages, including:

- safeguard orders, which speed up the implementation of actions by the relevant parties during situations where the safety of the electricity system could be compromised;
- alert messages, which are used in disturbed situations.

As in 2024, the hardware availability of RTE's alert and safeguard system was satisfactory: no SSE A was recorded in 2025 (compared with 1 SSE A in 2023 and 2 SSE A in 2022).

As in 2024, two SSEs (severity A) were recorded in 2025, corresponding to an error in the use of the tool by an operator (RTE, producer or distributor) when actual safeguard orders were sent.

To make appropriate decisions, from investment decisions concerning the network through to real-time operation management, network studies are carried out across numerous time horizons.

At shorter-term horizons, the study process incorporates renewable generation forecasts based on weather forecasts, market participants' schedules and expected exchanges. These forecast data, at half-hourly or even quarter-hourly granularity, are refreshed at least every hour from D-2 through to real time.

The continuous sharing of these data with neighbouring TSOs and RCCs (Regional Coordination Centres), together with the resulting coordination, makes it possible to consolidate and update joint network operating strategies.

The "Convergence" network study platform makes it possible to carry out network studies from development studies through to real time. The SEA tool (Anticipate Safety Issue) enables real-time teams to prepare the network for operation at time horizons close to real time.



In 2025, eight SSE A affected the application chain supporting the study process, caused by malfunctions in the communication gateways supplying them, whereas in 2024 the nine SSE A were caused by malfunctions in the study applications themselves.

The IPES-N system (Insert Renewable Generation in the System) provides estimates of actual and forecast wind and photovoltaic generation, at local, regional or national level, over an adjustable period from D-4 to D+2, and is used for short-term studies and by the real-time teams. No SSE A was recorded for this tool in 2025.

As regards tools for analysing the supply-demand balance, balancing and markets, 2025 marked the final stage in the overhaul of this application chain, which can now accommodate recent changes to market rules, particularly the move to 96 time slots.

7.2 The telecommunications network and the information system

The operational safety of the electricity system is closely linked to the proper functioning of secure telecommunications networks, the information system (IS), and their ability to withstand cyber threats.

The Secure Optical Network (**ROSE**) is a telecommunications network owned and operated by RTE. It provides secure telecommunications services that contribute to system safety: “high-level” remote control, information exchanges between protection systems against electrical faults, and secure telephony.

During 2025, several SSEs were related to the ROSE telecommunications network:

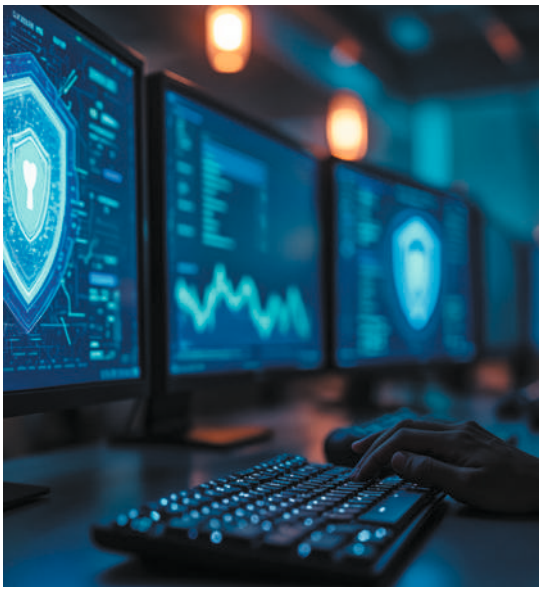
- One SSE B following the failure of a card.
- Two SSE A following a card failure and an incorrect configuration.

As in 2024, operation of the Secure Telephony System (STS) did not result in any SSE A in 2025 (2 SSE A in 2023).

To modernise its telecommunications networks, RTE has begun deploying the INUIT (Unified Infrastructure for Telecom Network) and SUR-T high-speed and very-high-speed networks across all its tertiary and industrial sites. Services are gradually being migrated to these optical networks, after which the old telecommunications networks will be decommissioned.

At the end of 2025, INUIT equipment had been deployed at almost all the sites concerned, while SUR-T equipment had been deployed at 80% of the sites concerned.

During 2025, no SSE was related to the INUIT infrastructure.



Beyond the operation of the telecommunications systems themselves, some SSEs were related to the infrastructure itself (i.e. the 22,000 km optical fibre infrastructure). During 2025, 4 SSE B and one SSE A were recorded:

- Two SSE B were related to optical fibre cuts (damage to the optical medium).
- Two SSE B were related to faulty equipment (optical multiplexer).
- One SSE A was related to scheduled work on an optical fibre that had an impact that had not been identified in advance.

Lastly, cybersecurity remains a major issue, managed from a dedicated 24/7 room with close links to ANSSI. Significant events are reported to ANSSI. They are not public.

8 Key events in 2025

8.1 Lessons learned from the blackout that occurred in the Iberian Peninsula on 28 April 2025

The Iberian blackout of 28 April 2025 resulted from a combination of factors: voltage control deviations in conventional generation, reactive power absorption by renewable generation that was not correlated with voltage, insufficient use of the reactive power absorption capacity of inductors, and insufficient voltage operating margins. These factors led to voltage instability, which resulted in a cascade of overvoltages leading to successive and widespread disconnections of generating facilities, followed by loss of synchronism between the Iberian Peninsula and the rest of the European network and, ultimately, the blackout.

The ENTSO-E final report and interim factual report are available via the following link: 28 April 2025 Blackout

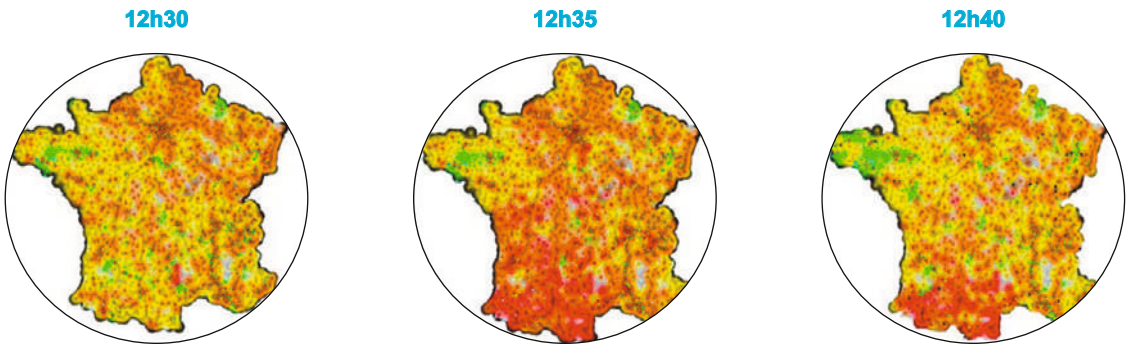
In parallel with the procedure conducted under the aegis of ENTSO-E, in which RTE participated through the designated expert panel, in accordance with Regulation (EU) 2017/1485 of 2 August 2017, RTE carried out a specific analysis of the consequences of the event for the French electricity system.

This analysis shows that the French defence plan operated as expected. 15 DRS protection trips (loss-of-synchronism network splitting) prevented the incident from spreading to France and the rest of Europe, subsequently making it possible to help restore the Iberian system rapidly. These trips were recorded as an SSE D.

The consequences for customers connected to the French transmission system were relatively limited given the scale of the event on the Iberian side: two Enedis substations had their supply interrupted for a maximum of 20 minutes, and a limited number of industrial customers were affected by the event.

Initially, the absence of a generating unit at Golfech (unit 2 was shut down and unit 1 tripped during the incident) and the tripping of the direct-current line between France and Spain, corresponding to the loss of approximately 1,500 Mvar of reactive power absorption, contributed significantly to the sharp and rapid increase in voltages in south-western France.

FIGURE 24 – EVOLUTION OF VOLTAGE IN FRANCE AT THE TIME OF THE BLACKOUT



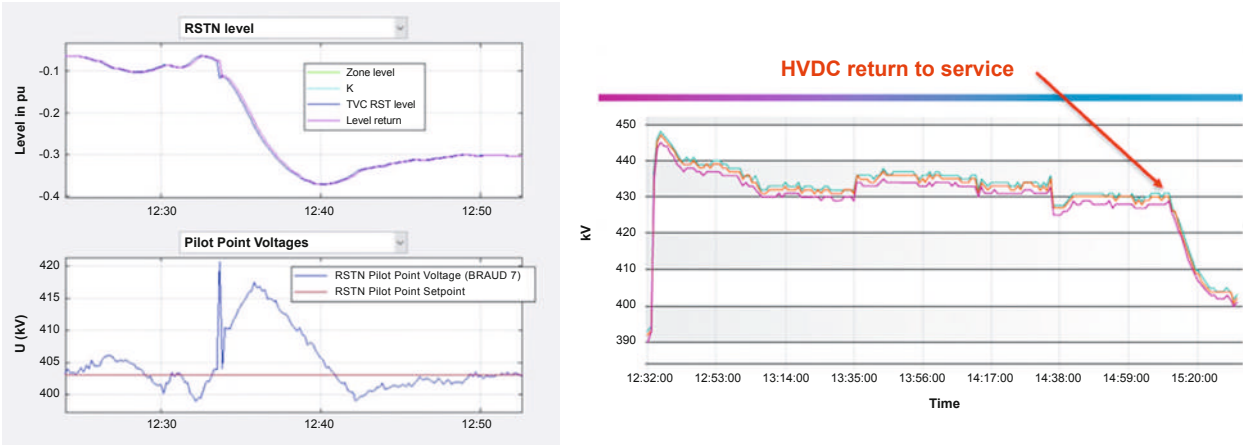
Before the blackout, voltage levels were relatively normal

Immediately after the blackout, voltages were high across a large part of France

At 12:40 p.m., voltages had stabilised across most of France

The French voltage control resources stabilised the situation within around ten minutes. Nevertheless, voltages did not return to normal levels until the direct-current line was returned to service, as it also provides voltage control services. Returning the asset to service required complex coordination between the many parties involved, both within RTE and between RTE and its Spanish counterpart, and consequently took several hours.

FIGURE 25 – EVOLUTION OF VOLTAGE IN THE BRAUD (BORDEAUX) AND BAIXAS (PERPIGNAN) AREAS

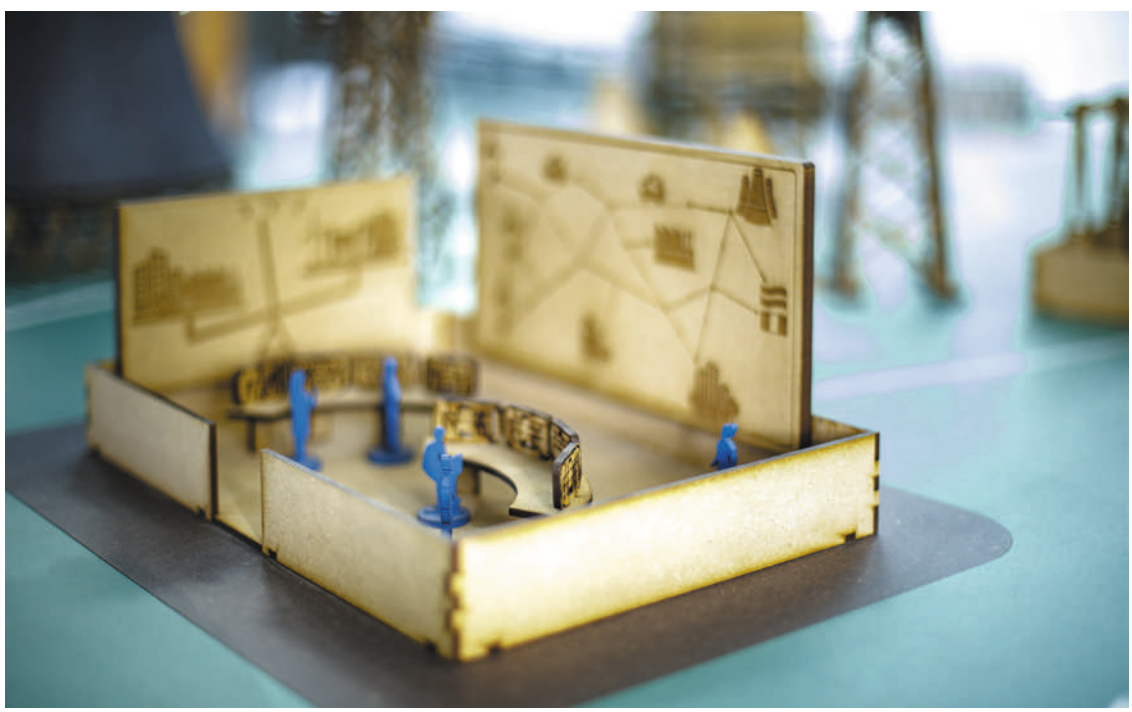


Many of the recommendations issued in the ENTSO-E final report published on 20 March 2026 are already in force within the French electricity system:

- applying greater operating margins for voltage management;
- implementing an inductor installation programme;
- developing automatic control of inductors for voltage control;
- adopting centralised real-time voltage control (Secondary Voltage Control);
- monitoring the requirements applicable to facilities for system services and voltage withstand, and adapting the remuneration and penalty system to provide greater incentives.

In accordance with certain recommendations, RTE is also working to further develop and refine the procedures and operating methods specifically aimed at preventing voltage escalation phenomena:

- under normal operating conditions: involving major consumers in voltage control, making overvoltage withstand requirements mandatory for producers connected to the RPT, developing static compensation for renewable energy facilities and storage facilities connected to the HTB network, and increasing network observability through the installation of PMU (Phase Measurement Units) sensors;
- under the Safeguard Plan: studying with producers the feasibility of SAS orders for high voltages;
- under the Defence Plan: developing, with Enedis, dynamic voltage control for producers connected to the RPD, studying an emergency mode for Secondary Voltage Control, making overvoltage protection on customer capacitor banks mandatory, deploying voltage control automation systems on unequipped static compensation equipment, and adapting the frequency-based load-shedding plan.



8.2 Management of periods of negative spot prices

WHY DO NEGATIVE PRICES HAPPEN?

In a electricity system with a growing share of renewables, an increase in negative prices is to be expected, particularly if electricity consumption remains low. Negative prices generally occur during times of low demand combined with high supply of renewable energy generation. When supply exceeds demand, generating units with a non-zero marginal production cost should stop generating. However, they may prefer not to stop and instead temporarily offer their electricity at a negative price, *i.e.* choose to pay buyers to consume it for a few hours. The reason for this is that shutting down a thermal unit temporarily can be costly due to technical and economic constraints (start-up costs, minimum technical requirements, minimum shutdown time, etc.). Thus, consumers are paid to consume electricity produced in abundance at these specific times. Negative prices are not in themselves an anomaly in the functioning of the market. In theory, a negative price is a relevant economic signal, encouraging consumers to consume during periods of high generation and producers to reduce their generation when there is no outlet for it. In fact, however, as only a small part of electricity consumption at a given time is covered by volumes traded at the spot price (or whose price is indexed to it), the incentive effect of this signal on the level of consumption is reduced. In addition, a large part of renewable production is also not exposed to market prices, having direct power purchase agreements through the feed-in tariff mechanism. On the other hand, facilities on the premium scheme have an incentive not to produce if prices are negative. The mechanism does not provide for any remuneration for generation during these episodes, but it provides compensation if the total number of hours the facility is shut down over the year exceeds a threshold defined for each generation source. In particular, wind and solar output during periods of negative prices was generally lower than during periods of zero prices. This difference clearly shows the effect of the curtailment of price-sensitive renewables (plants on the premium scheme or exposed to market prices) at negative price times, which is estimated to amount in total to 2.9 TWh over the course of 2025 (1.7 TWh in 2024).

INCREASINGLY FREQUENT PHENOMENA NOW MONITORED THROUGH SPECIFIC SSES.

The number of occurrences of negative spot prices is progressively rising 2022, with 513 hours in 2025, representing 6% of the time (compared with 352 hours in 2024). The number of negative price episodes has accelerated in recent years, driven by the combined effect of continued growth in low-carbon generation and consumption remaining at a lower level than during the 2014-2019 period.

FIGURE 26 – NEGATIVE SPOT PRICE PERIODS

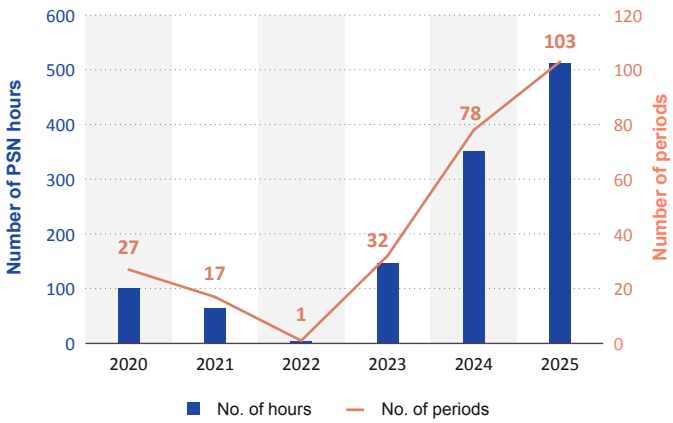
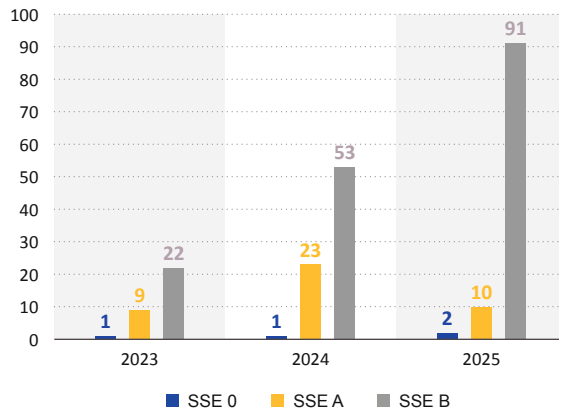


FIGURE 27 – SSES RELATED TO NEGATIVE SPOT PRICES



These negative spot price periods resulted in 103 SSEs in 2025: 2 SSE 0, 10 SSE A and 91 SSE B, defined as follows:

- SSE 0: generation reduction between 600 and 1,500 MW
- SSE A: generation reduction between 1,500 and 3,000 MW
- SSE B: generation reduction of more than 3,000 MW

As SSE reporting a generation reduction during periods of negative spot prices were introduced in 2025, the figures for 2023 and 2024 were therefore assessed retrospectively. These SSEs are intended to be removed from the reference framework once forecasting models are sufficiently accurate and the arrangements for generation shutdowns and restarts have been defined and implemented by players.

The majority of onshore wind capacity and some photovoltaic installations are now being developed under the premium scheme ("*complément de rémunération*"). This framework includes incentives for the installations involved to interrupt production when the spot price is negative. Capacity developed under the premium scheme, as well as some non-supported installations, may therefore shut down their generation during periods of negative spot prices. Between 2024 and 2025, this capacity increased by 3.3 GW, thereby exceeding 25 GW.

Large volumes of renewable generation were therefore observed to shut down simultaneously in 2025, with significantly greater frequency and magnitude than in previous years, as a result of the overall decline in market prices and the growing share of renewable energy in the French energy mix. These periods are particularly correlated with periods of high photovoltaic generation. Although they are known from the day before they occur, particular vigilance remains necessary during these periods in order to estimate and anticipate as accurately as possible the volumes of renewable generation that will shut down and restart.

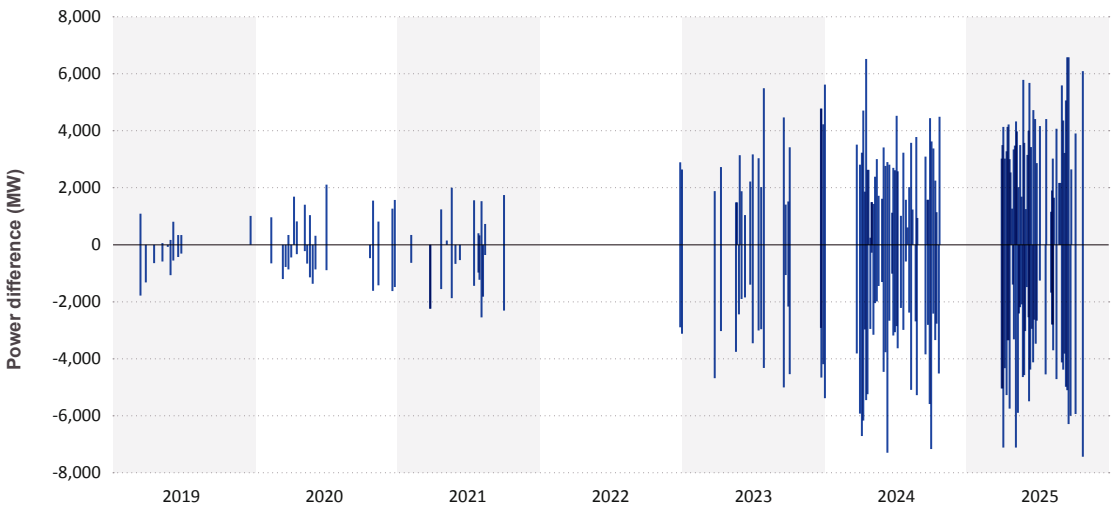
Beyond price signals, market participants' behaviour can vary, including from one period to another, which makes forecasting more complex, making **complete scheduling by all market participants necessary.** Indeed, these rapid changes in generation can now reach considerable volumes, of **up to around 10 GW**.

The following curve illustrates the trend towards increasing volumes of renewable generation shutdowns and restarts during periods of negative spot prices since 2020.

For example, on 23 October 2025, a negative price period beginning at 2 p.m. resulted in approximately 9 GW of renewable generation being shut down. Due to the difficulty of estimating this volume, linked to insufficient visibility of renewable energy producers' schedules, a frequency drop of 103 mHz was observed, despite RTE activating more than 2 GW of fast-response generation adjustments to compensate for the imbalance.

To assess the impact on operational safety, the number of periods encountered should be considered in addition to the number of hours. Indeed, managing the balance of the electricity system is made more complex at the beginning and end of each of these periods.

FIGURE 28 – ESTIMATED VOLUME OF RENEWABLE GENERATION SHUTDOWNS AND RESTARTS DURING PERIODS OF NEGATIVE SPOT PRICES



THE SIMULTANEOUS SHUTDOWN AND RESTART OF RENEWABLE GENERATION INVOLVE RAPID DYNAMICS THAT ARE COMPLEX TO MANAGE IN TERMS OF SDB, NETWORK FLOWS AND VOLTAGE, AND CAN NOW HAVE IMPACTS AS FAR AS THE HTB2 AND HTB3 NETWORKS.

Beyond the volume involved, accurately forecasting the location of the generation facilities concerned when they shut down and restart during these periods is also an important challenge. For example, wind or sunshine conditions change between the shutdown and restart of generation, thereby altering both the volumes and geographical distribution of renewable generation. These uncertainties affect the optimisation of real-time balancing as well as the management of power transfers and voltages, requiring close coordination between balancing and grid operation activities. In addition, the very rapid changes in generation during these periods cause variations in network parameters (frequency, voltages and currents) that place significant demands on balancing and operational safety systems.

These periods therefore combine, with increasingly rapid changes, national issues such as electricity system supply-demand balance with more local issues involving the management of network flows on electrical connections and the voltage plan, particularly in areas affected by large volumes of generation shutdowns or restarts. These phenomena are most often observed on the regional transmission system (63 and 90 kV), to which some renewable generation is directly connected, but which also interfaces with the distribution system, to which the majority of facilities are connected.

Nevertheless, given the increasingly large volumes involved, these generation shutdowns and restarts can also affect higher voltage levels:

- In terms of network flows, IST exceedances were recorded on 1 April and 3 May (SSE A) on the 225 kV Trois Domaines–Vandières connection (Meuse/Meurthe-et-Moselle) during the restart of renewable generation at the end of negative spot price periods;
- In terms of voltage, as indicated in Chapter 5 on voltage, significant voltage drops (more than 30 kV at Revigny on 1 April and more than 20 kV at La Chaussée on 3 May) and orders to block transformer tap changers were observed at the end of the periods on 1 April and 3 May.

These sudden fluctuations in voltage at the end of negative spot price periods are explained by renewable generation facilities connected to the distribution system injecting reactive power into the transmission system when they reconnect, as these generating facilities are configured to provide reactive power proportional to active power.

It can also be noted that, at this stage, the consequences for voltage are more pronounced at the end of negative spot price periods than at the beginning because the restart dynamics are stronger than the shutdown dynamics, resulting more often in low-voltage issues than high-voltage issues. The opposite phenomenon, at the beginning of negative spot price periods, is closely monitored by RTE because of the risk of uncontrolled voltage increases.

The actions of automation systems and control systems enable a return to stable operating conditions, often supplemented by network configurations at substations to balance the distribution of network flows across the network.

PHENOMENA SUBJECT TO INITIAL REGULATORY AND LEGISLATIVE MEASURES IN 2025

These phenomena illustrate the importance of the work initiated by RTE, in coordination with the public authorities and DSOs, along the following three lines:

- **Shared forecasting:** extending day-ahead scheduling obligations to new actors (storage facilities, HTB-connected consumers) and to the intraday time horizon for all actors. Tools are also being upgraded to improve consumption and renewable generation forecasts, notably by incorporating negative spot prices into generation forecasting models.

- **Levers for balancing the system:** extending the obligation to participate in the balancing mechanism to all generators of more than 10 MW connected to either the RPT or RPD. This obligation came into force on 1 January 2026. The wind and solar capacities that can be mobilised through the balancing mechanism increased nearly tenfold during 2025, reaching 5.6 GW in December 2025.

- **Levers for managing system dynamics:** implementing measures to stagger shutdowns and restarts during periods of negative spot prices for all renewable energy producers. The legislator has introduced specific provisions to organise staggered shutdowns and restarts for renewable generation benefiting from a supplementary remuneration scheme.



9 European coordination

The electricity transmission system is a European network. Today, the 43 TSOs in 36 countries are interconnected through around 420 interconnections, around 30 of which are on the French borders. The safety of the French network therefore partly depends on the operation of the European electricity system.

MOLDOVA JOINS ENTSO-E.

At the end of 2023, Moldelectrica, the Moldovan TSO, also joined ENTSO-E as an observer member. As with the procedure followed for the accession of Ukrenergo, the Ukrainian TSO, the analyses of Moldelectrica's compliance with European rules continued in 2025 and will also continue in 2026.

CONNECTION OF THE BALTIC TSOS TO THE CONTINENTAL EUROPEAN AREA.

Throughout 2024, work was carried out within ENTSO-E to ensure that the Baltic transmission system operators, AST (Latvia), LitGrig (Lithuania) and Elering (Estonia), complied with the European codes, as well as with the rules defined in the framework agreement governing the operation of the Continental European synchronous area.

The Baltic TSOs made significant investments to ensure that they had the capacity to manage system balancing and voltages and to deal with potential inertia issues in the event of separation from Europe. Indeed, the Baltic countries are synchronised with Continental Europe via a single double-circuit 400 kV link.

The Baltic countries – Lithuania, Latvia and Estonia – were successfully connected to continental Europe on 9 February 2025.

They form a single frequency control block. The monitoring period that followed the connection ended on 25 November with the definitive and full accession of the Baltic countries, which achieved full member status within the Continental Europe Regional Group.

PROCEDURE FOR ANALYSING MAJOR EUROPEAN INCIDENTS AND MONITORING THE IMPLEMENTATION OF RECOMMENDATIONS BY ENTSO-E.

The European SOGL Regulation defines a framework of operational security limits to be monitored and ensured by European TSOs. In addition, the ICS (Incident Classification Scale) methodology defines the scale for classifying incidents to be monitored and reported by all European TSOs.

This methodology, jointly drafted by the TSOs under the aegis of ENTSO-E, defines the criteria for classifying incidents, particularly in terms of severity. It is approved by the Agency for the Cooperation of Energy Regulators and defines the procedure for reporting, classifying and declaring major incidents, as well as the data to be collected for the analysis.

The methodology provides for a specific analysis and investigation procedure for incidents considered major according to the classification criteria, particularly cases of total or partial blackout. It provides for an expert panel to meet to conduct the incident analysis investigation. This expert panel is established on an ad hoc basis for each incident and includes representatives of European TSOs, ACER, national regulatory authorities and Regional Coordination Centres (RCCs), such as CORESO.

The expert panel is established for each major incident and produces two public reports:

- An initial interim report that sets out the factual sequence of the incident. It provides a description of the system conditions before the incident, traces the evolution of these conditions during the event, and describes the measures taken immediately after the incident began and before system restoration was initiated. It also describes the communication between the Regional Coordination Centres (RCCs) and transmission system operators (TSOs).
- A final report aimed at identifying and analysing the causes of the incident. The expert panel also issues recommendations aimed at drawing lessons from the incident analysis and improving the robustness of the European electricity system in order to limit the recurrence of similar incidents. These recommendations may be pan-European, regional, or targeted at a small number of TSOs.

In view of the various major incidents observed in recent years, an organisation was established within ENTSO-E to oversee the monitoring of the implementation of the various recommendations issued by the different expert panels.

This organisation, the Task Force Monitoring Implementation des Recommendations, coordinates monitoring within the TSOs in collaboration with ENTSO-E working groups whose remit may include implementing certain recommendations. The Task Force also reports to the European Agency for the Cooperation of Energy Regulators on progress with the implementation of the recommendations at European level.

Final report on the 28 April 2025 Iberian blackout.

For the blackout that affected Spain and Portugal, in addition to the points set out in Section 6.1, it should be noted that some of the recommendations issued may lead to proposals for amendments as part of the work to develop SOGL 2.0.

The ENTSO-E final report and interim factual report are available via the following link: 28 April 2025 Blackout

Incident in North Macedonia on 18 May 2025.

The expert panel published its final report on 20 April 2026: ENTSO-E Publishes Expert Panel Final Report on 18 May 2025 Blackout in North Macedonia

The investigation concluded that the blackout resulted from operation of the transmission system at voltage levels above the defined limit of 420 kV. This overvoltage condition caused all 400/110 kV transformers to trip, resulting in the separation of the 400 kV network from the 110 kV network and, consequently, loss of electricity supply in the affected region.

Based on these findings, the expert panel issued several targeted recommendations aimed at preventing similar events. These include, in particular, with the support of the Regional Coordination Centres (RCCs) and ENTSOE:

- developing a coordinated action plan at SouthEast Europe (SEE) level for managing and preventing overvoltage conditions;
- strengthening operational alignment between TSOs regarding voltage control.

These measures are intended to improve the management of high voltages, regional coordination and, more broadly, the operational security of the European electricity system.

Incident in the Czech Republic on 4 July 2025

Continental Europe experienced a third major incident in 2025. On 4 July 2025, shortly before 12:00 CEST, an incident occurred on the Czech transmission system, resulting in significant power cuts in the eastern and northern regions of the Czech Republic, including the Prague area. The event led to the separation of the northern and eastern part of the Czech network, which subsequently collapsed rapidly. System restoration was initiated immediately after the incident, with all consumers and network users resupplied at around 5.35 p.m.

The expert panel published its interim report on 19 December 2025: 4 July grid incident in the Czech Republic: Expert Panel releases factual report. The final report is expected in the second quarter of 2026.

NETWORK CODES

The network codes, arising from the Third European Energy Package, define the main rules to be applied by all actors whenever the interconnected operation of networks is concerned. All the codes have been published and are now applicable.

Covering different areas (operation, markets and connection), the codes contribute, within their respective scopes, to the operational safety of the interconnected European electricity system:

- The Emergency and Restoration code defines common rules for managing emergency situations and restoring the system. The System Operation Guideline code brings together the common principles for operating the electricity network.
- With regard to markets, operational safety is a major concern of the Electricity Balancing code, which addresses supply-demand balancing, the Forward Capacity Allocation code and the Capacity Allocation and Congestion Management code, whose purpose is to organise electricity exchanges at long- and short-term time horizons, respectively.
- The Requirements for Generators code incorporates requirements relating to the connection of generating facilities, including technical requirements designed to strengthen the resilience of the electricity system.
- The fourth package, known as the Clean Energy Package, which entered into force on 5 July 2019, defines new rules, including a minimum threshold of 70% of interconnection capacity that must be made available for cross-border trading, as well as the regulation on risk-preparedness in the electricity sector.

Work to implement the network codes defined within the European regulatory framework continued, resulting in several milestones and revision projects carried out at European level.

ANNEX 1: Thematic glossary

ID	Concept
Balancing Mechanism (BM)	French law requires generators to make their technically available capacity available to RTE for balancing supply and demand. This is done through the Balancing Mechanism, which enables RTE to pool the resources held by market participants through a permanent and open mechanism, while enabling participants to derive value from their demand response capabilities or generation flexibility. Based on price-volume bids, RTE makes the necessary adjustments by ranking the bids according to their price until its requirements are met. Provisions are in place for situations where there is insufficient capacity: ▶ more than 8 hours ahead, RTE requests additional bids by means of an alert message; ▶ less than 8 hours ahead, a “degraded mode” message enables RTE, in addition to any additional bids, to mobilise exceptional bids and resources not offered through the Balancing Mechanism.
Primary and secondary frequency control	Primary control automatically restores the balance almost immediately following any contingency affecting the balance between generation and consumption, through the coordinated participation of all parties to the synchronous interconnection. Rules are established by the ENTSO-E “Continental Europe” regional group to ensure that this action maintains the frequency within defined limits. *This is followed by secondary control by the party responsible for the disturbance, which automatically eliminates the residual deviation from the reference frequency, as well as deviations from the exchange schedules between the different control areas.*

ID	Concept
ENTSO-E	ENTSO-E (European Network of Transmission System Operators for Electricity), established at the end of 2008, has been the sole association of European TSOs since 1 July 2009. ENTSO-E is intended to strengthen cooperation between TSOs in key areas such as the development of network codes relating to technical and market-operation aspects, coordination of the operation and development of the European transmission system, and research activities. Under its statutes, the association's main decisions are taken by the General Assembly. An executive Board is responsible for overall management and preparing strategic guidelines. Operational work is carried out by four main committees and their sub-structures: the Market Committee (MC), the System Development Committee (SDC), the System Operations Committee (SOC) and the Research and Development Committee (RDC), supplemented by a legal analysis group. RTE is represented in each of these groups. To ensure the technical coordination of synchronously interconnected TSOs in Continental Europe and the assessment of safety-related commitments, defined in eight "policies" and agreed under the Multilateral Agreement signed by members of the former UCTE association, the SOC established an ad hoc regional subgroup, the Regional Group Continental Europe (RGCE).
Secure telecommunications	This secure network is based on dedicated telecommunications infrastructure, most of which is owned and operated by RTE, enabling the transmission of all information (voice and data) required for remote control. These *systems* perform the following functions: ▶ transmission ("low level") of remote-control data from all Remote-Controlled Substations (PA), as well as a limited number of telephone calls between transmission substations and substation clusters; ▶ transmission ("high level") of remote-control data and telephone calls between substation clusters and the dispatching centre; ▶ transmission of remote-control data and telephone calls between generating plants and the dispatching centre; ▶ transmission of remote-control data and telephone calls between distribution network control centres and the dispatching centre.

ID	Concept
Performance controls of generating units	Given the critical nature of the services provided by generating facilities, those connected to the RPT may be subject to performance monitoring. This monitoring makes it possible to verify the behaviour of generating units with regard to primary and secondary frequency-power control (static gain, known as droop, scheduled reserves, response time, etc.), as well as primary and secondary voltage control (availability of the contractual operating range in the U/Q diagram, response dynamics).

ANNEX 2: Syntactic glossary

ACER	Agency for the Cooperation of Energy Regulators
ADN	Northern Automatic Scheme against Voltage Collapse
ADO	Western Automatic Scheme against Voltage Collapse
aFRR	Automatic Frequency Restoration Reserve (secondary reserve)
ANSSI	National Information Technology Services Security Agency
BCP	Business Continuity Plan
BM	Balancing Mechanism
BRP	Business Recovery Plan
CACM	Capacity Allocation & Congestion Management
CCC	Coordinated Capacity Calculation
CCR	Capacity Calculation Region
CGM	Common Grid Model (study network model)
CGS	Critical Grid Situation
CNPE	Nuclear Power Plant
CONSOL	Application for the calculation and display of real-time estimation curves, and multiregional results.
CORE	Capacity Calculation Region covering Central Western Europe and Central Eastern Europe
CORESO	Coordination of Electricity System Operators (Brussels-based RCC)
CORSN	Operational Centre for Digital Networks and Systems

COSE	Electricity System Operation Centre
CRE	French Energy Regulatory Commission
CSA	Coordinated Security Analysis
CURTE	Power Transmission System Users' Committee
DACC	Day-Ahead Capacity Calculation
DGEC	General Directorate for Energy and Climate
DRS	Loss-of-Synchronism Tripping
DSO	Distribution System Operator
EBGL	Electricity Balancing Guidelines
ECG	Electricity Coordination Group
END	Energy Not Dispatched
ENTSO-E	European Network of Transmission System Operators for Electricity
EPR	European Pressurised Reactor
EU-DSO Entity	Association of Distribution System Operators (DSOs) in Europe
FCAGL	Forward Capacity Allocation Guidelines
FCR	Frequency Containment Reserve (primary reserve)
FW	Firewall – a key component of internet access point security
GRT	Transmission System Operator
HLM	High-Level Meeting
HTA	HV (A) High Voltage A, managed by the DSOs
HVDC	High Voltage Direct Current link
ICS	Incident Classification Scale
IDCC	Intraday Capacity Calculation
IGA	Major incident
INUIT	Integrated Telecommunications Network Infrastructure

IPES-N	Integration of Renewable Generation into National Electricity System Operations
ISP	Imbalance Settlement Price
IST	Temporary Emergency Current Rating
LPM	Military Programming Law
MARI	Manually Activated Reserves Initiative (for managing the 15-minute fast reserve)
mFRR	Manual Frequency Restoration Reserve (fast tertiary reserve)
NCCS	Network Code on Cybersecurity (NCCS), aimed at establishing a European standard for the cybersecurity of cross-border electricity flows.
NCER	Network Code on Emergency and Restoration
OPC	Outage Planning Coordination
ORTEC	RTE emergency response organisation
PER	Regional Exchange Gateway: tool used by the dispatching centre's TCD network
PICASSO	Platform for the International Coordination of the Automatic frequency restoration process and Stable System Operation
PLASMA	Equipment Monitoring Software Platform
PMU	Phasor Measurement Unit
PRR	System Restoration Plan
RC	Complementary Reserve (Balancing Mechanism)
RCC	Regional Coordination Centre
RE	Renewable Energy
RfG	Requirements for Generators
RGCE	Regional Group Continental Europe (ENTSO-E)
ROSE	Secure Optical Network
RPD	Public Distribution System
RPT	Public Transmission System
RR	Rapid Reserve (Balancing Mechanism)

S3REnR	Regional Renewable Energy Grid Connection Plan
SAS	Safeguard and Alert System
SCADA	Supervisory Control And Data Acquisition
SCC	Stress Corrosion Cracking
SDB	Supply-Demand Balance
SDDR	RTE Ten-Year Network Development Plan for France
SLFC	Secondary Load Frequency Control
SOGL	System Operation GuideLines
SOR	System Operation Regions
SSE	Significant System Event
STA	Short Term Adequacy (pan-European supply-demand balance assessment)
STANWAY	Network operation and SDB management system
STS	Secure Telephony System
SVC	Static Var Compensator
SVC	Secondary Voltage Control
SWE	South-West Europe (Capacity Calculation Region)
TC-BS	Automatic on-load tap changer blocking scheme
TERRE	Trans-European Replacement Reserve Exchange (management of tertiary reserves, traded in 30-minute blocks) By mutual agreement between the TSOs involved in the TERRE project, operations on the platform ceased on 30 December 2025. Indeed, the reform of the electricity market organisation, adopted on 21 May 2024, sets the gate closure time for cross-border intraday trading at 30 minutes before real time, with effect from 1 January 2026. The Complementary Reserve (RC) process is not compatible with such a time horizon. Indeed, the RC process involves a longer full activation time, which cannot be reduced due to potential similarities with the mFRR process (MARI platform).
TOC	Transient Overcurrent
TSCNET	RCC covering Central and Eastern Europe, based in Munich
TYNDP	ENTSO-E Ten-Year Network Development Plan for Europe
UFE	French Electricity Union (professional association of the electricity sector in France)

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SAFETY REPORT

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