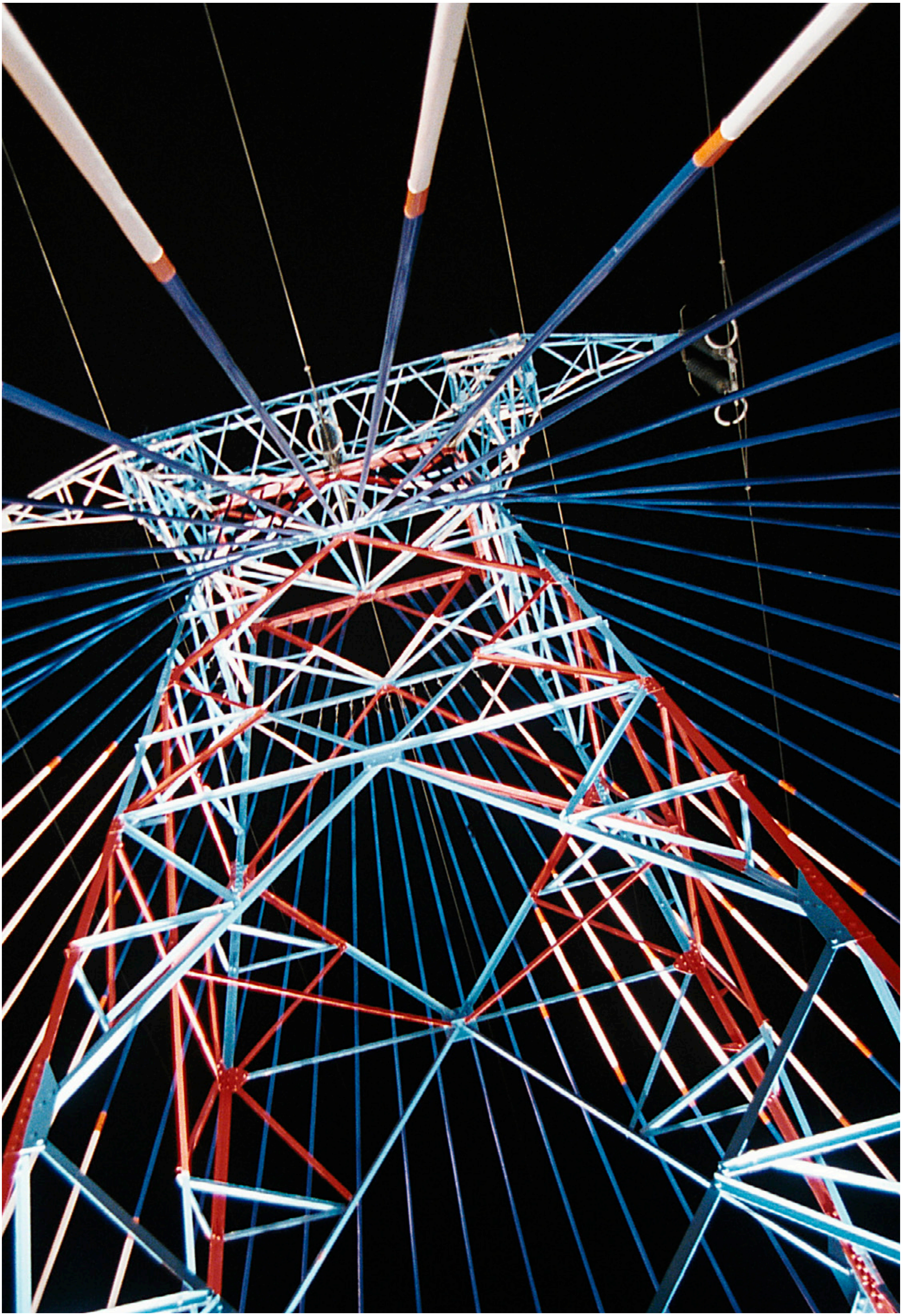
Le réseau
de transport
d'électricité

2018
Reliability Report



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SUMMARY

Every year, RTE draws up a reliability report for the past year. This document provides key information on the reliability of the power system in 2018 and the measures in progress to continue to guarantee reliability in the future.

In the context of energy transition supported by the Long-term Energy Programme (PPE, Programmation Pluriannuelle de l'Energie), changes in the power system require RTE to make adaptations on a ongoing basis. These changes have a radical impact on the structure and overall operation of the power system in terms of frequency, voltage and flows transmitted by the public electricity transmission grid and could constitute a risk to power system reliability.

Watchpoints for 2018 include:

- a further increase in the number of Significant System Events (SSE) which, even if system reliability is not significantly impacted, reflect more complex operation entailing more variable and less predictable flows;
- an increase in the number of margin deficits affecting the supply-demand balance in 2018. This situation is consistent with the Long-term Adequacy Report, which depicts a balanced and adjusted power system presenting lower margins than in previous years;
- the number of frequency deviations observed in the European power system, which continues to cause concern and reflects occasional significant imbalances between supply and demand when changes are made to power generation and trading schedules, which are synchronised hourly on the hour in Europe;
- the number of high voltage threshold overruns on the grid, which remains globally high, mainly due to more accentuated consumption lows and a decrease in extractions from the transmission grid due to the development of power generation in the distribution grid.

Nevertheless, the 2018 results show a satisfactory level of operational reliability.

The risk of encountering more strained operating conditions (not only during winter peaks), particularly in the event of strains on the supply-demand balance or on the provision of system services, has prompted RTE to roll out a number of measures designed to guarantee a high level of reliability:

- Further increases in cross-border electricity trading capacity;
- Leveraging the **power generation flexibility and modulation potential of renewable energies** in order to contribute to supply-demand balance management and reliable system operation (managing congestion, stress, system services). These developments must be supported by market and contractual mechanisms in order to take advantage of the various operators' **flexibility reserves and service offerings,** in coordination with distribution system operators (DSO);
- Stronger **cooperation between transmission system operators (TSO) and coordination centres, supported by the implementation of European grid codes;**
- Technical support for the Long-term Energy Programme (PPE) regarding energy-related decisions and guidelines in France up to 2035 and changes in the structure of power generation facilities (renewable energies, fossil-fired, nuclear);
- Implementation of projects and trials aimed at forestalling constraints on the power system and developing new ways of meeting these challenges, in particular by harnessing the latest digital innovations.

The "Clean Energy For All Europeans" package, a key step in consolidating the European energy model, has been adopted. The package bolsters European coordination by establishing regional cooperation centres, thereby enhancing the role of CORESO, and sets ambitious grid development and availability targets for electricity trading. With the package due to be transposed into French domestic law before 2021, RTE will continue to actively support this transposition whilst guaranteeing the operational reliability of the European and French electricity system.

1

SIGNIFICANT SYSTEM EVENTS (SSE)

Every year, RTE measures the grid's operational reliability by recording Significant System Events (SSE) ranked on a severity scale ranging from 0 (no evidence of direct impact on reliability) to F (widespread incident). These events correspond to incidents that can result from a broad range of causes. The RTE classification is consistent with the four-level ICS (Incident Classification Scale) issued by ENTSO-E.

Monitoring of the SSEs over several years flags up any adverse emergent trends requiring in-depth analysis and enables us to measure the effectiveness of all initiatives implemented to improve operating reliability in the long term.

With 94 level A incidents and 11 level B incidents, **2018 again marked a significant increase in Significant System Events (SSE) compared to the years prior to 2017.**

While system reliability was not materially impacted, these trends in the typology and growing number of level A and B SSEs reflect the challenges of operating a modified generation base resulting in more variable flows in terms of direction and intensity. They remind us that all power system operators have an important role to play in maintaining reliability at the expected levels.

Regarding level A SSEs, the following trends may be noted:

- **A constantly high number of alerts issued** to power system operators ("critical situation alert" safeguard orders) **due to insufficient margin availability for normal supply-demand balance management;**

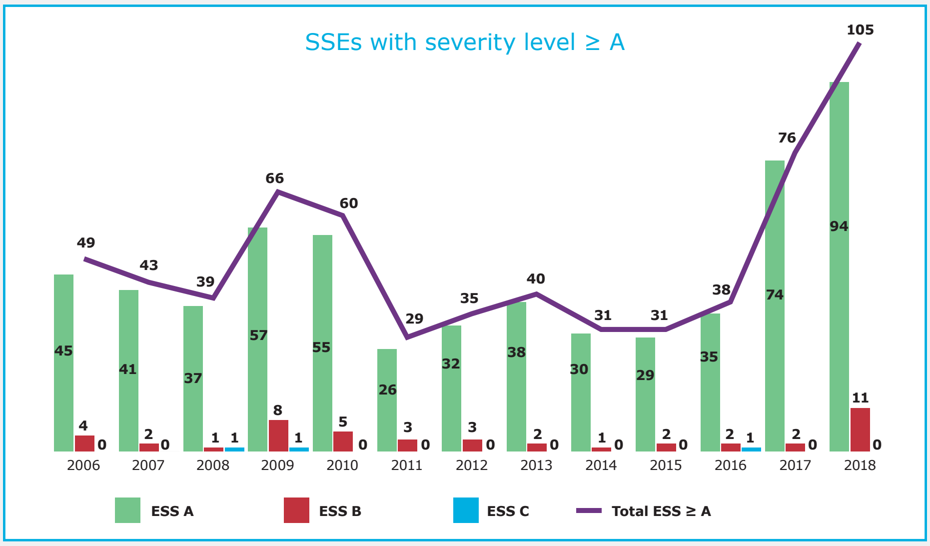
- **An increase in the number of events related to failure to acknowledge messages or anomalies in the processing of safeguard orders by generator and distributor customers.** The processing of these messages by power system operators is essential for the reliable operation of the system;

- **A significant increase in the number of overload protection start-ups** in the Rhône Valley and the Basque region (region upstream of the France-Spain interconnection) **related to flow variations in Europe mainly related to generation via renewable energies and trading.**

Most level B SSEs involve system operation conditions where an additional contingency could have had major consequences for the power system. These conditions could not be avoided **due to the difficulties experienced by nuclear power plants in meeting RTE's operational requirements** (power reduction request) **in order to ensure their stability in the event of an additional contingency.**

Furthermore, two level B SSEs involved significant system observability losses following damage to the fibre optic network, which restricted local knowledge of transmission grid status.

All of these events are analysed and give rise to action plans on the main inductors (overload protection start-ups, systems designed to identify modulation capacity in power generation resources, etc.).



2

OPERATIONAL CONDITIONS ENCOUNTERED

2018 was one of the **warmest years ever recorded.** It was marked by the 2nd warmest summer on record (though far behind 2003) and a late cold spell in late February with average temperatures 2.2°C below normal, after an exceptionally mild start to the year.

As regards grid management, the following events are to be noted:

- **An exceptionally stormy year:** with close to 725,000 cloud-to-ground lightning strikes and 296 days of storm, **France has not been struck by lightning in this way for at least 30 years.** The impacts on power system operation remained low: in 2018, power cut frequency was 0.42 cut/site excluding exceptional events. This result is below the 0.46 threshold set by the incentive regulation and below the average for the past ten years;

- Storm ELEANOR which hit the northern half of France on 2 and 3 January with winds gusting at around 140 kph on the coast and over 100 kph inland, without major impact on the grid, mainly due to the completion of the programme to secure the mechanical strength of the public transmission network (2 short power cuts and 1 long one);

- Sticking snow (Poitou Charentes) and freezing rain (North) causing a few localised power cuts;

- **The exceptional fire which destroyed the 63 kV substation at Harcourt** in the Paris region, mainly causing the power cut affecting Enedis customers and the power supply to trains serving Montparnasse railway station over a weekend of heavy rail traffic. This event required intensive work by RTE technicians to restore power supply within 3 days.

Equivalent outage time (EOT) in 2018 was 2mn 59s, excluding exceptional events. This result is slightly higher than the 2mn 48s target set by the CRE, the French Energy Regulatory Commission, as part of the incentive regulation on continuity of supply.

After the excellent results of 2017, the year 2018 was in line with the average for the past 10 years, marked firstly by difficult weather conditions and secondly by high impact incidents. The most significant incidents were the late July fire at the Harcourt 63 kV substation leading to a power cut in part of the south-west Paris distribution grid and the loss of power supply to

Montparnasse station at a time of heavy rail traffic. In November, equipment failure at the Baixas 63 kV substation led to a power cut in part of the Pyrénées-Orientales region with restoration of power supply taking up to 2 hours.

2.1 SUPPLY-DEMAND BALANCE AND FREQUENCY MANAGEMENT

MONITORING OF SUPPLY-DEMAND BALANCE MANAGEMENT

The 2018 long-term Adequacy Report , which aims to update the forecast for developments in the supply-demand balance over a five-year period, shows a **balanced, margin-free electricity system from the point of view of the power supply reliability criterion defined by the authorities,** with the excess capacities of the French power system now fully cleared.

In 2018, 56 margin shortfalls were recorded which triggered a safeguard order in real time (49 in 2017 and 26 in 2016): 52 upper and 4 lower margin (versus 43 and 6 in 2017).

These figures reflect the strains on availability that affected French and European power generation facilities throughout the year. They also recall the fact that, apart from generating electricity, initiatives aimed at encouraging people to reduce their energy consumption, in order to reduce peak demand, should be seen as a highly effective means of ensuring power system reliability and the successful transformation of the energy mix.

Besides the late winter cold spell and industrial action affecting power generation, **the range of available resources is shrinking:**

- Although the number of available balancing service providers is higher, the **power volumes offered for balancing are globally smaller.**

- **This decrease is partly due to the loss of balancing flexibility in the nuclear and hydroelectric sectors.**

There has been a spate of normally rarer occurrences such as primary reserve deficits and lack of margins available in 15 minutes.

Apart from these figures which have increased over three consecutive years, the breakdown in shortfalls occurring in 2018 changed, with a high incidence of upper margin shortfalls mid-year, particularly during the summer period. **The difficulty meeting margin requirements, normally experienced in winter, was spread over the whole year.**

In order to better manage these strains on the supply-demand balance and the imbalances occurring within the Balance Responsible Parties' respective remits, in 2018 RTE introduced a new standardised margin calculation of D-1 in real time, which is available for consultation by all operators. The 2h margin and changes in forecast imbalance among Balance Responsible Parties over the next five hours may be consulted in real time on the RTE customer website, at morning and evening peak times. This publication enables sharing of the result of the forward-looking balancing strategies employed by the various Balance Responsible Parties at these two key times of the day, i.e. the morning and evening peak times.

Against a backdrop of stable energy consumption, increasing use of renewable energies and reduced balancing flexibility among controllable generation facilities, special attention must be paid to these issues of margin and flexibility by developing arrangements that allow wind and solar power generation to be fully integrated into the balancing system.

ANALYSIS OF WINTER 2017-2018

The winter of 2017-2018 was marked by a late cold spell linked to the passage of a polar wind coming from Russia: on 28 February, RTE logged the **3rd highest consumption peak ever recorded in France** at 96.6 GW.

Generation contingencies and fluctuations in cross-border trading exerted stress on the supply-demand balance for 3 days in a row, from 27 February to 1 March.

This lasting strain on power system operation resulted in warning messages being sent systematically on D-1, followed in real time by graded alerts. Three level A SSEs were recorded for lack of upper margin availability in 15 minutes.

In an environment where consumption forecasting was made difficult due to the type of weather conditions encountered and major fluctuation in renewable energy generation, major imbalances between Balance Responsible Parties were observed: balancing volumes reaching 5,550 MW on 1 March and largely exceeding normally experienced contingencies used to dimension the operating reserves used in RTE's operating window, once market participants have in theory guaranteed balance in their commitment portfolio, were required in order to balance the system.

INTEGRATION OF DEMAND RESPONSE

Demand response, regardless of whether it concerns industrial consumption or aggregate consumption, is a source of flexibility that involves consumers voluntarily waiving or postponing some or all of their power consumption in response to a signal. Demand response can now be directly valued on market, balancing or reserve mechanisms, or can be valued by suppliers in their own portfolio (when demand response is related to a supply offer).

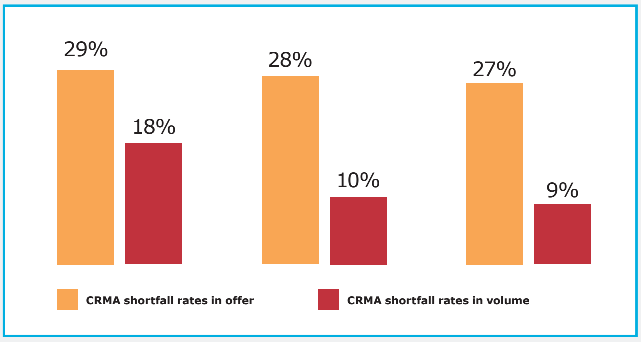
Demand response is now a further source of power, system services and flexibility for managing the supply-demand balance and frequency in addition to power generation. It supplements the options available to the transmission system operator for ensuring grid reliability.

1 March alone accounted for 6 GWh of demand response, which is a record for a single day. On 1 March, over 1 GW of demand response was sought from the Balancing Mechanism, a figure never reached before.

In 2018, the average volume of demand response offered in the Balancing Mechanism (BM) was 727 MW, close to the 2017 average. Total demand response volume was 22 GWh and was mainly recorded in winter, particularly during the late cold spell.

The milder start to the 2018/2019 winter explains the lower annual demand response requirement compared to 2017, when demand response volume was around 27 GWh.

The last three years have seen a gradual improvement in the reliability of demand response; nevertheless, this improvement must be continued over time and made more efficient.



CRMA shortfall rates in demand response offers

Indicators to measure demand response reliability in the Balancing Mechanism have been introduced. Within the framework of the Balancing Mechanism performance control procedure (CRMA), these two indicators, one tracking volume and the other tracking the number of bids activated, enable measurement of the shortfall rates of demand response offers following calls by RTE. These indicators are periodically presented to market participants at meetings of the committee of electricity transmission grid users (CURTE).

RTE has drawn up a "demand response reliability roadmap" aimed at continuing to develop the sector whilst improving RTE's visibility on the actual availability of these resources (obtaining approval, regulating redeclaration possibilities, etc.). It is designed to provide robust and regular monitoring of actual performance.

Progress expected will reinforce and capitalise on the growing role that this sector is playing in balancing the power system.

On the energy markets, the NEBEF (Demand Response Block Exchange Notification) mechanism allows users to value demand response directly on the market. To date, 23 companies have signed contracts with RTE to take part in this mechanism.

In 2018, the volume of demand response valued on markets remained low at 27 GWh, down compared to 2017 (39 GWh) due to changes in market conditions between these two years (2017 average market prices were double those in January 2018), but up compared to 2016 (11 GWh).

RAPID AND COMPLEMENTARY RESERVES

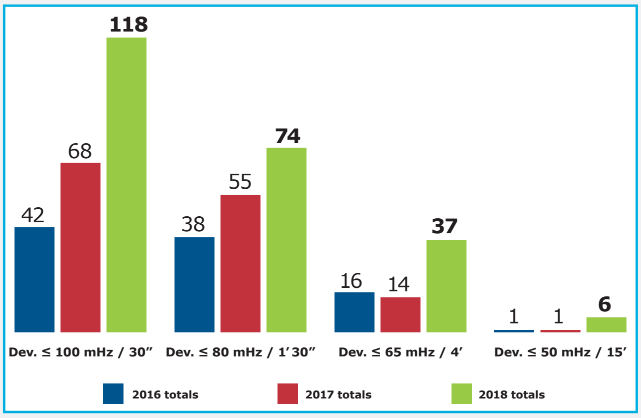
The call for tender for manuel frequency restoration and replacement reserves (mFFR-RR) launched in September 2017 covered the period from January-December 2018. During this period, RTE signed RR-RC contracts with nine balancing service providers in order to ensure 1,000 MW of manuel frequency restoration reserves (mFFR) that can be activated in less than 15 minutes, plus 500 MW of replacement reserves (RR) that can be activated in less than 30 minutes. **Contractually-agreed volumes now stand at 1,343 MW,** just over **half of which is supplied by demand response capacities.** The subscribed volume of complementary reserves is mainly supplied by conventional power generation.

ONGOING QUALITY ISSUE WITH EUROPEAN GRID FREQUENCY CONTROL

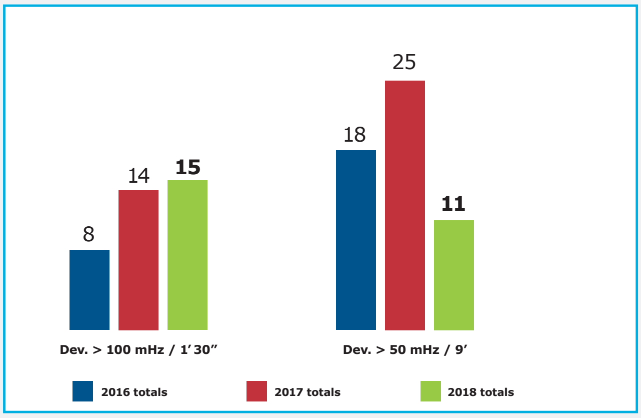
In 2018, 261 frequency deviations (deviation from normal operating ranges in terms of the depth/duration pairing) were recorded, compared to 177 in 2017 and 123 in 2016; **this figure has more than doubled in three years.**

This increase is solely due to frequency deviations related to one-off major imbalances between supply and demand in the Continental Europe power system. They occur during changes to schedules, which are synchronised on the hour and reflect transactions in market products.

While this phenomenon is known and understood, it has intensified during periods of load reduction over the last two years, at certain times in particular (8pm, 9pm and 10pm). Out of 261 deviations, 235 were downward variations, i.e. 90% of deviations recorded over the past year (compared to 78% in 2017 and 79% in 2016).



Total downward frequency deviations recorded



Total upward frequency deviations recorded

France contributed to these downward deviations in the same proportions as other equivalent European countries (load-frequency control blocks).

26 upward deviations were recorded during the year (39 in 2017, 26 in 2016).

The most significant frequency deviations for which France was mainly responsible were upward and night-time deviations.

The reason for this is that, against a backdrop of stable consumption, the rise of renewable energies and reduced flexibility in downward balancing of controllable generation facilities (nuclear and hydroelectric power plants), the power system increasingly faces difficulties balancing generation downwards over time constants of a few minutes (a cause of upward frequency deviation), especially during periods of low consumption.

This year also saw increased lack of availability of system services due to:

- intermittent compliance with secondary reserve stipulations during the day (ineffective financial incentive system) or strict and now margin-free compliance with stipulations requiring restoration of the volume of system services in the event of a contingency affecting one of the resources participating in this service;
- the reduced modulation capacity of nuclear power plants.

To meet these challenges, initiatives and discussions have been set up with stakeholders in France (CURTE, CRE, etc.) and at European level within the framework of ENTSO-E:

- **Certification of frequency containment reserve batteries** in 2018 (2 MW in 2018, with the prospect of around 100 MW in the short term);
- **Contractual incentives** incorporated into upcoming calls for tender **to provide products that can be activated at short notice for short periods** to cover changes in cross-border trading arrangements occurring on the hour;
- **Roadmap for the dimensioning of frequency reserves.**

As regards frequency system services, since 16 January 2017 RTE has provided for its **frequency containment** reserve needs via a weekly combined call for tender to TSOs in Belgium, Germany, Switzerland, Austria and the Netherlands.

In 2018, France imported an average of 24 MW of its total 536 MW requirement (**frequency containment** reserve exports averaged 49 MW for 33% of the time, while imports averaged 60 MW for 67% of the time).

At the end of 2018, certified power for consumption site frequency control stood at 106 MW (including 10 MW of **frequency containment** reserve cre-

ated by a multi-site reserve entity). This is potentially equal to around 20% of France's **frequency containment** reserve requirement.

The opening of frequency system services to new operators, technical developments in these services and the creation of market mechanisms appropriate for reserves are likely to provide new options for managing the supply-demand balance and stabilising frequency, while improving economic efficiency in conjunction with the various European projects undertaken in this area.

IMPLEMENTING THE EUROPEAN ELECTRICITY BALANCING CODE

The Electricity Balancing Code aims to establish a real-time cross-border supply-demand balancing mechanism in order to harmonise European practice, pool reserves and reduce costs. This will create **additional flexibility resources for the Balancing Mechanism at European level** as well as standardising shared supply-demand balance offers. Special attention will need to be paid to compatibility between the standard products and the flexibility currently offered by French power generation facilities.

RTE is involved in the three European projects aimed at establishing European platforms, namely TERRE (Trans-European Replacement Reserve Exchange) for managing replacement reserves by the end of 2019, MARI (Manually Activated Reserves Initiative) for managing manuel frequency restoration reserves and PICASSO (Platform for the International Coordination of the Automatic frequency restoration process and Stable System Operation) for managing automatic frequency restoration reserves by 2022.

2.2 VOLTAGE MANAGEMENT

THE LAST WINTERS DID NOT CAUSE ANY PARTICULAR DIFFICULTIES FOR LOW VOLTAGE MANAGEMENT

The west and north defence programmable controllers which are part of the grid voltage collapse defence plan were armed four times in 2018 for preventive purposes without their activation voltage thresholds being reached. Only one safeguard order was issued for low voltage during the year in the Albertville zone on 19 December 2018.

SPECIFIC ATTENTION IS STILL PAID TO HIGH VOLTAGE THRESHOLD OVERRUNS

The total number of upward voltage threshold overruns remains high.

400 kV overruns have decreased sharply due to improved management of control procedure voltages at nuclear power plants.

The number of 225 kV overruns has increased, although individual overruns are of low amplitude and duration.

These high voltages occur when consumption is low (night-time or weekend) and are related to three main factors:

- The extensive development of renewable energies in distribution grids, which reduces extractions from the transmission grid. The minimal extractions volume amounted to 25.5 GW in 2018 and has been decreasing steadily for several years;

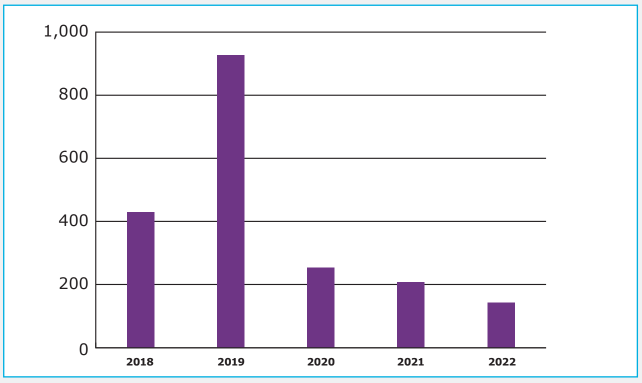
- Changes in the physical structure of transmission and distribution grids, which are increasingly installed underground and therefore generate more reactive power;

- Lastly, changes in the technical nature of consumption leading to a decrease in the consumption of reactive power.

As far as reliability is concerned, high voltage has less short-term impact than low voltage (risk of grid collapse). However, it can adversely affect equipment lifetime and cause degradation that impacts the quality of the electricity.

RTE implements major compensation measures to reduce high voltage: in 2018 a further 450 Mvar of inductors were installed. New investments in compensation measures are also scheduled for the coming years.

Resources for controlling high voltage include conventional and renewable energy generation facilities connected to both transmission and distribution grids. The



Inductor projects (in Mvar excl. connection of marine wind farms) by year of commissioning current state of technology of all this machinery enables voltage to be regulated.

The tests conducted with Enedis on the use of power generation connected to the distribution grid to reduce high voltage continued:

- Further to the tests conducted in Hauts-de-France in 2017, creation of a map of potential resources per electricity generator;

- Completion of Vendée tests in 2018 showing the possibility of combining the use of an advanced reactive power management function on the distribution grid (capacitors and generation) depending on RTE requirements.

The audit conducted on high voltage management in 2018 led to a review of the management method and operational process (including anticipation).

Initiatives have also been undertaken to estimate the impacts of overruns on equipment and to assess developments in reactive power drawn from the transmission grid.

Furthermore, changes in the Reference Technical Documentation (DTR) led to the introduction of a pricing schedule more appropriate to the interface between distribution and transmission grids in terms of managing high voltages.

The challenges raised by changes in the rules governing voltage system services now relate to participation in voltage control of new resources: wind and solar farms connected to the transmission or distribution grid, consumer sites and batteries. In mid-2018 RTE submitted a report to CRE on the optimisation of voltage control.

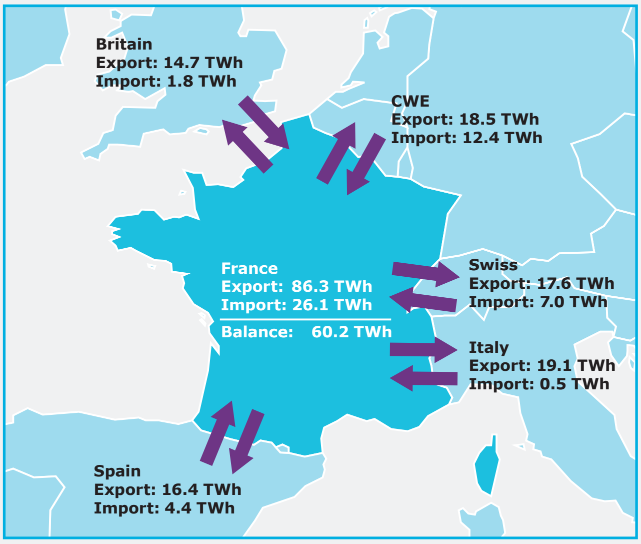
To date, only one renewable energy facility has contracted with RTE for voltage control, due to the lack of incentives to maintain control capacities in these facilities over the long term. **The use of the control potential will be addressed as part of the consultation launched by RTE, with the support of CRE, on the development of voltage system services.** This work will be conducted in 2019.

In parallel with the consultation conducted with generators and builders, RTE has initiated an action plan to optimise contribution to voltage control by industrial operators (requests to the latter for the management of high voltage constraints in summer). Feedback on this initiative is scheduled for the end of 2019.

Lastly, the process of reducing nuclear plant reactive capacity limitations, which may be detrimental to controlling high and low voltage, stalled in 2018 after a marked improvement in 2017. Indeed, a number of limitations reported in late 2018 prevented the 2018 reactive power supply target from being reached (the absorption target was met leading to a beneficial impact on high voltage).

2.3 INTERCONNECTIONS AND CROSS-ZONE FLOWS

INTERCONNECTIONS: TRADING POSTS THAT ILLUSTRATE THE INTEGRATION OF RENEWABLE ENERGIES IN EUROPE, THE POOLING AND OPTIMISATION SOLUTIONS MADE POSSIBLE BY THE DEVELOPMENT OF INTERCONNECTIONS AND THE UNIFORM MARKET MECHANISMS DEVELOPED AT EUROPEAN LEVEL OVER THE PAST DECADE, NOT TO MENTION EUROPEAN SOLIDARITY



Balance of contractual exchanges in 2018

In terms of the trade balance, France is a net exporter at 60.2 TWh in 2018, up compared to the two previous years.

In 2018 France was the biggest electricity exporter in Europe. The increase in exports is due to French price levels and the combined efforts of TSOs to maximise cross-border capacities while maintaining reliability. Trade remained highly volatile throughout the year, with the balance varying from net imports of 10 GW at 8am on 28 February to net exports of 16 GW at 3am on 22 January. These fluctuations illustrate how the different interconnections support European solidarity and optimisation.

Exports were particularly significant in May and June, reaching historically high net amounts of 2.64 TWh then 2.56 TWh. On the other hand, France is a net importer in winter months, when its needs are higher, particularly during cold spells, as it is more temperature-sensitive than its neighbours.

Trading capacity at interconnections is a real advantage for successful energy transition and the integration of renewable energies.

CROSS-ZONE AND FREQUENCY OSCILLATION

While frequency oscillation can be seen following a malfunction in a single generating unit, cross-zone oscillations or modes are more complex electromechanical events between two or more parts of the European power system oscillating antiphase and causing active power oscillations, in particular on interconnection lines, presenting real risks to reliability in Europe if they approach frequency consisting in modes specific to the European power system.

This occurred again on 29 October 2018, with significant cross-zone oscillations lasting 6 minutes, during a particular operational situation between the Iberian Peninsula and France (one interconnection line under maintenance and high imports from Spain).

Other than the change in operational parameters of the direct current link between France and Spain under certain conditions, RTE is currently working on a monitoring and forecasting tool (identification of risky situations) for power system oscillation modes.

An ENTSO-E working group is also developing a detailed model of the dynamic behaviour of the European power system and specific analytical methods for these occurrences.

2.4 SHORT-CIRCUITS AFFECTING TRANSMISSION STRUCTURES

The number of short-circuits (8,968) affecting transmission structures increased for the first time since 2014. This increase is due to the increase in the number of lightning strikes, which has doubled since 2016: 2018 was the year most heavily struck by lightning since 2004.

The improvements made to lightning protection on our structures over several years have limited the impact.

Since 2015, encouraging results concerning cases of sparking with vegetation highlight the effectiveness of the maintenance actions: this trend was confirmed in 2018 with 0.4% of short-circuits due to sparking with vegetation (0.5% last year).

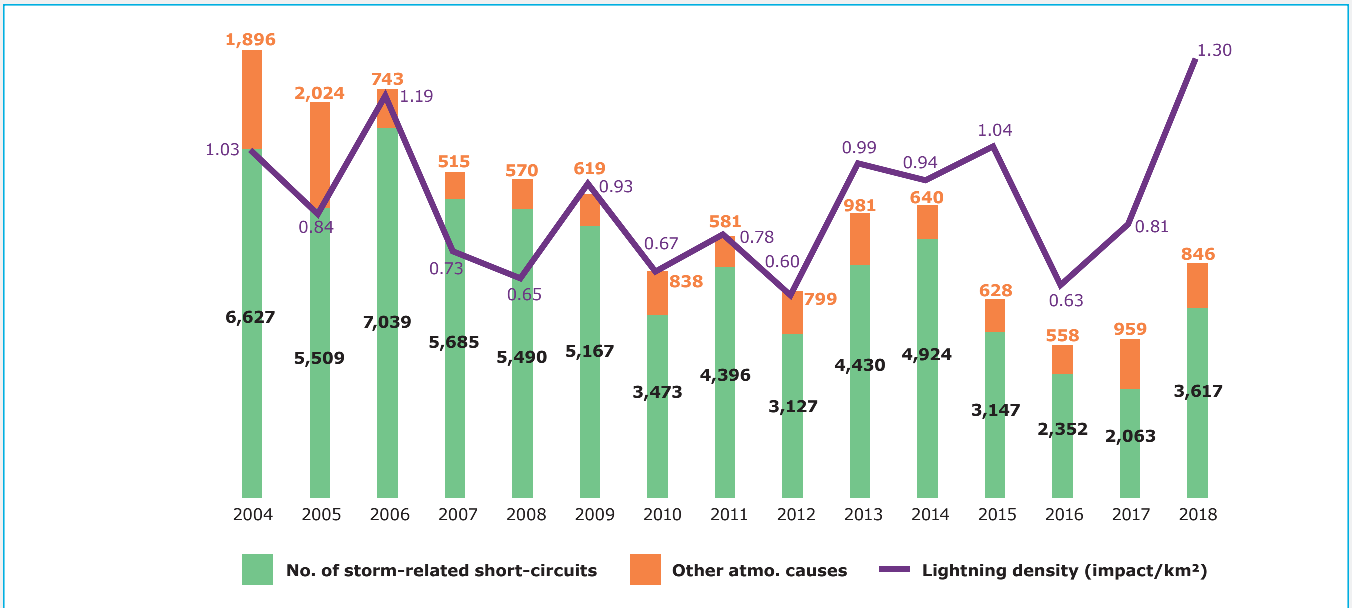
In terms of reliability, the analysis needs to focus on the contingencies leading to the shutdown of two paral-

lel 400 kV lines. This type of incident is liable to cause major disruption: in 2018, 11 fleeting faults (fault eliminated in less than 1 second) occurred without definitive shutdown.

To accelerate return to service in the event of defective infrastructure following a definitive shutdown caused by a short-circuit, RTE undertook the automatic fault finding (LAD) project. The aim of the project is to return sound infrastructure to service as quickly as possible, avoiding the need for on-site inspection, and to speed up the inspection of the power line via precise location of defective infrastructure.

Following the launch of the service for RTE users in 2016, around 600 power lines were monitored using the LAD tool by 2018 year-end.

In 2018, a test was launched to facilitate use of the incident management method (MDLD - fault-finding method): the system, called RUBICUB, provides a shared digital incident management interface to facilitate access to information. It is due to be deployed in 2019 across all RTE operating units with an extension to customers for the monitoring of incident resolution.



Trends in storm and other atmospheric causes of short-circuits and lightning density

3

RESTORATION OF POWER TO THE GRID FOLLOWING A GENERAL POWER CUT

Successful house load operationof nuclear power plants in the event of a widespread incident is important for nuclear safety and is vital for reinstating the grid and restoring power supply to customers as soon as possible.

In 2018, 12 house load operationwere performed on nuclear power plants, with a 100% success rate (93% in 2017, 92% in 2016 and 77% in 2015). The success rate was 91% over a four-year rolling period, which is highly satisfactory compared to the 60% long-term target.

Regarding scenarios of voltage recovery by nuclear power plant auxiliary systems via the grid, their operational status is checked periodically in terms of the physical behaviour of equipment and operator training in setting up these lines.

While the rate of completion of simulator trials of voltage recovery scenarios is very good, 2018 saw a decrease in the number of actual trials completed, beyond RTE's control, due to the postponement of five of the eleven scheduled trials by EDF, and a further increase in non-availability of these scenarios (five out of a total of 58 scenarios will be declassified in 2019 due to lack of trials).

4

INTEGRATION OF RENEWABLE ENERGIES AND USE OF FLEXIBILITY CAPACITY

In connection with the introduction of the additional remuneration system for renewable energy generators no longer subject to the purchase obligation, **RTE is testing renewable energy capacity to modulate quickly downwards** during consumption low points or lower margin shortfalls. An initial test with this system in relation to the Balancing Mechanism was conducted in February 2019.

In view of the development of decentralised power generation, **information-sharing and clear mutual understanding of requirements are becoming essential for managing the future operation of the transmission and distribution grids** and relations at interfaces between all stakeholders, including renewable energy generators.

RTE continued the work undertaken with several distributors. This work covers the sharing of operating data, the management of programmable controllers and voltage management at interface, by aligning with European code requirements (in particular those concerning the observability and forecasting of decentralised generation and consumption).

The information system developments required for data exchange between RTE and Enedis were carried out in 2018 in order to establish an infrastructure for the real-time exchange of forecast data (between SCADAs).

Extensive work was also carried out in 2018 by RTE in cooperation with DSOs in order to clarify and formalise the contractual framework governing access to flexibilities connected to distribution grids in MV voltage by RTE programmable controllers, in order to deal with constraints affecting the transmission grid. RTE is currently testing new programmable controller solutions for peak-shaving decentralised generation developed with Enedis, as well as the contractual framework.

The purpose of the Ampacité and Ampacité 2 projects, which have become the DLR (Dynamic Line Rating) Project, is to test a more flexible type of operation, by adjusting transmission capacities in real time, depending on external conditions measured (temperature, wind, sunshine) so as to free up additional margins and optimise the countermeasures available. These measures, which ensure optimised use of the structures to the best of their physical characteristics, help facilitate incorporation of electricity generated by wind turbines.

Experiments conducted in the different projects have tested the solution of one supplier. This solution was incorporated into real-time operation from the grid development decision-making test phase.

Lastly, the NAZA project (new adaptive zone programmable controllers) is designed to provide new technical solutions enabling coordinated exploitation of flexibilities connected in MV and HV voltage (modulation of generation, interfacing with DLR and Ringo batteries, etc.). The first version of a zone programmable controller lead product is expected to be commissioned in summer 2019 in western France to manage the complex operational constraints arising from the increasing role played by renewable energies.

5

MATERIAL COMPONENTS OF RELIABILITY

5.1 GRID PROTECTION EQUIPMENT

In the 400 kV grid, 419 short-circuits were eliminated in 2017 (473 in 2017), including 352 single-phase faults. The response rate, in keeping with the deployment of protection devices and programmable controllers in the event of electrical faults on the 400 kV grid, is in compliance with the rules with a compliance rate slightly above 98%. Furthermore, good results on the 225 kV grid, a key requirement for grid stability, also contribute to a high level of reliability.

The 400 kV differential busbar protection devices, which play a major role in fast and selective elimination of busbar faults which, although very rare, represent a high risk for reliability, gave rise to 16 SSEs (10 in 2017), while their availability rate of 99.2% remained stable compared to 2017.

Protection devices involving ring openingin case of loss of synchronism (DRS) are part of the defence plan and play an essential role in isolating grid zones that have lost synchronism from other zones which are still intact and thus prevent spread in the event of a major incident. Although infrequently deployed, they need to be able to respond reliably if required. In 2018, there was only one operation of the loss-of-synchronism protection device. Analysis showed that it worked properly following a frequency disruption due to the shutdown of a nearby structure.

5.2 CONTROL ROOM TOOLS

CONTROL SYSTEMS

In 2018, two cases of unplanned unavailability with shutdown of transmission at automatic load-frequency control level for 26 minutes and 8 minutes respectively affected the National Control System (SNC).

The number of SSEs increased in the case of Regional Control Systems SRC (SCADA: 1 level B SSE, 4 level A SSEs and 5 level 0 SSEs (versus 20 level 0 SSEs in 2017, 16 level 0 SSEs in 2016 and 11 level 0 and 3 level A SSEs in 2015).

Major events prompted the implementation of special action plans (resistance to fibre optic network breakdown, software upgrades, etc.).

RTE launched the STANWAY project to deal with **ageing of programmable logic controllers (PLC)** currently in use in order to procure a unique PLC system based on the market Supervisory Control and Data Acquisition (SCADA) System. The project aims to **replace the SRCs and SNC with a single solution. The commissioning of the new tool is scheduled in 2021 for the eight RTE control rooms.**

The regional inter-dispatching support system (SIDRE) has been operational since June 2015 in the three cross-zone bubbles. Skills upkeep is mainly based on monthly changeover testing (partial or total). In 2018, the SIDRE was used 25 times, hence ensuring the observability and operation of the grid during control system incidents.

OTHER POWER SYSTEM CONTROL ROOM TOOLS

The SAS Alert and Safeguard System is a key tool for managing high-risk or degraded conditions during which availability and reliability need to be excellent.

In 2018, **80 level 0 SSEs and 13 level A SSEs were recorded** (39 level 0 SSEs and 3 level A SSEs in 2017). **The high number of SSEs** is not symptomatic of tool malfunction but is **mainly due to messages not being acknowledged,** mainly by generators and distributors, during periodic testing within the context of real critical situation orders for insufficient margins transmitted by RTE. A reminder was issued to all participants to ensure response in keeping with expectations in high-risk or degraded conditions requiring deployment of the Alert and Safeguard System (SAS).

The Convergence grid test platform is the reference tool used by all RTE operators to conduct electrotechnical research to prepare for operation in real time.. This application is also used by CORESO. The overall availability of the Convergence platform was 99.68%, in line with expectations for the year 2018.

However, following several significant incidents, a number of projects have been undertaken to:

- render application redundancy more reliable and fine-tune the Business Recovery and Continuity Plans;

- improve assessments of the impact on risky operations.

The IPES system (incorporation of intermittent renewable energy production into the power system) is used for short-term real-time research on D+1 and for control. The system provides estimates of actual wind and solar power generation and forecast generation, at local, regional or national level, over an adjustable period ranging from D-4 to D+2.

As at the end of 2018, **total renewable energy output measured remotely by IPES amounted to 78% of the wind power base and 25% of the solar power base installed in France.** The percentage of remotely measured solar power generation needs to be increased over the coming years, given the pace of development in this sector, in order to increase the reliability of local generation forecasts in order to anticipate grid conditions.

In order to tackle the growing volume of data, at the end of 2018 RTE launched a revamp of the IPES tool with commissioning scheduled for early 2020.

5.3 SECURITY TELECOMMUNICATIONS NETWORKS AND INFORMATION SYSTEM

Operational reliability of the power system is closely linked to the proper functioning of security telecommunications networks and tothe information system, including its ability to withstand cyber attacks.

The year 2018 was marked by the setting up of RTE's new telecommunication network infrastructure: HORUS. It will host the STANWAY application in two data centres and create the related telecom network between the Operations Centres and these data centres.

The ROSE Optical Security Network, an infrastructure owned and operated by RTE, is distributed over approximately 22,000 km of optical cables and provides telecommunication services which contribute to system reliability: high-level remote operation, information exchange between electrical fault protection systems and safety telephones.

In 2018, there were two level B SSEs and two level A SSEs (no SSEs in 2017 and two in 2016). One of the two level B SSEs was due to the failure of fibre optic equipment on 14 December leading to the loss of the SNC and several SRCs for several hours, while the second was due to the breakdown of an optic link during works.

In 2018, operation of the Safety Telephone System (STS) was affected by two level A SSEs (none in 2017 and one in 2016) and 26 level 0 SSEs (13 in 2017, nine in 2016). One of the level A SSEs was due to a breakdown at a distributor, while the other was due to unavailability caused by the relocation of the Lyon dispatching centre. Of the level 0 SSEs, 15 were due to generator or distributor failures or works which have been discussed with the relevant parties, while 11 concerned unplanned unavailability of safety telephones.

RTE IT system security is pivotal to the operational reliability of the power system. This applies in particular to the industrial IT system as well as to the way in which information is shared with customers, market participants and partners.

In 2018, RTE's Operational Security Centre (COrS'R) tackled over 10,000 attacks every month, prevented 3.3 million spam emails and eradicated 200 viruses on RTE's IT system.

Furthermore, user awareness drives for the protection of the information system are implemented on a regular basis. New in-house training programmes on information system security have been put in place.

In 2018, several audits of RTE's information system security were carried out to assess the level of prevention in the face of cyber attack threats and to ensure the continuity of critical activities. Organisational and operational recommendations were issued on the basis of these audits.

RTE also actively contributed to work on the cyber security of European organisations such as ENTSO-E.

6

HUMAN AND ORGANISATIONAL CONTRIBUTIONS TO GRID RELIABILITY

IMPROVED PERFORMANCE THROUGH PROFESSIONALISM (APGP)

The "improved performance through professionalism" (APGP) initiative involves recording and sharing human factor deviations, regardless of whether they impact industrial safety in the broadest sense of the term, in order to collectively improve performance.

In 2018, 940 human factor related events were reported (962 in 2017), including 800 in operation (761 in 2017), which demonstrates the impetus in this field over the past few years.

As part of the Industrial Safety Culture programme at RTE, human and organisational factors are identified as one of the pillars of performance. Work is underway to unify event-related and safety feedback processes, including identification of adverse emergent trends (human factor and risky situations), with a view to sharing analytical methods and tools concerning work accidents or human errors.

CONTINUOUS ADAPTATION OF TRAINING AND SKILLS UPKEEP

In addition to the annual training programme for operator skills upkeep, including simulation of rare circumstances (in particular the resumption of service after an incident), the large number of projects and policy changes required special training in operational and maintenance tasks.

The training programmes are regularly modified in line with changes to the methods and tools used for preparation, research or grid operation.

Distance training tests between operations centres were launched in early 2018 based on a revamp aimed at integrating new learning methods (e-learning, tutorials, video training, etc.).

RTE's training teams are paying special attention to the forthcoming STANWAY project, in particular as regards the training simulator.

7

BEYOND RTE, TOWARDS RELIABILITY IN EUROPE

The power transmission system is a European system. The 43 TSOs operating in 36 countries are now linked by around 420 interconnections, around 50 of which cross the French border. Therefore, the reliability of the French system depends on the operation of the European power system.

The European grid codes set out the main rules applicable to all players with regard to interconnected grid operation. **All the codes have been published and are now applicable.**

Other than operational implementation, the main issues over the period of **effective implementation of all the codes in 2021/2022** will be:

- finalisation of the broad options on sharing of balancing offers and development of the corresponding platforms, as well as adaptation to French market participants and the CRE;

- definition of the methods of analysis of regional safety, in particular countertrading and redispatching aspects and sharing of the related costs for the four regions of concern to RTE;

- transition to a common grid model for all data exchange with other TSOs and with the regional coordination centres.

EUROPEAN COOPERATION

Highlights of 2018 include the fact that CORESO continued to deploy the five services to TSOs in anticipation of certain grid code requirements: establishment of common grid models, calculation of regional trading capacities, analysis of regional safety with transnational corrective actions, assessment of short-term supply-demand balance reliability, coordination of isolations and coordination of operations.

HIGHLIGHTS OF 2018 IN TERMS OF R&D AND MAJOR EUROPEAN RELIABILITY-RELATED PROJECTS ARE AS FOLLOWS:

Migrate and OSMOSE projects: The aim of these projects is to develop and approve innovative technological solutions for the grid to manage the European power system, in which power electronics are being increasingly used (integrated into renewable energy generation and storage facilities), and to analyse the impact of the growing penetration of power electronics on power system stability.

ODYSSEY project: The aim of this project is to develop an interactive database common to a synchronous zone in order to ensure the stability of the European system while sharing a single interpretation with an interactive reference simulation tool.

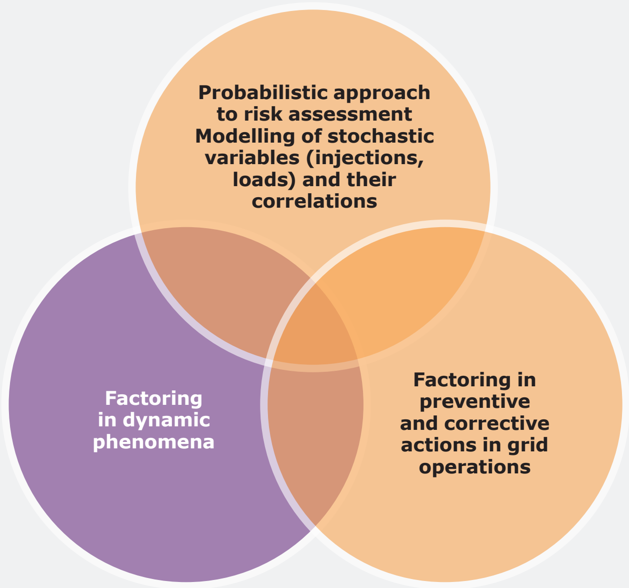
BESTPATHS project: Development of the instrumentation and control interoperability test platform for the AC-DC conversion station on a DC grid with multi-terminals. The purpose of the European BestPaths project was to pave the way for Supergrids. The project was completed in 2018.

Let's Coordinate: The "Let's Coordinate" industrial project uses the building blocks developed through R&D work on the future management tool (Apogée) and on the simulation platforms for grid analyses (iTesla project). The project aims to offer an open concept and a tool for sharing structured information between all TSOs and regional coordination centres as part of European regional coordination.

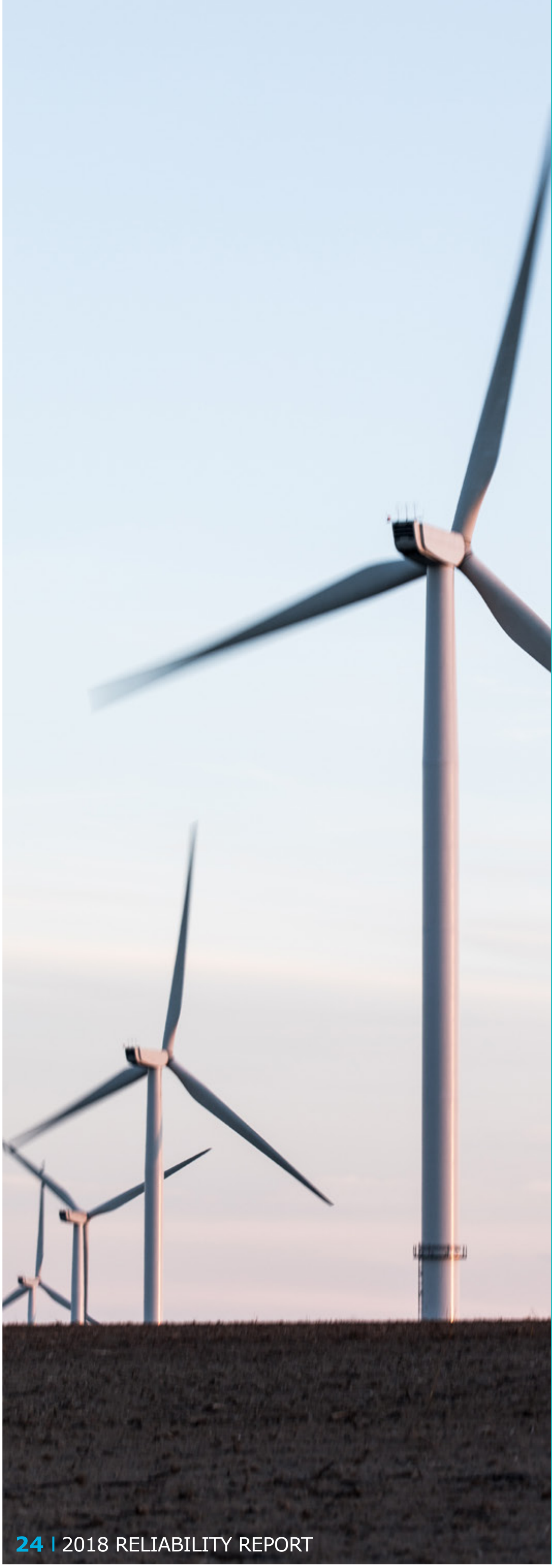
GARPUR project: The European GARPUR project completed in 2017 aimed to propose methods of assessing risk of occurrence and the consequences of grid failure in order to support decision-making during operation and in terms of investment. It currently supports projects such as SEA (reliability during operation), Imagrid (research tools for grid development) and MONA (support tools for asset management strategies).

New generation substation: The purpose of this project is to use demonstrators to redesign functional substation architecture in response to new power system requirements. It incorporates in its design environmental targets and technological solutions envisaged over the coming decades. In 2017, the basic functions of the Blocaux substation were started up. A new version integrating the feedback from two years of operation will be put in place in September 2019, also incorporating the RTE data model and finalising monitoring functions.

Operating tools for round-the-clock control rooms: The Apogée project (forward planning of the operator station for advanced management of the electricity system) was related to a hypervision environment for operating the power system and automating certain tasks; iTesla foreshadowed the next generation of grid security analysis platforms, which use a probabilistic approach to analysing the risks incurred during operation, by factoring in possibilities for countermeasures and dynamic phenomena.



The Apogée and iTesla projects merged into a unique project aimed at developing tools and methods to help operators take decisions on D-1 in real time. In 2018, the **SEA (forward reliability) project** led to the start of industrialisation of the experimental work conducted by the Apogée project. Part of the advances have been made public as part of RTE's Open Source strategy aimed at capitalising on these building blocks, creating a community and ensuring its promotion and dissemination.



CLEAN ENERGY

On 30 November 2016, the European Commission unveiled a package of legislative measures, collectively known as "Clean energy for all Europeans". Its aim is to adapt the European framework to the fundamentals of energy transition and to detail the aims of the 2030 energy-climate package adopted by the European Council in October 2014. The "Clean energy for all Europeans" package constitutes a major revision of power grid operating principles and electricity market operation.

This in-depth reform of power system operating principles and the operation of the electricity market has a direct impact on the activity of TSOs. As such, it entails major challenges for RTE in terms of guaranteeing the reliability of the French and European power systems.

Negotiations initially focused on renewable energies. The texts of the "energy-climate" part were adopted in the first half of 2018, under the Bulgarian chairmanship, and published in the Official Journal of the European Union at the end of 2018.

The "energy-climate" part of the package sets the following targets for 2030:
- **32% renewable energies in Europe's energy consumption with a series of measures to support the development of self-consumption;**
- **32.5% energy efficiency improvement.**

It also provides for the development of national "Energy-Climate Plans" by Member States as from 2021. In France, the Long-term Energy Programme (PPE, Programmation Pluriannuelle de l'Energie) will be one of the key components of the Energy-Climate Plan.

Furthermore, the European Commission has set a target of 15% interconnection by 2030, only if the cost-benefit analysis is positive for the community. A new interconnection investment will therefore only be decided under regulator supervision if its cost-benefit analysis is positive for the community.

As regards the "internal energy market", the European Union reached a political agreement on the final provisions on 19 December 2018.

Following this decisive step for the European power system as a whole, these provisions are now final: they were approved on 25 March 2019 by the European Parliament and must be formally adopted by Member

FOR ALL EUROPEANS

States at the next Council meeting, before being published in the Official Journal of the European Union.

It is the "internal market" part of the text that will impact RTE's business and that of its counterparts, involving major and sometimes highly technical challenges. The following provisions are of particular interest to RTE:

• Revision of the directive on common rules for the internal electricity market;

• Revision of the regulation on the internal energy market;

• Revision of the regulation setting up a European cooperation agency consisting of energy regulators;

• The "risk preparedness" regulation.

Regarding regional cooperation, regional cooperation centres (RCC) must be set up in each operating region at least as large as the capacity calculation regions. In the Central Western Europe (CWE) region to which RTE is attached, the possibility of having two regional cooperation centres is maintained, but with some operating constraints. The list of tasks to be carried out by the centres is long, but only coordinated capacity calculation and regional safety analysis would be binding. **In this context, CORESO's duties will change so as to enhance its expertise in market or development related activities.**

As regards balancing studies, national studies (such as the long-term adequacy report for France) and European studies will have to follow a common methodology (to be developed by ENTSO-E) to reach a European forward estimate complementary to the French long-term adequacy report.

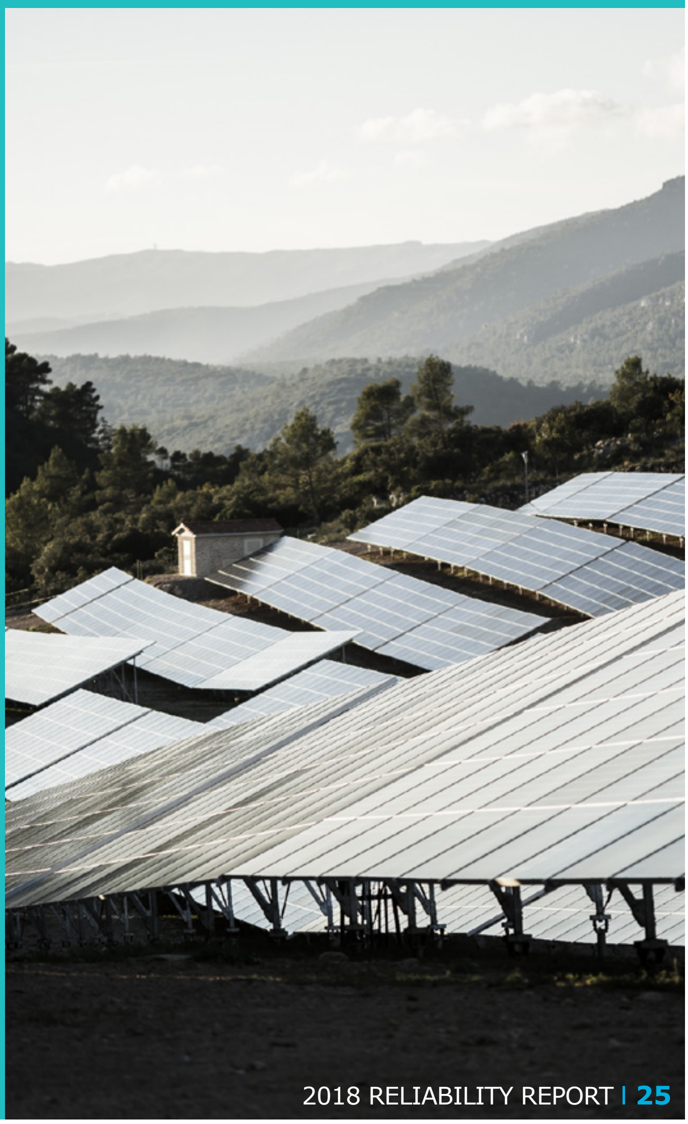
Member States will maintain the option to introduce **capacity mechanisms** if their national study shows an imbalance, but only as a last resort and in parallel with an action plan by the European Commission to remove any distortions in the energy market. The mechanisms will be temporary and must be approved by the European Commission.

Regarding capacity calculation at borders, a minimum threshold of 70% of interconnection thermal capacity will be imposed in respect of the share of capacity put on the market by the TSOs. However, the calculation methods lack clarity and need to be further fine-tuned in order to ensure sustainable power system reliability.

The creation of an association of DSOs in Europe, as provided for in the text, will also allow us to work with distributors at European level.

Once it has been published in the EU Official Journal, the regulation will be immediately applicable and the directive will have to be transposed into national law for each Member State by 31 December 2020.

RTE will remain actively involved to support the transposition of the texts into French law by seeing that the solutions are compatible with our TSO model and power system reliability requirements.



8

RELIABILITY AUDITS AND INTERNAL CONTROL

As part of RTE's **internal control system,** management of operations (and therefore reliability) is assessed on an annual basis in light of the risks identified and placed in order of priority, measures implemented and their effectiveness. **Internal controls conducted in 2018 showed a satisfactory level of reliability management,** while areas of improvement were identified in some cases.

In the same context, specific reliability audits were conducted on behalf of senior management. The topics targeted by the audits are designed to ensure that all major reliability aspects are covered over a period of 2 to 3 years. In particular, risks flagged up by operating experience from the past year are monitored. Audit findings are presented to the RTE Executive Committee. Recommendations are made to improve risk management. The initiatives undertaken based on these recommendations are covered by an action plan, progress with which is monitored by the Audit and Risk Division. An annual report is submitted to the RTE Executive Committee and to the Economic Monitoring and Audit Committee (CSEA).

Three reliability audits were conducted in 2018 on the following topics:

- Risk management method, voltage and stability.
- Emergency response arrangements: information system loss affecting supply-demand balance.
- Grid restoration plan following a widespread incident.

The audits found that the operation of the power system so as to ensure reliability was broadly satisfactory.

9

OUTLOOK

The key watchpoints identified in this report entail the need, over the coming years, to continue and bolster initiatives already implemented.

This mainly involves:

- contributing towards significant improvements in the quality of European frequency control and stopping the degradation that has affected the European system over the last few years;

- continuing to improve high voltage management operational processes during operation by capitalising on opportunities, including those provided by self-distributed generation resources;

- evaluating the effectiveness of contractor maintenance and renovation operations in order to minimise malfunctions on sensitive equipment in terms of reliability (differential busbar protection devices, high-voltage components, etc.);

- continuing to improve research methods and tools by factoring in changes in context and increased uncertainty.

TOGETHER WITH ITS PARTNERS:

- consolidating and adapting tools used to manage supply-demand balance to ensure that they fulfil future requirements;

- broadening the range of market participants in order to increase economic efficiency and flexibility in managing short-term supply-demand balance (demand response, peak-shaving, modulation, etc.);

- adapting the contractual framework to the needs of voltage and frequency system services now and in the future (dimensioning of reserves, system services for renewable energies, taking storage considerations into account, etc.);

- developing interactions between transmission and distribution system operators (voltage control at interface, programmable controllers, data exchange, works planning, etc.).

AND MORE SPECIFICALLY IN EUROPE:

- understanding, controlling and improving the forecasting of frequency deviations;

- supporting the application of the European grid codes in our tools and methods, in particular the Electricity Balancing Code, which represents risks as well as opportunities for the balancing of the European and French power systems;

- stepping up cooperation with system operators and Regional Service Centres (RSC) and contributing to the emergence of future Regional coordination Centres (RCC) and the expansion of CORESO's remit;

- actively contributing to the implementation of the "Clean energy for all Europeans" legislative package whilst seeking to ensure the operational reliability of the power system, particularly with regard to the dimensioning of trading capacities at borders.

APPENDIX 1: GLOSSARY OF TERMS

Term	Definition
Operational reliability of the power system	System reliability is defined as the ability to: • ensure normal operation of the power system; • limit the number of incidents and prevent major incidents; • minimise the consequences of major incidents when they do occur. Ensuring reliability is one of the key responsibilities entrusted by the law of 10 February 2000 to RTE in its capacity as the French Transmission System Operator.
Operating margins and reliability rules	The reliability rules stipulate: • a minimum margin of more than 1,500 MW that can be deployed in under 15 minutes. This figure is dimensioned so that the loss of the largest connected generation unit can be compensated for at any time; • a minimum margin at the furthest deadline, the required volume of which increases from a 15-minute timescale to one of several hours. If these conditions are not fulfilled, depending on the circumstances, RTE issues an alert message on the Balancing Mechanism or an S order for a critical situation.
Balancing Mechanism (BM)	Under French law, generators must provide RTE with technically available power for balancing supply and demand. This is carried out via the Balancing Mechanism, whereby RTE pools all resources available from operators in the form of a continuous and open mechanism, and whereby operators can value their demand response capacity or their generation flexibility. Based on price-volume proposals, RTE makes the necessary balancing adjustments by classifying proposals on the basis of their price until its needs are met. Provisions are made for cases of shortages: • for a timeframe of over 8h, RTE requests additional proposals via an alert message; • for less than 8h, RTE uses a "degraded mode" message to secure exceptional proposals, besides any additional proposals, and resources not offered for the balancing process.
Primary and secondary frequency control	Primary control is for automatically ensuring that balance is restored virtually immediately after any contingencies affecting balance between generation and consumption, by all of the partners involved in synchronous secondary interconnection working together as one. Rules are laid down by the ENTSO-E's regional "continental Europe" group so that this action then maintains the frequency within defined limits. Thereafter, secondary control of the partner behind the disruption automatically cancels the residual frequency deviation relative to the reference frequency, as well as deviations from the scheduled cross-border trade between the various control zones.
ENTSO-E	ENTSO-E (European Network of Transmission System Operators for Electricity), created at the end of 2008, has been the sole association of European TSOs since 1st July 2009. The role of ENTSO-E is to strengthen cooperation among TSOs in key areas such as the development of grid codes relating to technical aspects and market operation, coordination of operation and development of the European transmission grid and research activities. In accordance with its articles of incorporation, the association's main decisions are taken by the General Meeting. An Executive Board is responsible for overall management and for establishing strategic guidelines. The operational work is carried out by four main committees and their sub-structures, the Markets Committee (MC), the System Development Committee (SDC), the System Operation Committee (SOC) and the Research and Development Committee (RDC), along with a legal analysis group. To ensure the technical coordination of synchronous interconnected TSOs in continental Europe and the assessment of reliability commitments, as defined in 8 policies and agreed upon under the Multi-Lateral Agreement signed by the members of the former association, UCTE, the SOC has created an ad-hoc sub-group, the Regional Group Continental Europe (RGCE). See: www.entsoe.eu

Term	Definition
Security telecom-munications networks	This security network is based on a dedicated telecommunications infrastructure, mostly owned and operated by RTE, which carries all information (voice, data) necessary for remote operation. These systems take care of the following functions: • transmission ("low level") of remote operation data of all remote substations and of a limited number of telephone conversations between main transmission grid substations and area transmission substation groups; • transmission ("high level") of remote operation data and telephone conversations between area transmission substation groups and dispatching centres; • transmission of remote operation data and telephone conversations between generation plants and dispatching centres; • transmission of remote operation data and telephone conversations between distribution grid operations centres and dispatching centres.
Significant System Events (SSEs)	Pre-established criteria are used for detecting events from which lessons can be learned for power system reliability. They are grouped together in the SSE classification grid. The grid is used for classifying events based on their precise level of importance in terms of reliability, by placing them on a severity scale with seven levels. Level 0 is assigned to events which have the lowest consequences for reliability, but which should be recorded nonetheless. Levels A to F are assigned to incidents of growing severity up to widespread nationwide incident. The method used to classify incidents involves assessing combined severity based on two types of input: • one input records the occurrence of concrete elementary events that affect an operational function in a certain number of areas (transmission grid, generation, system operation, control resources and distribution); • the second input shows the extent to which the event has a damaging impact on system operation.
Performance controls on generation facilities	Given the criticality of services rendered by generation facilities when connected to the transmission grid, they can be subject to performance controls. This control, which is performed with a view to limiting the extra amount of work or expenditure for users and RTE, is designed to maintain system reliability and transmission grid operating conditions for all those concerned. The intended principle is that performance should be controlled at the facility's delivery point, where such a control is sufficient to ensure performance compliance. Controls serve to assess the behaviour of generation units towards primary and secondary load frequency controls (static gain, scheduled reserves, response time, etc.) and towards primary and secondary voltage controls (availability of the contractual field in the U/Q diagram, response dynamics).
Emergency response arrangements	The ORTEC (RTE emergency response arrangements) system was set up in the wake of the storms at the end of December 1999. It lays out the measures to be taken and the organisational structure to be set up at both national and regional levels when a serious emergency is declared by RTE. In addition to sourcing the necessary human resources and technical expertise, it specifies implementation of communication initiatives for emergency response management. In concrete terms, emergency response teams can be rapidly deployed across all of RTE's units and at its headquarters. In addition, Priority Response Groups have been set up for each of the regional units. Their main aim is to ensure that the lines that have sustained serious damage, and which are particularly important for power system reliability, can be restored in less than five days.

APPENDIX 2: GLOSSARY OF ABBREVIATIONS

ACER — Agency for Cooperation of Energy Regulators

ACR — Regional operations centre

ADEeF — Association of energy distributors in France

ADN — Northern defence programmable controller

ADN — Western defence programmable controller

AGSOM — Agreement on Grid and System Operation Management

AMPRION — German TSO

ANSSI — National information service security agency

APGP — Improved performance through professionalism

BCP — Business Continuity Plan

BM — Balancing Mechanism

BRP — Business Recovery Plan

CACM — Capacity Allocation and Congestion Management

CASTEN — Administration and supervision centre for national operation telecommunications

CASTER — Administration and supervision centre for regional operation telecommunications

CCRT — Transmission grid code of conduct

CNER — National grid expertise centre

CNES — National system operation centre

CNPE — Nuclear power generation centre

CORESO — CO-oRdination of Electricity System Operators

COrS'R — RTE operational security centre

CR — Complementary reserves (BM)

CSEA — Economic Monitoring and Audit Committee

CSPR — Static reactive power compensator

CURTE — Committee of electricity transmission grid users

CWE — Central Western Europe

DCC — Demand Connection Code

DGEC — Department of Climate and Energy

DSO — Distribution System Operator

DTR — Reference Technical Documentation

EAS — ENTSO-E Awareness System

ECCT — Short-term coordinated research

EH — Electronic Highway

ELD — Local distribution company

ENTSO-E — European Network of Transmission System Operators for Electricity

ELIA — Belgian TSO

EOT — Equivalent outage time

GEMCC — Maintenance, instrumentation, control and research group

GIP — Priority response group

GMR — Grid maintenance group

HDP — High-density generation

HVDC — High Voltage Direct Current link (IFA)

ICS — Incident Classification Scale

IFA — France-England Interconnection

IGCC — International Grid Control Cooperation

IPES — Incorporation of intermittent renewable energy production into the power system

IST — Transient overload intensity

LAD — Automatic fault finding system

LFCR — Load Frequency Control and Regulation

LPM — Military programming law

MARTI — Intraday real-time forward planning of control model

NEBEF —— Demand Response Block Exchange Notification

NEMO——— Nominated Electricity Market Operator

NG ———— National Grid, English TSO

NGET——— National Grid Electricity Transmission

NGIC ——— National Grid Interconnectors Limited

NTC ——— Net Transfer Capacity

ORTEC —— RTE emergency response arrangements

PEXI ——— Computerised operation desks

PSEM ——— Metal-enclosed substation

RCC ——— Regional Coordination Centre

REE———— Spanish TSO

RfG———— Requirements for Generators

RGCE——— Regional Group for Continental Europe

ROC ——— Regional Operation Centres

ROSE——— Optical Security Network

RMS ——— Multi-service network

RPD ——— French public electricity distribution grid

RPT———— French public electricity transmission grid

RR ———— Rapid reserves (BM)

RSFP ——— Secondary load frequency control

RST ——— Secondary voltage control

RSTN ——— Renewed secondary voltage control

RSC ——— Regional Service Centre

SAS ——— Alert and Safeguard System

SDB ——— Supply-demand balance

SDIS ——— Departmental fire and rescue services

SIDRE —— Regional inter-dispatching support system

SISTER —— Information summary and data storage for the operation of the electricity system

SNC ——— National Control System

SOGL——— System Operation GuideLine

SPD ——— System Protection and Dynamics

SRC ——— Regional Control System

SRJ———— Daily grid statements

SSE———— Significant System Event

SSY———— System Services

STANWAY— SRC replacement project

STATNETT— Norwegian TSO

STS———— Safety Telephone System

SWISS-GRID ——— Swiss TSO

S3REnR—— Regional plan for connection of renewable energies to the grid

TCD ——— Remote operation

TCM ——— Telecommunication

TENNET-NL ———— Dutch TSO

TERNA —— Italian TSO

Transnet BW ———— German TSO

TSC———— TSO Security Cooperation

TSO ——— Transmission System Operator

TURPE —— Transmission grid usage tariff

TYNDP —— Ten-Year Network Development Plan

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