Source of data

The information in this report is based on metering data collected by RTE on the public transmission network and on data obtained from the distribution system operators, particularly ERDF and ADEeF, electricity generators, EDF Systèmes Énergétiques Insulaires for Corsica, and ENTSO-E, the European Network of Transmission System Operators for Electricity. Temperature data were provided by Météo France.
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Glossary 67
As required by the energy transition law for green growth, RTE has prepared and published this Annual Electricity Report to provide a general overview of developments affecting the power system over the previous year.

The 2015 edition of the Electricity Report shows that the effects of the energy transition are becoming visible in France:

- After holding at the same level for three years, power demand rose slightly in a more buoyant economic climate. Adjusted for weather impacts, power consumption in mainland France, excluding the energy sector, increased by 0.5% to 476.3 TWh. Growth was stronger in some industrial sectors, like car manufacturing and metallurgy, while others saw declines. Together with improved energy efficiency, this growth was reflected in consumption by households and SMEs.

- The weather in France was warm on the whole in 2015, though not as mild as in 2014. Gross consumption in mainland France thus rose 2.2% year-on-year.

- Renewable generation capacity continued to grow: the country is now home to more than 10 GW of wind capacity and 6 GW of solar capacity. Wind power covered about 4.5% of domestic demand and solar power 1.6%. Taken together with hydropower, which made a moderate contribution over the year, renewable energy sources covered 18.7% of power demand.

- The six remaining 250 MW coal-fired plants were taken out of service during the year. All in all, nearly 4 GW of coal-fired generation capacity was decommissioned in France between 2013 and 2015.

- Thanks to the new method for optimising cross-border exchange capacity (flow-based coupling) and the strengthening of the interconnection between France and Spain, France’s exchange balance with neighbouring countries reached 61.7 TWh. This is the third time it has risen above 60 TWh in the past ten years.

- New demand-side flexibility options continue to be developed. Thanks to tenders on the Balancing Mechanism, RTE had up to 1,900 MW of load shedding capacity ready for activation in 2015, up from 1,200 MW in 2014.

- Lastly, RTE continues to work to ensure that power is available to all parts of France: it is adapting the grid to accommodate renewable energy sources and enable the pooling of energy produced within the new territorial organisation.

### Adjusted Consumption Up 0.5% After Holding Steady for Three Years

Overall, the weather was warm in France in 2015, but less so than in 2014 (2015 was the third warmest year on record but 2014 was the warmest). Gross consumption in mainland France thus ended the year at 475.4 TWh, or 2.2% higher than in 2014.

Power demand peaked on 6 February 2015, during a cold spell, at 91.6 GW, which was similar to the peaks of 2011 and 2013. Though the 2012 Building Energy Regulation will limit the increase in temperature sensitivity going forward, the temperature sensitivity of demand in winter is still close to 2,400 MW/°C.

Consumption adjusted for weather and the 29th day in February, excluding energy withdrawn by the energy sector

<table>
<thead>
<tr>
<th>Year</th>
<th>Consumption (TWh)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2006</td>
<td>455.5</td>
</tr>
<tr>
<td>2007</td>
<td>462.6</td>
</tr>
<tr>
<td>2008</td>
<td>468.9</td>
</tr>
<tr>
<td>2009</td>
<td>461.5</td>
</tr>
<tr>
<td>2010</td>
<td>471.4</td>
</tr>
<tr>
<td>2011</td>
<td>476.4</td>
</tr>
<tr>
<td>2012</td>
<td>476.7</td>
</tr>
<tr>
<td>2013</td>
<td>476.3</td>
</tr>
<tr>
<td>2014</td>
<td>474.0</td>
</tr>
<tr>
<td>2015</td>
<td>476.3</td>
</tr>
</tbody>
</table>

Consumption adjusted for weather effects, excluding the energy sector, inch ed up by 0.5% to 476.3 TWh, after holding steady for three years. As the amount of renewable power connected to distribution grids rises, energy withdrawn from the RTE network, adjusted for weather, does not necessarily trend in line with consumption anymore, and has been declining since 2011 (~0.6% between 2014 and 2015).

Consumption in the industrial sector was comparable to the past three years and reached 67.6 TWh, reflecting opposing trends in different sectors of activity: demand increased in the car manufacturing and metallurgy sectors but declined in the chemicals,
During 2015, 895 MW of solar power capacity was connected in mainland France, taking total installed capacity to almost 6,200 MW. About a quarter of this increase corresponded to the connection to the RTE network in September 2015 of the Constantin farm in Cestas, in the Gironde department, the largest photovoltaic power plant in Europe.

Hydropower capacity was flat in 2015, as has been the case since the late 1980s, but production declined by 13.7% due to well-below-average rainfall. Output for the year was among the lowest of the past decade.

Following the decommissioning of the last six 250 MW coal-fired plants, including one reconversion, fossil-fired thermal capacity declined again in 2015. Output from gas-fired plants rose by almost 55% on 2014.

RENEWABLES CONTINUE TO BE DEVELOPED TO SUPPORT THE ENERGY TRANSITION

Installed power generation capacity in mainland France inched up by 584 MW (+0.5%) in 2015. Coal-fired capacity contracted by 1,500 MW, while renewable generation capacity – primarily solar and wind power – rose by 2,000 MW. In connection with the rise in gross consumption and the slight decline in the export balance, total power generation in France reached 546 TWh, which was 1.1% higher than in 2014. The split between technologies was comparable to the previous year.

Installed wind power capacity climbed above the 10,000 MW mark in 2015. It thus appears that the uptick observed in 2014 is continuing, notably thanks to the finalisation of the tariff framework and the gradual easing of some regulatory constraints. Wind power output rose by 23.3% (21.1 TWh) from the 2014 level. Maximum output exceeded 5,500 MW every month during the year. Hourly output set a new record on 29 March, at 1:00 pm, with 8,266 MW produced, representing a capacity factor of 86.3%, while daily output reached an absolute maximum on 29 November (at 184 GWh).

Installed solar capacity

Hydropower capacity was flat in 2015, as has been the case since the late 1980s, but production declined by 13.7% due to well-below-average rainfall. Output for the year was among the lowest of the past decade.

Following the decommissioning of the last six 250 MW coal-fired plants, including one reconversion, fossil-fired thermal capacity declined again in 2015. Output from gas-fired plants rose by almost 55% on 2014.
**RTE KEEPING POWER FLOWING TO THE NEW REGIONS**

The transmission grid is laid out in such a way that electricity generation resources can be pooled to ensure adequate supply to each part of France. Five regions, besides Corsica, are importers: Ile-de-France is the largest followed by Brittany and Burgundy Franche-Comté and, to a lesser extent, Pays de la Loire and Provence-Alpes-Côte d’Azur. Guaranteeing supply to these regions requires bringing large amounts of power from neighbouring regions. Three regions defined under the new administrative maps imported about as much electricity as they exported during the year: Nord-Pas-de-Calais Picardie, Aquitaine Limousin Poitou-Charentes and Languedoc-Roussillon Midi-Pyrénées. While annual totals might create the impression that flows were balanced, the truth is that exchanges may in fact have been largely dominated by imports or exports during different periods of the year. It is very rare for flows in these regions to be balanced at a given point in time (6% of the time in Nord-Pas-de-Calais Picardie, close to 4% in Aquitaine Limousin Poitou-Charentes and Languedoc-Roussillon Midi-Pyrénées).

Some regions have seen their power consumption rise by more than 5% since 2006: Languedoc-Roussillon Midi-Pyrénées and regions on the Atlantic coast. Conversely, consumption has been declining in the Nord-Pas-de-Calais Picardie and Alsace Champagne-Ardennes Lorraine regions due to slower demographic growth and the reduced weighting of local industry.

The heat wave in the summer of 2015 drove consumption up by as much as 25% at one point relative to the same days in 2014 at the local level (Auvergne Rhône-Alpes, Provence-Alpes-Côte d’Azur and Languedoc-Roussillon Midi-Pyrénées).

Alsace Champagne-Ardennes Lorraine and Nord-Pas-De-Calais Picardie were home to 40% of installed wind power capacity in France in 2015. A quarter of capacity is located in Brittany, Centre Val de Loire and Languedoc-Roussillon Midi-Pyrénées. Wind energy is being developed in these regions thanks to favourable local climates as reflected in the Regional Plans for the Climate, Air and Energy targets for connecting wind farms.

The Aquitaine Limousin Poitou-Charentes, Provence-Alpes-Côte d’Azur and Languedoc-Roussillon Midi-Pyrénées regions enjoy more sunlight and are thus home to more than half of solar capacity.

**FRENCH EXPORTS REMAIN HIGH BECAUSE PRICES REMAIN LOW**

Spot prices in France averaged €38.5/MWh in 2015, one of the lowest figures on record for the past decade. Total transactions (purchases/sales) on the EPEX Spot France market reached 106.9 TWh, which represented more than 20% of France’s gross consumption for the year.

Since 25 February 2015, price-based market coupling has included Italy and Slovenia. Coupling is a way to create a single trading zone such that prices are identical as long as interconnection capacity does not limit cross-border exchanges. Remarkable examples of convergence are now seen regularly.

On 21 May 2015, flow-based market coupling went live in the CWE region (France, Germany, Austria, Belgium, the Netherlands and Luxembourg), replacing the Net Transfer Capacities model previously used. Cross-border trades are now optimised to reflect the actual physical capacities of the network as closely as possible, thanks to extensive coordination between the TSOs in the region. Since flow-based coupling began, maximum exchanges between France and the CWE region have exceeded the combined maximum France-Belgium and France-Germany exchanges (exports and imports) observed over more than five years with NTC. France’s exports climbed to 7,745 MW in July and imports reached 6,828 MW in November, representing flexibility of more than 14.5 GW for the French power system.

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**Overview of contractual trades in 2015**

- **Great Britain**
  - Exports: 15.9 TWh
  - Imports: 1.8 TWh

- **CWE**
  - Exports: 20.1 TWh
  - Imports: 13.4 TWh

- **France**
  - Exports: 91.3 TWh
  - Imports: 29.6 TWh
  - Balance: 61.7 TWh

- **Switzerland**
  - Exports: 25.9 TWh
  - Imports: 12.0 TWh

- **Italy**
  - Exports: 20.1 TWh
  - Imports: 0.4 TWh

- **Spain**
  - Exports: 9.3 TWh
  - Imports: 2.0 TWh
France was a net exporter on all of its borders. The export balance ended the year at 61.7 TWh, down from 65.1 TWh in 2014. This was the third time in the past ten years that the balance has exceeded 60 TWh. The new Baixas – Santa Llogaia interconnection line has been brought into commercial service gradually since 5 October 2015, lifting export capacity to Spain to 2,950 MW and import capacity to 2,450 MW during certain hours. France’s export balance with Spain ended 2015 at 7.3 TWh.

France was again a net exporter to Switzerland (13.9 TWh). The export balance with Italy was 19.7 TWh and exchange capacity was saturated 78% of the time. The export balance with Great Britain was 14.1 TWh with exchange capacity saturated 86% of the time. New interconnections are planned for both borders.

**DEMAND-SIDE FLEXIBILITY SCHEMES CONTINUE TO GAIN MOMENTUM**

Load shedding schemes, which give the system operator more flexibility and facilitate balancing by market players, continue to be developed. RTE has since 2008 been contracting load shedding capacity with balancing actors to guarantee the availability of these offers on the Balancing Mechanism, and since 2011 it has contracted load shedding capacity that can be activated on very short notice for the rapid and complementary reserves. Contracts resulting from RTE’s calls for tenders left as much as 1,900 MW of load shedding capacity at its disposal in 2015.

Meanwhile, for the second year, the NEBEF mechanism (Block Exchange Notification of Demand Response) allowed market actors to realise value with load shedding capacity directly on the market. In 2015, 18 players had contracts with RTE and actual load shedding volumes reached 1.5 GWh, compared with just over 300 MWh a year earlier.

**RTE CONTINUES TO INVEST TO UPGRADE THE NETWORK AND SUPPORT GROWTH MOMENTUM IN ALL REGIONS**

In 2015, RTE invested a total of €1,402 million within the perimeter regulated by the CRE, with about 30% of infrastructure investment devoted to replacements.

Equivalent Outage Time for customers connected to the RTE network was 7 min 02 sec, factoring in 5 min 44 sec due to the damage caused to a number of instrument transformers by a heat wave between 30 June and 4 July.

The average number of short or long outages that affected RTE’s distributor and industrial customers during the year (excluding the energy and rail sectors) was 0.39 per site, below the average for the past ten years and within the 0.6 limit set out in incentive regulation.

With 105,448 km of lines in service, one feature of RTE’s network expansion in 2015 was an increase in the length of underground lines. Other highlights for the year included the commissioning of the new France-Spain DC interconnection and the official launch of the “PACA safety net” that had been tested in 2014.
Part 1
Consumption
Gross consumption in mainland France ended the year at 475.4 TWh, which was 10.3 TWh, or 2.2%, higher than in 2014.

This increase reflected temperatures that were on average cooler in the earlier part of the year and hotter in the summer relative to 2014. Differences in temperature drove gross consumption up nearly every month of the year, as more people switched on heat in the early months and used air-cooling systems in the summer (See temperature maps in Chapter 7, Additional Information).

Though higher than in 2014, gross consumption was in line with the average of the past ten years. The average temperature in 2015 was only 0.3°C above the reference temperature.

Year-on-year trends in gross consumption in Europe can be found in Chapter 7, Additional Information.

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**GROSS CONSUMPTION WAS HIGHER THAN IN 2014 BECAUSE TEMPERATURES WERE COOLER EARLY IN THE YEAR AND WARMER IN SUMMER**

Gross consumption in mainland France ended the year at 475.4 TWh, which was 10.3 TWh, or 2.2%, higher than in 2014.

This increase reflected temperatures that were on average cooler in the earlier part of the year and hotter in the summer relative to 2014. Differences in temperature drove gross consumption up nearly every month of the year, as more people switched on heat in the early months and used air-cooling systems in the summer (See temperature maps in Chapter 7, Additional Information).

Though higher than in 2014, gross consumption was in line with the average of the past ten years. The average temperature in 2015 was only 0.3°C above the reference temperature.

Year-on-year trends in gross consumption in Europe can be found in Chapter 7, Additional Information.

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**Temperature trends in France* compared with reference temperatures**

* Calculated based on data from 32 weather stations located across France
WEATHER-ADJUSTED CONSUMPTION SLIGHTLY HIGHER

Adjusted for differences in the weather, and excluding the energy sector from the calculation, consumption rose 0.5% to 476.3 TWh.

It was confirmed for the fifth year in a row that annual electricity consumption in France is tending to stabilise (See Adjusted monthly consumption section in Chapter 7, Additional Information).

In the early part of the previous decade, adjusted consumption grew at an average annual rate of 1.4%. So this stabilising trend is in keeping with a gradual slowdown observed for more than 60 years now, the main drivers of which are:

- Changes in economic growth rates;
- Changes in France’s industrial fabric (offshoring, refocusing on high-tech industry);
- Changes in the structure of consumption notably with services, which consume less electricity than industry, accounting for a larger share of economic activity;
- The diffusion of the effects of demand-side management and particularly the more widespread development of energy efficiency in buildings and equipment (See Energy Efficiency and Energy Savings section in Chapter 7, Additional Information).

INDUSTRIAL DEMAND IS STILL FLAT

Power consumption by industrial customers directly connected to the public transmission system, including own consumption but excluding losses and the energy sector, reached 67.6 TWh in 2015. The figure was broadly unchanged from 2014 (+0.2%). The same trend is visible below in the seasonally-adjusted monthly consumption figures for heavy industry excluding the energy sector.

In calculating trends in adjusted consumption, it is necessary to exclude the energy sector because the adoption of a new uranium enrichment process in 2012 severely impacted the sector and caused a steep decline in consumption.
Conversely, consumption increased in other sectors, including car manufacturing (+5%), where demand rebounded after several years of declines, and metallurgy (+5.6%), which continues to be buoyed by a vibrant aerospace market.

<table>
<thead>
<tr>
<th>Monthly consumption in car manufacturing industry (seasonally adjusted)</th>
</tr>
</thead>
<tbody>
<tr>
<td>GWh</td>
</tr>
<tr>
<td>350</td>
</tr>
<tr>
<td>300</td>
</tr>
<tr>
<td>250</td>
</tr>
<tr>
<td>200</td>
</tr>
<tr>
<td>150</td>
</tr>
</tbody>
</table>

A more detailed analysis of these sector trends can be found in the 2015 Generation Adequacy Report.

CONSUMPTION BY SMI/SMES, RESIDENTIAL AND PROFESSIONAL USERS BOUNCED BACK TO 2013 LEVEL

Consumption by customers connected to distribution grids, which include SMI/SMEs and residential and professional users, along with any losses associated with energy withdrawn, bounced back to the 2013 level after edging lower last year.

<table>
<thead>
<tr>
<th>Monthly consumption by SMI/SMEs, residential and professional users (seasonally adjusted)</th>
</tr>
</thead>
<tbody>
<tr>
<td>TWh</td>
</tr>
<tr>
<td>34</td>
</tr>
<tr>
<td>33</td>
</tr>
<tr>
<td>32</td>
</tr>
<tr>
<td>31</td>
</tr>
<tr>
<td>30</td>
</tr>
<tr>
<td>29</td>
</tr>
<tr>
<td>28</td>
</tr>
</tbody>
</table>

The growth rate for the year was 0.6%, comparable to that seen between 2012 and 2013, as illustrated by the series of seasonally-adjusted consumption figures for distribution grids.

Factors driving the trend included the lacklustre economic climate for SMEs/SMI and professional customers and, to a lesser degree, weak household spending, together with the effects of directives and regulations on the energy efficiency of equipment. Slower growth in the share of new buildings heated with electricity following the application of the 2012 Building Energy Regulation also had an impact.

2015 GENERATION ADEQUACY REPORT

Every year, RTE prepares and publishes a Generation Adequacy Report on the electricity supply-demand balance in France. Its goal is twofold: establish forecasts for trends affecting the equilibrium of the power system over five years and generate prospective scenarios for the longer term (15-20 years).

The 2015 Generation Adequacy Report can be found on the RTE website:
PEAK DEMAND FOR THE YEAR MATCHED 2011 AND 2013

The highest level of demand recorded in 2015 was on 6 February at 7:00 pm, during a cold spell, when 91,610 MW was consumed at a temperature of 0.75°C, which was 5.9°C below the reference temperature. This demand peak was comparable to the highs recorded in 2011 and 2013 (See Chapter 7, Additional Information).

Demand was at its lowest for the year on 16 August, at 29,558 MW.

POWER DEMAND STILL HIGHLY SENSITIVE TO TEMPERATURES

Power demand in France is highly sensitive to temperatures, notably during the winter months, given the large installed base of electric convection heaters. This is why the cooler temperatures in the early months of the year drove demand up relative to 2014.

RTE uses a model that distinguishes between temperature-sensitive and non-temperature-sensitive demand to calculate weather-adjusted consumption. It is the temperature-sensitive share that determines the overall trend in demand.

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

The types of heating systems installed in new homes can greatly impact temperature sensitivity. Indeed, since the 2012 Building Energy Regulation took effect, the share of electric heating in new build has plummeted. This shift is liable to keep the increase in temperature sensitivity in check going forward. However, new homes only make up a very small portion of housing stock, so the impact will only be visible over the long term.
Other end-uses besides heating (primary and backup systems) also contribute, to a lesser degree, to determining the share of power demand that is sensitive to temperatures, including sanitary hot water production, cooking and cold production.

**RESIDENTIAL SECTOR ACCOUNTED FOR 35% OF NET CONSUMPTION**

The residential sector accounted for the largest share of power demand making up 35% of net consumption, followed by the business sector (26%), heavy industry (16%), SMEs/SMI (12%) and professional users (10%).

2. Heat pumps

3. Net consumption corresponds to consumption by final customers at the point where energy is withdrawn. It differs from gross consumption in that it does not include power transmission and distribution losses.
Part 2
Generation
NEW RENEWABLE CAPACITY REPRESENTED 2 GW

Total installed power generation capacity in mainland France increased by a slight 584 MW, or 0.5%, in 2015. Renewable generation capacity rose by almost 2,000 MW, primarily on the back of solar and wind power. Meanwhile, coal-fired capacity declined by 1,500 MW after the last 250 MW units at Bouchain, Vitry and La Maxe were taken offline.

In connection with the rise in gross consumption, total power generation in France reached 546.0 TWh, for a 1.1% increase on 2014. France’s export balance contracted slightly during the year.

Maps showing generation in different parts of Europe can be found in Chapter 7, Additional Information.

The breakdown between generation sources was similar to 2014.

DEMAND COVERAGE BY RENEWABLES WAS UNCHANGED FOR THE YEAR

The share of demand covered by power generated from renewable energy sources has held at around 19% for the past three years. An increase in renewable energy generation excluding hydropower in 2015 (+20.8%) only partially offset a decline in hydropower output due to lower rainfall at a time when consumption was rising.

<table>
<thead>
<tr>
<th>Installed capacity at 31/12/2015</th>
<th>Capacity</th>
<th>Change vs. 31/12/2014</th>
<th>Change</th>
<th>Share of installed capacity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nuclear</td>
<td>63,130</td>
<td>0.0%</td>
<td>0</td>
<td>48.8%</td>
</tr>
<tr>
<td>Fossil-fired thermal</td>
<td>22,553</td>
<td>-5.9%</td>
<td>-1,414</td>
<td>17.4%</td>
</tr>
<tr>
<td>Of which coal</td>
<td>3,007</td>
<td>-33.3%</td>
<td>-1,500</td>
<td>2.3%</td>
</tr>
<tr>
<td>oil</td>
<td>8,645</td>
<td>+0.3%</td>
<td>+23</td>
<td>6.7%</td>
</tr>
<tr>
<td>gas</td>
<td>10,901</td>
<td>+0.6%</td>
<td>+63</td>
<td>8.4%</td>
</tr>
<tr>
<td>Hydropower</td>
<td>25,421</td>
<td>0.0%</td>
<td>-1</td>
<td>19.7%</td>
</tr>
<tr>
<td>Wind power</td>
<td>10,312</td>
<td>+10.7%</td>
<td>+999</td>
<td>8.0%</td>
</tr>
<tr>
<td>Solar power</td>
<td>6,191</td>
<td>+16.9%</td>
<td>+895</td>
<td>4.8%</td>
</tr>
<tr>
<td>Bioenergy</td>
<td>1,703</td>
<td>+6.6%</td>
<td>+105</td>
<td>1.3%</td>
</tr>
<tr>
<td>Total</td>
<td>129,310</td>
<td>+0.5%</td>
<td>+584</td>
<td>100.0%</td>
</tr>
</tbody>
</table>

In connection with the rise in gross consumption, total power generation in France reached 546.0 TWh, for a 1.1% increase on 2014. France’s export balance contracted slightly during the year.

Maps showing generation in different parts of Europe can be found in Chapter 7, Additional Information.

<table>
<thead>
<tr>
<th>Energy produced</th>
<th>TWh</th>
<th>Change 2015/2014</th>
<th>Share of generation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Net generation</td>
<td>546.0</td>
<td>+1.1%</td>
<td>100.0%</td>
</tr>
<tr>
<td>Nuclear</td>
<td>416.8</td>
<td>+0.2%</td>
<td>76.3%</td>
</tr>
<tr>
<td>Fossil-fired thermal</td>
<td>34.1</td>
<td>+31.9%</td>
<td>6.2%</td>
</tr>
<tr>
<td>Of which coal</td>
<td>8.6</td>
<td>+3.0%</td>
<td>1.6%</td>
</tr>
<tr>
<td>oil</td>
<td>3.4</td>
<td>+5.3%</td>
<td>0.6%</td>
</tr>
<tr>
<td>gas</td>
<td>22.1</td>
<td>+54.8%</td>
<td>4.0%</td>
</tr>
<tr>
<td>Hydropower</td>
<td>58.7</td>
<td>-13.7%</td>
<td>10.8%</td>
</tr>
<tr>
<td>Of which renewable</td>
<td>53.9</td>
<td>-13.7%</td>
<td>9.9%</td>
</tr>
<tr>
<td>Wind power</td>
<td>21.1</td>
<td>+23.3%</td>
<td>3.9%</td>
</tr>
<tr>
<td>Solar power</td>
<td>7.4</td>
<td>+25.1%</td>
<td>1.4%</td>
</tr>
<tr>
<td>Bioenergy</td>
<td>7.9</td>
<td>+4.9%</td>
<td>1.4%</td>
</tr>
<tr>
<td>Of which renewable</td>
<td>5.9</td>
<td>+8.1%</td>
<td>1.1%</td>
</tr>
</tbody>
</table>

1. Calculation method drawn from EU directive 2009/28/EC: Production from pumped storage units less 70% of consumption for pumping, municipal waste incineration plants counted at 50%. This does not correspond to the calculation under the official methodology, which assumes that results are also adjusted for weather.
Wind and solar power plants produced 28.5 TWh, which corresponded to 32.2% of total renewable electricity generation in France. This seven-point increase relative to 2014 was driven by a combination of growth in installed wind and solar power capacity and a decline in hydropower output. At the same time, the renewable share of bioenergy (municipal waste, paper waste, biogas, wood-energy and other solid biofuels) rose 8.1% to 5.9 TWh. Adding in the renewable share of hydropower, total renewable power generation in France reached 88.4 TWh.

**Breakdown of renewable generation**

- **Hydro**: 61%
- **Wind**: 24%
- **Solar**: 8%
- **Bioenergy**: 7%

**WIND POWER**

Installed wind power capacity ended 2015 at 10,312 MW after 999 MW was added during the year. Of this total, 585 MW was connected to the RTE network and 9,727 MW to the grids of ERDF, LDCs or EDF-SEI for Corsica. It thus appears that the uptick seen in 2014 is continuing, notably thanks to the finalisation of the tariff framework and the gradual easing of some regulatory constraints.

**Wind power output once again rose year-on-year, with total generation increasing by 23.3% to 21.1 TWh.**

**Wind power generation**

- **2011**: 17.1 TWh
- **2012**: 15.9 TWh
- **2013**: 14.2 TWh
- **2014**: 12.1 TWh
- **2015**: 21.1 TWh

Maximum wind power output exceeded 5,500 MW during every month in 2015. A new half-hourly output record was set on 29 March at 1:00 pm with 8,266 MW generated. The related capacity factor also climbed to a new high of 86.3%.

The highest output for a single day was recorded on 29 November, with 184.0 GWh produced.

**Monthly wind power generation**

- **January**: 3,639 MW
- **February**: 3,076 MW
- **March**: 2,011 MW
- **April**: 2,106 MW
- **May**: 1,732 MW
- **June**: 1,878 MW
- **July**: 1,503 MW
- **August**: 2,295 MW
- **September**: 1,722 MW
- **October**: 3,526 MW
- **November**: 4,389 MW
- **December**: 5,589 MW
On average, wind power covered 4.5% of total demand in 2015, up from 3.7% in 2014.

Wind conditions have a considerable impact on wind power output, though the wider spread of geographic sites is tending to compensate for this variability. This reliance on wind conditions is visible in half-hourly breakdowns of output. The top and bottom deciles trended higher on average, reflecting the rise in installed wind power capacity, with increases of 38% in the top decile and 23% in the bottom.

The wind power capacity factor averaged 24.3%, which was slightly higher than in 2014 (22.6%).
SOLAR POWER

In 2015, 895 MW of new solar power capacity was connected in mainland France, taking total installed solar capacity to 6,191 MW. About a quarter of this increase corresponded to the commissioning in September 2015 of the Constantin plant in Cestas, in the Gironde department. This 230 MW facility, connected to the RTE grid, is the largest solar photovoltaic farm in Europe. All in all, there is 565 MW of solar capacity connected to the RTE grid and another 5,626 MW connected to the networks of ERDF, LDCs and EDF-SEI in Corsica. The uptick observed since the second half of 2014 is mainly a reflection of the maturity of projects in the queue.

The Multiannual Investment Programme (Programme Pluriannuelle des Investissements - PPI) targets 8,000 MW of installed capacity by 2020 which, together with an increase in the feed-in tariff, should result in continued growth in new connections.

Solar power output increased by 25.1% between 2014 and 2015, reflecting both the expansion of installed capacity and good sunlight conditions. For each month of the year, output was higher than in the same month of 2014.

Output peaked on 24 June 2015 at 2:00 pm, at 4,601 MW, representing a capacity factor of 82.2%. Over 2015 as a whole, the average solar capacity factor was 15% compared with 14% in 2014.
BIOENERGY

Installed bioenergy capacity increased by 105 MW to 1,703 MW over the year. This increase was driven in large part by plants running on wood-energy and other solid biofuels, and by biogas plants.

Municipal waste incineration plants made up more than half of this capacity, with the balance corresponding to biogas, paper waste, wood-energy and other solid fuels.

Solar power output fluctuates from day to day, depending on sunlight conditions and cloud cover, and from season to season, depending on when the sun rises and sets. In 2015, solar power covered an average 1.6% of demand, up from 1.4% in 2014. Maximum coverage was recorded on 2 August 2015 at 3:00 pm, when it reached 11.2%.
HYDROPOWER

Installed hydropower capacity was unchanged in 2015, as has been the case since the late 1980s, but output declined by 13.7% relative to 2014. The annual total was among the lowest on record in the past decade. It is explained by a decline in rainfall, whereas 2014 had seen a good deal of precipitation.

The Panorama of Renewable Electricity provides a more detailed analysis of the hydropower industry.

PANORAMA OF RENEWABLE ELECTRICITY

RTE, Syndicat des Energies Renouvelables (Renewable Energy Association), ERDF and ADEeF jointly publish a detailed analysis of developments in renewable energies.


THERMAL POWER GENERATION INCREASED

Nuclear

Nuclear generation capacity did not change in 2015 and output was flat (+0.2%).

Fossil-fired thermal

Installed fossil-fired thermal power capacity declined further in 2015. Closures of coal power plants reduced coal-fired capacity by 33.3% and fossil-fired thermal capacity by 5.9%.

Oil-fired plants representing combined installed capacity of 5 GW, as well as 1.7 GW of combined-cycle gas turbine (CCGT) plants, are taken offline for at least four months during the summer, when demand is lower.

Maps showing the locations of fossil-fired thermal plants can be found in Chapter 7, Additional Information.

Cool temperatures in the early part of the year drove consumption up. Because of this colder weather, and a drop in hydropower output, backup generation resources (fossil-fired thermal) were dispatched more than in 2014. For instance, output from gas-fired plants rose by almost 55% on the previous year.

Contrary to 2014, fossil-fired thermal power plants were heavily used in January and February. Generation from renewable energy sources excluding hydropower was higher than fossil-fired thermal power output between April and September and in terms of annual totals.
Monthly trends in fossil-fired and renewable generation (excluding hydro) in 2015

VARIABILITY OF GENERATION FROM DIFFERENT SOURCES

France’s power generation capacity comprises resources that are sensitive to various parameters: cloud cover and sunlight for solar power, wind conditions for wind power, rainfall and temperatures for hydropower. By way of example, coverage by hydropower output is highest in May, when snow is melting. But this output can be modulated and used to help offset fluctuations in wind and solar power output. The median rate of coverage of demand by solar power is at its highest in June, but fluctuates over the course of the day.

Facilities that run on fossil fuels (coal, oil and gas) are powered up more often in the winter, and their coverage of total consumption ranges between 2% and 17%.

Monthly coverage of consumption in France with different energy sources excluding nuclear

Note to readers: We can see, for instance, that wind power coverage peaked in July, at 16.7%. During that same month, coverage exceeded 3.2% half the time.
CO₂ EMISSIONS

Whereas CO₂ emissions² had fallen sharply in 2014 due to relatively clement winter weather and strong hydropower output, the amount of power generated with fossil-fired thermal plants rose in 2015. This increase, driven by a rise in gross consumption combined with a decrease in hydropower generation, caused CO₂ emissions to start trending higher again (+21.7%). Most of these emissions were the result of increased gas-fired generation. Total CO₂ emissions not counting own consumption were nonetheless still 28% lower than in 2013. CO₂ emissions resulting from own consumption were estimated at 5.3 Mt. These emissions are included in the carbon footprint assessments of the industrial sites in question.

CO₂ emissions have been decreasing overall since 2008. Over the course of a year, monthly CO₂ emissions can vary by a factor of five. Daily CO₂ emissions curves in winter show wide swings caused by the use during the day of thermal generation resources. Curves are flatter in summer.

<table>
<thead>
<tr>
<th>CO₂ emissions (millions of tonnes) excluding own consumption</th>
<th>2015</th>
<th>2014</th>
</tr>
</thead>
<tbody>
<tr>
<td>Net production</td>
<td>23.1</td>
<td>19.0</td>
</tr>
<tr>
<td>Nuclear</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Fossil-fired thermal</td>
<td>17.4</td>
<td>13.5</td>
</tr>
<tr>
<td>Of which coal</td>
<td>8.2</td>
<td>8.0</td>
</tr>
<tr>
<td>oil</td>
<td>0.9</td>
<td>0.7</td>
</tr>
<tr>
<td>gas</td>
<td>8.4</td>
<td>4.9</td>
</tr>
<tr>
<td>Hydropower</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Wind power</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Solar power</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Other energy sources</td>
<td>5.7</td>
<td>5.4</td>
</tr>
<tr>
<td>Of which renewable</td>
<td>4.2</td>
<td>3.9</td>
</tr>
</tbody>
</table>

Trend in CO₂ emissions since 2008

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>40</td>
<td>35</td>
<td>30</td>
<td>25</td>
<td>20</td>
<td>15</td>
<td>10</td>
<td>5</td>
</tr>
</tbody>
</table>

2. CO₂ emission factors only represent CO₂ emissions generated by the consumption of the primary fuel source. The different generation technologies contributed to total CO₂ emissions as follows:
- 0.96 t/MWh for coal-fired units;
- 0.67 t/MWh for oil-fired units;
- 0.46 t/MWh for gas-fired units;
- 0.98 t/MWh for other thermal power plants (biogas, waste, wood-energy and other solid fuels).
These rates are calculated based on emission factors in g/CO₂ per kWh of thermal energy as reported by the Inter-professional Technical Centre for Studies on Atmospheric Pollution (Centre Interprofessionnel Technique d’Etudes de la Pollution Atmosphérique - CITEPA) and on RTE’s estimate of output between kWh of thermal energy and kWh of electricity.
Part 3
Territories and Regions
CONSUMPTION IN THE ADMINISTRATIVE REGIONS

BREAKDOWN OF CONSUMPTION

Demand levels in the different metropolitan areas are a reflection of demographics. Residential customers and the service sector consume the most power, with Ile-de-France, the most densely populated region in France, leading the way despite its relatively limited size. Demand growth rates are high in Aquitaine Limousin Poitou-Charentes, Languedoc-Roussillon Midi-Pyrénées and Provence-Alpes-Côte d’Azur, regions with attractive coastal zones and large populations.

The Alsace Champagne-Ardennes Lorraine region, home to a number of industrial areas with very high power demand, also consumes more electricity than other more populous regions.

CONSUMPTION TRENDS OVER THE PAST EIGHT YEARS

Trends in weather-adjusted demand in the different regions between 2006 and 2014 are a reflection of local demographic and economic growth.

1. 2014 is the last year for which data is available at this level.
Demand growth rates were highest – exceeding 5% – in Languedoc-Roussillon Midi-Pyrénées and regions along the Atlantic coast. Conversely, demand contracted in the northeast – Nord-Pas-de-Calais Picardie and Alsace Champagne-Ardenne Lorraine – due to weaker demographic growth and, more significantly, to deindustrialisation.

TRENDS IN REGIONAL POWER DEMAND IN SUMMER

Significant swings in regional demand were observed in summer due to the heat wave, notably in Auvergne Rhône-Alpes, Provence-Alpes-Côte d’Azur and Languedoc-Roussillon Midi-Pyrénées. In these regions, local consumption was as much as 25% higher than on the same days in 2014.

Adjusting for weather, the difference in average consumption between summer and winter (using figures for the winter of 2014-2015 and the summer of 2015) was fairly small in Provence-Alpes-Côte d’Azur relative to other regions with a decrease of about 20%, compared with an average of 40% in mainland France. This reflects the vibrant tourism industry in the region during the summer as well as an industrial sector that is not as impacted by summer holidays.

It should be noted that according to Météo France, July 2015 was the third hottest month of July on record since 1900.

Consumption declines considerably in all French regions during the summer months, when temperatures are higher. The magnitude of decreases reflects region-specific characteristics.

MONTHLY OVERVIEWS OF ELECTRICAL ENERGY

Every month, RTE publishes a monthly overview of electrical energy trends. These documents summarise developments affecting the power system in terms of consumption, generation, renewable energy growth, electricity markets and exchanges in the territories and regions, similar to the data presented here about summertime demand and hydropower output.

**Consumption in Key Heavy Industry Areas Connected to the Transmission Grid**

Most of the large heavy industry areas connected to the RTE network are still located in the northeast of France and in the Auvergne Rhône-Alpes region. There are also some smaller consumption centres where demand is high along the Atlantic coast. The largest consumption centre alone accounts for 2.7% of net consumption in France.

**The Balance Between Generation and Consumption**

The transmission grid is laid out in such a way that electricity generation resources can be pooled to ensure adequate supply to each part of France.

Five regions, besides Corsica, are importers: Ile-de-France is the largest followed by Brittany and Burgundy Franche-Comté and, to a lesser extent, Pays de la Loire and Provence-Alpes-Côte d’Azur. Guaranteeing supply to these regions requires bringing large quantities of power in from neighbouring regions, and sometimes more distant ones, with power crossing through neighbouring regions in Brittany’s case. Most of these exchanges flow over the public transmission grid.

Three regions defined under the new administrative map for France imported about as much electricity as they exported during the year: Nord-Pas-de-Calais Picardie, Aquitaine Limousin Poitou-Charentes and Languedoc-Roussillon Midi-Pyrénées. While annual totals might create the impression that flows were balanced, the truth is that exchanges may in fact have been largely dominated by imports or exports during different periods of the year. It is very rare for flows in these regions to be balanced at a given time (6% of the time in Nord-Pas-de-Calais Picardie, 4.3% in Aquitaine Limousin Poitou-Charentes and 4% in Languedoc-Roussillon Midi-Pyrénées). Moreover, there are significant exchanges within these large territories, for instance between the former Poitou-Charentes and Limousin regions. The power exchanged in such cases also flows over the public grids.

The regions where nuclear power plants are located are the ones that generate surplus power or enough for their own needs. Maps of these facilities can be found in the Generation Capacity section of Chapter 7, Additional Information.

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2. The methodology used to define these areas was developed by RTE. It does not provide an exhaustive representation of all heavy industry activity in France, but rather presents the main heavy industry areas connected to the public electricity transmission grid.
RENEWABLE ELECTRICITY GENERATION IN THE REGIONS

WIND POWER PRODUCTION IN THE REGIONS

Two regions have more than 2,000 MW of wind power installed: Alsace Champagne-Ardennes Lorraine and Nord-Pas-de-Calais Picardie. Together, these regions generate 48% of total wind power in mainland France and cover about 10% of their consumption. Brittany, Centre Val de Loire and Languedoc-Roussillon Midi-Pyrénées have more than 800 MW of wind power installed and cover between 6% and 10% of their consumption.

Differences in wind power development rates in the regions reflect weather factors (See weather maps in Chapter 7, Additional Information) as well as environmental constraints and local public policies. Priorities given to these criteria are notably translated in the regional targets for wind power connections set out in Regional Plans for the Climate, Air and Energy (RPCAE). These plans, drawn up based on the former administrative maps, will by 2019 be integrated into the regional plans for land use, sustainable development and territorial equality (schémas régionaux d’aménagement, de développement durable et d’égalité des territoires - SRADDET) created by Law 2015-991, known as the NOTRe Act. Bearing in mind that the targets have not yet been adapted to the new administrative map, and to make it possible to track renewable electricity policies, the map below shows the objectives set out in the RPCAE for wind power aggregated to reflect the new regional structure.

### Average coverage of consumption with wind power

<table>
<thead>
<tr>
<th>Coverage</th>
<th>Regions</th>
</tr>
</thead>
<tbody>
<tr>
<td>More than 6%</td>
<td>More than 1,000 MW</td>
</tr>
<tr>
<td>4 to 6%</td>
<td>750 to 1,000 MW</td>
</tr>
<tr>
<td>2 to 4%</td>
<td>500 to 750 MW</td>
</tr>
<tr>
<td>Less than 2%</td>
<td>Less than 250 MW</td>
</tr>
</tbody>
</table>

### Wind power targets (for 2020) set forth in RPCAE, aggregated to reflect new map of regions

<table>
<thead>
<tr>
<th>Target</th>
<th>Regions</th>
</tr>
</thead>
<tbody>
<tr>
<td>More than 4,000 MW</td>
<td>More than 4,000 MW</td>
</tr>
<tr>
<td>1,000 to 2,000 MW</td>
<td>3,000 to 4,000 MW</td>
</tr>
<tr>
<td>2,000 to 3,000 MW</td>
<td>1,000 to 2,000 MW</td>
</tr>
<tr>
<td>Less than 1,000 MW</td>
<td>Less than 1,000 MW</td>
</tr>
</tbody>
</table>

---

Two regions have more than 1,200 MW of installed solar power capacity: Aquitaine Limousin Poitou-Charentes and Languedoc-Roussillon Midi-Pyrénées. They are both large in size and are situated in the southernmost part of France. Provence-Alpes-Côte d’Azur, which is smaller in size, has solar power capacity of 870 MW.

The rate of coverage of consumption with solar power was 4.2% in Aquitaine Limousin Poitou-Charentes and 2.9% in Provence-Alpes-Côte d’Azur.

Regional plans for developing solar power focus primarily on territories in the south. For instance, in order to meet the targets set for 2020, a 1.8-fold increase in installed capacity is planned for Aquitaine Limousin Poitou-Charentes, a 4-fold increase for Auvergne Rhône-Alpes and a 2.4-fold increase for Languedoc-Roussillon Midi-Pyrénées.
BIOENERGY

Bioenergy capacity is divided amongst all French regions, with a high concentration of household waste incineration plants in Ile-de-France.

Regions with large mountain areas (Auvergne Rhône-Alpes, Languedoc-Roussillon Midi-Pyrénées and Provence-Alpes-Côte d’Azur) are home to 79% of total hydropower capacity in France because of the hydroelectric dams installed there, notably water reservoir and pondage facilities.

Most other regions have some small amount of hydropower capacity, often run-of-river or pondage systems.

With eight months of rainfall deficit during the year, 2015 saw below-average rainfall, unlike the two previous years.

This rainfall deficit impacted hydropower generation at run-of-river and pondage facilities as they rely directly on river flows. Output at these types of plants was 20 to 30% lower than in 2014 in the three regions that generate the most hydropower.

Output at water reservoir and pumped storage stations was not impacted as much, declining by less than 10%. This stability was made possible by the reserves in the reservoirs at these facilities. Reserves were lower at the end of 2015 than a year earlier.

Hydropower output in the summer of 2015 vs. summers of 2013 and 2014

HYDROPOWER

Installed hydropower capacity of 25 GW is divided unevenly across France.

Map of installed bioenergy capacity

Bioenergy capacity is divided amongst all French regions, with a high concentration of household waste incineration plants in Ile-de-France.
Part 4
Markets and Europe
MARKET PRICES REMAIN LOW IN EUROPE

Average spot prices on power exchanges in 2015 and change vs. 2014

- Great Britain: €55.7 MWh (+6.7%)
- Belique: €44.7 MWh (+9.5%)
- France: €38.5 MWh (+11.2%)
- Switzerland: €40.3 MWh (+9.5%)
- Spain: €50.3 MWh (+17.8%)
- Netherlands: €40.0 MWh (-2.8%)
- Germany: €31.6 MWh (-3.6%)
- Italy: €52.3 MWh (+0.4%)

Sources: European power exchanges (for Nord Pool: system price; for Italy: Prezzo Unico Nazionale, or PUN)

Spot price trends over past five years

€/MWh

2011 2012 2013 2014 2015

France Germany Italy (PUN) Spain Great Britain

MARKET PRICES REMAIN LOW IN EUROPE

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Sources: European power exchanges (for Nord Pool: system price; for Italy: Prezzo Unico Nazionale, or PUN)

Spot price trends over past five years

€/MWh

2011 2012 2013 2014 2015

France Germany Italy (PUN) Spain Great Britain
Spot prices in France were higher than in 2014 but remained close to ten-year lows. The annual average was €38.5/MWh, below the ARENH price of €42/MWh for the second year in a row. This increase was driven first and foremost by a rebound in electricity demand, bearing in mind that the weather had been particularly mild in 2014.

The decline in fuel prices first observed in 2014 continued. This helped keep prices low in Italy and Germany. An increase in installed wind power in Germany, notably offshore, added to downward pressure and in some cases resulted in negative prices (during 126 hours spread over 25 days in 2015).

On the other hand, even though its electricity mix is dominated by gas and coal, prices rose in Britain (in euros). This upward trend was supported by the carbon floor price hike required by national law and by the pound’s rise against the euro.

In Spain, hydropower output was significantly lower than in the two previous years, which drove up the average annual price.

Nuclear capacity availability in Belgium was limited over the entire year, versus during nine months in 2014, which is why market prices rose. Belgian prices became the highest in the CWE (France, Germany, Austria, Belgium, Netherlands, Luxembourg), especially after Dutch prices, which had been the highest in the region for four years, were driven down by the commissioning of several high efficiency coal plants.

Against this backdrop, market prices were only identical across the entire CWE region (total convergence) 19% of the time, which was roughly the same as in 2014.

The decline in fuel prices first observed in 2014 continued. This helped keep prices low in Italy and Germany. An increase in installed wind power in Germany, notably offshore, added to downward pressure and in some cases resulted in negative prices (during 126 hours spread over 25 days in 2015).

Number of different prices within CWE region (% of time during year)

<table>
<thead>
<tr>
<th>Number of Prices</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>19%</td>
</tr>
<tr>
<td>2</td>
<td>22%</td>
</tr>
<tr>
<td>3</td>
<td>23%</td>
</tr>
<tr>
<td>4</td>
<td>36%</td>
</tr>
</tbody>
</table>

Distribution of spreads* and convergence rate between France and each of its neighbours

Average annual spread:
- GB-FR**: 16.19
- BE-FR: 6.20
- DE/AT-FR: -6.85
- IT(N)-FR: 14.23
- ES-FR: 11.85

Convergence:
- GB-FR**: 14%
- BE-FR: 44%
- DE/AT-FR: 27%
- IT(N)-FR: 13%
- ES-FR: 13%

*Spread (€/MWh) = Price XX – Price FR
** For GB-FR, losses on France-England interconnection (IFA) are deducted from spread

Nuclear capacity availability in Belgium was limited over the entire year, versus during nine months in 2014, which is why market prices rose. Belgian prices became the highest in the CWE (France, Germany, Austria, Belgium, Netherlands, Luxembourg), especially after Dutch prices, which had been the highest in the region for four years, were driven down by the commissioning of several high efficiency coal plants.

Against this backdrop, market prices were only identical across the entire CWE region (total convergence) 19% of the time, which was roughly the same as in 2014.
Further extension of market coupling in 2015

On 25 February 2015, Italy and Slovenia joined the price coupling region. Note that Italy is subdivided into six price zones of which only one – the North zone – is interconnected with France, Slovenia and Austria.

Day-ahead price coupling helps make the European power system more economically efficient. It enables the creation of a single trading area and thus identical price zones when interconnection capacities do not limit cross-border exchanges. RTE and its partners adopted the flow-based coupling method on 21 May 2015 to optimise the calculation of power trading capacity within the CWE region.

Remarkable examples of convergence are now seen regularly. For instance, between 8 and 9:00 am on Thursday 8 October, prices were identical in 11 European countries representing more than two-thirds of total power consumption in Europe.

Prices within coupled area on Thursday 8 October 2018, 8-9:00 am

Gap with French prices

€/MWh

- Price > FR price
- Price < FR price
Contractual trades between countries are the result of commercial transactions between market players. Physical exchanges correspond to the electricity actually carried over interconnector lines directly linking countries. For instance, a commercial programme for imports on the Franco-Swiss border may be “offset” by significant exports to Italy, though from a physical standpoint some of the power will leave from France and go through Switzerland.

For a given country, the balance of physical exchanges over all of its borders and the balance of contractual trades with all of its neighbours are identical.

Year-on-year trends in net physical flows in Europe can be found in Chapter 7, Additional Information.

France exported 91.3 TWh in 2015 and imported just 29.6 TWh, and the export balance was significant every month of the year. Net exports ended the year at 61.7 TWh, exceeding 60 TWh for the third time in the past ten years.
France was a net importer during 38 hourly periods, spread over ten days, though it was not a net energy importer over an entire day on any day.

On 13 July, between 6 and 7:00 am, France’s export balance reached a record high of 15.6 GW, topping the previous record set in January 2011 by 2 GW. It was possible to achieve such export levels thanks to the adoption of the flow-based method in the CWE region and to the commissioning of the new interconnector between France and Spain late in the year. The record set in 2011 has already been exceeded during more than 48 one-hour periods since 21 May 2015.

**CWE REGION**

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

Prior to that, these four price zones were coupled based on a Net Transfer Capacities (NTC) model, meaning that limitations on trading were set bilaterally at each border (one constraint per border and per direction, implicitly taking into account the state of the grid).

Now, constraints explicitly take into account the physical network infrastructure in the four countries. Cross-border exchanges are thus optimised to reflect the actual physical capacities of the network as closely as possible. This requires very close coordination between TSOs within the region.

In sum, it is no longer possible to consider borders separately, and indicators previously used for the France-Belgium and France-Germany borders have been replaced by France-CWE region indicators.

Since flow-based coupling began, maximum exchanges between France and the CWE region have exceeded the combined maximum France-Belgium and France-Germany exchanges (exports and imports) observed over more than five years with NTC. France’s exports climbed to 7,745 MW in July and imports reached 6,828 MW in November, representing flexibility of more than 14.5 GW for the French power system.
France remained a net exporter to the CWE region for the year with an export balance of 6.7 TWh compared with 10.6 TWh in 2014. Exchange levels within the CWE region fluctuate with the seasons: France exports between April and October but imports during the winter months, when consumption is higher in France.

### Monthly exchange balances with CWE region

<table>
<thead>
<tr>
<th>Month</th>
<th>Jan</th>
<th>Feb</th>
<th>Mar</th>
<th>Apr</th>
<th>May</th>
<th>Jun</th>
<th>Jul</th>
<th>Aug</th>
<th>Sep</th>
<th>Oct</th>
<th>Nov</th>
<th>Dec</th>
</tr>
</thead>
<tbody>
<tr>
<td>2014</td>
<td>0.0</td>
<td>-1.0</td>
<td>-0.5</td>
<td>0.0</td>
<td>0.0</td>
<td>0.5</td>
<td>1.0</td>
<td>1.5</td>
<td>2.0</td>
<td>2.5</td>
<td>2.0</td>
<td>0.5</td>
</tr>
<tr>
<td>2015</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
</tbody>
</table>

### Capacity and daily exchanges between France and CWE region in 2015

- **Export**
- **Import**
- **Launch of flow-based coupling**

### High/low France-CWE exchange balances by month

- **Maximum France-CWE export balance**
- **Maximum France-CWE import balance**
- **Maximum NTC export and import**
The new Baixas – Santa Llogaia line has been brought into commercial service gradually since 5 October 2015, lifting maximum export capacity to Spain to 2,950 MW and import capacity to 2,450 MW during certain hours. Since the line has been in service, interconnections with Spain have been saturated 81% of the time, down from 89% in 2015 pre-commissioning.

However, the capacity offered on the market has averaged close to 2,050 MW for exports and 1,800 MW for imports, due to constraints on the Spanish grid. It will have to be strengthened further for the interconnection to be operated at full capacity.

France exported to Spain during 83% of hourly periods in 2015, up from 69% in 2014. The annual export balance doubled to 7.3 TWh.
Prices in Spain are still shaped in large part by renewable generation, which during some months makes up more than half of the country’s energy mix. Over the past three years, the 11 months during which average monthly prices were lower than in France were the 11 months when monthly renewable generation in Spain was highest, and the 11 months when imports were highest.

Renewable electricity production in Spain, notably hydropower, was lower in 2015 than in the two previous years, which is why Spanish prices rose – and why French exports were higher at the beginning of the year.
**SWITZERLAND**

The annual export balance with Switzerland was the lowest in more than a decade at 13.9 TWh. Exports were notably sharply lower between May and August. At the end of 2015, monthly exports were once again very high due to the unavailability of two nuclear reactors in Switzerland.

---

**ITALY**

Exchanges with Italy were again largely dominated by exports with the export balance reaching 19.7 TWh. Though France was a net exporter each month, like in 2014, for the first time since the cold spell of February 2012 there were two business days in October when France was a net importer. Interconnections were not as saturated as in 2014, notably early in the year and in October (saturation was just 47% for that month) when hourly prices in France were regularly higher than hourly prices in northern Italy.

In the spring and summer, Italy must limit its imports on days when demand is low. Indeed, given the significant photovoltaic capacity connected, the country must keep in operation a sufficient number of thermal plants capable of modulating their output and ensuring the stability of the power system.

---

**Monthly exchange balances with Switzerland**

<table>
<thead>
<tr>
<th></th>
<th>2015</th>
<th>2014</th>
</tr>
</thead>
<tbody>
<tr>
<td>Export</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Import</td>
<td></td>
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</tr>
</tbody>
</table>

---

**Capacity and daily exchanges between France and Switzerland, 2015**

---

**Monthly exchange balances with Italy**

<table>
<thead>
<tr>
<th></th>
<th>2015</th>
<th>2014</th>
</tr>
</thead>
<tbody>
<tr>
<td>Export</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Import</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

---

**Capacity and daily exchanges between France and Italy, 2015**

---
GREAT BRITAIN

France once again exported much more to Great Britain than it imported with an annual export balance of 14.1 TWh, the second highest level since the record set in 2014, despite being a net energy importer for a few days in November. Interconnections were used more than 97% of the time for exports but availability was limited between mid-October and mid-December due to failures.

RTE ADAPTING ITS MARKET MECHANISMS

From the beginning, RTE has been working with market stakeholders to create mechanisms that facilitate the opening of the French electricity market and its integration within Europe.

In 2015, RTE worked to prepare for future developments:

- The move to half-hourly granularity for intraday exchanges with Germany and Switzerland became effective in December 2015 and will give market players even more flexibility in 2016.
- The overhaul of intraday trading processes between France and Belgium will be integrated into the platform already used to manage Franco-Swiss and Franco-German processes and help make the use of interconnections more fluid and closer to real time.
- Lastly, the introduction of a new “coordinated” methodology for calculating exchange capacities at northern Italian borders (two days prior to use) will help optimise the commercial capacities made available to market players (NTC).
Part 5
Flexibility
MARKET MECHANISMS GIVE POWER SYSTEM STAKEHOLDERS FLEXIBILITY

Activities of the Balance Responsible Entities

The balance responsible entity system allows consumers, generators, suppliers and traders to conduct all types of commercial transactions in the electricity market, on timeframes ranging from several years ahead to almost real time. Thanks to the additional flexibility this mechanism provides, players can respond to a wide range of contingencies and uncertainties. Each balance responsible entity creates an activity portfolio and agrees to settle the costs resulting from imbalances between generation and consumption within the portfolio, as recorded after the fact. The entities have a financial incentive to maintain a balance within their portfolios and thus contribute to the equilibrium of the French power system.

At the end of 2015, there were 195 balance responsible entities with valid contracts, or three more than in 2014. Of these, 137 were actually active during the year and 25 made significant injections into or withdrawals from the grid.

Transactions conducted by balance responsible entities on EPEX Spot France (monthly totals)

A 50% year-on-year jump in party-to-party transactions (Block Exchange Notifications, or NEB).

A 57% rise in transaction volumes on the day-ahead market. Trading volumes on the French day-ahead exchange set a record of 106.9 TWh during the year and in November the monthly total exceeded 10 TWh for the first time.

Intraday transactions conducted by balance responsible entities

Total transactions conducted by balance responsible entities increased sharply in 2015, with substantial differences between product types:

- Steep drop in ARENH transactions, as the ARENH price of 42 €/MWh was no longer competitive relative to other products (party-to-party and power exchange), which market players consequently favoured. This trend has carried over to the first half of 2016 with no new contracts created for ARENH.
A rise in intraday trades, in line with previous years, mainly on the back of party-to-party transactions (47% jump in re-declarations) and, to a lesser degree, volumes traded on the power exchange (+8%). These trades give balance responsible entities the flexibility to operate in close to real time.

The definitive elimination of Virtual Power Plant (VPP) volumes, that mechanism having been phased out completely at the end of the first half of 2015.

**Balancing Mechanism**

The Balancing Mechanism allows RTE to modulate generation, consumption and exchange levels to ensure that electricity supply and demand are always balanced. The mechanism involves the selection of offers submitted by balancing actors based on the merit order and needs identified.

Total balancing volumes declined between 2014 and 2015, falling to 7.2 TWh, the lowest level since 2008. This represented less than 1% of total trading volumes of balance responsible entities. Balancing offers from other countries are increasingly being accepted, notably thanks to exchanges between TSOs via the BALIT\(^1\) mechanism, which can during some months account for up to 5% of total volumes adjusted upward.

---

1. The BALIT (BALancing InterTSO) mechanism allows RTE and a neighbouring TSO (National Grid or Red Eléctrica de España) to exchange balancing energy if the merit order so justifies and interconnection capacities remain after intraday trading.
A supply-demand imbalance situation is considered to exist when RTE generates one or more messages about insufficient offers on the Balancing Mechanism (alerts or degraded mode) so that actors will submit additional offers.

**Load shedding**

Load shedding mechanisms continue to be developed to complement traditional schemes (See Demand-Side Flexibility section in Chapter 7, Additional Information).

Load shedding involves consumers cancelling or postponing all or part of their consumption in response to a signal.

There are two main categories of load shedding that contribute to the supply-demand balance:

- **Industrial load shedding**, when consumption is reduced at one or more industrial sites (either by shutting down processes or switching over to own consumption). In these cases load shedding can be proposed either directly by the industrial user or through an aggregator.

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

 These types of load shedding allow more flexibility both for grid management and balancing by market players.

Indeed, it has been possible since 2003 to offer load shedding capacity on the Balancing Mechanism. As of 2014, it can also be initiated directly by a market player through the NEBEF (Block Exchange Notification of Demand Response) mechanism.

---

2 A supply-demand imbalance situation is considered to exist when RTE generates one or more messages about insufficient offers on the Balancing Mechanism (alerts or degraded mode) so that actors will submit additional offers.
For the second year now, the “NEBEF” mechanism (Block Exchange Notification of Demand Response) has allowed players to realise value on load shedding directly through the market. Players inform RTE of the load shedding planned for the next day and now have the option of re-declaring schedules at the intraday scale. RTE verifies after the fact that loads actually shed correspond to the schedules submitted by actors.

RTE uses a series of calls for tenders to contract industrial or distributed load shedding capacity that can be activated on the Balancing Mechanism.

Through these contracts, players commit to offer to shed loads under specific conditions, in exchange for which they are compensated:

- Since 2008, RTE has been contracting load shedding capacity with balancing actors to guarantee the availability of these offers on the Balancing Mechanism.
- Since 2011, RTE has been contracting load shedding capacity that can be activated on very short notice for the rapid and complementary reserves.

Thanks to these tenders, RTE had up to 1,900 MW of load shedding capacity at its disposal in 2015, capacity it could activate under specific conditions. For 2016, RTE has contracted load shedding capacity of 2,100 MW, of which 200 MW at sites with contracted power of less than 36 kVA, with seven users. All in all, some €30 million will be paid to demand-side operators through these contracts.

The contracts in question drove the load shedding capacity offered on the Balancing Mechanism by balancing actors up sharply in 2015: RTE had at least 125 MW available nearly all of the time and the maximum offered was 1,980 MW. This capacity contributes to power system margins.

Load shedding volumes activated on the Balancing Mechanism rose by 19% on the 2014 level, to 14.5 GWh. This was the second highest amount on record since the Balancing Mechanism was created.

100 MW or more of load shedding capacity was activated on 33 days during the year and the 450 MW mark was exceeded on 15 October and 9 December 2015 during the evening peak.

### NEBEF

For the second year now, the “NEBEF” mechanism (Block Exchange Notification of Demand Response) has allowed players to realise value on load shedding directly through the market. Players inform RTE of the load shedding planned for the next day and now have the option of re-declaring schedules at the intraday scale. RTE verifies after the fact that loads actually shed correspond to the schedules submitted by actors.
A total of 79% of loads are shed at times when spot prices are above €39/MWh (annual median spot price in France), and about a third are during the 10% of hourly periods when prices are the highest of the year.

Moreover, 40% of load shedding volumes are concentrated within the 10% of days of the year when the average daily price is the highest.

The mechanism will evolve further with the implementation of the NEBEF 2.1 rules scheduled for 1 April 2016.

By the end of 2015, the number of actors having entered into contracts with RTE to participate in the mechanism had risen to 18.

A total of 1,587 MWh of load shedding capacity was submitted to the mechanism during the year, up from 347 MWh in 2014. Activity levels were especially high in the last two months of 2015. The maximum capacity declared for a half-hour period was 18.9 MW.

Load shedding via NEBEF is primarily concentrated in three periods of the day: between 11:00 pm and 3:00 am, during the morning load ramp-up period in France (6 to 10:00 am) and during the evening peak, between 5 and 8:00 pm.

Breakdown of load shedding volumes declared on NEBEF based on spot prices in 2015

- Below €39/MWh: 21%
- €39-54/MWh: 7%
- €54-69/MWh: 25%
- Above €69/MWh: 47%

€39/MWh is the annual median price in France
€54/MWh is the highest decile and €69/MWh the highest centile
CAPACITY MECHANISM

The goal of implementing a capacity mechanism from 2017, in compliance with the NOME Act, is to guarantee security of supply in France, particularly during periods when demand is very high.

This mechanism creates a new obligation for electricity suppliers to contribute to security of supply in proportion to their customers’ power and energy consumption. Holding suppliers responsible for their customers’ power consumption is notably a way to contain peak demand growth by creating an economic incentive to reduce demand.

The mechanism involves imposing an obligation for suppliers to hold capacity certificates and for capacity operators to have their capacities certified through contracts.

Suppliers and other obligated parties must demonstrate, for each delivery year, that they hold a quantity of capacity certificates matching the calculation of their customers’ consumption during peak periods, after this figure is extrapolated to the reference extreme temperature to ensure that the security of supply criterion defined in article L.335-2 of the Energy Code will be met.

After the delivery year, RTE informs each obligated party of the imbalance between its obligation and the capacity certificates held, and of the corresponding settlement due.

Generators and demand-side operators enter into certification contracts with RTE for their capacities. Through these contracts, they commit to specific capacity levels and to making that capacity available when supply is tight in winter. They are issued capacity certificates based on the contribution the capacity offered makes to security of supply. At the end of the delivery year, RTE verifies that the capacities were effectively made available.

Once the first capacities have been effectively certified, operators and suppliers can trade capacity certificates up until the transfer deadline, which is after the end of the delivery year.

The capacity price reflects the cost of ensuring security of supply for each delivery year

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3. Other obligated parties: consumers or system operators for the portion of their consumption not covered by purchases from a supplier.
Part 6
Network
QUALITY OF ELECTRICITY IMPACTED BY THE HEAT WAVE

EQUIVALENT OUTAGE TIME

Equivalent outage time (Temps de Coupure Équivalent - TCE) is one of the indicators used to measure the quality of the electricity supplied by RTE. It is calculated as a ratio between:

- The total energy not served during times when power is not delivered to RTE’s distributor and industrial customers (excluding the energy and rail sectors); and

- The average power served annually by RTE to these same customers.

In 2015, the equivalent outage time for RTE customers was 7 min 02 sec. This time takes into account the consequences of a heat wave that damaged a number of instrument transformers between 30 June and 4 July 2015, resulting in significant power cuts. These events alone were responsible for 5 min 44 sec of equivalent outage time.

OUTAGE FREQUENCY AND LIGHTNING DENSITY

Since August of 2013, outage frequency has been factored into the incentive regulation created by CRE to promote continuity of supply. It corresponds to the average number of short outages (between 1 sec and 3 min) or long ones (more than 3 min) experienced during the year by RTE’s distributor and industrial customers (excluding the energy and rail sectors).

In 2015, outage frequency excluding exceptional events was 0.39 outage/site, which was within the 0.6 limit set out in the incentive regulation and below the average of the past ten years.

Lightning density is a predominant cause of the short outages observed during the year. In 2015, lightning density climbed above 1.0 strike per km² across France as a whole, a level not seen since 2006. Taking this into account, the frequency of short outages was relatively low compared with previous years.

The impact of lightning density on outage frequency is visible at the regional level: usually, the regions that are hit by lightning the most show a high frequency of short outages. Conversely, in regions where lightning is rare, short outages are less frequent.
Protecting and encouraging the development of biodiversity are the cornerstones of RTE’s environmental policy. Its commitment is recognised as part of the “2011-2020 National Strategy for Biodiversity” by the Ministry for Ecology, Sustainable Development and Energy.

In 2015, RTE had 152 biodiversity-friendly areas developed on a total surface area of 648 hectares.

Detailed sustainable development information can be found in RTE’s Management Report.

**LOSS RATE STABLE IN 2015**

Line losses occur when electricity is moved from generation sites to consumption sites, and loss volumes depend on the power carried, the distance over which it is carried, weather conditions and the characteristics of the grid. Though most of these factors are external, RTE works to minimise losses by making decisions about the development and operation of the grid that optimise the distance over which electricity travels taking advantage of the leeway it currently has. Nearly 80% of losses are due to the Joule effect and Corona effect on high and very high voltage lines. Other effects contribute as well, notably when current passes into transformer substations. The environmental impact of losses reflects the power that has to be generated to offset them.

In 2015, losses reached 10.3 TWh, which corresponded to 2.01% of total injections (generation and imports).

**RTE INVESTED €1.4 BILLION IN 2015**

RTE’s investments within the scope of businesses regulated by the CRE totalled €1,402 million in 2015. Investments chiefly targeted the reconstruction of the 400 kV Charleville-Rheims line, the start of work on the French side of the new direct current line between France and Italy, which will run through the service gallery in the Fréjus tunnel, the completion of work on the direct current line that will boost interconnection capacity between France and Spain via the Eastern Pyrenees, and ongoing work to replace conductors to make flows more secure on the 400 kV line between Montélimar and Lyon. Some 30% of grid infrastructure investments were for replacements.
MORE OF NETWORK UNDERGROUNDED

With 105,448 km of lines in service, RTE’s network expanded in 2015 as the length of underground lines increased. The new direct current France-Spain interconnection also went live during the year, and the PACA safety net tested in 2014 was officially inaugurated. All in all, the network in service expanded by 117 km in 2015 and the direct current network by 66 km. New underground lines (newly created or overhead lines newly undergrounded) totalled 325 km, while 394 km of overhead lines were taken down (definitively or for replacement) during the year.

The investment programme for 2016 approved by the regulator is close to €1,550 million. Some of the investments planned relate to customer connection needs that are financed largely by requestors through investment subsidies. The increase in the investment budget relative to 2015 reflects a combination of factors: the overlapping in 2016-2017 of five large development projects (Charleville-Rheims, Savoy-Piedmont, Haute Durance, 2Loires and Brittany safety net) as well as steep and ongoing investments in the expansion and upgrading of information systems.

These investments are planned bearing in mind that, over the coming years, rising to the challenges of the energy transition will require more and more effort. Indeed, the French transmission grid will play a key role in accommodating new generation sources (including offshore wind farms), integrating the European energy market (by strengthening cross-border exchange capacity) and ensuring the operational safety of the networks and quality of supply to the different consumption areas and regions.

Nearly all of the new lines brought into service in 2015 were laid underground, whereas just 10 km of new overhead lines were installed. RTE nonetheless replaced more than 263 km of overhead lines on its network.

<table>
<thead>
<tr>
<th>Length of lines in service (km)</th>
<th>Total (AC)</th>
<th>Total (DC)</th>
</tr>
</thead>
<tbody>
<tr>
<td>At 31/12/2014</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Overhead</td>
<td>100,610</td>
<td>4,721</td>
</tr>
<tr>
<td>Underground</td>
<td></td>
<td></td>
</tr>
<tr>
<td>New</td>
<td>283</td>
<td>342</td>
</tr>
<tr>
<td>Newly added</td>
<td>20</td>
<td>237</td>
</tr>
<tr>
<td>Replaced</td>
<td>263</td>
<td>17</td>
</tr>
<tr>
<td>Overhead lines buried</td>
<td>0</td>
<td>88</td>
</tr>
<tr>
<td>Scrapped</td>
<td>-394</td>
<td>-2</td>
</tr>
<tr>
<td>Other modifications (length adjustments)</td>
<td>-87</td>
<td>-25</td>
</tr>
<tr>
<td>At 31/12/2015</td>
<td>100,412</td>
<td>5,036</td>
</tr>
<tr>
<td>Change 2014 – 2015</td>
<td>-198</td>
<td>315</td>
</tr>
</tbody>
</table>

* Including overhead lines buried

** Only includes French portion of new France-Spain interconnection
Over the course of 2015, 24 new substations were connected to the public transmission system, of which 17 were very high voltage (THT). RTE added a new 400 kV voltage level at the Henri-Paul substation in Saône-et-Loire to help meet the increased power needs of the Sud-Est high-speed train line. The 400 kV substations at Clerac, in Gironde, and Rom, in the Vienne department, were also brought into service during the year ahead of the commissioning of the Sud-Europe-Atlantique high-speed train line. Lastly, the expansion of the 400 kV Seuil substation in the Ardennes will help accommodate wind power development in the region.

As regards the 225 kV network, the Mas-Bruno substation in the Eastern Pyrenees is helping to bring more power to the urban area around Perpignan and the Cestas substation in Gironde made it possible to connect the 230 MW Constantin solar power facility.

It should also be noted that AC-DC conversion stations using VSC (Voltage Source Converter) technology, for cables that can transmit 2,000 MW of power at ±320 kV, were brought into service at locations in Baixas (France) and Santa-Llougaia (Spain) as part of the new direct current France-Spain interconnection.

### Length of new lines on RTE network

<table>
<thead>
<tr>
<th>Year</th>
<th>Direct current</th>
<th>France-Spain link</th>
<th>HV overhead (90 kV and 63 kV)</th>
<th>VHV overhead (400 kV and 225 kV)</th>
<th>Cotentin-Maine link</th>
<th>HV underground (90 kV and 63 kV)</th>
<th>VHV underground (400 kV and 225 kV)</th>
<th>PACA safety net</th>
</tr>
</thead>
<tbody>
<tr>
<td>2011</td>
<td>100</td>
<td></td>
<td>100</td>
<td>100</td>
<td></td>
<td>100</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>2012</td>
<td>200</td>
<td></td>
<td>100</td>
<td>100</td>
<td></td>
<td>100</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>2013</td>
<td>300</td>
<td></td>
<td>100</td>
<td>100</td>
<td></td>
<td>100</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>2014</td>
<td>400</td>
<td></td>
<td>100</td>
<td>100</td>
<td></td>
<td>100</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>2015</td>
<td>500</td>
<td></td>
<td>100</td>
<td>100</td>
<td></td>
<td>100</td>
<td>100</td>
<td>100</td>
</tr>
</tbody>
</table>

### ADDITIONS AND REPLACEMENTS OF 400 KV AND 225 KV LINES

#### INAUGURATION OF PACA SAFETY NET

The PACA safety net was tested late in 2014 and inaugurated in April of 2015, marking the completion of a project launched in 2009 and carried out in record time – three years of consultation followed by 30 months of construction.

Comprising three underground lines (Boutre-Trans, Biançon-Fréjus and Biançon-La Bocca) spanning 107 km in total, this new infrastructure completes the existing 225 kV network in the region. It will now be possible to consistently guarantee supply to the entire area while it works toward the goals of reducing demand and encouraging the development of local electricity generation, notably renewable.

#### 400 KV LONNY – SEUIL – VESLE LINK

In 2015, the Seuil substation, in the Ardennes, was expanded in terms of 400 kV voltage. The work done enabled the commissioning of a double busbar and 400 kV coupling, the installation of a 400/90 kV transformer, as well as tapping to the 400 kV Lonny-Vesle line.
Underground lines

A total of 76 km of new 225 kV underground lines were brought into service, notably to ensure security of supply to large urban centres. Examples include the Charenton-Nation link in Paris and the Aix Mouret-La Duranne line near Aix-en-Provence. The undergrounding technology used at this voltage is no longer reserved exclusively for very urbanised areas, as illustrated notably by the commissioning in December 2015 of the Merlatière-Recouvrance underground link in Vendée.

Overhead lines

Conductors were replaced along 220 km of 400 kV and 225 kV overhead lines. Examples include the 400 kV Coulange-Pivoz Cordier link in Auvergne Rhône-Alpes and Le Havre-Rougemontier in Normandy. In both cases the goal was to strengthen the grid and adapt to the introduction of generation in these regions. Meanwhile, a number of 225 kV lines reached the end of their useful lives and were replaced. This was notably the case with the Orsonville-Villevaudé line in Seine-et-Marne and Barbuise-Les Fosses in the Aube department.

Additions and replacements of 63 kV and 90 kV lines

Undergrounding rates

After stabilising for a time, the undergrounding rate for new 63 kV and 90 kV infrastructure rose to 99% in 2015, lifting the average for the past three years (2013-2015) to 97%.

Undergrounding rates for 63 kV and 90 kV lines

<table>
<thead>
<tr>
<th>Year</th>
<th>Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>2001</td>
<td>30%</td>
</tr>
<tr>
<td>2002</td>
<td>33%</td>
</tr>
<tr>
<td>2003</td>
<td>34%</td>
</tr>
<tr>
<td>2004</td>
<td>37%</td>
</tr>
<tr>
<td>2005</td>
<td>46%</td>
</tr>
<tr>
<td>2006</td>
<td>57%</td>
</tr>
<tr>
<td>2007</td>
<td>67%</td>
</tr>
<tr>
<td>2008</td>
<td>74%</td>
</tr>
<tr>
<td>2009</td>
<td>81%</td>
</tr>
<tr>
<td>2010</td>
<td>93%</td>
</tr>
<tr>
<td>2011</td>
<td>97%</td>
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<td>2012</td>
<td></td>
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<tr>
<td>2013</td>
<td></td>
</tr>
<tr>
<td>2014</td>
<td></td>
</tr>
<tr>
<td>2015</td>
<td></td>
</tr>
</tbody>
</table>

This work was part of a plan to create a production node at the Seuil substation in response to the development of new renewable energy connection capacity.
Due to its length and specific characteristics, DC technology was used. This is why the project also required the construction of converter stations at each end, using VSC (Voltage Source Converter) technology, so that the direction of flows between the countries can be reversed very quickly (50 ms).

**NEW FRANCE-SPAIN INTERCONNECTION GOES LIVE**

**SHARED BENEFITS**

One highlight of 2015 was the commissioning of the new interconnection between France and Spain. This 700 million project was 50/50 funded by RTE and REE through their jointly-owned subsidiary INELFE. Enhanced exchange capacities between the countries will facilitate the integration of renewable energies while also securing power supply to areas of activity on both sides of the border. The new interconnection will also allow the Iberian market to be integrated into the European electricity market and foster further electricity price convergence.

**TECHNOLOGICAL CHALLENGES**

With two fully underground lines each spanning 65 km and total capacity of 2,000 MW, this is the longest underground power interconnector in the world operating at that voltage. It links the town of Baixas in France to Santa Llogaia in Spain, notably crossing through the Albera Massif via an 8.5 km tunnel, and its path follows that of existing infrastructure like the AP-7 motorway and high-speed rail line between Figueras and Perpignan.

**Why Direct Current?**

The power grid is used for the transmission and distribution of electrical energy between production sites and consumption centres. Working at higher voltage has advantages when it comes to optimising network losses. General technical and economic factors thus justify three-phase AC operation.

When it comes to very long distances, or underground or underwater lines spanning more than 50 km, AC power transmission generates, through a capacitive effect, reactive power that impedes the flow of electricity.

As public authorities wanted to underground the 65 km France-Spain interconnection, the use of direct current emerged as the ideal solution from a technical and economic standpoint.
Map of main projects brought into service in 2015

Source: Ten-Year Network Development Plan

See Chapter 7, Additional Information, to read more about the main projects under way.
Part 7
Additional information
ADJUSTED MONTHLY CONSUMPTION

Consumption adjusted for weather and the 29th day in February, excluding energy withdrawn by the energy sector

Monthly trends

PEAKS IN DEMAND

Peak demand levels since 2001
WEATHER MAPS

Wind power is notably developing in regions with favourable local weather conditions that guarantee wind speeds and, therefore, above-average capacity factors. Wind zones in mainland France can be divided into four roughly homogeneous areas represented on the map below.

This means that windy periods within a defined wind zone tend to occur at the same time and be of similar intensity. It also means that significant gaps are observed between patterns in different zones. It is this diversity across the country that makes it possible to have wind turbines operating at all times in France.

Average temperatures in 2015

JANUARY TO MARCH

APRIL TO SEPTEMBER

OCTOBER TO DECEMBER

Four homogeneous wind zones

Average annual speed within each zone:
- 5.2 to 9.1 m/s
- 2.5 to 6.6 m/s
- 6.3 to 8.9 m/s
- 4.5 to 7.0 m/s

1. This map was drawn up for an RTE study aiming to model wind variability based on Météo France data for 2015, reproducing wind speed 100 m above ground at different grid points 50 km apart. Statistical treatment was carried out to identify the geographic areas with homogeneous wind speeds.

Source: Météo France
GENERATION CAPACITY

Nuclear power plants

- Flamanville (2)
- Penly (4)
- Paluel (4)
- St Laurent des Eaux (2)
- Dampierre (4)
- Chooz (2)
- Cattenom (4)
- Gravelines (6)
- Nogent-sur-Seine (2)
- Penly (2)
- Belleville (2)
- Civaux (2)
- Le Blayais (4)
- St Alban (2)
- Cruas (4)
- Tricastin (4)
- Golftech (2)

1,450 MW
1,300 MW
900 MW

(number of units in service)

Coal and oil-fired plants

- Dirinon (2)
- Brennilis (3)
- Cordemais (2)
- Cordemais (2)
- Le Havre (1)
- Porcheville (4)
- Vaires-sur-Marne (3)
- Emile Huchet (1)
- Arrighi (2)
- Aramon (2)
- Provence (1)

- Coal
- Combustion turbine
- Steam turbine oil-fired

Gas-fired

- Montoir (1)
- Bayet (1)
- Bayet (1)
- Cycofos (1)
- Martigues (2)
- Combigolfe (1)
- Montoire (2)
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EUROPEAN VISION

The data below are calculated on a year-on-year basis (from July 2014 to June 2015) and compared to the prior 12 months (July 2013 to June 2014).

GROSS CONSUMPTION STABILISING WITH UPWARD TREND IN EASTERN COUNTRIES

gross consumption in Western Europe was more or less flat (+0.4% in Spain and France) and declined in some cases (-0.9% in Italy and -0.8% in Belgium). Larger increases were seen in Eastern European countries (+2.5% in Poland and Hungary, +3.2% in Romania).

All in all, annual power consumption within ENTSO-E member countries stabilised between 2014 and 2015 (+0.4%). In more than half of these countries, changes in gross consumption relative to 2013-2014 ranged between -1% and +1%.

Annual trend in power consumption

- Increase of > 4%
- Increase of 0.5 to 4%
- Flat ± 0.5%
- Decrease of 0.5 to 4%
- Decrease of > 4%

Countries’ share of total ENTSO-E generation

- More than 15%
- 5 to 15%
- 3 to 5%
- Less than 3%

CALCULATED FOR THE JULY 2014 TO JUNE 2015 PERIOD VERSUS THE 12 PREVIOUS MONTHS

THE LION’S SHARE OF EUROPEAN GENERATION CONCENTRATED IN THE WEST

Europe produced a total of 3,296 TWh in 2014-2015, for an increase of just 0.3%, in line with the trend in demand. France and Germany accounted for a large share of this generation (about 17% each) and these countries, together with Great Britain, Italy and Spain, accounted for more than 60%.

Rate of coverage of consumption with different types of generation

The share of consumption covered with renewable energy sources varies greatly from one country to the next. Coverage exceeds 50% in some ten countries including Portugal, Austria and Sweden. Norway’s renewable output exceeds its domestic consumption, though other types of generation are available if needed to meet annual electricity needs. Coverage rates exceed 30% in Germany as well as in Italy (35%) and Spain (38%).

Average coverage of electricity demand with renewable energies in ENTSO-E member countries is 33%.
Solar plants covered between 5% and 8% of consumption in Germany, Italy, Spain and Greece, which was much higher than the average for ENTSO-E countries (2.9%).

Five countries stood out with wind power generation meeting more than 15% of annual consumption, especially Denmark, where coverage was 40% compared with an average rate of 7.9% in ENTSO-E countries, up 0.4 point from the previous period.

Hydropower generation covered an average 18.2% of consumption within ENTSO-E countries. The rate exceeded 50% in Austria, Switzerland, Iceland, Bosnia-Herzegovina and Montenegro. Norway’s hydropower output actually exceeded its annual consumption in 2014-2015.

Data available for the UK at press time do not include the entire country.
The share of Belgian consumption met with nuclear power fell from 51% in 2013-2014 to 31% in 2014-2015 because several reactors were out of service.

**FRANCE AND GERMANY THE BIGGEST EXPORTERS**

in the 2014-2015 period, the highest export balances within ENTSO-E countries were seen in France (+64 TWh) and Germany (+41 TWh), followed by Norway, Sweden and the Czech Republic (+15 TWh). Italy was the biggest importer (-44 TWh), followed by Belgium (-22 TWh), where imports increased in 2014-2015 (See Markets and Europe section).

**FRANCE HAS THE HIGHEST TEMPERATURE SENSITIVITY IN EUROPE**

a country’s electricity consumption is largely dependent on its temperature sensitivity. It is estimated that in France, power demand increases by about 2,400 MW with each degree Celsius drop in winter temperatures. This phenomenon is the most noticeable by far in France: temperature sensitivity is approximately three times higher in France than in Great Britain and Germany and four to seven time higher than in Spain or Italy, where summer temperature sensitivity is greater than in France.
DEMAND-SIDE FLEXIBILITY

TRADITIONAL TARIFF-BASED DEMAND RESPONSE SCHEMES

Special tariffs have been introduced to help maintain the supply-demand balance, notably during peak periods in winter, focusing on the demand side rather than supply in order to keep peak demand in check.

“EJP” (Effacement Jour de Pointe) tariffs, introduced in the 1980s, involved raising tariffs in times of system stress but not for more than 22 days a year and only during the winter months. Users have not been able to sign up for these tariffs since 1998, and their effects have been diminishing since. “Yellow” and “green” regulated tariffs were phased out on 1 January 2016 and the corresponding contracts will be terminated. Former customers will have to sign up for new contracts that apply market rates, with or without load shedding. It is also possible to realise value on demand response through market mechanisms.

Other demand response tariffs were introduced in the 1990s thanks to the Tempo signal. RTE has been managing the Tempo signal since 1 November 2014 and providing information about it through éCO2mix to allow alternative suppliers to offer supply contracts that include demand response.

RTE estimates the demand response made available through these two schemes in the winter of 2014-15 at 1,900 MW², down from about 6,000 MW in the late 1990s.

VOLUNTARY LOAD SHEDDING: THE ECOWATT SCHEME

The EcoWatt scheme has been introduced in two regions: Brittany, because power supply is precarious there, and the Provence-Alpes-Côte d’Azur (PACA) region.

RTE launched the EcoWatt scheme in Brittany in 2008 with the State, the Regional Council of Brittany, ERDF and ADEME, and in partnership with the local education authority, the Brittany chamber of commerce and industry, La Poste and France Bleu. It is designed to encourage locals to proactively reduce their power consumption when demand peaks during cold spells.

This initiative supports the Demand-Side Management component of the Breton Electric Pact which, together with the other two focal points (renewable energy development and network security), aims to address all of Brittany’s electricity supply concerns.

There were a total of 56,000 EcoWatt participants in Brittany in the winter of 2015-2016, or 6.5% more than a year earlier. Though the past three winters have been alert-free, a poll shows that more than 90% of participants in Brittany still feel committed to the initiative.

Trends in power demand and generation in Brittany in 2015

Work also got under way in September of 2015 on the Brittany safety net, which aims to ensure better supply starting in 2017. The EcoWatt initiative will continue to play a vital role for the region in the meantime.

The EcoWatt scheme was carried over to the 2015-2016 winter in Provence-Alpes-Côte d’Azur, and 26,000 people are still signed up. The EcoWatt PACA scheme is now intended to help keep growth in regional peak demand in check, particularly on very cold evenings, to guarantee that the safety net implemented in 2015 will remain efficient over the long term. The 2014-2015 winter was alert-free.

Even though recent winters have been mild and no alerts have been issued, participant numbers and awareness are growing. The 2015-2016 season kicked off on 24 November for Brittany and on 3 December for the PACA region.

Other citizen-driven initiatives at the local or national levels, such as the “Positive Energy Family Challenge”³, are helping to keep energy consumption in check while also encouraging voluntary load shedding.

Trends in power demand and generation in PACA in 2015


3. Consumer initiative promoting energy savings through contests
ENERGY EFFICIENCY AND ENERGY SAVINGS

Changes in technologies, consumer behaviours and government incentives are all combining to favour a reduction of electricity consumption.

Energy labels were created in 1994 to help consumers make choices and limit sales of energy-hungry appliances. They have been applied across the European Union since 2010 and are evolving to reflect changes in the electricity consumption of appliances (addition of A+, A++ and A+++ labels to existing A to G range).

It is now mandatory to display energy labels on the following products: lighting, domestic cold appliances, washing appliances (including clothes dryers), television sets, ovens and cooker hoods, vacuum cleaners, devices used for heating, producing and storing hot water and air conditioning units.

Products with the lowest ratings – i.e. those that consume the most energy – will ultimately be removed from the market either through obligations or consumer choices. For instance, since 1 September 2014, only vacuum cleaners rated below 1,600 MW can be sold in the European Union, and in 2017 the ceiling will be lowered to 900 W.

Another example is the way the profile of residential lighting has changed in recent years with the introduction of energy-saving lamps and LEDs and the market ban on incandescent bulbs. These shaved an estimated 300 MW or so from consumption during the 7:00 pm peak between 2010 and 2015.

Restrictions on non-residential lighting at night (store windows and signs, etc.) are also helping drive consumption down by eliminating lighting considered “non-essential”.

The efficacy of energy labelling is also being reflected in the steady downward trend for the past ten years now in the unit energy consumption of appliances such as washing machines and refrigerators.

Estimated annual unit energy consumption for washing machines and refrigerators

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<tbody>
<tr>
<td>Washing machines</td>
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TV power consumption has also changed substantially in recent years. The shift to flat and larger screens drove unit energy consumption up until 2013, but new technologies have since reversed the trend and unit energy consumption is declining.

Example of residential lighting profile on a January day

Estimated annual unit consumption of primary television sets

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peak between 2010 and 2015.
Measures targeting refrigerated display cases have been taken since 2012 in the food retailing sector. By 2020, 75% of these cases will have to have doors that close. The target set for 2015 was 25%. It is estimated that this change will generate energy savings of about 11 TWh between 2012 and 2020.\(^5\)

The Energy Saving Certificates (ESC) scheme was launched as part of France’s programme law on energy policy of 13 July 2005. Its purpose is to encourage energy savings.

Under the scheme, public authorities impose an obligation on energy suppliers to save energy. Pluriannual targets are set and divided between operators based on their sales volumes for different types of energy (electricity, gas, heat, cold, domestic fuel oil and fuel for motor vehicles). For the 2011-2014 period, the total obligation was 460 TWh cumac\(^6\) of which 193.7 for electricity supply. The target for the current period (2015-2017) is twice as high, with a total obligation of 700 TWh cumac of which 193.8 for electricity supply. Suppliers that fail to meet their obligation must make a full-discharge penalty payment of €20 per MWh cumac of shortfall.

By way of illustration, ESC declared for lighting in 2014 and the first half of 2015 totalled 361.5 GWh cumac.\(^7\) Over the same period, the ESC corresponding to making refrigerated display cases closable reached 325 GWh cumac.

The scheme was expanded to include an energy saving obligation to benefit fuel-poor households. The total volume for the 2016-2017 period was 150 TWh cumac. Penalties will normally be €15 per MWh of shortfall.

Meanwhile, regulations and labels in the building sector – the 2012 Building Energy Regulation and HQE (High Environmental Quality) and BBC (Low-Energy Consumption Building) standards – are also contributing to energy savings, notably by requiring better thermal insulation of residences and offices. A total of 12% of existing homes have undergone renovation work: 70% of this work targeted building insulation and 30% heating systems (taking all energy sources together). Lastly, the “Energy Performance Diagnostic” can be used to assess a home’s power consumption and summarise its performance in an energy label. These labels are required when homes are sold or offered for rent.

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6. Le kWh cumac (cumulé et actualisé) est l’unité de référence “kWh cumac” (cumulative and discounted) is the standard unit used for ESC. It represents the cumulative final energy saved over the period measured, discounted at a rate of 4%. Each kWh saved is thus calculated relative to the product’s lifespan and discounted at the market rate.
8. Source: ADEME, key building industry figures, 2013
France has set a target of having 6,000 MW of offshore wind power installed by 2020 and having this capacity cover 3.5% of total consumption by that year. Offshore wind development offers significant power generation potential in France given the country’s natural assets (11 million sq. metres of water under its jurisdiction). Known resources are primarily concentrated off the coasts of Normandy, Brittany and Pays de la Loire. The government has already launched two calls for tenders for the construction of six offshore wind farms in these areas.

These projects aim to connect to the French power grid some 3,000 MW of offshore capacity represented by more than 400 offshore wind turbines. RTE is in charge of studying and handling the connection of these farms. The solution proposed is to create 225 kV double-circuit lines, starting out underwater between the wind farm connected to the offshore substation and the landing point and then running underground between the landing point and the 225 kV substation where they are earthed.

The sites selected through the first call for tenders have already been the subject of a broad consultation with local stakeholders, government services and infrastructure operators to determine the best possible path for the lines from a technical and environmental standpoint. At the end of 2015, public inquiries had been launched for the projects in the towns that will be affected by the future Fécamp, Courseulles-sur-Mer, Saint Nazaire and Saint-Brieuc wind farms. Consultations are under way regarding the sites for the second call for tenders.
ENSURING SECURITY OF SUPPLY TO THE TERRITORIES AND REGIONS

“Brittany safety net” project

Brittany produces about 12% of the power it consumes. Its network of 400 kV and 225 kV lines is heavily used and must bring power in over long distances, from plants outside the region. This situation could result in power outages when demand peaks in winter. Addressing this risk requires making the grid more secure.

The solution proposed by RTE involves creating about 80 km of 225 kV lines, all underground, between the substations in Calan (near Lorient) and Plaine-Haute (near Saint-Brieuc), bringing power on the way to the Mûr-de-Bretagne substation. The new link will contribute greatly to grid security in the north and centre of Brittany, and to carrying the electricity produced by existing and future renewable generation sites in the region.

Since 2011, RTE has been using compensation equipment in the region to maintain voltage stability on the network. In August of 2015, a 200 MVar phase-shifting transformer was installed at the 225 kV Brennild substation.

The Declaration of Public Utility was issued in April 2015 for this major project, which will require 26 months of work and be divided into several phases:

- Civil engineering, power cable laying and assembly;
- Upgrades to existing substations in Calan, Mûr-de-Bretagne and Plaine-Haute.

The goal is to have the Brittany safety net in place by the end of 2017.

« 2Loires »

Built in 1941, the 225 kV link between Le Puy-en-Velay, Yssingelais and Saint-Etienne moves through a number of urban and industrial hubs in the Loire and Haute-Loire departments. The line has reached its technical limits after 70 years of service and due to changes taking place in the region.

The “2Loires” project involves replacing the existing line with a new 225 kV double circuit line with more capacity and adjusting its path to reflect the region’s changing needs. The idea is to supply power to the 225 kV substations at Sanssac and Trevas (Haute-Loire). A Declaration of Public Utility was issued for this project in July 2014, and work kicked off early in 2015 with the replacement of the conductors on the 225 kV Pratclaux-Sanssac line in November. The project is expected to be completed in 2017.

« Haute-Durance »

Power is supplied to this region primarily via a single 150 kV line dating back to 1936. The Haute-Durance now finds itself in a vulnerable position, particularly when power demand peaks in winter.

RTE has designed a programme divided into six projects that involve creating a 225 kV network to replace the existing 150 kV one and upgrading the 63 kV network (undergrounding, reconstruction or strengthening) while protecting the environment in Haute-Durance.

After six years of consultations with local stakeholders, the Hautes-Alpes prefecture and RTE officially launched work on the programme in April 2015 with a start on the partial undergrounding of the 63 kV Embrun-Mont Dauphin link. This project involving 18 work sites will be staggered over time until completion in 2020.
Main projects planned for the 2016-2025 period

Source: 2015 Ten-Year Network Development Plan
**ADEeF:** Association of Electricity Distributors in France.

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

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

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

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

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

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

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

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

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

**ERDF:** Électricité Réseau de Distribution France.

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

**Generation:**
- The “Hydro” category includes all types of hydropower stations (pondage, run of river, etc.). Consumption resulting from pumping at “STEP” (pumped storage stations) is not deducted from generation.
- The “Nuclear” category includes all nuclear power plants. Consumption by auxiliary generator sets is deducted from generation.
- The “Fossil-fired thermal” category includes fuels like coal, oil and gas.
- The “Bioenergy” category includes biogas, paper/paperboard waste, municipal waste, wood-energy and other solid biofuels.

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

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

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

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

Lightning density: Number of times lighting strikes per year and per square kilometre in a given region.

Load shedding: Mechanism by which consumers cancel or postpone all or part of their power consumption in response to a signal.

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

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

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

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

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

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

**Residential and professional customers:** Final customers to which distribution system operators provide low-voltage power, with contracted power of 36 kVA or less.

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

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

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

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

**Water reserves:** Filling rate (expressed as a percentage), corresponding to the relation between the storage volume recorded the previous Monday at midnight and the maximum storage volume, in aggregate.
GENERATION ADEQUACY REPORTS
Every year, RTE prepares and publishes a Generation Adequacy Report on the electricity supply-demand balance in France. Its goal is twofold: establish forecasts of trends affecting the equilibrium of the power system over five years and generate prospective scenarios for the longer term (15-20 years).

REGIONAL ELECTRICITY REPORTS
In March of every year, RTE breaks down the national Electricity Report to look at the individual administrative regions. These regional reports give local governments insight into consumption, generation and exchange trends as well as network development projects at the regional level.
http://www.rte-france.com/fr/article/bilans-electriques-regionaux

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