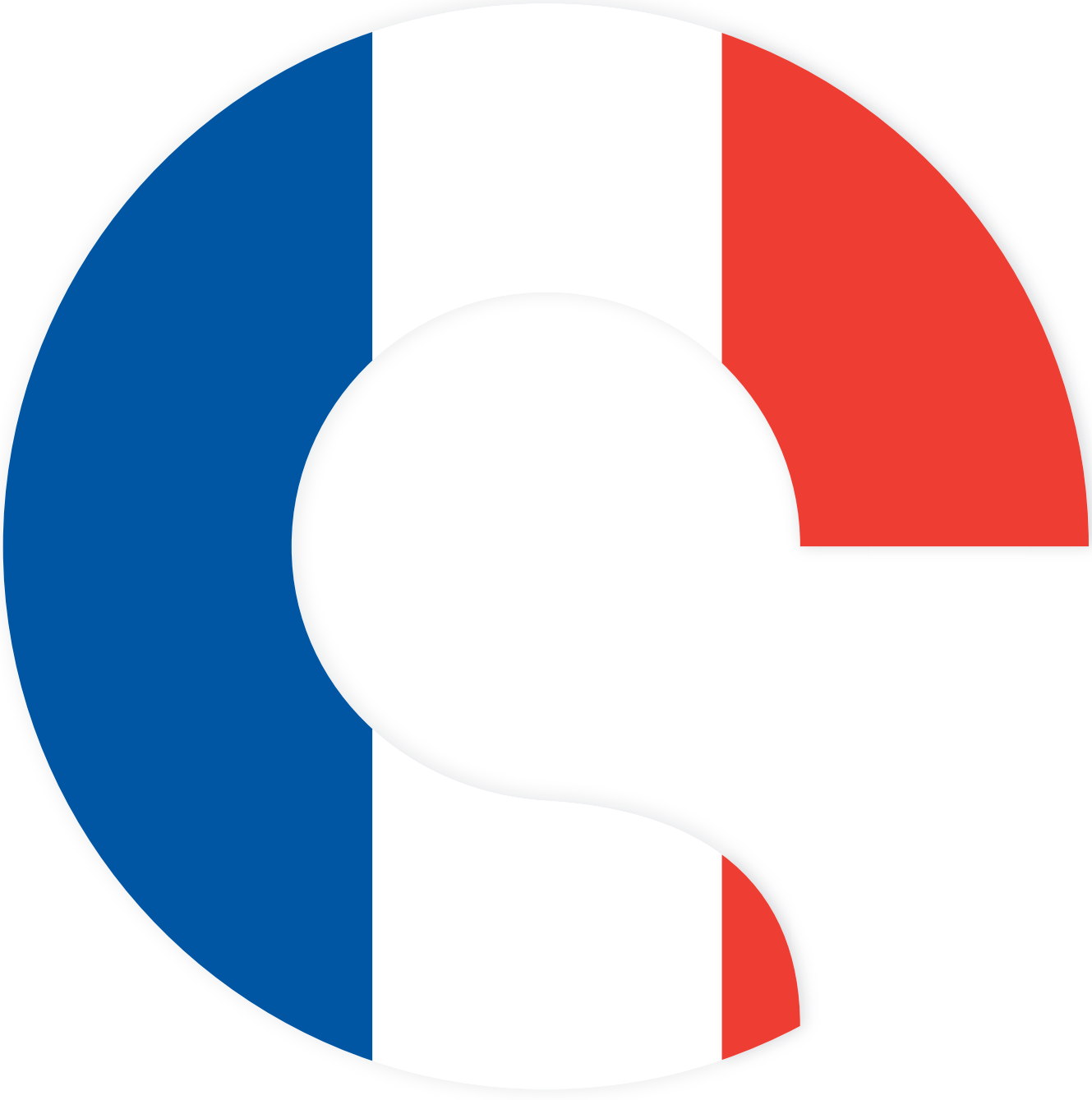
Report on the French Power System

Version 1.1

COUNTRY PROFILE

Agora Energiewende



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IMPRINT

COUNTRY PROFILE
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Preface

Dear Reader,

In recent years, the European Union adopted ambitious goals to move towards a low carbon economy and fully integrated energy markets. Although European countries pursue different strategies to achieve these goals, they are facing similar challenges in terms of cost-efficiency, security of supply and sustainability.

France is playing an important role in this transformation process. The country is currently reshaping its energy and climate policy, with a commitment to reduce the share of nuclear energy in the power mix, together with ambitious goals for the development of renewables and energy efficiency. This French energy transition paradigm (transition énergétique) is serving as a common ground for stronger energy cooperation with Germany.

The French-German relationship is indeed a singular one, and this is no less true for energy policy! France and Germany are the two largest power markets in Europe, together representing more than a third of the electricity consumed and produced in the European Union. Both countries have a track record of cooperation in the field of energy policy and play a driving role in the process of integrating European power markets. Though they have relied on different power mixes historically, France and Germany are currently implementing comparable energy transition policies that make use of renewable energy and energy efficiency, but to different degrees and at different speeds.

This convergence has naturally led the two countries to enhance their bilateral and regional cooperation. This is especially important since the two power systems are already significantly intertwined, directly through cross-border electricity flows, and indirectly through ties with common neighbours. Whatever happens in one country unavoidably affects the other.

While cooperation between the two countries is important, there is still a number of misunderstandings and misperceptions on both sides of the Rhine. In this context, this country profile aims to provide a better understanding of the French power sector. It focuses on recent energy policy and regulatory developments as France reshapes its energy and climate policy.

This country profile is the fourth of a series that will eventually cover Germany and a selection of other European countries. It is an ongoing effort to understand what is happening beyond Germany's borders as a key for further cooperation. The paper provides a descriptive overview of market structure, regulatory frameworks and political developments of the French power sector. This report is certainly not exhaustive. Rather, it is work in progress that will be updated regularly. We thus invite everyone to send us comments and corrections to countryprofile@agora-energiewende.de.

May this country profile be helpful for your work!

Dr. Patrick Graichen
Executive Director of Agora Energiewende

Markus Steigenberger
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Content

Acronyms Table 1

ADEME	Agence de l'Environnement et de la Maîtrise de l'Energie – French Environment and Energy Management Agency
ARENH	Regulated access to historical nuclear power (Accès Régulé à l'Electricité Nucléaire Historique)
ASN	Autorité de sûreté nucléaire – Nuclear Safety Authority
CoRDiS	Comité de règlement des différends et des sanctions – Standing Committee for Disputes and Sanctions
CRE	Commission de Régulation de l'Energie – French Energy Regulator Authority
CSPE	Contribution au Service Public de l'Electricité – tax levy recovering charges related to the public service obligation (including financing renewable energies)
CTA	Contribution tarifaire d'acheminement – transportation tariff contribution
Cumac	Unit for energy savings – Cumulative energy savings discounted at 4% over the life-time of the energy efficiency measures.
DSO	Distribution System Operator
EDF	Électricité de France
EEX	European Energy Exchange
EPEX	European Power Exchange
ERDF	Électricité Réseau Distribution France
EU ETS	European Emissions Trading System
FiT	Feed-in tariff
GW	Gigawatt
GWh	Gigawatt hour
kWh	kilowatt hour
MW	Megawatt
MWh	Megawatt hour
POPE Law	Loi de Programmation fixant les Orientations de la Politique Énergétique
PV	Photovoltaic
RTE	Réseau de Transport d'Électricité – French Electricity Transmission System Operator
TCFE	Taxe sur la consommation finale d'électricité – tax on final consumption of electricity
TSO	Transmission System Operator
TURPE	Tarif d'Utilisation des Réseaux Publics d'Electricité – Charge for Use of Public Electricity Grids
TWh	Terawatt hour
VAT	Value Added Tax

1 Overview

This report explores the structure of the French power sector. It looks at the power mix, production and consumption, ownership and market structure, cross-border trade and energy policy.

The French power mix is dominated by nuclear power, which in 2014 accounted for 49 percent of the 129 GW total installed capacity and 77 percent of electricity production. France also has a significant amount of hydropower, accounting for about 20 percent of installed capacity and 13 percent of production in 2014. The share of renewable resources in France has been continuously rising over the past few years and in 2014 accounted for 11.3 percent of installed capacity and 5.3 percent of production (excluding hydro). Other resources, including coal, natural gas and oil, accounted for 5, 7 and 8 percent of installed capacity, respectively.

Main Indicators	
Total population	66.3 million
GDP	2138 billion EUR
Average electricity consumption per household	4,977 kwh/year (electrified households)
Total annual consumption	474.1 TWh (weather adjusted)
Total Installed Capacity	129 GW
Max Peak Demand	102.1 GW (February 2012)

The French power market is highly concentrated. It is dominated by Electricité de France (EDF), which is 85 percent owned by the French state and is responsible for the bulk of generation and retail services in France. EDF also owns the transmission system operator (TSO), RTE. While there is retail choice, customer switching from incumbent to alternative suppliers remains low. In 2013, alternative suppliers accounted for just 8 percent of the residential retail market and 22 percent of the commercial retail market (as a percentage of annualised sales).

In August 2015, the French "energy transition bill for green growth" entered into force. This ambitious legislative package implements French objectives in terms of environmental protection, energy mix diversification and energy security. In particular, this package set targets to:

- 1. reduce the share of nuclear energy in the power mix to 50 percent by 2025 (as opposed to a share of 72 percent in 2012) and cap nuclear capacity at its current level (63 GW)[1];
- 2. increase the proportion of renewable energy in final energy consumption to 32 percent by 2030 (2012: 16 percent) and in power consumption to 40 percent by 2030 (2014: 20 percent);
- 3. reduce CO_2 emissions by 40 percent between 1990 and 2030;
- 4. reduce the consumption of fossil fuels by 30 percent by 2030;
- 5. reduce final energy consumption by 50 percent by 2050; and
- 6. develop 7 million loading stations for electric vehicles in 2030.

The Energy Transition Bill is the result of a broad national debate started in 2012. This law builds on the commitments of President Hollande (2012) as well as on the goals and policies set forth in the Grenelle I and II laws (2009 and 2010). A multi-year energy program (programmation plu-

1 President Francois Hollande also committed to close the oldest French nuclear power plant (Fessenheim) but the energy transition law does not explicitly mention the commitment. Nevertheless, the capping of nuclear capacity to its current level implies that power plant capacities must be closed down in order to allow the start of the new Flamanville 3 nuclear reactor (currently scheduled for 2018).

riannuelle de l'énergie – PPE) is currently being developed in order to steer the trajectory of the power sector transformation.

This transformation process is addressed in the context of important reinvestment decisions: a number of nuclear power plants will reach the end of their 40-year life cycle in the decade to come and about half of France's oil and coal-fired fleet (11 GW in 2015) will retire between 2015 and 2018.

2 Industry Structure, Ownership and Regulation

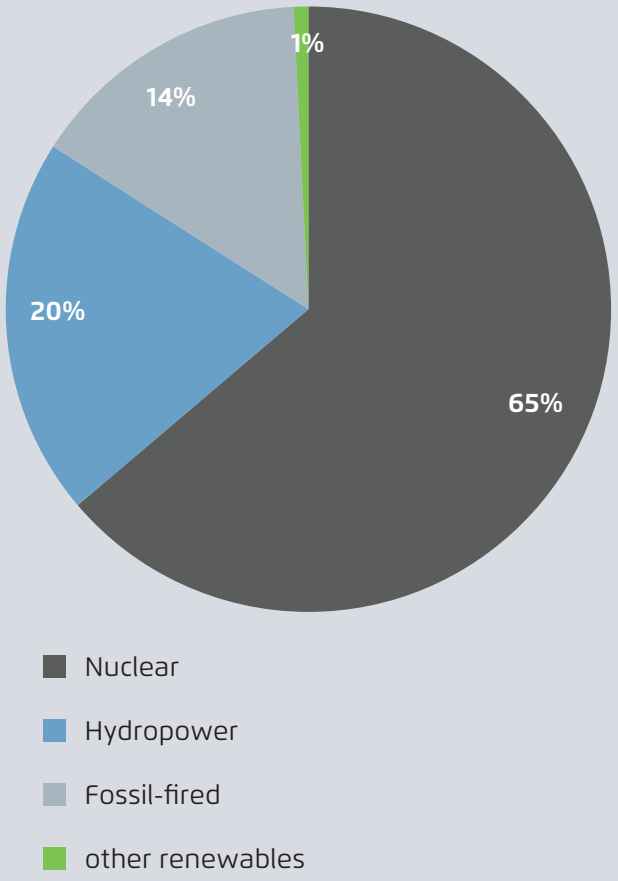
2.1 Industry structure

Electricite de France (EDF) is the largest energy company in France, and a majority state-owned company. EDF and its subsidiaries clearly dominate all market sectors in France, including transmission (RTE), distribution (ERDF), generation and retail supply. The company owns about 80 percent of the installed capacity in France and generates 86 percent of national electricity production. In 2014, nuclear power dominated its portfolio, making up 64 percent of installed capacity, followed by hydro at 20 percent.

EDF's subsidiary, Réseau de Transport d'Electricité (RTE), owns and operates France's transmission network.

EDF's distribution subsidiary, Électricité Réseau Distribution France (ERDF), manages 95 percent of electricity distribution grid in France through more than 730 concession contracts with local authorities[2].

EDF Installed Capacity in France, 98 GW (end 2014) Figure 1



EDF, 2015.

Since 2007 all customer classes have been able to select their retail provider, however, most customers – especially residential customers – have remained with incumbent suppliers (EDF, local distribution companies and their subsidiaries) and pay regulated tariffs (see Section 5.2 - The Retail Market). In the context of the reorganization of the power sector (NOME Law – see section 5.1.1), regulated tariffs for non-residential customers will be phased out by the end of 2015. Residential customers will keep the choice of contracting with an incumbent supplier at market rates or continuing to pay regulated tariffs.

Currently there are twenty retail suppliers active on the market, all of whom offer supply to non-residential customers and twelve of whom offer supply to residential customers as well[3]. In 2015, 92 percent of residential customers remained under regulated electricity tariffs – the majority directly with EDF[4]. 54 percent of non-residential customers had regulated electricity tariffs with EDF, 23 percent had market-price contracts with incumbent suppliers, and 22 percent had market-price contracts with alternative suppliers.

2 Électricité Réseau Distribution France ("ErDF"), 2013a.

3 Commission de Régulation de L'énergie ("CRE"), 2014c.

4 Under 5% of those customers have regulated electricity tariffs with incumbent local distribution companies. See CRE, 2015.

Market Share of French Electricity Companies — Table 2

Sector	Leading companies	Market Share	Remaining companies
Transmission	RTE	**100%**	
Distribution	ErDF	Manages **95%** of distribution network under over 730 concession contracts with local authorities	160 local distribution companies provide distribution services for 5% of the network (and population)*
Generation	EDF	About **80%** of installed capacity (98 GW) and 85% of production (460 TWh) in 2014**	Compagnie Nationale du Rhône (3% – mostly hydro); GdF Suez; E.On
Retail	EDF	35 million connection points (customers) in mainland France***	See Table 4****. No other retailer serves even 5% of the retail market.

*ErDF, 2013b. **EDF, 2015. ***EDF, 2013a at 14. ****European Commission, 2013a.

Ownership Structure of French Electricity Companies — Table 3

Companies	Ownership
EDF	84.5% French government; remainder: institutional investors, retail investors, employer shareholding, treasury shares.
RTE	100% owned by EDF.
ErDF	100% owned by EDF.

EDF, 2013b.

France has transposed Directive 2009/72/EC concerning common rules for the internal market in electricity. The electricity transmission operators (TSO) and most of the distribution system operators (DSO) consolidated their independence from their parent companies. Still, the regulator (CRE) reported various breaches in the independence of some DSOs, as well as confusion between

Energy Supplies in France Table 4

Supplier	Residential	Commercial
Alpiq		X
Alterna	X	X
Axpo		X
Direct Energie	X	X
E.ON		X
Enalp		X
EDF	X	X
Enel France		X
Enercoop	X	X
Energem	X	X
Enovos		X
GDF SUEZ	X	X
GEG	X	X
Iberdrola		X
Sélia	X	X
Lampiris	X	X
Lucia	X	x
Planète Oui	X	X
Proxelia	X	X
Vattenfall		X

CRE, 2014c.

corporate identity, communication practices and branding of some DSOs and their parent companies[5].

5 Council of European Energy Regulators, 2014.

2.2 Policy setting and regulation

The **Commission de régulation de l'énergie (CRE)** is the national energy regulator. Its main mission is to support "the correct operation of the electricity and natural gas markets for the benefit of the end consumer, in accordance with energy policy objectives"[6].

The CRE is divided into two independent bodies: the Board of Commissioners and the Standing Committee for Disputes and Sanctions (CoRDiS - Comité de règlement des différends et des sanctions). The Board of Commissioners oversees regulation of the electricity and gas markets, while CoRDiS is responsible for settling technical and financial disputes between operators and users of the public electricity and natural gas networks. Members of the Board of Commissioners serve a non-renewable term of two to six years, and members of the CoRDiS serve for a non-renewable term of six years.[7]

The CRE's duties include:

- → regulating the markets to ensure competition;
- → ensuring non-discriminatory access to the transmission and distribution networks;
- → setting the transmission and distribution tariffs (starting in January 2016, CRE will also propose regulated tariffs for residential end-use consumers[8]; through December 31, 2015, these tariffs will continue to be set by the Energy and Finance Ministers);
- → approving annual investment programmes of RTE and reviewing Ten Year Network Development Plans;
- → monitoring the retail market, as well as the transactions on the wholesale electricity, natural gas, and CO_2 markets;
- → as of December 7, 2013, setting the price for regulated access to nuclear power, previously under the purview of the Energy and Finance Ministers (section 5.2);

6 CRE, 2013a at 6.

7 CRE 2013a at 6-7.

8 The decision is regarded as established unless there is opposition from one of the ministers within three months of the proposal.

→ issuing opinions on market design issues, as well as on decrees that set feed-in tariffs for energy produced from waste or renewable energy facilities[9].

Ministry of Ecology, Sustainable Development, and Energy (Ministère de l'Ecologie, du Développement durable et de l'Energie, MEDDE) has broad responsibilities covering energy, environmental and climate policy, as well as a range of other areas including transport, aviation and urban development. Within the Ministry, the Directorate General for Climate and Energy (DGEC) is responsible for shaping and implementing climate and energy policies.

The **Supreme Council of Energy** (CSE -Conseil superieur de l'énergie) is an advisory body set up by the MEDDE, whose objective is to advise MEDDE on national energy policy. It also assesses the development of renewables in final energy consumption. The opinions of the CSE are purely advisory. The CSE members are appointed by the Minister of Energy for a five-year term. The CRE must consult the Supreme Council of Energy prior to decisions on matters "that could have a significant impact on energy policy objectives"[10].

ADEME (Agence de l'Environnement et de la Maîtrise de l'Energie) is the French Environment and Energy Management Agency. The agency is charged with the implementation of public policy related to environmental protection, energy, and sustainable development. One of the agency's chief roles is the implementation of France's policy on the rational use of energy – including energy efficiency and renewable energy. ADEME works with businesses, local governments, public administrations and the general public by providing its expertise and financing assistance.[11]

The **Competition Authority** (Autorité de la concurrence) carries out all activities related to regulation of competition in France, including inquiries, antitrust activities, merger control, publication of opinions and recommendations. Among other things, it consults with CRE in setting the accounting rules for separation of activities between the production, transmission and distribution of electricity.

The **Nuclear Safety Authority** (Autorité de sûreté nucléaire, ASN) is an independent administrative authority tasked with regulating nuclear safety and radiation protection according to the June 2006 law on nuclear transparency and safety.[12]

9 CRE, 2013a at 8-17.

10 CRE, 2013a at 8.

11 Agence de l'Environnement et de la Maîtrise de l'Energie, 2013.

12 From ASN, 2013.

3 Energy Production and Consumption

3.1 Installed capacity

In 2014, France has 129 GW of installed capacity. The power mix is dominated by nuclear power, which accounts for about 50 percent of installed capacity and 77 percent of total electricity production[13].

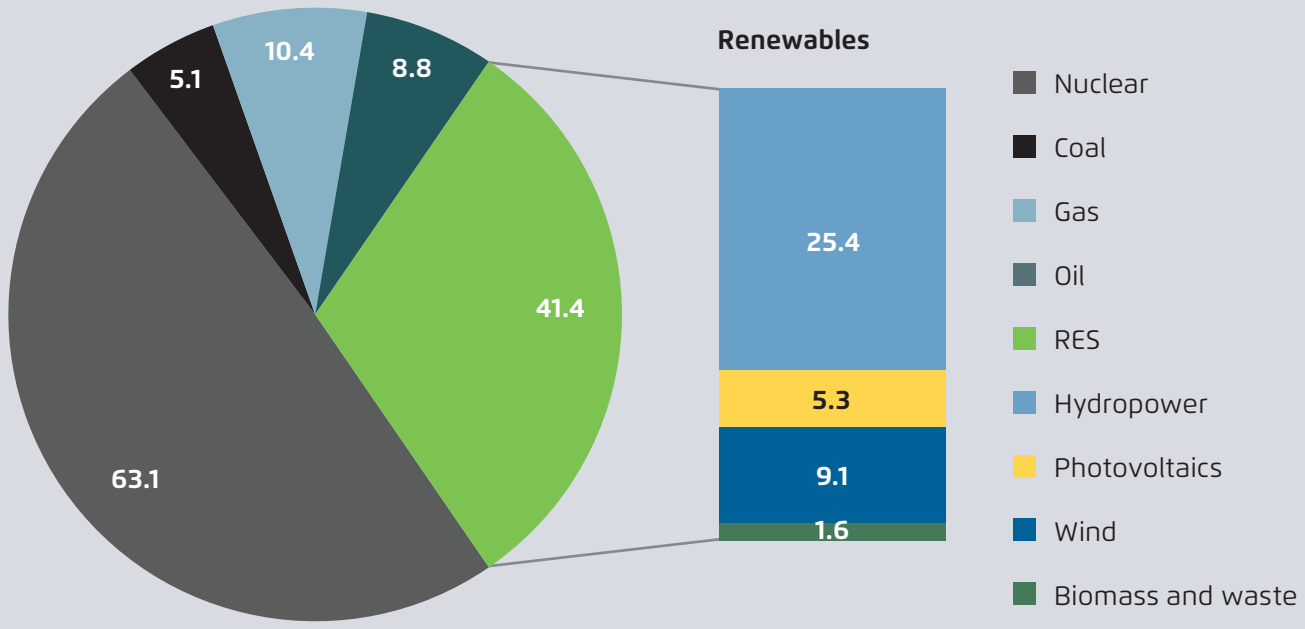
Key Figures	
Installed capacity	129 GW (2014)
Peak Demand	102.1 GW (2012)
Energy Consumption	465 TWh (2014) non-weather adjusted

Renewable energy is dominated by large, established sources of hydropower, which account for nearly 65 percent of total installed renewable capacity (39.3 GW). Wind power accounts for 22 percent of installed renewable capacity (9.1 GW) and solar PV for 13 percent (5.3 GW). France also has 1.5 GW of electricity generated by thermal renewables (biogas, biomass and particularly waste).

3.2 Electricity production

In 2014, 77 percent of electricity production came from nuclear power, 13 percent from hydropower, 5 percent from gas, coal and oil-fired facilities, and the remainder from wind, PV, and other renewables. Figure 3 reflects electricity

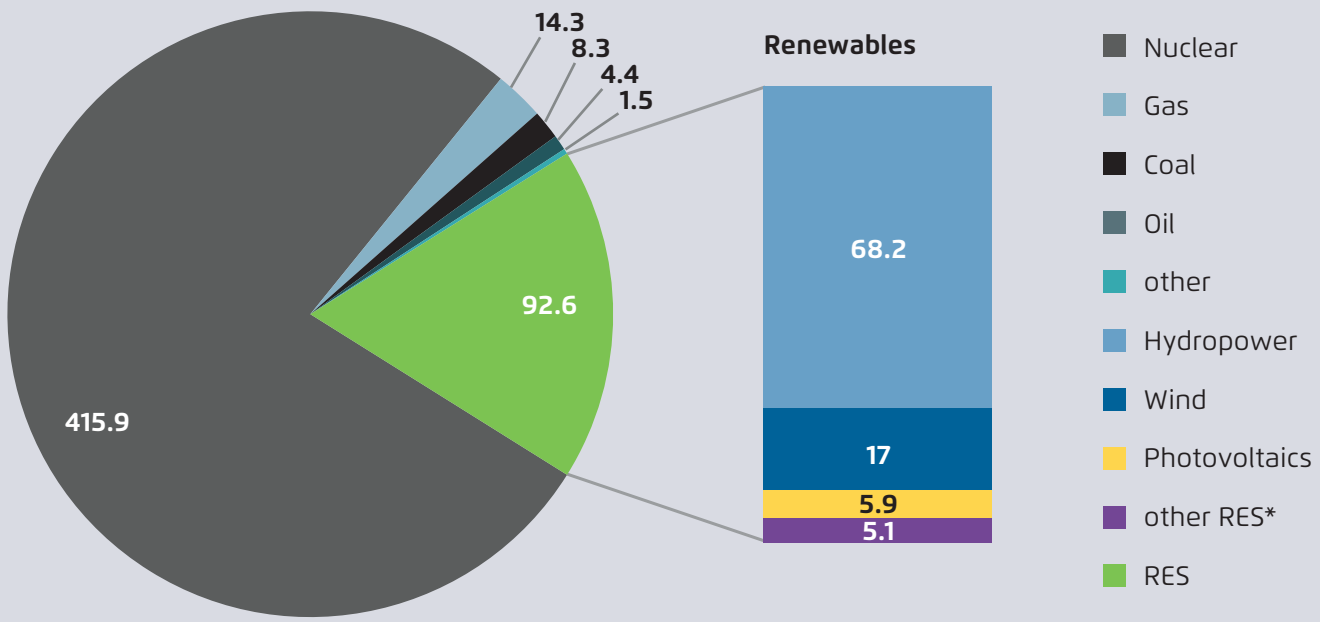
French Power Mix, Installed Capacity in GWs (total of 128 GW), 2014 Figure 2



RTE 2014

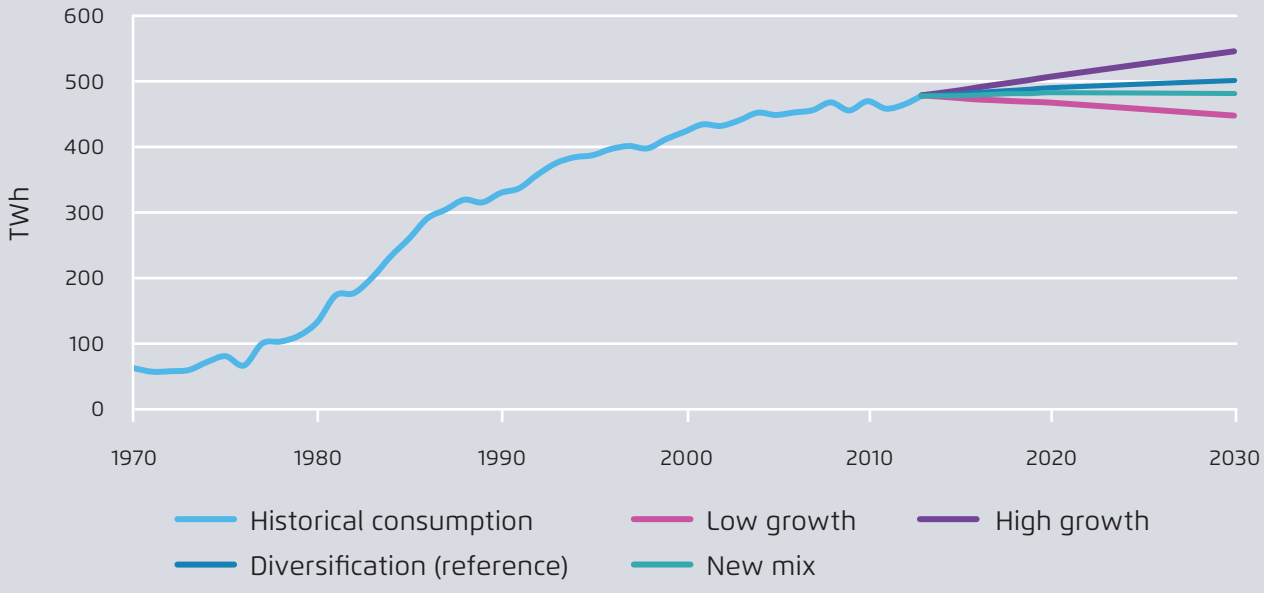
13 RTE, 2014.

Electricity Production by Energy Source (total of 540.6 TWh), 2014 Figure 3



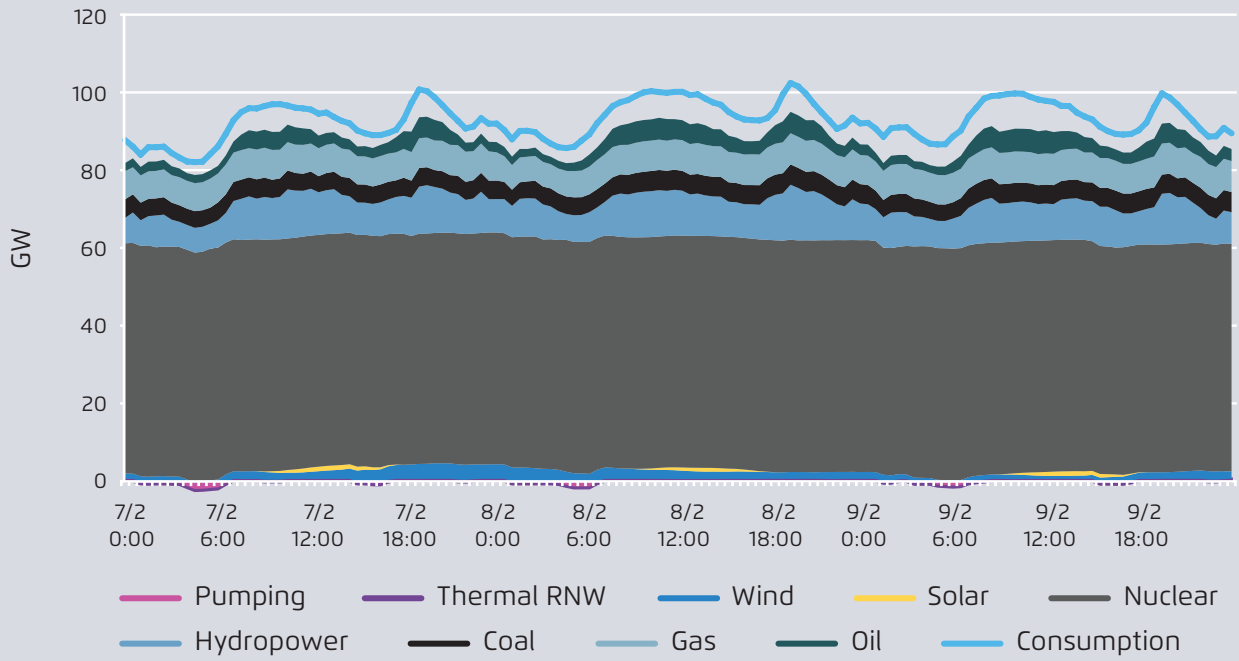
RTE, 2014; *Thermal power plants burning household waste, biogas, and biomass from paper production.

Annual Demand and Projected Demand to 2030 (in TWh) in four Different Scenarios Figure 4



Source: RTE, 2014 at 179.

Sample Breakdown of Load Curve on Very Cold Days, 7 – 9 Feb. 2012 Figure 5



Source: RTE, eco2mix.

production in France in 2015 by source, including electricity exports.

3.3 Electricity consumption

In 2014, electricity consumption (including transmission and distribution losses) reached 465.3 TWh. Consumption was about 30 TWh lower than in 2013, primarily due to a mild winter[14]. In a reference scenario of the French TSO RTE, French domestic demand is expected to grow slowly through 2030 ("diversification" scenario).

3.4 Peak demand

French annual peak demand coincides with cold winter weather due to the significant proportion of electric heating in buildings. About 35 percent of primary residences (2013) and 25 percent of floor space in the tertiary sector (2011) were heated with electricity.[15] Energy consumption usually peaks at 7:00 pm in the winter, when people go home and turn on heating, lights and home appliances, while businesses are still consuming high amounts of energy. The highest historical peak of 102.1 GW was reached on 8 February 2012 at 7:01pm, higher than the previously recorded highest peak on 15 Dec 2010 (96.71 GW)[16]. Figure 5 demonstrates the load curve of the peak demand on that day. Table 4 shows the expected evolution of a "one-in-ten-years" peak load.

3.5 Planned conventional power plants in the pipeline

While the French power sector is dominated by nuclear power, fossil fuel-fired power plants account currently for 24 GW of installed capacity, making up 20 percent of the

14 RTE, 2012b, 2013.

15 ADEME, 2014 and ADEME, 2013.

16 CRE 2013a.

"One-in-ten-Year" Peak Load Forecast by Scenario, GW Table 5

	2020	2030
High demand (high economic and population growth)	106.1	114.0
Diversification (reference mix)	103.1	105.2
New mix (high RES and DSM)	101.7	100.0
Low demand (low economic and population growth)	99.7	96.1

Source: RTE 2014.

total fleet. By 2016, about half of this fleet will be retired, including 1.9 GW of coal, 3.8 GW of oil and a minimum of 3 GW of CHP units[17]. At the same time, two new combined cycle gas turbines are expected to come online by 2017, and existing OCGTs are expected to remain in service[18].

One nuclear reactor is currently under construction in France, the Flamanville 3 reactor. The reactor will have an installed capacity of 1.63 GW and, after delays and cost increases, is expected to operate in 2018. Since the energy transition bill caps the maximum level of nuclear capacity to its current level (63 GW), 1.63 GW of nuclear capacities will have to shut down when Flamanville opens. While President Francois Hollande publicly committed to close the oldest French nuclear power plant (Fessenheim), the energy transition law does not explicitly name any reactor. Other reactors could therefore in principle be shut down in place of Fessenheim.

17 These CHP units are covered by electricity purchase contracts, and include three main types of sources – steam turbines, OCGTs and internal combustion engines that are part of heating networks or industrial operations.

18 See RTE, 2014 at 91-93.

4 Imports and Exports

France is interconnected with Belgium, Germany, the UK, Spain, Italy and Switzerland. It takes part in four of the seven Electricity Regional Initiatives defined by the European Commission: Central-West, Central-South, South-West and France-UK-Ireland[19].

The French day-ahead market is coupled with all neighbouring markets (except Switzerland) and beyond, as part of the Multi-Regional Coupling area[20]. The next integration steps, namely the coupling of the continuous intraday markets, is under way. In addition, France has had in place a continuous intraday mechanism with Switzerland since 2012.

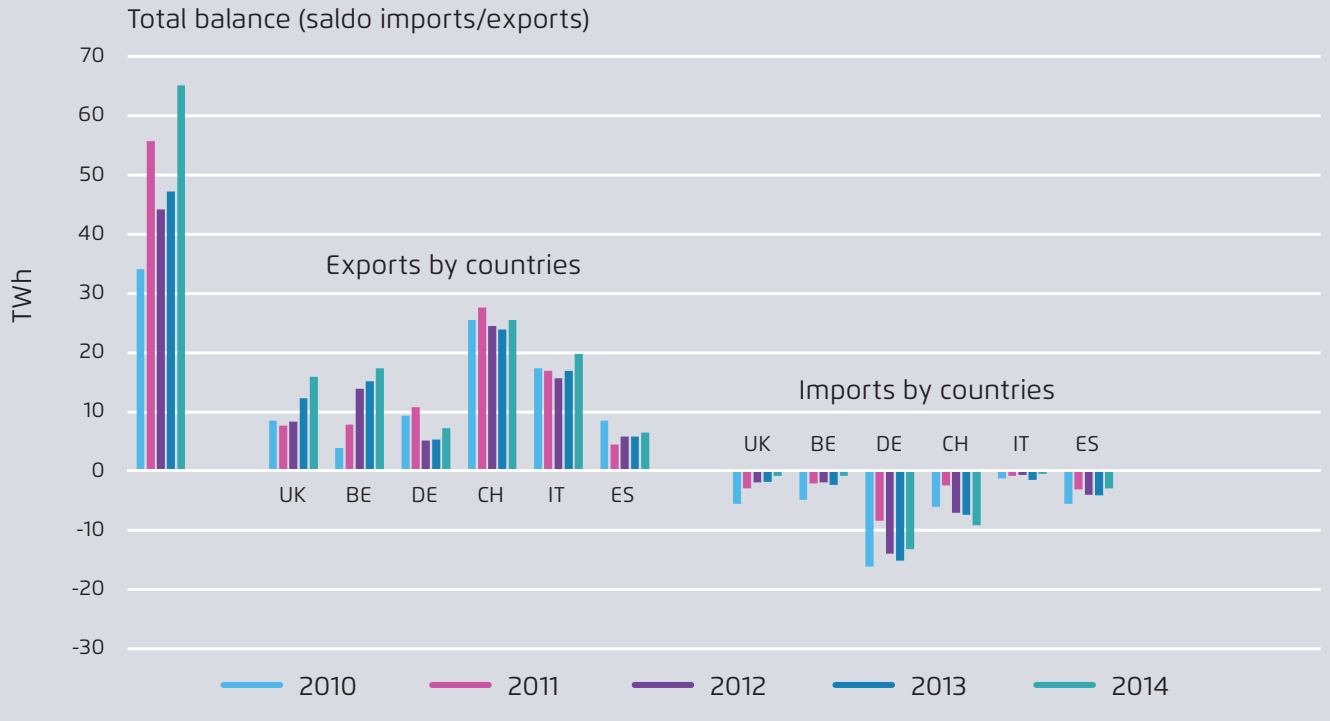
France is a significant net exporter of electricity (with a balance of 65 TWh in 2014, corresponding to 14 percent of its electricity consumption). The greatest volumes of contractual exports flow to Switzerland and Italy (see Figure 6). France is a net importer from Germany. However, in physical terms, France exports a larger share to Germany, which are in fact transit flows to Switzerland, Belgium and Italy.

19 See Council of European Energy Regulators, 2013b.

20 The Multiregional Coupling area is composed of 19 countries: CWE region (France, Belgium, Germany, Austria, The Netherlands, Luxemburg), the SWE region (Denmark, Sweden, Finland, Norway, Latvia, Lithuania, Estiona, Great Britain), Finland, Italy, Portugal, Spain.

Import / Export Balance of Contractual Exchanges between France and its Neighbours (2010–2014), in TWh

Figure 6



RTE 2014.

5 Electricity market

5.1 Wholesale market, prices, and liquidity

5.1.1 Electricity market design

The French wholesale electricity market adheres to the West European design, with producers, suppliers and traders able to buy and sell energy bilaterally via brokered contracts or on the EPEX and EEX power exchanges. Trading takes place in the forward, day-ahead spot and intra-day timeframes up until gate closure, which occurs 1 hour before real time. At this point, the System Operator, RTE, assumes responsibility for creating a final energy balance for each trading period and ensures that the power flows resulting from the trading process do not exceed the physical capabilities of the electricity grid.

The electricity market has to date operated as an "energy-only" market, with no explicit reward for capacity other than in the reserve markets. However, following the adoption of the "Nome law" (Nouvelle Organisation du Marché de l'Electricité) in 2010, a decentralized capacity market has been introduced in 2015 with certification of capacities in preparation for the first delivery period, planned for 2017. Details of the capacity mechanism are set out in Décret n° 2012-1405 du 14 décembre 2012[21]. A second resolution, specifying the concrete rules of the mechanism, has been adopted in January 2015 on the basis of a proposal made by the TSO (RTE)[22].

The **French capacity mechanism** was introduced in response to a projected decrease in resource adequacy, reinforced by the historic system peak of 102.1 GW on February 9, 2012, which brought the system to the breaking point. The French power system is highly sensitive to temperature fluctuations due to the prevalence of electric heating systems. A 1°C decrease in temperature increases demand by 2.3 GW. To address this issue, the capacity mechanism obliges suppliers to purchase sufficient capacity certificates to cover forecast demand at peak time. All producers and DSM aggregators in France must certify ex-ante the availability of their capacities. Renewable energy producers must certify their capacities either on a normative basis (applying a capacity factor) or on a declarative basis (allowing pooling of diverse capacities). Demand response, which is expected to fulfill much of the demand for certificates for peak periods, can be certified explicitly as well as implicitly (by reducing the suppliers' level of obligation).

Suppliers will comply with their obligation by purchasing the volume of capacity certificates that corresponds with the projected demand of their clients' portfolio. Certificates will be procured via bilateral transactions, though an organized trading platform may be implemented as well. An ex-post control system with high penalties ensures that participants meet their obligations[23].

At the moment, only capacities in metropolitan France can participate in the market. Interconnections are taken into account implicitly by reducing the overall level of the suppliers' obligations. In order to comply with EU-legislation, the TSO (RTE) will work out detailed rules, on the basis of a broad public consultation, on if and how foreign capacities will be able to participate in the mechanism.

5.1.2 Market liquidity

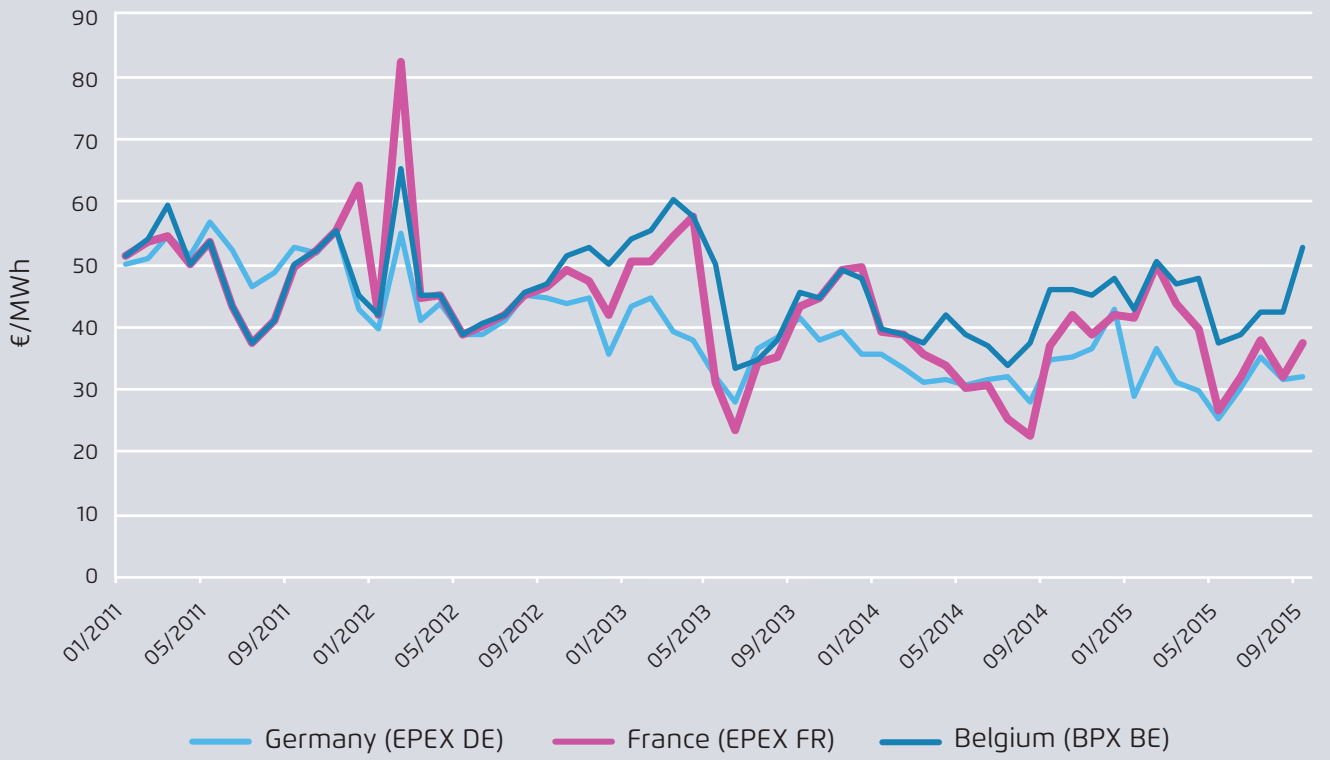
The French power market remains highly concentrated and, although increasing, wholesale market liquidity is low compared with its neighbours. Wholesale market concentration in terms of production as measured by

21 Décret n°2012-1405, 2012 relatif à la contribution des fournisseurs à la sécurité d'approvisionnement en électricité et portant création d'un mécanisme d'obligation de capacité dans le secteur de l'électricité.

22 RTE, 2014c and Arrêté du 22 janvier 2015 définissant les règles du mécanisme de capacité

23 RTE 2014c.

Monthly Average Wholesale Electricity Prices in the CWE Region Figure 7



EpexSpot, Belpex.

the HHI index[24] is currently at 8852[25], while liquidity in 2014 measured as the percentage of energy traded day-ahead compared with national energy demand was 14 percent[26] (compared with around 40 percent for Germany and 67 percent for Spain[27]).

5.1.3 Wholesale market prices

France's wholesale electricity market is well integrated with those of its neighbours through the Central-West European (CWE) regional market, which has a generally high level of price convergence[28]. The price convergence between French and German prices , while historically high (65 percent in 2012), has fallen since 2013 (price convergence of 48 percent in 2013, 51 percent in 2014 and 33 percent during the first semester of the year 2015). The convergence between French and Belgian prices is historically very high (85 percent over 2012) but has drastically fallen with the temporary closure of two Belgian nuclear power plants (Doel 3 and Tihangue 2) since March 2013.[29]

24 The Herfindal-Hirschman Index (HHI) is defined as the sum of the squares of the percentage market share of each market participant. The index can range in value from 0 to 10,000 – the higher the index the more concentrated the market. A market with an HHI of less than 1000 is generally considered competitive; a market with an HHI in the range 1000-1800 is considered as moderately concentrated; a market with an index above 1800 is considered highly concentrated.

25 As of the second quarter of 2015, CRE, 2015.

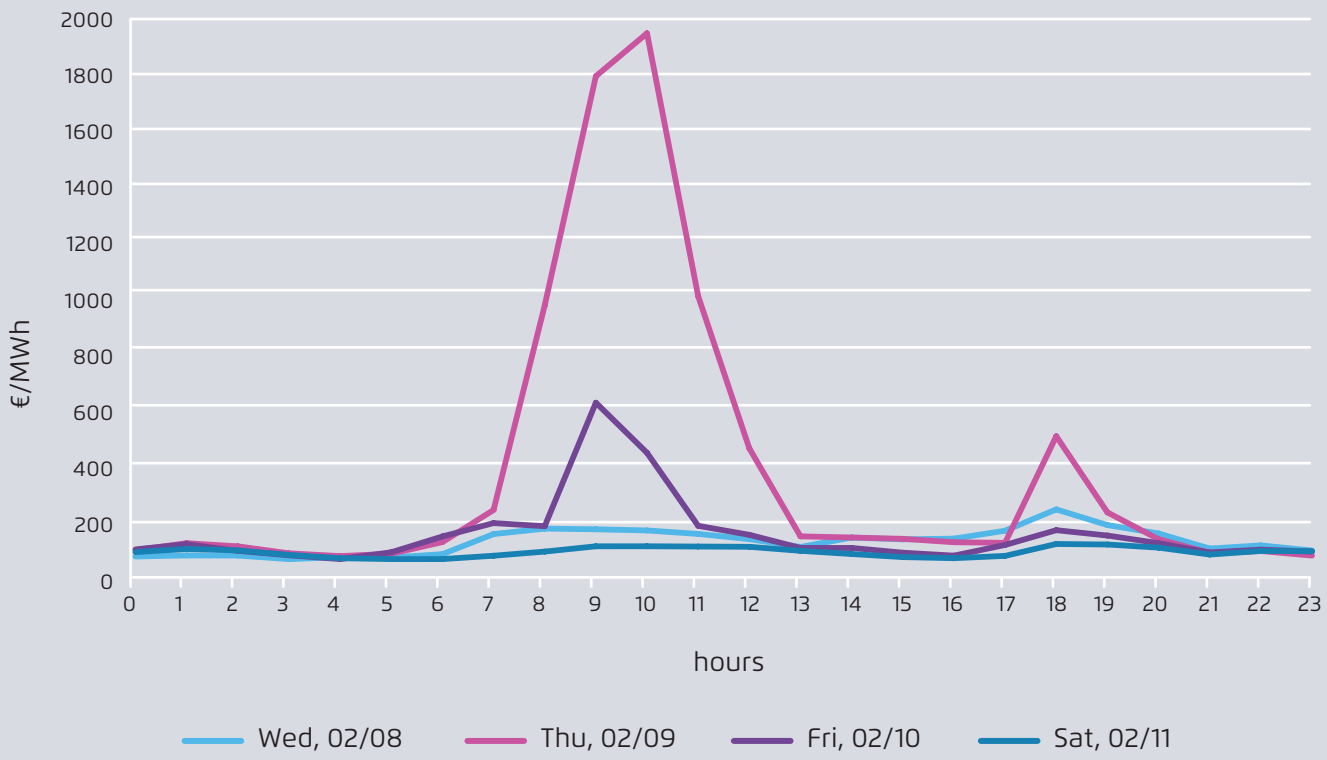
26 Data excludes day-ahead exchanges through brokers. Including these exchanges, the percentage of energy traded day-ahead compared to national energy demand amounts to 21%. CRE, 2014b.

27 Data for 2012. ACER, 2012.

28 European Commission, 2012.

29 CRE 2014.

France Price Spikes in 2012 – Hourly Electricity Prices from 8 to 11 February 2012 Figure 8



Source: Epexspot.

Since 2012, day-ahead electricity prices have taken a diverging trend in the CWE region, in response to increasing share of wind and pv in Germany (driving German wholesale prices down more than elsewhere in the region), low CO_2 prices and cheap coal in the international market (contributing further to low German prices). Reduced availability of the nuclear power plants in Belgium strengthens this divergence. As a consequence, electricity exports – especially from Germany – reached a record, constraining interconnectors between national markets.

France has also experienced a couple of negative-prices events, most notably on the 16th June 2013, where high levels of wind and solar power in Germany caused wholesale prices in France to fall below -€200 /MWh.

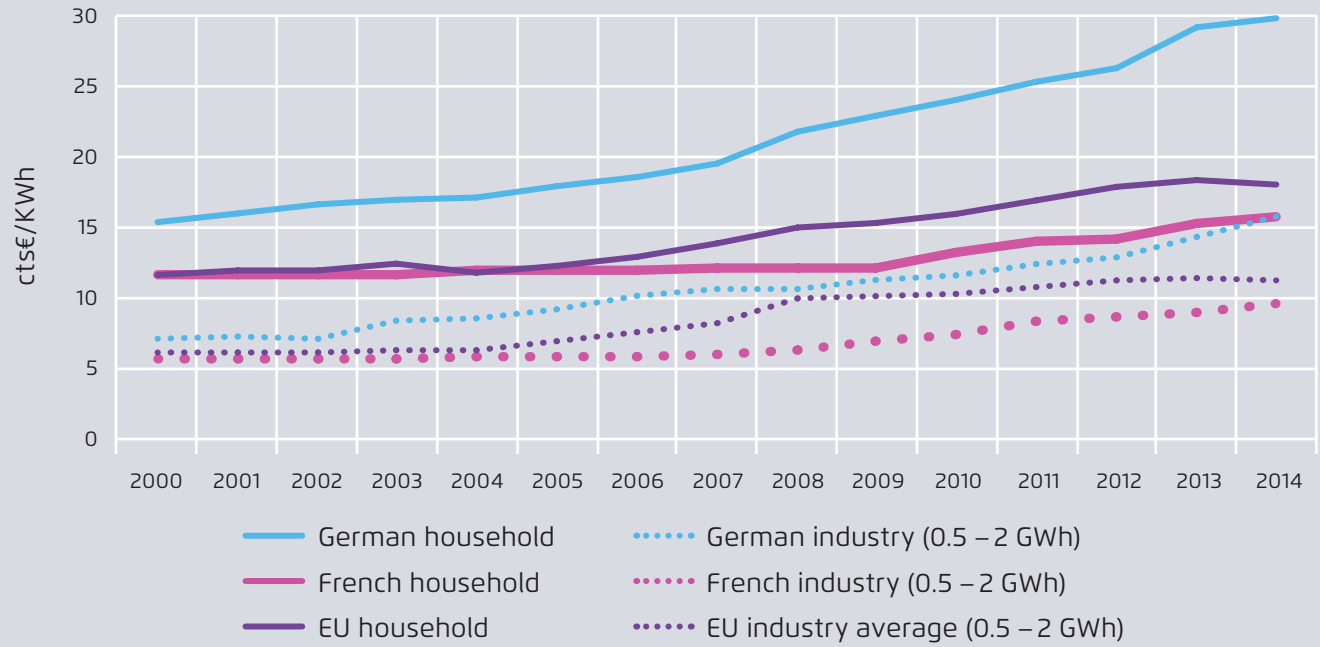
France experienced huge price spikes in Feb 2012 due to cold temperatures, culminating in the coldest day on Feb 9, 2012.[30] The last three winters have been milder with reduced peak prices. Since 2013, the day-ahead prices on the French market have been globally in decline. The baseload prices reached an historical minimum with an average of 34.7 €/MWh in 2014. This trend is explained by mild weather, low demand, as well as good hydro and nuclear availability in France. The monthly average prices have, however, slightly increased since the beginning of the year 2015.

5.2 The retail market

The deregulation of the retail electricity market in France has been, and continues to be, developed in stages. Since

30 CRE, 2013a at 40.

Retail Electricity Prices in France, Germany and EU Average (cts€/kWh*) Household Prices include all Taxes; Industry Prices are without VAT (consumption band 0.5-2 GWh) Figure 9



Eurostat, 2015; *This is based on prices for medium-sized industrial customers (500 – 2000 MWh/year) and for average household customers (2,500 – 5,000 kWh/year).

2007 all customers, including domestic customers, have been able to contract at market rates with an alternative or incumbent supplier. However, regulated electricity tariffs with incumbent suppliers (EDF, local distribution companies and their subsidiaries) remain under certain circumstances. In 2010, in response to two investigations of the European Commission, a new law on the organisation of the French power market (NOME law) was adopted by the French parliament as an attempt to increase competition at the retail level. This new regulatory framework eliminates the regulated tariffs for industrial customers (so-called "yellow and green tariffs") at the end of 2015. Regulated tariffs are nevertheless maintained for household customers ("blue tariffs"). On the other hand, this new legislation allows alternative suppliers to purchase a certain volume of EDF nuclear power, with an overall ceiling of 100 TWh[31], at a regulated price, currently set at €42/MWh (so-called ARENH[32] scheme).

The 100 TWh ceiling represents about 25 percent of EDF's total nuclear power generation. The ARENH scheme played a central role in the decision to eliminate regulated tariffs for industrial consumers at the retail level.

Currently, most customers remain in the regulated sector, with alternative suppliers occupying only 8.0 percent of the residential market and 20.9 percent of the non-residential market, as a percentage of annualised sales[33]. Switching rates remain low – less than 1 percent for residential customers. Overall retail market concentration as measured by the HHI index remains very high, at around 6500 (based on annualised consumption).

31 The amount depends on the consumer portfolio of each producer.

32 ARENH : Regulated Access to Historic Nuclear Power

33 CRE, 2015.

Electricity prices for household and industrial consumers in France fall within the median range of prices in Europe[34]. Household customers have three choices of rate structure under regulated tariffs: flat rate ("option base"), peak and off-peak rates ("option heures pleines heures creuses") and variable ("option tempo" – only available through EDF). A fourth option, EJP, remains in force for customers who signed up before 1998. Both tempo and EJP tariffs are multi-tiered rates, with low base level rates and high peak period rates.

Figure 10 shows the sample breakdown of typical residential and large industrial customers (as of 1 January 2016, these "green tariffs" are replaced by market offers). Electricity prices are expected to rise over the next few years due to increased investments in the power system (grid and generation) combined with relatively flat demand.

5.3 Allocation of grid costs

The costs of financing and operating the transmission and distribution networks are passed on to end users through the so-called TURPE (Tariff d'Utilisation des Reseaux Publics d'Electricite). The TURPE, which was proposed by the CRE and approved by the Energy and Finance Ministers, is charged to suppliers and passed through to end users. Currently, TURPE accounts for some 30 percent of the total electricity charges applied to domestic customers (41 percent and 16 percent for small and large industrial consumers, respectively[35]). Costs associated with congestion management, energy balancing (excluding revenues recovered via imbalance charges), transmission and distribution losses and the purchase of ancillary services are also recovered via TURPE. The charges seen by customers are non-locational in nature but include incentives to encourage reduced consumption during peak-demand periods.

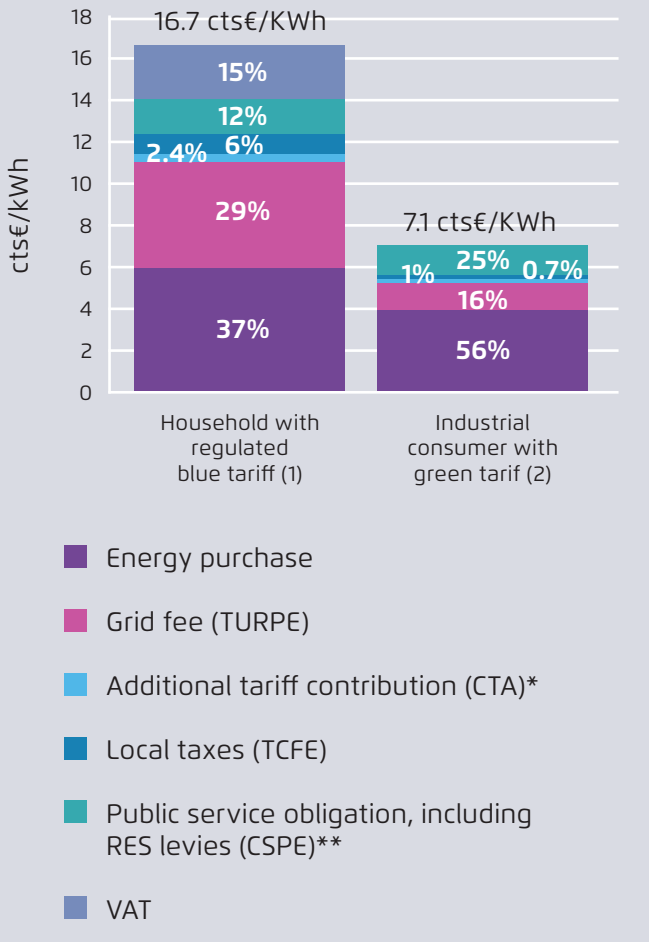
Customers connecting to the electricity grid are charged directly for assets necessary to connect to the nearest suitable substation, with demand charged 70 percent of the associated costs and generation charged 100 percent. Any wider transmission or distribution costs incurred as a result of the connection are recovered through TURPE and are effectively socialised[36].

34 See Eurostat, 2015.

35 CRE 2015.

36 ENTSO-E 2013b.

Breakdown of Electricity Prices under the Regulated "blue" Tariff (Residential Consumers) and "green" Tariff (Industry) Figure 10



CRE 2015, www.energie-info.fr; *CTA (contribution tarifaire d'acheminement) is tax added to transmission and distribution tariffs introduced in 2004 to cover pensions for employees in the electricity industry., **CSPE (contribution au service public de l'électricité) serves to cover the costs of "public service" of electricity. It covers, among other things, support for renewable energy and the social tariff for low-income households., (1) Yearly consumption 4251 KWh, option base, 9 kVA., (2) Consumption between 20 and 70 TWh (Eurostat methodology: consumer group Ie).

6 Electricity Balancing / Reserve Markets

The French Transmission System Operator, RTE, uses the Balancing Market to ensure a continuous energy balance and to prevent power flows as a result of market clearing from exceeding the physical capabilities of the transmission system. Balance Responsible Entities are required to declare their contractual position at gate closure (1 hour ahead of real time) for each half-hourly trading period and are financially responsible for any imbalance between their declared position and actual outturn. Imbalances that add to the system imbalance are settled at a price that reflects the average upward or downward regulation price incurred by RTE, while imbalances that reduce overall system imbalance are settled at the EPEX spot price. RTE selects offers of upward and downward regulation made by Balance Responsible Entities in economic order to resolve energy imbalances or manage congestion. Offers utilised by RTE are paid at offer price.

France also has a price control mechanism – a Request for Quotes (RFQ) – that is automatically triggered when hourly prices on the spot market exceed a certain threshold. The current threshold has been set at €500/MWh. The RFQ consists of a request that market players post new orders if they are able to do so, in order to reduce the spread between supply and demand on the spot market. This mechanism was triggered on February 9, 2012, when the spot price reached €1,938.5/MWh[37].

37 CRE, 2013a at 40.

7 Long-Term Energy and Decarbonisation Policy

France is currently reshaping its energy and climate policy[38]. Following a broad energy debate that started in 2012, the French "energy transition" bill entered into force in Summer 2015. This ambitious legislative package implements French goals with regard to climate change, environmental protection, energy mix diversification and energy security. In particular, this package set targets to 1/reduce the share of nuclear energy in the power mix to 50 percent by 2025 (as opposed to a share of 72 percent in 2012), 2/ increase the proportion of renewable energy in final energy consumption to 32 percent by 2030 (as opposed to 16 percent in 2020) and in power consumption to 40 percent by 2030, 3/ reduce CO_2 emissions by 40 percent between 1990 and 2030, 4/ reduce the consumption of fossil fuels by 30 percent by 2030, 5/ reduce final energy consumption by 50 percent by 2050. 6/ gradually increase the domestic carbon tax on natural gas, heating oil, coal and transport fuels (from 14.5 EUR/tCO_2 in 2015 to indicative targets of 22 EUR/tCO_2 in 2016, 56 EUR/tCO_2 in 2020 and 100 EUR/tCO_2 by 2030)[39]. The energy transition law introduces a new governance mechanism through carbon budgets (following the UK example).

Long-term French energy efficiency and climate policies, now embodied in the energy transition bill, are framed through a set of successive laws, in particular the 2005 POPE law, the transposition of the 2008 EU climate and energy package (with binding objectives for 2020)[40] and the Grenelle laws of 2009 and 2010.

The 2005 POPE law[41] establishes a GHG reduction trajectory of 3 percent annually, with the long-term objective of reaching a 75 percent reduction by 2050 (against 1990 levels). It also calls for a 2 percent annual reduction in the energy intensity of the economy by 2015, and 2.5 percent annually from 2016 to 2030[42]. It also introduces a national climate plan, updated every two years, in which all climate-related policies are assessed[43]. According to the latest climate plan, France has made significant progress, but has yet to meet the POPE targets: the energy intensity of the economy has decreased on average by 1.3 percent per year since 2005 (rather than the 2 percent that the POPE law calls for) and GHG emissions have decreased an average of 1.8 percent since 2008 (rather than the stipulated 3 percent)[44].

Following the adoption of the POPE law, France underwent two extensive high-level public dialogues on French environmental policy in 2009 and 2010, referred to as Grenelle I and II. The dialogues involved the French government, local authorities, businesses, unions and NGOs, and led to

38 See for example IDDRI (2014).

39 For more information on the French energy transition, see http://www.transition-energetique.gouv.fr/.

40 The EU has set the goal of reducing GHG emission by 20 percent below 1990 levels by 2020. This target is divided between sectors covered under the EU Emissions Trading Scheme (ETS) – covering about 45 percent of total EU GHG emissions – and the Effort Sharing Decision, which sets targets for all remaining economic sectors. Under the ETS Directive there are no country-level target. Instead a EU-wide cap requires covered sectors to cut greenhouse gas emissions by 21 percent below 2005 levels by 2020. The effort-sharing decision requires France to reduce greenhouse gas emissions in non-ETS sectors 14 percent below 2005 levels by 2020.

41 Loi n° 2005-781, 2005.

42 See footnote 57, articles 2 and 3.

43 Loi n° 2005-781, 2005, Article 2.

44 Ministère de l'Écologie, du Développement durable et de l'Énergie, 2013c.

the adoption of two laws [45] that reinforce and expand the climate goals set in the POPE law. The Grenelle laws set the additional goal of reducing energy consumption in buildings by 38 percent by 2020. They further set a 23 percent renewables energy target in end-use consumption by 2020.

45 Law No. 2009-967 of 3 August 2009 relating to the implementation of the Grenelle Environment Forum ("Grenelle I") Law No. 2010-788 of 12 July 2010 on the national commitment to the environment ("Grenelle II"). Ministère de l'Écologie, du Développement durable et de l'Énergie, 2012.

8 Renewable Energy

Under the Renewable Energy Directive of 2008, France is required to meet 23 percent of gross final consumption of energy with renewable sources by 2020. This is equivalent to an approximate doubling of renewable energy production (relative to 2006), with a target of an additional 20 megatons of oil equivalent (Mtoe) in renewable energy production by 2020.[46]

In order to reach this overall objective, France has set sectorial targets for 2020 of 27 percent renewables in the electricity sector, a 33 percent renewables in the heating and cooling sector and 10.5 percent target for transport[47]. These 2020 goals, which are made explicit in the multi-annual investment plan[48], currently include:

- 25,000 MW of wind power, divided between 19,000 MW onshore (as of June 2015, 9,700 MW onshore wind capacities were installed) and 6,000 MW offshore;
- 8000 MW of solar PV[49] (as of june 2015, 5700 MW were installed);
- 2,300 MW of biomass;
- 3 TWh per year and 3,000 MW of peak capacity for hydropower.

The renewable energy objectives of the current energy transition bill (40 percent renewables in the power consumption by 2030) will be translated into capacities targets in a new multi-annual investment plan (to be adopted by the beginning of 2016).

Electricity from renewable sources is currently promoted through feed-in tariffs (FiT), special tenders and tax benefits. As part of the energy transition bill, the French government will modify its support scheme and move towards a market premium regime.

The current FiT obligation[50] requires electricity distributors to purchase renewable electricity at fixed prices depending on the technology. Tariff levels are set by ministerial decrees and periodically reviewed[51]. The following table shows the latest FiT for hydro, geothermal, wind and solar power. FiTs have also been set for cogeneration, biogas, biomass, solid waste, and other technologies.

Special tenders are called periodically to help ensure that France's renewable energy goals are met[52]. In practice, these tenders became the exclusive instrument for promoting big renewable energy projects (especially ground-mounted photovoltaic and offshore wind, whose FiTs are too low to launch new projects).

Electricity generated from renewable energy sources is also promoted through several tax incentives[53], including an income tax credit for taxpayers domiciled in France who invest in renewable energy and a reduced VAT for services, equipment, and delivery related to investments in renewable energy[54].

46 NREAP at 4.

47 European Commission, undated at 12.

48 Programmation Pluriannuelle des Investissements PPI - Art. 8 loi n°2000-108.

49 The 2020 PV target has been increased from 5400 to 8000 MW in september 2015.

50 Codified in Article 10 of Law No. 2000-108 of Feb 10, 2000,

51 Ministère de l'Écologie, du Développement durable et de l'Énergie, 2010.

52 Information on current tenders is available at www.cre.fr/documents/appels-d-offres.

53 Najdawi, 2013.

54 The reduced VAT does not apply to entities engaged in business activities.

Feed-in Tariff Levels for Selected Renewable Technologies — Table 6

Technology	Orders governing the purchase of electricity	Duration of contracts	Sample tariffs for installations commissioned on the date that FiT order was issued
Hydro	1 March 2007	20 years	**6.07 c€/kWh** + bonus **between 0.5 and 2.5** for small installations + premium between **0 and 1.68 c€/kWh** in winter depending on level of production **15 c€/kWh** for offshore hydropower (wave, tidal, and hydrokinetic)
Geothermal	23 July 2010	15 years	**Mainland France: 20 c€/kWh** + premium for energy efficiency of between **0 and 8 c€/kWh** **Overseas France (DOM): 13 c€/kWh** + premium for energy efficiency between **0 and 3 c€/kWh**
Wind	17 June 2014	15 years (onshore) 20 years (offshore)	**Onshore: 8.2 c€/kWh** for 10 years, then between **2.8 and 8.2 c€/kWh** for 5 years depending on site **Offshore: 13 c€/kWh** for 10 years, then between **3 and 13 c€/kWh** for 10 years depending on site
Solar	4 March 2011, amended 7 Jan. 2013	20 years	Tariff rates for solar power are set quarterly, based on the number of projects submitted over the previous quarter and compared to annual targets*. Tariffs are set for facilities under 100 kW, and tenders issued for facilities above 100 kW. The FiT for the second quarter of 2015 are the following : - Rooftop PV, 0-9kW: **26.17 c€/kWh** - Simplified rooftop PV, 0-36 kW: **13.95 c€/kWh** - Simplified rooftop PV, 36-100 kW: between **13.25 c€/kWh** - All types of ground-mounted installations (from 0 to 12 MW): **6.45 c€/kWh**

Ministère de l'Écologie, du Développement durable et de l'Énergie, 2015.
* As of the 7 January 2013, amendments to the FiT, the total annual target for solar power is 1000 MW for the next several years. This doubles the previous target. It is divided into targets for various sizes of rooftop and ground-based solar PV [Ministère de l'Écologie, du Développement durable et de l'Énergie, 2013a.].

9 Energy Efficiency

France has set the goal of reducing annually the energy intensity of its economy by 2 percent by 2015, and by 2.5 percent between 2016 and 2030. It has also set the goal of increasing efficiency of buildings by 38 percent by 2020, and to this end has called for the renovation of 400,000 buildings a year between 2013 and 2020 and the renovation of 800,000 social housing units by 2020[55]. The new energy transition law has added two ambitious energy efficiency targets: a 30 percent reduction of fossil fuel consumption by 2030 and a 50 percent reduction in final energy consumption by 2050. To date, France has fallen short of meeting its targets for energy intensity and building efficiency.

One of the main mechanisms implemented to meet national energy savings goals is the French energy efficiency obligation programme. It is often referred to as a "white certificate scheme" since the obligated entities must document their achievement of required savings by turning in certificates to the government that document the savings. These white certificates can also be traded bilaterally, though there has been very little trading to date (representing less than 3 percent of all certificates submitted by obligated parties in phase 1 of the scheme)[56]. The scheme was launched on July 1, 2006, and has operated in three-year periods. The third phase of the scheme is expected to be launched in early 2015.

The white certificate scheme sets overall energy saving targets (in TWh cumac[57]) that must be met by energy suppliers[58]. In practice, 80 percent of the obligation has fallen to EDF and GDF SUEZ, with the remaining 20 percent falling to smaller suppliers. The first period (2006–2009) of the French white certificate scheme set an overall yearly target of 18 TWh cumac. The second period (2010–2014) increased the target to 115 TWh cumac yearly. The third phase has set annual targets of 220 TWh cumac. This goal is expected to help France meet its energy savings obligation under Article 7 of the Energy Efficiency Directive, which is calculated to be 97 TWh cumac in 2014 and 171 TWh cumac annually from 2015 on[59]. Since the start of the energy efficiency obligations in 2006, energy savings achieved through the white certificate scheme have amounted to 431.9 TWh cumac, exceeding the three-year targets set for the first and second periods[60].

From the start, the obligation could be met through energy savings in any sector, including transport. In the first compliance period, most savings came from deemed savings measures[61]. 83.8 percent of savings were achieved in residential buildings, with over 72 percent of energy efficiency improvements being heating equipment improvements, particularly boilers and heat pumps.

55 LOI n° 2009-967, 2009 at Article 5. See also United Nations Environment Programme, 2012.

56 The Regulatory Assistance Project, 2012.

57 Cumulative and discounted (in French, cumulés actualisés). This term refers to the annual delivered energy savings from an energy efficiency measure, added over the lifetime of the measure and discounted at a standard rate, in this case 4% per annum.

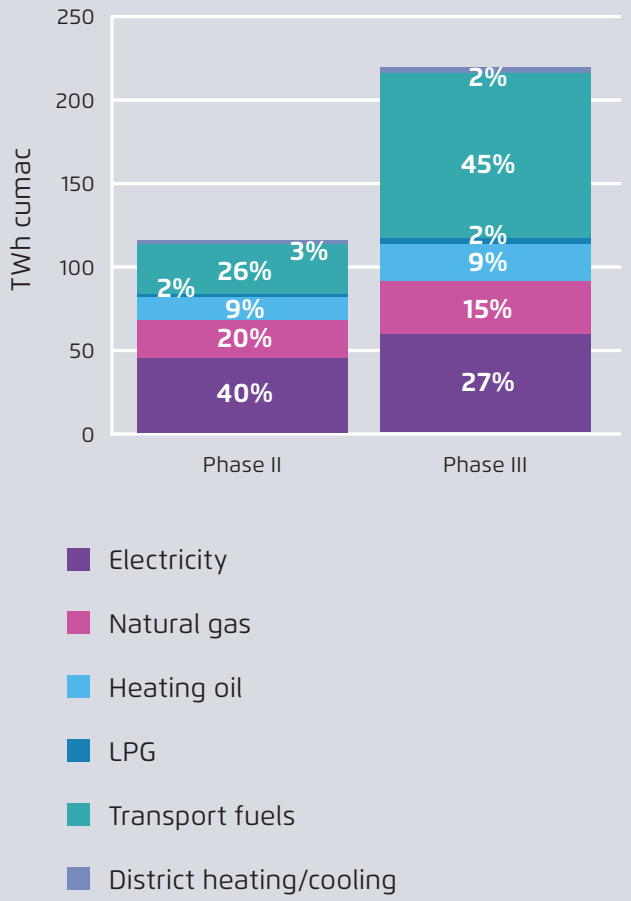
58 In the first phase of the scheme, all energy retailers outside the transport sector were obligated to meet energy savings targets. The second phase added importers of road transport fuel to the obligation. Obligated parties were those whose level of sales exceeded a certain threshold. (For example, electricity, natural gas, district heating and cooling suppliers with sales exceeding 400 GWh/year were obligated under the second phase of the scheme, while suppliers of heating oil were obligated if sales exceeded 500 m3/year.)

59 Ministère de l'Ecologie, du Développement durable et de l'Energie, 2013e.

60 Ministère de l'Ecologie, du Développement durable et de l'Energie, 2013d.

61 Deemed energy savings are established ex ante for selected standardized energy efficiency measures whose savings values are well established. As such, they do not require post-installation savings measurement by the obligated party.

Breakdown of Energy Efficiency Obligation in Phases 1 and 2 Figure 11



Ministère de l'Écologie, du Développement durable et de l'Énergie, 2013e.

The third period continues to obligate all energy retailers and importers of road transport fuel. A greater share of the obligation fall to importers of transport fuels (see Figure 11). The obligation will continue to be met by measures with deemed savings, particularly those in the building sector. It is important to note that all deemed savings measures have been revisited, and many have been lowered, particularly those for boilers, which until now have represented a significant share of the savings achieved through the white certificate programme. Moreover, deemed savings measures may not facilitate the deeper savings attainable through more comprehensive efficiency retrofits in existing buildings, which may be needed in greater numbers to reach France's overall savings targets for its building sector.

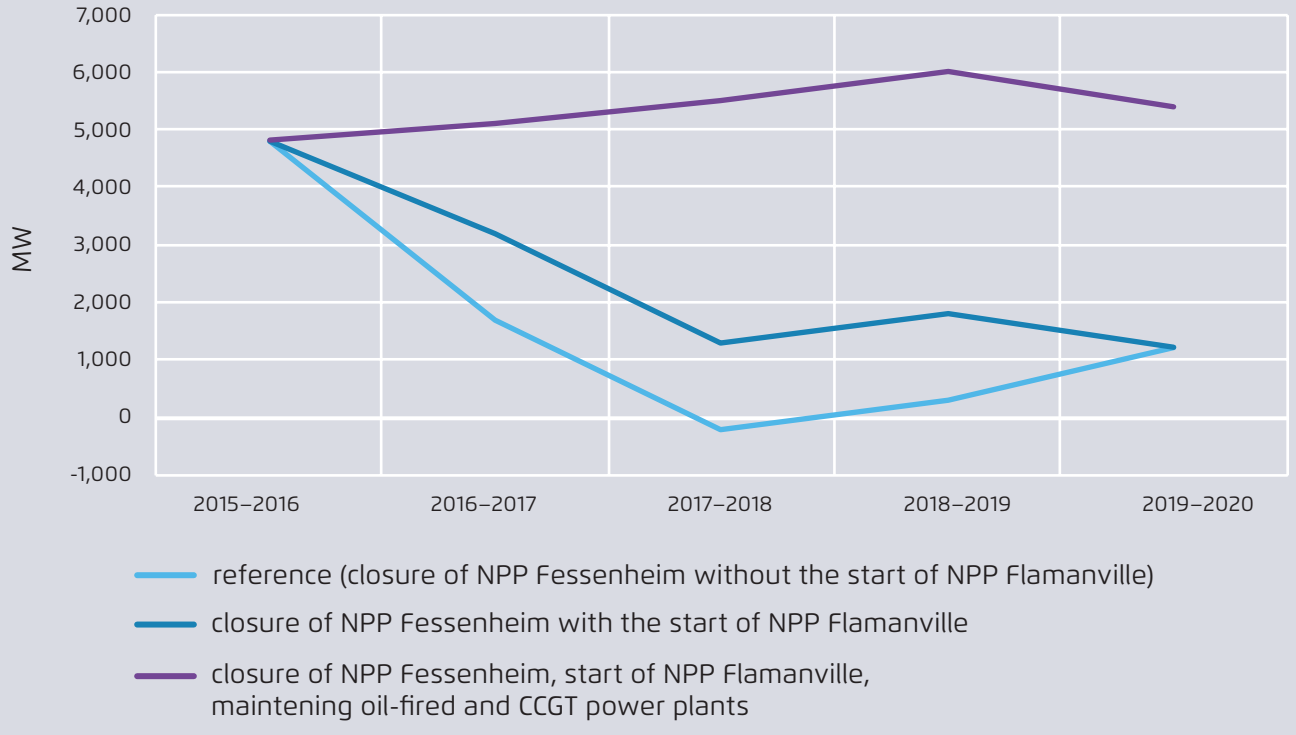
10 Generation Adequacy, Grid Reliability and Infrastructure

10.1 Generation adequacy standard

France has a mandated generation adequacy standard of 3 hours for the loss of load expectation (LOLE) a year. RTE forecasts a reduction of capacity margin up to 2018 and especially 2016/2017 due the planned decommissioning of fuel and coal-fired facilities, to the forecasted closure of the Fessenheim nuclear reactors and delays in the construction of the Flamanville 3 nuclear reactor [62]. The adequacy situation has, however, improved compared to the previous forecast. The development of wind parks (onshore and offshore), energy efficiency measures into increased interconnections as well as the start of the Flamanville 3 nuclear reactor (2018) will further improve the situation in the years to come.

In response to projected capacity shortfalls, RTE has introduced a new generation adequacy indicator, referred to as an "adequacy margin." The adequacy margin represents the theoretical power needed to meet demand that could still be removed to ensure that the 3-hours LOLE requirement is met. RTE has calculated changes in anticipated capacity margins under four different scenarios for the winters 2015/2016 to 2019/2020 (Figure 12).

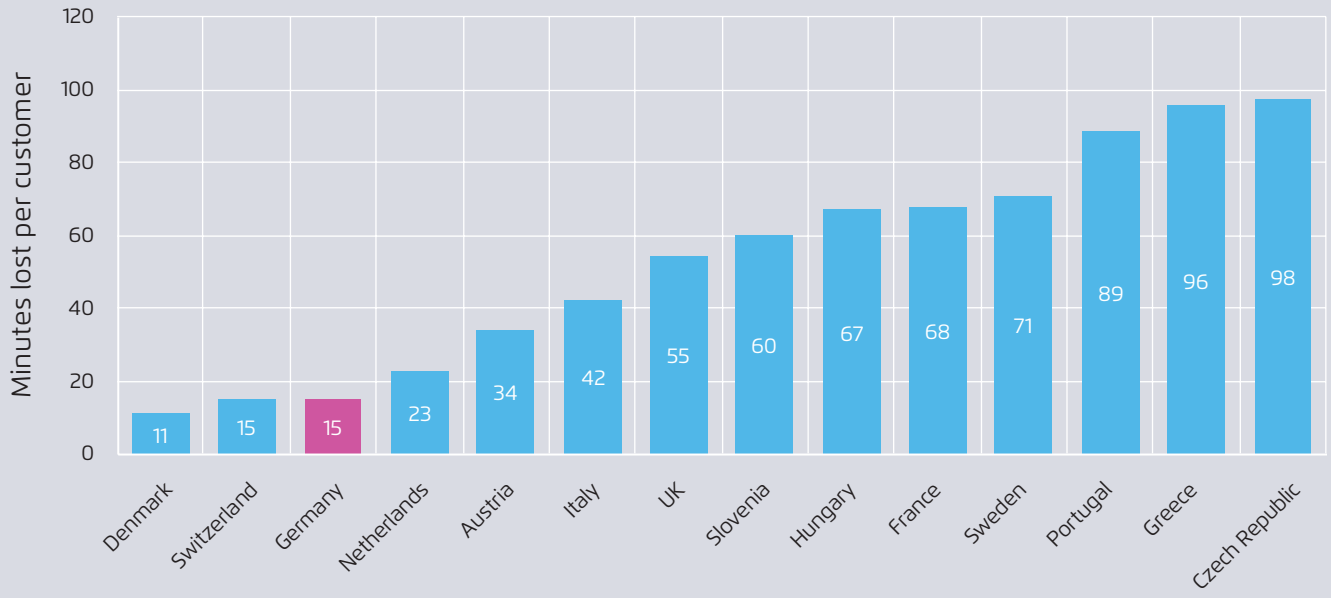
Summary of Capacity Margins and Shortfall under Different Scenarios — Figure 12



RTE 2015.

62 RTE 2015.

SAIDI – Unplanned Interruptions, excluding Exceptional Events in 2013 Figure 13



CEER, 2015.

In a reference scenario (closure of the nuclear power plant Fessenheim without the start of the nuclear power plant Flamanville 3), a shortage occurs in the winter 2017/2018 (-200 MW). In the other scenarios (start of Flamanville 3, with or without maintaining oil-fired and CCGT power plants), no capacity shortage occurs. All scenarios rely on electricity imports, which play a critical role for the reliability of the French power system (in the different scenarios, about 8-10 GW of the winter peak demand is covered by imports).

10.2 Grid reliability

Grid reliability is commonly measured by the System Average Interruption Duration Index (SAIDI) and represents the average outage duration for each customer served. SAIDI is measured in units of time, often minutes or hours, over the course of a year. France has historically seen levels of grid reliability that are in line with the average for West European systems. Figure 13 presents a comparison of average French SAIDI with other European Member States.

10.3 Transmission developments

A number of grid reinforcements are planned or are under investigation to address internal security issues, connect new generation capacity and accommodate demand growth[63]. In addition, RTE estimates that some 8 GW of additional international transfer capacity will be required to meet European market integration and energy policy objectives, including 2.8 GW of capacity for which permits are being sought or are under construction. In 2015, the interconnection capacity with Spain was increased from 1400 MW to 2600 MW, via the completion of the Baixas-Santa Llogaia circuit. Further ongoing projects include[64]:

63 CRE , 2012.

64 RTE 2014b.

- An additional HVDC 1000 MW interconnector with the United Kingdom (after 2020);
- A new interconnector with Belgium together with a new France – Belgium - Germany exchange point in Luxembourg (after 2020);
- Increased interconnection capacity with Italy with the construction of a 1200 MW circuit between Grande Ile and Piossasco, due to commission in 2017;
- A possible undersea circuit between Bilbao and Aquitaine to increase the total interconnection between France and Spain to 4000 MW.

10.4 Smart metering

In July 2013, French Prime Minister Jean-Marc Ayrault announced that an initial rollout of smart meters would take place in France. Électricité Réseau Distribution France (ERDF) will be responsible for the rollout of 3 million smart meters in homes by the end of 2016. By 2020, France aims to have installed 35 million smart meters at a cost of €5 billion, which is what is required to meet EU mandates[65]. France has piloted several smart meter programs in Touraine and Lyon since 2009, testing the effectiveness of the "Linky" meter, the meter that will be rolled out under the new initiative. The meters are expected to cost roughly 30 euros apiece, with an additional charge of 120 euros for the installation of the meter[66].

65 St. John, 2013.

66 De Clercq & Mallet, 2013.

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