Deloitte.

European energy market reform
Country profile: France

Contents

Current situation

Energy consumption and trade balance

In 2012, France's primary energy consumption (PEC)[1] reached 259 Mtoe. More than 40% of gross energy consumed is derived from nuclear power. However, fossil fuels still play an important role: petroleum products make up 31% and natural gas totals 8% of the mix.

Figure 1. Gross inland consumption in 2012 (259 Mtoe)[2]

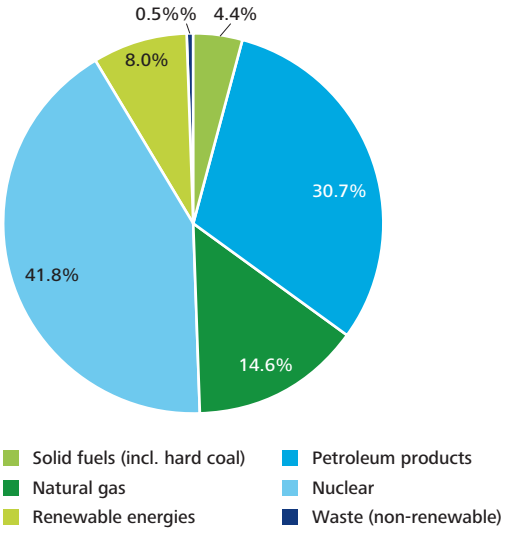
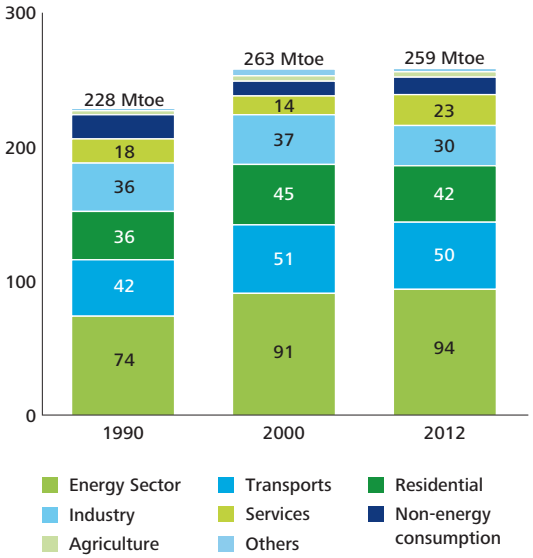


Figure 2. Primary energy consumption by sector (in Mtoe)[3]



Primary energy consumption increased by 15% from 1990 and 2000, and decreased by 2% between 2000 and 2012. This decrease was mainly due to the industrial (energy and non-energy uses) and services sectors.

- The energy sector represented 36% of primary energy consumption in 2012, and has remained stable in volume since 2000.
- The transport sector is the second highest consumer, accounting for 19% of primary energy consumption in 2012, which marked a 19% increase since 1990.
- The residential sector accounted for 16% of primary energy consumption in 2012 (stable between 2000 and 2012).
- The industrial sector accounted for 12% of consumption (19% decrease between 2000 and 2012).

Key figures:

Population (2013): 65.5 m cap.

GDP (2013): 2,059 bn €

GDP/capita (2013): 31,435 €

GDP/PEC (2012): 7.8 €/kgoe

PEC/capita (2012): 3.97 toe/cap.

While nuclear makes up the highest share (42%) of primary energy consumption, France remains dependent on fossil fuel imports, mainly for transport.

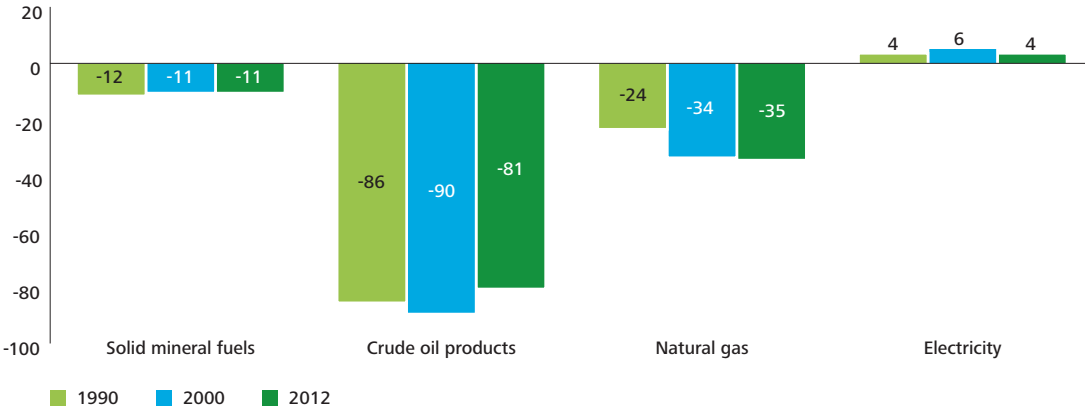
The energy sector represented 36% of primary energy consumption in 2012, a volume that has remained stable since 2000. Fossil fuel imports remain high and the French energy bill reached an historic high of € 69 bn in 2012.

1 The primary energy consumption value presented refer to 'Gross inland energy consumption by fuel type' in Eurostat (Data Table: tsdcc320)

2 Eurostat

3 MEDDE – Chiffres clés de l'énergie, Edition 2013

Figure 3. Energy trade balance (Mtoe)[2]



A high preponderance of nuclear in power production and a very low share of renewables outside hydropower.

The country depends on imports of solid mineral fuels, crude oil products and natural gas. In 2012, the French energy bill reached a record high of € 69 bn (€ 55 bn from oil products and € 13.5 bn from natural gas), accounting for 13% of overall French imports and overtaking the country's trade deficit (€ 67.2 bn in 2012).[4] Oil imports (crude and refined) reached 99.8 Mtoe and natural gas imports amounted to 39.9 Mtoe in 2012.

As far as power is concerned, France is generally a net exporter of large volumes of base-load electricity, but frequently imports peak electricity. In 2013, France exported 79 TWh globally and imported 32 TWh.

Power generation

France has the second largest electricity generation capacity in the EU, and the second "least-carbonized" electricity generation mix after Sweden.

In 2013, nuclear energy accounted for 49% of the generation capacity mix (63 GW), but delivered 73% of the power (402 TWh). Renewable energy sources generated 19% of electricity production, but 74% came from hydro. **Wind and solar** represented an installed capacity of 8.1 GW and 4.3 GW, respectively, and **generated 3% and 1% of overall electricity**.

Nuclear is operated as base-load or mid-merit. Due to its large share in the electricity mix, France has been historically short of peak capacity.

Figure 4. Electricity capacity – 128 GW (2013)[5]

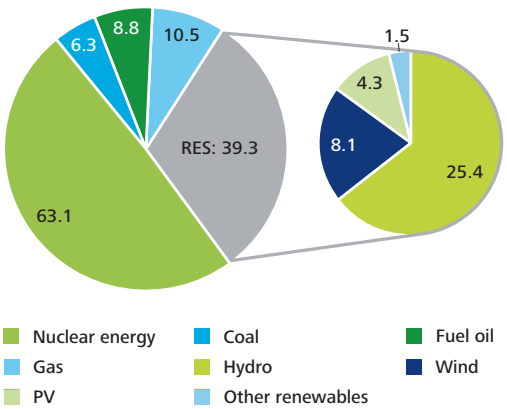
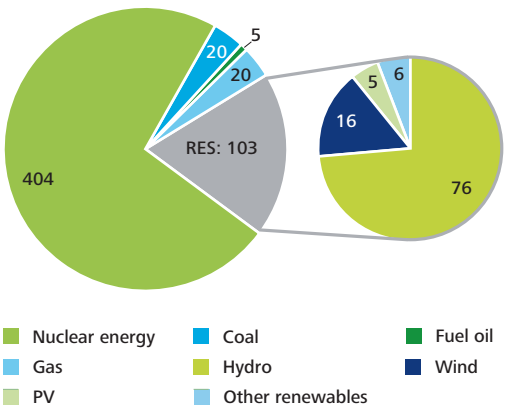


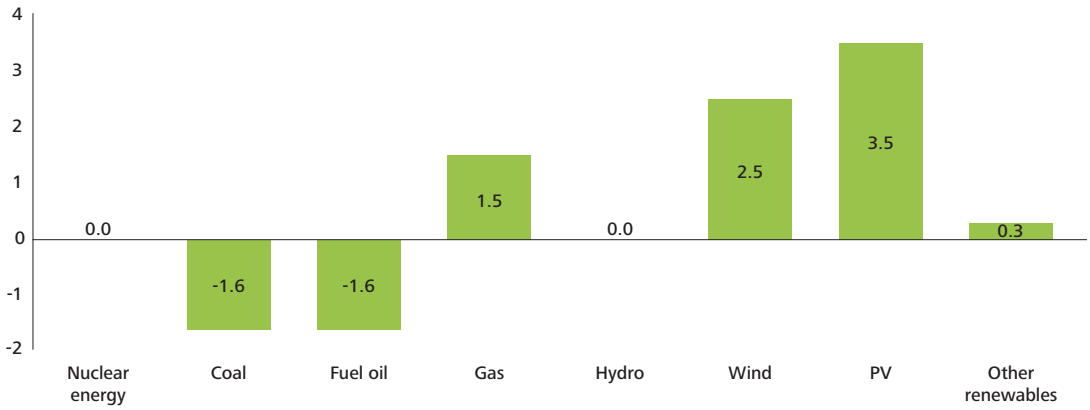
Figure 5. Electricity production – 551 TWh (2013)[5]



4 MEDDE – Panorama énergies-climat, Edition 2013

5 RTE, Bilan électrique français 2013

Figure 6. Electricity capacity change from 2010 to 2013 (in GW)[6]

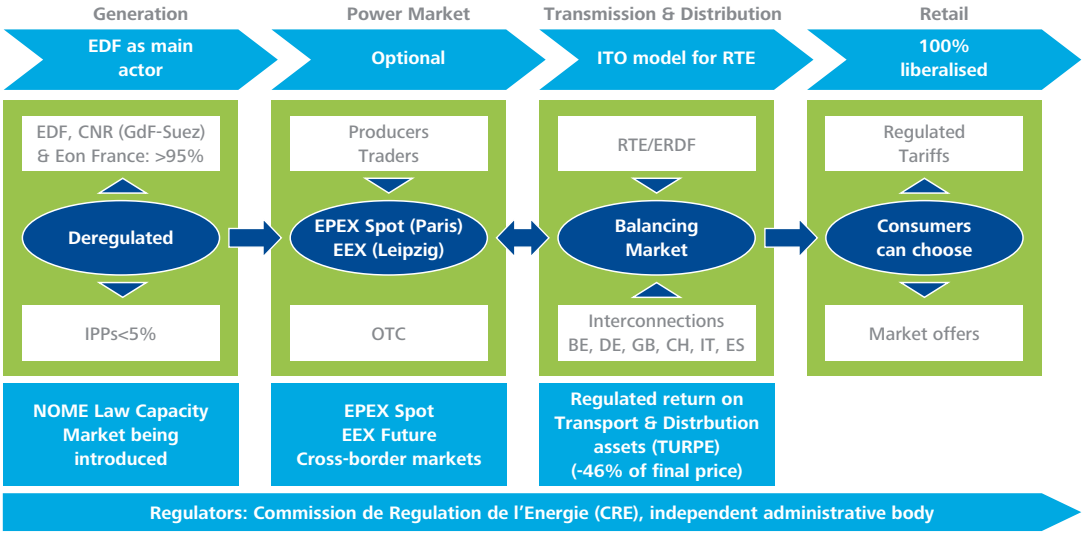


19 GW of new capacity were installed between 2000 and 2013, over two-thirds of which were renewable capacity (mostly onshore wind and solar).

Net capacity has increased by 11% since 2000 and by 3.8% since 2010.

Power market: main actors

Figure 7. Market mechanism



A highly concentrated power market.

The French generation and retail markets are still largely dominated by EDF, the French incumbent utility.

The French power market is highly concentrated. Electricity generation is still largely dominated by EDF, the vertically integrated French incumbent utility that is still controlled by the French state. The French transmission system operator, RTE, and the distribution network operator, ERDF, are 100% owned by EDF.

ERDF manages about 95% of the electricity distribution network in continental France. This network belongs to French municipalities or groups of municipalities that subcontract to ERDF as an operator through a public service delegation. In 2010, the French government approved an energy law (NOME) designed to increase competition in the retail electricity market. By law, EDF has the obligation to make available up to 25% of the nuclear electricity it generates to alternative suppliers on the wholesale market at a regular price, which was set at 42 €/MWh in 2012.

6 RTE, Bilan électrique français 2013 & Bilan électrique français 2010

Rising power prices.

Power prices are not completely deregulated (producers other than EDF pay a regulated access price for nuclear electricity, while residential users and SMEs pay a regulated tariff).

Power prices have increased for both residential and industrial users, primarily as a result of network and tax charge increases. They are likely to rise further in the coming years due to the necessary evolution of the power production mix.

Power prices

French market liberalization began in 1999 as industrial sites became eligible to choose their suppliers. This shift continued in 2004 for SMEs, and was completed in 2007 for residential customers. Residential customers have the choice between contracts at regulated tariffs or contracts at market prices. For SMEs, regulated tariffs will be abandoned from mid-2014 through the end of 2015. This should increase competition among retailers and expand the range of commercial offers and available value-added services.

As at the end of 2012, the incumbent EDF still dominated the market, with a market share of roughly 80%, leaving the remaining share to alternative market suppliers.

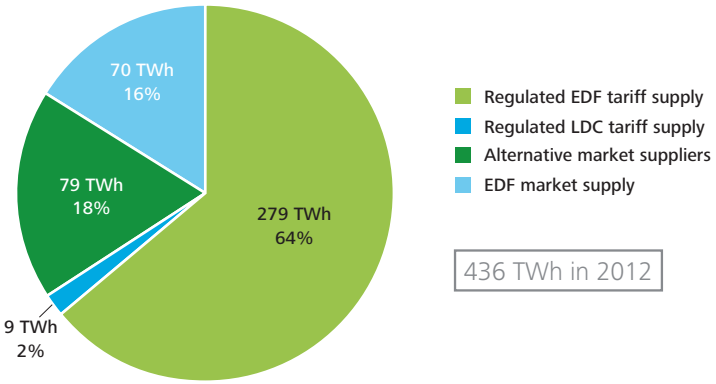
In 2012, 64% of electricity was sold at **regulated prices**.

Retail prices for industrial users totalled 119 €/MWh in 2012, slightly below the European average (125 €/MWh). A 28% price increase between 2008 and 2012 was driven by tax increases (+67%), rising grid costs (+28%), and higher generation and supply costs (+17%).

Residential customer retail prices reached 139 €/MWh in 2012, which is significantly lower than the European average (€ 200 in 2012). The 15% rise since 2008 was mainly driven by an increase in both taxes (+27%) and energy generation and supply components (+13%).

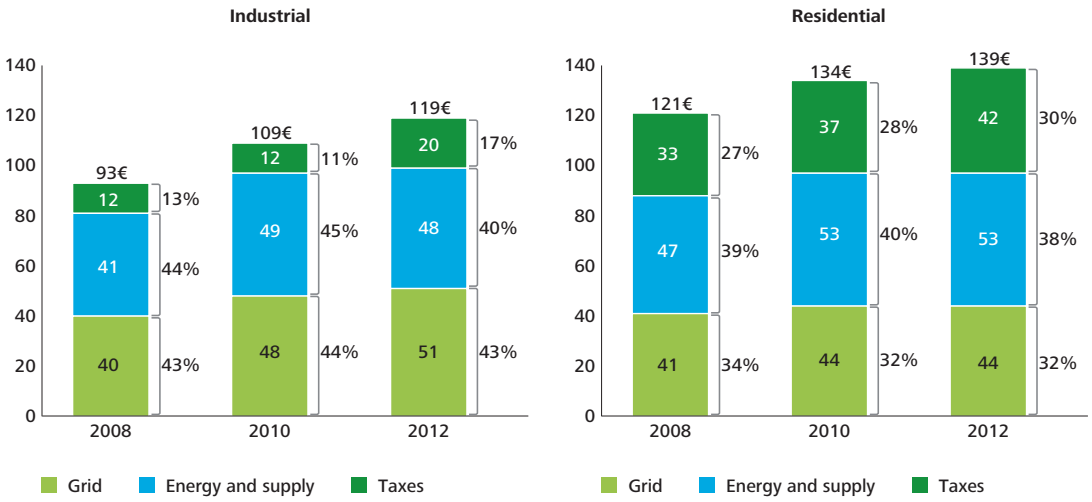
The development of renewable capacity is financed through the CSPE, which is supported by EDF, and not entirely passed on to final consumers.

Figure 8. Total retail market split per supplier and contract type in 2012 (TWh;%)



Source: CRE

Figure 9. Retail prices for industrial and residential users (€/MWh)[7]



The energy and supply component of the **price** is largely driven by the fact that nuclear power plants are amortized. Nonetheless, electricity prices are likely to increase in the coming years as investments are made to improve the grid, extend the useful life of nuclear power plants and upgrade their safety standards to post-Fukushima expectations (total cost is estimated to be € 62.5 bn between 2011 and 2025).[8]

7 CRE

8 Cours des Comptes, 2014

Targets for 2020

20-20-20 EU targets for France: what is France committed to?

- **20% energy savings versus 2020 energy demand projections**, i.e. primary energy consumption of 236 Mtoe in 2020 and 131 Mtoe for final energy consumption in 2020
- **23% renewable energies in 2020 final energy consumption**
- **-17% of total GHG emissions in 2020 versus 1990 levels**

  This target was restated later as:

  – -21% for ETS – (emission trading scheme) related GHG emissions in 2020 vs. 2005

  – -14% for non-ETS related GHG emissions in 2020 vs. 2005

Energy and climate policies have been articulated in several laws and regulations over the last few years. In 2007, the "Grenelle de l'environnement" defined a framework for environmental regulation, including a non-binding roadmap to develop renewable energy.

After a consultation phase launched in the aftermath of the "Grenelle de l'environnement," the National Climate Plan was adopted in 2011. It restated the "factor four" commitment (i.e. reducing French GHG emissions by a factor of four between 1990 and 2050), initially announced in 2003. It also set out several policies and measures to promote energy efficiency (energy efficiency in buildings information and eco-labeling), renewable energy (promotion of biofuels and heating from biomass) and reduction of GHG emissions (proposed carbon taxes, which were not ultimately adopted). The main targets regarding power and gas have been reiterated in the country's regular Pluriannual Investment Plans.

In the fall of 2014, all these targets and measures were updated in a new energy transition law (see "Energy transition: definition of the future energy mix" below).

Energy efficiency targets

Figure 10. Final energy consumption (Mtoe)[9]

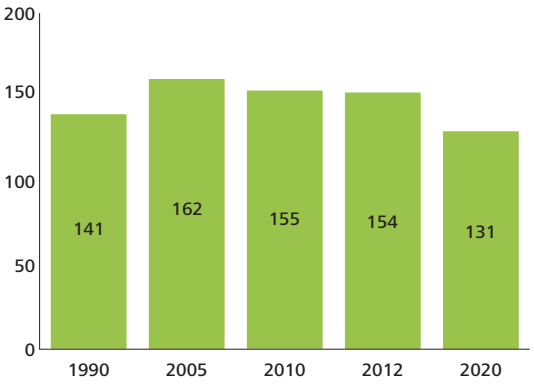
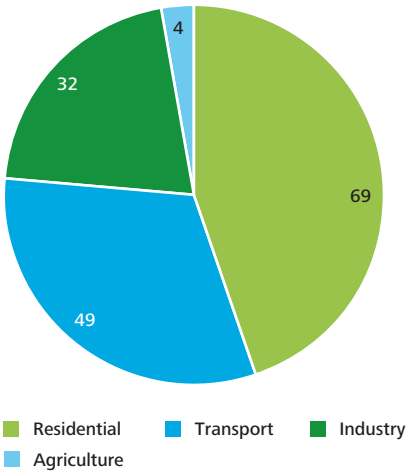


Figure 11. Final energy consumption in 2012, per sector (Mtoe)

Total: 154 Mtoe



France initially committed to a target of 20% energy savings compared to 2020 energy demand projections. According to the country's latest National Energy Efficiency Plan (24/04/2014), this would reduce final energy consumption to 131 Mtoe in 2020 vs. 162 Mtoe in 2005 and 154 Mtoe in 2012.[10] To meet this target, France would need to reduce its final energy demand by 23 Mtoe by 2020, compared to 2012. Yet, between 2005 and 2012, France only realized 26% of its energy efficiency target.

The first priority is to reduce final energy consumption in buildings (44% in 2012 final energy consumption). Since the mid-2000s, final energy consumption in buildings has been relatively stable at around 68-69 Mtoe. Different policy measures have been adopted:

- For existing buildings, the objective is to retrofit 500,000 households each year. To this end, various measures (low interest loans, tax credits, etc.) were implemented. To date, however, France has not come close to hitting its retrofit targets (145,000 retrofits in 2012 and 160,000 in 2013). These measures are expected to reduce final energy consumption by 4.4 Mtoe.

- New buildings have to comply with a limit of 50 kWh/m^2/year (from 2011-2013). This measure is expected to reduce final energy consumption by 1.2 Mtoe.

9 MEDDE – Panorama énergies-climat, Edition 2013

10 European Commission, Energy Country Factsheets 2012 v1.3

For **transport** (32% in 2012 final energy consumption), the energy efficiency of vehicles is promoted:

- The European regulation on GHG emissions per km for new vehicles and the French system of bonus/malus are powerful drivers to increase the energy efficiency of private cars. Between 2007 and 2011, GHG emissions from new vehicles decreased from 149.3 to 127 gCO_2/km. These measures are expected to reduce final energy consumption by 2.2 Mtoe.

- For heavy duty vehicles, an environmental tax ("écotaxe") was scheduled, but the government finally abandoned it in October 2014 in the wake of heavy protest.

Eco-design measures have also been implemented to increase the **energy efficiency of various products** (e.g. phasing out traditional light bulbs, expected to reduce final energy consumption by 0.8 Mtoe).

Moreover, at a cross-sector level, a **white certificate scheme** ("CEE") was implemented in 2006. It reflects the obligation of energy suppliers (electricity, gas, domestic fuel oil and heating sellers) to promote energy efficiency to their customers (households, local authorities and professionals). This scheme is expected to reduce final energy consumption by more than 9 Mtoe in 2020 (including some double counting with the above mentioned measures).

Yet, in 2012, France still needed to reduce its final energy consumption by 23 Mtoe by 2020. This means that only 26% of its initial 2020 target has been realized so far.

Given this reality, it is difficult to see how France can meet its commitment, other than by issuing additional policy measures for building or driving new momentum in the CHP (combined heat and power) industry, which will still take time to become fully efficient.

Energy efficiency: in 2012, 74% of France's target was yet to be achieved.

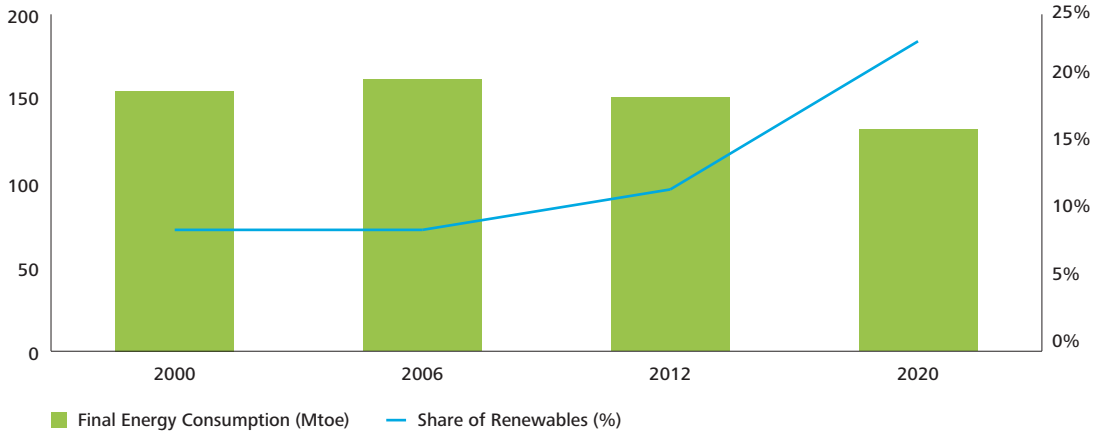
It is difficult to see how France can meet its energy efficiency commitment, other than by issuing additional policy objectives for buildings or resurrecting the cogeneration industry.

Renewable energy targets

France aims to have a 23% share of renewables of final energy consumption in 2020, vs. 9.5% in 2005 and 13.4% in 2012.[11] **Between 2005 and 2012, France only realized 29% of its renewable target**.

If this energy efficiency target (131 Mtoe of final energy consumption in 2020) is reached, 30 Mtoe of final energy consumption should come from renewables in 2020, compared to 19.6 in 2011,[12] This means an additional 11.4 Mtoe will still be needed by 2020.

Figure 12. Renewable energy share of final energy use (2012)[13]

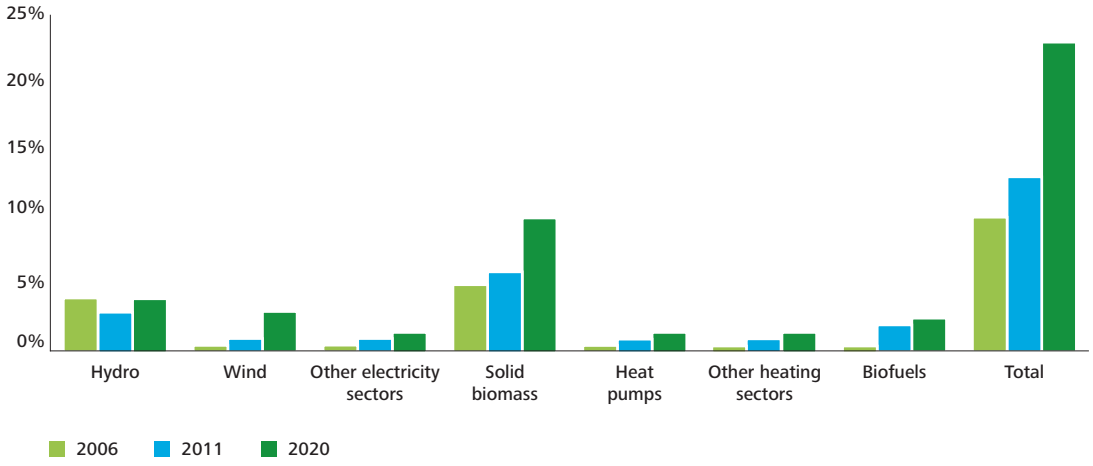


11 Eurostat

12 CGDD 2013

13 European Commission (2012)

Figure 13. Renewable energy share of final energy use by type, in 2006 and 2011, and target for 2020, in %[14]



In 2007, the "Grenelle de l'environnement" proposed a non-binding roadmap to develop renewable energy in France:

Table 1. Grenelle roadmap for renewables[15] and situation in 2011 (Mtoe)[16] or 2013 (GW)[17]

	Situation in 2006	Target in 2020	Targeted increase	Situation in 2011 or 2013
Heating	**9.6 Mtoe**	**19.7 Mtoe**	**+ 10 Mtoe**	***11.8 Mtoe***
Wood (domestic heating)	7.4 Mtoe	7.4 Mtoe	–	
Wood and waste (collective, tertiary, industry)	*1.8 Mtoe*	*9 Mtoe*	*+ 7.2 Mtoe*	
Other renewables	0.4 Mtoe	3.2 Mtoe	+ 2.8 Mtoe	
Power	**5.6 Mtoe**	**12.6 Mtoe**	**+ 7 Mtoe**	***5.8 Mtoe***
Hydropower	5.2 Mtoe (25 GW)	5.8 Mtoe (27.5 GW)	+ 0.6 Mtoe	*25.4 GW*
Biomass	0.2 Mtoe (0.35 GW)	1.4 Mtoe (2.3 GW)	+ 1.2 Mtoe	*1.5 GW*
Wind	0.2 Mtoe (1.6 GW)	5 Mtoe (25 GW)	+ 4.8 Mtoe	*8.1 GW*
Photovoltaic	0	0.4 Mtoe (5.4 GW)	+ 0.4 Mtoe	*4.3*
Biofuels	**0.7 Mtoe**	**4 Mtoe**	**+ 3.3 Mtoe**	***2.4 Mtoe***
TOTAL	**~ 16 Mtoe**	**~ 36 Mtoe**	**+ 20 Mtoe**	***19.6 Mtoe***

14 CGDD 2013

15 Grenelle, COP N°10 (2007)

16 CGDD, 2013

17 RTE, Bilan électrique 2013

Since then, targets have slightly changed (overall target of 30 Mtoe by 2020 instead of 36), but this roadmap still provides an interesting view of the main trends and potential targets.

- **Heating** (+10 Mtoe between 2006 and 2020): solid biomass for heating is already the most important renewable energy in terms of energy production, while **heating is the sector in which the largest increase is targeted**. A specific fund ("Fonds Chaleur") was created to develop the generation of heat from renewable energy sources, and biomass in particular. This fund is the main driver of development of wood-energy in France for public housing, local authorities and all businesses (agriculture, industry and tertiary). Between 2009 and 2013, € 1.2 bn was spent to enable the development of approximately 1.1 Mtoe/year of renewable energy (which included 0.9 Mtoe from biomass).[18] Money allocated to this fund is expected to reach € 400 M/year in 2017.

- **Renewables in power production** (+7 Mtoe between 2006 and 2020): hydropower capacity represented 74% of renewable electricity produced in 2012, with capacity remaining rather stable. Targeted increases to meet the country's renewable objectives have been assigned mainly to wind (25.4 GW vs. 1.6 GW in 2020) and solar. Between 2006 and 2013, an additional 12.4 GW capacity from renewables was installed, which represents 37% of the targeted additional capacity to be installed between 2006 and 2020 (33.3 GW).[19]

The support for renewable electricity is mainly based on financial subsidies to generation through a purchase tariff (feed-in tariff) that differs according to sector.

Table 2. 2014 feed-in tariffs (in c€/kWh) and contract duration (years)

	Onshore wind	Offshore wind	Solar	Geothermal	Biomass (CHP)
Feed-in tariffs (cEUR/kWh)	2.8-8.2	3-13	7.17-27.94	20 + bonus	4.5 + bonus
Contract duration (years)	15	20	20	15	20

The biggest challenge ahead is for wind power, where less than 30% of the additional targeted capacity for 2020 has been installed so far (new capacity of 6.5 GW was installed between 2006 and 2013, vs. an initial target of 23.4 GW).

- **Transport sector**: biofuels have seen strong development since the mid-1990s. The production of biofuels is encouraged by a tax whose rate depends on the deviation from the biofuel incorporation target.

  France set a target of a 7% (energy content) biofuel share in transportation fuel in 2010, which was almost achieved in 2012; biofuels represented 5.5% of the total fuels for transport consumption. But, since it is difficult to consume more first generation biofuels,[20] both for technical and political reasons, going further will depend mainly on the timeline of the industrial development of second generation biofuels.[21]

Between 2005 and 2012, France realized only 29% of its renewable energy target. An additional production of 11 Mtoe/year is still needed, which seems difficult to implement in eight years. The most likely way to meet the 23% target will come from:

- a large deployment of biomass for heating (target: +8 Mtoe between 2011 and 2020), provided that there is enough available biomass (until now, access to biomass has been a major hurdle to develop biomass for heating projects); and

- an increased development of wind power (both onshore and offshore) to fulfil the targeted capacity in 2020: around 17 GW of new power capacity is targeted to be installed between 2013 and 2020 (out of the 23.4 GW targeted between 2006 and 2020).

Renewable target: in 2012, 71% of the target had yet to be achieved.

The renewable energy target is very ambitious and seems difficult to reach, especially for heating and power.

The most likely way of meeting it would come from large-scale deployment of biomass for heating (subject to biomass availability) and from increased development of wind power.

18 Ademe

19 It can be noted that in November 2014, the French company Neoen announced the construction of Europe's largest photovoltaic solar park with a total combined output of 300 MW in the Bordeaux area. The park will be operational in October 2015 and is supposed to produce 350 gigawatt-hours yearly to a price of 105 €/MWh for 20 years (Neoen press release (05/11/2014), Reuters)

20 Conventional biofuels made from sugar, starch or vegetable oil

21 Advanced biofuels produced from non-edible biomass, i.e. lignocellulosic biomass or woody crops, agricultural residues or waste

CO_2 emissions and targets

CO_2 targets: France has already met 76% of its 2020 target.

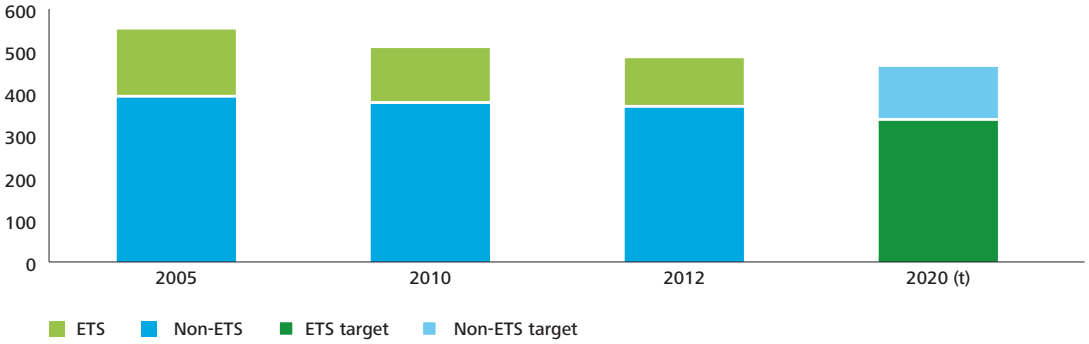
Until now, France has been a low GHG-emitting country, thanks to its high share of nuclear and hydro power.

The 2020 GHG emissions target seems reasonably attainable.

Reaching the target for the non-ETS sector depends mostly on the success of the energy efficiency measures applied to buildings, products and private cars, and on the development of renewables.

In 2012, the 2020 target for the ETS sector had already been met.

Figure 14. GHG emissions and targets ($MtCO_2eq$)[22]



- CO_2 target: in the ETS sector, the target is to reduce GHG emissions by 21% between 2005 and 2020 (i.e. by 34 Mt CO_2eq). In 2005, GHG emissions from the ETS sector amounted to 162 Mt CO_2eq. In the non-ETS sector, the target is to reduce GHG emissions by 14% between 2005 and 2020 (i.e. by 55 Mt CO_2eq).[23] In 2005, GHG emissions from the non-ETS sector amounted to 396 Mt CO_2eq.

Total GHG emissions amounted to 558 Mt CO_2eq in 2005 and to 490 Mt CO_2eq in 2012,[22] while targeted total GHG emissions are 469 Mt CO_2eq in 2020. This will require France to reduce its emissions by 89 Mt CO_2eq between 2005 and 2020. **By 2012, however, France had already achieved 76% of its initial target**, leaving only 21 Mt CO_2eq still to be abated before 2020.

- For the **ETS sector**, which essentially represents the power and heat generation industry, emissions had already decreased to 118 Mt CO_2eq[24] in 2012 (i.e. -44 Mt CO_2eq versus a target of -34 Mt CO_2eq in 2020). The 2020 target has already been surpassed, even if it is due more to the decrease of industrial activity in France (structural and cyclical, linked to the 2008 crisis) than it is to deep efforts by the industrial sector to reduce GHG emissions.

- For the **non-ETS sector**, emissions had already decreased to 372 Mt CO_2eq[24] in 2012 (i.e. -24 Mt CO_2eq compared to a reduction target of 55 Mt CO_2eq in 2020). Reaching the target largely depends on the success of the energy efficiency measures applied to buildings (a reduction of more than eight Mt CO_2eq is expected), products (a reduction of more than 4 Mt CO_2eq is expected), private cars (-9 Mt CO_2eq expected) and the development of renewables (more than 6 Mt CO_2eq expected).[25]

With "only" 21 Mt CO_2eq remaining to be abated as of 2012, or 24% of the initial target, France seems well on its way to meeting the EU target, even if a few additional measures may be necessary for the non-ETS sector.

22 EEA, 2014a
23 RMS, 2013
24 EEA, 2014b
25 MEDDE, 2013

Road ahead and main challenges: the way to 2030 and beyond

Energy transition: definition of the future energy mix

For many years, France has been relying on nuclear power and hydropower to reach low carbon intensity, and on hydropower to constitute a high share of renewables.

This situation, however, may no longer be sustainable, since serious political debate surrounds the future of nuclear energy. This likely means that nuclear capacity will decrease slightly by 2030, while hydropower capacity remains more or less stable.

France has implemented several policy measures to reach its targets regarding energy efficiency, renewables and GHG emissions. But these measures may not be ambitious enough to reach the country's targets, and their horizon does not go much further than 2020. **Moreover, France set itself an ambitious target for 2050: to reduce its GHG emissions by a factor four, i.e. emit less than 140 Mt CO_2eq by 2050. Meeting this target without building more nuclear or hydro capacity will be a serious challenge**. As a result, France must find new ways to increase its share of renewables and further decrease its carbon intensity.

In 2013, the French government launched a public debate on energy transition (DNTE), and its lower house of Parliament voted on the new law on October 14, 2014. In February 2015, debate was ongoing in both houses of Parliament. In its present form, this law includes the following provisions:

- Reducing nuclear energy production from 75% to 50% of the electricity mix by 2025.
- Increasing the share of renewables of final energy consumption to 23% in 2020 and to 32% in 2030.
- Reducing primary energy consumption from fossil fuels by 30% by 2030, compared to 2012.
- Reducing GHG emissions by 40% by 2030 and dividing by four GHG emissions by 2050 (both compared to 1990 levels).
- Reducing energy consumption by 50% by 2050 (compared to 2012), with an intermediate goal of 20% in 2030.

Energy efficiency measures for buildings, support for renewables and plans for a new transport infrastructure are also included in the law.

Nuclear power

Many questions with respect to nuclear power are currently being debated in France:

- The French government announced its willingness to decrease nuclear energy production from 75% to 50% of the electricity mix by 2025.

  However it remains unclear how this target will be reached and what pathway the country will follow to replace this capacity in less than 10 years, considering the impact these reductions will have on the country's energy competitiveness, security of supply and sustainability.

  Additionally, it is not clear to what extent the French government is entitled to close nuclear power plants for energy policy reasons (rather than for economic or safety ones).

  This decrease from 75% to 50% of electricity production represents around 140 TWh (based on 2013 power production), which is equivalent to five times the power produced from non-hydropower renewables in 2013 or three times the power produced from fossil fuels in 2013.[26] To reduce nuclear power production, while complying with renewable and GHG emission targets, the country will likely need to develop a larger share of renewable energy in power production.

26 Based on figures from RTE (2014), Bilan électrique 2013

Fundamentally, the objective to make up for 140 TWh of lost nuclear power, replaced by a mix of renewable sources, assumes that a renewable capacity of around 70 GW of a mix of solar and wind needs to be financed, developed and commissioned by 2025. A 140 TWh increase is much more significant (at least more than twice higher) than what can be expected from reaching the renewable target for 2020. As such, other measures to support energy efficiency and renewable energy are necessary to compensate for the decrease in nuclear power production by 2025.

Additionally, replacing nuclear power, typically used for base power production, with renewables, which are intrinsically intermittent, raises several questions about how to match spot power demand and supply.

- The **useful life of a nuclear power plant is currently set at 40 years**. This age will be reached between 2020 and 2035 by most of the French nuclear power plants. A decision has to be made about lifetime extensions. Lifetimes are likely to be extended by 10 or 20 years, mainly on economic grounds, since it is less expensive than building a new plant. In fact, according to Percebois and Mandil (2012), the average power cost could rise between 2010 and 2030 from 50 €/MWh to:

  – 50-65 €/MWh if nuclear still represents 70% of the power capacity mix (with the extension of the useful life of existing nuclear power plants);

  – 60-100 €/MWh if EPR (third generation nuclear reactors) nuclear power plants replace existing ones;

  – 80-95 €/MWh if renewable energies are extensively developed.

- Even if the useful life of nuclear power plants is extended, the **question of the replacement of actual nuclear power plants must be addressed by 2040**. Will France build new generation nuclear power plants? Will it rely mostly on energy efficiency and renewable energy (enhanced by all the technological progress realized by this date) to compensate for the progressive closure of its nuclear power plants?

- **Civil and political opposition to nuclear power exists in France** and was recently bolstered by the Fukushima disaster. While this opposition is not as vocal as it is in some other countries (e.g. Germany), it may still have an impact on future political decisions regarding nuclear power production in France in the coming years.

- **Whichever option is chosen, the cost will be significant. The necessary investments for the extension of nuclear plant useful life and those linked to the consequences of the Fukushima disaster are estimated at roughly € 62.5 bn between 2011 and 2025, and at € 30 bn between 2025 and 2033.**[27]

Renewables

Renewable energy may seem to be a good candidate for the required capacity development in the short and mid-terms, but many questions are still pending:

- **Hydropower** is produced by some 400 hydropower plants with a total capacity of 25.5 GW under a concession regime, which is mainly operated by EDF.

  Hydro concessions representing some 5.3 GW expire before 2015. For the first time, concessions will then be submitted to competitive bids. However, terms and conditions are under discussion with the French government.

- **Concerns about the availability and sustainability of biomass are growing**. The biggest barriers for large biomass for heating projects are generally linked to the difficulty of getting access to enough biomass. In fact, although French forests have a rather large potential of wood production, it is often difficult to mobilize. More generally, extending cultivation areas to produce more biomass for energy purposes raises the question of land use changes (LUC): more and more studies argue that using biomass for energy purposes is not as beneficial for the climate as initially thought; it might even increase overall GHG emissions.

27 Cours des Comptes, 2014

- **The financial support for renewable energy is already significant and should rise in the coming years**. In 2013, the Cour des comptes estimated the cost of public support for renewable energy. **The part of the CSPE (renewable financing support charge to be billed to consumers) used to support renewable energy amounted to € 1.4 billion in 2011 and should rise to € 2.2 billion in 2012, € 3 billion in 2013 and approximately € 8 billion in 2020**.[28] This means a global cost for the support of renewables in power production of around € 40.5 billion for the 2012-2020 period (which adds to the € 14.3 billion already allocated between 2006 and 2011). Other expenses also have to be taken into account, such as fiscal measures promoting biofuels, other budgetary subsidies for investment and public support, and public R&D. Moreover the CSPE level is not high enough to pass completely the cost of renewable development (among other components of the CSPE) on to customers. At the end of 2013, the tariff deficit for the CSPE (the major part of it being due to the cost of renewable) amounted to € 5.1 billion,[29] to which one must add € 0.7 billion of deficit for the year 2014.[30]

Fossil fuels and peak power production

Nuclear is mainly used for base-load power production and mid-merit. But new generation reactors, smaller and more flexible, are also on their way. Renewable energies produce electricity in an intermittent way. **So the question is how France will be able to meet its peak demand in the future**. As of today, France is to a certain extent already relying on imports to offset demand. To ensure France has enough power capacity during cold winter days, a decree was signed in January 2015 implementing a national peak power capacity mechanism beginning in the winter of 2016-2017.

Peak power is usually produced from gas or coal. Power production from coal emits much more GHG than that from gas, but is currently less expensive.

Although some countries (mostly the United States for the time being) are developing shale gas to produce more gas and reduce their power production costs, France is very reluctant to exploit its (potential) shale gas resources. Until now, French law has banned geological surveys to estimate these reserves on the grounds that exploiting them could cause serious environmental damage.

Impacts on transmission and supply/demand balances

All these evolutions will have deep impacts on the power transmission and distribution industry.

The **metering, transmission and distribution** of electricity is expected to evolve significantly. Many energy efficiency measures rely on a more efficient way to consume energy, by measuring energy consumption more precisely or by optimizing energy transmission, among other measures. All this depends on the development of smart meters and smart grids. For instance, smart metering will be deployed between now and 2020. Three million power smart meters are expected to be installed between 2014 and 2016, with a remaining 32 million meters implemented from 2017 to 2020.

With the heightened role of independent power producers (IPP), decentralized production and renewable energy, **the power system will move from a highly centralized** (capital, production and network) **to a more decentralized system**. In such a context, smart grids and energy storage will be increasingly useful.

If nuclear capacity remains stable at 50% of power production after 2025, power production capacity from renewables increases and overall electricity demand falls (due to energy efficiency policies, especially in buildings), **there may be a risk of overcapacity of centralized base power production capacity**, except in the case of increased demand for power in transport (due to the development of hybrid and electric vehicles).

Conclusion

France is now at a crossroads. After having relied for several decades on a power production mix dominated by nuclear energy and, to a lesser extent, by hydropower, it is now necessary to find new ways to meet very ambitious energy efficiency and GHG emission reduction targets, when nuclear and hydropower capacities are either capped or on the decline.

The energy transition law, currently under discussion, sets the path for less nuclear and more renewables in the future electricity mix. Should France pursue this path, it will significantly change the country's energy landscape and raise questions about how to cost-effectively transition from a centralized to a decentralized system.

2030 and beyond: in search of a new paradigm.

The whole energy paradigm is changing in France. In recent decades, this paradigm has been based on a power production mix dominated by nuclear energy and, to a lesser extent, by hydropower.

France has not yet defined its future energy mix.

It is now necessary to find new ways to meet very ambitious energy efficiency and GHG emission reduction targets amid stable (or decreasing) nuclear and hydropower capacity.

28 Cour des comptes, 2013
29 EDF, 2014
30 EDF, 2015

Selected bibliographic references

Ademe, review of the "Fond chaleur": http://www.ademe.fr/fondschaleur/

CGDD (2013) – Chiffres clés des énergies renouvelables – Édition 2013

CGDD (2014) – Chiffres clés de l'énergie – Édition 2013

Cour des comptes (2014) – Le coût de production de l'électricité nucléaire – Actualisation 2014

Cour des comptes (2013) – La politique de développement des énergies renouvelables – juillet 2013

EDF (2014), Comptes consolidés 2013: http://finance.edf.com/fichiers/fckeditor/Commun/Finance/Publications/Annee/2014/EDF2013_rapport_financier_comptes_consolides_vf.pdf

EDF (2015), Communiqué de presse, 12 février 2015: http://medias.edf.com/fichiers/fckeditor/Commun/Finance/Publications/Annee/2015/resultats_annuels/vf/CP_resultats_2014_20150212_vf.pdf

EEA (2014a) – Annual European Union greenhouse gas inventory 1990–2012 and inventory report 2014 – Submission to the UNFCCC Secretariat

EEA (2014b), Trends and projections in Europe 2014

Europe 2020 Targets [online] available on: http://epp.eurostat.ec.europa.eu/portal/page/portal/europe_2020_indicators/headline_indicators

European Commission – Climate and energy priorities for Europe – the way forward. Presentation of J.M. Barroso on 20/21.03.2014
http://ec.europa.eu/clima/policies/2030/docs/climate_energy_priorities_en.pdf

European Commission Energy Country Factsheets 2012. Gross Inland Consumption by fuel (Primary Energy Consumption) in Mtoe for year 2010 [online] on: http://ec.europa.eu/energy/observatory/countries/doc/2012-country-factsheets.pdf

European Commission Energy Country Factsheets 2012, Final Energy Consumption for year 200 & 2010 [online] on: http://ec.europa.eu/energy/observatory/countries/doc/2012-country-factsheets.pdf

Eurostat Tables and Graphs Final Energy consumption for year 2012 updated on 17.02.2014

Eurostat Tables and Graphs Final Energy consumption for year 2012 updated on 17.02.2014

Grenelle de l'environnement, comité opérationnel n° 10 (2007) – Plan de développement des énergies renouvelables à haute qualité environnementale (http://www.ladocumentationfrancaise.fr/var/storage/rapports-publics/084000523/0000.pdf)

Jacques Percebois & Claude Mandil (2012): Rapport Energies 2050 http://www.strategie.gouv.fr/system/files/rapport-energies_0.pdf

Magritte Group: http://www.gdfsuez.com/wp-content/uploads/2014/03/press-kit-magritte-group-call-for-immediate-and-drastic-measures-to-safeguard-europe-s-energy-future-march-19th-2014.pdf.

MEDDE (2013) – Climate and energy efficiency policies – Summary of France's undertakings and results

MEDDE – Chiffres clés de l'énergie, Edition 2013

MEDDE – Panorama énergies-climat, Edition 2013

NEA/OECD (2012): Nuclear Energy and Renewables – System Effect in Low-carbon Electricity Systems

RMS 2013 – Rapport de la France au titre du paragraphe 2 de l'article 3 de la décision n°280/2004/CE du Parlement européen et du conseil du 11/02/2014 – Actualisation 2013

RTE – Bilan électrique français 2013

Tarif Bleu Résidentiel, Rapport CRE Marché Détail 2013, 2012, et 2011

UFE: Loi de programmation pour la transition énergétique Pour une stratégie bas carbone, une renaissance industrielle dans une Europe plus solidaire. http://www.ufe-electricite.fr/IMG/pdf/projet_de_loi_vdef-2.pdf

Xerfi 700 – Le marché de l'électricité, Février 2014/JPI/ADE

Produit et réalisé par le Creative Studio, Zurich. 42168A