Technology Collaboration Programme on Heat Pumping Technologies (HPT TCP)

Annex 42

Heat Pumps in Smart Grids

Market overview: Country report for France

Appendix to the Final report

Operating Agent: The Netherlands

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Market overview

Country report for FRANCE

Report compiled by

ABSTRACT
This appendix provides the detailed summary report discussing the market overview for France.

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1 Overview of the French Energy Sector

1.1 Overview of main challenges in France

The French Ministry in charge of Energy [1] defines and implements the policy on energy and its uses, with two objectives:

- Control the **emissions of greenhouse gas** to fight against global warming and air pollution;
- Maintain **competitiveness** and **security of supply**.

To meet the challenge of global warming, policy measures are developed in the following directions:

- Improve **energy efficiency** in all sectors and reduce energy consumption
- **Decarbonise the economy** and develop **renewable energy** in a sustainable way to make the economy more robust and more competitive.

Alongside these objectives, the French energy policy aims also at ensuring to all consumers the availability of energy they need at **competitive prices**, while contributing to **national cohesion** and **continuity of public service**.

France has committed in 2005 (POPE Law) to **reduce its greenhouse gas emissions** by 2050 to a quarter of the 1990 level [2]. The French economy's **carbon intensity** is already one of the lowest in Europe (around 210 gCO_2/€GDP[1] in 2012, 37% below the EU average [3] [4])[2]. France over-achieved its **emission target** defined under the Kyoto protocol: France committed to stabilizing its GHG emissions at the 1990 level, but average 2008-2012 emissions were 9% below this [5].

In 2013, the transport, residential, and agriculture sectors have emitted over two-thirds of total greenhouse gas emissions [5]. In contrast, CO_2 emissions from the **power sector** contribute only a small share to total emissions (29 million tons CO_2, or 6% of total greenhouse gas emissions). Thanks to its **nuclear basis**, the French power mix is one of the least carbon-intensive in Europe. In 2013, emission intensity averaged 41 g/kWh, compared with 350 g/kWh for the European Union.

1.1.1 Future supply and demand mismatches

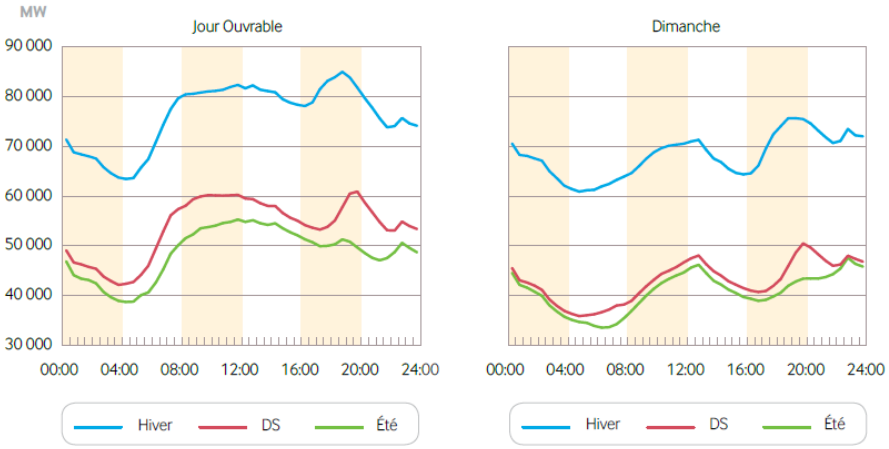
The development of wind turbines and photovoltaic panels initiated in the middle of 2000 in Europe generates a lot of changes in the organisation of the electric system: in particular, it progressively modifies the structure of the demand addressed to the classical centralized production means. Indeed, these renewable energy sources have today priority in the dispatch process. So as it may be, their zero variable operation cost would nevertheless insure them a very good position in the stack according to the merit order. As a result, the centralized production means have to satisfy the electrical demand minus the intermittent productions which is called in the following "the net demand".

Massive insertion of wind and photovoltaic generation will impact the net demand in two ways. On the one hand, it will reduce its average level; and on the other, it will increase its variability. However, the development of electrical uses, such as mobility, that would distort the demand is not taken into account in this analysis.

[1] This value is expressed in € 2005

[2] Moreover, France accounts for 4% of world GDP and only to 1% of global green house gas emissions [27].

Figure 1 – Typical daily demand profiles of week-days (on the left) and Sundays (on the right) in winter (blue curve), summer (green curve) and intermediate period (red curve) – RTE.



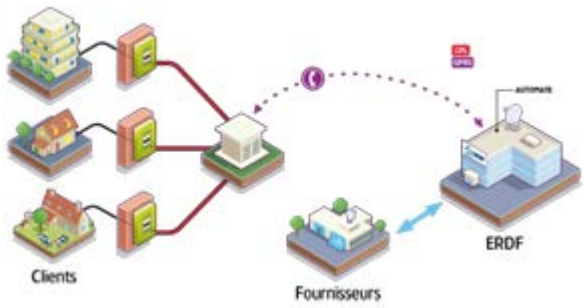
The French electrical demand is characterized by a steep in the early morning (between 6h and 8h) due to the resume of domestic and economic activities followed by a slow rise till noon. Then it begins to slightly decrease till the next day except a first time around 19h due to tertiary and residential sector plus transport and another time around 23h because of the tariff structure. Eventually, the demand is modified by seasonal effects, mainly lighting and space heating. The actual thermal sensitivity reaches 2 300 MW/°C that explains the interest in load management and energy efficiency and the accuracy of the present annex.

The reduction of the average level of the net demand will entail a decrease of the yearly running hours of both base and semi-base power plants. Moreover, the moments of very low net demand will be more difficult to forecast because they will also occur when the cumulated production of renewable generation is high.

The increase of the variability of the net demand will reinforce the needs of semi-base and peak power plants whereas the participation of wind and photovoltaic production to the peak is limited compared to their installed capacity. Within a day, the valley as well as the winter peak will no more take place at a fixed hour (19h).

The development of electric uses and production from renewable energy sources create new constraints on the electrical system. These trends, coupled with rising prices of primary energy sources and an awareness of global climate issues, call for a better demand-side management and a greater efficiency of the entire electric system enabled by the emergence of smart grids. Demand response may bring part of the required flexibility to insert renewable generation on the grid. Besides, on the 28th September of 2011, authorities decided to generalize the deployment of smart meters for domestic customers and small professionals: 35 million units should be installed throughout the territory within the end of 2020. Linked to a supervision centre, these new generation meters interact permanently with the grid and contribute to make it smart by offering new possibilities in terms of load management, remote monitoring (including a better knowledge of the customers' consumption profiles) and innovative tariffs.

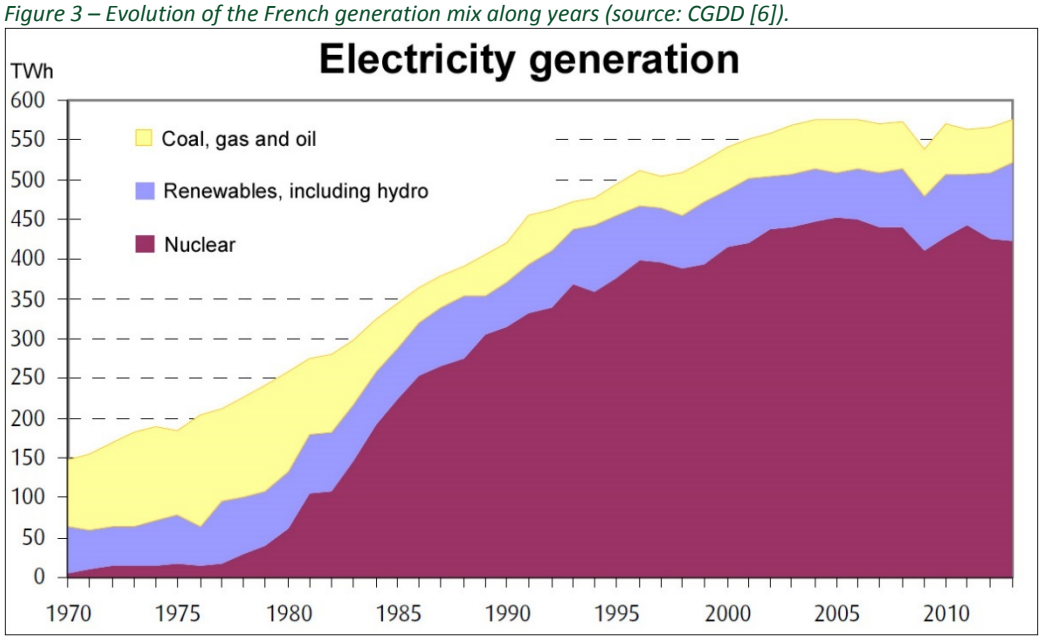
Figure 2 – General scheme of the Linky infrastructure (source ERDF).



1.2 French electricity generation

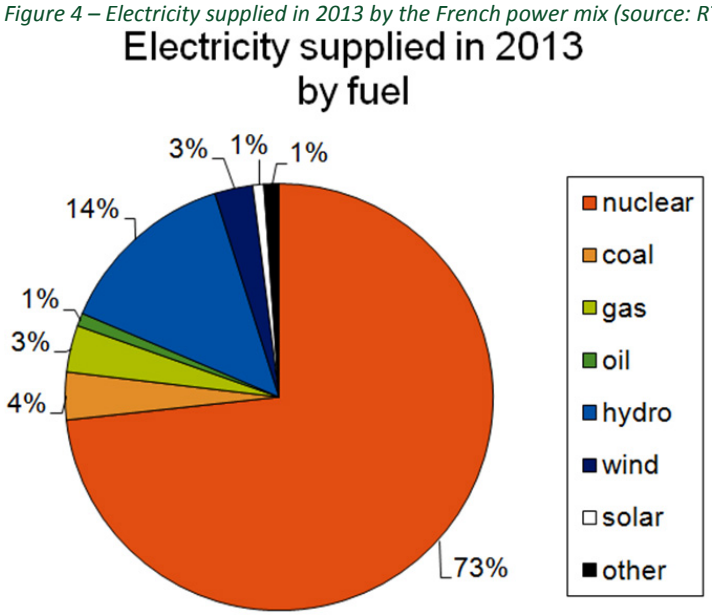
The 80's and 90's have seen the large **increase of nuclear generation**, decided after the first oil shock.

Figure 3 – Evolution of the French generation mix along years (source: CGDD [6]).



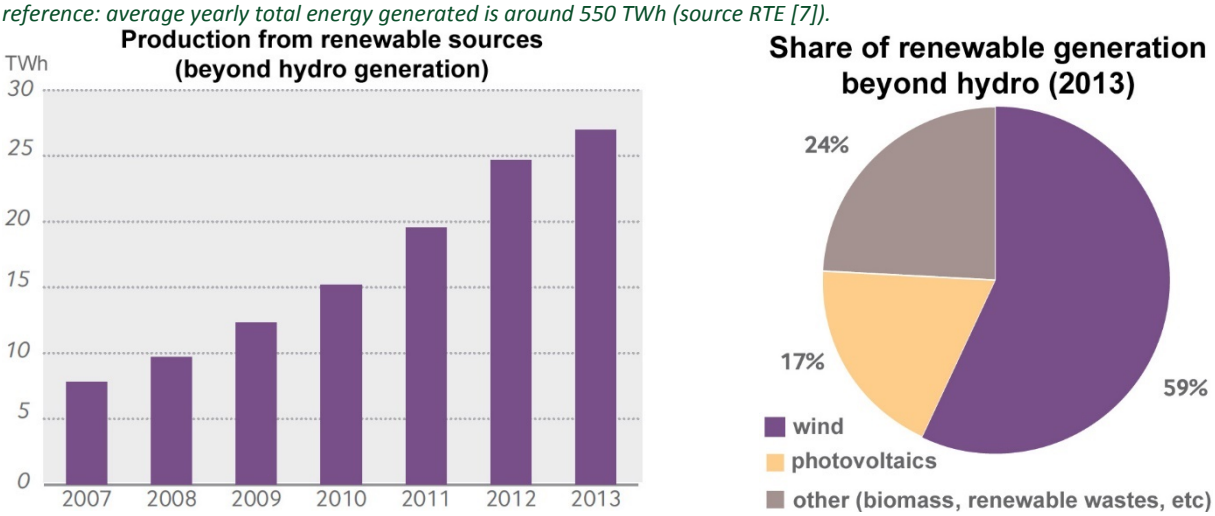
The French electricity supply is now **decarbonised at 92%**, thanks to the nuclear, hydro, and new renewable components.

Figure 4 – Electricity supplied in 2013 by the French power mix (source: RTE [7]).



Generation from renewable sources is **dominated by hydro**. Over the last years, the **share of other renewables** (wind, photovoltaic, biomass and renewable wastes) **has been rising** significantly.

Figure 5 – Production from renewable sources [left, hydro not included] and breakup of renewables for 2013 [right]. For reference: average yearly total energy generated is around 550 TWh (source RTE [7]).



More than half of the renewable energy production excluding hydropower comes from wind generation. Photovoltaic production also increased sharply compared to 2012 (16.2%) and reaches 4.6 TWh. Production from renewable fuel plants (household waste, paper waste, biomass and biogas) increased by 7.0%. Total production from renewable energy sources excluding hydro increased in 2013 (8.1%) to reach 26.8 TWh.
Production from all renewable energy sources reached 20.7% of the French electricity demand in 2013.

Figure 6 – Annual share of production issued from renewable sources compared to the electricity consumption.

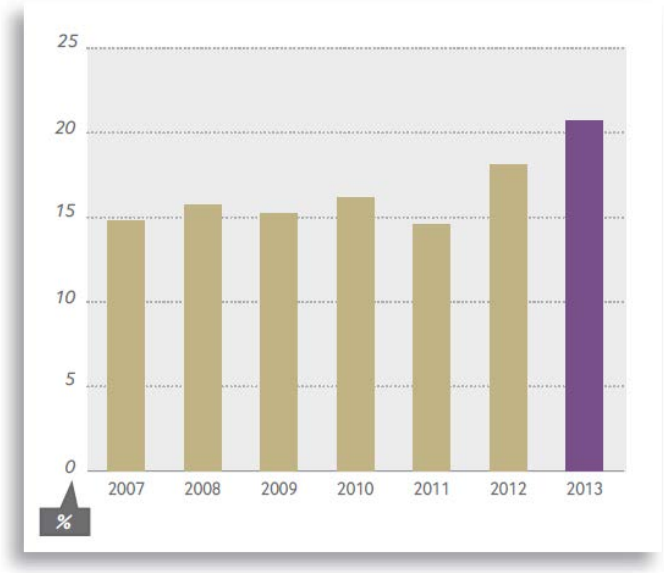
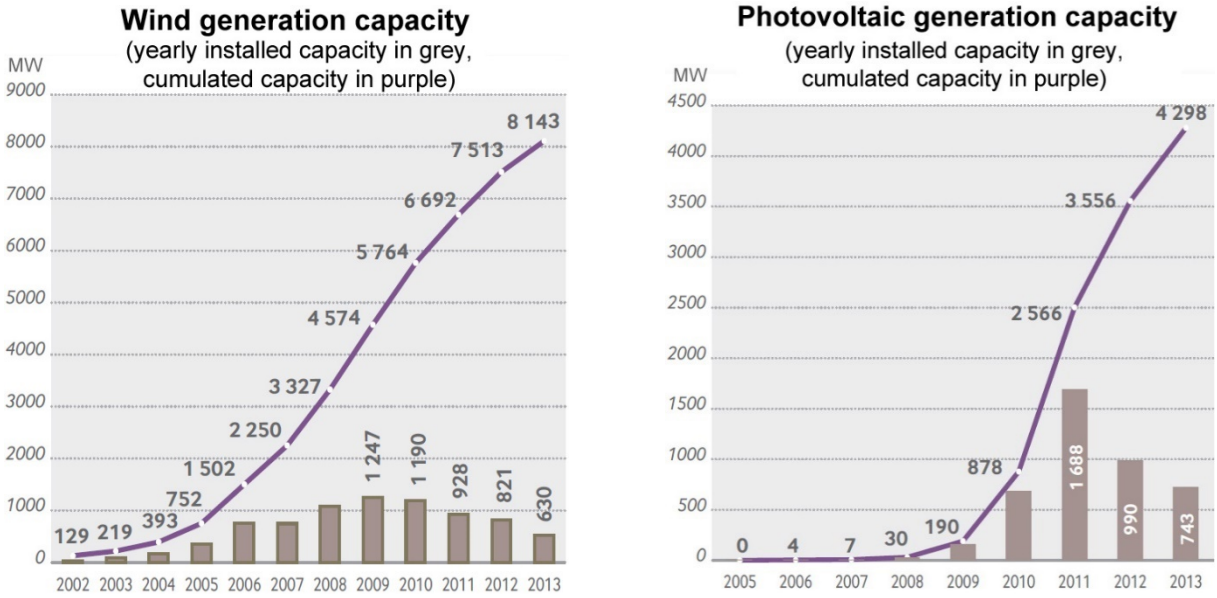


Figure 7 – Evolution of wind [left] and photovoltaic [right] generation capacity. For comparison, total installed capacity (all technologies) is equal to 128,000 MW in 2013 (source RTE [7]).

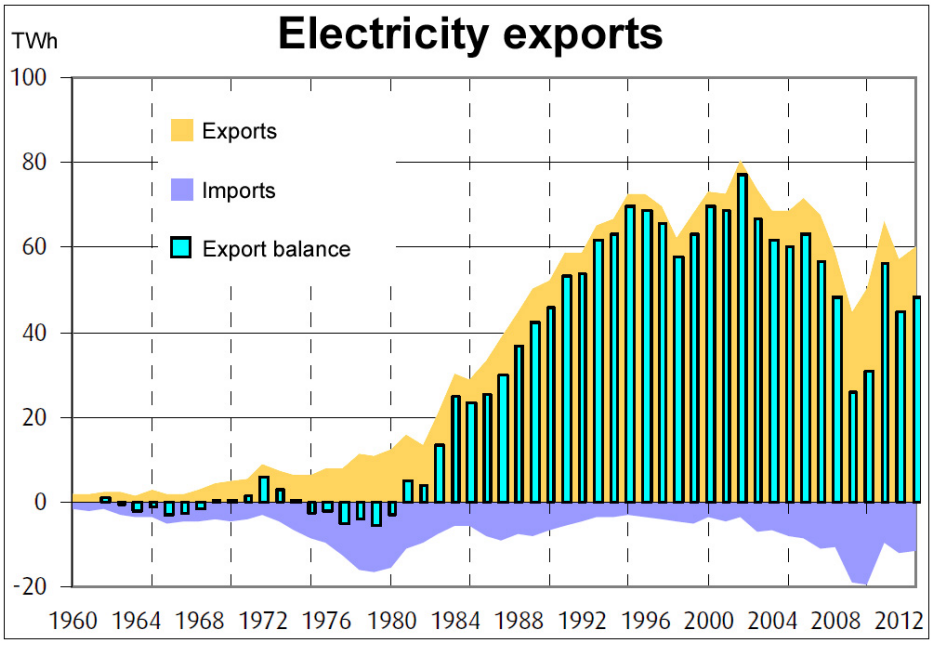


The slowdown of the development of new wind farms can be explained by economic and regulatory uncertainties (conditions of crisis, price of purchase, lending) and the duration of administrative procedures. In 2013, the wind farm produced on average at 23.2% of its capacity with a maximum of 80.3% reached on December 23. By its so-called "non-dispatchable" nature, wind generation has a variability that affects its contribution to the supply-demand balance. Thus, the wind farm produced at more than 47% of its capacity for 10% of the year but at less than 6% of its capacity for an equivalent period. The average **coverage rate** of consumption by **wind** generation was 3.3% in 2013, with a maximum at 16.2% on Sunday 27th October 2013 at 5am, and a minimum at 0.1% on Monday 22nd July 2013 at 12am [8].

The growth of Photovoltaic Park slows down too. In 2013, the maximum of PV power was reached on the 21st August at 14h with 2997 MW, which corresponds to a load factor of 75.5%. The average **coverage rate** of consumption by **photovoltaic** generation was 1% in 2013, with a maximum at 7.3% on Sunday 11th August 2013 at 2pm [8].

French **electricity export balance** has been representing around 10-15% of the electricity generated since the 90's.

Figure 8 – French electricity exports (source: CGDD [6]).



In 2013, total electricity production in France amounted to 550.9 TWh, which corresponds to an increase of 1.7% compared to 2012. This development covers a consumption growth of 1.1%, hence a slight increase in net exports.

1.2.1 Forthcoming development of renewable energy

France must achieve a legally binding **target of 23%** share of energy from renewable sources in gross final consumption of energy [9]. The National Renewable Energy Action Plan [10] sets the target of renewable energies to be **27% in electricity sector, 33% in heating/cooling sector, and 10.5% in transport** sector by 2020. The Grenelle laws [11] [12] and the planning document "PPI" [13] have fixed development objectives for the various technologies concerned, in particular in the electricity sector.
Observers make regularly assessments about the current development pace compared to the required one to be able to achieve the objectives. The following table present one recent evaluation [14].

Table 1 – Will France reach its 2020 renewable electricity objectives? (source: RTE-SER-ERDF-ADEeF [8] for the data, Observ'ER [14] for the assessments).

Technology	***Situation end 2013***	***Capacity in queue (end 2013)***	***2020 objective***	***Assessments***
Onshore wind	8.1 GW	6.1 GW	19 GW[3]	Very uncertain
Offshore wind	0	4.2 GW[4]	6 GW	Unattainable
Photovoltaics	4.3 GW	2.4 GW	5.4 GW[5]	2020 objective could be reach by 2015
Share of renewable energy generation in the electricity sector (referred to the final electricity consumption)	17% (hydro inflow corrected)	-	27 %	Trends could lead to a share between 21 et 22%

In order to fulfil the legally binding target of 23% share of energy from renewable sources in gross final consumption of energy, the French administration [6] assesses that there is an **important effort to be made on the thermal sector**: the energy use of wood has to be increased (+5.2 Mtoe) outside the individual residential sector, i.e. in district heating, tertiary, and industry.

1.2.2 Total available generation capacity

The installed capacity decreased by 785 MW over the year 2013. This decrease is the result of the closure of conventional thermal plants, partially offset by an increase in wind, photovoltaic and other renewable energy sources.

Table 2 – Installed capacity by generation type (source RTE).

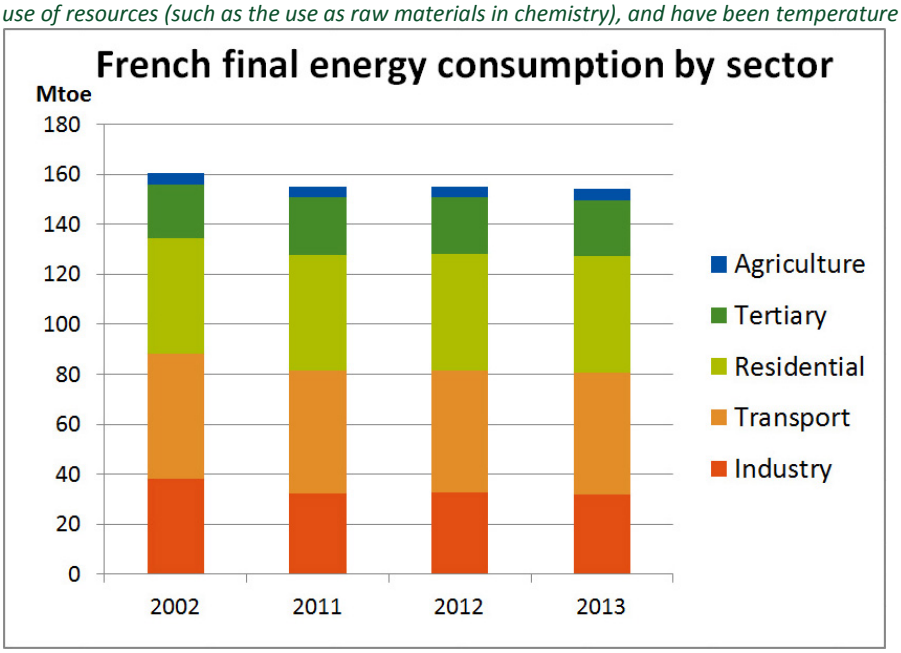
Generation type	*Capacity (MW)*
Nuclear	63,130
Coal	6,341
Oil	8,779
Gas	10,456
Hydro	25,404
Wind	8,143
Solar	4,33
Other	1,478

[3] The sum of ambitions expressed in the Regional Schemes SRCAE [27] for the year 2020 is equal to 28.8 GW as far as onshore wind is concerned [8]
[4] The first offshore facilities should be commissioned between 2017 and 2019 [29]
[5] The sum of ambitions expressed in the Regional Schemes SRCAE [27] for the year 2020 is equal to 15.5 GW as far as photovolatics is concerned [8]

1.3 French Energy Demand

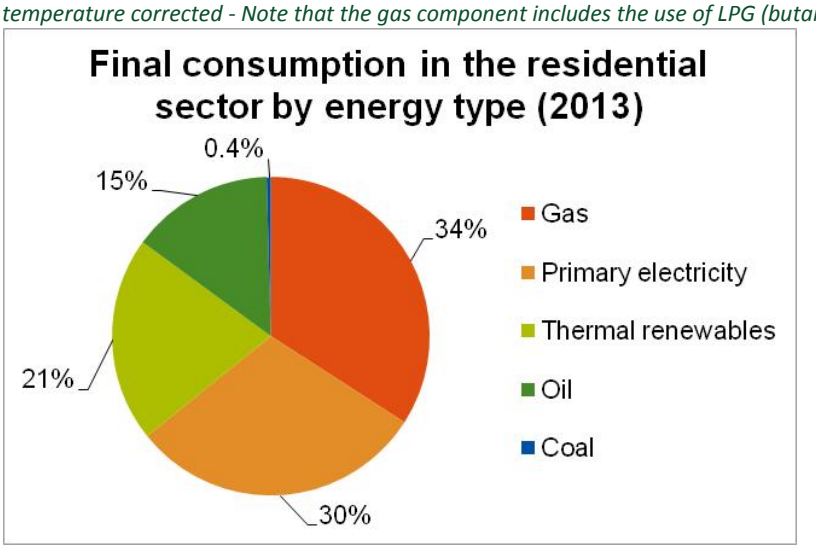
The French **final energy demand** was in 2013 around 150 Mtoe, 30% of which consumed by the domestic sector.

Figure 9 – French final energy consumption by sector (source: CGDD [6]). Note that these values exclude the non-energetic use of resources (such as the use as raw materials in chemistry), and have been temperature corrected.



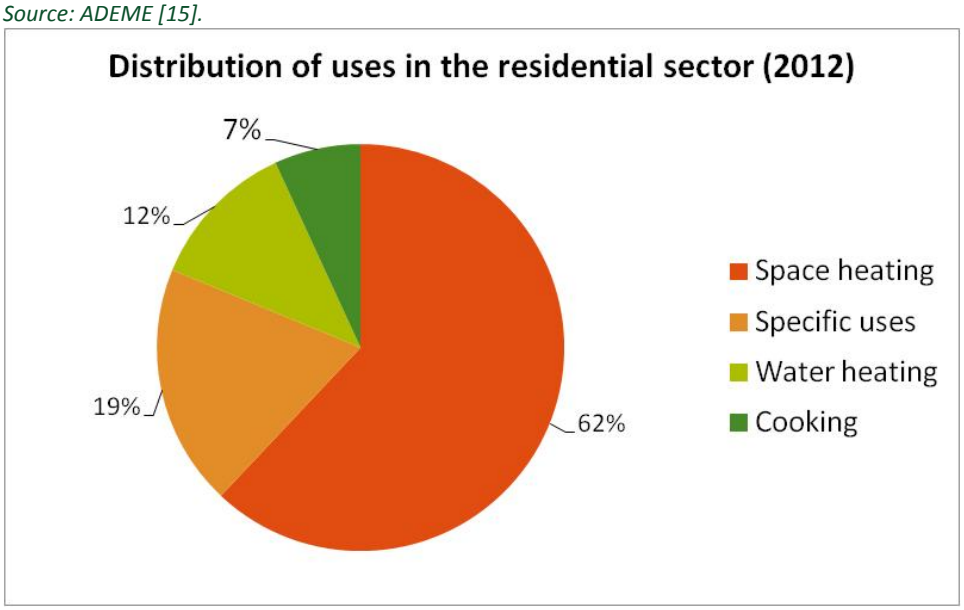
Gas is the **most used** energy in the **residential sector**, followed by electricity and thermal renewables (wood).

Figure 10 – French final consumption in the residential sector by energy type in 2013. (source: CGDD [6]). These values are temperature corrected - Note that the gas component includes the use of LPG (butane, propane) for approx. 2% [15].



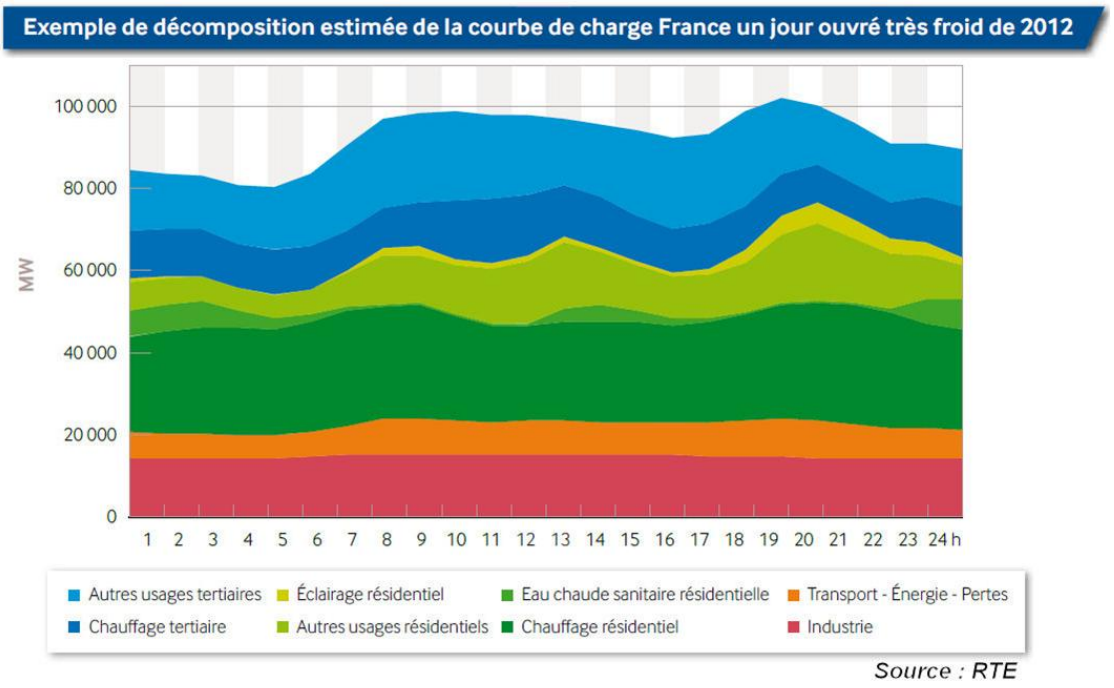
In 2012, the average energy consumption by home was 16.6 MWh [15]. **Space heating accounts for 62%** of the energy use in the residential sector, followed by the specific uses of electricity (19%), and water heating (12%).

Figure 11 – Average distribution of the energy uses in the residential sector for the year 2012 (temperature corrected) - Source: ADEME [15].



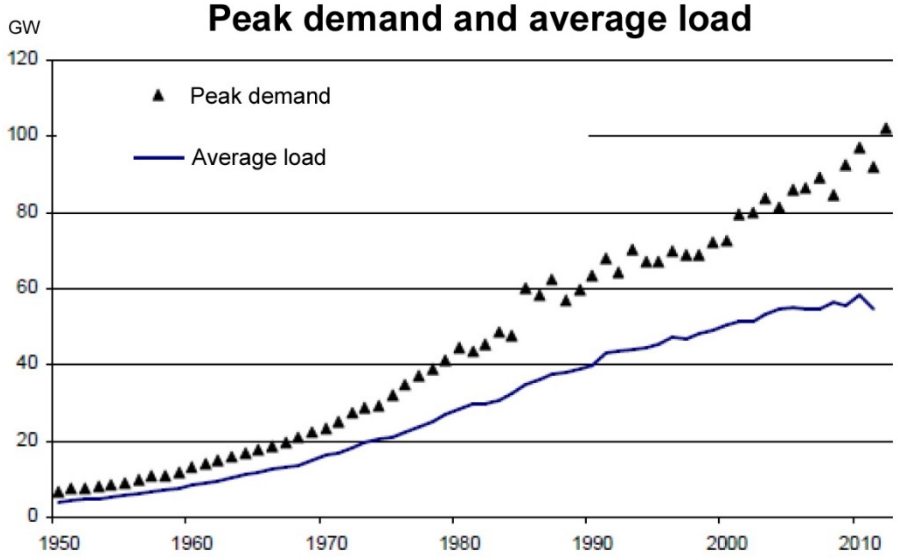
On a **very cold** business day, **electrical space heating** in **residential** and **tertiary** buildings can represent **30%** of electricity demand.

Figure 12 – Sample of a French daily load curve and estimated decomposition of uses on a very cold business day (source: RTE [16]).



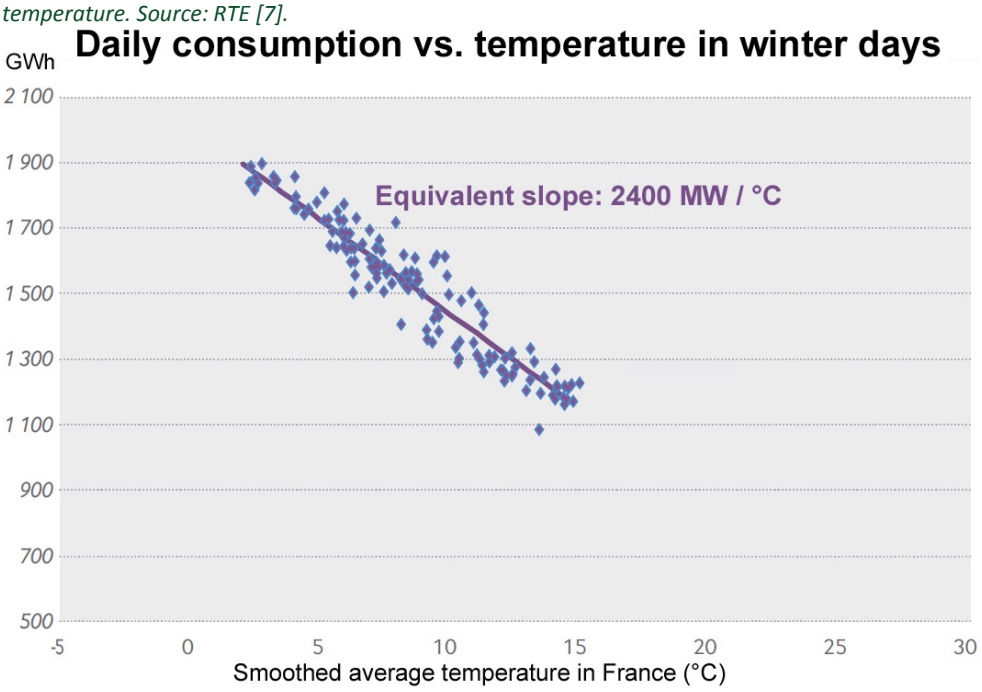
Final electricity demand reached 432 TWh in 2013, a 0.9% increase over 2012. **Peak load** is growing at a more rapid rate than energy consumption. An all-time high of 102 GW was reached in 2012. This situation is one of the motivations that lead to the implementation of a **capacity mechanism** in the near future (see §1.5).

Figure 13 – Evolution of peak demand and average load in France (source: DGEC [17]).



Power demand sensitivity to temperature is high in France owing to the large share of electric heating, reaching **+2,400 MW** for each additional **degree** Celcius below normal temperatures.

Figure 14 – Daily consumption of business days during the period June 2012 - May 2013 when selecting the days where the average temperature in France is lower than 15°C. The purple line shows the sensitivity of electric consumption to temperature. Source: RTE [7].

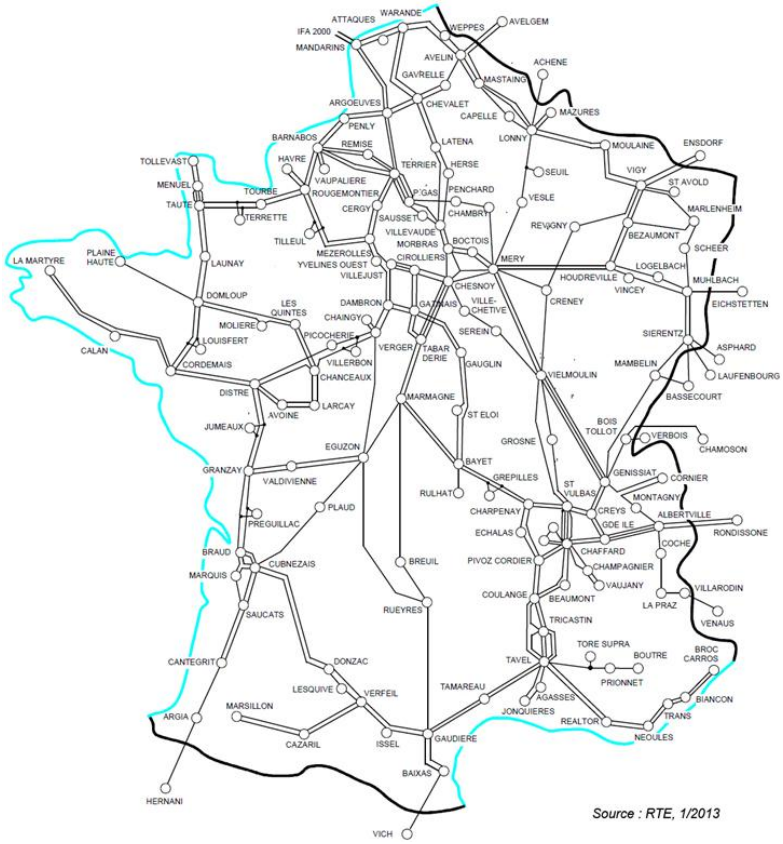


1.4 French Energy Infrastructure

1.4.1 The French Electricity Grid

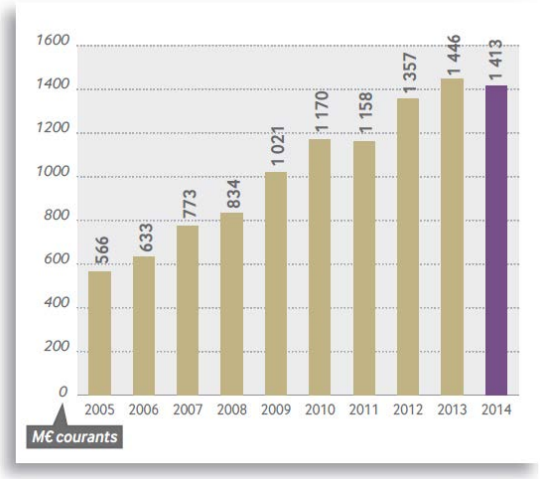
Transmission Grid: The electricity transmission network in France is owned and managed by **RTE**. 46 **interconnections lines** connect the French system to the neighbouring countries (Spain, Italy, Switzerland, Germany, Belgium, and the UK).

Figure 15 – French electricity transmission grid showing the 400kV infrastructures (source: RTE).



The investments of RTE aim at meeting the challenges of the energy transition. The French electricity transmission network is in fact an essential link for receiving new productions (especially offshore farms), for the European energy integration (through the strengthening of cross-border trading capacities), for the safe operation of grids and the power quality.

Figure 16 – Investments of RTE in millions of Euros (source RTE).

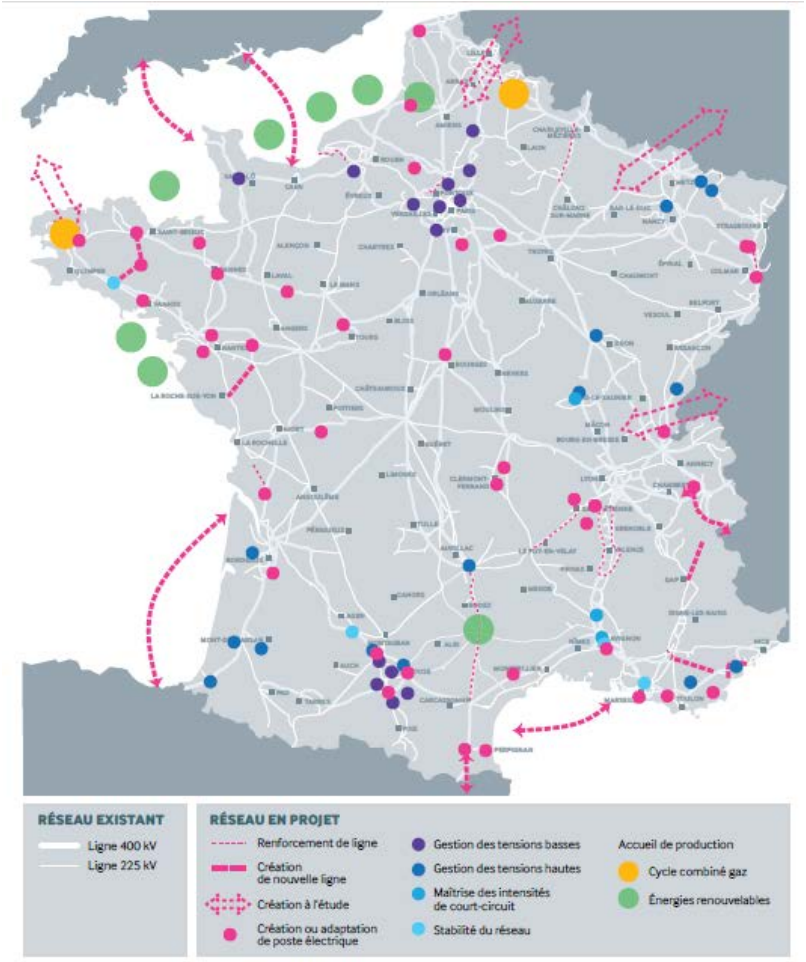


Its adaptation is based on the objectives of the Climate Air Environment regional schemes. When the hosting capacities are enough, a part per substation is reserved for renewable energies during 10 years. Otherwise, solutions of reinforcement or creation of power lines or substations are proposed.
Some oncoming projects are listed here-after:

- The France-Spain interconnection line (2000 MW, 320 kV) – 700 M€

- The upgrade of the electricity supply in the PACA region where local power generation covers less than half the demand and where a unique 400kV transmission line fulfils most of the consumer electricity needs – 170 M€
- The connection of offshore farms (6 000 MW by 2020)
- The France-Italy interconnection line

Figure 17 – Map of major projects (source RTE).

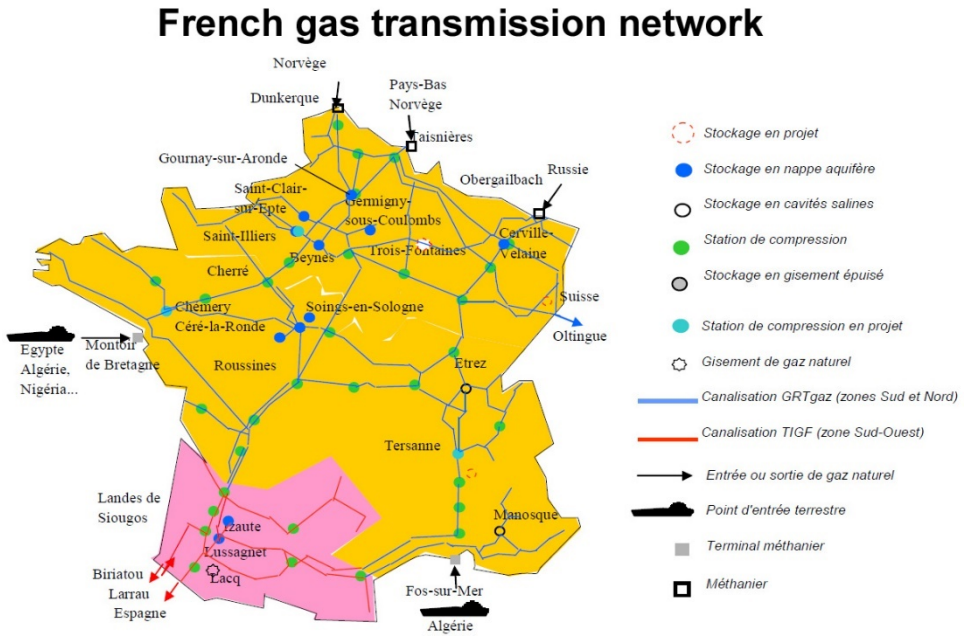


Distribution Grid: In France the distribution grid **belongs to local authorities** (municipalities), which delegate network operation to Distribution System Operators via **concession contracts**. There are about 150 distribution system operators, the most important one being ERDF (it covers 95% of the French territory) [18]. 31.3 million homes are connected to the electricity grid [19].

1.4.2 The French Gas Grid

The French gas **transmission** network is shared between two operators: **GRTgaz** [20], for 80% of the country (in yellow on the following figure), and **TIGF** [21] for the South-West French region (in pink on the figure). This gas transmission network is interconnected with Spain, Switzerland, Germany and Belgium.

Figure 18 – French gas transmission network (source: [6]).



As for electricity, the **distribution** gas network **belongs to local authorities**, which delegate network operation to Distribution System Operators via **concession contracts**. There are about 30 gas distribution system operators, the most important one being GrDF [22]. 10.6 million homes are connected to the gas network [19].

1.5 French Energy Policy

The building sector, which represents 44.5% of the final energy consumption of France in 2012, is a major issue of the energy efficiency policies. The up-grading of the thermal performances of buildings is essential to reach the objectives in terms of energy efficiency, greenhouse gases reduction and renewable energy development. The targets are ambitious:

- Generalizing the low consumption buildings in 2013 for new constructions and positive energy buildings in 2020
- Refurbishing 500 0000 old dwellings per year until 2017

To do this France adopted a range of diversified tools: regulations, financial incentives (fiscal and tax), training, information and awareness actions.

1.5.1 Thermal Regulations

The **2012 thermal regulation** reinforces the requirements regarding the thermal performances of **new buildings**, starting from 2013: they may not consume more than **50 kWh of primary energy per square meter** for space and water heating, space cooling, ventilation and lighting. This reference value depends on climate zone, altitude, type of use of the building and the average area of housing. This is a significant tightening compared with previous legislation, which modulated the energy consumption allowance by type of heating system. This new regulation has strong impact on insulation requirements and guides strongly the space heating modes.

The **thermal regulation for retrofitted buildings** of less than 1000 m^2 is based on minimal performance requirements for installed or replaced equipments. It deals with equipments of insulation, space heating/cooling and hot water production. This is called the “element by element” thermal regulation. A modification of this RT is underway to make mandatory the inclusion of energy performance in case of extensive work on the building (e.g. facelift).

1.5.2 High Energy Performance Label

A **label "high energy efficiency renovation"** was also created. It includes two levels for buildings dedicated to residential use: the label "high energy efficiency renovation, HPE 2009» for buildings reaching a primary energy consumption of less than 150 kWh_{ep} / m^2 / year for the afore mentioned 5 uses and the label "low energy consumption building renovation, BBC 2009» for buildings reaching less than 80 kWhep / m^2 / year.
From January 2013, it is required to provide a certificate of inclusion of the RT delivered by a professional.

1.5.3 Incentive Schemes

Many **incentive schemes for individuals** have been implemented:

- The sustainable development tax credit (CIDD): since 2005, individuals can receive a tax credit for the purchase and installation of materials or equipment that are the most efficient in terms of energy-saving or energy production from renewable sources (only in existing dwellings). More than 7 million homes have been renovated thanks to this measure that has been extended until the end of 2015. From January 2014, a rate of 15% - conditioned to level of income - is allocated for a single action; and a rate of 25% for several ones. Moreover, qualification requirements of installers will be introduced from January 2015.
- The Eco-interest loan (eco-PTZ) is available from April 2009 and designed for individual homeowners or lenders to fund major renovation works. This loan finance up to 30 000 € improvements in energy efficiency of a home over a period of 10 years.
- The property tax exemption built: the amended Finance Act 2006 introduced the possibility for local authorities to exempt from property tax built for 5 years, with an exemption rate of 50 or 100%, constructions completed before January 1989 for which significant work to eligible CIDD has been made or constructions of new dwellings completed since January 2009 and bearing the low consumption building label.
- Reduced VAT rates for renovation: from January 2014, the energy renovation works of more than 2 years housings have a reduced VAT rate (5.5%). It concerns the work eligible for the tax credit Sustainable Development (CIDD).
- The book of Sustainable Development (LDD) allows, since January 2007, to grant favorable loans to finance renovation works eligible CIDD of dwellings built since more than 2 years. Its maximum deposit was increased to 12 000 Euros in October 2012.
- In the frame of the program of investments for the future, a support program of € 500 million for energy renovation of buildings dedicated to low-income owner-occupiers, entitled "Live Better", was implemented.

1.5.4 Energy Savings Certificates [24]

Created by the POPE law in 2005 [2], this mechanism encourages **energy suppliers** (suppliers of electricity, gas, fuel oil, and transport fuel from the second period) to **promote energy efficiency** to their customers by imposing a multi-year obligation of achieving energy savings. To fulfil its obligation, an energy supplier has to be an enabler of energy savings implementation (provided that this has an additional effect compared to business as usual actions). Certificates can be exchanged (bought and sold) between actors. All sectors are covered (residential, commercial, industrial, transportation, etc.), as far as all types of customers are covered (households, companies, public authorities, etc.). The major part of the actions performed is selected within a catalogue of **standardized operations** whose list is determined by ministerial order. At the end of the multi-year period and in case of failure to comply with their obligations, the suppliers must pay a penalty of 20 € per certificate. The unit used for the certificate is the "**MWh cumac**", which correspond to the **cumulated** energy savings brought by the action during its life duration, considering that each yearly saving is **amortised** at a 4% ratio. The first period objective (2006-2009) was fixed at 54 TWh cumac (distributed among suppliers). For the second period (2010-2013), the objective has increased up to 345 TWh cumac, alongside with an extension of the list of energy suppliers concerned. An additional objective of 115 TWh cumac was fixed for 2014. For the next period (2015-2017), a total of 660 TWh cumal has been decided. Details of implementation for this new period are still expected. At the end of November 2013, the volume of energy savings certificates produced since the beginning was 462 TWh_{cumac}. 90.4% of the operations were carried out in the building sector.

1.5.5 The NOME law [23]

The NOME law was voted in December 2010 and came into effect in July 2011. This law grants **access up to 100 TWh of base-load nuclear power to** the incumbent (EDF) **competitors** at a regulated price (currently €42 per MWh). This law aims to foster competition in the French electricity market, it will run until 2025. The law provides that **existing regulated tariff for final commercial and industrial customers are to be phased out by 2016**. Regulated tariff for final residential customers will be retained, but will have to reflect the full cost of electricity.

1.5.6 Capacity market

As required by the NOME law [23], RTE is currently charged to create a **decentralized capacity remuneration market** that will be operating from winter 2016/17 [17]. This mechanism will remunerate existing plants that are not recovering their fixed costs on the energy market, incentivize the deployment of demand response resources, and in the longer term potentially encourage new investments in peaking generation units.

1.5.7 Proposed Energy Transition Bill

The Ministry in charge of energy has proposed in June 2014 a draft bill [25] on the "**New French Energy Model**". The elaboration of this text follows the organisation of a large debate on energy transition that took place in 2012-2013. We present below the main measures proposed in the draft bill, considering of course that the Parliament will certainly amend and/or complete some of these measures.

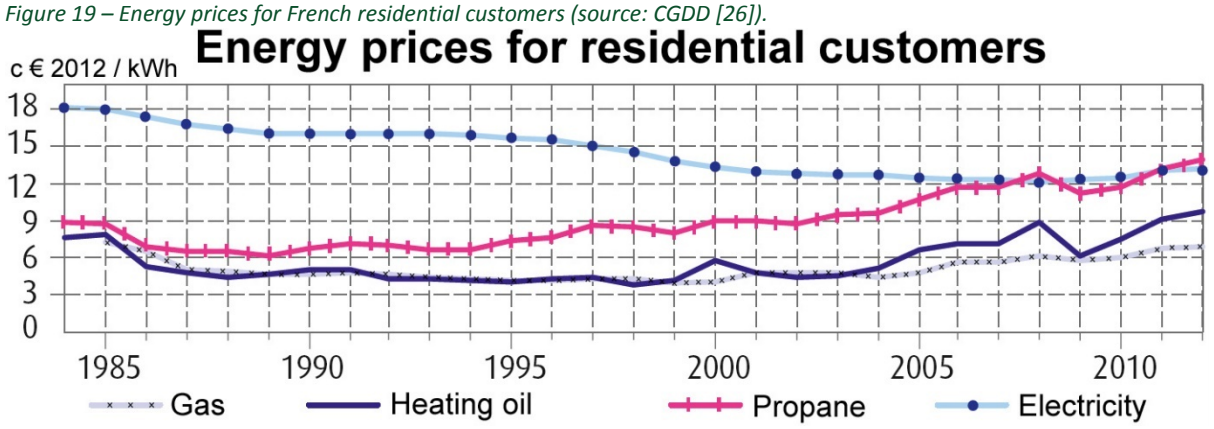
- **Two planning tools** at the hand of public authorities are introduced: a **low carbon strategic plan**, and a **multi-year energy plan**. They will set objectives in all the sectors concerned for 5-years periods, and will aim at respecting "carbon budgets", promoting renewable energies, diversifying energy sources, improving energy efficiency, and ensuring security of supply.
- -The draft bill proposes the following midterm and long term targets: a 40% reduction of **greenhouse gas emissions** in 2030 compared to 1990, a 50% reduction of **energy consumption** in 2050 compared to 2012 (with an intermediate target of 15% reduction in 2020), a 30% reduction of **fossil fuels** use in 2030 compared to 2012, a share of 32% of **renewables** in the final energy consumption in 2030 (40% in the electricity sector, 38% in the heating sector, 15 in the transport sector), a share of **nuclear energy** in the electricity generation limited to 50% at the 2025 horizon, and a cap of the global **nuclear capacity** to the current one (63.2 GW).
- New support measures are proposed to help households to launch investments in **home energy renovation**, new promotion measures for **electric vehicles**, new support measures for **renewables** (heating thanks to biomass, biogas, marine technologies, and adaptation of financial support for onshore wind and photovoltaics)
- A new method is announced to adjust the remaining **regulated electricity tariff** for final customers (the residential one) to the most competitive sources, alongside with a new modulation of **network tariff** for electricity intensive industries.

The objective of total renewable energy production from heat pumps in all sectors amounted to 1 300 ktoe in 2012 and 1850 ktoe in 2020. In the residential sector, supporting the development of heat pumps is part of an overall policy supporting the development of renewable energies in buildings (CIDD, eco-PTZ, CEE).
The development of geothermal energy has been identified by France as one of the priority sectors for green growth and the fight against climate change, and is treated like a "green channel".

1.6 Energy Prices, Tariffs & Structures

During the last 30 years, **fossil fuel** prices for French residential customers have followed the **rising trend** of raw materials prices on international markets. Instead, the **electricity price**, due to the structure of the French mix and the large part of nuclear, has **decreased substantially** (in constant Euros) up to 2005. Since then, a new rising trend has begun, linked to the maintenance costs of the generation units and the new investments made to reinforce the networks.

Figure 19 – Energy prices for French residential customers (source: CGDD [26]).



The structure of the French **electricity costs** can be summed up as follows: the supply component counts for approx. a third, the network component for a second third, and taxes for the last third.
For the **gas costs**, the supply component counts approx. for a half, network and tax components representing a fourth each.

Figure 20 – Indicative structure of electricity and gas costs - Tariffs for French residential customers (sources, DGEC [1] and CRE [19]).

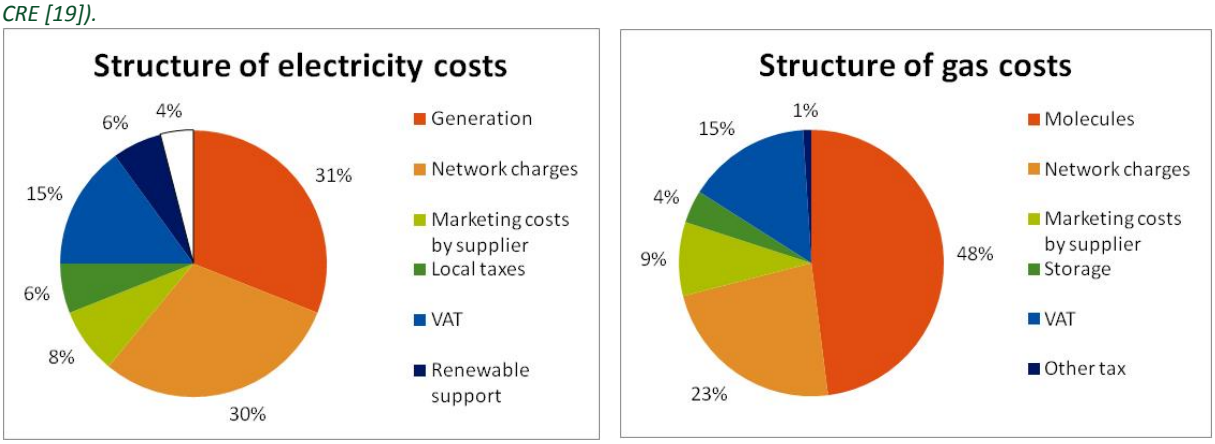


Table 3 – Energy prices for a 110m2 well insulated individual house – RT 1989. (source: Energie Plus n°526 from the 15th of April, 2014).

		Unit	*€/unit*	*€ cents / kWh PCI*	*% variation over a year*
Natural gas		*(kWh PCS)*	0.069	7.63	-0.3%
Domestic fuel		*(hectolitre)*	88.32	8.88	-6.2%
Propane		*(ton)*	2,044	15.98	1.5%
Electricity	HC option	*(kWh)*	0.144	14.37	7.5%
	TEMPO option	*(kWh)*	0.122	12.17	7.7%

Today, the consumer has the choice between two types of quotations: the regulated retail tariffs, offered only by the incumbent supplier (EDF) and the local incumbent suppliers (Electricité de Strasbourg) and market offers proposed by all suppliers (historical or not).

There are three types of regulated retail tariffs. A first one with a flat rate and a second one with day & night rates and finally a "time-of-use" tariff.

Table 4 – Flat rate retail tariffs.

Power level	*Subscription (Euros/year)*	*Price (Euros/kWh)*
3 kVA	52.11	0.1372
6 kVA	84.55	0.1372
9 kVA	111.95	0.1372
12 kVA	172.62	0.1372
15 kVA	198.04	0.1372

Table 5 – Day and night retail tariffs.

Power level	*Subscription (Euros/year)*	*Peak price (Euros/kWh)*	*Off-peak price (Euros/kWh)*
6 kVA	90.98	0.1510	0.1044
9 kVA	121.90	0.1510	0.1044
12 kVA	197.78	0.1510	0.1044
15 kVA	229.23	0.1510	0.1044
18 kVA	257.91	0.1510	0.1044

The customers benefit from a low price of electricity 8 hours per day, generally between 22 and 6 o'clock. These 8 hours are determined by the electricity distribution network operator and can be split in up to 3 periods. They cannot match with the national peak loads that occur from 8h to 11h and from 18h to 20h.

Table 6 – "Time-of-use" tariff.

Power level	*Subscription (Euros/year)*	*BLUE Peak*	*BLUE Off-peak*	*WHITE Peak*	*WHITE Off-peak*	*RED Peak*	*RED Off-peak*
9 kVA	121.01	0.1003	0.0840	0.1400	0.1175	0.5593	0.2142
12 kVA	194.23	0.1003	0.0840	0.1400	0.1175	0.5593	0.2142
15 kVA	225.06	0.1003	0.0840	0.1400	0.1175	0.5593	0.2142
18 kVA	247.02	0.1003	0.0840	0.1400	0.1175	0.5593	0.2142

It is composed of 6 rates determined both by the colour of the day (blue, white or red) and the time of use (peak or off-peak periods). The price per kWh is higher on Red and White days (to a lesser extent). These days generally correspond to the winter period, when electricity demand is very high. In return, the rest of the year and all the weekends, customers enjoy cheap electricity on Blue days.
Over the year, the days are divided as follows:

- 22 Red days: from beginning of November to end of March, Monday to Friday (Saturdays, Sundays and holidays are never Red, so there cannot be more than 5 consecutive Red days)
- 43 White days spread all over the year, mainly from October to May and never on Sunday
- 300 Blue days the rest of the year (all Sundays)

The Red days are determined mostly by EDF and partly by the electricity transmission network operator (RTE) and customers are warned the day ahead.

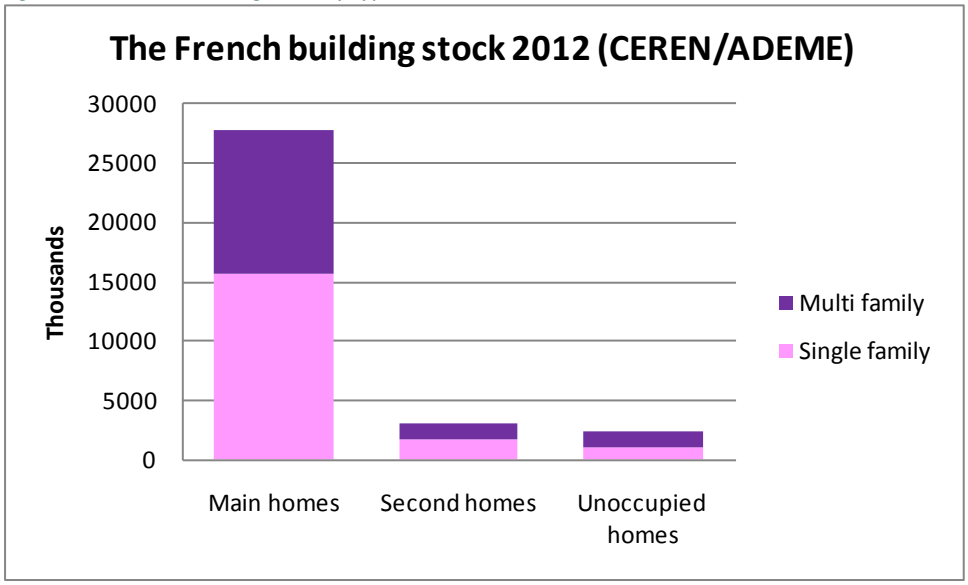
The main problem with the liberalization of the electricity market in France lies in the fact that the incumbent supplier EDF could propose regulated retail tariffs based on its low-cost power plants (dependent on 90% of the cost of nuclear and hydro), and not alternative suppliers. The market offers proposed by the latter are correlated with electricity prices on the European wholesale market. To reduce the gap, the solution is to allow alternative suppliers to purchase part of the EDF nuclear generation at a rate called ARENH. In April 2011, this rate was set by the government to 40 Euros per MWh during the 1st July and the 31 December and 42 Euros per MWh after January 2012.

2 Analysis of the French housing stock & heating market

2.1 French Housing Stock Characteristics

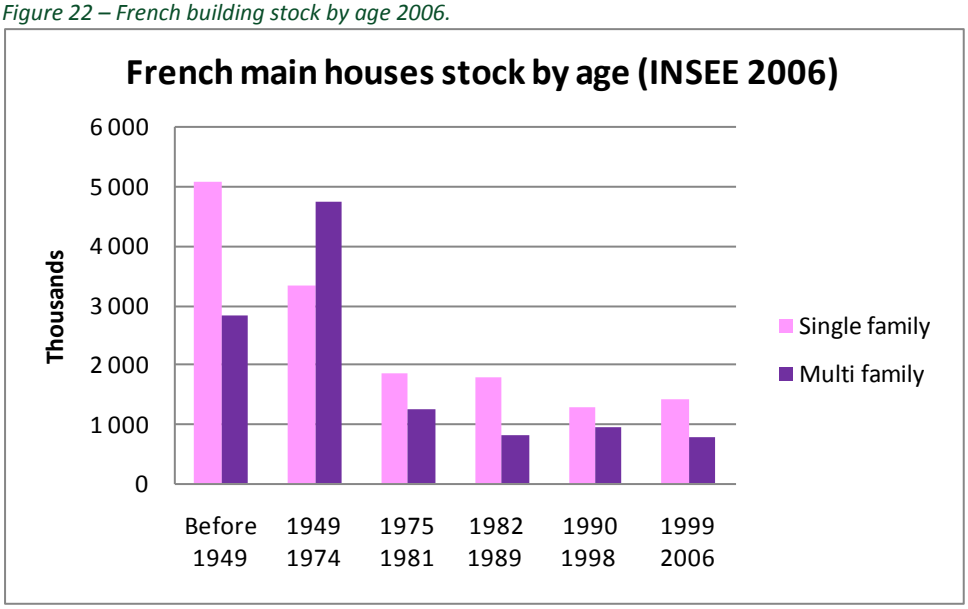
In 2012, France had 33.4 million residential buildings. Among these, 27.8 million were main homes, 3.2 million were second homes and 2.4 million were unoccupied. If we consider the main homes only, 15.75 million are single-family homes whereas 12.04 million are multi-famly homes.

Figure 21 – French building stock by type 2012.



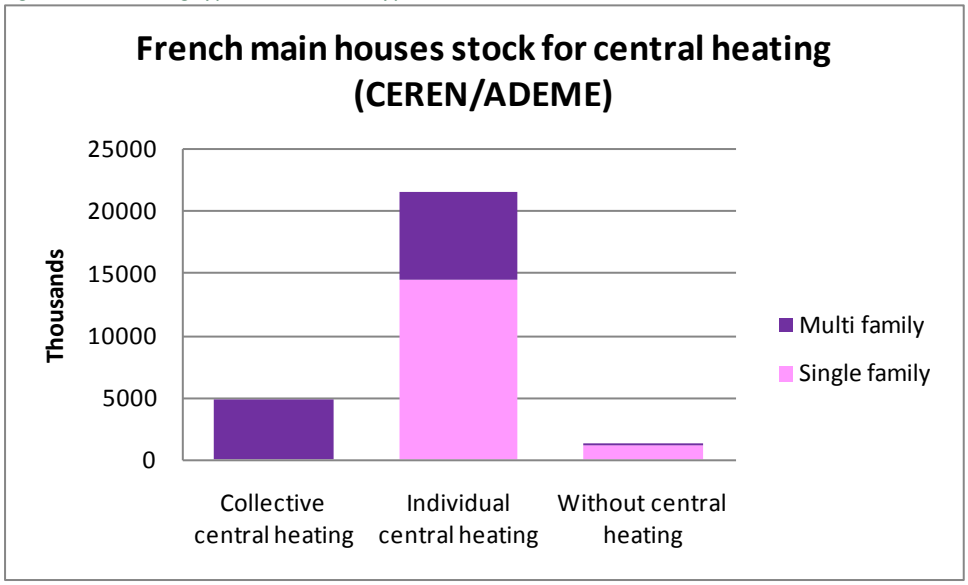
The main houses stock was mainly built before the first thermal regulation (61% before 1975). The single family houses are the most numerous before 1949 whereas for the multi family houses it is between 1949 and 1974.

Figure 22 – French building stock by age 2006.



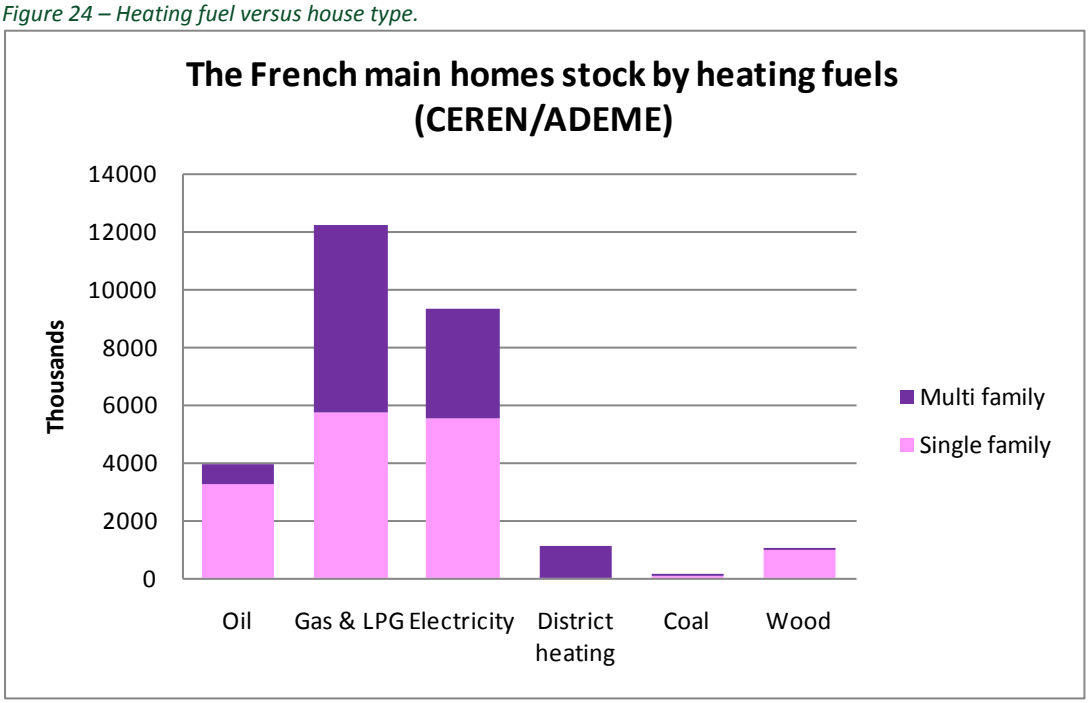
In 2012, 58.2% of the households are owner-occupiers, social housing and private renting representing respectively 17,1% and 22,0%. Central heating is owned by 95% of the main houses. And collective heating represents about 18% for the multifamily houses.

Figure 23 – Heating type versus house type.



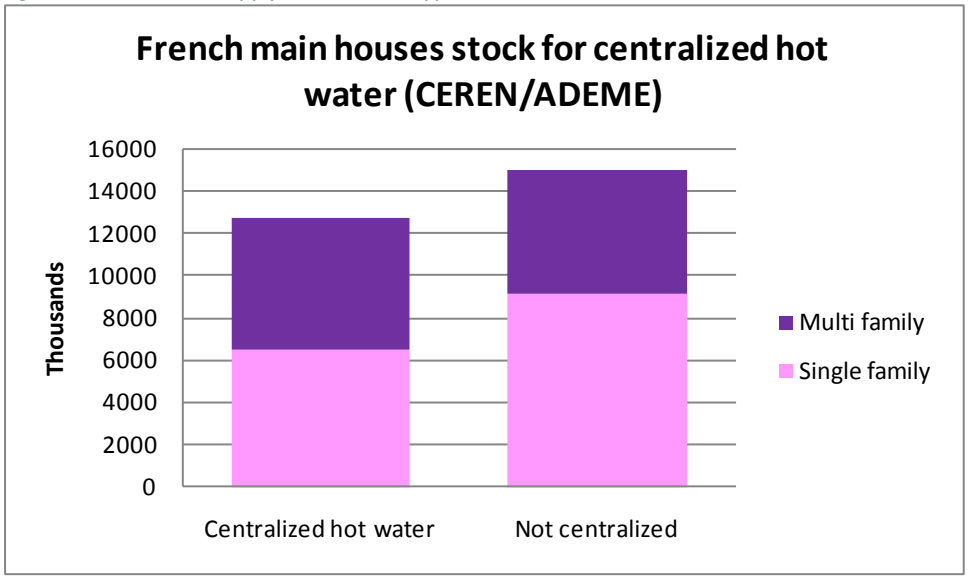
If we take a look at the fuel types used for heating, gas comes first with a 44% market share. Electricity is second with 33.5% of the heating systems oil is third with 14% but is mainly installed in single-family houses. District heating for flats is not negligible with 1.1 million households and so is the wood for houses with 1 million households concerned.

Figure 24 – Heating fuel versus house type.



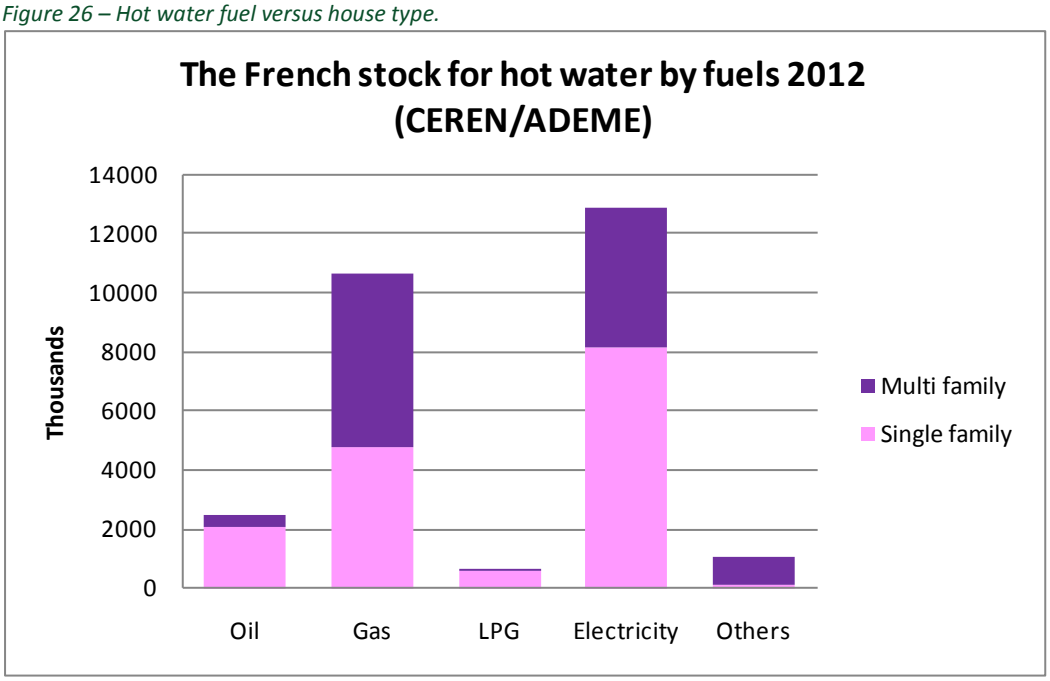
For electricity, there are about 1.5 million heatpumps, mainly in single-family houses. Air to air heat-pumps dominate with a 60% market share followed by air to water heat-pumps (21%). Centralized (the centralized heating system warms the water) hot water concerns nearly 46% of the main homes. For the multi-family houses, it reaches 51.4%.

Figure 25 – Hot water supply versus house type.



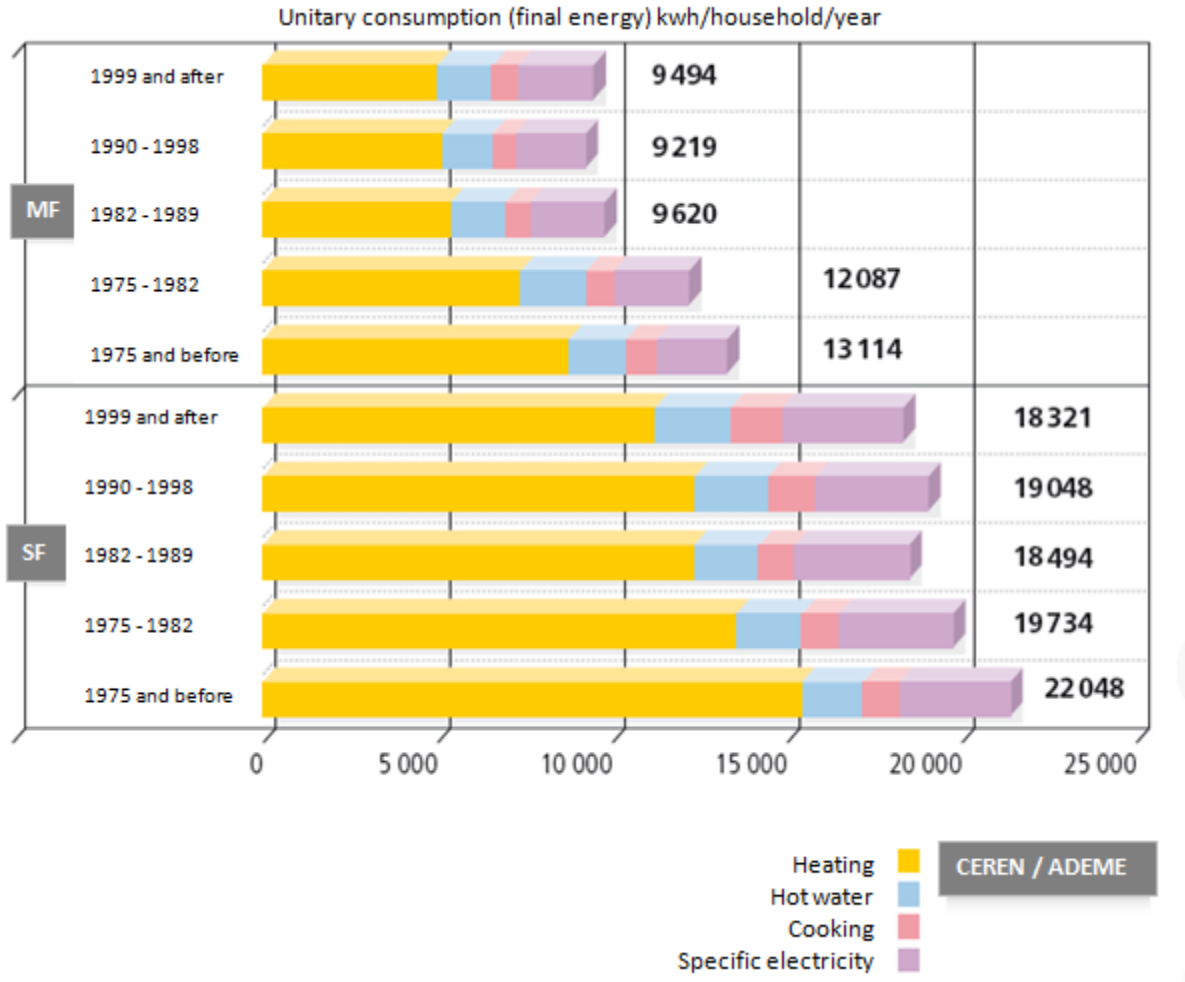
For hot water, electricity is first with a 46.5% market share and even dominates for houses (51.9%). Gas comes second for the whole stock with 38.4% but is near half the stock for flats (48.8%).

Figure 26 – Hot water fuel versus house type.



For electricity, Joule effect with storage represents about 92% of the systems. If we now consider the final energy consumption by end-uses regarding the buildings' ages, it appears that heating is first with an average share of 61.3%. Hot water comes third with 12.1%.

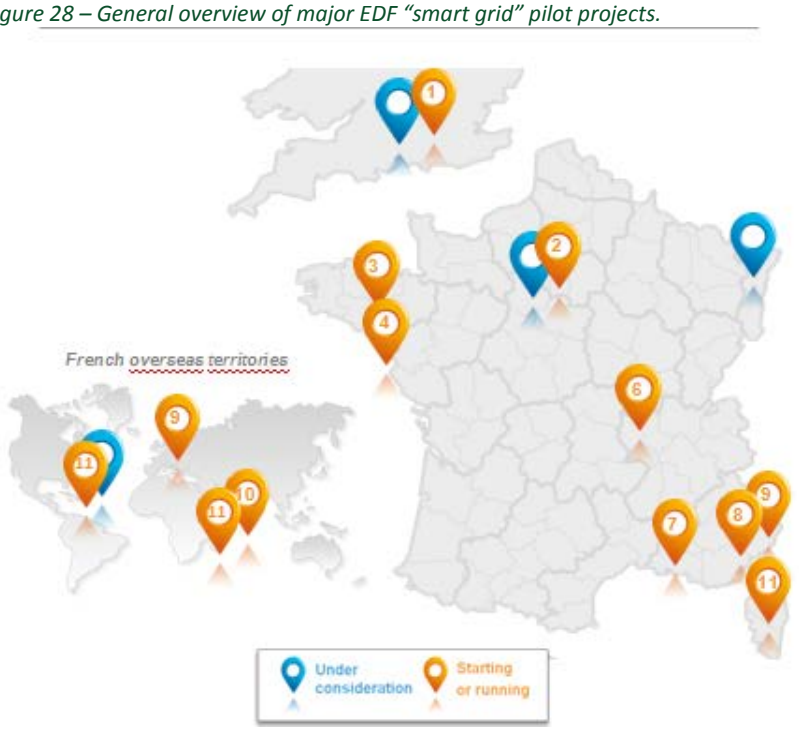
Figure 27 – Breakdown of electricity consumption in households.



A List of smart heat pump projects in France

In the frame of the Research demonstrator fund and then Investments for the future, four Calls for Expressions of Interest (AMI) supported by ADEME have financed 16 demonstration projects (public funding of € 83 million total budget € 304 million) covering all voltage levels and flexibility fields (integration of renewable energy and energy storage on networks, load management in industrial, tertiary and residential sectors). These demonstration projects should contribute to the technical and economic validation of new architectures for electrical systems and to the identification of new business models, including innovative pricing facilitated by smart meters, in view of a large-scale deployment.

Figure 28 – General overview of major EDF "smart grid" pilot projects.



	PROJECT name	Site
1	Low Carbon London	London
2	ISSY GRID	Issy Les Moulineaux
3	Une Bretagne d'avance	Bretagne
4	ADDRESS	Houat & Hoëdic Islands
5	Sécurisation électrique	Houat & Hoëdic Islands
6	SMART ELECTRIC LYON	Lyon
7	PREMIO	Lambesc
8	Energie Efficace PACA	Nice-Toulon-Marseille
9	NICEGRID (takes part of Grid4EU)	Nice
9	Grid4EU	6 projects in Europe
10	PEGASE	La Réunion
11	MILLENER	Corse - Réunion Guadeloupe

General overview of major EDF "smart grids" pilot projects

A.1 PREMIO

Virtual Power Plant: optimizing the integration of Distributed Generation, Storage & Demand Response.

PARTIES
Coordinator : CAPENERGIES

Industrial partners : EDF, ERDF, RTE, Watteco, Cristopia, SAED

Academics and R&D : EDF R&D, Armines, Cerfise

Consultancy : Transenergie, SmartFuture

Institutionnals : Municipalities of Lambesc, Gardannes, Frejus, ADEME, the PACA Region

PREMIO takes part of the Smart-Grid Demonstration Initiative of EPRI (US)

20 + 7 + PL systems
20 Households
7 small tertiary buildings (schools, workshops, offices)
Public lighting

8,1 Millions €
Global budget

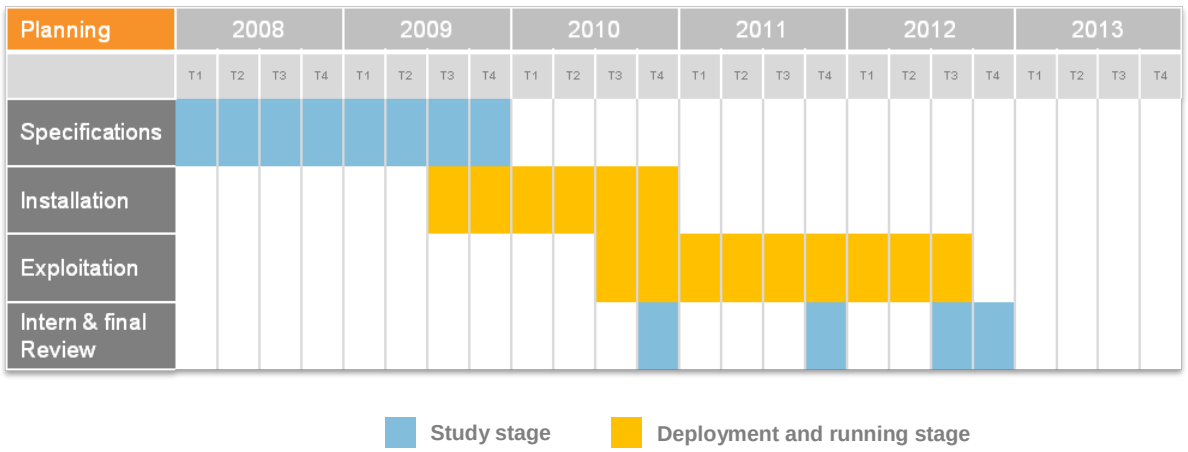
Subsidies : the PACA Région

Specific context of the project

In the PACA region (south-east of France), electricity demand is concentrated on the Mediterranean coast which accounts for 80% of total regional consumption. Local generation covers less than half of regional demand. Eastern region is supplied by a unique 400kV transmission line. During very high-demand periods or natural disaster, load sheddings are operated to avoid general power outages.

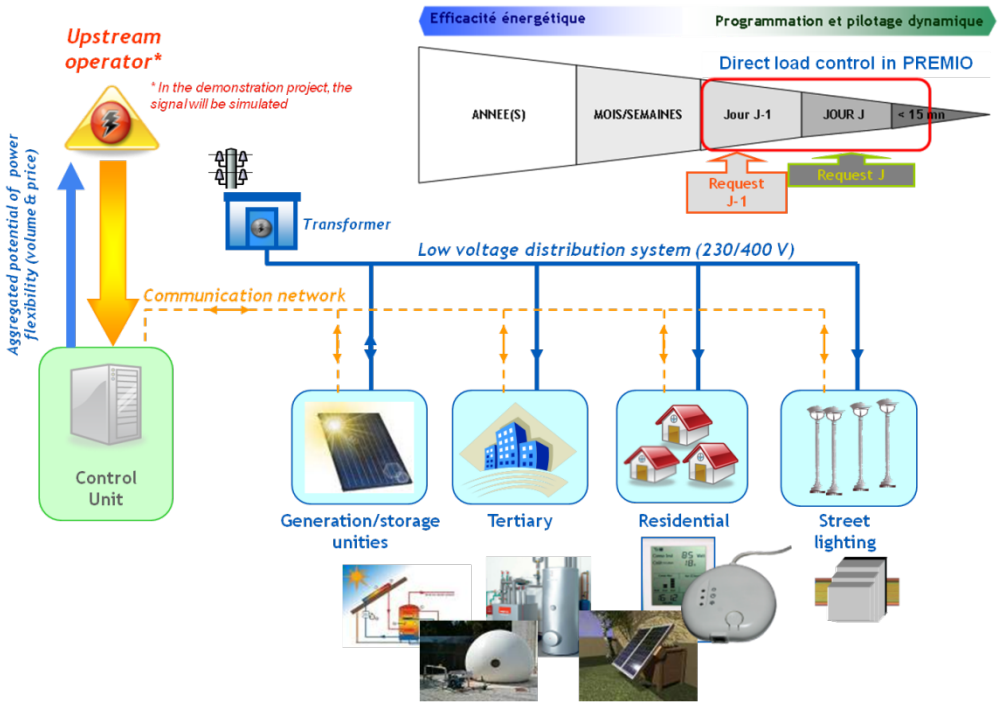
Main objectives

The project aims to implement in the PACA region an innovative local energy architecture optimizing the integration of local production and storage, renewable energy resources, dynamic load control and energy efficiency initiatives to relieve the strain on the local electrical power grid (peak load).



Detailed objectives of the project

1 Develop and test a «Virtual Power Plant» aiming at the integration on a limited geographic area of varied distributed resources (10 technologies are tested) all connected to the low voltage grid: decentralized generation, storage, and load shedding boxes
2 Develop a control unit able to aggregate and optimize the use of different resources in order to offer two load curtailment services (day-ahead and intraday) to a technical or commercial upstream operator
3 Implement interfaces for the different stakeholders
4 Evaluate the technical and environmental performances of the distributed resources tested (power shed, energy saved, CO_2 emissions reduction
5 Evaluate the relevance of the optimization concept
6 Evaluate the suitability of integrating the virtual power plant in the operation of the grid and its constraints (peak load)
7 Evaluate the acceptance of direct and indirect stakeholders
8 Study the impacts of a simulated roll-out of the virtual power plant on a larger scale
9 Develop methods and experience to prepare further Smart-Grids projects
10 Capitalize experiences through the exchanges among the EPRI SG demonstration initiative



A.2 Energie efficace PACA

Remote control of heat pumps in PACA region

PARTIES

Coordinator : **EDF**

Industrial partners : DAIKIN, MITSUBISHI ELECTRIC

Academics and R&D : EDF R&D

Consultancy : EDELIA

Institutionnals :

100 Households

Provence – Alpes – Côte d'Azur

1 Million €

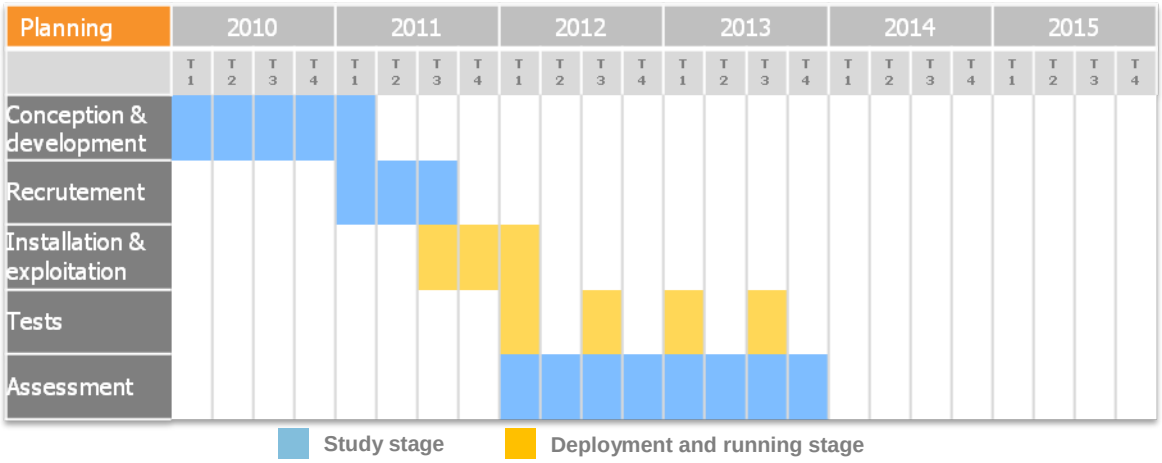
Global budget

Specific context of the project

In South France, the PACA region meets a specific situation which stress the supply of electricity. Indeed, the electric peninsula-like east of the region (around Nice), meets a rate of electricity demand that raises faster than the French average. More, massive photovoltaïc generation newly connected on the electric system indicates possible constrains on the distribution grid at very short term.

Main objectives

Residential sector. Are tested load management in summer and winter, with modification of the temperature of comfort of the clients. The heat pumps are remotly controled (Air/Air reversible, 100 houses equipped with DAIKIN or MITSUBISHI ELECTRIC) with a incentive strategy.

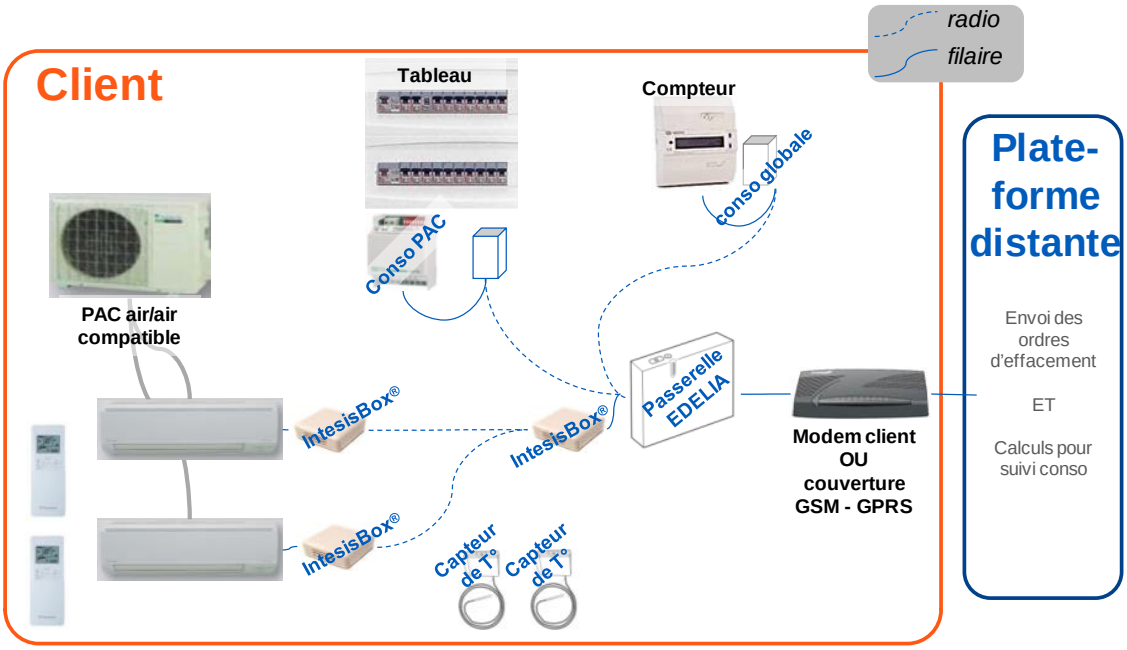


Detailed objectives of the project

1 Understand the behaviour of clients in individual homes when the temperature of their heat pump is remotly changed during long period (summer: up to + 2 to + 3 ° C over a period of 8 hours, winter:-1 to -2 ° C, 16 hours).

2 Test technical and business solutions : remote load control by EDF and incentives.

3 Measure the customer impact of a consumption tracking tool (web or smartphone).



A.3 Smart Electric Lyon

It should start next year and involve, among other systems, hybrid heat pumps.

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