Transposition of Article 2a of Directive 2012/27/EU on the energy performance of buildings, as amended by Directive 2018/844/EU of 30 May 2018

Long-term strategy of France for mobilising investment in the renovation of the national stock of residential and commercial buildings, both public and private

This strategy has been established in accordance with the requirements of Article 2a of the Directive on the energy performance of buildings, as amended on 30 May 2018, the wording of which is set out below and underlies the overall scheme of the present document.

Article 2a

Long-term renovation strategy

1. Each Member State shall establish a long-term renovation strategy to support the renovation of the national stock of residential and non-residential buildings, both public and private, into a highly energy efficient and decarbonised building stock by 2050, facilitating the cost-effective transformation of existing buildings into nearly zero-energy buildings. Each long-term renovation strategy shall be submitted in accordance with the applicable planning and reporting obligations and shall encompass:

(a) an overview of the national building stock, based, as appropriate, on statistical sampling and expected share of renovated buildings in 2020;

(b) the identification of cost-effective approaches to renovation relevant to the building type and climatic zone, considering potential relevant trigger points, where applicable, in the life-cycle of the building;

(c) policies and actions to stimulate cost-effective deep renovation of buildings, including staged deep renovation, and to support targeted cost-effective measures and renovation for example by introducing an optional scheme for building renovation passports;

(d) an overview of policies and actions to target the worst performing segments of the national building stock, split-incentive dilemmas and market failures, and an outline of relevant national actions that contribute to the alleviation of energy poverty;

(e) policies and actions to target all public buildings;

(f) an overview of national initiatives to promote smart technologies and well-connected buildings and communities, as well as skills and education in the construction and energy efficiency sectors; and

(g) an evidence-based estimate of expected energy savings and wider benefits, such as those related to health, safety and air quality.

The previous version of this strategy was addressed to the European Commission in May 2017 and was accorded a favourable assessment[1] by the latter; in the assessment, distributed on 2 August 2019, the strategy was found to be fully compliant with the requirements of the Energy Efficiency Directive.

[1] The French strategy was judged 'fully compliant' in the document entitled *Assessment of second long-term renovation strategies under the Energy Efficiency Directive* (https://op.europa.eu/en/publication-detail/-/publication/e04473ed-2daf-11e9-8d04-01aa75ed71a1/language-en/format-PDF/source-86607487)

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1 PREFACE

Buildings are particularly energy-intensive, accounting alone for almost 45% of final energy consumption and 25% of greenhouse-gas emissions in France. To this environmental fact, moreover, may be added the social fact that seven million dwellings are poorly insulated and almost four million households struggle to pay their bills or deprive themselves of heating.

The Climate Action Plan, which was presented in July 2017, sets ambitious targets for the country in pursuit of the goal of carbon neutrality by 2050. It fleshes out the commitments made by France in the Paris Agreement, enabling the Agreement to become a reality for the people of France, for Europe and for our diplomatic activity. By signing that Agreement, the parties undertook to hold the increase in the global average temperature to 2°C and, if possible, 1.5°C. To this end, they undertook, in accordance with the recommendations of the Intergovernmental Panel on Climate Change (IPCC), to achieve worldwide carbon neutrality during the second half of the 21st century. Developed countries are called on to achieve carbon neutrality as quickly as possible.

To this end, the Ministry for the Ecological and Inclusive Transition published a draft revised National Low-carbon Strategy (SNBC) on 6 December 2018; the final round of public consultation on the draft took place in January 2020 after the opinions of all administrative authorities had been taken into account. It sets out the road map for France's green and inclusive transition towards carbon neutrality in 2050. This principle of carbon neutrality means not emitting more greenhouse gas than our territory can absorb, particularly through forests and soil.

The building sector constitutes a priority source of energy savings and of greenhouse-gas reductions, the scale of which justifies a great incentivisation and support effort targeting households and the building trades. In particular, the National Low-carbon Strategy is targeting a 49% cut in greenhouse-gas emissions from buildings by 2030 and carbon neutrality by 2050.

To focus and marshal its efforts in this sector, the Government published, in April 2018, the Plan for the Energy Renovation of Buildings (PREB) as a road map for that element of the Climate Action Plan. Through the PREB, France is embarking on a project designed to protect the climate as well as to advance the transition to a green economy and to serve as an instrument of the public policy of solidarity.

The stock of existing buildings far outweighs that of newly constructed properties, and so the renovation of the existing stock is the foremost aim of political efforts to reduce energy consumption and greenhouse-gas emissions. France has 35.4 million dwellings, 29.7 million of which are main residences (INSEE data as of 1 January 2018), and a quarter of those main residences fall into the highest energy-consumption categories, with environmental performance certificate (EPC) ratings of F or G.

Accordingly, the Plan for the Energy Renovation of Buildings (PREB) proceeds from five basic convictions:

- Energy-efficient buildings must be made a national priority and eventually become the norm for all French people and improve their everyday lives. This aim can only be achieved by mobilising all actors, local authorities, building trades, associations, etc.
- To achieve these objectives, conditions must be created in which the renovation of housing can be expanded:
    - by acknowledging the role of energy renovation programmes in a more holistic approach to housing improvement;
    - by adopting a policy of clear and persuasive communication;
    - by simplifying processes, aid mechanisms and incentives for all stakeholder categories;
    - by putting regions and municipalities at the heart of government policies:
    - by encouraging staged renovation in various ways so as to make rapid initial gains by means of effective basic measures without neglecting the rapid development of global high-efficiency approaches, particularly through more ambitious programmed renovation operations that are targeted and reproducible and lend themselves to industrialisation.
- Public support for energy renovation of housing should be allocated on a priority basis to efforts to combat energy poverty.

- The stock of public and commercial buildings, particularly those belonging to the state and local or regional authorities, constitutes a rich source of potential energy savings which should be maximised by means of new forms of action and funding.
- If ambitious quantity and quality targets are to be achieved cost-effectively, the trades involved in energy renovation must become even more competent and innovative.

The national legal framework

To speed up and expand the implementation of this large-scale renovation drive, the law provides for means of legal, financial, support and monitoring action designed to stimulate both supply and demand and addressed not only to households and local and regional authorities but also to companies and individuals in the building trades.

Among these instruments are the mechanisms provided since 2015 by the Energy Transition for Green Growth Act (LTECV), particularly:

- the national roll-out of individualised heating bills;
- the obligation to take action to reduce energy consumption in the service sector, with targets being stepped up every ten years with a view to achieving 60% less energy consumption by 2050;
- the obligation to achieve a minimum standard of energy performance, in one or more steps, in a way that is consistent with the aims of national energy policy when major renovation works are carried out on existing buildings (incorporation of insulation into scheduled renovation work, known as the 'embedded works' approach to energy renovation);
- the inclusion of energy performance in the standards of decency for rented housing;
- the ban on the sale of energy-intensive social housing if renovation works are not carried out.

These instruments have been supplemented and reinforced by the Housing, Planning and Digitalisation Development Act (*Loi portant Évolution du Logement, de l'Aménagement et du Numérique*, ELAN) of 2018 and by the recent Energy and Climate Act (*Loi Énergie Climat*, LEC) of 2019, particularly though the following measures:

- provisions making the energy performance certificate (EPC) more reliable and contestable with effect from 1 January 2021;
- the requirement to have an energy audit conducted on energy-intensive dwellings, which comes into force on 1 January 2022;
- the introduction of an obligation to have renovation works carried out on the most energy-intensive buildings by 1 January 2028;
- the introduction of an annual report on the achievement of the energy-renovation targets for housing, particularly the elimination of energy leaks, to be presented to Parliament on 1 July every year;
- the confirmation and reaffirmation of the obligation to take steps to reduce energy consumption in the tertiary sector;
- the introduction of a cost-efficiency criterion into the obligation to individualise heating costs.

In addition, to accompany these measures, new types of support have been introduced or will be in 2020 and 2021:

- the establishment in 2019 of an obligation to make energy savings, put into practice by means of dedicated Energy Saving Certificates, for the benefit of low-income households and by means of 'helping hands' for heating and insulation, making it possible to offer some simple basic measures, such as changing boilers, loft insulation or low-level floor insulation) at a price of one euro;
- the creation in 2020 of a new system of energy renovation grants, known as '*MaPrimeRénov*' as the result of merging the energy transition tax credit and the *Habiter mieux Agilité* renovation grant

scheme; the new system is a powerful renovation incentive for low-income and very-low-income households, and its cost very closely matches the actual savings that it generates;

- reinforcement of the mechanisms for informing and supporting individuals in the energy renovation of their homes through a dedicated programme entitled SARE (*Service d'accompagnement à la renovation énergétique* – Energy Renovation Support Service), part-funded by Energy Saving Certificates and launched in 2019;
- revision of the distribution arrangements for eco-loans for social housing;
- operational start-up of third-party financing companies;
- flexibilisation of the conditions for obtaining the interest-free eco-loan so that renovation works can be rolled out much more widely.

The European framework

The European Union is a leading player in the field of climate action. Energy efficiency is central to the energy policy of the Union.

The 2030 climate and energy framework provides for EU-wide strategic objectives and targets for the period from 2021 to 2030. The framework was adopted by the European Council in 2014. The objectives for renewables and energy efficiency were raised in 2018.

Key objectives of the European Union for 2030:

- to reduce greenhouse-gas emissions by at least 40% compared with 1990;
- to increase the share of energy from renewable sources to at least 32%;
- to improve energy efficiency by at least 32.5%.

The EU has adopted integrated rules on information and monitoring with a view to progressing towards the climate and energy objectives for 2030 and honouring its international commitments under the Paris Agreement. A process of transparent and dynamic governance will help the Union to achieve its energy objectives in an efficient and coherent way, including its climate and energy objectives for 2030. Based on the principles of better regulation, the governance process encompasses consultations with citizens and other stakeholders.
Member States are required to adopt integrated national energy and climate plans for the period from 2021 to 2030. They were to submit their draft plans by the end of 2018 and their final plans by the end of 2019. Member States were also required to finalise long-term national strategies by 10 March 2020 and to ensure consistency between those long-term strategies and their national energy and climate plans.

The statement setting out the long-term strategy for mobilising investment in the renovation of residential and commercial buildings, both public and private, in order to improve the energy performance of the housing stock has its origins in Article 4 of Directive 2012/27/EU of the European Parliament and of the Council of 25 October 2012. The obligation to establish such a strategy is now enshrined in Article 2b of the Directive on the energy performance of buildings as amended in 2018. It forms part of a process to evaluate and compare the mobilisation procedures implemented by Member States. It was created to ensure that, beyond the statement of objectives, the means to mobilise investment and the dynamism of stakeholders are actually in place. This is why it dedicates a large section to the methods that have been adopted and in particular to the tools for mobilisation on the ground. To permit comparisons between Member States and monitoring over time, it includes the plan introduced by the article of the Directive.

This report is the second update of France's strategy, which was first submitted in 2014 then updated in 2017, to mobilise investment in renovation of the national building stock in order to seize growth and employment opportunities in all sectors connected with construction. This report, a brief summary of which is presented below, includes an overview of the present stock of residential and tertiary-sector buildings, followed by an

evaluation of the most appropriate ways to expedite the production of framework guidelines and mobilise drivers with a view to engaging public and private stakeholders in this effort; the third part of the report then expands on the policies and resources that have been put in place for this purpose.

Structure of the report

A general presentation of the national building stock highlights the significant percentages of home ownership and of individually owned houses, as well as the impact of rental stock, comprising mainly apartment blocks, and the large percentage of social housing. An analysis of the major construction periods in conjunction with an identification of the most energy-intensive housing, confirms that housing constructed before 1974 should be a priority for renovations. As for tertiary-sector buildings, the most significant generation in terms of renovation requirements is likewise the pre-1975 stock.

The subsequent case studies serve to highlight cost-effective approaches to renovation, demonstrating that clusters of works are the most viable approach in terms of global cost. The cost of investment is indeed much higher in the case of major renovations, but these scenarios are the most cost-efficient over the lifetime of the buildings. Installing highly efficient appliances and insulating walls properly serve to reduce energy bills significantly and therefore generate long-term savings in spite of the high capital cost. In this clustered approach, work is carried out on both on the energy systems (heating and domestic hot water) and on the building structure (walls, roof and downstairs floors). The study of a sample group of buildings demonstrates the effectiveness of clustered works in significantly reducing energy consumption. In some cases, however, we found it difficult to achieve very high efficiency levels on budget for certain types of construction with the technical solutions and incentives that are currently available. Achieving France's strategic objectives will therefore depend on mobilising innovative capacity to ensure that efficient and affordable solutions emerge quickly.

A key part of the report focuses on the policies, measures and guidelines that have been adopted to provide individuals, industry, the building trades and financial institutions with the transparency they need to take investment decisions which often entail medium-term or even long-term commitments. It should be re-emphasised that success will come from the impetus injected by local initiatives designed to innovate, to raise awareness and to consolidate networks of collectively committed stakeholders with a view to harnessing the drive for energy renovation within their own territories. At that level, attention will be focused on amassing and deploying a rich diversity of best practices.

Lastly, part of the strategy will endeavour to give an account of the long-term pathways traced out in the major national guideline documents, namely the Multiannual Energy Plan and the National Low-carbon Strategy. In this context, the work that has been undertaken to define clear and precise monitoring indicators for measuring adherence to these pathways and achievement of objectives will be set out in detail.

This strategy provides an account of all of the measures that have been taken to realise the ambitions described above. It presents the numerous works that are currently being carried out to meet the challenges of this priority policy of sustainable development.

Its purpose is to illustrate the unprecedented activity set in motion by France with a view to succeeding in this key area in accordance with the country’s European commitments and the Paris Agreement.

2 PRESENTATION OF THE NATIONAL BUILDING STOCK

This section provides an analysis of the residential and tertiary-sector building stock.

For the residential stock, statistics are examined for five main construction periods. These statistics enable us to make separate estimates for one-dwelling houses and apartment blocks as regards:

- the share of main residences and the nature of their occupants (owners or tenants);
- the most common energy systems;
- the energy performance recorded (EPC ratings and consumption levels).

For the tertiary-sector stock, a detailed analysis provides:

- details regarding the broad categories of buildings (shops, offices, etc.);
- estimations of energy performance overall and by building category.

2.1 Detailed analysis of the national building stock for residential use

In 2013, the French housing stock included around 33.5 million homes,[2] 27.8 million of which were main residences. The data presented below are based on the Action Programme for Construction Quality and the Energy Transition[3] (PACTE). Funded by the public authorities and launched in 2015, PACTE is designed to encourage the development of knowledge, the establishment of technical benchmarks and the provision of practical modern tools adapted to trade practices, and to support local and regional authorities in all of their initiatives relating to energy performance.

The purpose of this analysis is to identify the existing studies and data on building types in France and then collate the information obtained from those studies so as to arrive at an appropriate classification of the national housing stock in terms of the national energy objectives. The sources we have used are shown in the detailed report on the study.[4]

The analysis is partly based on the findings of the European Episcope project. One of the aims of that project was to propose a homogeneous categorisation model for all Member States. The descriptors used in the Episcope study therefore served to supplement those used in the analysis. International studies enabled us to validate and supplement our own set of descriptors.

In 2017, the long-term strategy for mobilising investment in the renovation of the national stock of residential and commercial buildings, both public and private, drew on two main sources to describe the stock of residential buildings, namely the Phebus survey[5] (Performance Survey of Housing, Needs and Usages, see annex) and the database of the Standardised Summaries of Thermal Assessments (RSET, see annex) for new buildings. As the Phebus survey has not been repeated since 2013, it was decided to rely on more recent studies which synthesise data from various sources to define the building stock as accurately as possible in 2019. To this end, the PREB provides for the creation of a national energy renovation observatory, the main task of which will be to provide

[2] Source: INSEE, *Enquête nationale logement* (National Housing Survey), 2003. A new survey is currently being conducted to update these figures. The findings should be available in 2020.

[3] https://www.programmepacte.fr/

[4] Detailed analysis of the existing residential stock, updated on 2 November 2017, at https://www.programmepacte.fr/sites/default/files/pdf/ranalyseparcresidentielexistantneufrenojuil17073web.pdf)

[5] The Phebus survey (Performance Study of Housing, Needs and Uses, see Annex) conducted by the Observation, Studies and Statistics Department of the Ministry of Ecology on a statistical sample representing the state of the stock of primary residences in 2013. This database, populated with data from the National Housing Survey (ENL) of INSEE; the National Institute of Statistics and Economic Studies, made it possible to obtain accurate information on the characteristics of the residential building stock until 2013.

input for studies in the form of information on French building stock. Its remit is set out in detail in section 4, which presents the public policies adopted in support of building renovation.

2.1.1 *Data on the existing housing stock*

This part of the report gives the main characteristics of the existing housing stock. It provides an inventory of the stock on the basis of parameters such as occupancy status and geographical location.

Occupancy status

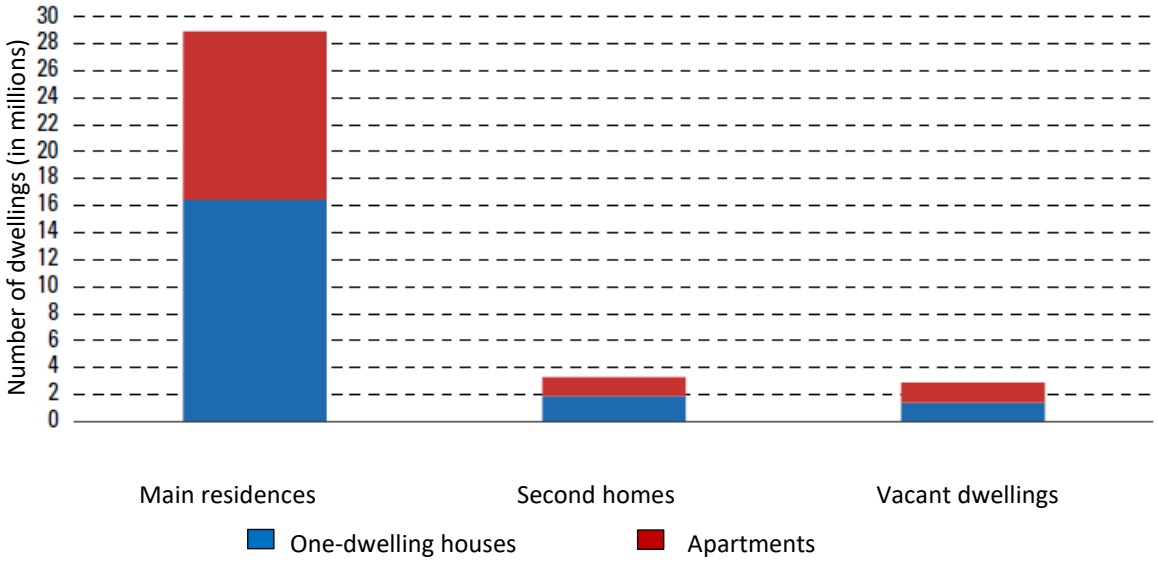


Figure 1 – Distribution of dwellings by occupancy status (INSEE, 2015; key figures from ADEME, 2015)

Definition of terms:

- Main residence: dwelling occupied on a permanent basis by the taxpayer in his or her capacity as owner or tenant or under another arrangement, such as rent-free occupancy.
- Second home: property which, by definition, is lived in by the taxpayer and his or her household for less than eight months a year. This may be the case with a holiday home or a dwelling intended for holiday lets.
- Vacant dwelling: a vacant dwelling is an housing unit which is unoccupied, that is to say is for sale or is being offered for rent, has been sold to a new owner or allocated to a new tenant who has not yet moved in, is the subject of a pending estate settlement, is held by an employer for future use by one of his or her employees or is being kept vacant and not being placed on the market by its owner, for example because it is in a very poor state of repair.

Geographical location

French heating legislation divides France into eight climatic areas, which are grouped into three large climate zones on the basis of heating seasons (areas H1, H2 and H3):

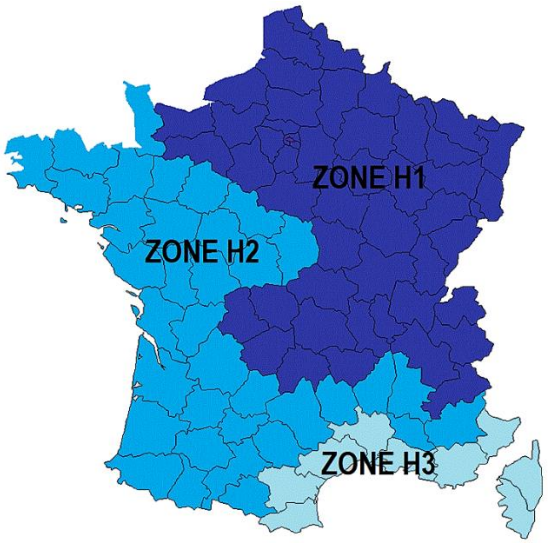


Figure 2 – Climate zones

- Zone H1: 51 departments. This is the zone where most heating is needed and the annual heating season is longest.
- Zone H2: 36 departments. This intermediate zone needs less heating and has a shorter annual heating season.
- Zone H3: This is the zone where heating plays a lesser role because of higher temperatures, and the annual heating season is therefore shorter.

Figure 3 – Distribution of dwellings by climate zone (INSEE, 2015)

It is noticeable that climate zone H1 has the largest number of dwellings – more than half of the total housing stock. This is explained by the size of the geographical area but also by the dense concentrations of dwellings in the Ile-de-France and Auvergne-Rhône-Alpes regions, By contrast, climate zone H3, comprising only nine departments, has the smallest number of dwellings.

Climate zone H2 has a very high proportion of one-dwelling houses, which can be explained by the predominantly rural nature of that zone.

Regional distribution

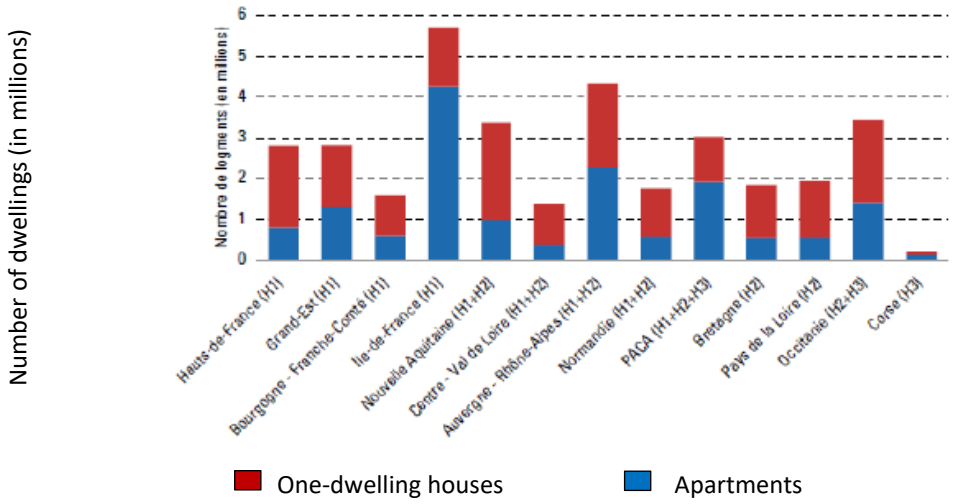


Figure 4 – Distribution of dwellings by administrative regions (Filocom, 2013)

Construction date

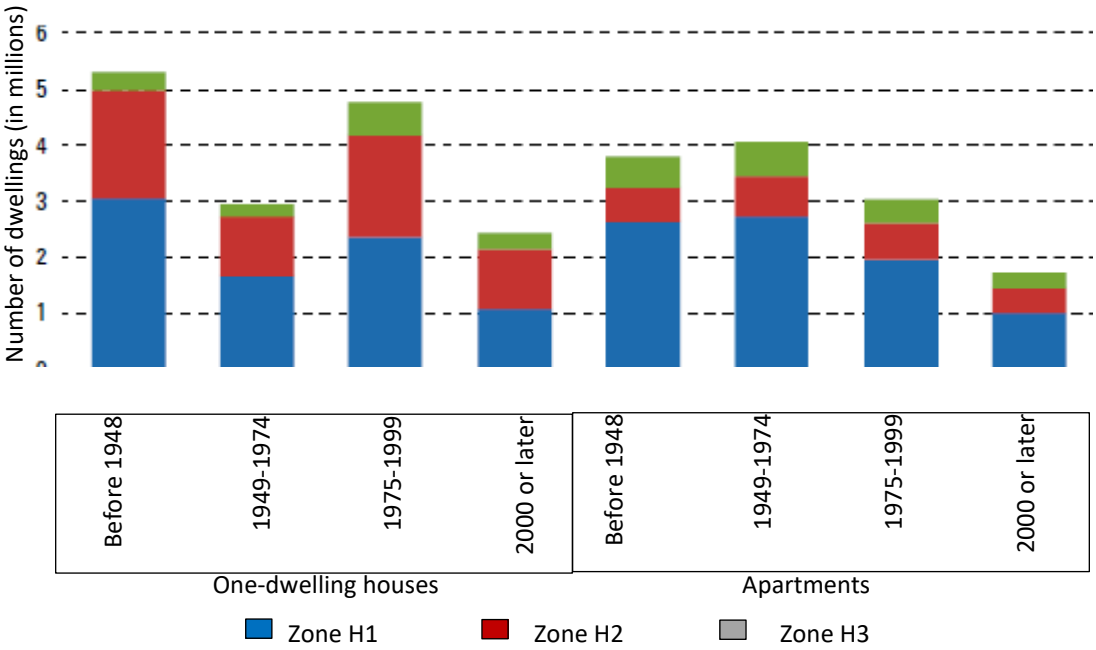


Figure 5 – Distribution of main residences by construction periods (Filocom, 2013)

2.1.2 *Detailed analysis of the stock of one-dwelling houses*

Number of one-dwelling houses by construction dates

The distribution of the stock of one-dwelling houses by construction date, based on broadly defined construction periods, is as follows, according to the Filocom database (Housing Database by Municipalities, compiled by the Public Finances General Directorate (DGFiP)):

Construction period	Before 1948	1949-1974	1975-1999	2000 and later
Share of one-dwelling houses	36%	18%	30%	16%

The largest category of one-dwelling houses comprises those built before 1948.

Percentages of one-dwelling houses by occupant status

The stock of one-dwelling houses is distributed as follows:

- owner-occupiers: 82%
- tenants (private sector): 13%
- tenants in social housing: 3%
- others: 3%

The vast majority of one-dwelling houses, in other words, are owner-occupied.

PERIODS	TYPES	DATA ON THE STOCK OF ONE-DWELLING HOUSES		
		Number of dwellings in the stock of one-dwelling houses (%)	Final energy consumption, all uses (%)	Energy consumption for heating[A] (annual kWh per m²)
Old (pre-1948)	Rural house	10%	10%	175
	Bourgeois house	1%	2%	139
	Village/small-town house	13%	12%	167
	Eclectic villa	4%	6%	183
	Suburban detached house	11%	13%	202
Recent uninsulated 1948-1974	Reconstruction-era detached house	13%	15%	209
	Detached house, 1968-1974	10%	11%	164
Recent insulated 1975-2000	Detached house, 1975-1981	13%	12%	134
	Detached house, 1983-1989	12%	10%	100
	Detached house, 1990-2000	12%	10%	89

[A] *Cf. Energy consumption for heating for the whole housing stock (main residences, second homes and vacant dwellings)*

Figure 6 – One-dwelling house categories by construction periods and data on housing stock (PACTE, 2017)

2.1.3 *Detailed analysis of the stock of multiple-dwelling buildings*

Number of apartments by construction dates

The distribution of the stock of apartment dwellings by construction eras is as follows, according to the Filocom database:

Construction period	Before 1948	1949-1974	1975-1999	2000 and later
Share of apartments	29%	32%	25%	14%

Percentages of apartment dwellings by occupant status

The stock of apartment dwellings is distributed as follows:

- owner-occupiers: 24%
- tenants (private sector): 42%
- tenants in social housing: 30%
- others: 4%

The construction period from 1948 to 1974 saw a large concentration of low-rent social housing units; social housing accounts for almost 40% of the housing units built between 1948 and 1974.

In the sphere of social housing, the number of units in apartment blocks far outweighs the number of one-dwelling houses.

PERIODS	TYPES	DATA ON THE STOCK OF MULTIPLE-DWELLING HOUSES		
		Number of dwellings in the stock of multiple-dwelling houses (%)	Final energy consumption, all uses (%)	Energy consumption for heating[A] (annual kWh per m²)
Old (pre-1948)	Village/small-town building	11%	11%	132
	Haussmann buildings and similar	10%	11%	143
	Eclectic building	4%	4%	171
	Social housing	1%	1%	146
Recent uninsulated 1948-1974	Infill building	3%	3%	139
	Bourgeois-style building	2%	3%	213
	Urban blocks, 1968-1974	3%	5%	187
	Miscellaneous small apartment types, 1948-1974	20%	25%	157
	Large apartment block, 1948-1974	12%	14%	140
	High-rise block, 1948-1974	< 1%	< 1%	150
Recent insulated 1975-2000	Urban blocks, 1975-1981	1%	1%	95
	Miscellaneous small apartment types, 1975-1981	5%	4%	74
	Large apartment block, 1975-1981	6%	5%	120
	High-rise block, 1975-1981	< 1%	< 1%	74
	Buildings, 1982-1989	8%	5%	61
	Buildings, 1990-2000	11%	7%	56

[A] *Cf. Energy consumption for heating for the whole housing stock (main residences, second homes and vacant dwellings)*

Figure 7 – Multiple-dwelling house categories by construction periods and data on housing stock (PACTE, 2017)

2.1.4 *Work carried out on the national housing stock*

The characteristics of the French national housing stock in 2016 differed from the original characteristics of the buildings, that is to say when they were newly built. Renovations, especially thermal renovations, undertaken on the original building stock have led to changes in the characteristics of buildings. These changes, however, are very difficult to estimate, as relevant data are rarely available and accurate.

Accordingly, and in the framework of this study, we provide a grid defining the types of renovation work carried out on the housing stock. This grid does not list each of the architectural categories but is divided into the two main types of building occupancy, namely one-dwelling houses and multiple-dwelling buildings, broken down into three construction periods.

Table of renovations carried out

The table below shows the proportion of renovation works carried out between 2006 and 2015 for each type of dwelling, broken down by construction period and type of renovation work.

These data are from a representative sample of 10,600 dwellings from the national housing stock. The percentage figures shown correspond to the number of dwellings where the listed renovation measure was carried out in relation to the total number of dwellings dating from the same period.

For example, the table shows that 5% of the dwellings in the sample of apartments built before 1948 had their roof cavities insulated between 2006 and 2016.

ENERGY RENOVATION WORKS CARRIED OUT BETWEEN 2006 AND 2016	APARTMENTS			ONE-DWELLING HOUSES		
	Before 1948	1949-1974	After 1975	Before 1948	1949-1974	After 1975
Insulation of loft floor or roof rafters – attic	5.00%	1.70%	1.60%	18.60%	22.20%	14.30%
Insulation of roof slab or joists – flat roof	2.40%	3.70%	2.30%	13.40%	9.50%	5.30%
Internal wall insulation – External wall insulation	4.80%	5.80%	2.50%	12.00%	11.20%	4.40%
Windows – total replacement	15.90%	17.10%	10.20%	32.80%	31.40%	19.40%
Windows – partial replacement	9.80%	14.00%	5.40%	14.40%	14.80%	7.70%
Windows – shutters only	6.60%	13.10%	7.30%	18.20%	19.80%	14.40%
Replacement or installation of a central heating system – fluid network	18.40%	12.70%	10.90%	31.80%	30.80%	21.10%
Replacement or installation of domestic hot water system – fluid network	9.70%	7.90%	6.80%	17.10%	14.50%	10.90%
Upgrading of heating controls – fluid network	6.20%	5.00%	3.10%	8.20%	8.00%	4.20%
Lagging of all or part of an installation for producing or distributing heat or domestic hot water – fluid network	0.90%	0.60%	0.80%	1.10%	1,60%	0.30%
Replacement or installation of renewable energy sources for heating – fluid network	0.40%	1.10%	0.60%	6.80%	4.70%	5.80%
Replacement or installation of renewable energy sources for domestic hot water – fluid network	0.40%	0.60%	0.30%	3.30%	1.60%	2.90%
Replacement or installation of equipment for electricity production from a renewable energy source – Joule room and water heating	0.30%	0.40%	0.20%	2.40%	2.20%	3.80%
Installation or replacement of a controlled mechanical ventilation (CMV) system	7.10%	5.40%	4.00%	14.50%	14.10%	12.60%

Figure 8 – Energy renovation work carried out on housing stock between 2006 and 2016 (PACTE, 2017)

2.2 Detailed analysis of the national stock of buildings for tertiary-sector use

2.2.1 *Scope of the building stock for tertiary-sector use*

The main source of information on tertiary-sector buildings that was used in the 2017 renovation strategy was the BASIC/CODA database created by BASIC Consultants and CODA Stratégies, the data in which had undergone a new update in 2012. No study on that scale has been conducted since then.

To update the data from the previous version of the strategy, it was decided to rely on the data from CEREN,[6] which provides information on the overall energy consumption of the stock of buildings used by the tertiary sector. The categories used by CEREN are based on sectors of activity from the SIRENE[7] classification of the main activities performed by tertiary-sector establishments.

The CEREN surveys target tertiary-sector establishments whose energy consumption is largely due to their buildings. This means that the energy consumed by some activities in the tertiary sector is not included in the recorded statistical data because the consumption results from an industrial process or from a very specific use of energy. In principle, data relating to specific types of electricity consumption, particularly computing, are not processed in CEREN surveys.

The database is divided into the following eight activity categories:

- offices
- hotels and restaurants
- commercial premises
- education
- communal residences
- health care
- sport, leisure and culture
- transport

The stock of tertiary-sector buildings is highly heterogeneous in terms of surface area, building types, occupancy status and hence energy consumption. For this reason, we intend to supplement the macroanalysis of the stock with a more probing analysis of the two most energy-intensive categories of tertiary-sector buildings, namely offices and commercial premises. This analysis will be based on data for 2018 from the Green Building Observatory (*Observatoire de l'Immobilier Durable*, OID),[8] published in the *Baromètre performance energétique et environnementale des bâtiments tertiaries*.[9] The barometer study is based on a sample of 17,600 tertiary-sector buildings covering a total surface area of 37 million square metres.

The analysis of the building stock that is undertaken in this study should be seen in connection with the regulatory developments described in detail in the chapter on politics and measures in support of building renovation. Provision has, in fact, been made for the introduction of an obligation to report energy consumption figures for tertiary-sector buildings from 2020.

[6] CEREN is the Centre for Economic Studies and Research on Energy (https://www.ceren.fr)

[7] For details of this categorisation, see the notes on tertiary-sector data (*Précisions sur les données du tertiaire*) on the CEREN website at https://www.ceren.fr/download/880/

[8] The OID is an independent association consisting of private and public operators in the real-estate business (https://www.o-immobilierdurable.fr/)

[9] The barometer of energy and environmental performance of tertiary-sector buildings for 2018 is available in full (in French) on the OID website at https://www.o-immobilierdurable.fr/hc_ressources/barometre-2018-de-la-performance-energetique-et-environnementale-des-batiments-tertiaires/.

2.2.2 *Consumption levels of the national stock of tertiary-sector buildings by activity category*

2.2.2.1 Distribution of the tertiary-sector building stock by uses

The building stock used by the tertiary sector may be divided into the following usage categories:

- offices
- hotels and restaurants
- commercial premises
- education
- communal residences
- health care
- sport, leisure and culture
- transport

These are the categories that will be used in this report.

Sector	Millions of m^2	% of building stock
Offices	225	**23%**
Hotels and restaurants	65	**7%**
Commercial premises	212	**22%**
Education	188	**19%**
Communal residences	70	**7%**
Health care	115	**12%**
Sport, leisure and culture	72	**7%**
Transport	25	**3%**
Total	973	100%

Table 1 – Total heated surface areas in the tertiary sector by activity category in 2016 and corresponding shares of total building stock (CEREN)

The analysis of the percentage shares of the various building categories in the tertiary sector highlights the predominance of three building types that account for 65% of the total surface area, namely offices, commercial premises and education establishments.

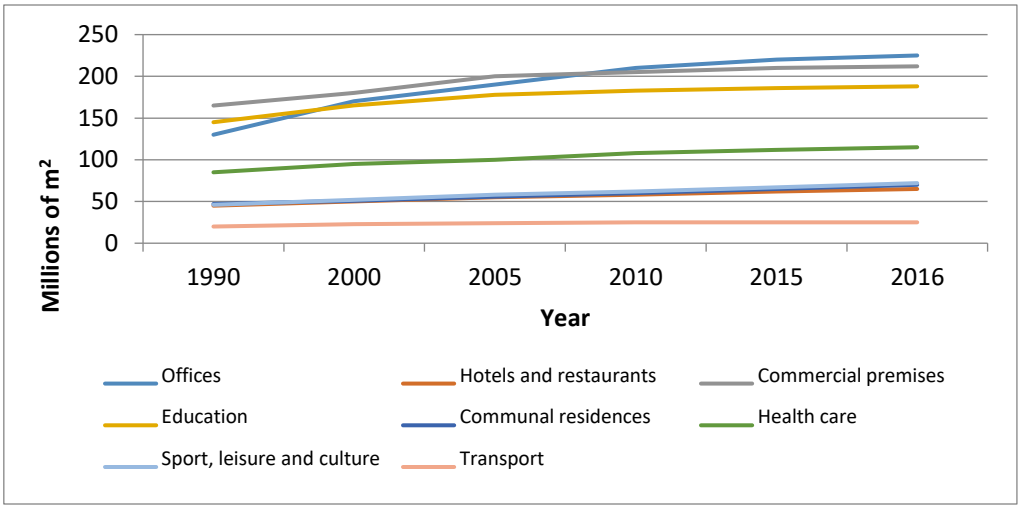


Figure 1 – Time series showing total heated surface areas of buildings in the tertiary sector from 1990 to 2016 (CEREN)

Besides building categories, the stock of tertiary-sector buildings can also be broken down by the types of energy that are used to heat them:

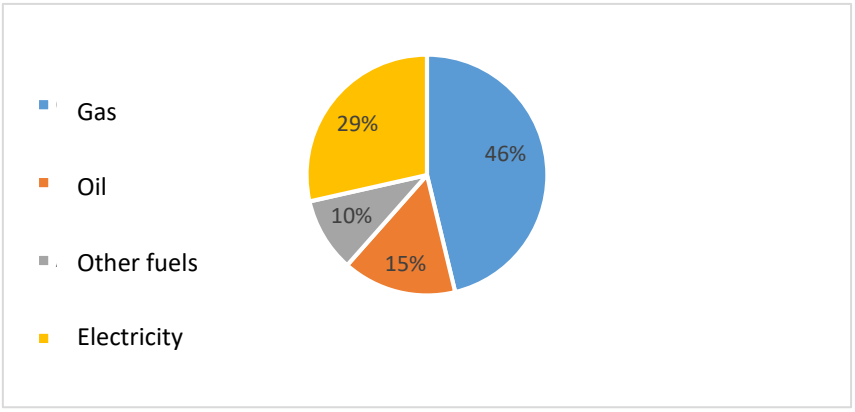


Figure 10 – Shares of energy sources used for heating buildings in the tertiary sector in 2016 (CEREN)

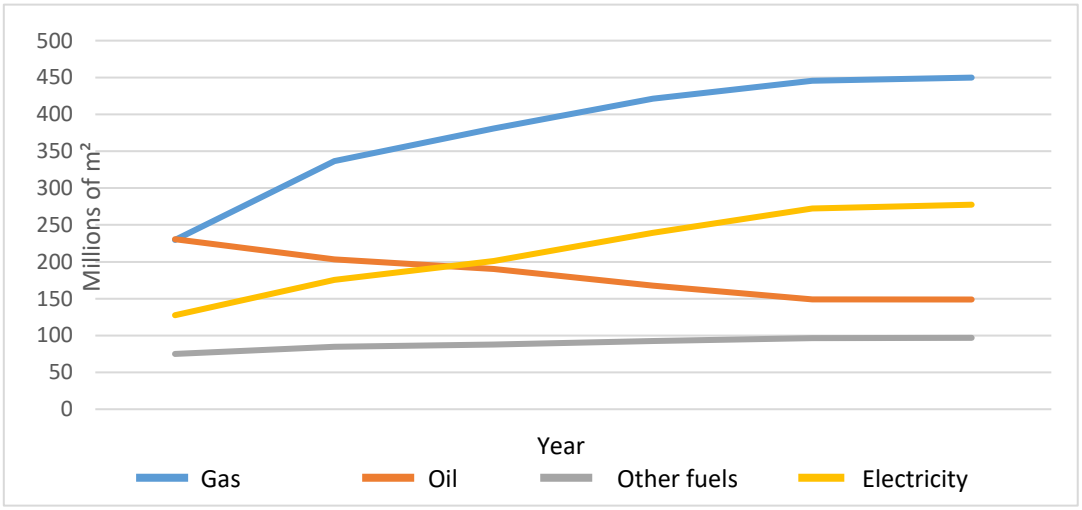


Figure 11 – Time series showing total surface areas of buildings in the tertiary sector by heating source (CEREN)

The data reveal the preponderance of gas, which heats almost half of the stock of tertiary-sector buildings. The main point to emerge from this analysis of trends in the heating energy mix is the decline in the share of oil as a

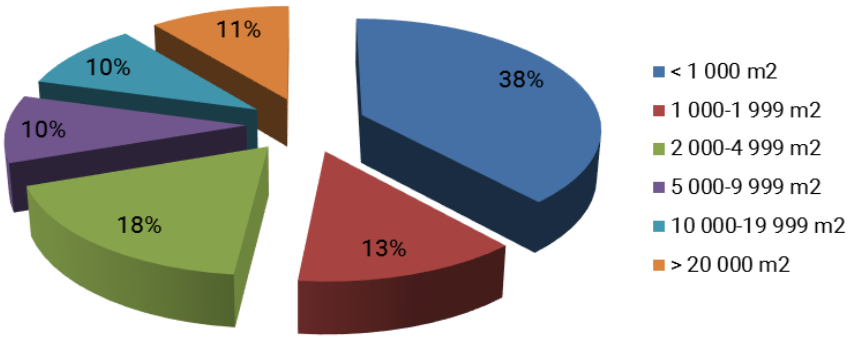
heating fuel in the tertiary sector, which reflects France's climate objectives and the announcement that heating oil is to be phased out by 2028.

2.2.2.2 Detailed presentation of office buildings

Categories of office buildings

The private sector accounts for the majority of office buildings.

In 2016, the stock of office buildings comprised a total surface area of some 225 million square metres in buildings of all sizes. For the record, the CODA study of 2012 showed the following distribution by surface area:



Distribution of office buildings by surface area. Source: BASIC/CODA study, 2012

Analysis of energy consumption of office buildings

The chart below provides an assessment, based on data from the Green Building Observatory (OID), of the energy consumption levels of office buildings, broken down by EPC ratings:

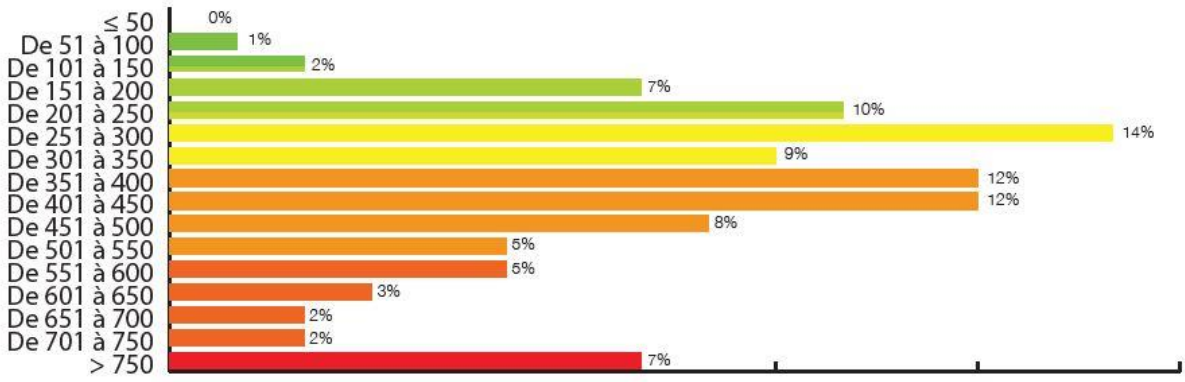


Figure 2 – Distribution of buildings by primary energy consumption (annual kWh per m²)

According to CEREN, the final energy consumption of all office buildings came to 58 TWh in 2016.

Heating is the main source of energy consumption in office buildings, accounting for 26 TWh a year, which is almost half of all their energy use. Lighting and air-conditioning are the next-largest factors. The share of electricity in the energy consumption of office buildings is constantly rising because of the increasingly widespread use of office technology and other electronic devices at the expense of energy from fossil fuels such as heating oil. Almost two thirds of office buildings were built before 1973, in an era when, as with residential

buildings, there were no thermal regulations, which makes this part of the building stock particularly energy-intensive. Energy consumption, in short, varies very widely, depending on when buildings were constructed and whether they have undergone renovation:

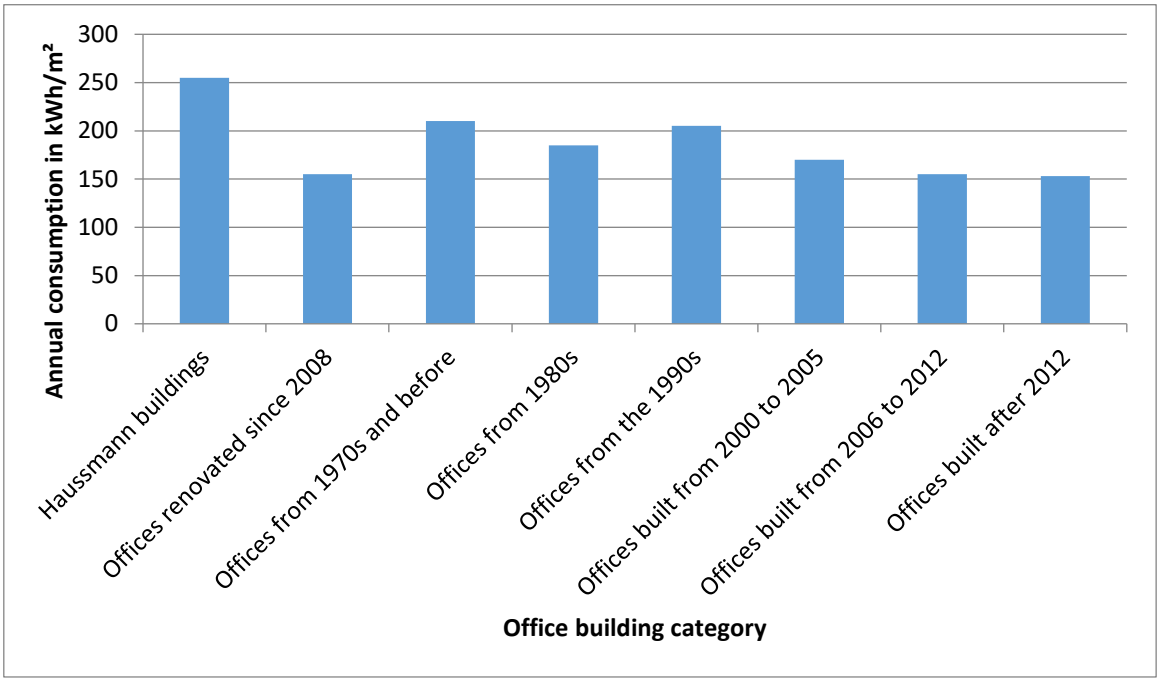


Figure 3 – Energy consumption by category of office building (OID)

2.2.2.3 Detailed presentation of commercial buildings

Categories of commercial buildings

The purpose of commercial buildings is to accommodate sales and service activities, which may be classified into three major categories:

- town-centre or village shops (small floor areas);
- shopping malls, which are complexes with at least 20 retail and service outlets with a total surface area of at least 5,000 m² and which are designed, built and administered as a single entity;
- retail parks, which are open-air sites grouping together stores with large surface areas and forming a single entity.

For the record, the number of commercial buildings amounted to 476,546 in 2011. The stock is dominated by the category of 'other specialised outlets' with 175,835 buildings, representing 37% of the total number. Shopping malls and hypermarkets are the lowest in number, accounting for only 3% of the building stock. Small general food stores and other non-specialised outlets, which constitute 6% of the stock, are in decline because of the strong competition they face from supermarkets and hypermarkets.

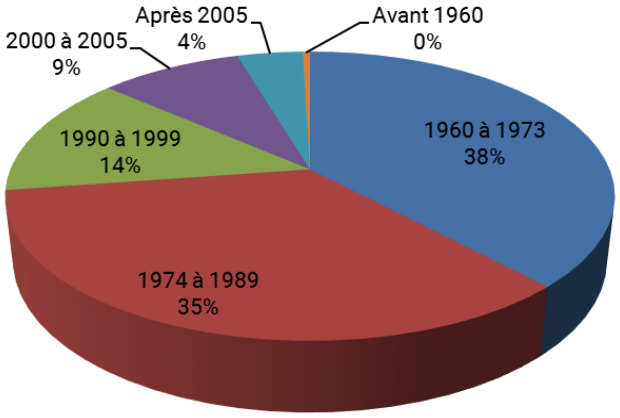
	Number in 2011	**%**
Specialised non-food outlets	175,835	36.90%
Shopping malls	643	0.13%
Wholesale outlets	68,160	14.30%
Specialised food outlets	74,366	15.61%
Specialised traders in luxury products	15,348	3.22%
Vehicle dealerships	31,145	6.54%
Hypermarkets and department stores	1,461	0.31%
Small non-specialised outlets	29,214	6.13%
Vehicle repair workshops	69,670	14.62%
Supermarkets	10,704	2.25%
Total	**476,546**	**100%**

Distribution of the total number of commercial buildings by use. Source BASIC/CODA study, 2012

The surface areas of commercial buildings vary widely, because the building stock includes, at the one extreme, specialised outlets, selling food or non-food items such as sports, leisure or household goods or clothing or small non-specialised outlets – neighbourhood shops with an average floor space well below 1,000 square metres – and, at the other extreme hypermarkets and shopping malls centres, where the surface area can exceed 20,000 square metres.

Large-scale construction of commercial buildings began in the 1960s. More than 70% of the commercial building stock was built between 1960 and 1989. That was the period when the concept of large supermarkets and hypermarkets. It was also part of the *Trente Glorieuses*, the 30 post-war boom years when the increase in people's purchasing power fuelled the development of trade. Buildings built before 1960 make up barely one per cent of the stock of commercial buildings.

Many of the more recent buildings are supermarkets and hypermarkets but may also take the form of shopping malls and retail parks, which account for most of the commercial buildings that are built at the present time.



Distribution of the total number of commercial buildings by construction period from pre-1960 to post-2005. Source: BASIC/CODA study, 2012

Energy consumption of commercial buildings

The stock of commercial buildings in France consumed 50 TWh of final energy in 2016. The distribution of energy consumption in the commercial stock is very uneven.

Large food stores consume high volumes of energy, averaging more than 1,200 kWh of final energy per square metre annually.[10] Consumption figures for small shops average about 200 kWh/m² a year, which is close to average consumption levels for residential properties (source: OID).

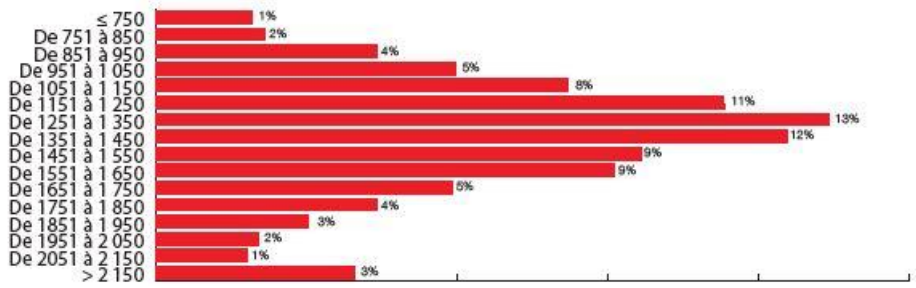


Figure 4 – Distribution of annual consumption levels (kWh/m²) for large food stores

Most of the energy consumed by this sector comes from electricity, which makes up more than 80% of total consumption. This is due to the large quantities of equipment that run on electricity. Gas is chiefly used for heating.

A survey conducted by CODA Stratégies for the French Environment and Energy Management Agency (ADEME) in 2015[11] presents electricity and gas consumption data by activity type and size of surface area in the commercial sector.[12] These data reveal that small shops specialising in leisure, cultural, sports and household goods have above-average energy consumption levels. Supermarkets and department stores are the second-highest energy consumers and the highest in the 1,000 to 5,000-m² category).

[10] This figure is based on a sample of consumption data for 3,134 large food stores located throughout France (OID Barometer).

[11] CODA Stratégies, GrDF, ADEME and RTE, *Caractérisation des consommations énergétiques des bâtiments du secteur tertiaire accueillant des activités de bureau et de commerce*, accessible at https://www.ademe.fr/caracterisation-consommations-energetiques-batiments-secteur-tertiaire-accueillant-activites-bureau-commerce

[12] Unlike the CEREN study, this survey does not target building-related consumption alone. The total consumption levels registered for the sector may therefore exceed those in the CEREN study.

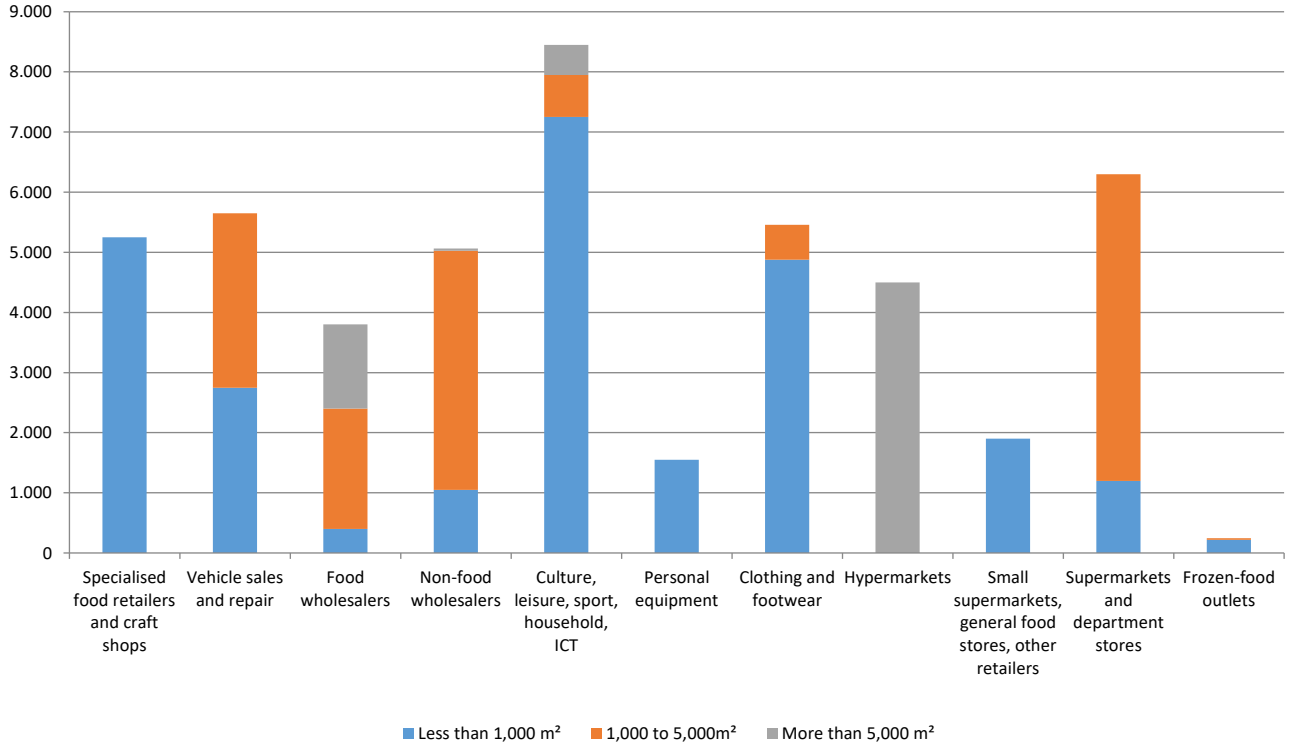
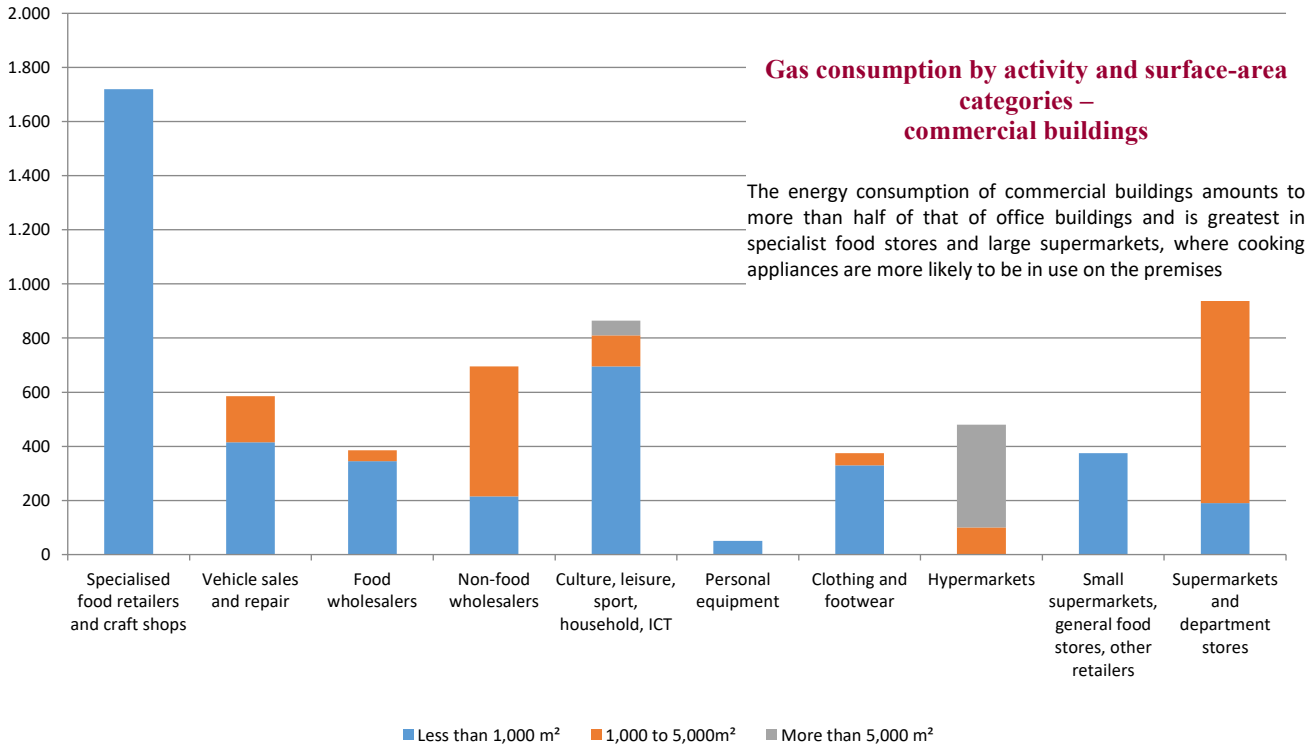


Figure 5 – Electricity consumption by surface area in the wholesale and retail sectors (in GWh; CODA, 2015)



Gas consumption by activity and surface-area categories – commercial buildings

The energy consumption of commercial buildings amounts to more than half of that of office buildings and is greatest in specialist food stores and large supermarkets, where cooking appliances are more likely to be in use on the premises

Figure 6 – Gas consumption by surface area in the wholesale and retail sectors (in GWh; CODA, 2015)

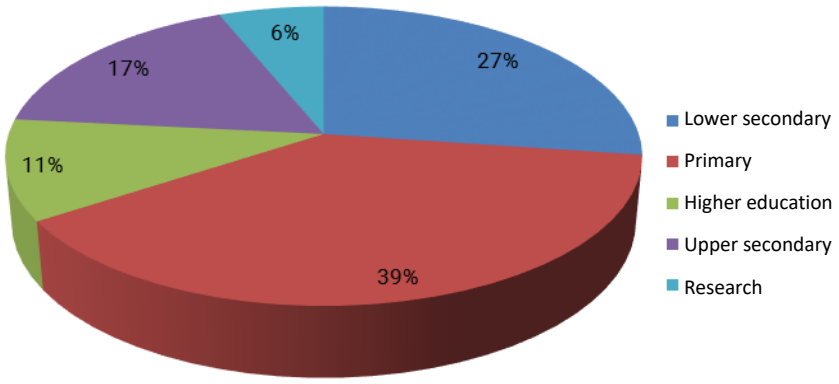
2.2.2.4 Education and research buildings

Building categories

The stock of education buildings is one of the biggest in terms of surface area. This category of building is being examined by a specific working group that was launched at the end of 2019. The data presented below are the most recent available and come from the BASIC/CODA study of 2012 that were used in the last long-term strategy. Specific work will be carried out in 2020 to update knowledge of this category of tertiary-sector buildings.

The total surface area of education buildings amounts to 168,250,965 m². This area is mainly occupied by primary schools (*écoles*) and lower secondary schools (*collèges*), which cover a total of 110,641,994 m², or 66% of the total floor surface of the stock of education buildings. The remainder surface area is distributed as follows:

- upper secondary schools (*lycées*) : 17% of the total surface area of the building stock;
- institutions of higher education: 11% of the total surface area;
- research establishments: 6% of the total surface area.

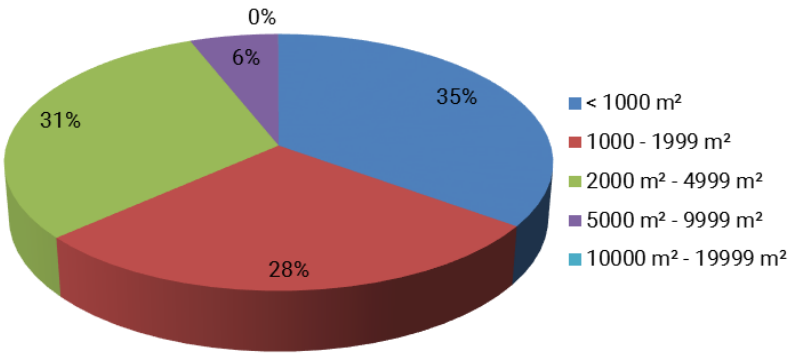


Distribution of the stock of education and research buildings by surface. Source: BASIC/CODA study 2012

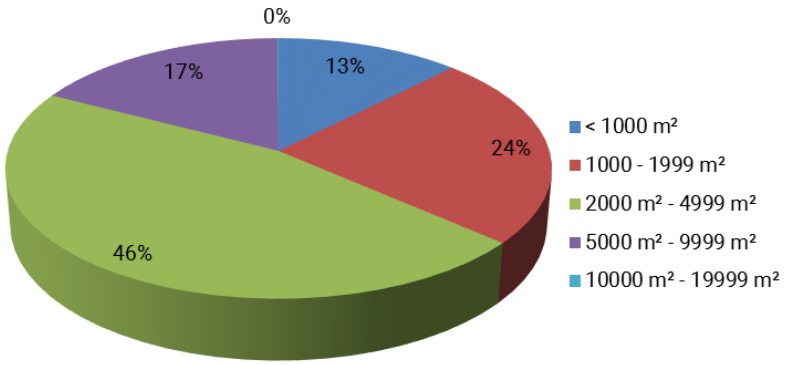
The education stock is dominated by medium-sized buildings. There are only 16 buildings with a surface area between 10,000 and 20,000 m^2. Buildings of less than 1,000 m^2 are the most common with a 35% share (in number of buildings) while second place is occupied by buildings with areas of 2,000 to 4,999 m^2, which represent 31% of education and research buildings.

Buildings from 2,000 to 5,000 m^2 represent almost half of the surface area of the education stock. The remaining surface area of education buildings is distributed as follows:

- Buildings from 1,000 to 2,000 m^2: 24% of the stock;
- Buildings from 5,000 to 10,000 m^2: 17% of the stock;
- Buildings with less than 1,000 m^2: 13% of the stock.

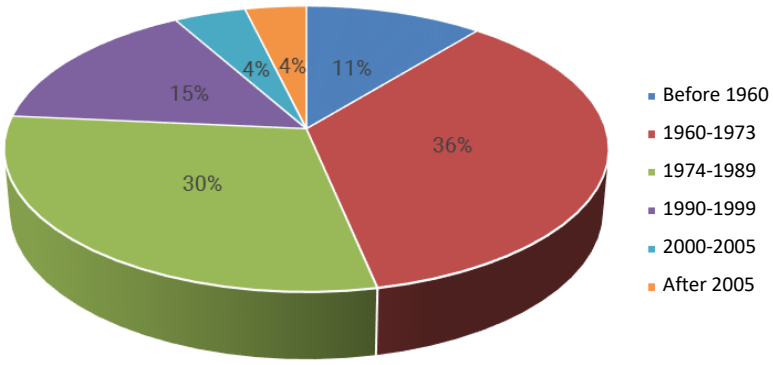


Distribution of the education and research building stock by surface area, based on NUMBERS of buildings. Source: BASIC/CODA study, 2012



Distribution of the education and research building stock by surface area, based on total SURFACE AREAS of buildings. Source: BASIC/CODA study, 2012

The period from 1960 to 1989 saw a boom in the construction of education buildings, with two thirds of the stock having been built during this period. This corresponds to a period of huge commitment from the state to the construction of school and university buildings.



Distribution of the education and research building stock by construction period, based on NUMBERS of buildings.
Source: BASIC/CODA study, 2012

2.2.2.5 Hotel and restaurant buildings

The data from the BASIC/CODA database which was used in 2017 and which is taken from INSEE statistics show a constant decrease in the number of hotels over the previous 20 years, which translates into an increase in the average size of those establishments. The number of cafés also shows a decline, whereas the number of restaurants rose.

Restaurant buildings are the larger category in this sector. About a quarter of the hotel and restaurant buildings were built in the period from 1974 to 1989. Restaurants consume more energy than hotels, not only because of their larger share of this sector but also because of the consumption associated with cooking. Electricity remains the main source of energy for most usage categories, and heating consumes the most energy.

2.2.2.6 Communal residences

This part of the building stock comprises a range of buildings which, by dint of their residential purpose, are akin to residential buildings in terms of function and energy consumption. Examples of these buildings are houses of religious communities with accommodation, penal institutions, youth hostels and shelters, holiday centres for young people, self-catering accommodation, guest houses, barracks, dormitory buildings of boarding schools, residential schools, student residences and workers' hostels.

In particular, these buildings are eligible for the Energy Saving Certificates (CEE) scheme. Buildings in some categories, such as workers' hostels, may be held by a social landlord and treated as dwellings.

The energy consumption of communal residential buildings amounted to 13 TWh in 2016, according to CEREN data, corresponding to 189 kWh per m². This level of consumption would qualify residential buildings for a D rating on their Energy Performance Certificate.

2.2.2.7 Buildings dedicated to leisure pursuits

The stock of buildings dedicated to leisure pursuits is highly diverse, as it includes buildings used for cultural purposes as well as those used for sports. According to the CEREN data, they represent 7% of the total surface area of tertiary-sector buildings.

Most of these buildings are held by local authorities.

The cultural category includes cinemas, museums, theatres, libraries, youth centres, cultural centres, smaller performance venues and community halls. The rate of construction of these amenities has undergone significant fluctuations over recent decades. However, the economic crisis of 2008 and the decline in government and local-authority investment has led to a sharp fall in building activity in this sector.

The total energy consumption of buildings dedicated to leisure pursuits was estimated at 18 TWh in 2016. Consumption per square metre of floor space was 243 kWh.

2.2.2.8 Transport-related buildings

This category includes airports and aerodromes, railway stations, bus stations, car parks, private garages and shopping-centre car parks.

These buildings account for only 3% of the total surface area. Their total consumption amounts to 8 TWh, or 311 kWh/m².

Given the diversity of the ways in which these buildings are used, there are extremely wide variations in their energy consumption patterns. The main items of energy consumption are:

- lighting, IT and displays for railway stations, which are old buildings;
- air-conditioning for airports;
- lighting and ventilation for car parks.

2.2.2.9 Healthcare buildings

Healthcare buildings include public and private hospitals. Their total energy consumption is estimated at about 27 TWh, or 235 kWh/m². They consume high volumes of energy because of the large quantity of energy-intensive equipment they use but also because of the heating required to maintain an average temperature of 23°C. Consequently, electricity is the most-used type of energy in these buildings.

2.2.3 *Analysis of the overall energy consumption of the national stock of building stock for tertiary-sector use*

The CEREN statistics for 2016 do not provide information on all uses of tertiary-sector buildings. The CEREN surveys target buildings in that sector where consumption essentially stems from ‘building-centred’ amenities, that is to say heating, air-conditioning and lighting. Accordingly, data concerning specific types of electricity consumption, such as the use of information technology, are not processed in CEREN surveys, although they account for more than 15% of the total energy consumption of office buildings, for example (CODA study, 2012).

The CEREN data do serve, however, to illustrate the diminution of energy consumption for heating in this sector since the start of the 21st century. This downward trend may be attributed both to renovation work (especially in office buildings – see point 1.2.2.2 above) and to the construction of new buildings in accordance with stringent thermal regulations. Overall consumption, on the other hand, continues to rise. This trend may be explained by an increase in other uses of electricity, particularly for cooling systems, which have become more widespread since the 1990s, and lighting.

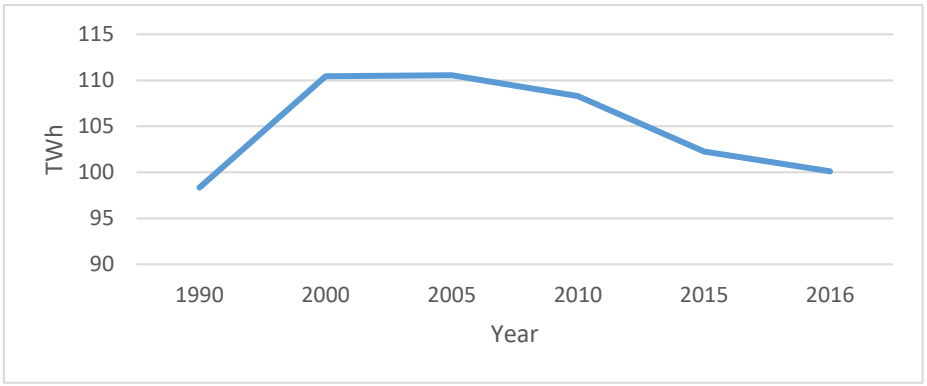


Figure 7 – Development of total heating consumption in the tertiary sector (CEREN)

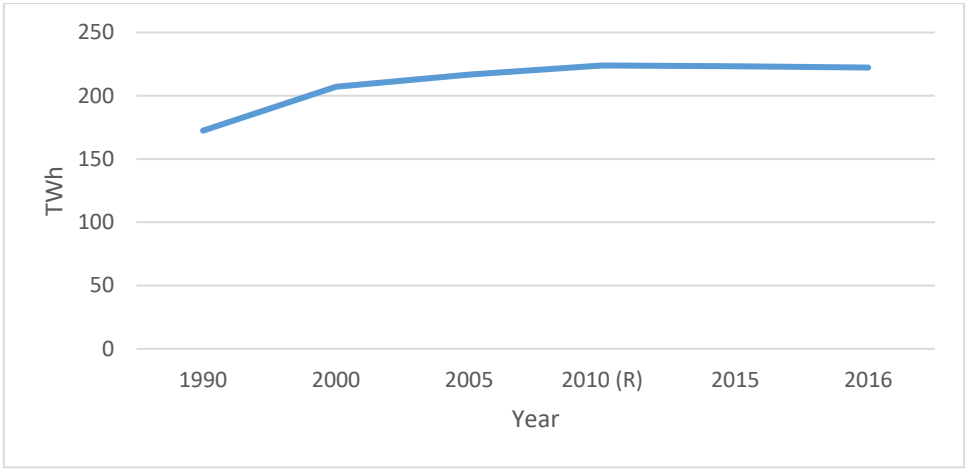


Figure 8 – Development of total energy consumption in the tertiary sector (CEREN)

Following increases in the consumption of buildings in the office, commercial and sport/leisure/culture categories in the 1990s, total consumption for every building category is now falling.

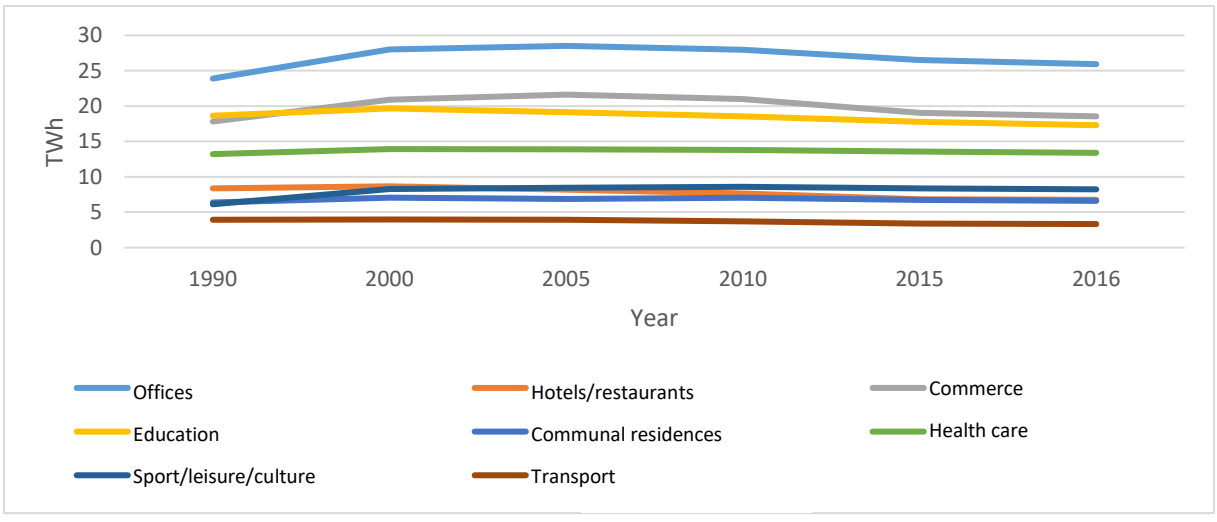


Figure 9 – Development of heating consumption by activity type (CEREN)

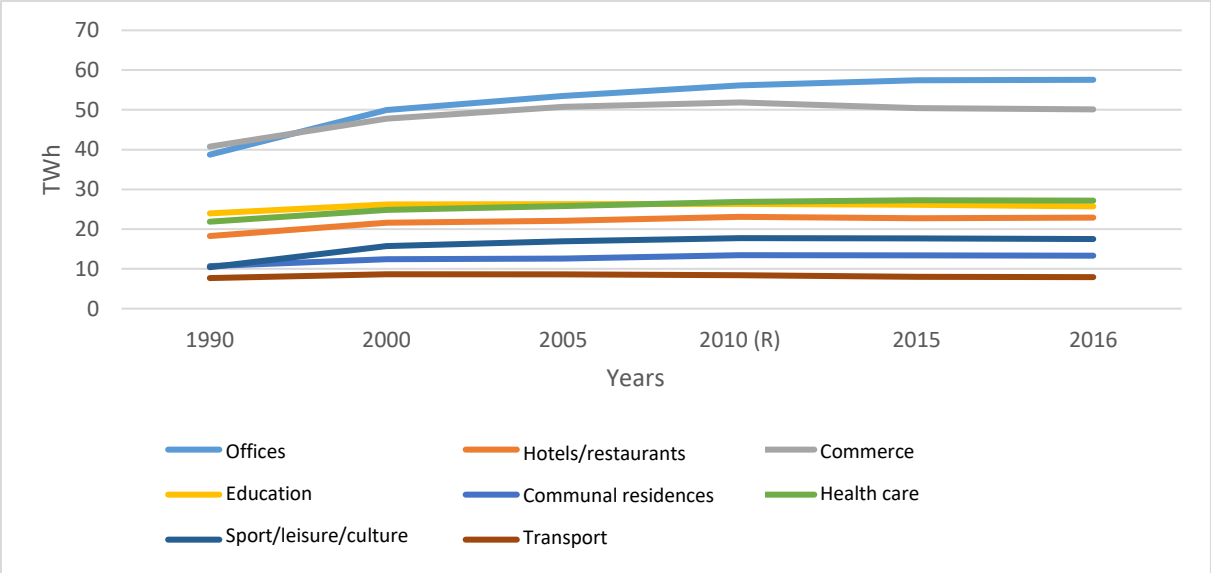


Figure 10 – Development of total energy consumption by activity type (CEREN)

2.3 A large number of households in energy poverty

According to the National Environmental Commitment Act (*Loi portant engagement national pour l'environnement*) of 12 July 2010, "a person is living in energy poverty if he experiences particular difficulties in obtaining the supply of energy required for the satisfaction of his basic needs by reason of the inadequacy of his resources or housing conditions".

To quantify this qualitative definition, the National Observatory of Energy Poverty (ONPE), which is administered by ADEME, the French Environment and Energy Management Agency, defines a household as living in energy poverty if its energy spending for its home exceeds 8% of its income and if its income per consumption unit is below the third decile of income per consumption unit. This, according to the Observatory, means that:

- 11.6% of people in France are living in energy poverty;
- 15% of the French population stated that they suffered from coldness for at least 24 hours in the course of the winter of 2017; for four out of ten households, this was down to poor insulation (National Energy Ombudsman, 2018);
- 572,440 households were subject to action on the part of an energy supplier (power reduction, disconnection or termination of contract) in 2018 for unpaid energy bills;
- the proportion of households living in energy poverty in metropolitan France as measured by the expenditure indicator fell between 2013 and 2017 from 14.5% to 11.6%, i.e. 3.3 million households comprising 6.7 million individuals.

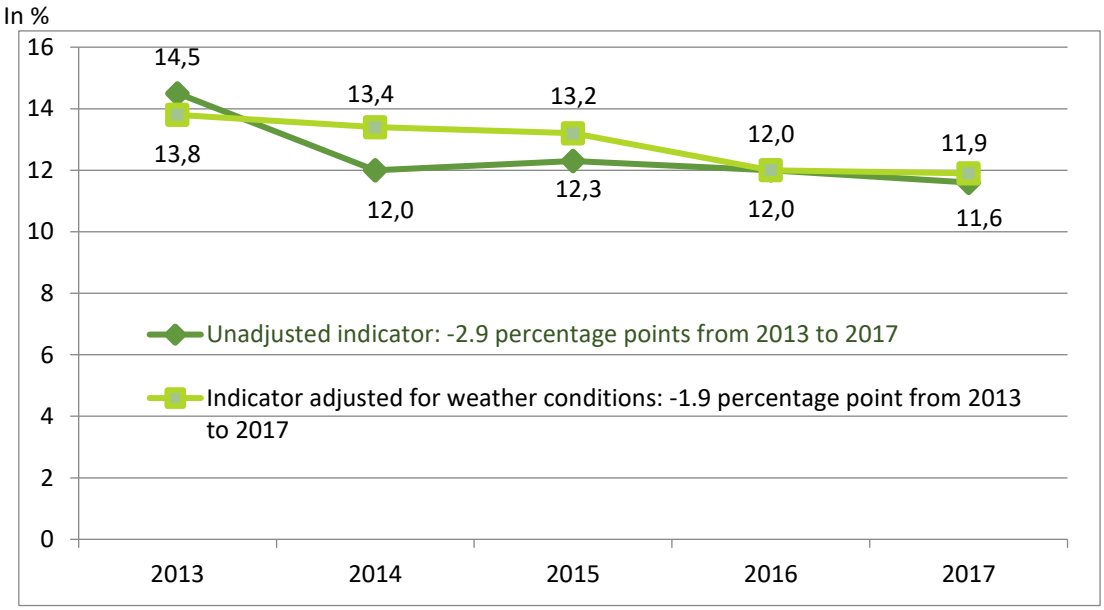


Figure 11 – Levels of energy poverty (ONPE, 2018)

The contrast between the mild weather of 2017 and the particularly harsh winter of 2013 is one of the reasons for this decrease. If this meteorological effect is factored out, a less marked decline is registered, namely minus 1.9 percentage points (from 13.8% to 11.9%) rather than minus 2.9.

The reduction in household energy consumption, adjusted for weather conditions, probably connected with the trend towards more energy-efficient housing resulting from new housing stock and renovations, is the main factor in the drop in average household energy bills between 2013 and 2017, when energy prices, including taxes, have remained stable.

Heating in winter

15% of respondents suffered from coldness, most frequently because of poor insulation

Q. 40a. In your home in the course of last winter, did your household suffer from coldness for any period of at least 24 hours?

Q. 29. Was this because of … (please choose one reply)

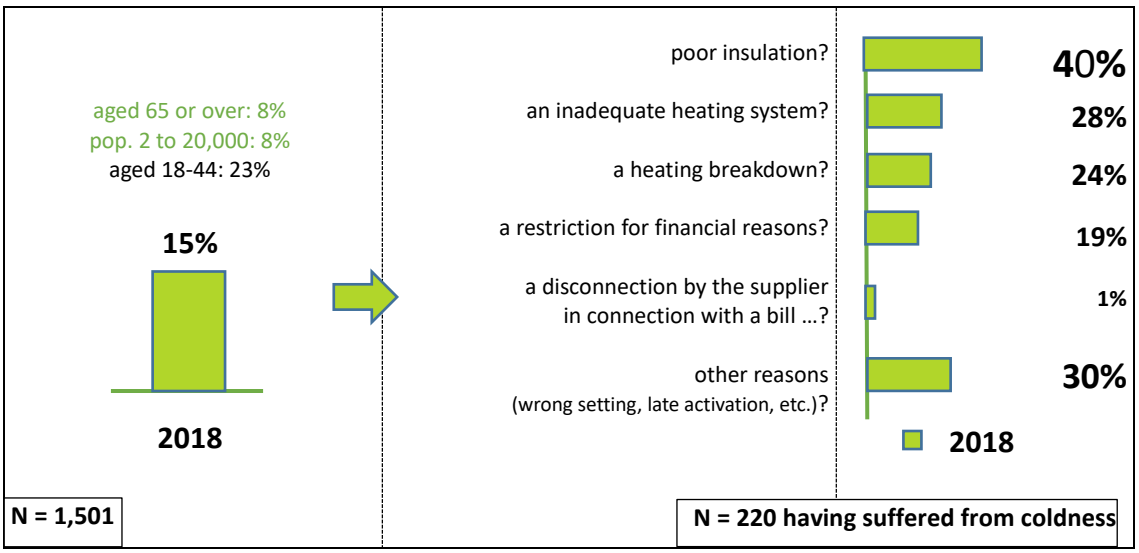


Figure 12 – Heating in winter (Energy Ombudsman) (ONPE, 2018)

According to the National Energy Ombudsman's indicator of feeling cold, 15% of households suffered from a sensation of coldness in their homes in the winter of 2017/18.

For 40% of them, the sense of discomfort resulted from poor insulation of their homes, while 28% blamed an inadequate heating system.

The National Observatory of Energy Poverty also has the task of assessing households' views on energy issues.

The Energy Information Barometer is compiled by the National Energy Ombudsman. Every year, 1,500 individuals are interviewed by telephone in September. The sample is selected by means of the quota method, based on ages and occupations of heads of household after stratification by region and size of settlement in order to ensure that it is representative of the French population.

In 2018, the Barometer produced the following findings:

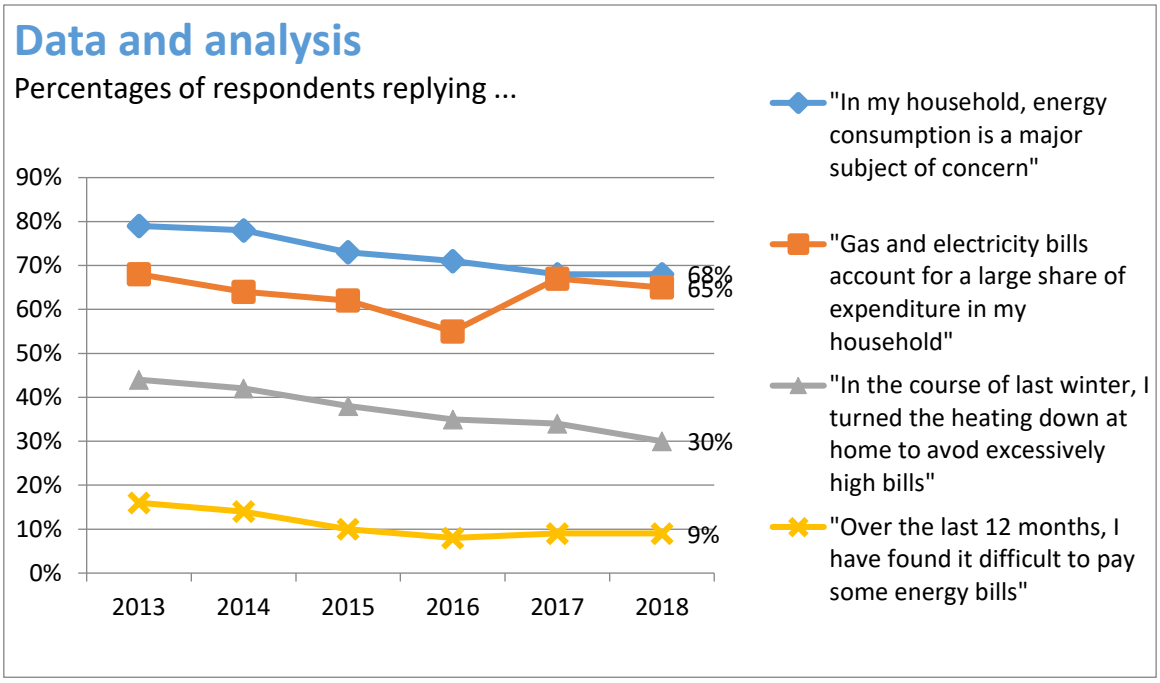


Figure 13 – Energy Information Barometer (National Energy Ombudsman, 2018)

The climate of economic and social crisis extended into the second decade of the 21st century, and the uncertainties that plagued both decision-makers and the public at large are perceptible in the findings of the Energy Information Barometer, even if, generally speaking, concerns seem to subsiding. In 2012, for instance, almost eight out of ten households indicated that energy consumption was a major subject of concern for them. This was the highest proportion since the creation of the barometer in 2007. By 2018 it had fallen to 68%.

By contrast, the percentage of householders stating that their gas and electricity bills accounted for a large share of their household expenses rose from 55% to 65% from 2016 to 2018.

Strategies of restricting heating to avoid excessively high bills seem to have become less and less common since 2012 but were still being used in 30% of respondents' households in 2018.

One particular reason for the concerns expressed by householders may be the succession of increases in the cost of energy, especially gas, in the period from 2008 to 2014. On the other hand, the relative fall or the slowdown in the rise of energy costs – apart from electricity – from 2015 may partly explain why the percentage of householders expressing major concern about energy consumption reached its lowest level since 2010 and why turning down heating in anticipation of energy bills is being done a little less frequently.

Nevertheless, this practice of restricting heating remains significant. The Phebus survey had shown that 6.4 million households had felt compelled to limit their heating in the course of 2017; 78% of those households reported that they favoured cost savings over comfort, which is considerably higher than the national average of 55%.

The number of households experiencing difficulty in paying their energy bills remains high, hovering around 10% since 2012 and reflecting the significance of the phenomenon of energy poverty, even when energy prices stop rising.

Created in March 2011, following the adoption of the National Environmental Commitment Act of 12 July 2010, the National Observatory of Energy Poverty (ONPE) has the task of **observing and analysing policies designed to combat energy poverty** and to be a repository of reliable shared knowledge about that phenomenon in France, primarily in the housing sector but also with regard to mobility.

The aim is that the Observatory should become a **reference tool on energy poverty** to monitor and analyse the phenomenon and the existing mechanisms that can assist government departments and agencies, local and regional authorities, energy suppliers and all associations and specialists operating in the field in their decision-making.

Every year, **ONPE produces a fuel-poverty scoreboard** in close collaboration with the Department for the Economics, Evaluation and Integration of Sustainable Development (SEEIDD) at the Ministry for the Ecological and Inclusive Transition as well as with INSEE. This collaboration provides access to robust scientific expertise, which is a real asset for the Observatory.

The main tasks of ONPE are:

- to serve as an instrument for the observation of energy poverty and the analysis of associated public policies;
- to contribute to leading the debate on energy poverty;
- to publicise and disseminate studies on the phenomenon;
- to perform watchdog and think-tank functions in liaison with its partners.

Observatory website: http://onpe.org

3 IDENTIFICATION OF COST-EFFECTIVE APPROACHES TO RENOVATION

The aim of this chapter is to identify efficient approaches to renovation that maximise energy gains while also returning a financial profit over 30 years[13] for households or property managers. The method used to define cost-effective approaches to renovation is made up of five successive stages:

1. identification of works that can be performed on each of the 'standard' buildings representing particular construction periods;
2. definition of clusters of works in the form of renovation scenarios with progressive levels of efficiency: clusters of initial works, higher-efficiency renovations and achievement of the BBC (*Bâtiment Basse Consommation* – Low-Energy Building) renovation level;
3. thermal simulation and economic costing of multiple variants: cost of investment and global cost over 30 years;
4. identification of the most economically and technically pertinent solutions;
5. conclusion on the cost-effective approaches to renovation.

In the case of residential buildings, it was considered appropriate to focus on the periods before 1990, as those buildings are the priority target for renovation works and date from periods before the introduction of thermal regulations for buildings. The choice was made to examine additional residential buildings to those studied in the previous Renovation Strategy.[14] This approach led to the identification of six reference buildings:

- For one-dwelling buildings, which make up 59% of the national housing stock, it was important to analyse edifices built during the three construction periods and to test renovations relating to the energy sources gas, electricity and oil.
- For multi-dwelling buildings (41% of the housing stock) the examination focused on three building typologies from three different construction periods, namely a bourgeois building with district gas heating, a low/mid-rise rectangular block dating from the period of mass reconstruction, heated by electricity, and a small apartment block from the 1975-81 period, also heated by electricity.

The description of buildings from the tertiary-sector stock, for their part, reveals a highly diverse stock that is difficult to model. Office buildings constitute the largest surface area in terms of total square metreage in the tertiary-sector stock, and heating, ventilation and air conditioning account for 60% of their energy consumption. The category of offices is relatively homogeneous compared with the stock of commercial premises. Education buildings form another relatively homogeneous category but are in public ownership. We therefore propose to study the following:

- a large office building located in the outskirts of a city, dating from the 1970s and heated by gas;
- a standard lower secondary school built in 1970 located in a medium-sized town and heated by gas.

On the basis of these eight reference buildings, it is possible to conduct numerous simulations with a view to outlining renovation processes reflecting the variety of choices that may be made by households or property managers.

[13] Commission Delegated Regulation (EU) No 244/2012 of the Commission of 16 January 2012 supplementing Directive 2010/31/EU of the European Parliament and of the Council on the energy performance of buildings advises a calculation period of 30 years for residential buildings

[14] Available in French at https://ec.europa.eu/energy/sites/ener/files/documents/fr_building_renov_2017_fr.pdf

The Episcope project is part the European programme Intelligent Energy Europe (IEE), launched in 2003 to follow up the Datamine and Tabula projects, which developed a **common data structure for housing stock**, residential building typologies in the participating countries and a calculation method for assessing energy consumption on heating and domestic hot water and energy savings resulting from measures of energy renovation.

The strategic aim of the Episcope project is to make energy renovation processes in the housing sector more transparent and efficient in European countries. **Its mission is to build foundations that will enable governments of EU Member States to meet the need to identify cost-effective approaches to renovation tailored to building types and climate zones**.
This project is therefore **a response to the challenges described in the present chapter of this report**. The work on this project has been performed by Pouget Consultants and funded by the European Union and ADEME.

The same consultancy firm was commissioned by the Directorate for Housing, Urban Development and Landscapes (DHUP) to analyse the residential buildings examined in this part of the strategy. The choice was made to provide an analysis that would supplement the report on the Episcope project by focusing on less ambitious renovation scenarios resembling the current practice of building owners.

All of the project findings are available (in French) on the Episcope website at
http://episcope.eu/building-typology/country/fr/

3.1 Detailed methodology

3.1.1 *Description of the scenarios*

In order to define cost-effective approaches to renovation, energy renovation scenarios were studied for all of the buildings. The purpose of this section is to conduct simulations of works on the five selected buildings in the light of current financing conditions, particularly the amounts of available incentives and the eligibility criteria, in order to identify cost-effective approaches to renovation

Renovation scenarios have been simulated for each of the building typologies.

- For some dwellings, works involving only one or two measures have been modelled to take account of current household practices and to assess the potential gain of minor works supported by incentive schemes for energy renovation.
- For each of the buildings, two scenarios are presented:
    - Scenario 1: this scenario corresponds to an **efficiency-enhancement renovation**, compatible with a phased approach leading to low-energy building status (see the relevant part of the chapter entitled *Policies and measures in support of building renovation*).
    - Scenario 2: this scenario relates to a **high-efficiency renovation**, covering all items of energy related work that can be undertaken. The installed items of equipment have high efficiency levels.
- For suitable building typologies, a **scenario 3** is presented. This corresponds to the high-efficiency renovation of **scenario 2**, but in this case the replacement systems run on renewables. This scenario is

regarded as the key to achieving low-energy building status. Some buildings, by their nature, cannot meet this standard.[15]

The technical solutions adopted in the scenarios were proposed in the framework of a contract concluded with Pouget Consultants and are based on the types of efficiency-enhancement renovations that are most often carried out for each building typology under examination. The creation of scenarios forges a link with the description of the building stock and the works recommended in the PACTE programme described in the preceding chapter.

The resulting works on the interior layout and fittings have not been included in the calculation as the global cost for the purposes of the study relates only to actions with an impact on energy efficiency.

The scenarios were defined in several steps:

- The first consisted in determining which of the works most commonly performed by households were suitable for the building, in other words whether a particular intervention was technically possible.
- Those works were then costed, and thermal and economic simulations were carried out for the various feasible combinations of works.

For this analysis, it was decided to focus in depth, in the construction and analysis of renovation scenarios, on a limited number of buildings with a view to presenting cost-effective approaches to renovation. A more exhaustive approach can be found in the Episcope project report.

The so-called 'element by element' thermal regulations define minimum requirements that must be met when an element of a building is replaced that has an impact on its energy efficiency. These regulations were revised in 2016, a point that will be discussed in detail later in the document, and so we will be referring to the new requirements when, for each action taken, we define the minimum equipment performance level that complies with the regulations. This is the compliance level referred to above.

3.1.2 *Defining global cost*

The profitability of the scenarios was examined with the aid of a global-cost approach, in which all costs associated with the operation are taken into account. The method used complies with the recommendations made in Delegated Regulation (EU) No 244/2012 of 16 January 2012 supplementing Directive 2010/31/EU on the energy performance of buildings. In accordance with Article 5 of Regulation No 244/2012, longer-term costs are updated.

The global cost comprises:

- the initial investment costs: all costs incurred up to the point when the building or the building element is delivered to the customer (supply and installation, excluding consultancy costs);
- the updated energy consumption cost: the annual costs associated with the energy consumed to run the building or part of the building, updated each year; ;
- updated replacement costs: a substitute investment for a building element, according to the estimated economic life cycle during the calculation period;
- updated maintenance costs: expenditure required to service and maintain the building over time;
- the updated residual value: the total residual value of all elements of the building at the end of the calculation period; the residual value is determined by a straight-line depreciation of the initial investment or replacement cost of a given building element until the end of the calculation period discounted to the beginning of the calculation period.

[15] Non-attainment of low-energy building status by a building typology is not a problem in itself. There is general agreement that some buildings, because of their technical, historical or architectural characteristics, cannot be renovated to a very high standard of energy-efficiency. This fact is not incompatible with the attainment of a low-energy building stock by 2050, because new buildings and high-efficiency renovations will be able to offset the consumption of less energy-efficient buildings.

The global cost is calculated by means of the following formula:

$$C_g(T) = C_I + (\sum_{t=1}^{T} \frac{C_t}{(1+a)^t}) + \frac{V_T}{(1+a)^T}$$	where C_g is the global cost C_I is the initial investment cost C_t is the sum of annual costs a is the annual discount rate in % V_T is the residual value

3.1.3 *Calculation assumptions*

The assumptions made for the purpose of calculating the global cost are as follows:

- calculation period: 30 years;
- discount rate: 4%;[16]
- the buildings under examination are in climatic area H1b;
- energy prices per kWh of final energy:[17]
  - electricity : €0.1389 + 18% tax;
  - gas: €0.0574 + 18% tax;
  - heating oil: €0.0624 + 20% tax;
- inflation rates per energy carrier:
  - 1.1% for electricity;
  - 1.9% for gas;
  - 3% for heating oil;
- capital cost: the cost of renovation works is obtained from the Batichiffrage, Batitel and Batiprix databases of building prices, which were valid as of September 2018;
- maintenance costs: maintenance costs are calculated as a percentage of the initial investment cost, obtained from French NF EN 15459 on the energy performance of buildings;
- replacement costs: the replacement cost of an item corresponds to the discounted capital cost and is based on the assumption of like-for-like replacement of an appliance or component at the end of its life cycle;[18]
- VAT: 10% for dwellings, according to Article 278-0 *bis* of the French Tax Code; 20% for offices.

Energy savings, initial investment cost and the global cost of renovation works are calculated with the aid of the *Cost-Optimal* tool developed by the Scientific and Technical Centre for Building (CSTB) on behalf of the

[16] The Commissions Impact Assessment Guidelines suggest a societal discount rate of 4%.

[17] Energy costs have been based, on the one hand, on the average of basic and peak tariffs for electricity, gas and heating oil observed over the course of 2017. On the other hand, energy price trends are based on assumptions made in the context of analyses conducted by the General Directorate for Energy and the Climate modelling the development of energy consumption in France in the period up to 2050. These tariffs incorporate the CCE – the climate and energy contribution, a tax established in France on energy generated by fossil fuels. It may be likened to a carbon tax, because it is based on the carbon content of energy carriers and on the cost of a tonne of CO_2 over and above the price on the European carbon market.

[18] The lifespans of appliances and components are taken from French standard NF EN 15459.

Directorate for Housing, Urban Development and Landscapes (DHUP) for the purpose of fulfilling the obligations established by Article 5 of Directive 2010/31/EU.[19]

3.1.4 *Calculation of financial aid*

For the calculation of the profitability of works scenarios, the national public financial aid available at the time of the initial investment was taken into account. Local assistance and European assistance administered through regional and local authorities were not included in the calculation, as they vary widely from one area to another.

Similarly, national assistance intended specifically for low-income and very-low-income households (the Live Better programme of the National Housing Agency, ANAH) have not been included, because they target specific households. The decision was taken to include only aid that was available to all households.

It is important, however, to note that aid schemes which specifically target low-income households serve to reduce the householders' own capital contribution and therefore encourage them to have renovation work done.

Lastly, the aid relates to privately owned housing stock and does not include the funding mechanisms designed to encourage renovation of the social housing stock.

In this model, financial aid is granted only for the initial investment, not for the replacement of appliances.

Forms of aid for housing renovation	
Energy transition tax credit (CITE)	- single rate of 30% of eligible expenditure, except for glazing, where a 15% rate is applied for the replacement of single glazing (0% for other glazing replacements) - eligible works must meet the performance criteria defined in Article 18a of Annex IV to the General Tax Code; [20] - eligible expenditure corresponds to the cost of equipment (except for thermal insulation works on opaque walls for which the cost of installation is included in eligible expenditure); - for our study, we have assumed that the housing was occupied by a married couple or couple in civil union, and so the ceiling for eligible expenditure would be EUR 16,000, making a maximum tax credit of EUR 4,800.
Reduced rate of VAT	– 5.5 % applied to energy renovation works (supply and installation) performed in housing properties more than two years old; – eligible works must meet the performance criteria defined in Article 18a of Annex IV to the General Tax Code.
Energy savings certificates (CEE)[21]	– assessed using the standardised calculation form for the fourth CEE period for buildings in the residential sector.

Details of aid for residential buildings

Forms of aid for tertiary-sector building renovation

[19] French authorities' report on the calculation of cost-optimal levels of minimum energy performance requirements for buildings and building elements, available in French at https://ec.europa.eu/energy/sites/ener/files/documents/fr_2018_cost-optimal_fr_version_existing_buildings.pdf.

[20] Text in French at https://www.legifrance.gouv.fr/affichCode.do;jsessionid=7D043C74A68E7CA5C2E486D87582B161.tplgfr35s_2?idSectionTA=LEGISCTA000030292712&cidTexte=LEGITEXT000006069576&dateTexte=20190730

[21] https://www.ecologique-solidaire.gouv.fr/operations-standardisees-deconomies-denergie (in French)

Energy savings certificates (CEE)	– assessed using the standardised calculation form for the fourth CEE period for buildings in the tertiary sector.

Details of aid for tertiary-sector buildings

3.2 Summary of building typologies examined

Typologies				
HOUSES	**Typologies**	**% of total stock (PACTE)**	**Construction period**	**Heating energy**
	Rural house	5.5%	Before 1948	Oil
	Reconstruction-era detached house	7.1%	1948-1974	Electricity
	Detached house, 1975-1985	7.3%	After 1974	Gas
APARTMENTS	**Typologies**	**% of total stock (PACTE)**	**Construction period**	**Heating energy**
	Bourgeois building	7.1%	Before 1948	Gas (district heating)
	Low/mid-rise blocks, 1948-1974	4.6%	1948-1974	Electricity
	Miscellaneous small apartment blocks	2.3%	After 1974	Electricity
TERTIARY	**Typologies**	**% of total stock (PACTE)**	**Construction period**	**Heating energy**
	Large office building	Insignificant	After 1974	Gas
	Lower secondary school		1948-1974	Gas

Renovation scenario										
					Heating					
External walls		Roof cavity	Floor	Exterior joinery	Boiler replacement	Conversion to gas	Conversion to heat pump	Replacement of radiators	Improved regulation	DHW cylinder replacement
Exterior insulation	Interior insulation									
Scenario	*Scenario*	*Scenario*	*Scenario*	*Scenario*	*Scenario*	*Scenario*	*Scenario*	*Scenario*	*Scenario*	*Scenario*
	2	1		1		2	3		2	
1		1	1	2			2	1		3
1		1	1	2	2		3		2	
External walls		Roof cavity	Floor	Exterior joinery	Heating			Replacement of radiators	Improved regulation	DHW cylinder replacement
Exterior insulation	Interior insulation				Boiler replacement	Conversion to gas	Conversion to heat pump			
Scenario	*Scenario*	*Scenario*	*Scenario*	*Scenario*	*Scenario*	*Scenario*	*Scenario*	*Scenario*	*Scenario*	*Scenario*
	2	1	2	1	2				2	
1		1	1	1				2		2
1		1	1	1			3	2		2
External walls		Roof cavity	Floor	Exterior joinery	Heating			Replacement of radiators	Improved regulation	DHW cylinder replacement
Exterior insulation	Interior insulation				Boiler replacement	Conversion to gas	Conversion to heat pump			
Scenario	*Scenario*	*Scenario*	*Scenario*	*Scenario*	*Scenario*	*Scenario*	*Scenario*	*Scenario*	*Scenario*	*Scenario*
2		1	2	1	2		3		1	
2		1	1	1	1		3		1	

Notes:

- The '% of total stock' column shows how much of the building stock is constituted by each of the typologies. It is the result of the classification work on the housing stock undertaken as part of the PACTE programme.
- Ventilation must be incorporated into all clusters of works. For the sake of simplicity, its impact on energy consumption has not been modelled.

3.3 *Detailed analysis of building-stock renovation strategies*

3.3.1 *Rural house*

MAISON RURALE FIOUL | **5,5% du parc**

ELEMENTS DE TYPOLOGIE	
Type de bâtiment	Maison individuelle
Période constructive	Avant 1948
Nombre moyen de logements	1
Nombre de niveaux chauffés	2
Surface chauffée (SHAB)	115 m²
Surface SHON	144 m²
Orientations façade principale	Sud
Mitoyenneté	0%
Plancher bas sur	Terre-plein
Situation géographique	Zones rurales, hors villages ruraux
Surface du logement	115 m²
Hauteur sous plafond	3 m au RDC / 2,5 m dans les combles aménagés
Compacité du bâti	0,89

DESCRIPTION DE L'ENVELOPPE / METRES TYPE

Elements du bâti	Surface (m²)	Description	Résistances R (m².K/W)	Coefficient U (W/m².K)
Toiture - plancher haut	78	Double pente : rampants isolés par 6cm de laine minérale	1,58	0,63
Façades (toutes orientations)	191	Pierre naturelle d'épaisseur 48cm avec enduit plâtre côté intérieur	0,55	1,83
Baies vitrées (en nombre)	6	Menuiseries bois ou PVC avec double vitrage 4/10/4 air	-	2,60
Porte d'entrée (en nombre)	1	Porte pleine bois ancienne	-	3,10
Plancher bas	65	Dalle béton non isolée de 15 cm / revêtement type carrelage	1,14	0,88

Travaux réalisés	Changement des baies vitrées et isolation de la toiture

DESCRIPTION DES SYSTEMES

Systèmes	Description
Chauffage	Chaudière fioul standard 2000-2010 / Radiateurs eau chaude d'origine
Eau Chaude Sanitaire	Ballon ECS électrique de 200L
Ventilation	Ventilation naturelle par ouverture de fenêtres

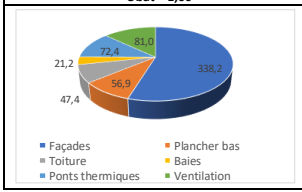
Travaux réalisés	Changement de la chaudière

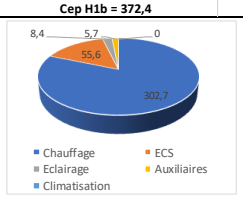
CARACTERISTIQUES ENERGETIQUES

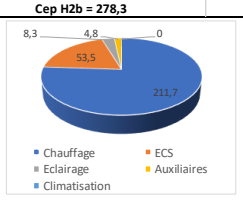
Désignation	Description	Energie utilisée
Part dans le parc français	5,5%	Fioul

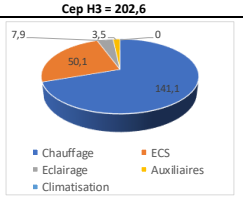
PERFORMANCES

Enveloppe thermique (W/K) Total déperditions = 552 W/K	Consommation énergie primaire (kWhep/m².an) - Zones H1b ; H2b ; H3 - 5 usages		
Ubat = 1,60	Cep H1b = 372,4	Cep H2b = 278,3	Cep H3 = 202,6









RURAL HOUSE, HEATED BY OIL — **5% of the building stock**

Building type	one-dwelling building
Construction period	before 1948
Average number of dwellings	1
Number of storeys heated	2
Heated surface (living area)	115 m²
Net floor area	144 m²
Orientation of main facade	south-facing
Party walls	0%
Ground floor built on	soil
Geographical location	rural areas, outside rural villages
Surface area of dwelling	115 m²
Floor-to-ceiling height	3 m on ground floor, 2.5 m in converted attic
Compactness ratio of the building	0.89

DESCRIPTION OF THE ENVELOPE

Building elements	Surface area in m²	Description	Resistance (R = m².K/W)	Coefficient (U = W/m².K)
Roof - attic floor	78	Gable roof: roof insulated at rafter level by 60mm of mineral wool	1.58	0.63

Building elements	Surface area in m²	Description	Resistance (R = m².K/W)	Coefficient (U = W/m².K)
All external walls	191	Natural stone, 480mm thickness with internal plaster coating	0.55	1.83
Number of windows	6	Wooden joinery or PVC with 4-10-4 double glazing, air-filled	-	2.60
Entrance doors (No)	1	Old opaque wooden door	-	3.10
Downstairs floor	65	Uninsulated concrete slab, 150mm thick, tiled	1.14	0.88

Work performed	Windows replaced and roof insulated

DESCRIPTION OF SYSTEMS

Systems	Description
Heating	Standard oil-fired boiler, 2000-2010/original hot-water radiators
Domestic hot water	200-litre electric hot-water cylinder
Ventilation	Natural ventilation obtained by opening windows

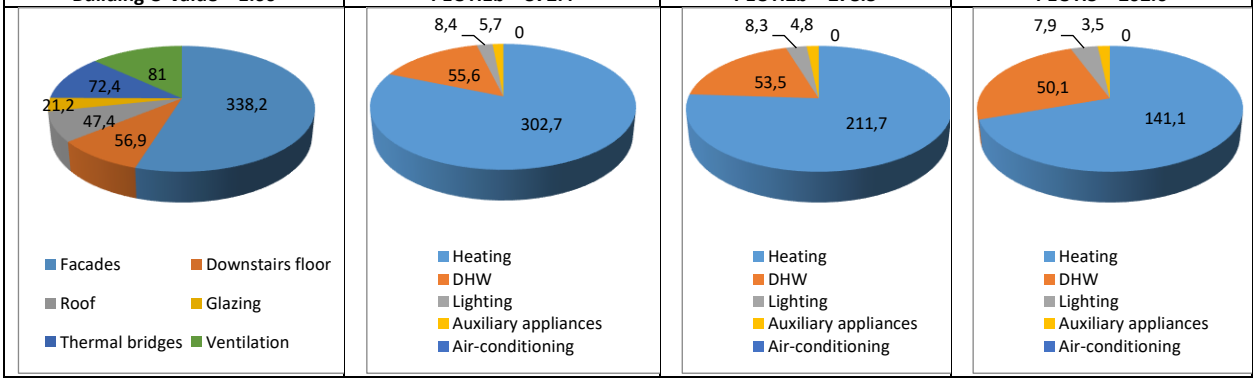
Work performed	Boiler replaced

ENERGY CHARACTERISTICS

Designation	Description	Energy used
Share of French building stock	5.5%	Heating oil

PERFORMANCE DATA

Thermal envelope (W/K) Total losses = 552 W/K	Annual primary energy consumption (PEC) in kWh/m² - zones H1b, H2b and H3 – 5 uses		
Building U-value = 1.60	PEC H1b = 372.4	PEC H2b = 278.3	PEC H3 = 202.6



Proposed renovation works:

- 200mm glass wool between rafters in the roof space (R-value = 6.25 m².K/W)
- 120mm glass wool internal insulation of outside walls (R-value = 3.7 m².K/W)
- Low-emissivity PVC double glazing, 4-16-4 (excluding shutters), Uw-value 1.4 W/m².K / U-value with shutters 1.4 W/m².K
- Condensing storage combination boiler, gas - IdraEco Condens Micro 5000 (Atlantic) – heating and domestic hot water
- Air-source heat pump - AUER HRC70 – heating and domestic hot water
- Installation of thermostatic valves

Scenarios:

External walls		Roof cavity	Floor	Exterior joinery	Heating			Replacement of radiators	Improved regulation	DHW cylinder replacement
Exterior insulation	Interior insulation				Boiler replacement	Conversion to gas	Conversion to heat pump			
Scenario	*Scenario*	*Scenario*	*Scenario*	*Scenario*	*Scenario*	*Scenario*	*Scenario*	*Scenario*	*Scenario*	*Scenario*
	2	1		1		2	**3**		2	

Financial estimate:

	Total	Breakdown of costs (in EUR, incl. tax)						Totals (in EUR, incl. tax)	
Configuration	**PEC**	**Investment costs**	**Amount of aid**	**Replacement costs**	**Residual value**	**Operating costs**	**Energy consumption**	**Global cost**	**Financial implications: cost per m²**
Building as is	372	-	-	-	-	-	96,932	96,932	673
Roof insulation	357	7,566	2,780	-	933	-	92,825	96,678	671
Scenario 1	350	11,270	4,081	-	2,075	641	91,539	97,293	676
Scenario 2	147	43,648	9,887	2,645	6,167	2,405	31,412	64,056	445
Scenario 3	102	51,052	10,591	6,777	6,231	7,750	21,670	70,426	489

3.3.2 *Detached house from the reconstruction era*

PAVILLON DE LA RECONSTRUCTION — **7,1% du parc**

ELEMENTS DE TYPOLOGIE	
Type de bâtiment	Maison individuelle
Période constructive	1948-1974
Nombre moyen de logements	1
Nombre de niveaux chauffés	1
Surface chauffée (SHAB)	72 m²
Surface SHON	83 m²
Orientation façade principale	Ouest
Mitoyenneté	Isolé
Plancher bas sur	LNC
Situation géographique	Zones urbaines hors centre ancien Zones rurales hors centre ancien
Surface du logement	72 m²
Hauteur sous plafond	2,5 m
Compacité du bâti	0,99

DESCRIPTION DE L'ENVELOPPE / METRES TYPE

Elements du bâti	Surface (m²)	Description	Résistances R (m².K/W)	Coefficient U (W/m².K)
Toiture - plancher haut	72	Combles perdus : 6 cm PSE / BA13	1,33 / 0,05	0,63
Façades (toutes orientations)	85	Murs en briques creuses non isolés / enduits des deux côtés	0,33 / 0,02	1,91
Baies vitrées (en nombre)	6	Menuiseries bois ou PVC avec double vitrage 4/10/4 air	-	2,60
Porte d'entrée (en nombre)	1	Porte pleine bois ancienne	-	3,10
Plancher bas	72	Hourdis béton 19 cm avec granulats lourds + 6 cm de laine minérale	0,08 / 1,33	0,57

Travaux réalisés	Changement des baies vitrées, isolation de la toiture et du plancher bas

DESCRIPTION DES SYSTEMES

Systèmes	Description
Chauffage	Convecteurs électriques NF / Pas de réseau de distribution
Eau Chaude Sanitaire	Ballon ECS électrique / Distribution individuelle sans bouclage
Ventilation	Ventilation naturelle par entrées d'air hautes et basses

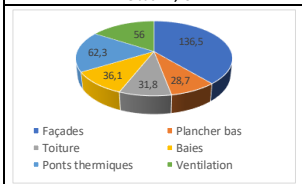
Travaux réalisés	Remplacement des convecteurs

CARACTERISTIQUES ENERGETIQUES

Désignation	Description	Energie utilisée
Part dans le parc français	7,1%	Electricité

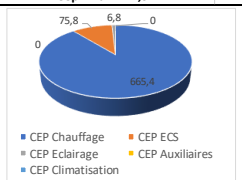
PERFORMANCES

Enveloppe thermique (W/K)
Total déperditions = 351 W/K
Ubat = 1,29

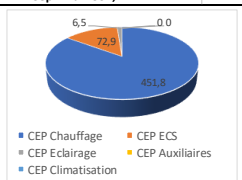


Consommation énergie primaire (kWhep/m².an) - Zones H1b ; H2b ; H3 - 5 usages

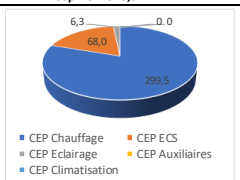
Cep H1b = 747,9



Cep H2b = 531,2



Cep H3 = 373,9



DETACHED HOUSE FROM THE RECONSTRUCTION ERA — 7.1% of the building stock

	Building type	one-dwelling building
	Construction period	1948-1974
	Average number of dwellings	1
	Number of storeys heated	1
	Heated surface (living area)	72 m²
	Net floor area	83 m²
	Orientation of main facade	west-facing
	Party walls	detached house

	Ground floor built on	unheated premises
	Geographical location	urban areas outside old town/city centre rural areas outside old town/city centre
	Surface area of dwelling	72 m²
	Floor-to-ceiling height	2.5 m
	Compactness ratio of the building	0.99

DESCRIPTION OF THE ENVELOPE

Building elements	Surface area in m²	Description	Resistance (R = m².K/W)	Coefficient (U = W/m².K)
Roof - attic floor	72	Lost attic space: 60mm expanded polystyrene/ BA 13 plasterboard	1.33 / 0.05	0.63
All external walls	85	Uninsulated perforated bricks; walls rendered inside and outside	0.33 /0.02	1.91
Number of windows	6	Wooden joinery or PVC with 4-10-4 double glazing, air-filled	-	2.60
Entrance doors (No)	1	Old opaque wooden door	-	3.10
Downstairs floor	72	Poured concrete floor, 190mm thick, with coarse aggregate and 60mm of mineral wool	0.08 / 1.33	0.57

Work performed	Windows replaced and roof and downstairs floor insulated

DESCRIPTION OF SYSTEMS

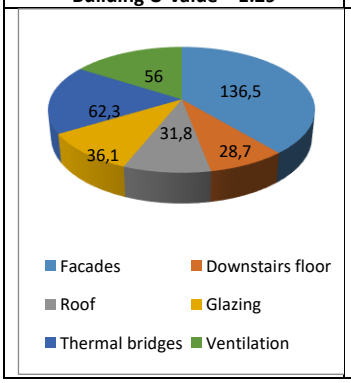
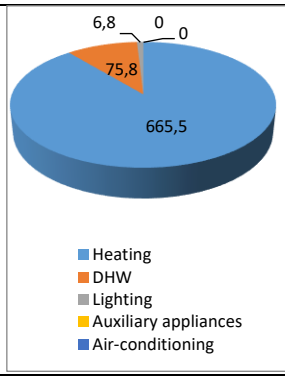
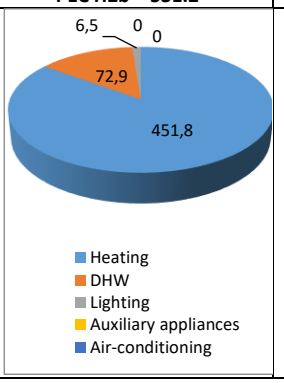
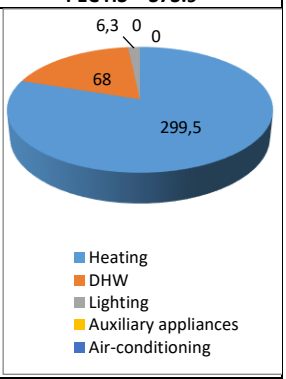
Systems	Description
Heating	Electric convector heaters, compliant with French standards. No central heating
Domestic hot water	Electric hot-water cylinder; individual feed pipes, no loop system
Ventilation	Natural ventilation by means of high and low air inlets

Work performed	Convector heaters replaced

ENERGY CHARACTERISTICS

Designation	Description	Energy used
Share of French building stock	7.1%	Electricity

PERFORMANCE DATA

Thermal envelope (W/K) Total losses = 351 W/K	Annual primary energy consumption (PEC) in kWh/m² - zones H1b, H2b and H3 – 5 uses		
Building U-value = 1.29	PEC H1b = 747.9	PEC H2b = 531.2	PEC H3 = 373.9
			

Proposed renovation works:

- Glass wool, 240mm thick, blown or laid onto the floor of the lost attic space (R-value = 7.5 m².K/W)
- External rockwool insulation, 160mm thick, rendered over (R-value = 4,4 m².K/W)
- Flocking on the unheated premises, 140mm thick (R-value = R=3,0 m²K/W)
- Low-emissivity 4-16-4 double-glazed window (excluding shutters), Uw-value 1.4 W/m².K / U-value with shutters 1.4 W/m².K
- Air-source heat pump - AUER HRC70 – heating only
- Thermodynamic water boiler with energy recovery from ambient air (Atlantic Odyssée)
- Replacement of convector heaters with water-filled radiators with certified thermostatic valves

Scenarios:

External walls		Roof cavity	Floor	Exterior joinery	Heating			Replacement of radiators	Improved regulation	DHW cylinder replacement
Exterior insulation	Interior insulation				Boiler replacement	Conversion to gas	Conversion to heat pump			
Scenario	*Scenario*	*Scenario*	*Scenario*	*Scenario*	*Scenario*	*Scenario*	*Scenario*	*Scenario*	*Scenario*	*Scenario*
1		1	1	2			2	1		3

Financial estimate:

	Total	*Breakdown of costs (in EUR, incl. tax)*						Totals (in EUR, incl. tax)	
Configuration	**PEC**	**Investment costs**	**Amount of aid**	**Replacement costs**	**Residual value**	**Operating costs**	**Energy consumption**	**Global cost**	**Financial implications: cost per m²**
Building as is	748	-	-	-	-	-	78,636	78,636	947
Ext. wall insulation	449	18,887	8,048	-	2,329	-	47,153	55,662	671
Scenario 1	344	35,192	11,481	-	4,102	778	36,143	56,530	681
Scenario 2	142	48,033	13,466	4,131	10,162	6,101	14,914	49,550	597
Scenario 3	91	51,873	14,016	5,884	10,754	6,765	9,528	49,280	594

3.3.3 *Detached house, 1975-1985*

PAVILLON 1975 - 1985 — **7,3 % du parc**

ELEMENTS DE TYPOLOGIE	
Type de bâtiment	Maison individuelle
Période constructive	Après 1974
Nombre moyen de logements	1
Nombre de niveaux chauffés	1
Surface chauffée (SHAB)	95 m²
Surface SHON	104 m²
Orientations façade principale	Sud
Mitoyenneté	0%
Plancher bas sur	Vide sanitaire
Situation géographique	Zones rurales ou périphéries de zones urbaines
Surface du logement	95 m²
Hauteur sous plafond	2,5 m
Compacité du bâti	0,73

DESCRIPTION DE L'ENVELOPPE / METRES TYPE

Elements du bâti	Surface (m²)	Description	Résistances R (m².K/W)	Coefficient U (W/m².K)
Toiture - plancher haut	95	Dalle béton 16 cm / 6 cm de laine minérale	0,07 / 1,4	0,60
Façades (toutes orientations)	83	Murs en blocs béton / 2 cm de laine minérale	0,07 / 0,47	1,42
Baies vitrées (en nombre)	?	Menuiseries bois ou PVC avec double vitrage 4/12/4 air	-	2,20
Porte d'entrée (en nombre)	1	Porte pleine bois ancienne	-	4,10
Plancher bas	95	Dalle béton 15 cm / 2 cm de laine minérale sur vide sanitaire	0,7 / 0,47	0,57

Travaux réalisés	Changement des baies vitrées DV

DESCRIPTION DES SYSTEMES

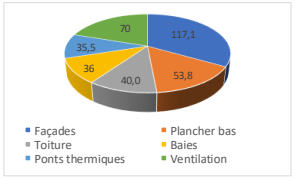
Systèmes	Description
Chauffage	Chaudière gaz basse température 2010-2015 / Radiateurs sans robinets thermostatiques / Réseau individuel (> 65°C) non isolé
Eau Chaude Sanitaire	Instantanée liée au chauffage
Ventilation	VMC simple flux autoréglable
Travaux réalisés	Changement de la chaudière

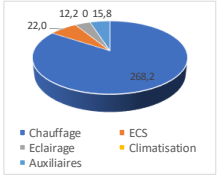
CARACTERISTIQUES ENERGETIQUES

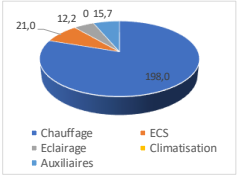
Désignation	Description	Energie utilisée
Part dans le parc français	7,3%	Gaz

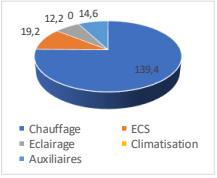
PERFORMANCES

Enveloppe thermique (W/K) Total déperditions = 352 W/K	Consommation énergie primaire (kWhep/m².an) - Zones H1b ; H2b ; H3 - 5 usages		
Ubat = 1,01	Cep H1b = 318,46	Cep H2b = 246,74	Cep H3 = 185,27









DETACHED HOUSE (BUNGALOW), 1975-1985

7.3% of the building stock

	Building type	one-dwelling building
	Construction period	after 1974
	Average number of dwellings	1
	Number of storeys heated	1
	Heated surface (living area)	95 m²
	Net floor area	104 m²
	Orientation of main facade	south-facing
	Party walls	0%
	Ground floor built on	crawl space
	Geographical location	rural or peripheral urban areas
	Surface area of dwelling	95 m²
	Floor-to-ceiling height	2.5 m
	Compactness ratio of the building	0.73

DESCRIPTION OF THE ENVELOPE

Building elements	Surface area in m²	Description	Resistance (R = m².K/W)	Coefficient (U = W/m².K)
Roof - attic floor	95	Concrete slab, 160mm, 60mm mineral wool	0.07 / 1.4	0.60
All external walls	83	Breeze-block walls, 20mm of mineral wool	0.07 /0.47	1.42
Number of windows	?	Wooden or PVC frames with 4-12-4 double glazing, air-filled	-	2.20
Entrance doors (No)	1	Old opaque wooden door	-	4.10
Downstairs floor	95	Concrete slab, 150mm thick, 20mm of mineral wool over crawling space	0.08 / 1.33	0.57

Work performed	Windows replaced with double glazing

DESCRIPTION OF SYSTEMS

Systems	Description
Heating	Low-temperature gas boiler, 2010-2015, radiators without thermostatic valves, individual CH system
Domestic hot water	Instant, linked to heating system
Ventilation	Single-flow controlled mechanical ventilation with automatic setting

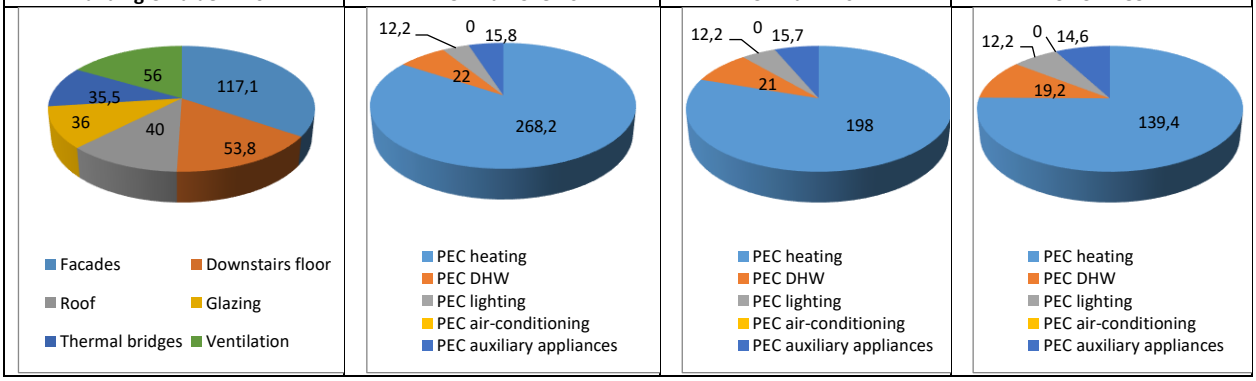
Work performed	Boiler replaced

ENERGY CHARACTERISTICS

Designation	Description	Energy used
Share of French building stock	7.3%	Gas

PERFORMANCE DATA

Thermal envelope (W/K) Total losses = 352 W/K	Annual primary energy consumption (PEC) in kWh/m² - zones H1b, H2b and H3 – 5 uses		
Building U-value = 1.01	PEC H1b = 318.46	PEC H2b = 246.74	PEC H3 = 185.27



Proposed renovation works:

- Glass wool, 240mm thick, blown or laid onto the floor of the lost attic space (R-value = 7.5 m².K/W)
- External rockwool insulation, 160mm thick, rendered over (R-value = 4,4 m².K/W)
- Flocking on the unheated premises, 140mm thick (R-value = 3.0 m²K/W)
- Low-emissivity 4-16-4 double-glazed windows (excluding shutters), Uw-value 1.4 W/m².K / U-value with shutters 1.4 W/m².K

- Condensing storage combination boiler, gas - IdraEco Condens Micro 5000 (Atlantic) – heating and domestic hot water
- Air-source heat pump - AUER HRC70 – heating only
- Installation of thermostatic valves

Scenarios:

External walls		Roof cavity	Floor	Exterior joinery	Heating			Replacement of radiators	Improved regulation	DHW cylinder replacement
Exterior insulation	Interior insulation				Boiler replacement	Conversion to gas	Conversion to heat pump			
Scenario	*Scenario*	*Scenario*	*Scenario*	*Scenario*	*Scenario*	*Scenario*	*Scenario*	*Scenario*	*Scenario*	*Scenario*
1		1	1	2	2		3		2	

Financial estimate:

	Total	*Breakdown of costs (in EUR, incl. tax)*						Totals (in EUR, incl. tax)	
Configuration	**PEC**	**Investment costs**	**Amount of aid**	**Replacement costs**	**Residual value**	**Operating costs**	**Energy consumption**	**Global cost**	**Financial implications: cost per m²**
Building as is	318	-	-	-	-	-	49,004	49,004.03	471
Air-source heating	306	13,200.00	5,506.73	6,776.53	957.60	6,847.65	47,041	67,600.96	650
Windows, roof	257	12,444.00	5,508.97	-	2,824.45	1,205.60	39,684	45,000.59	433
Scenario 1	165	37,094.40	12,108.27	-	4,574.76	-	25,064	45,475.03	437
Scenario 2	120	57,986.40	15,106.73	6,776.53	7,713.67	8,240.00	18,319	68,501.07	659
Scenario 3	112	50,582.40	14,141.27	2,645.22	7,649.58	2,895.72	17,043	51,375.90	494

3.3.4 *Bourgeois buildings*

IMMEUBLES BOURGEOIS — **7,1% du parc**

ELEMENTS DE TYPOLOGIE	
Type de bâtiment	Logement collectif
Période constructive	Avant 1948
Nombre moyen de logements	52
Nombre de niveaux chauffés	7
Surface chauffée (SHAB)	3204 m²
Surface SHON	4005 m²
Orientation façade principale	Nord
Mitoyenneté	50%
Plancher bas sur	Local Non Chauffé ou Commerces
Situation géographique	Zone urbaine : grandes villes
Surface moyenne des logements	62 m²
Hauteur sous plafond	2,5 m
Compacité du bâti	0,52

DESCRIPTION DE L'ENVELOPPE / METRES TYPE

Elements du bâti	Surface (m²)	Description	Résistances R (m².K/W)	Coefficient U (W/m².K)
Toiture - plancher haut	485	Zinc	0,20	2,9
Façades (brisis)	205	Ardoises	0,16	3,0
Façades (courettes)	611	Maçonnerie enduite (brique) / Enduit	0,15	3,1
Façades (sur rue et sur cour)	1768	Pierre de taille	0,33	2,0
Baies vitrées (en nombre)	309	Simple vitrage bois / Double vitrage PVC 4/16/4 argon	-	5,1 / 1,4
Porte d'entrée (en nombre)	52	Porte pleine bois	-	3,50
Plancher bas	510	Planchers métalliques avec voutains en céramique	0,27	2,10 (petit b = 0,2)

Travaux réalisés	Changement des menuiseries

DESCRIPTION DES SYSTEMES

Systèmes	Description
Chauffage	Chaudière gaz standard collective 2013 / Radiateurs sans robinets thermostatiques (appoint avec convecteurs électriques) / Réseau collectif (> 65°C) isolé
Eau Chaude Sanitaire	Ballons ECS électriques individuels / Distribution individuelle sans bouclage
Ventilation	Ventilation naturelle par entrées d'air hautes et basses

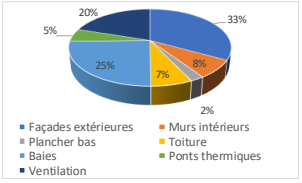
Travaux réalisés	Isolation du réseau collectif, changement de la chaudière gaz collective et changement des ballons ECS électriques individuels

CARACTERISTIQUES ENERGETIQUES

Désignation	Description	Energie utilisée
Part dans le parc français	7,1%	Gaz (collectif) + appoint électricité / ECS électrique

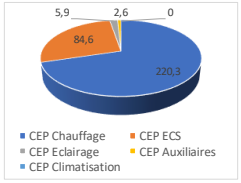
PERFORMANCES

Enveloppe thermique (W/K)
Total déperditions = 13 769 W/K
Ubat = 2,63

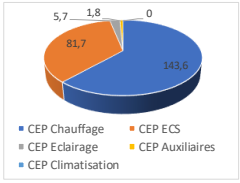


Consommation énergie primaire (kWhep/m².an) - Zones H1b ; H2b ; H3 - 5 usages

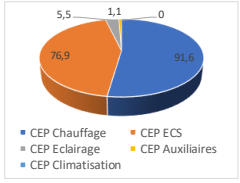
Cep H1b = 313,4



Cep H2b = 232,7



Cep H3 = 175



BOURGEOIS BUILDINGS — 7.1% of the building stock

Building type	multi-dwelling building
Construction period	Before 1948
Average number of dwellings	52
Number of storeys heated	7
Heated surface (living area)	3,204 m²
Net floor area	4,005 m²
Orientation of main facade	north-facing
Party walls	50%
Lowest floor built on	unheated premises or shops
Geographical location	urban areas: cities
Surface area of dwelling	62 m²
Floor-to-ceiling height	2.5 m
Compactness ratio of the building	0.52

DESCRIPTION OF THE ENVELOPE

Building elements	Surface area in m²	Description	Resistance (R = m².K/W)	Coefficient (U = W/m².K)
Roof - attic floor	485	Zinc	0.20	2.9
Facades – roof break	205	Slate	0.16	3.0
Facades – inner courtyard	611	Rendered masonry (brick); plaster coating	0.15	3.1

Building elements	Surface area in m²	Description	Resistance (R = m².K/W)	Coefficient (U = W/m².K)
Facades – street side and rear	1,768	Dressed ashlars	0.33	2.0
Number of windows	309	Single-glazed wooden or PVC with 4-16-4 double glazing, argon-filled	-	5.1 / 1.4
Entrance doors (No)	52	Opaque wooden doors	-	3.50
Downstairs floors	510	Metal-framed floors with ceramic vaulting	0.27	2.10 (small b = 0.2)

Work performed	Replacement of window frames

DESCRIPTION OF SYSTEMS

Systems	Description
Heating	Standard gas communal boiler, 2013 / radiators without thermostatic valves (electric convector heaters as back-up) / stand-alone communal distribution system (>65°C)
Domestic hot water	Individual electric DHW cylinders, individual feed pipes, no loop system
Ventilation	Natural ventilation by means of high and low air inlets

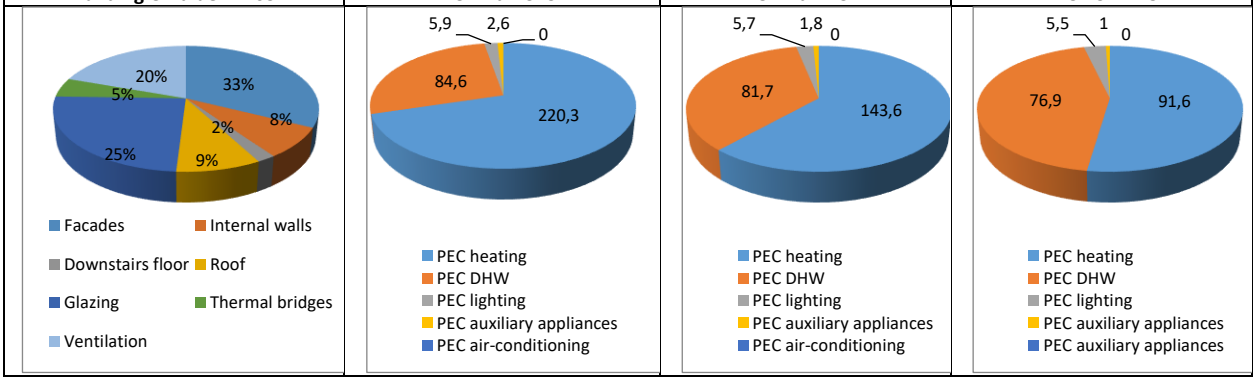
Work performed	Insulation of the communal system, installation of a replacement communal gas boiler and replacement of individual electric DHW cylinders

ENERGY CHARACTERISTICS

Designation	Description	Energy used
Share of French building stock	7.1%	Gas (communal heating) and electricity (back-up heating and DHW))

PERFORMANCE DATA

Thermal envelope (W/K) Total losses = 13,769 W/K	Annual primary energy consumption (PEC) in kWh/m² - zones H1b, H2b and H3 – 5 uses		
Building U-value = 2.63	PEC H1b = 313.4	PEC H2b = 232.7	PEC H3 = 175



Proposed renovation works:

- Internal insulation with 40mm vacuum insulation panels (R-value = 6.1 m².K/W)
- Mineral wool, 300mm thick, on floors of lost attic spaces (R-value = 7.5 m².K/W)
- Rockwool, 140mm thick, on the undersides (R-value = 4.05 m².K/W)
- Low-emissivity 4-16-4 double-glazed windows (excluding shutters), Uw-value 1.4 W/m².K / U-value with shutters 1.4 W/m².K
- Communal gas condensation boiler - Condenseco Atlantic 300 KW – heating only
- Installation of thermostatic valves

Scenarios:

External walls		Roof cavity	Floor	Exterior joinery	Heating			Replacement of radiators	Improved regulation	DHW cylinder replacement
Exterior insulation	Interior insulation				Boiler replacement	Conversion to gas	Conversion to heat pump			
Scenario	*Scenario*	*Scenario*	*Scenario*	*Scenario*	*Scenario*	*Scenario*	*Scenario*	*Scenario*	*Scenario*	*Scenario*
	2	1	2	1	2				2	

Financial estimate:

	Total	Breakdown of costs (in EUR, incl. tax)						Totals (in EUR, incl. tax)	
Configuration	**PEC**	**Investment costs**	**Amount of aid**	**Replacement costs**	**Residual value**	**Operating costs**	**Energy consumption**	**Global cost**	**Financial implications: cost per m²**
Building as is	313	-	-	-	-	-	1,797,331	1,797,330.96	449
Heating	206	84,115.20	41,912.94	38,389.08	12,967.14	21,817.84	1,233,529	1,322,971.21	331
Scenario 1	277	483,239.59	198,831.64	-	146,794.09	81,507.66	1,567,910	1,787,031.62	447
Scenario 2	88	1,708,255.99	529,511.13	38,389.08	296,903.71	114,978.95	525,415	1,560,624.21	390

3.3.5 *Low/mid-rise rectangular blocks, 1948-1974*

BARRES 1948-1974 — **4,6% du parc**

ELEMENTS DE TYPOLOGIE

Type de bâtiment	Logement collectif
Période constructive	1948-1974
Nombre moyen de logements	128
Nombre de niveaux chauffés	5
Surface chauffée (SHAB)	10 516 m²
Surface SHON	12 619 m²
Orientation façade principale	Est
Mitoyenneté	0%
Plancher bas sur	Caves
Situation géographique	Zone urbaine : très grande ville ZUP
Surface moyenne des logements	83 m²
Hauteur sous plafond	2,5 m
Compacité du bâti	0,59

DESCRIPTION DE L'ENVELOPPE / METRES TYPE

Elements du bâti	Surface (m²)	Description	Résistances R (m².K/W)	Coefficient U (W/m².K)
Toiture - plancher haut	2337	Toiture-terrasse dalle béton 20 cm / 8 cm de polyuréthane	0,10 / 2,00	0,44
Façades (toutes orientations)	7465	Béton banché de 18 cm non isolé	0,08	4,02
Baies vitrées (en nombre)	304	Menuiseries métalliques simple vitrage	-	5,50
	475	Menuiseries bois ou PVC avec double vitrage 4/12/4 air	-	2,60
Porte d'entrée (en nombre)	128	Porte pleine bois ancienne	-	3,10
Plancher bas	2337	Dalle béton 20 cm sur Local Non Chauffé / 10 cm de flocage	0,10 / 2,22	0,38

Travaux réalisés	Remplacement de 60% des menuiseries extérieures

DESCRIPTION DES SYSTEMES

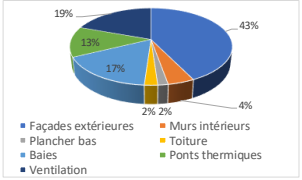
Systèmes	Description
Chauffage	Convecteurs électriques / Pas de réseau de distribution
Eau Chaude Sanitaire	Eau chaude sanitaire individuelle électrique (ballons)
Ventilation	Ventilation naturelle sur conduits SHUNT
Travaux réalisés	Aucuns

CARACTERISTIQUES ENERGETIQUES

Désignation	Description	Energie utilisée
Part dans le parc français	4,6%	Electricité

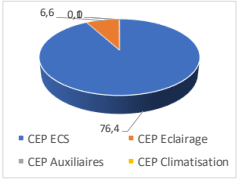
PERFORMANCES

Enveloppe thermique (W/K)
Total déperditions = 46 283 W/K
Ubat = 2,4

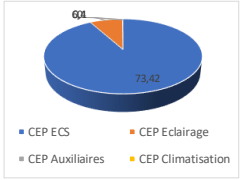


Consommation énergie primaire (kWhep/m².an) - Zones H1b ; H2b ; H3 - 5 usages

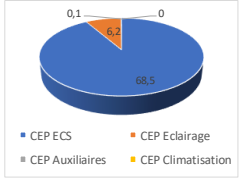
Cep H1b = 572,9



Cep H2b = 384,0



Cep H3 = 267,5



LOW/MID-RISE RECTANGULAR BLOCKS, 1948-1974 — **4.6% of the building stock**

Building type	multi-dwelling building
Construction period	1948-1974
Average number of dwellings	128
Number of storeys heated	5
Heated surface (living area)	10,516 m²
Net floor area	12,619 m²
Orientation of main facade	east-facing
Party walls	0%
Lowest floor built on	cellars
Geographical location	urban areas: large cities, large 1960s estates

	Surface area of dwelling	83 m²
	Floor-to-ceiling height	2.5 m
	Compactness ratio of the building	0.59

DESCRIPTION OF THE ENVELOPE

Building elements	Surface area in m²	Description	Resistance (R = m².K/W)	Coefficient (U = W/m².K)
Roof - attic floor	2,337	Flat roof, 200mm concrete slab, 80mm polyurethane	0.10 / 2.00	0.44
Facades – all sides	7,465	Shuttered concrete, 180mm, not insulated	0.08	4.02
Number of windows	304	Metal frames, single glazing	-	5.50
	475	Wooden or PVC frames with 4-12-4 double glazing, air-filled	-	2.60
Entrance doors (No)	128	Old opaque wooden doors	-	3.10
Downstairs floors	2,337	200mm concrete slab on unheated premises, 100mm layer of flocking	0.10 / 2.22	0.38

Work performed	Replacement of 60% of external window frames

DESCRIPTION OF SYSTEMS

Systems	Description
Heating	Electric convector heaters; no distribution system
Domestic hot water	Individual electric DHW cylinders
Ventilation	Natural ventilation using shunt ducts

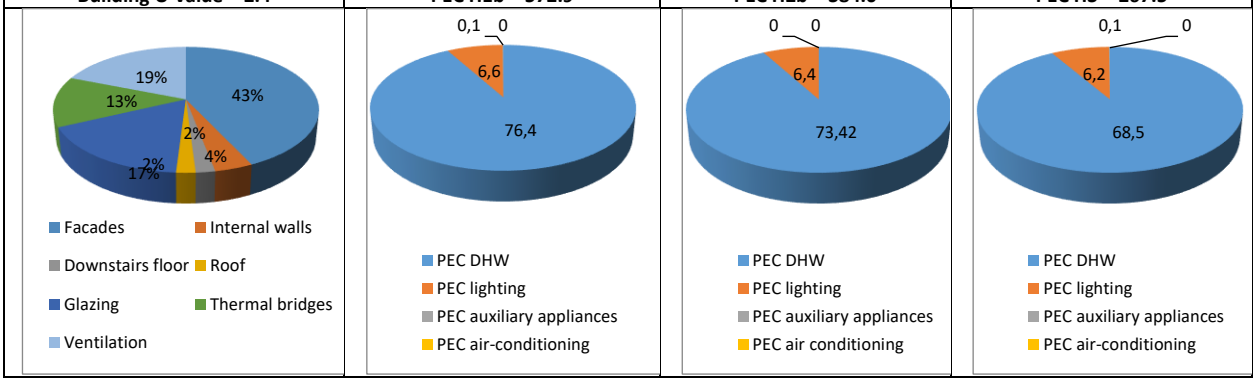
Work performed	None

ENERGY CHARACTERISTICS

Designation	Description	Energy used
Share of French building stock	4.6%	Electricity

PERFORMANCE DATA

Thermal envelope (W/K) Total losses = 46,283 W/K	Annual primary energy consumption (PEC) in kWh/m² - zones H1b, H2b and H3 – 5 uses		
Building U-value = 2.4	PEC H1b = 572.9	PEC H2b = 384.0	PEC H3 = 267.5



Proposed renovation works:

- External rockwool insulation, 160mm thick, rendered over (R-value = 4.4 m².K/W)
- Polyurethane on the flat roof – 180mm (R-value = 7.83 m².K/W)
- Rockwool on undersides – 140mm (R-value = 4.05 m².K/W)
- Low-emissivity 4-16-4 double-glazed windows (excluding shutters), Uw-value 1.4 W/m².K / U-value with shutters 1.4 W/m².K
- Storage radiators with control accuracy of 0.15°C (Thermor Mozart Evolution type)
- Installation of more efficient DHW cylinders and removal of existing cylinders

Scenarios:

External walls		Roof cavity	Floor	Exterior joinery	Heating			Replacement of radiators	Improved regulation	DHW cylinder replacement
Exterior insulation	Interior insulation				Boiler replacement	Conversion to gas	Conversion to heat pump			
Scenario	*Scenario*	*Scenario*	*Scenario*	*Scenario*	*Scenario*	*Scenario*	*Scenario*	*Scenario*	*Scenario*	*Scenario*
1		1	1	1				2		2

Financial estimate:

	Total	*Breakdown of costs (in EUR, incl. tax)*						Totals (in EUR, incl. tax)	
Configuration	**PEC**	**Investment costs**	**Amount of aid**	**Replacement costs**	**Residual value**	**Operating costs**	**Energy consumption**	**Global cost**	**Financial implications: cost per m²**
Building as is	573	-	-	-	-	-	9,156,203	9,156,203	726
Heating and roof insulation	540	1,263,304	501,288	243,783	172,269	92,367	8,630,479	9,556,376	**758**
Scenario 1	242	4, 383,384	1,308,023	-	781,311	225,012	3,870,573	6,389,635	**507**
Scenario 2	**232**	4,919,260	1,381,242	244,567	863,921	317,676	3,700,600	6,936,940	550

3.3.6 *Small apartment building, 1975-1981*

PETITS COLLECTIFS DIVERS 1975-1981 | **2,3% du parc**


ELEMENTS DE TYPOLOGIE	
Type de bâtiment	Logement collectif
Période constructive	Après 1974
Nombre moyen de logements	17
Nombre de niveaux chauffés	6
Surface chauffée (SHAB)	1086 m²
Surface SHON	1195 m²
Orientation façade principale	Ouest
Mitoyenneté	Sur 2 côtés
Plancher bas sur	Extérieur ou sous-sol
Situation géographique	Zone urbaine principalement
Surface moyenne des logements	64 m²
Hauteur sous plafond	2,5 m
Compacité du bâti	0,40

DESCRIPTION DE L'ENVELOPPE / METRES TYPE

Elements du bâti	Surface (m²)	Description	Résistances R (m².K/W)	Coefficient U (W/m².K)
Toiture - plancher haut - Terasse inaccessible	153	Dalle béton 20 cm / 4 cm de polyuréthane	0,1 / 1,6	0,54
Toiture - plancher haut - Terasse privative	37	Dalle béton 20 cm / 4 cm de polyuréthane	0,1 / 1,6	0,54
Façades (toutes orientations) - Mur extérieur	578	Béton 22 cm / 2 cm de laine de verre	0,11 / 0,44	1,40
Façades (Ouest) - Mur brisis	11	Bois 3 cm / 2 cm de laine de verre	0,17 / 0,44	1,30
Mur intérieur sur ascenseur	73	Béton 16 cm	0,08	2,94 (petit b = 0,12)
Mur intérieur sur hall	10	Béton 16 cm	0,08	2,94 (petit b = 0,62)
Mur intérieur sur SAS	14	Béton 16 cm	0,08	2,94 (petit b = 0,43)
Mur intérieur sur rampe parking	25	Béton 16 cm	0,08	2,94
Baies vitrées (en nombre)	76	Menuiseries PVC avec double vitrage 4/10/4 air	-	2,70
Porte d'entrée (en nombre)	17	Porte pleine bois	-	3,10
Plancher bas sur sous-sol	149	Dalle béton 20 cm / 2 cm de flocage	0,1 / 0,44	1,14 (petit b = 1)
Plancher bas sur hall	13	Dalle béton 20 cm / 2 cm de flocage	0,1 / 0,44	1,14 (petit b = 0,62)
Plancher bas sur SAS	6	Dalle béton 20 cm / 2 cm de flocage	0,1 / 0,44	1,14 (petit b = 0,43)
Plancher bas sur extérieur	28	Dalle béton 20 cm / 2 cm de flocage	0,1 / 0,44	1,34

Travaux réalisés	Changement des menuiseries

DESCRIPTION DES SYSTEMES

Systèmes	Description
Chauffage	Convecteurs électriques anciens / Pas de réseau de distribution
Eau Chaude Sanitaire	Eau Chaude Sanitaire individuelle Electrique (ballons)
Ventilation	Ventilation simple flux autoréglable

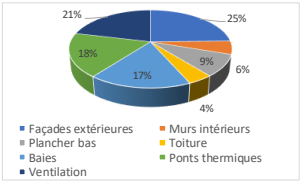
Travaux réalisés	Aucuns

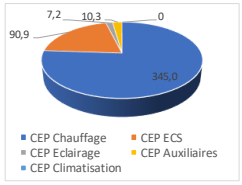
CARACTERISTIQUES ENERGETIQUES

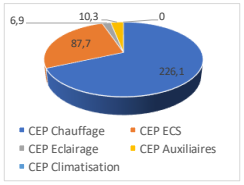
Désignation	Description	Energie utilisée
Part dans le parc français	2,3%	Electricité

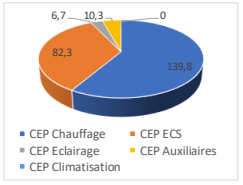
PERFORMANCES

Enveloppe thermique (W/K) Total déperditions = 2 457 W/K	Consommation énergie primaire (kWhep/m².an) - Zones H1b ; H2b ; H3 - 5 usages		
Ubat = 1,76	Cep H1b = 453,4	Cep H2b = 331,0	Cep H3 = 239,0









MISCELLANEOUS SMALL APARTMENT BUILDINGS, 1975-1981 — 2.3% of the building stock

	Building type	multi-dwelling building
	Construction period	After 1974
	Average number of dwellings	17
	Number of storeys heated	6
	Heated surface (living area)	1,086 m²
	Net floor area	1,195 m²
	Orientation of main facade	west-facing
	Party walls	0%
	Lowest floor built on	exterior or basement
	Geographical location	mainly urban areas
	Surface area of dwelling	64 m²
	Floor-to-ceiling height	2.5 m
	Compactness ratio of the building	0.40

DESCRIPTION OF THE ENVELOPE

Building elements	Surface area in m²	Description	Resistance (R = m².K/W)	Coefficient (U = W/m².K)
Roof - attic floor – inaccessible roof deck	153	Flat roof, 200mm concrete slab, 40mm polyurethane	0.1 / 1.6	0.54
Roof – attic floor – roof terrace with private access	37	Flat roof, 200mm concrete slab, 40mm polyurethane	0.1 / 1.6	0.54
Facades – all sides, external walls	578	Concrete, 220mm; glass wool, 20mm	0.11 / 0.44	1.40
West facade – wall break	11	Wood, 30mm; glass wool 20mm	0.17 / 0.44	1.30
Internal wall – lift shaft	73	Concrete, 160mm	0.08	2.94 (small b = 0.12
Internal wall - lobby	10	Concrete, 160mm	0.08	2.94 (small b= 0.62)
Internal wall - airlock	14	Concrete, 160mm	0.08	2.94 (small b= 0.43)
Internal wall – garage access ramp	25	Concrete, 160mm	0.08	2.94
Number of windows	76	PVC frames with 4-10-4 double glazing, air-filled	-	2.70
Entrance doors (No)	17	Opaque wooden doors	-	3.10
Floor above basement	149	200mm concrete slab / 20mm layer of flocking	0.1 / 0.44	1.14 (small b = 1)
Floor above lobby	13	200mm concrete slab / 20mm layer of flocking	0.1 / 0.44	1.14 (small b= 0.62)
Floor above airlock	6	200mm concrete slab / 20mm layer of flocking	0.1 / 0.44	1.14 (small b= 0.43)
Floor above exterior	28	200mm concrete slab / 20mm layer of flocking	0.1 / 0.44	1.34

Work performed	Replacement of window frames

DESCRIPTION OF SYSTEMS

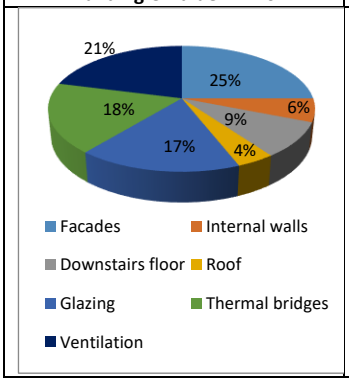
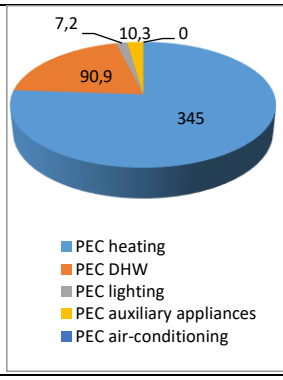
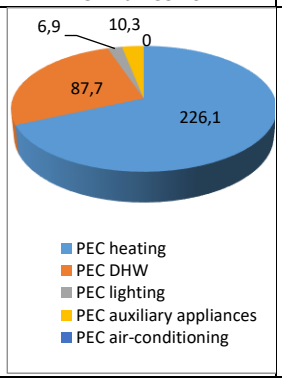
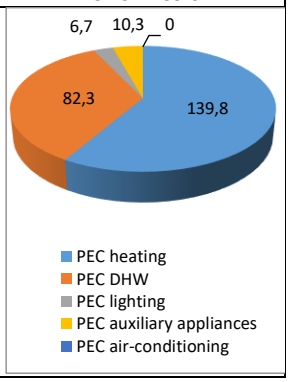
Systems	Description
Heating	Old electric convector heaters; no distribution system
Domestic hot water	Individual electric DHW cylinders
Ventilation	Auto-adjustable single-flow ventilation

Work performed	None

ENERGY CHARACTERISTICS

Designation	Description	Energy used
Share of French building stock	2.3%	Electricity

PERFORMANCE DATA

Thermal envelope (W/K) Total losses = 2,457 W/K	Annual primary energy consumption (PEC) in kWh/m² - zones H1b, H2b and H3 – 5 uses		
Building U-value = 1.76	**PEC H1b = 453.4**	**PEC H2b = 331.0**	**PEC H3 = 239.0**
			

Proposed renovation works:

- External rockwool insulation, 160mm thick, rendered over (R-value = 4.4 m².K/W)
- Polyurethane on the flat roof – 180mm (R-value = 7.83 m².K/W)
- Rockwool on undersides – 140mm (R-value = 4.05 m².K/W)
- Low-emissivity 4-16-4 double-glazed windows (excluding shutters), Uw-value 1.4 W/m².K / U-value with shutters 1.4 W/m².K
- Storage radiators with control accuracy of 0.15°C (Thermor Mozart Evolution type)
- Installation of more efficient DHW cylinders and removal of existing cylinders
- Communal AUER HRC 70 (4 x 35 kW in a cascade system) for heating and DHW

Scenarios:

External walls		Roof cavity	Floor	Exterior joinery	Heating			Replacement of radiators	Improved regulation	DHW cylinder replacement
Exterior insulation	Interior insulation				Boiler replacement	Conversion to gas	Conversion to heat pump			
Scenario	*Scenario*	*Scenario*	*Scenario*	*Scenario*	*Scenario*	*Scenario*	*Scenario*	*Scenario*	*Scenario*	*Scenario*
1		1	1	1			3	2		2

Financial estimate:

	Total	*Breakdown of costs (in EUR, incl. tax)*						Totals (in EUR, incl. tax)	
Configuration	**PEC**	**Investment costs**	**Amount of aid**	**Replacement costs**	**Residual value**	**Operating costs**	**Energy consumption**	**Global cost**	**Financial implications: cost per m²**
Building as is	453	-	-	-	-	-	686,107	686,107	574
Windows, roof	416	152,453	61,185	-	36,038	16,112	630,043	701,385	587
Walls	313	139,465	58,993	-	17,200	-	473,067	536,339	449
Scenario 1	240	315,395	113,179	-	56,133	16,112	362,382	524,576	439
Scenario 2	206	388,794	123,173	33,498	67,448	28,804	311,200	571,674	478
Scenario 3	143	315,395	118,004	920	56,133	16,111	216,666	374,036	313

3.3.7 *Large office building*

GRAND BUREAU

ELEMENTS DE TYPOLOGIE	
Type de bâtiment	Immeuble de bureau
Période constructive	1976
Nombre de niveaux chauffés	5
Surface SHON	5042 m²
Orientations façade principale	Sud
Mitoyenneté	0%
Plancher bas sur	Vide sanitaire
Situation géographique	Périphérie urbaine
Hauteur sous plafond	3 m

DESCRIPTION DE L'ENVELOPPE / METRES TYPE

Elements du bâti	Surface (m²)	Description	Résistances R (m².K/W)	Coefficient U (W/m².K)
Toiture - plancher haut	1403	Toiture terrasse : dalle de béton de 20 cm sans isolation	2,40	0,42
Façades (toutes orientations)	2048	béton préfabriqué d'épaisseur 25 cm sans isolation	3,11	0,32
Baies vitrées	869	PVC simple vitrage	-	4,70
Plancher bas	1403	Dalle béton non isolée de 20 cm sur local non chauffé	2,40	0,42

Travaux réalisés	/

DESCRIPTION DES SYSTEMES

Systèmes	Description
Chauffage	deux chaudières collectives au gaz de 1976, radiateurs à eau
Eclairage	Tubes fluo-compacts de 18W
Ventilation	VMC simple flux auto réglable

Travaux réalisés	/

CARACTERISTIQUES ENERGETIQUES

Energie utilisée
Gaz

PERFORMANCES

Enveloppe thermique	Consommation énergie primaire (kWhep/m².an) - Zones H1b ; H2b ; H3 - 5 usages		
Ubat = 1,03	Cep H1b = 244,5	Cep H2b = 162,6	Cep H3 = 112,3

LARGE OFFICE BUILDING

	Building type	office building
	Construction period	1976
	Number of storeys heated	5
	Net floor area	5,042 m²
	Orientation of main facade	south-facing
	Party walls	0%
	Lowest floor built on	crawling space
	Geographical location	urban periphery
	Floor-to-ceiling height	3 m

DESCRIPTION OF THE ENVELOPE

Building elements	Surface area in m²	Description	Resistance (R = m².K/W)	Coefficient (U = W/m².K)
Roof - attic floor	1,403	Flat roof, 200mm concrete slab without insulation	2.40	0.42
Facades – all sides	2,048	Precast concrete panels, 250mm thick, without insulation	3.11	0.32
Windows	869	PVC, single glazing	-	4.70
Downstairs floors	1,403	Uninsulated 200mm concrete slab over unheated premises	2.40	0.42

Work performed	None

DESCRIPTION OF SYSTEMS

Systems	Description
Heating	Two communal gas boilers dating from 1976, water-filled radiators
Lighting	18w compact fluorescent tubes
Ventilation	Auto-adjustable single-flow ventilation

Work performed	None

ENERGY CHARACTERISTICS

Energy used
Gas

PERFORMANCE DATA

Thermal envelope (W/K)	Annual primary energy consumption (PEC) in kWh/m² - zones H1b, H2b and H3 – 5 uses		
Building U-value = 1.03	PEC H1b = 244.5	PEC H2b = 162.6	PEC H3 = 112.3

Proposed renovation works:

- External rockwool insulation, 160mm thick, rendered over (R-value = 4.4 m².K/W)
- Polyurethane on the flat roof – 180mm (R-value = 7.83 m².K/W)
- Rockwool on undersides – 140mm (R-value = 4.05 m².K/W)
- Low-emissivity 4-12-4 double-glazed windows (excluding shutters), argon-filled, Uw-value 2.3 W/m².K / U-value with shutters 2.1 W/m².K
- Communal gas condensation boiler – Atlantic Condenseco 145 KW – heating and hot water
- Communal AUER HRC 70 (4 x 35 kW in a cascade system) for heating and hot water
- Installation of thermostatic valves

Scenarios:

External walls		Roof cavity	Floor	Exterior joinery	Heating			Replacement of radiators	Improved regulation	DHW cylinder replacement
Exterior insulation	Interior insulation				Boiler replacement	Conversion to gas	Conversion to heat pump			
Scenario	*Scenario*	*Scenario*	*Scenario*	*Scenario*	*Scenario*	*Scenario*	*Scenario*	*Scenario*	*Scenario*	*Scenario*
2		1	2	1	2		3		1	

Financial estimate:

	Total	*Breakdown of costs (in EUR, incl. tax)*						Totals (in EUR, incl. tax)	
Configuration	**PEC**	**Investment costs**	**Amount of aid**	**Replacement costs**	**Residual value**	**Operating costs**	**Energy consumption**	**Global cost**	**Financial implications: cost per m²**
Building as is	245	-	-	-	-	-	1,765,816	1,765,816	350
Scenario 1	221	678,179	18,371	-	125,527	59,325	1,568,886	2,162,492	429
Scenario 2	133	1,535,352	67,238	93,010	237,523	112,186	906,277	2,342,063	464
Scenario 3	101	1,612,356	70,954	128,153	249,394	132,159	661,201	2,213,522	439

3.3.8 *Lower secondary school*

COLLEGE

ELEMENTS DE TYPOLOGIE	
Type de bâtiment	Bâtiment scolaire
Période constructive	1970
Nombre de niveaux chauffés	3
Surface SHON	3045 m²
Orientations façade principale	Sud
Mitoyenneté	0%
Plancher bas sur	Vide sanitaire
Situation géographique	Ville
Hauteur sous plafond	2,80 m

DESCRIPTION DE L'ENVELOPPE / METRES TYPE

Elements du bâti	Surface (m²)	Description	Résistances R (m².K/W)	Coefficient U (W/m².K)
Toiture - plancher haut	2085	Toiture terrasse : dalle de béton de 20 cm sans isolation	2,44	0,41
Façades (toutes orientations)	1513	béton préfabriqué d'épaisseur 20 cm sans isolation	2,70	0,37
Baies vitrées	550	PVC simple vitrage	-	5,55
Plancher bas	2085	Dalle béton non isolée de 20 cm sur local non chauffé	3,45	0,29

Travaux réalisés	/

DESCRIPTION DES SYSTEMES

Systèmes	Description
Chauffage	deux chaudières collectives au gaz
Eclairage	Tubes fluo-compacts de 18W
Ventilation	Ventilation naturelle

Travaux réalisés	/

CARACTERISTIQUES ENERGETIQUES

Energie utilisée
Gaz

PERFORMANCES

Enveloppe thermique	Consommation énergie primaire (kWhep/m².an) - Zones H1b ; H2b ; H3 - 5 usages		
Ubat = 0,81	Cep H1b = 520	Cep H2b = 358	Cep H3 = 236

LOWER SECONDARY SCHOOL (*COLLÈGE*)

Building type	school building
Construction period	1970
Number of storeys heated	3
Net floor area	3,045 m²
Orientation of main facade	south-facing
Party walls	0%
Lowest floor built on	crawling space
Geographical location	urban location
Floor-to-ceiling height	2.80 m

DESCRIPTION OF THE ENVELOPE

Building elements	Surface area in m²	Description	Resistance (R = m².K/W)	Coefficient (U = W/m².K)
Roof - attic floor	2,085	Flat roof, 200mm concrete slab without insulation	2.44	0.41
Facades – all sides	1,513	Precast concrete panels, 200mm thick, without insulation	2.70	0.37
Windows	550	PVC, single glazing	-	5.55
Downstairs floors	2,085	Uninsulated 200mm concrete slab over unheated premises	3.45	0.29

Work performed	None

DESCRIPTION OF SYSTEMS

Systems	Description
Heating	Two communal gas boilers
Lighting	18w compact fluorescent tubes
Ventilation	Natural ventilation

Work performed	None

ENERGY CHARACTERISTICS

Energy used
Gas

PERFORMANCE DATA

Thermal envelope (W/K)	Annual primary energy consumption (PEC) in kWh/m² - zones H1b, H2b and H3 – 5 uses		
Building U-value = 0.81	PEC H1b = 520	PEC H2b = 358	PEC H3 = 236

Proposed renovation works:

- External rockwool insulation, 160mm thick, rendered over (R-value = 4.4 m².K/W)
- Polyurethane on the flat roof – 180mm (R-value = 7.83 m².K/W)
- Rockwool on undersides – 140mm (R-value = 4.05 m².K/W)
- Low-emissivity 4-12-4 double-glazed windows (excluding shutters), argon-filled, Uw-value 2.3 W/m².K / U-value with shutters 2.1 W/m².K
- Communal gas condensation boiler – Atlantic Condenseco 145 KW – heating and hot water
- Communal AUER HRC 70 (4 x 35 kW in a cascade system) for heating and hot water
- Installation of thermostatic valves

Scenarios:

External walls		Roof cavity	Floor	Exterior joinery	Heating			Replacement of radiators	Improved regulation	DHW cylinder replacement
Exterior insulation	Interior insulation				Boiler replacement	Conversion to gas	Conversion to heat pump			
Scenario	*Scenario*	*Scenario*	*Scenario*	*Scenario*	*Scenario*	*Scenario*	*Scenario*	*Scenario*	*Scenario*	*Scenario*
2		1	1	1	1		3		1	

Financial estimate:

	Total	*Breakdown of costs (in EUR, incl. tax)*						Totals (in EUR, incl. tax)	
Configuration	**PEC**	**Investment costs**	**Amount of aid**	**Replacement costs**	**Residual value**	**Operating costs**	**Energy consumption**	**Global cost**	**Financial implications: cost per m²**
Building as is	520	-	-	-	-	-	2,353,736.02	2,353,736	773
Scenario 1	268	1,230,505	18,548	93,015	186,929	82,750	1,193,673.03	2,364,466	777
Scenario 2	65	1,751,343	63,527	157,484	255,518	119,228	261,777.85	1,970,789	647
Scenario 3	46	1,611,951	64,783	93,867	234,029	83,072	177,416.31	1,667,495	548

3.4 Conclusion

3.4.1 *Conclusion on cost-effective approaches to renovation*

The analysis of the global cost of renovating the various reference buildings demonstrates the profitability of the suggested renovation scenarios.[22] In the assumed macroeconomic conditions, all of the residential buildings have cost-optimal scenarios for the enhancement or maximisation of energy efficiency.

The analysis of the diverse building typologies enables us to draw several conclusions:

(1) There is no standard cluster of works which would be ideal for all building types.

The variety of construction periods, of energy carriers, of energy consumption levels prior to renovation and of levels of effectiveness of interventions compel us to work on a case-by-case basis to propose one or more scenarios that will reduce energy consumption while minimising investment costs.

Identical works on different building types may result in different performance levels. Nevertheless, there is an efficient solution for every building under all of the headings under examination, in spite of the limitations outlined above.

(2) Renovation incentives serve to reduce investment substantially and are a key asset in ensuring maximum cost-effectiveness of renovation works.

In the assumed conditions, the incentives on offer make several of the works scenarios more cost-effective than the *status quo*. Renovation incentives are therefore essential at the present time as the economic catalyst for the initiation of renovation works.

The amounts of such aid are substantial and cover up to 50% of the cost of the works in the modelled scenarios. The above-mentioned limitation resulting from the capping of the CITE will be removed for low-income households in 2020 then for all households in 2021, when the CITE will be changed into a lump-sum grant and aid ceilings for households will be raised.

It should be noted that other financial incentives exist in addition to those that have been taken into account in this simulation. The National Housing Agency (*Agence Nationale de l'Habitat - ANAH*) distributes aid payments intended for households living in poverty. Some banks also distribute interest-free eco-loans to finance the residual cost of renovation works. This loan provides extra support by eliminating interest charges for households lacking the resources to fund renovation works. Details of these incentives is available in the chapter below on *Policies and measures in support of building renovation*.

3.4.1 *Limitations of the exercise*

The approach presented in this chapter imposes a number of limitations. In order to compare the proposed renovation scenarios for a building as its stands, the model does not take account of replacement and operating costs that will be incurred if the building is not renovated. This is an important limitation in the sense that the heating and hot-water systems of the building will almost certainly have to be replaced within the life cycle under examination.

The characterisation of those systems, however, is by no means straightforward. The age of the installed systems is unknown and may vary from one building to another, depending on the date of installation of the systems.

[22] Apart from the office building, for which none of the proposed scenarios seems profitable in relation to the *status quo*. This problem, however, is due to the limitations described above. In fact, the major investment options set out in the scenarios cannot be compared in practice with the 'building as is' scenario, for which the investment cost is zero. The lifespan of the systems installed in the unrenovated building does not exceed the period covered by the analysis. What is more, the maintenance of the building will necessitate work on the facade or the roof, into which measures to enhance energy efficiency can be embedded at less expense. The manager of a property will only take into account the additional expense and the resulting increase in the value of the property. In the light of this assessment, the works may turn out to be profitable. Modelling on the basis of the Cost-Optimal tool cannot simulate to this level of detail.

This limitation is conducive to the *status quo*, because it reduces the global consumption cost for the building in its present state, whereas the installation of more efficient systems gives rise to investment and replacement and operating costs.

The residual value in the calculation of global cost, moreover, takes account only of the new systems that have been installed and not the entirety of the use of the asset. This line of approach does not allow the value of a property to be recorded on the basis of its state of upkeep. In the case studies, the unrenovated building is 'left to rot', and its market value would be far below that of the same building that had undergone the maintenance work from which energy renovation works ensue, such as the refurbishment of facades, the maintenance of flat roofs or the replacement of windows.

The modelled scenarios are based on the assumption that all of the works are carried out in year 0. This assumption minimises the energy consumption of the renovated buildings but also the amount of energy transition tax credit (CITE) that is granted, because the tax credit is capped at EUR 4,800 per household (in the case of a couple with no children). Some of the scenarios could be improved by considering the option of spreading the benefit of a CITE over two or more periods. The modelling tool, however, did not allow that calculation.

The profitability of the scenarios depends on the defined macroeconomic parameters. For example, a sharpish increase in energy prices might enhance the relative profitability of clusters of deep renovation works. A lower discount rate would also favour long-term savings. Conversely, in a shorter-term approach with a high discount rate, large investments would be penalised.

Lastly, it should be remembered that this analysis relates to the stock of privately owned residential buildings and tertiary-sector buildings and does not cover the stock of publicly owned housing, particularly social housing. The macroeconomic parameters are different for that stock, for which discount rates are lower and funds can be borrowed over longer terms, etc. The policies adopted for the stock of social housing, which are described later in this document, serve to ensure the achievement of the renovation objectives for those buildings.

4 POLICIES AND MEASURES IN SUPPORT OF BUILDING RENOVATION

The purpose of this chapter is to outline all of the public policies that have been adopted to stimulate the renovation of buildings to high standards of energy efficiency (Articles 2a(c), (d), (e) and (f) EPBD).

Through the Grenelle Environment Round Table and the subsequent Grenelle Acts of 2009 and 2010, followed by new laws adopted by Parliament in 2015, 2018 and 2019, firm commitments have been made to reduce the energy consumption of buildings and their emissions of greenhouse gases, and France has adopted robust and coordinated public policies to encourage the energy renovation of the entire national building stock.

In this chapter, the intervention mechanisms of the various policies pursued by France will be examined in sequence:

- first of all, the thermal regulations enacted for existing buildings, which set a minimum level of thermal performance for renovation works;
- then the specific mechanisms for providing households with information, advice and support and the assistance made available to individuals to help them finance the renovation of their homes;
- the initiatives taken to enhance the professionalism of the building trades;
- the initiatives taken to encourage local authorities to support and implement public policies on energy renovation in their respective territories;
- the mechanism, which remains unique in Europe, requiring owners of buildings in the tertiary sector to achieve graduated energy-saving targets by 2030, 2040 and 2050;
- lastly, in a final section, the methods used to evaluate the results of these policies and the establishment of a national energy renovation observatory.

The number of these measures and the link that exists between energy renovation and other policy areas, such as housing, economics, social welfare and data-processing, made it necessary to reflect on governance in this field. To meet this need for a cross-cutting approach, an interdepartmental coordination team on the energy renovation of buildings was appointed in the summer of 2019 to structure all of the administrative bodies involved in implementing the Plan for the Energy Renovation of Buildings. Operating with the support of the ministries responsible for the environment and housing, on the basis of the Sustainable Building Plan and with the aid of its own networks, the team has a mandate to remove obstacles to the success of the building renovation policy and to ensure that the measures presented below are implemented efficiently and effectively.

4.1 Encouraging deep renovations, staged if necessary

General renovation is the subject of an instrument known as the *RT globale*, or Thermal Regulations for General Renovations, which sets requirements in the form of attainment targets. Its applicability is subject to certain criteria, which are enumerated below. Besides the rules on general renovations, in cases involving the installation or replacement of one element of a building – fitting insulation or a window or changing a boiler – the Regulations define minimum performance standards for the new element.

In addition, labelling and incentive schemes have been developed nationally and regionally to supplement these requirements and encourage contracting bodies to follow the right path.

4.1.1 *Scope*

The statutory order of 13 June 2008[23] on the energy performance of existing buildings larger than 1,000 square metres in surface area undergoing major renovation works defines the applicable regulatory requirements and

[23] Text available in French at https://www.legifrance.gouv.fr/affichTexte.do?cidTexte=JORFTEXT000019308241

the level of performance to be achieved to meet the requirements of the Thermal Regulations for General Renovations.

The Thermal Regulations for General Renovations apply to residential and tertiary-sector buildings that satisfy each of the following three conditions:

- their net floor area (NFA) must exceed 1,000 m² ,
- the completion date of the building must be later than 1 January 1948, and
- the cost of thermal renovation works that the client intends to order must exceed 25% of the value of the building, excluding land, which corresponded, as of 1 January 2017, to EUR 382.50 per m², excl. tax, for residential properties and EUR 326.25 per m², excl. tax, for non-residential properties.

To verify compliance with this last condition, the client compares the following two amounts:

- the estimated cost of the work on the building envelop and systems; the estimated amount corresponds to the cost of the works that are envisaged for the coming two years; it also covers the cost of removal, supply and installation and the cost of compliance with any obligations to which the works may be subject;
- the value of the building, excluding land, which is determined on the basis of a fixed amount per square metre laid down by a statutory order of 20 December 2007 and updated every year.

This comparison is made before submission of the application for a building warrant or works permit.

4.1.2 *Requirements to be met*

Where a project is subject to the Thermal Regulations for General Renovations, the client, before applying for the building warrant, must conduct a technical and economic feasibility study of the various energy-supply options for the building. He must also comply with various requirements relating to the thermal performance of the renovated building, which are described below. Compliance is demonstrated by means of a statutory calculation with the aid of a software package equipped with the calculation engine Th-CE ex.

4.1.2.1 Assessment of the initial state of the building

A calculation is performed to estimate the initial energy consumption of the building. The calculation serves to assess the initial performance of the building, to guide renovation decisions and to estimate how much energy the proposed works are likely to save in relation to the present situation.

4.1.2.2 Energy savings

Following completion of the works, the global energy consumption of the building for heating, hot water, cooling, auxiliary appliances and lighting must be lower than the reference consumption figure for that building. The latter figure corresponds to the energy that the same building would consume on the basis of the stipulated performance data for its constituent structures and equipment.

The Regulations therefore give the designer the option of using items of equipment or materials with a lower performance level than the reference standard, subject to safeguards and provided that the other equipment and materials outperform the reference items.

In the case of existing buildings, this flexibility serves in particular to overcome constraints connected with the architecture or initial design of the building. For example, the impossibility of insulating a floor or to use particular efficient heating systems can be offset by extra work on another part of the building.

In addition to this requirement, the following provisions also apply:

For housing, the Regulations introduce a maximum consumption value. This means that energy consumption for a residential building with renovated heating, cooling and domestic hot water systems should be lower than a

maximum level, which is determined by the form of heating and the climate. This consumption limit varies between 80 to 165 kWh/m² a year from case to case.

For non-residential buildings, renovation works should result in a 30% gain in energy efficiency from the pre-renovation level.

4.1.2.3 Summer comfort

In order to limit occupants' discomfort and the use of air-conditioning, renovated buildings should ensure an acceptable level of comfort in summer in so far as the existing building structure permits.

The pre-set indoor temperature must therefore be lower than a reference temperature.

4.1.2.4 Safeguards

Minimum performance standards are prescribed for a number of elements, such as insulation, ventilation and the heating system, when they have been altered by renovation works.

4.1.3 *Renovation to low-energy building (BBC) standard*

The concept of renovation to BBC (*bâtiment basse consommation*) standard has existed in the statute book since 2009. It was introduced by the statutory order of 29 September 2009 on the content and award criteria of the 'high energy performance – renovation' label.[24]

The *BBC-Effinergie rénovation* label created by the Effinergie association[25] prefigured this concept. Since 2006, the Effinergie association has been bringing together stakeholders from diverse backgrounds to lend impetus to the drive for energy efficiency in newly constructed and renovated buildings. It actively supports the promotion of comfort and eco-friendliness in new and renovated buildings.

The *BBC-Effinergie rénovation* label encompasses the project in its entirety and targets an annual energy performance level of 80 kilowatt hours of primary energy per square metre. It leaves project participants to choose their own technical solutions. They can pursue various complementary objectives – architectural, economic or aesthetic qualities, simplicity of design or execution, propagation. The label is formulated on the basis of the Thermal Regulations and adds specific requirements to the substance of the statutory order of 2009.

It is awarded by certification bodies accredited by Cofrac, the French Accreditation Committee, which have signed a special agreement with the French Government and Effinergie. In a parallel move, in order to support this approach on a regional scale, regional authorities that are members of the Effinergie association have incorporated the criteria for the *BBC-Effinergie rénovation* label into their regional calls for projects. They make the payment of public support funds dependent on the planning and/or implementation of low-energy renovation works.

4.1.3.1 The BBC renovations market

According to the Effinergie association,[26] 190,000 dwellings have been renovated to low-energy building standard over ten years. The vast majority of the dwellings that have obtained the label – 98% – are apartments. An upward trend has been observed since 2013. In 2018, more than 30,000 dwellings were renovated to low-energy building standards.

[24] The French text is available at https://www.legifrance.gouv.fr/affichTexte.do?cidTexte=JORFTEXT000021089668

[25] The elements of this part of the strategy are taken from a study conducted by Effinergie, Pouget Consultants and Eireno in response to a call for research projects published by ADEME. For more information (in French), see the Effinergie website at https://www.effinergie.org/web/bbc-par-etapes

[26] Fuller information (in French) can be found in the scoreboards (*tableaux de bord*) of Effinergie's BBC Observatory at https://www.observatoirebbc.org/publications/tableaux-de-bord.

In the tertiary sector, 455 operations, covering a total surface area of 3.7 million square metres, have been initiated under the BBC labelling scheme. Most of these investments have been made by the private sector – 87% of the operations, the majority of which are focused on the renovation of office buildings. The renovation efforts of public contracting authorities have been concentrated on education buildings and on office buildings with smaller surface areas.

At the same time, it is estimated that 60,000 apartments as well as more than 1,000 single-dwelling houses have been renovated under regional support programmes for low-energy renovation.

The following are the main obstacles to the growth of low-energy renovation:

- a large financial investment (EUR 40 to 50k) is needed to achieve BBC level in a single step;
- it is difficult for clients to identify the incentives that are available to fund their projects;
- it is difficult for clients to identify trained and qualified specialists who can act as site manager for all of the renovation works;
- the definition of renovation focuses on the aspect of deep renovations, whereas the great majority of current renovations are partial;
- there is no turnkey package on offer that covers the financial, insurance, professional and technical components of renovation works.

The development of third-party financing companies, such as Oktave in the Grand Est region and the models created in the regions of Normandy and Burgundy-Franche Comté to structure stakeholder activities are designed to overcome this absence of structured packages.

4.1.3.2 BBC in stages[27]

With the publication of PREB, the Plan for the Energy Renovation of Buildings, the concept of BBC-compatible works has been given a higher profile, and efforts are now being made to formulate a precise definition, particularly through the National Energy Renovation Observatory. All stakeholders are demonstrating growing interest in this concept. Two concepts are often assimilated, although their meanings differ, namely 'BBC-compatible' and 'BBC in stages'.

BBC-compatible works

The concept of 'BBC-compatible' works relates to each individual lot of works – wall insulation, roof insulation, ventilation, etc. It guarantees that the level of requirement defined for each lot is consistent with the achievement of the BBC renovation label once all of the works have been carried out.

This guarantee is valid whether the deep renovation is carried out in one or in several stages. The concept of BBC-compatible renovation work, in other words, is not solely associated with a staged renovation. It may also be used in the case of a single complete renovation.

Lastly, being BBC-compatible does not only mean that works have achieved a target outcome, such as the resistance of a wall, floor or ceiling or the thickness of an insulation layer, but can also refer to compliance with methodological requirements, such as the installation of a vapour barrier or the nomination of a person responsible for overseeing draughtproofing on site.

BBC works in stages

The concept of working towards the BBC label in stages is associated with the definition of a route map setting out an overall strategy culminating in the eventual achievement of low-energy building status. It is a credible alternative to a single deep renovation.

[27] The information here is taken from Effinergie, *Le BBC par étapes – Etat des lieux des initiatives*, available at https://www.effinergie.org/web/bbc-par-etapes

Numerous initiatives operated by regional or local government or supported by the public authorities have been launched to promote renovations for the achievement of low-energy building status in one or more stages.[28]

Effinergie lists the following:

- the Energy Efficiency Passport, operated by the Experience P2E association; it supports any individual who wishes to embark on a staged renovation with the aim of achieving low-energy building status by 2050;
- the *123 rénovation* project of the Provence-Alpes-Côte d'Azur region, the aim of which is to quarter greenhouse-gas emissions and energy consumption by 2050; it was created as part of the European MARIE project;
- the Effilogis support programme, run by the Burgundy-Franche Comté region, for the BBC renovation of one-dwelling houses; it is intended for low-income household and aims to support the development of tradespersons' skills;
- the Oktave programme, an independent service, initially piloted by the Grand Est region, which provides support and guidance for complete or phased renovation projects; the ADEME study focuses only on staged renovation;
- *Efficacité Energétique des bâtiments – Rénovations globales ou BBC compatibles* ('Energy efficiency of buildings – full or BBC-compatible renovations'), a programme offered by the Territorial Collectivity of Corsica to promote effective energy renovation of buildings with the highest energy consumption rates.

4.1.4 *Renovation obligations for housing with excessive consumption*

The Energy and Climate Act, promulgated on 8 November 2019, has introduced new rules and obligations:

- Entitlement to apply the mechanisms for revising and reassessing rents will soon be conditional on the performance of energy renovation work that lifts dwellings out of the category of 'thermal sieves', a term used in France to denote dwellings with excessive energy consumption, by 1 January 2021 at the latest.
- No later than 1 January 2022, energy performance certificates and tenancy agreements will have to include indications of the actual energy consumption of dwellings, expressed in primary and final energy, and an estimate of the theoretical amount of energy expenditure.
- By 1 January 2022 at the latest, property advertisements will have to include an estimate of the theoretical amount of energy expenditure.
- Lastly, the Act introduces an obligation to renovate dwellings in that category.

As far as this renovation requirement is concerned, in an initial phase, beginning on 1 January 2023, energy performance will become a criterion to be used in assessing the decency of dwellings. From that date, dwellings with final energy consumption that exceeds a particular threshold can no longer be rented out.

By the start of the next phase, on 1 January 2028, all dwellings with excessive energy consumption will have to have been renovated.

[28] Particularly in the context of ADEME's call for research projects B2C2, which is referred to above.

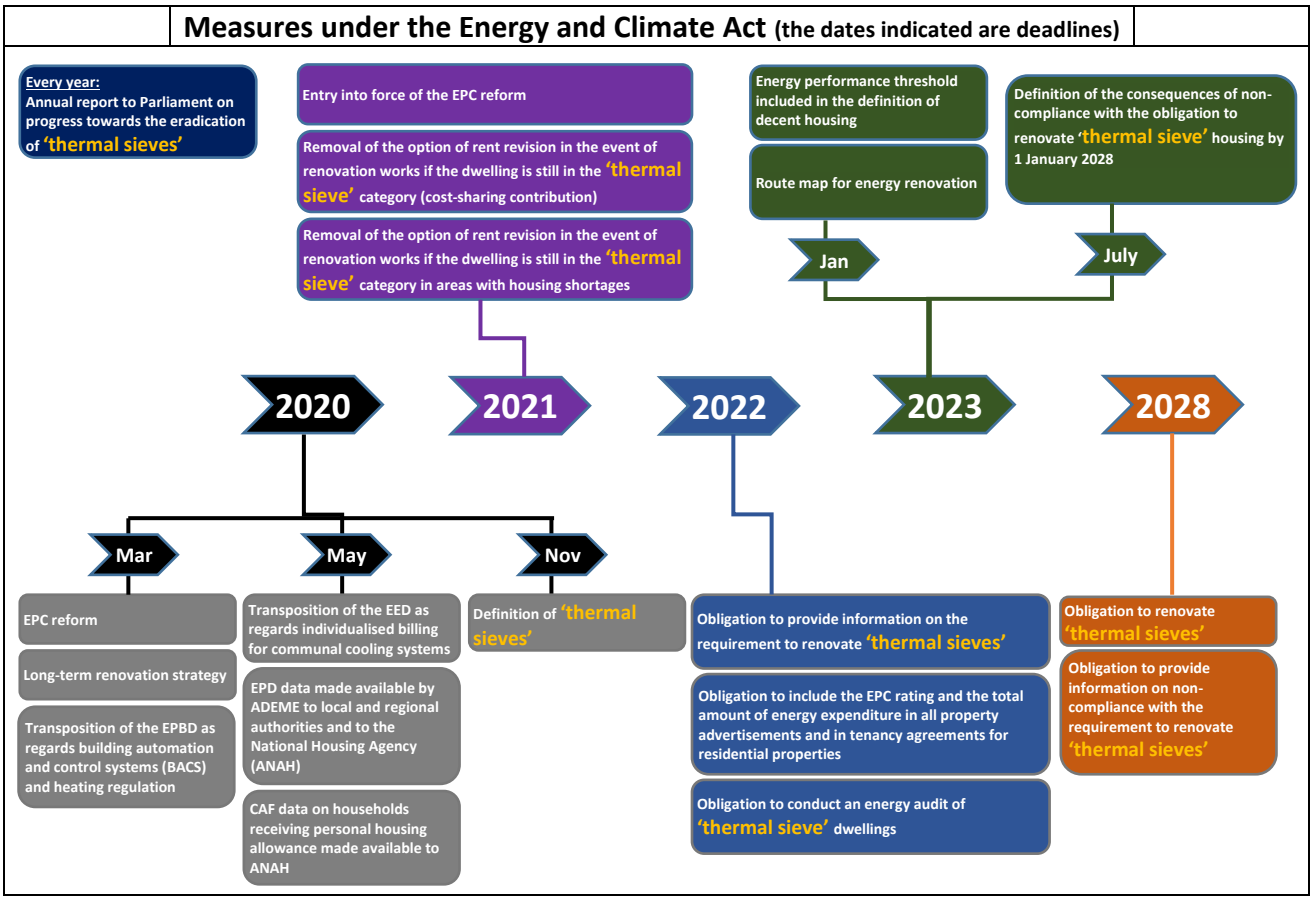


Figure 14 – Timeline showing the dates of entry into force of the measures prescribed by the Energy and Climate Act

4.1.5 *Innovation in renovation*

New digital tools designed to collect and process data describing housing stock can now be used as a basis for energy renovations.

The digital logbook (*carnet numérique*) established by the Energy Transition for Green Growth Act in 2015 and reconfigured by the Housing, Planning and Digitalisation Development Act (the *Loi ELAN*) in 2018 is a mechanism that will enable users to gather information relating to housing and to access a range of support services. The original idea, the product of a 2014 report on the Sustainable Building Plan,[29] was piloted from 2016 in the framework of the Plan for the Digital Transition of the Construction Sector with a view to identifying the most effective solutions.

The digital logbook is a secure online service designed to provide better knowledge of the housing for and from its successive users, particularly with a view to promoting the implementation of energy-performance improvement works, providing more targeted alerts for owners about the breakdown of an appliance or about available incentives and also raising awareness of better ways to manage a building and its consumption levels. It will also be a source of useful information for tradespeople who have to renovate a building or improve its energy performance. In this way it is intended to reduce energy poverty.

The arrangements for its implementation will be defined in the course of 2020.

[29] 'Inventons ensemble la carte vitale du logement!', October 2014, at www.planbatimentdurable.fr/IMG/pdf/Rapport_-_Construisons_ensemble_la_carte_vitale_du_logement_VD.pdf

Initiated in the Netherlands, where it has already delivered more than 4,000 renovated dwellings, the EnergieSprong approach is based on a demanding set of specifications: refurbishment to net-zero energy consumption level with a 30-year performance warranty, on-site works completed within a week and a sharp focus on occupant satisfaction in terms of comfort, etc. The economic model, which should eventually operate without public subsidies, is based on works funded by the energy savings they generate and on industrial-scale renovations, which are also intended to cut costs.

The objective is to **create mass demand for renovation without imposing uniformity and with stringent performance criteria**.

To date, three initial pilot schemes have been completed; these were carried out in 2018 in the Hauts de France region and in Brittany on properties belonging to social landlords. Three other pilot schemes are still running on social housing stock in Auvergne-Rhône-Alpes and Hauts de France. Future projects are being set up: **in 2018, 64 stakeholders, including 14 social landlords, signed a commitment to have a combined total of 6,550 dwellings renovated**.

Energiesprong is an **open approach involving collaboration between stakeholders in the ecosystem**. National and local authorities, stakeholders on the demand side – social landlords and tenants – and on the supply side – contracting bodies, builders, maintainers, industrial manufacturers and distributors – work together to remove obstacles to the roll-out of such an approach.

In France, market support for the roll-out of these net-zero energy renovations is provided by GreenFlex together with the Social Union for Housing (*Union sociale pour l'habitat*), the Scientific and Technical Centre for Building (CSTB) and the Fibres-Energivie Competitiveness Cluster, working in close liaison with all of their fellow signatories of the EnergieSprong France commitment charter. This support is made possible by financial backing from the European Union through the programmes Interreg North-West Europe (project E=0) and Horizon2020 (project Transition Zéro), from ADEME and from the Caisse des Dépôts. Following its financial support from the European Union, the project is now funded under a programme implemented in the framework of the Energy Saving Certificates (CEE) scheme.

The Energiesprong approach is also being rolled out in the United Kingdom and Germany, and development teams are being established in Italy, New York, Ontario and British Columbia.

EnergieSprong France website: http://www.energiesprong.fr

4.2 Providing better support to households for renovation projects

4.2.1 *The Public Service for Housing Energy Performance – information, advice and initial support*

Information, advice and support are keys to engaging households in energy renovation projects for their homes.

In France, the task of providing these is performed by public or semi-public structures, funded by the state and by regional and local authorities (regions, departments, public establishments for cooperation between local authorities (EPCIs), etc.) as a public service – a 'service of general interest' within the meaning of the Services Directive.

This Public Service for Housing Energy Performance (SPPEH) was created by the Energy Transition and Green Growth Act of August 2015. The Act stipulates that it should be established nationwide and based on a network of local energy renovation platforms covering the territories of local authorities. To this end, the Act also requires each region to establish a regional energy-efficiency programme, which is to include a plan for the deployment of these territorial platforms as well as a core of minimum advice and recommendation entitlements.

The Government and the local and regional authorities, together with ADEME, ANAH and the National Housing Information Agency ANIL, have established a nationwide network of more than a thousand advisers who are qualified to provide households with information and support for the energy renovation of their homes and are accessible to individuals at about 450 contact points. They are part of the FAIRE network, an acronym for *Faciliter, Accompagner et Informer pour la Rénovation Energétique* ('facilitating, supporting and informing for energy renovation'). They are one of the main instruments for mobilising and supporting householders so as to ensure that France meets the target of 500,000 energy renovations a year that is laid down in the Plan for the Energy Renovation of Buildings.

Some regions are now very advanced in the establishment of this public service. The Haut-de-France region, for example, has created help centres throughout most of its territory where individuals are offered comprehensive solutions for the energy renovation of their homes, comprising information, advice, support and funding through a third-party financing company.

Other regions are less advanced in this respect and still need assistance in establishing such a network. Against this backdrop, France has developed a dedicated programme to create these structures and support their activities with the aid of funding from the Energy Saving Certificates (CEEs), namely the CCE programme SARE (Energy Renovation Support Service) which is described in point 4.7.1.2 of this strategy.

To this end, PACTE, the Action Programme for Construction Quality and the Energy Transition, funds numerous actions for the promotion of coherent strategies for the staged renovation of the housing stock. The content of the programme is enlarged upon in the section devoted to the building trades.

It is not enough, however, to argue on the basis of energy savings to initiate energy renovation works on housing.

Accordingly, communication campaigns are regularly conducted to promote the activities of the network among the general public and to focus households' interest on the improvement of thermal comfort in their homes. This was the purpose of the slogan *Tous éco confortables* ('Everyone eco-comfortable') used by the last FAIRE campaign. Schemes are also operated in partnership with the building trades, the large DIY stores, etc.

The main channels of communication on which the FAIRE network depends are as follows:

- a dedicated national phone line: 0 808 800 700;
- a national FAIRE website, which serves to direct individuals to their closest adviser: http://www.faire.fr/ ;
- a media campaign (TV, radio and Web-based) led by the government ministries with responsibility for building;
- a guide to financial support schemes, which is available on the Internet, is well visited and is updated every year (https://www.ademe.fr/aides-financieres-2019).

Other thematic guides on renovation matters provide targeted information for households and can be consulted at http://www.ademe.fr/guides-fiches-pratiques.

4.2.2 *Support before and during renovation works*

Since 2018, France has been encouraging the performance of energy audits before renovation work to enable households to obtain advice on the nature of the works that are needed to attain, in one operation or in several stages, the *BBC rénovation* standard, which is the target that all existing buildings are required to meet by 2050.

The audit must be conducted by qualified specialists, such as a thermal engineering consultant or licensed architect.

In 2019, this energy audit is eligible for a tax credit amounting to 30% of its cost. The energy transition allowance that will replace the tax credit in 2020 will subsidise an even greater part of this expenditure for low- income households for low- and very-low-income households; it will meet EUR 500 of the cost for households with very low incomes and EUR 400 for those with low incomes, the average cost of an energy audit being estimated at EUR 850 including tax.

Schemes providing support before and after renovation works have also been established at two levels:

- Nationally:
    - The *Habiter mieux Sérénité* programme is offered by the National Housing Agency. It supports households wishing to arrange a deep renovation of their single-dwelling house, subject to the requirement of a minimum energy saving of 25%. Households are supported in this project by a project management assistant, who carries out the energy performance assessments before and after the works himself and who oversees the works on behalf of the household. His fee, in the order of EUR 600, is met in full by ANAH.
    - The CEE programme SARE, which serves to part-finance support or even project-management measures (except in the case of beneficiaries of the *Habiter mieux Sérénité* programme) for households wishing to arrange clusters of works that will deliver energy savings of at least 35% in a one-dwelling house or multi-owner building.
- Locally, the schemes are offered by local authorities, which have established third-party financing companies and set up one-stop renovation bureaux.

ANAH also supports energy renovation works undertaken in multi-owner buildings classed as fragile or in difficulty. The extension of its support to cover all multi-owner buildings is planned for 2021.

4.3 Financing of renovation works: simplification, higher visibility and innovation

Since the Plan for the Energy Renovation of Buildings (PREB) was launched in April 2018, renovation incentives have been enhanced. Renewed efforts to harmonise and simplify the aid mechanisms have been pursued in the past few years.

4.3.1 *Private housing*

For the stock of private housing, the three main schemes have been enhanced for all households:

- To make it easier for households to fund the residual cost of renovations, the interest-free eco-loan (*éco-PTZ*) was drastically simplified in 2019 with the abolition of the obligation to have works carried out in clusters, standardisation of the maximum term of the loan to 15 years, simplification of the interest-free eco-loan for deep energy renovations and of loan ceilings for individual measures, etc.
- In 2020, the energy transition tax credit (CITE) is to be transformed into an allowance for low-income and very-low-income households and will be a more effective inducement to embark on renovation works, because it will be paid as the works are carried out; from 2021, moreover, it will be extended to middle-income households.
- Energy savings certificates (CEEs), which all households can obtain, and the CEE Helping Hand (*coup de pouce*) scheme are to be maintained.

The interest-free eco-loan, created in 2009, is accessible regardless of income to finance works designed to improve energy performance and is capped at EUR 30,000 per dwelling:

- either for an intervention to improve the energy performance of the dwelling (the eligible works are listed in statutory orders),
- or for attainment of a minimum level of global energy performance of the dwelling, bringing it out of EPC rating F or G and improving energy efficiency by at least 35%,
- or for work on the rehabilitation of non-communal wastewater disposal and treatment systems.

The eco-loan is open to natural persons who are owner-occupiers or landlords, to non-trading partnerships that are not subject to corporation tax and to homeowners' associations of multi-owner buildings. It is awarded for dwellings that are more than two years old.

To contribute to the achievement of the targets set by the Government under the Plan for the Energy Renovation of Buildings (PREB), the Finance Act for 2019 extended the interest-free eco-loan scheme for three years until 31 December 2021, thereby providing certainty and predictability for households, building trades and banks. In connection with that extension, the eco-loan has been made more operable and greatly simplified so as to remove the constraint of the liquidity requirement for households whose intended works will not be clustered. In fact, since 1 March 2019, the clustering requirement has been abolished, which means that funding can be obtained for a single renovation measure, making it easier to meet the residual cost, especially for low-income and very-low-income households, which cannot afford to commit to more than one job at a time. Other simplifications, such as the standardisation of the maximum repayment period at 15 years, the simplification of the interest-free eco-loan for global performance upgrading and the loan ceilings for individual measures, took effect on 1 July 2019.

The energy transition tax credit (CITE) allows beneficiaries to deduct from their taxable income 30% of expenditure incurred for certain energy-performance works. The eligible expenditure is capped at EUR 8,000 for an individual and EUR 16,000 for a couple. This ceiling is raised by EUR 400 for each dependant.

Claimed in tax returns, it is intended for owner-occupiers, tenants and rent-free occupants for a dwelling which must be the taxpayer's or taxpayers' main residence and must be more than two years old.

The eligible works are those relating to:

- heating and domestic hot water;
- insulation of walls, doors and windows;
- support measures.

For households whose incomes are below the ANAH resource ceiling, eligibility for the CITE has been extended in 2019 to labour costs for the installation of heating appliances using renewable energy sources and to the removal of oil tanks, the eligibility rate in these cases being 50% instead of the usual 30%. On 1 January 2020, for low- and very-low-income households, CITE is to be converted into an allowance paid directly by ANAH (see below).

The amounts of the main incentives dedicated to the renovation of private housing stock in 2018 are set out in the following table. The list is not exhaustive.[30]

Incentives	Energy transition tax credit (CITE)	Interest-free eco-loan (Eco-PTZ)	ANAH *Habiter mieux* scheme (see point 4.3.1.1)
Amounts in 2018 (€m.)	1,116	33	527
Number of beneficiaries in 2018	950,000	18,750	51,300

[30] Incentives not listed in the table include the reduced rate of VAT (5.5%), the exemption from land tax on developed property TFPB, the *Denormandie* tax-reduction scheme for the refurbishment of old buildings and third-party financing.

Since 2014, the **5.5% reduced rate of value-added tax (VAT)** for renovation works targeting high energy that are eligible for the tax credit has been available to everyone. For 2018, this item of fiscal expenditure was estimated at EUR 1.1 billion, representing an increase of EUR 30 million from 2017. A 10% rate has been maintained for maintenance and improvement works.

Third-party financing serves to combine all possible instruments – technical support, funding, execution of works, etc. – with a view to maximising the volume of energy renovation operations. These operations have two main targets, namely the renovation of one-dwelling houses to low-energy building (BBC) standard and the energy renovation of multi-owner buildings. Following the successive advances made by the Housing Access and Urban Renewal Act (*Loi ALUR*) and the Energy Transition and Green Growth Act (LTECV), the legal basis for third-party financing is now complete and fully operational. The LTECV also permits an exemption from the banking monopoly for third-party financing companies in which local or regional authorities hold a majority stake or which are attached to a supervisory authority. Half a dozen companies that are active today – public-private enterprises (semi-public companies or direct-management entities (*régies*)) – were initiated by regional or local authorities, notably by the regions of Haut-de-France (Régie Régionale du SPEE - Picardie Pass Rénovation), Île-de-France (IDF Energie), Nouvelle-Aquitaine (Artéé), Grand Est (Oktave), Centre-Val de Loire and Occitanie – and by metropolitan authorities (Bordeaux Métropole and Brest Métropole). These initiatives are being monitored by a working group, and exchanges have been taking place since 2015 between PUCA (*Plan Urbanisme Construction Architecture*, an interministerial research and experimentation programme on spatial planning, housing, construction and architectural and urban design) and local and regional authorities, which have established an experimentation programme on an integrated approach to the renovation of private housing.

Local authorities may, after deliberation, propose a **partial or total exemption from land tax on developed property (TFPB)** for owners of dwellings built before 1 January 1989 who make capital investments in the dwelling. Local authorities may also establish additional aid schemes to promote energy renovation by targeting the needs and priorities of their areas. The FAIRE network and the National Housing Information Agency ANIL produce a consolidated summary of the available aid schemes to make it easier for local households and tradespeople to become aware of them. The schemes generally target low- and very-low-income households or are designed to encourage renovations that will deliver a very high level of energy performance.

We have also seen the emergence of a great number of local initiatives designed to initiate the creation of bank products on a regional or more local scale. These partnership initiatives take the form of calls for expressions of interest from local banking networks, discussion forums with all those in local government with responsibilities relating to building renovation and training initiatives for bank advisers. A total of 554 areas recognised as 'Positive Energy Territories for Green Growth' (TEPCVs) have benefited from support from the Energy Transition Fund, with sums of 500,000 to two million euros being awarded to local and regional authorities participating in the voluntary TEPCV scheme. Acceleration of the renovation of housing and public buildings is one of the range of TEPCV actions that has been very widely advertised and implemented. As a result, Positive Energy Territories have probably accounted for some 5,000 deep renovations of dwellings, i.e. to BBC standard, and some 1,500 renovated public buildings.

4.3.1.1 Low-income households

For the stock of private housing and for households in the lowest income group, the *Habiter mieux* ('Better living') programme of the National Housing Agency (ANAH) has been developing since 1 January 2018; its original ambitious target was the renovation of 75,000 dwellings by 2022, but that target was achieved in 2019. The funding options have been widened by means of the following measures:

- the creation of an incentive known as *Habiter mieux Agilité*, which is a simplified option designed to meet pressing social challenges and to fund one item of work from among the three operations recognised as the most effective; this scheme will end on 31 December 2019;
- the continuation of the old *Habiter mieux* programme (renamed *Habiter mieux Sérénité* for owner-occupiers); it is implemented in three steps, namely identification of the situations to be addressed, diagnosis and technical, social and financial support and, lastly, the provision of funding of up to EUR 20,000, excluding tax, for works which should lead to an improvement of at least 25% in the energy performance of dwellings for owner-occupiers and at least 35% for landlords and homeowners' associations in multi-owner buildings classed as being in difficulty;

- lastly, the energy solidarity benefit (ASE) grants funded by the Thermal Renovation Assistance Fund (*Fonds d'aide à la renovation thermique*), which came to an end on 31 December 2017, were replaced by *Habiter mieux* grants of the same amount.

The income ceilings for owner-occupier eligibility mean that the programme covers 45% of homeowners in France, corresponding to seven million households.

On 1 January 2020, the interest-free eco-loan is being changed into a grant paid directly by ANAH for low- and very-low-income households, that is to say households falling below an income ceiling set by ANAH. The grant, which will be calculated as a percentage of the estimated gain in energy efficiency resulting from renovation works to avoid the inflationary effect that had previously been observed in the existing tax credit scheme, will be paid at the same time as the works are being carried out. It will replace the *Habiter mieux Agilité* allowance and the tax credit, merging them into a combined grant. Alternatively, moreover, low-income households may opt to benefit from the aid payments that are available under ANAH's *Habiter mieux Sérénité* scheme for more extensive supported renovation programmes in a 'topped-up' version.

The interest-free eco-loans – *éco-PTZ Habiter mieux* and the original version of the loan – which are awarded to households subject to the aforementioned income ceilings qualify for coverage by the Energy Renovation Guarantee Fund (FGRE), which extends to 75% of eligible losses. The objective of the Fund is to guarantee individual eco-loans for 35,000 low-income households a year by 2021. Financing of the FGRE began in 2019 with the establishment of a programme funded by EDF in the framework of the Energy Saving Certificates scheme. It has been envisaged that the FGRE will reach its maximum capacity of EUR 57 million between 2019 and 2021.

4.3.1.2 Multi-owner buildings

The existing mechanisms for multi-owner buildings have been maintained and strengthened. The interest-free eco-loan for these properties was simplified in 2019, for example through the removal of the 75% threshold for the residential use of the property. It is a collective loan granted to the building management body, acting on behalf of the homeowners. This version of the eco-loan, from which more than 8,000 dwellings have benefited since 2015, can finance the same categories of works as the individual interest-free eco-loan. The Energy Renovation Guarantee Fund can now provide a counter-guarantee for eco-loans awarded to building management bodies and for collective loans obtained for the purpose of funding energy-related improvement projects, covering 50% of eligible losses. The objective is that the Fund should be counter-guaranteeing 6,500 loans to building management bodies by 2021.

Since 1 January 2017, the *Habiter mieux* programme of the National Housing Agency ANAH has also been open to homeowners' associations of buildings classed as 'fragile' if the financed works will achieve an energy-efficiency gain of at least 35%.

4.3.2 *Energy savings certificates*

The Energy Saving Certificate (CEE) scheme, which was created in 2005 and is governed by Articles L.221-1ff. of the Energy Code, is one of the major support tools for the energy renovation of housings and tertiary-sector buildings.

The certificates, each of which corresponds to one kWh_{cumac}[31] of final energy, are issued by the government ministry holding the energy portfolio to eligible stakeholders – bodies that are under a legal obligation but also other corporate entities which are not bound by an obligation, such as local authorities and social landlords – which have implemented energy-saving operations in accordance with certain criteria laid down in statutory instruments. These certificates can be freely exchanged.

Data sheets for standard operations defined by statutory instruments are drawn up for the commonest operations to facilitate the arrangement of energy-saving measures. They define the fixed volumes of energy savings in kWh_{cumac} and the lifetime of the operations. These operations correspond to a volume of 'expected

[31] The term '*cumac*' is a contraction of '*cumulée*' (accumulated) and '*actualisée*' (updated, discounted). For example, the saving in terms of kWh_{cumac} following the installation of an appliance with a high level of energy performance represents the energy savings accumulated over the lifetime of that product. In addition, the annual energy savings achieved after the first year are discounted by dividing the previous year's savings by 1.04, reflecting a discount rate of 4%

savings' and are regularly updated. The list of data sheets for standardised operations, of which there are some 200, is available on the website of the Ministry for the Ecological and Inclusive Transition.

These data sheets are drawn up by groups of specialists in each field, directed by the Technical Association for Energy and the Environment (ATEE) and bringing together stakeholder representatives. The data sheets are then reviewed by ADEME and approved by the ministry with responsibility for energy.

Special operations serve to reap energy savings in areas not covered by the standard operations. They are less common operations that have not been standardised, particularly as regards a stock definition of the volume of energy savings they should deliver. In this case, certificates are based on estimated savings.

The Environment and Energy Management Agency (ADEME) and the National Energy Saving Certificate Hub verify the validity and accuracy of claimed energy savings.

The Energy Saving Certificates scheme is described in detail in the National Energy Efficiency Action Plan (PNAEE) and in the National Integrated Energy and Climate Plan (PNIEC), which were submitted at the end of 2019.

4.3.2.1 The Energy Saving Certificates used for energy renovations

The mechanism of Energy Saving Certificates, used in conjunction with standardised and special operations, made it possible to distribute EUR 1,188 million in financial incentives for energy-savings operations on private housing stock in 2018.

(in €m.)	**2017**	**2018[32]**	**2019[33]**
Volume of financial incentives	652	1,188	1,520
includes: Helping Hand measures for insulation	62	21	319
Helping Hand measures for heating	14	1	35

Here are a few figures to illustrate the impact of the Energy Saving Certificate scheme since its inauguration in 2005:

- installation de 1,000,000 individual high-efficiency boilers;
- insulations of attic floors, roofs or walls of 450,000 dwellings;
- installation of solar heating panels in 50,000 dwellings in French overseas territories.

4.3.2.2 Focus on the Helping Hand scheme for energy savings

Launched in 2017, the *Coup de pouce* (Helping Hand) scheme for energy savings enables households to benefit, subject to means testing, from a one-off grant to assist them in funding certain energy renovation works.

In 2018, the scheme was refocused on particular types of operation, namely replacing an old boiler by purchasing an appliance running on renewable energy, such as a biomass boiler or an air-source, ground-source or hybrid heat pump, having a combined solar heat and power system installed or being connected to a district heating network.

At the start of 2019, the Ministry for the Ecological and Inclusive Transition decided to roll out this scheme on a large scale and to start assisting all householders to abandon fossil fuels and insulate their homes and so cut their energy bills significantly.

[32], [29] Estimated financial incentives

This new mechanism provides for the establishment, in the framework of the Energy Saving Certificate scheme, of premiums for certain operations in cases where the body applying for certificates has signed up to a commitment charter enabling it to grant significant premiums to households and so reduce their residual costs when energy renovations are carried out. The premium applies to operations initiated on or before 31 December 2020 which are covered by the *Coup de pouce* heating or insulation charter that the applicant body has signed.

All households can benefit from this offer. The amounts of the grants that are allocated, however, will differ according to levels of household income. The lowest-income households will be awarded the largest grants.

In 2019, it is estimated that more than a million energy renovation measures were implemented under the *Coup de pouce* scheme.

In fact the insulation element of the *Coup de pouce* scheme made it possible for households to embark on more than 750,000 projects for the insulation of attic floors, roofs or downstairs floors, for which a total of EUR 720 million in financial incentives was paid out. In the same year, the heating component of the scheme enabled householders to proceed with the replacement of almost 300,000 boilers at a steady rate, averaging 25,000 replacements each month. In 110,000 of these cases (37%), oil-burning boilers were replaced. This represented an investment of EUR 131 million in incentive payments. These operations are enabling households to save EUR 174 million a year on their energy bills and to avoid the emission of 796 kilotonnes of CO_2.

4.3.2.3 Focus on programmes

During the second phase of the scheme, payment of a financial contribution to information, training and innovation programmes promoting the management of energy demand or the reduction of energy poverty has been earning Energy Saving Certificates for applicant bodies. These programmes have been defined in statutory instruments by the ministry holding the energy portfolio

The National Environmental Commitment Act – Law No 2010-788 of 12 July 2010 – made it possible to issue Energy Saving Certificates in connection with financial contribution to programmes relating to energy demand management. And so Article L. 221-7 of the Energy Code prescribes that the following may give rise to the issuing of certificates:

'The contribution:

(a) to programmes rewarding operations to reduce the energy consumption of the most disadvantaged households;

(b) to information, training or innovation programmes promoting energy savings or relating to fossil-fuel-saving logistics and mobility;

(c) to the guarantee fund for energy renovation referred to in Article L. 312-7 of the Building and Housing Code;

(d) to programmes for logistical improvements in the transport of goods on the part of forwarding agents, such as the use of pooled supply chains or multimodal transport and of rail and waterway freight transport;

(e) to programmes for the renovation of buildings for the benefit of local and regional authorities.

The list of eligible programmes and the conditions for issuing Energy Saving Certificates are defined by a statutory order enacted by the minister holding the energy portfolio.

In the case of programmes, certificates are issued for actions that do not result directly in an easily quantifiable gain in energy efficiency. By way of compensation, they are subject to the following requirements:

- a sufficiently stringent proportionality factor must be maintained;
- the state must participate in the governance of the programmes;
- the number of certificates obtainable through programmes is limited to a certain percentage of the national energy-saving obligation; for the fourth period, for example, the maximum allocation for programmes has been set at 200 TWh_{cumac}.

As of 1 October 2019, the scheme covers 48 programmes divided among four subject areas: building, transport, energy saving on the part of occupational groups and programmes intended for school pupils.

The following tables show the programmes relating to the building sector that are currently running.

Development of innovative tools for identifying buildings and carrying out energy renovation works	
NAME	**OBJECTIVES**
Profeel	To develop support instruments and innovative solutions for the execution of energy renovation works To develop protocols for the measurement of actual performance To ensure the implementation of innovative renovation solutions
TrEES	To identify standard renovations in educational establishments and to provide an overview and catalogue of standard technical solutions
Smart Reno	To analyse flaws in insulation systems by means of modelling and experimentation and to find solutions for the management of humidity in renovation works To enhance comfort through the definition of multiple criteria

SUBJECT AREAS	PROGRAMME NAME	TARGET POPULATION/BUILDING CATEGORIES
Information, awareness-raising and support relating to renovation	*Energy Renovation Support Service (Service d'accompagnement à la rénovation énergétique – SARE)*	*Householders* *Small operators in the tertiary sector*
	MAGE	*Households living in energy poverty*
	SLIME	*Households living in energy poverty*
	ECORCE	*Households living in energy poverty*
	DEPAR	*Households living in energy poverty*
	FRED	*Households*
	AEELA	*Farmers*
Train members of the building trades and property specialists in energy renovation	*FEEBAT*	*Students and members of the relevant occupational groups*
	ETHEC	*Building management bodies and homeowners' boards*
	Renovation of Co-owned Buildings in France (Rénovation des immeubles de copropriété en France – RECIF)	*Building management bodies and homeowners' boards*
	EXPERTISE RENOVATION COPROPRIETE	*Building management bodies and homeowners' boards*
	PEPZ	*Banks*
	Raising awareness and interest among participants in property transactions (Mobilisation et sensibilisation des acteurs de la transaction immobilière - ACTIMMO)	*Banks, estate agencies, building management bodies and notaries*
	Facilaréno	*Building trades*
	CEC COACHING Energétique des coPRO	*Building management bodies and homeowners' boards*
Rolling out renovation on a wider scale by developing special tools for particular sectors (public buildings, school buildings, residential properties, etc.)	*CaSBâ*	*Local and regional authorities*
	EnergieSprong France	*Social housing*
	Local and Regional Authority Action for Energy Efficiency (Action des Collectivités Territoriales pour l'Efficacité Energétique – ACTEE)	*Public buildings*

	Impulsion 2021 Raising awareness and innovating for the energy transition of social security buildings	*Social security buildings*
	Kits for energy eco-efficiency centres in small rural municipalities (KIT-EE)	*Small rural municipalities*
	Roofs First (Toits d'abord)	*Social housing*

4.3.3 *Social housing*

The national stock of social housing comprises some five million dwellings, or about 20% of all primary residences. At the present time it probably contains something like 250,000 'thermal sieves', buildings with an Energy Performance Certificate (EPC) rating of F or G, corresponding to annual primary energy consumption in excess of 331 kWh/m².

The energy renovation of this building stock, which should be exemplary, given the public support it receives, is therefore essential. It is also an issue of purchasing power for tenants.

Progress has already been significantly better than in the rest of the housing stock, according to the representative bodies of social landlords, with energy consumption 20% below the average for the entire housing stock and 11% of the total volume of CO_2 emissions from all primary residences, which corresponds to 15% of the CO_2 emissions of the entire housing stock, including second homes.

In the Big Investment Plan (*grand plan d'investissement* – GPI), a budget of four billion euros covering a five-year period was allocated for the renovation of 'energy sieves' in the social housing stock. The Investment Pact of 25 April 2019 has set an annual target of 125,000 energy renovations, which must raise the EPC rating of each building by at least one level, and has prescribed a faster rate of renovation for the buildings classed as 'energy sieves'.

The eco-loan for social housing (*éco-PLS*), distributed by the *Deposits and Consignments Fund (Caisse des Dépôts et Consignations* – CDC), is identified as the main mechanism for the energy renovation of social housing. In 2018, for example, eco-loans funded renovations in 45,000 dwellings. A new agreement between the Government and the CDC entered into force in August 2019, drawn up in consultation with the Social Union for Housing (*Union Sociale pour l'Habitat* – USH) and designed to make the *éco-PLS* more ambitious and more appealing while simplifying the adjudication process. In particular, the agreement provides for an increase in the maximum loan per dwelling from EUR 16,000 to EUR 20,000 with a top-up of EUR 2,000 for loans where the objective is an ambitious energy performance level, namely that of the *BBC Rénovation* label, and a new top-up of EUR 3,000 per dwelling if asbestos is present in the building.

A VAT rate of 5.5% is applied to energy renovation work on social housing. Moreover, social landlords who arrange for works which are designed to achieve energy and fluid savings and which are eligible for this reduced VAT rate can benefit from a **reduction in land tax on developed property (TFPB)** corresponding to one quarter of the expenses incurred in the course of the year preceding the one in which the tax was due. The cost of this measure in 2018 is estimated at EUR 92 million.

The energy renovation of rented social housing can also benefit from the support of the European Structural Funds, and indeed the energy transition is a priority for the European Union. In France, between now and 2020, almost EUR 750 million will be dedicated to projects designed to improve the energy efficiency of public buildings and of housing. During the period from 2014 to 2020, all of the regions, which are the managing authorities, have made energy renovation a priority of their operational programmes. The ERDF can generate valuable leverage for the energy renovation of social housing when its resources are used to supplement the existing public funding.

4.4 Renovating multi-owner buildings: a priority

The stock of multi-owner buildings in France comprises 6.9 million primary residences, that is to say 28% of all dwellings in France, located in some 617,000 buildings (ANAH, 2015). Buildings in multiple ownership are thus a strategic target for renovation because of the great potential they offer for cuts in energy consumption.

The dwellings in question are spread across a range of buildings of widely differing sizes, with 54% of multi-owner buildings containing fewer than five dwellings, 69% containing fewer than 10 and 94% fewer than 50. Multi-owner buildings with more than 200 dwellings represent only 0.4% of multi-owner buildings but almost 10% of the dwellings in such buildings. Most of the stock is old, 27% having been built before 1949 and 32% between 1949 and 1974.

Renovation projects in multi-owner buildings run into particular difficulties because of the complexity of the projects, the cumbersome financial and administrative mechanics, decision-making procedures, the need to be able to persuade a sufficient number of co-owners and, consequently, the timescale of projects.

Three means of increasing the number of energy renovations in multi-owner buildings have been identified, namely:

- developing the provision of information, advice and support to co-owner households;
- establishing appropriate mechanisms to provide technical and financial support for energy renovation programmes in multi-owner buildings, particularly those classed as fragile or in difficulty;
- making the execution of energy renovation works compulsory by means of 'embedded works' schemes.

4.4.1 *Actions taken to develop the provision of information, advice and support to households in multi-owner buildings*

First of all, households in multi-owner buildings benefit from general information, advice and support measures developed by local and regional authorities in the framework of the Public Service for Housing Energy Performance (SPPEH). The legal framework and the remit of the SPPEH are described in a separate paragraph of this strategy.

In addition, three Energy Saving Certificate programmes have recently been launched to multiply awareness-raising, training and coaching for multi-owner building stakeholders in energy renovation:

- CEC, led by Oxalys at a cost of EUR 3 million, which is developing a coaching scheme for homeowners and management bodies of multi-owner buildings to promote energy renovation;
- RECIF, led by Energie PositIF at a cost of EUR 2.8 million, which is waging a huge structured campaign to stimulate demand, managed regionally and implemented locally;
- ETHEC, led by ANAH at a cost of EUR 1.4 million, which targets multi-owner buildings in town and city centres undergoing revitalisation.

Finally, two Energy Saving Certificate programmes focus on awareness-raising and training for professional building management bodies:

- ACTIMMO, led by CLER, the Renewable Energy Liaison Committee, at a cost of EUR 5.75 million, which is developing a standardised awareness-raising tool for professional building management bodies;
- *Expertise rénovation copropriété* ('Expertise in the renovation of multi-owner buildings'), led by FNAIM, the National Real Estate Federation, at a cost of EUR 5 million, which implements awareness-raising and training measures for professional building management bodies and offers an online training module in energy renovation for co-owners at www.coprosvertes.fr.

These programmes will mobilise almost EUR 18 million in Energy Saving Certificates between now and mid-2021. Associations of representatives of multi-owner buildings and other stakeholders should be invited to meetings

soon so that they can be introduced to these programmes, which are intended to generate nationwide impetus for the renovation of multi-owner buildings.

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The strategic investment programme *Ville de demain* ('City of tomorrow') is devoting more than EUR 50 million to the energy renovation of more than 7,000 privately owned dwellings with the aim of achieving the low-energy building (BBC) performance level. With this exceptional injection of funding, the ÉcoCité network and the strategic investment programme *Ville de demain* aspire to incubate support and funding models that will serve to accelerate and multiply building renovation projects and so impact significantly on energy consumption in any urban district.

As part of this approach, an in-depth analysis of the triggers for engagement in energy renovation has been conducted, as has an instrumentation of the renovated dwellings, so as to demonstrate the practical consequences of the completed renovations and the characteristics of the post-renovation 'knock-on' effect on consumption levels.

4.4.2 *Technical and financial support schemes designed specifically for multi-owner buildings*

4.4.2.1 Incentive schemes designed to encourage full renovation of multi-owner buildings

Interest free eco-loans are the main funding mechanism offered by the Government for energy renovation works, supplementing grants received under incentive schemes. In spite of an encouraging start, with 70,000 loan applications in 2009 overshooting the initial target of 50,000 loans, take-up for the scheme is low today, which can chiefly be explained by a situation in recent years in which borrowing rates have been particularly low and the number of credit institutions issuing these loans has been in constant decline.

A reform of the scheme introduced by the Finance Act 2019 to make it more accessible to individuals and more attractive to banks and to harmonise it with the other support schemes has just been completed. This resulted in the appearance of a reformed interest-free eco-loan in March 2019, which is no longer contingent on works being part of a package, and a new wave of simplifications is scheduled for August 2019.

As a parallel option, third-party financing companies are offering technical and financial support to co-owners in the form of an energy audit, a programme of works, a financing plan and funding, thereby making it easier for them to commit to action. Picardie Pass Rénovation, for example, has already assisted more than 980 co-owners in Picardy, and more than 460 dwellings have undergone renovation.

Energy renovations in multi-owner buildings can also qualify for Energy Saving Certificates (CEEs). Several moves have recently been made or initiated to increase the number of CEE operations that are carried out in multi-owner buildings:

- Since the beginning of 2018 an information document with contractual force has allowed homeowners' associations of multi-owner buildings to identify and compare more easily the CEE offers made to them, which are firm offers.
- A standardised operation sheet for services under an energy performance contract was created at the end of 2018 to encourage the use of energy performance contracts for the execution of installation works. Operations associated with an energy performance contract attract a premium; the premium scheme should be developed by the autumn of 2019.
- A standardised operation sheet for the renovation of flues for the evacuation of combustion products from individual boilers was created at the beginning of June 2019 to enable more than a million households to consider the acquisition of energy-efficient condensation boilers.
- 'Helping Hand' grants were created in January 2019 to increase the level of aid for the insulation of roof voids or floors of multi-owner buildings (the *Coup de pouce isolation*) and for the replacement of individual heating systems (the *Coup de pouce chauffage*) or for connection to district heating networks.

4.4.2.2 Transformation of the tax credit into a grant paid at the same time as renovation works are being carried out

The transformation of the tax credit into a grant for low-income households will become operational in 2020 for owner-occupants of single-dwelling houses, landlords who have concluded an agreement with ANAH and management bodies of multi-owner buildings classed as fragile or in difficulty for works on the common parts of multi-owner buildings.

It is planned to extend this transformation to all multi-owner buildings in 2021.

A legal feasibility study is also being conducted with a view to crystallising the available amount of energy renovation support by the time the general assembly of the homeowners' association takes its vote on proposed renovation works on a multi-owner building. It has been observable that the stability of renovation support schemes is crucial when it comes to deciding to go ahead with works projects, given the time taken to reach such decisions in multi-ownership scenarios.

4.4.2.3 Support schemes intended for multi-owner buildings classed as fragile or in difficulty

Multi-owner buildings that are classed as fragile or in difficulty are priority targets for intervention, as they generally have a high concentration of households living in energy poverty.

The National Housing Agency (ANAH) provides technical and financial support for the execution of energy-efficiency improvement works in these buildings. To this end, the *Habiter Mieux copropriété* scheme finances projects that will achieve an energy-efficiency gain of at least 35% in a multi-owner building showing the first signs of fragility (rates of unpaid homeowners' association ranging between 8% and 25% or multi-owner building located in a district within the ambit of the National Urban Renewal Agency ANRU). This support is awarded to the householders' association. All of the owner-occupiers and landlords benefit on a *pro rata* basis, regardless of owner-occupants' income. In 2018, support was provided under this scheme for 7,574 apartments in multi-owner buildings classed as fragile or in difficulty; this figure represents 58% of the annual target.

4.4.3 *Measures designed to make the execution of energy renovation works compulsory during routine maintenance work on multi-owner buildings (the 'embedded works' approach)*

The Energy Transition for Green Growth Act (LTECV) of August 2015 introduced an obligation to incorporate measures for the reduction of energy consumption into major works for the refurbishment of facades, re-roofing projects and garage or attic conversions.

The relevant provisions establish the following requirements:

- to undertake thermal insulation from the outside of the heated walls of a communal building when they are undergoing any refurbishment work – either re-rendering, the replacement of existing facing or the installation of new facing – which affects at least 50% of their surfaces, excluding openings;
- to undertake thermal insulation of the roof or attic floor of a building when at least 50% of the roof surface, excluding openings, is being replaced or re-covered;
- to undertake thermal insulation of the opaque outer walls when work is being done to make living space in garages or unconverted roof voids and the surface in question amounts to at least 5 m².

Special provisions also apply to buildings undergoing a major renovation, the cost of which amounts to at least 25% of the market value of the building excluding land: for these buildings, owners are required to comply with the provisions of the General Thermal Regulations, which are more stringent in terms of the energy performance to be achieved.

4.4.4 *Support schemes to protect households against energy poverty*

Special support schemes exist for low-income households, which are the first to be affected by energy poverty. For example:

- **52,268 households renovated their home with the aid of the *Habiter mieux* programme in 2017**[34] (ANAH, 2017).
- **122,949 households received assistance from the Housing Solidarity Fund to help them with their energy bills in 2017** (Ministry of Territorial Cohesion, 2019).
- **Energy Saving Certificates (CEEs) were issued for 444 TWh_{cumac} between January 2016 and November 2019 under the CEE energy poverty scheme** (Ministry for the Ecological and Inclusive Transition, 2019).
- **To enable households living in energy poverty to finance their renovation works through banks, an Energy Renovation Guarantee Fund (FGRE) was replenished in 2018 to guarantee the interest-free eco-loans arranged under ANAH's *Habiter mieux* programme.**
- **Lastly, the energy voucher (*cheque energy*), established by the Energy Transition for Green Growth Act of August 2015, was extended to all energy sources in 2018 and so covered more than 3.6 million households.** Since it applies to all types of heating, it is fairer than the old social tariffs for gas and electricity; moreover, households benefit from it automatically as soon as they become eligible.

The Government decided to extend eligibility for the energy voucher to 5.8 million households in 2019, and to increase the amounts paid in 2018 by EUR 50; these measures were implemented even though the scheduled increase in carbon tax was cancelled.

Lastly, the energy voucher scheme has been improved, clarified and simplified. For example:

- An amnesty has been introduced for those who omit to declare their income, a situation that is particularly liable to occur in cases of zero taxation; such persons can now apply to benefit from the energy voucher from the year in which they put their tax affairs in order.
- The option of ensuring that the energy voucher is automatically used and the associated rights automatically exercised in subsequent years has been extended. In 2018, about 30% of vouchers were used online, and one in four of the beneficiaries who used their voucher in 2018 have already indicated the supply contract under which they wish the value of the voucher to be deducted from their energy bill in the coming years. This option has now been extended to the safeguards associated with the energy voucher.
- To facilitate recourse to these safeguards, consideration is also being given to their automatic activation in the customer records of electricity and natural-gas suppliers, subject to respect for data privacy.

4.5 A new approach for the tertiary sector

4.5.1 *A statutory incentive scheme*

From the beginning of 2020, the entry into force of laws adopted in 2009, 2015 and 2018 and a decree promulgated in the summer of 2019 will enable France to compel owners of tertiary-sector buildings to meet a series of energy-saving targets in their building stock over a period of 30 years from 2020 to 2050. This mechanism, which is unique in Europe at the moment, should make it possible to achieve the long-term renovation objectives in the sector. It supplements the provisions that are already in force, particularly the Thermal Regulations for Existing Buildings, which applies to tertiary-sector buildings but is confined to circumscribing the regulated uses of energy.

[34] The *Habiter mieux* support programme was renamed *Habiter mieux Sérénité* in 2018 and supplemented by a new programme called *Habiter mieux Agilité*, under which single renovation measures could be funded for low-income households.

This new mechanism is part of the Plan for the Energy Renovation of Buildings, priority 3 – accelerating renovations and energy saving in tertiary-sector buildings. The energy consumption of buildings in the tertiary sector, by virtue of their diversity, stems more from other uses of energy than is the case with buildings.

It is based on energy-saving measures that are not limited to works on the structure of the building but is extended to all the measures that can be taken to cut energy bills (see *Measures* below). The approach being followed is pragmatic and simplified, being based on returns indicating actual consumption figures.

The provision enshrined in L.111-10-3 of the Building and Housing Code by the Grenelle Act prescribing the execution of energy renovation works by 2020 was supplemented by the Energy Transition for Green Growth Act, which set energy reduction targets of 40% by 2030, 50% by 2040 and 60% by 2050. Article 175 of the Housing, Planning and Digital Services Development Act extended the obligation to all measures for the reduction of final energy consumption.

In addition, an implementing decree promulgated in July 2019 and a statutory order on methods for registering the energy consumption of tertiary-sector buildings will complete the mechanism, which can then be fully applied.

4.5.1.1 Measures

Wide coverage with very few exemptions

The mechanism applies from a threshold of 1,000 m², which may be reached by individual premises or cumulatively, in other words by one building used primarily for tertiary purposes or by a site comprising several buildings. All activities of the tertiary sector are covered, both public and private, with very few exemptions, namely for temporary structures, places of worship and places used for defence, civil protection and internal security of the state.

Objectives to be met by building owners

The aim of energy saving may be achieved in either of two ways:

- on the basis of a quantitative target related to a reference year, which must not be earlier than 2010; or
- on the basis of an absolute target value determined for the relevant category of activity.

The mechanism is based on the following policy levers:

- the energy performance of buildings;
- the installation of efficient appliances and of devices for actively controlling and managing those appliances;
- the ways in which the appliances are used;
- the adaptation of the premises for economical use of energy and the behaviour of their occupants.

Adjustment of targets

There is scope to adjust targets in the following circumstances:

- constraints of a technical, architectural or heritage-related nature;
- a change in the nature or volume of activity;
- an economic imbalance between the cost of measures and the expected benefits in terms of final energy consumption (gross payback times will vary between types of measure).

To justify an adjustment of targets or in the event of failure to achieve the objective, a technical dossier is to be compiled. It will comprise the following:

- a diagnosis of the reference situation (reference consumption level, initial targets, indicators of intensiveness of usage for the reference year);
- a description of the factors justifying the decision to adjust the targets because of constraints of a technical, architectural or heritage-related nature;
- an energy study of the measures taken to improve the energy performance of the building and the

corresponding reductions in energy consumption, the target being a BBC renovation scenario to justify a variation from the gross payback time);
- an energy study focused on measures designed to reduce the energy consumption of equipment connected with other building-related energy uses and with specific uses;
- an action programme which makes it possible to achieve the objective and is based on all of the policy levers; in the event of non-achievement of the objective, there must be either a justifiable adjustment of targets or demonstration that all of the policy levers have been activated.

A collection and monitoring platform: the Observatory of Energy Performance, Renovation and Actions in the Tertiary Sector (Operat)

The platform should cover the following:
- the annual consumption returns submitted by the responsible parties (proprietors and/or landlords);
- the production of an annual declaration of annual consumption figures, adjusted automatically by the platform for climatic variations, with an indication of the situation in relation to the chosen target, i.e. the reference year or the absolute threshold value, which serves to meet the requirements to publish and display this information for employees and, in the case of buildings with public access, for the general public, as well as the requirement to valuate compliance with the obligation in the context of property transactions (sales and rental agreements).

While enabling the use of the database as a benchmark for the entire sector, interoperability is also ensured through application programming interfaces.

An '*Eco Energie Tertiaire'* label will be introduced to support stakeholders who have embarked on this approach and will encourage emulation.

4.5.1.2 A system of administrative sanctions

Provision is made for sanctions in the event of failure to post consumption returns on the Operat platform. After a formal notice has been issued, the next step involves the application of a 'name and shame' mechanism.

In the event of non-achievement of the objective by the end of the ten-year period, an action plan must be produced. The same hierarchy of sanctions – formal notice then name and shame – applies in the absence of an action plan. Monetary penalties applicable to the fifth level of contravention in French law may be imposed.

4.5.1.3 Support

Regulations at the service of renovation of the tertiary-sector building stock

This set of regulations differs from traditional regulations in that it is primarily a support instrument for stakeholders during the energy transition.

It benefits economic activity by generating savings and acts as a propagator of technological innovations, helping to ensure compliance with international obligations and to set an example in the fight against greenhouse-gas emissions and global warming.

The platform should enable stakeholders to compare themselves with others in their sector. A practical guide and feedback and leaflets with case histories and planning aids are produced to promote a smooth entry into energy renovation and to create a desire to progress.

Financial support tools

Instruments have been put in place for local and regional authorities under the Big Investment Plan for the five-year term of the Plan: a soft loan from the *Caisse des Dépôts et Consignations* (CDC), an equity investment by the CDC in Energy Performance Contracts and the Intracting internal performance contracting scheme.

The Energy Saving Certificate (CEE) schemes, the ERDF and the ADEME Heat Fund serve to fund operations. Lastly, engineering support is provided under ADEME's shared energy consultancy scheme and CEE programmes.

4.5.2 *The exemplary role to which the public sector aspires*

The Plan for the Energy Renovation of Buildings announced by the Government on 26 April 2018, made the energy renovation of public buildings a priority. Action 9 of that plan is entitled 'Promoting the renovation of publicly owned tertiary-sector buildings by mobilising innovative strategies and funding mechanisms'.

The stock of public buildings for tertiary uses accounts for some 380 million square metres, or 37% of the national stock of tertiary-sector buildings; it is therefore a major energy renovation challenge. Central government and its agencies own about 100 million m², while the regional and local authorities possess some 208 million m². Through the Big Investment Plan, the Government has stepped up the effort to renovate this stock with a view to speeding up energy savings by applying innovative solutions – funding, engineering, works, interventions relating to energy use, etc. It has devoted EUR 4.8 billion to the pursuit of this aim.

A special effort is being made with regard to school buildings. Accounting for 30% of the consumption of all municipal buildings, schools remain the most energy-intensive type of building ahead of sports facilities and socio-cultural buildings. Besides the challenge and the obligation to reduce the energy consumption of these buildings, public action on this segment of the building stock also makes a powerful educational point about energy saving. While the Climate Plan drew attention to the exemplary role that had to be played by public buildings in terms of energy renovation, the Plan for the Energy Renovation of Buildings also highlighted the need to intensify efforts to educate and raise awareness with regard to good practices in the use of energy. The renovation of school buildings, then, serves to combine these two objectives, for example by educating the young generation.

In this framework, the Ministry for the Ecological and Inclusive Transition, the Ministry of National Education and Youth, the Ministry for Territorial Adhesion and Relations with Local Authorities and the Ministry of the Economy and Finance appointed a task force on the energy renovation of schools in 2019.

This task force will catalogue the energy challenges associated with the various categories of educational buildings and review the supply situation in the energy renovation market: prior diagnosis, planning and architecture, execution of works, quality and energy performance labels, technical oversight, packaged offers and funding. It will also identify the funding options and legal arrangements adopted by contracting authorities for the conduct of operations and their expectations with a view to accelerating projects and multiplying their number. On this basis, it will propose specific and quickly implementable improvements to the various links in the chain and any new instruments that may be necessary.

4.5.2.1 A significant property portfolio in the care of the state

In view of the Climate Plan and the aim of exemplarity, there is a particularly sharp focus on the building stock owned by central government.

First of all, there are plans to introduce an interdepartmental monitoring instrument for fluids (OSFi) in 2020. This project will enable the Government to monitor the energy consumption of its building stock in relation to a previous reference date and so to quantify progress in the efforts to save energy. It will also enable the Government to guide all of its measures for the reduction of consumption in its building stock more effectively while also ensuring better communication and higher visibility.

The Public Estate Directorate (DIE), with the support of the State Purchasing Directorate (DAE) and the Directorate for Housing, Urban Development and Landscapes (DHUP), is in the process of establishing this instrument.

An energy-consumption reduction target for the building stock belonging to the Government and its agencies has also been enshrined in the Plan: 'In conformity with the overall objectives of the Plan for the Energy Renovation of Buildings, the State thus sets itself the objective of reducing the energy consumption of its building stock by 15% by 2022 in relation to 2010. The purpose for the State is to move closer to the path leading to achievement of the statutory objective for the stock of tertiary-sector buildings.'

This, then, is a quantified short-term target, committing the Government to reduce its energy consumption. This milestone is necessary to set the state on a course that matches the ambitions set out in the Housing, Planning and Digitalisation Development Act (*Loi ELAN*) and in its decree on energy-saving obligations in tertiary-sector buildings, which is at the drafting stage.

The Plan for the Energy Renovation of Buildings actually provided for the maintenance of an ambitious renovation requirement for building stock in the tertiary sector, both public and private. That has been written into the *Loi ELAN*.

Lastly, the provisions of Article 175 of the *Loi ELAN*, which define the energy-saving obligations for the whole sector to be met by 2030, 2040 and 2050, cover all public buildings, whether they are the property of central government or of regional or local authorities.

4.5.2.2 The Big Investment Plan

Besides the establishment of an interdepartmental monitoring instrument for fluids, which is an essential step if progress in energy saving is to be monitored and measured, the state can avail itself of other vehicles to help it achieve the objectives of the *Loi ELAN* and, in more general terms, make the ecological transition part and parcel of the management of its property assets.

The Big Investment Plan (*Grand Plan d'Investissement* – GPI) allocates an appropriation of EUR 1.8 billion to the thermal renovation of government buildings in its Initiative 2 – *Reduce the energy footprint of public buildings*. This amount is divided as follows:

- €1bn for the renovation of administrative complexes through programme 348, which was established by the Public Estate Directorate;
- €0.8bn as part of the five-year allocation to the special-purposes account for the public estate.

Through this channel, 39 administrative complexes, covering more than 600,000 m², will see their energy consumption lowered between now and 2022.

4.5.2.3 The route map for the energy transition in government buildings

The national route map for the energy transition in government buildings, signed in 2018 by the Public Estate Director, the Interdepartmental Delegate for Sustainable Development and the Director for Housing, Urban Development and Landscapes, sets a course and prescribes methodology designed to generate momentum for energy efficiency in the everyday management of the state's property assets.

Its aim is to support the pursuit of the objectives of the Climate Plan and the Plan for the Energy Renovation of Buildings. It provides methodological support designed to enable the state to respond to the need to reduce the energy consumption of buildings and reduce operating costs while also enhancing the value of its property assets.

The route map is the product of lengthy collaborative drafting. Since 2016, for instance, six thematic workshops have been attended by more than 80 participants, representing the whole spectrum of government property management.

The document revolves around eight major recommendations:

1. Establish periodic reviews to refresh knowledge of the occupied building stock and its energy consumption.

2. Carry out a diagnosis and segmentation of the building stock on the basis of its energy consumption levels.

3. Act on the rotation cycles of the building stock.

4. Act on the retained building stock.

5. Improve the monitoring of actions and communication relating to progress made.

6. Improve the training and support of stakeholders in the relevant trades.

7. Launch experiments to spark interest.

8. Make the energy transition part and parcel of the governance of the public estate.

It structures the scope for intervention of the Regional Conferences on the Public Estate (CRIP) and more especially that of the Regional Directorates for the Environment, Planning and Housing (DREAL) and their service arms in the *départements*, the DDT(M), to promote mainstreaming of the ecological transition in the management of the public estate.

4.5.2.4 Multiplication of low-investment measures

The route map also promotes low-investment approaches to energy saving, involving technical improvements and better uses of energy, which make it possible to cut energy consumption by almost 20% without significant amounts of investment. These approaches to energy saving have already been introduced in some buildings, notably in the context of the CUBE2020 contest organised by the French Institute for the Energy Performance of Buildings (IFPEB).

In this contest, buildings compete to achieve the greatest reduction in energy consumption in one year solely by means of technical regulation and better usage practices. A total of 24 public bodies entered 48 buildings in the third edition of the contest, which was supported by the Directorate for Housing, Planning and Landscapes (DHUP). The results were good, with average energy savings of 10% and a top saving of 23.5%.

In the next annual contest, which took place in 2019, five buildings belonging to the Government and its agencies achieved more than 25% energy savings by taking part in the competition.

The Cerema booklet *Diminuer la consommation énergétique des bâtiments: des actions simples et concrètes pour la gestion du patrimoine immobilier* ('Reducing the energy consumption of buildings: simple and practical measures for the management of property assets'), commissioned by the DHUP and published on 17 April 2019, is another resource designed to boost the take-up of these low-investment measures for government buildings.

In 2020, France will be launching an action programme for rapid reduction of energy consumption in the public estate. With a budget of EUR 20 million and open to innovations, the programme focuses on simple works that can quickly lower energy consumption, such as control and regulation devices for lighting, heating and air-conditioning systems, and targets widespread execution of such works by 2022. The aim, in short, is to multiply the number of low-investment measures across the entire portfolio of government buildings. The government bodies responsible for the public estate will launch a call for expressions of interest with a view to funding the most relevant schemes.

4.5.2.5 Eradication of oil as a heating fuel in government buildings

To prepare for the withdrawal of individual oil-fired boilers in less than ten years, an objective that should soon be announced officially, an inventory of sites occupied by government buildings that are still heated by oil was launched in December 2018 by the Public Estate directorate.

Oil is being used less and less as a heating fuel but still features as an energy source in the public estate.

In 2005, 13% of the total surface of government buildings was heated by oil. This share fell to 8% in 2009 and to 5%, or 774,000 m², in 2015, so the role of oil heating in public buildings is certainly in decline.

In 2017, the amount spent by the public treasury on heating oil was EUR 36 million, compared with EUR 29 million in 2016; this represents about 4% of annual energy expenditure.

In December 2018, the inventory compiled by the Public Estate Directorate, which was supplemented by an internal survey conducted by the Ministry of the Armed Forces, revealed that there were 3,500 oil-fired boilers in buildings occupied by the Government and its agencies. Of these, 2,700 are in buildings which the Government or its agencies own or for which they exercise proprietary responsibility. The remaining boilers – about 800 in number – are primarily the property of regional or local authorities.

The stock of oil-fired boilers is old; almost half of the inventoried boilers are 20 years old or more. The average output of the boilers is 180 kW, but there are 71 appliances with an output in excess of one megawatt.

The distribution of the boilers within the control of the Government varies widely between ministries. Almost 60% of the oil-fired boilers in the inventory are the property of the Ministry of the Armed Forces. The Ministry of the Interior is also affected, albeit to a lesser extent, with 12% of the oil-boiler stock.

An initial explanation of this need for heating oil could be found in the difficulty involved in supplying some sites with any other form of energy or the need to have a back-up energy supply.

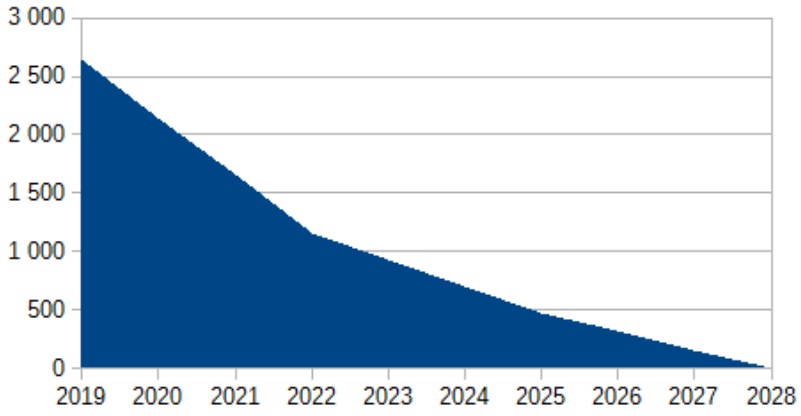
Various principles have been put forward regarding the stock of oil-fired boilers under the control of the Government and its agencies:

- setting 2008 as a target date for the abolition of the use of heating oil in government buildings;
- a ban on the installation of new oil-fired boilers in the building stock under the control of the Government or its agencies;
- a ban on major repair works on oil-fired boilers;
- adoption of the following timetable for the withdrawal of appliances:

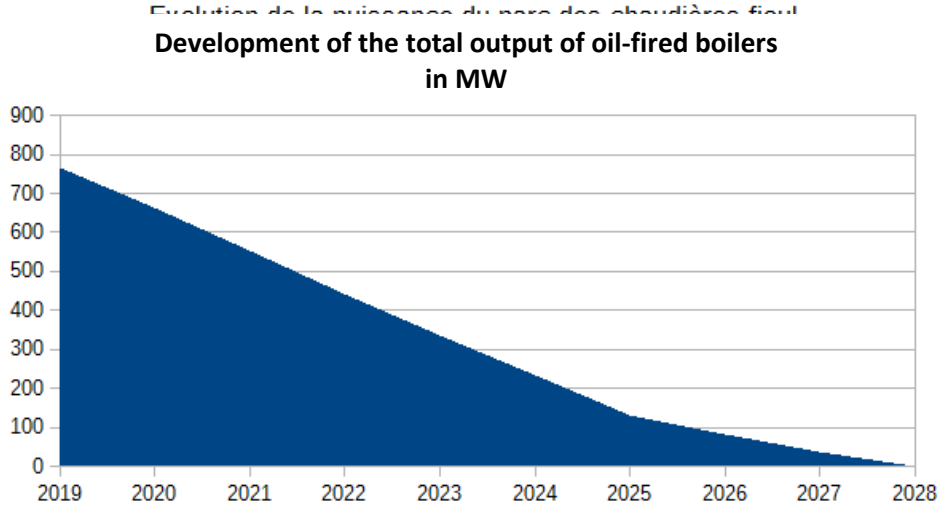
<table>
<tr><th>Installation date</th><th colspan="2">Output 0 to 200 kW</th><th colspan="2">Output 200 kW to 1 MW</th><th colspan="2">Output above 1 MW</th></tr>
<tr><td>Before 2000</td><td>Exit no later than 31 December 2022</td><td>639 boilers</td><td rowspan="2">Exit no later than 31 December 2025</td><td rowspan="2">1,188 boilers</td><td>Definition of an exit strategy before 1 January 2021
Exit no later than 31 December 2028</td><td rowspan="3">71 boilers</td></tr>
<tr><td>Between 2000 and 2010</td><td>Exit no later than 31 December 2025</td><td>303 boilers</td></tr>
<tr><td>After 2010</td><td>Exit no later than 31 December 2028</td><td>252 boilers</td><td>Exit no later than 31 December 2028</td><td>198 boilers</td></tr>
</table>

These stages have been chosen to smooth out the process of abandoning oil-fired boilers. The graph below shows the development of the number of operational oil-fired boilers of any output level:

Development of the stock of oil-fired boilers



The graph below shows the total output requirement met by the stock of oil-fired boilers:



For building stock where the Government or its agencies are lessors with no means of intervention with regard to heating appliances, there are plans to include the nature of the main heating fuel in the labelling criteria for leases. This would mean that a new lease could only be taken out on a building in future if it did not use heating oil or if oil were scheduled for replacement as the main energy source within the three years following the signing of the lease.

These leased buildings, moreover, are mostly held by regional or local authorities. A specific initiative could be envisaged, particularly through the Energy Saving Certificates (CEE) scheme.

Lastly, it seems paramount that systematic provision should be made for the connection of these buildings to district heating networks, and that could be established as a government commitment by the Working Group on Heating and Cooling Network.

4.5.2.6 Regional real-estate blueprints (SDIR)

For each region, regional real-estate blueprints (SDIR) define a target building stock and set out a plan of action, the ultimate aim being to rationalise and consolidate the property map and to improve the quality of the retained assets, including their environmental performance.

4.5.2.7 The labelling scheme for new building projects

The labelling scheme follows on from the aims of professionalising the design of building projects and verifying their conformity with the technical, economic and energy-efficiency criteria of government real-estate policy. In this way, attention is focused on the aspect of energy performance. That criterion is now an indispensable element of project analysis and must be the subject of close scrutiny, especially under the headings of building quality and expected energy-efficiency gains.

4.5.3 *The tertiary-sector building stock of local authorities*

When it comes to speeding up the renovation of their building stock, local authorities are confronted with difficulties regarding the funding and design of contracts or projects.

Financially, in the Big Investment Plan, the Government, in partnership with the Caisse des Dépôts, has assembled a toolkit for the funding of energy renovation of local authority buildings with a budget of three billion euros – two billion for soft loans and one billion for grants and subsidies.

These injections of funding can contribute to the conclusion of energy performance contracts, which are one of the instruments to be promoted. They serve to self-finance part of the investments and make it possible to obtain a guarantee from the project supervisor or from a company providing energy-efficiency services. They have proved their effectiveness, their use has stabilised, and they should now be rolled out on a wide scale. To this end, the interest-rate subsidies are being maintained through the Energy Saving Certificates.

In more general terms, besides the funding it will provide in the form of loans and equity finance, the Caisse des Dépôts, with the backing of the territorial network of ADEME, will support the local authorities when they devise their renovation projects. It will also support the creation of a property management blueprint to encourage property strategies which are coherent and which take energy renovation into account.

Besides the conventional public contracting model, for ambitious projects the Caisse des Dépôts will also finance internal performance contracting ('intracting') schemes. Intracting, which is often funded by virtual equity finance, makes it possible to account separately for the energy savings attained or future energy savings and assign them to energy-efficiency measures. This mechanism targets the fastest savings, particularly through action focused on user practice and system regulation, and automatically implies cash-flow savings for the local authorities, whose work is more than recompensed by the savings.

Lastly, to go further in removing the contractual, legal and institutional barriers, innovative arrangements will be encouraged.

The ability to undertake ambitious renovations is often hampered because of the fragmentation of ownership and management of buildings, especially school buildings, among local authorities. This makes it necessary to find mechanisms to facilitate pooling, at least at the intercommunal level.

4.6 Making the energy transition an opportunity for the building trades

The process of upgrading specialised skills in the building trades that was launched with the Plan for the Energy Renovation of Housing is taking place nationwide through a combination of several actions:

- improving the RGE ('recognised guarantor of the environment') quality mark system;
- continuing the CEE programme FEE Bat (training in energy-saving for builders);
- finalising the Action Programme for Construction Quality and the Energy Transition (PACTE) and the start of the CEE programme Profeel;
- supporting innovation in the field of energy renovation.

4.6.1 *Qualified specialists for quality work*

The national objectives for the energy renovation of buildings imply the need to upgrade tradespeople's skills and to ensure that small and large building firms are able to respond to the new markets that are developing, particularly as a result of government incentives and the eco-conditionality of state aid, introduced in September 2014 for the eco-loan and in January 2015 for the tax credit and the Energy Saving Certificates.

Accordingly, to benefit from the interest-free eco-loan, the energy transition tax credit – soon to be transformed into a grant – or Energy Saving Certificates, an individual must use a company with RGE registration, that is to say a tradesperson who meets the qualification criteria that will provide households with guarantees of quality work. Issued for a period of four years and monitored on an annual basis, the RGE qualification is based on staff training requirements, evidence of technical resources, evidence of professional liability insurance and checks on services rendered. In 2019, there are almost 58,000 RGE-qualified businesses, 85% of which have fewer than ten employees. The businesses holding quality marks can be found on the website www.faire.fr.

Some weaknesses in the RGE qualification system, however, have been revealed by surveys conducted by the consumer body *UFC-Que choisir* in 2016 and 2018 and the General Directorate for Competition Policy, Consumer Affairs and Fraud Control (DGCCRF) and a report published in 2018 by the General Council for the Environment and Sustainable Development (CGEDD), as well as by complaints and claims made by individuals against RGE-registered firms.

For this reason, with a view to enhancing the credibility of the scheme and developing it, the administration launched a large-scale consultation process in 2018 involving trade and professional organisations, qualification and certification bodies, consumer associations and the relevant administrative authorities. This consultation process served as the basis for initial regulatory developments during the summer of 2019, such as the changes in the nomenclature of the RGE works categories, which aligned them more closely with the associated vocational qualifications, and reinforcement of the system of on-site checks. These developments will enter into force in the first half of 2020. Others will follow, once the working groups, such as the group on training within RGE-registered businesses, have completed their deliberations.

4.6.2 *The FEEBat training programme as a source of ongoing support for specialists*

The introduction of environmental conditions for government support for works designed to improve the energy performance of buildings created a need to enable the maximum number of businesses and specialists to receive training that would enable them to enter the markets covered by government support and by the Energy Saving Certificates scheme. To achieve the energy performance targets for renovation works, members of the building trades need to understand the global character of the energy performance of a building and its implications in terms of execution quality and oversight.

Since 2007, the purpose of the FEEBat programme of training in energy-saving for builders has been to enhance the skills of members of the building trades. It receives funding from EDF in the Energy Saving Certificates framework, from the social security bodies run jointly by employers and unions (OPCA) and from the training benefit funds (FAF) for the building trades.

Since the programme was launched, more than 175,000 active members of the building trades have been through one of the 19 FEEBat training modules intended for construction businesses or one of the three modules in site management; 101,400 of these were trained during the last period, which ran from 2014 to 2017. Since 2014, 60,000 training courses have culminated in the award of a GRE quality mark. At the present time, about 1,000 trainees a month receive training under the FEEBat scheme.

Whereas the FEEBat programme was only for active members of the building trades until 2017, in the 2018-2020 period it has also been available to future members. One of the subject areas, in fact, concerns support for teachers and trainers in the training of future specialists under apprenticeship schemes, at school or in colleges of architecture. These new targets have served to include the Ministry of National Education and the Ministry of Culture in the programme alongside the occupational bodies that been involved since the birth of the programme.

In this new agreement, the accent is also placed on innovation in training arrangements so that each specialist, whether he or she is an active or future tradesperson, receives an individualised and innovative programme for the enhancement of his or her skills which combines face-to-face and distance training.

4.6.3 *PACTE and Profeel, two programmes to support the upgrading of trade skills*

4.6.3.1 PACTE

PACTE is a programme designed to support upgrading of the skills members of the building trades in the field of energy efficiency.

Its aim is to raise quality levels in building and renovation works so as to ensure better, faster and cheaper building and renovation.

Since 2015, PACTE has been designed to encourage the development of knowledge, the establishment of technical benchmarks and the provision of practical modern tools adapted to trade practices as well as to support local and regional projects developed for these purposes.

The programme is structured around three priorities:

- to develop, collate and increase knowledge relating to the number of accidents linked to the design and execution of energy-efficient construction and renovation works and the use of installed structures and appliances and to promote the dissemination of the most efficient technical solutions;
- to pursue the modernisation of building standards with regard to energy efficiency and to develop training tools for the execution of works and self-regulation on sites of all sizes;
- strengthen local and regional measures for the development of skills in the building trades in liaison with regional stakeholders.

Among the measures that are supported, mention may be made of the series of digital guides (*calepins de chantier*) that are intended for site workers and present building standards for particular operations in an informative way with illustrations, of the development of tools for the measurement of intrinsic energy efficiency of a building when it is handed over and projects focused specifically on a particular type of material.

At the sub-national level, the programme has supported about forty projects spread across the whole of France for the upgrading of occupational skills in the building trades, particularly the provision of several MOOCs (massive open online courses) and of instruments devoted to basic or continuing training; there have also been about forty overseas projects designed to adapt these techniques to specific local conditions and to establish regional structures for the building trades.

PACTE will end on 31 December 2019. A catalogue presenting all of the deliverables offered by the programme is currently being compiled.

4.6.3.2 Profeel

Profeel, the CEE programme of the building trades for the promotion of innovative energy savings in the construction sector, is dedicated to innovation in the field of energy renovation. It has been allocated a budget of EUR 24.55 million over two years, financed by Energy Saving Certificates along with a panel of funders. It falls within the framework of the Plan for the Energy Renovation of Buildings and particularly priority 4 of the Plan – Boosting skills and innovation.

The steering committee for Profeel comprises actors from the construction sector, funding bodies, the public authorities and project promoters – the Scientific and Technical Centre for Building (CSTB) and Agence Qualité Construction.

The nine projects that make up the programme respond to four objectives:

- to promote smart uses and so establish responsible behaviour patterns;
- to strengthen the results culture to inspire confidence in citizens and building owners by providing them with technical and economic data relating to performance levels on completion of renovation works;
- to be innovative within processes, particularly by supporting the development of digital tools to promote the energy performance of buildings, the quality of renovation works and smart energy use;
- to develop solutions to create and satisfy mass demand for energy renovation.

The role of the programme's secretariat-general has been entrusted to Agence Qualité Construction. The findings of these nine projects will be the subject of communications as they proceed, and their results will be processed by May 2021.

4.6.4 *Supporting innovation in the field of energy renovation*

Support for innovation will be a key to the fulfilment of ambitions in the field of energy renovation. Several public mechanisms exist at the present time.

The scheme operated by Scientific and Technical Centre for Building (CSTB), a public industrial and commercial undertaking, is intended to support stakeholders in introducing innovations and to guarantee sustainable building and energy-renovation projects that are in tune with the energy, environmental and digital transitions. The CSTB continues to make the assessment of innovative products more accessible: developments of the technical-opinion procedure, a national support network, technical and financial support services located in the provinces. The aim is to facilitate the emergence and market access of innovative building products and processes in the sphere of the energy, environmental and digital transition. The CSTB is also a driver of the digital revolution, for example through CSTB'LAB, a start-up accelerator for construction businesses. It is participating in Profeel, the programme described in the previous paragraph, through projects entitled *Renostandard* (full renovation and greater energy efficiency in one-dwelling houses), *Go Rénove* (innovative tool to assist with renovation decisions) and *Qualité sanitaire et énergétique des rénovations* (measurement methods for energy and health and safety performance).

The Future Investment Programmes (PIA) of the Secretariat-General for Investment (SGPI) provide numerous centres managed by various operators where innovative building projects may be submitted. In the framework of the PIA initiative *Démonstrateurs et territoires d'innovation de Grande ambition*, operated by ADEME, the ministry responsible for building takes care to ensure that the renovation issue is included in the initiative. The Flash calls for projects to be issued as part of that initiative are currently being formalised. The philosophy behind these calls for projects is that they should support public policies which are currently being pursued. This means that subjects like construction waste or renovation will benefit from treatment. It is also worth noting the call for projects entitled *Système énergétique – villes et territoires durables*, open from July 2019 to January 2020. It is open to innovative projects designed to generate impetus towards the creation and satisfaction of mass demand for the renovation of buildings.

The innovation contests that are held once a year are also a matter of interest, as they serve to bring forth innovative solutions that tend to be most relevant to start-up businesses and SMEs.

Lastly, initiatives aimed at value chains are being created and should be further pursued, such as the calls for industrial projects for the future and for competitiveness development projects and the initiative for improving the transformation of supply chains, which promotes the pooling of resources and supports the creation of digital platforms.

In this abundance, there is a need to ensure that innovations relating to energy renovation are supported in selection processes, to clarify the panorama of innovation incentives made available to businesses, to direct innovators towards the right windows and to bring forth projects to create new windows if necessary.

MOOC BÂTIMENT DURABLE

MOOC Bâtiment Durable ('MOOC Sustainable Building') is a **platform offering MOOC-type training** (massive open online courses), that is to say training courses which are free of charge, open to anyone and constantly accessible. The courses on offer consist of educational resources (videos and documents) and offer individual or collaborative activities that enable users to assess their level of knowledge. The aim of the platform, which is hosted by ADEME and the Sustainable Building Plan, is to **provide access to the best online training courses in sustainable building**.

MOOC Bâtiment Durable was launched in November 2006 and operates on the basis of shared governance with stakeholders in the sector – trade and professional organisations, training bodies and associations).

At the beginning of January 2018, there were almost **20,000 people registered on the platform**, most of them working in the sector. For the start of the new session in 2019, the platform is offering about 15 courses, including one devoted to understanding and acting on energy poverty and another on improving the energy efficiency of tertiary-sector buildings. ADEME and the Sustainable Building Plan regularly launch **new calls for applications in order to enrich the platform** and to meet the specific needs of stakeholders in the sector.

The Web gateway of *MOOC Bâtiment Durable* is at https://www.mooc-batiment-durable.fr

4.7 Prioritising and promoting local and regional authority initiatives

4.7.1 *Government support and monitoring of local and regional authority schemes to encourage the energy renovation of buildings*

4.7.1.1 Framework provided by the Energy Transition for Green Growth Act (LTECV)

The LTECV gives sub-national authorities a stronger role in the implementation of energy policies with different responsibilities for each tier of government:

- **The region is the planning tier, which means that it is** 'the proper tier for coordinating studies, distributing information and promoting actions relating to energy efficiency (LTECV, Article 188). Under the New Territorial Organisation of the Republic Act (*Loi portant nouvelle organisation territoriale de la République – Loi NOTRe*), by 2019 each region is to adopt its Regional Blueprint for Planning, Sustainable Development and Territorial Equality. The Regional Energy Efficiency Programme, which will be an integral part of that planning strategy, will define the Public Service for Housing Energy Performance on the basis of a framework set out in Article 22 of the LTECV, which should enable regions to offer support for the energy renovation of buildings to every household.
- **At the sub-regional level**, Article 22 of the LTECV stipulates that the Public Service for Housing Energy Performance (SPPEH) will be supported by a network of local energy renovation platforms. These platforms will perform essential basic functions and may, as an optional extra, take on responsibilities for generating demand, reaching out to the building trades or providing consumer guidance. The activity of local energy renovation platforms as defined by the law is therefore geared to providing information as a service of general public interest and must therefore be exercised from a neutral standpoint, impartially, objectively and free of charge.

4.7.1.2 The SARE programme

The CEE programme Energy Renovation Support Service (*Service d'accompagnement à la rénovation énergétique* – SARE), launched in September 2019 with a maximum budget of EUR 200 million for the period from 2019 to 2024, has the aim of supporting the establishment of sub-national SPPEH centres.

This programme should serve to generate fresh regional and local dynamism in energy renovation, mobilising all regional and local tiers of government and building-sector networks. The intention is to channel this dynamism into general support for the development of a high-quality range of building services, the upgrading of tradespersons' skills and the development of collective practices designed to encourage households and businesses to renovate their buildings.

With regard to the provision of information and advice to households, the CEE programme should offer a framework and co-funding mechanisms to back up that information and advice and to assist people in their renovation projects in close liaison with local authorities.

The programme will also serve to lend more effective support to households and small operators in the tertiary sector on the path to energy renovation. It will offer households an information and support process for their energy renovation projects. In the first instance, the programme is designed to ensure good linkage with the

everyday contacts – town halls, the Maison France Service administrative service centres, etc. Secondly, it is intended to consolidate the FAIRE network initiated by ADEME, ANAH and ANIL in consultation with the local and regional authorities.

The duration of the CEE programme in each territory will be three years. It will be rolled out first of all to regions where the regional authorities are prepared to give a commitment by the end of 2019. It may start later in the other regions, where the regional authorities will be able to sign up to the programme whenever they are ready. The calendar for the implementation of each regional programme, however, is to fit into the overall time frame of 2019 to 2024.

This programme will provide part-funding, alongside that of the regional authorities, for each operation implemented by the FAIRE services. The rate of this part-funding must not exceed the rate of the part-funding currently provided by ADEME for pending measures and must not exceed 50% of the expenses defined as eligible in the programme, whether the measures are new or have been implemented without external funding.

The programme will be framed by a national agreement and by agreements concluded in each regional community. Regional deployment plans will serve as a basis for the conclusion of these agreements. The plans will be binding as regards targets, the nature of the measures and the resources put in place to achieve the objective.

4.7.1.3 Regional dynamism pooled and supported by the regional Sustainable Building Plans

Since 2012, the dynamism generated nationally by the Sustainable Building Plan has also been channelled into seven pilot regions. In those areas, special encouragement on the part of the Regional Council, in close liaison with regional stakeholders, is truly serving to generate more activity, to promote collaborative ventures and to establish innovative mechanisms, primarily for the energy renovation of housing. These approaches will fit seamlessly into the future regional energy efficiency programmes (PREE) for which the Energy Transition for Green Growth Act provides.

4.7.1.4 Funding and publicising of projects piloted by local and regional authorities

The *Action cœur de ville* programme

The national plan of action for town centres (*Action cœur de ville*) has a twofold aim, namely to improve the living conditions of people in medium or large towns and to reinforce the role of those towns in regional development.

Devised in consultation with the Villes de France association, local councillors and three national funding partners, the programme is intended to facilitate and support the work of local authorities, to induce stakeholders in the realms of housing, trade and urban planning to reinvest in town centres and to promote the preservation or location of activities in town centres with a view to improving living conditions in medium and large towns. Built around a regional development plan, the revitalisation measures will engage both the municipality and the intercommunal entity to which it belongs as well as private and public partners. On the basis of a full diagnosis of the present situation in the relevant town centre, a local project committee will define the specific improvement measures to be taken in the following five priority areas:

- rehabilitation and restructuring of town-centre housing;
- economic and commercial development;
- accessibility, mobility and connectivity;
- making the most of public space and the built heritage;
- access to public services and equipment.

Through this plan, central government plays a facilitator role to enable regional and local authorities to develop their own projects. To this end, a sum of five billion euros has been allocated from the national budget for a five-year period, one billion euros of which is held by the Caisse des dépôts as equity capital and 700 million for lending, while a sum of 1.5 billion has been allocated to the Action Logement service and 1.2 billion to the National Housing Agency (ANAH).

A total of 222 authorities are benefiting from the national *Action cœur de ville* plan, which enables them to implement energy renovation projects on a district-wide scale, covering housing, public buildings, commercial premises, etc.

The Big Investment Plan

France's Big Investment Plan (*Grand plan d'investissement*) provides for various support schemes over the period from 2017 to 2022, with a budget of three billion euros, for the renovation of buildings owned by local or regional authorities, divided as follows:

- EUR 2 billion for low-interest loans issued by the Caisse des dépôts under the GPI AmbRE facility;
- EUR 0.5 billion as equity capital of the Caisse des dépôts for investment in energy performance contracts or innovative funding mechanisms such as *Intracting*.[35]
- EUR 0.5 billion for the Local Investment Support Allocation (DSIL). This is a direct government subsidy which is much used by local authorities.

Within the publicly owned stock of tertiary-sector buildings, school buildings – primary schools and lower and upper secondary schools) account for a total surface area of some 150 million square metres, representing more than half of the property portfolio of regional and local authorities. They are therefore a priority target for efforts to reduce greenhouse-gas emissions in that sector. The Government therefore wishes to support the sub-national authorities in the renovation of their own building stocks. Beyond the funding aspect, an agreement was concluded on 30 May 2018 by the Government, ADEME and the Caisse des dépôts with a view to establishing a comprehensive support system for the renovation of buildings belonging to regional and local authorities (local outreach, awareness-raising and incentivisation, support for skill development in regional and local authorities, etc.).

Accounting for 30% of the consumption of all municipal buildings, schools, for example, remain the most energy-intensive type of building ahead of sports facilities and socio-cultural buildings.

Besides the challenge and the obligation to reduce the energy consumption of these buildings, public action on this segment of the building stock also makes a powerful educational point about energy saving. While the Climate Plan drew attention to the exemplary role that had to be played by public buildings in terms of energy renovation, the Plan for the Energy Renovation of Buildings also highlighted the need to intensify efforts to educate and raise awareness with regard to good practices in the use of energy. The renovation of school buildings, then, serves to combine these two objectives, for example by educating the young generation.

4.8 Reconciling energy renovation with preservation of the architectural heritage

Article L1 of the Heritage Code defines heritage as 'the set of assets, movable or immovable, in public or private ownership which are of historical, artistic, archaeological, aesthetic, scientific or technical interest'.

The Architectes des Bâtiments de France, a body of architects within the Ministry of Culture, have a public duty to maintain and conserve the architectural heritage – both listed and unlisted buildings – and to provide free and impartial advice on other edifices belonging to the national cultural heritage. These architects help to compile financial and technical files for restoration projects and ensure that works are executed properly in accordance with the prescribed standards. In this capacity, the Architectes des Bâtiments de France have a *droit de regard* over energy renovation work on protected heritage properties.

Historic monuments, like the local built heritage, are not, in principle, exempted from pursuit of the general objective of energy renovation of the national building stock. On the other hand, every project relating to a specific building must be approached with due respect for the architectural, historical and aesthetic qualities of the building. Accordingly, the regulations demand a global technical diagnosis, which incorporates a collective EPC assessment or an energy audit and is the prerequisite for energy renovation works.

[35] Innovative funding scheme that serves to create a virtuous circle of funding derived from energy savings to finance renovation works.

In addition, the statutory provisions allow for exemptions in cases where renovations are technically or architecturally impossible if it is ascertained that they would detract from the architectural, historical or aesthetic qualities of the building or that they would be insufficiently cost-effective because of an excessive payback time or prohibitive costs.

Innovation should be encouraged with a view to developing technical solutions that tally with the particular characteristics of the building. PUCA is working on this.

PUCA (*Plan Urbanisme Construction Architecture*) is an interministerial research and experimentation body on urban planning, building and architecture under the supervisory authority of the Ministry for the Ecological and Inclusive Transition, the Ministry for Territorial Cohesion and Relations with Local Authorities, the Ministry of Culture, the Ministry of Higher Education, Research and Innovation.

Since its creation in 1998, PUCA has been developing incentive-research programmes and experimentation initiatives and has been supporting innovation and the dissemination of technical and scientific findings in the fields of spatial planning, housing, construction and architectural and urban design.

In particular, since 2011 PUCA has been conducting the REHA programme, in which a holistic approach to rehabilitation is pursued with a view to developing operations through which energy, environmental and comfort standards equivalent to those of new-builds can be achieved and to promote a revival of architectural quality while presenting enduring solutions for urban restructuring. To this end, it encourages and supports the emergence of innovative and adaptable low-carbon solutions. By means of experiments and through the associated studies, research and evaluations, REHA is designed to develop knowledge and create facilitating tools that can be used to deal with all aspects of mounting these operations – programming, finance, contracts and regulatory and legal requirements.

The national experimentation and research programme REHA is based on an aspiration to support the development of deep renovation of residential buildings, or the conversion of buildings into dwellings on the basis of an environmental, economic and social vision and with a view to driving a new culture of heritage conservation and urban renewal.

This programme is conducted in association with the following partner bodies: the Social Union for Housing (USH), the National Housing Agency (ANAH), the National Urban Renewal Agency (ANRU), the National Union for the Housing of Young Persons (UNHAJ), the National Centre for University and School Welfare Services (CNOUS) and Association of Heads of Building Management Bodies (ARC).

Lastly, it should be noted that the Effinergie association, with the support of the ministry responsible for architecture and the national heritage, ADEME and the DHUP, launched an experimental heritage label, *Effinergie Patrimoine*, in September 2019.[36] This label has three objectives:

- energy renovation to BBC level;
- preservation of the built heritage;
- improvement of the quality of life in those buildings.

The experiment will run for two years with the aim of developing the scheme gradually in the light of feedback and with due regard to the difficulties involved in reconciling these three objectives.

The experimental label is intended for all heritage buildings. A committee composed of experts in architecture, energy and heritage properties will meet on a quarterly basis.

[36] For more information (in French), see the website of the Effinergie association at https://www.effinergie.org/web/les-labels-effinergie/le-label-effinergie-patrimoine

CREBA is the **Resource Centre for the Responsible Rehabilitation of Old Buildings**. This portal is for specialists in the construction sector (site supervisors, architects, consultants, tradespersons, clients, technicians, experts, researchers, etc.) and, more generally, for anyone involved in a project for the rehabilitation, energy renovation or restoration of an old building. The CREBA portal **brings together several aids to the pursuit of a holistic approach to the rehabilitation of old buildings**. In particular, this online resource centre contains:

- bibliographies of studies and works published locally and nationally
- case reports of operations reconciling heritage conservation and energy renovation
- a decision-making tool in the form of a French adaptation of the 'Guidance Wheel' devised by the British organisation Sustainable Traditional Buildings Alliance (STBA).

The Guidance Wheel makes it possible to **compare various rehabilitation solutions from technical, heritage and energy angles**, to identify the concerns associated with each of these solutions and to assemble packages of measures. The wheel presents **more than 50 possible measures** for the retrofit of a traditional building.

It guides you in the choice of measures by showing their advantages and disadvantages as well as the links between them.

The CREBA portal is a collaborative tool administered by Cerema, the Centre for Studies and Expertise in Risks, the Environment, Mobility and Planning, together with the École des Arts et Métiers Paris Tech, the Architectural Research Laboratory of the École Nationale Supérieure d'Architecture of Toulouse, the Maisons Paysannes de France association and the Sites et Cités Remarquables de France association.

The Resource Centre for the Responsible Rehabilitation of Old Buildings is supported by the ministerial Action Programme for Construction Quality and the Energy Transition (PACTE) under the heading of Priority 4, which covers digital decision-making aids for renovation strategies.

Resource Centre website: http://www.rehabilitationbatimentancien.com/fr

4.9 Reconciling energy renovation and public health

The energy renovation of buildings should not be considered solely in terms of energy performance but on the basis of a holistic approach. When energy renovation works are arranged, they should take account of other factors such as fire safety, accessibility, health protection and acoustics.

4.9.1 *Energy renovation and IAQ*

It is important that improvement of the quality of the envelope or energy performance of a building does not diminish its comfort level or impair the health of its occupants. As buildings become increasingly airtight to conserve heat or coolness, thinking about the choice of materials and air exchange should serve to avoid the risk of trapping and concentrating in the indoor air pollutants emitted by heating systems, materials, furnishings or the occupants themselves.

The regulations that have been enacted are intended to promote the choice of building materials that release the lowest volumes of volatile pollutants and the installation of adequate air-extraction and ventilation systems.

4.9.1.1 Building materials

The impact on indoor air quality (IAQ) of the various building materials and products, including adhesives, paints, etc., is often underestimated. In order to limit the sources of air pollution, it is essential to refer to:

- the labels of building products for information regarding emissions of volatile pollutants, which are indicated in the form of a performance class, ranging from A+ (very low emissions) to C (high emissions).[37]
- the environmental and health declaration (FDES); these declarations, drawn up by certain industrial manufacturers or groups of manufacturers in accordance with French standard NF P 01-010, may show the emissions of volatile pollutants of products, particularly volatile organic compounds (VOCs) and formaldehyde, the risks of fibre release, resistance to micro-organisms, hygrothermal comfort, etc.[38]

4.9.1.2 Energy performance and air extraction/ventilation in existing building stock

When works for the improvement of energy performance are undertaken in existing buildings, compliance with minimum standards is required, particularly as regards air exchange.

In the case of deep renovations of buildings with a floor surface area exceeding 1,000 m² which were completed after 1948, those buildings must fulfil an overall energy performance requirement, and air exchange must be ensured, either through room-by-room ventilation with air intakes of at least a prescribed minimum capacity in the main rooms or by means of a general and permanent ventilation system (General Thermal Regulations for existing buildings[39]).

Other buildings undergoing energy-performance improvement works are subject to what are known as the 'element-by-element' Thermal Regulations for existing buildings.[40] Those regulations set minimum thermal performance requirements for each element to which the works relate. Particularly in the case of window replacements in places of residence or accommodation, the new windows in the main rooms must be equipped with air vents of a minimum size – except, of course, in rooms that are already fitted with air intakes. These same Thermal Regulations for existing buildings also require high and low air intakes to be retained when opaque walls are insulated, unless the works entail the installation of another ventilation system.

It should be noted that a deficient ventilation system can be a health hazard for occupants by restricting air exchange and so encouraging the development of mould, for example.

4.9.1.3 Energy performance and radon in existing buildings

Radon is a natural colourless and odourless radioactive gas that is present in variable concentrations, particularly in the ground. It is rapidly diluted in outdoor air, but may accumulate in enclosed and confined spaces and reach significant concentrations.

Since 2016, radon has been regarded as an indoor air pollutant.[41] Its management is catching up with IAQ improvement policies. Works that are undertaken to improve energy performance should therefore be accompanied by measures to ensure sufficient air exchange, as described in the previous point, in order to avoid excessively high concentrations of radon in buildings.

The most relevant works in this respect are:
- insulation of buildings
- window and door replacements

[37] Statutory order of 19 April 2011 concerning the labelling of building products and of wall or floor coverings and of paints and varnishes regarding their emissions of volatile pollutants, as supplemented by the amending order of 20 February 2012 and Articles L.221-10 and R.221-22 to R.221.28 of the Environment Code.

[38] For more information, see the INIES website at www.inies.fr, which publishes the database of building products sold in France.

[39] Statutory order of 13 June 2008, as amended on 22 March 2017, concerning the energy performance of existing buildings with a surface area exceeding 1,000 m² when they undergo major energy renovation works.

[40] Statutory order of 3 May 2007 concerning the thermal properties and energy performance of existing buildings.

[41] Order of 10 February 2016 establishing various provisions regarding nuclear matters.

- installation of a wood-burning heating system (chimneys, insert stoves, free-standing stoves): it is important to provide for a dedicated air intake in order to avoid infiltrations of radon from the ground into the building.

4.9.1.4 Critical points

- Internal and external insulation: thermal insulation of a wall alters the airtightness of a building. Such a measure may create the need to review the existing system of air exchange so as to avoid condensation on cold walls and the appearance of mould. In addition, thermal wall insulation must not block air intakes (see above).
- Replacement of windows and external doors: this measure improves airtightness. Replacement operations must be accompanied by an analysis of air exchange and possibly the renovation of the ventilation system, if one exists (see the requirements of the 'element-by-element' Thermal Regulations for existing buildings above).
- Replacement of heating systems: combustion systems must be regularly checked to prevent carbon monoxide poisoning (cf. Articles L131-7 and R131-31 to R131-37 of the Building and Housing Code (CCH) on the prevention of carbon monoxide poisoning in premises used for residential purposes). In the case of wood-burning heating systems, provision must be made for special air intakes.
- When installing a ventilation system, choose a robust system which is fit for its intended purpose and with maintenance requirements appropriate to the occupants. From the design stage, provide for fittings that will facilitate maintenance, such as inspection doors and access to the ventilation unit. On installation, provide for checks to ensure that the system is working properly. When the system is operational, inform the occupants of the need to undertake regular maintenance by cleaning air outlets and, where appropriate, changing filters and to avoid obstructing outlets or obscuring them with furniture.
- Other applicable provisions:
  - Monitoring of IAQ in certain facilities open to the public:
    - Article L.221-8 of the Environment Code
    - Decree of 2 December 2011 concerning the monitoring of IAQ in certain facilities open to the public
    - Decree of 5 January 2012, as amended on 30 December 2015, concerning assessment of means of ventilation and measurement of pollutants in the context of IAQ monitoring in certain facilities open to the public
    - Decree of 17 August 2015 concerning detailed rules for monitoring IAQ in certain facilities open to the public
    - Statutory orders of 1 June 2015 concerning detailed rules for monitoring IAQ in certain facilities open to the public and for the presentation of the report on the assessment of means of ventilation
  - Monitoring of radon in certain facilities open to the public and in workplaces
    - Decree of 4 June 2018 establishing various provisions regarding nuclear matters
    - Decree of 4 June 2018 concerning the protection of workers from risks arising from ionising radiation
    - Statutory order of 26 February 2019 concerning detailed rules for the management of radon in certain facilities open to the public and for the distribution of information to persons who frequent those facilities
  - Guideline values for indoor air
    - Article L.221-1 of the Environment Code
    - Decree of 2 December 2011 concerning guideline values for indoor air (formaldehyde and benzene)
  - Guide: *Construire sain – Guide à l'usage des maîtres d'ouvrage et maîtres d'œuvre pour la construction et la rénovation* ('Healthy building - a guide to construction and renovation for the use of clients and site

supervisors'), published in April 2013, with a supplement on reconciling the requirements of clean air and comfort, added in October 2015.

4.9.2 *Energy and acoustic renovation*

Energy renovation works must be carried out with due regard to noise regulations relating to buildings located in areas subject to significant noise.

These regulations concern residential buildings, living quarters in educational establishments, accommodation and care facilities in health establishments and bedrooms in hotels located on the periphery of the noise pollution map of an airport or in an area where the maximum levels defined by road and rail traffic noise maps are exceeded.

Applicable provisions:

- Decree of 14 June 2016 implementing the Energy Transition and Green Growth Act (Law No 2015-992 of 17 August 2015) – Article 14, codified in Article L 111-11-3 of the Building and Housing Code);
- Statutory order of 13 April 2017 concerning the acoustic properties of existing buildings in the context of major renovation works.

4.9.2.1 Critical points

- The noise regulations that apply to existing buildings on the basis of their construction date must be observed.
- The improvement of thermal performance, by limiting the transmission of external noise, may lead to more acute awareness of internal noise, especially sounds from ventilation systems. Occupants may therefore be disposed to block air inlets or outlets or even to shut down the ventilation system.
- Some thermal insulation works on external walls, such as the replacement of windows or glazing units, may lower the initial acoustic performance of those walls; for this reason, it is preferable to use thermo-acoustic products, which combine thermal and acoustic properties.
- *Concilier efficacité énergétique et acoustique dans le bâtiment* ('Combining energy and acoustic efficiency in construction'), published by the Scientific and Technical Centre for Building (CSTB) and the General Directorate for Planning, Housing and Nature (DGALN), is a guide designed to raise awareness among stakeholders in the building sector of the importance of an approach that incorporates both aspects.

4.9.3 *Energy renovation and asbestos*

Although it has been banned since 1996, asbestos is still present in very large quantities in buildings – in asbestos-cement sheeting, floor slabs, caulking compounds, tile cements, etc. Renovation works, involving operations such as sanding and drilling, can be the source of very high exposure levels. A preliminary site appraisal is essential so that the financial impact of asbestos removal can be assessed before the renovation work begins and does not come as a surprise during the operations.

The regulations require the identification of asbestos before any work takes place on buildings constructed prior to 1997 in order to protect the health and safety of site worker and the general public.

Applicable provisions:

- Decree of 24 December 1996 concerning the prohibition of asbestos;
- Decree of 9 May 2017 concerning the identification of asbestos before certain operations;
- Statutory order of 16 July 2019 concerning the identification of asbestos before certain operations conducted in built properties and its amendment of 23 January 2020.

4.10 Observing and evaluating renovation policy

One of the actions in the Plan for the Energy Renovation of Buildings was improvement of energy-renovation monitoring and of access to data.

Significant work is needed on the knowledge base. This was emphasised by the European Commission in particular in its assessment of the updated strategy in 2017.[42] There is insufficient knowledge about the state of the building stock, both residential and tertiary-sector, and the same applies to energy consumption levels as well as to the volume of renovation work that has been performed. Besides the shortage of reliable data, questions also arise about the accessibility of the available data for public and private stakeholders and for specialists in the building sector. Yet they need to obtain such information to pursue and monitor their activity more effectively and to create new highly beneficial services.

4.10.1 *Monitoring the dynamics of renovation and evaluating public policies*

The first requirement is being able to monitor satisfactorily the dynamics of renovation and the associated public policies, be they national or sub-national. There is a wealth of data – ADEME surveys on renovation works in one-dwelling houses, the Energy Performance Certificate (EPC) database, data from the regional observatories, and so on, but they remain incomplete and are not sufficiently structured to allow a robust assessment of the policies that are being pursued.

To establish knowledge of the number of renovated dwellings and tertiary-sector buildings, the condition of the stock of government and regional and local authority buildings, the expenditure incurred and the energy savings made, provision should be made for more systematic sharing of information, especially in connection with the distribution of renovation incentives (Energy Saving Certificates, grants replacing the interest-free eco-loan, ANAH support, local grants, etc.).

4.10.2 *Putting knowledge and data regarding renovation at the service of stakeholders*

There is also a need to make the relevant data available to those who novation projects – local authorities, renovation specialists in the building trade or property managers, etc. All parties' ability to monitor and target as well as the quality of services could only benefit.

Lastly, in the era of big data and open data, cross-referencing and joint compiling of data are essential instruments of public policy matching the spirit and letter of the Act for a Digital Republic as regards the opening and sharing of data.

In this context, the teams responsible for the *GreenTech verte* initiative arrange periodic 'hackathons', where public and private actors conceive start-up projects on the basis of data made available by the public authorities. One of these sessions is due to take place right at the start of 2020.

4.10.3 *Creating a national energy renovation observatory and providing it with the resources for an ambitious mobilisation of data*

The Data and Statistical Studies Department of the Commission-General for Sustainable Development was commissioned in 2019 by the ministries in charge of housing and energy to undertake the work required for the creation of this observatory. The Department will draw the existing mechanisms into a coherent whole to create and activate a genuine National Energy Renovation Observatory. Its task will be to ensure that links are created with the existing stakeholders and that important contributors are brought on board, such as the network of Centres for Income and Expenditure Studies (CERC), the Low-energy Buildings (BBC) Observatory, the French Environment and Energy Management Agency (ADEME) and the National Observatory of Energy Poverty.

[42] Assessment of second long-term renovation strategies under the Energy Efficiency Directive (2019)

As part of its general remit of data supervision, with the aid of Etalab and in consultation with the secretariats-general of the Ministry for the Ecological and Inclusive Transition and the Ministry for Territorial Cohesion the Commission-General for Sustainable Development will lead an effort to identify, qualify, mobilise and 'APIse' data and make them available to all stakeholders. The Commission-General will draw on the work that the Directorate for Housing, Planning and Landscapes (DHUP) has already done to open its own data and on the work of the National Observatory of Energy Poverty. In this framework, other stakeholders are likely to be mobilised by the new observatory: energy companies, the tax administration, the National Authority for Energy Saving Certificates (PNCEE), the Public Estate Directorate (DIE), ANAH, ADEME, local authorities, providers of renovation advice and support, etc. So that the data mobilised in this way can be exploited in an innovative way, cooperation with start-up businesses will be encouraged, and a government start-up could be created, if appropriate. Precise targeting of the most energy-intensive buildings, of the most vulnerable households or of areas that best lend themselves to large-scale operations are just some of the paths to be explored.

Besides its task of studying and analysing the dynamics of renovation and the public policies that are being pursued, the new observatory will seek to consolidate knowledge on the supply of renovation service in order to provide individuals and the market with reference points and instil confidence. In particular, this will involve constructing indicators of average prices for the most common measures, identifying market practices, such as the use of financial incentives, Energy Savings Certificates and 'packaged' loans) and highlighting standard operations and specific scenarios. In performing this function, it will capitalise on work that has been performed locally and regionally and will be able, in return, to feed information into the public service responsible for the energy performance of housing.

This work began in 2019 and will be based on an preliminary configuration of the observatory initiated by ADEME with the support of a service provider. It will take a year and will be divided into four stages, culminating in the delivery of its first output in 2020:

- Stage 1: consolidation of a scoreboard, permitting up-to-date monitoring of progress towards renovation targets;
- Stage 2: consultation of stakeholders, which will be done on a sufficiently wide scale to encompass all potential users;
- Stage 3: observatory benchmarking with the aim of determining why and how the oldest observatories still exist and which resources have made them so durable;
- Stage 4: definition of operational arrangements for the generation and management of data.

Siterre and Casbâ

These two additional tools enable sub-national authorities to pursue their energy renovation policies from the identifying the challenges to monitoring on-site project execution.

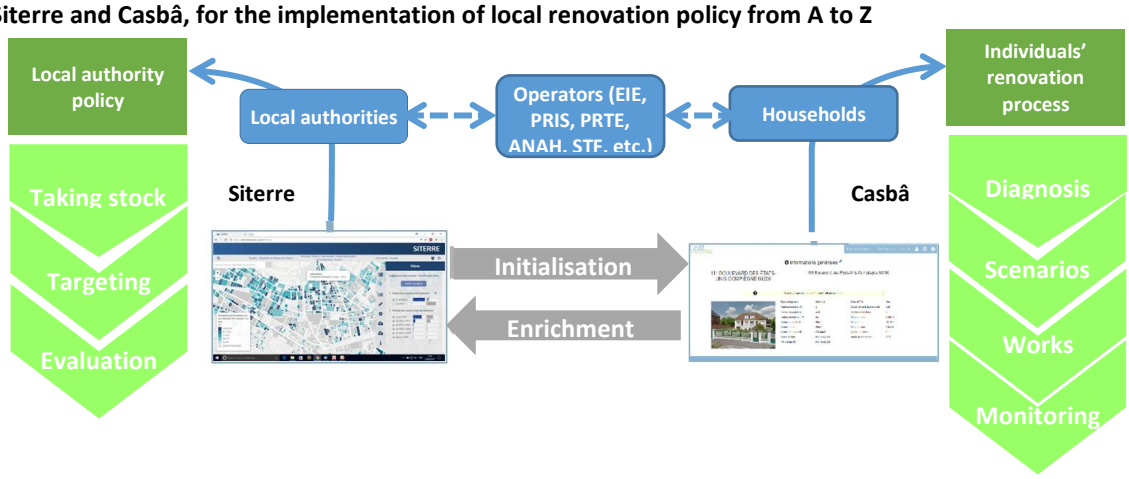
Siterre, the sub-national energy information system of the consultancy firm Énergies Demain, is a **cartographic aid to the definition and monitoring of regional and local policy**. Every French dwelling is characterised there (building type, construction period, wall material, etc.) and modelled by Énergies Demain (consumption for each type of energy use, EPC ratings, etc.). **Siterre offers every sub-national authority the opportunity to quantify its housing challenges and to target and monitor its renovation policy** in accordance with the characteristics of each building.

Casbâ is **the grass-roots aid to policy implementation**. It enables its users to estimate quickly, without having to move about their home, the impact of precisely defined renovation scenarios in terms of energy savings, cost, etc., and to keep a record of executed works. It is designed for one-dwelling houses and may be used by individuals or by operators delegated by local or regional authorities.

The two tools are interfaced. Siterre automatically feeds Casbâ to initialise it with the aid of the existing public data. Once Casbâ has been used and the household has given its consent, information is uploaded to Siterre (works executed on the housing stock, etc.).

Under an Energy Saving Certificates (CEE) programme, the Government concluded an agreement with Energies Demain and the programme funders to provide for **the distribution of 80,000 Casbâ digital logbooks** and for the identification of 12,000 households that have had energy renovation works done.

Siterre and Casbâ, for the implementation of local renovation policy from A to Z



Project promoter's website: https://www.energies-demain.com/

As the work of the observatory is not sufficiently advanced at this stage, it is not yet possible in the framework of this strategy to present the renovated proportion of the housing stock in 2020.

5 ESTIMATE OF EXPECTED ENERGY SAVINGS

5.1 Presentation of the SNBC and the PPE

The French energy and climate strategy, based on the National Low-carbon Strategy (SNBC) and the Multiannual Energy Plan (PPE), was presented in November 2018 in a revision of the documents approved in 2015-2016. To achieve the objective of carbon neutrality, France essentially relies on two mutually complementary strategies:

- the National Low-carbon Strategy (SNBC), which is France's route map for the reduction of is greenhouse-gas emissions;
- the Multiannual Energy Plan (PPE), which sets the priorities for action on energy for the coming decade.

The revised SNBC and PPE are at the public consultation stage at the start of 2020 and will obtain final approval in the first half of 2020.

5.1.1 *The Multiannual Energy Plan*

The Multiannual Energy Plan (PPE) is a steering instrument for France's energy policy. It was created by the Energy Transition for Green Growth Act 2015. All of the pillars of energy policy and all energy sources are addressed in the plan. Accordingly, the PPE consists of several strands:

- security of supply;
- reduction of energy consumption, particularly energy from fossil fuels (oil, gas and coal);
- diversification of the energy mix by harnessing renewables and reducing the share of nuclear power;
- balanced development of networks;
- preservation of consumer purchasing power and business competitiveness;
- assessment of needs in terms of vocational skills in the energy sector and appropriate training courses.

The PPE is a key stage in the pursuit of the progress mapped out in the National Low-carbon Strategy (SNBC) in the period up to 2050. The PPE defines intermediate objectives and lays down operational measures for the energy sector that will serve, over the next ten years, to put France on the path of carbon neutrality, as defined by the SNBC.

In particular, the programme must be compatible with the national greenhouse-gas emission ceilings, known as 'carbon budgets', defined by the SNBC.

5.1.2 *The National Low-carbon strategy*

Established by the Energy Transition for Green Growth Act of 17 August 2015, the National Low-carbon Strategy (SNBC) is France's route map for the pursuit of its policy for the mitigation of climate change.

The strategy defines short- and long-term targets for the reduction of greenhouse-gas emissions in France in the form of carbon budgets. The carbon budgets are ceilings, expressed in millions of tonnes of CO_2 equivalent, which national emissions of greenhouse gases must not exceed over periods of five years.

It realises the ambition declared by the Government in the Climate Plan of July 2017 of accelerating the implementation of the Paris Agreement by setting the goal of carbon neutrality in French territory by 2050, which is defined as the achievement of balance between anthropogenic emissions and anthropogenic removals of greenhouse gases, that is to say gases absorbed by natural environments managed by humans, such as forests, meadows, agricultural soils and wetlands, and by certain industrial processes (carbon capture and storage or carbon recycling).

It is consistent with the commitments made by France to the European Union and in the Paris Agreement framework and with national commitments, which include a 40% reduction by 2030 of France's 1990 level of greenhouse-gas emissions.

The strategy provides policy guidelines for the transition to a low-carbon economy in which materials and energy are consumed in moderation and the principle of the circular economy applies in every sector of activity.

5.1.2.1 The reference scenario

The National Low-carbon Strategy is based on a reference scenario that was devised in the course of a joint modelling exercise in the context of the Multiannual Energy Plan (PPE). This reference scenario identifies policy measures, over and above those that already exist, which would enable France to meet its short-, medium- and long-term climate and energy targets.

The reference scenario is designed to be both ambitious in its objectives and reasonable in the methods proposed for their achievement, without making any major technological assumptions. Nevertheless, the scenario does make reasonable use of some new technologies, such as carbon capture, storage and utilisation (CCSU), power-to-gas (P2G) and energy storage.

Looking ahead to 2050, a certain level of emissions seems to be irreducible, particularly in non-energy sectors like agriculture and in industrial processes. Achieving carbon neutrality therefore means offsetting these emissions by means of carbon sinks.

The provisional bottom line of the first carbon budget, covering the period from 2015 to 2018, shows an estimated overshoot of 72 megatonnes (Mt) of CO_2 over the whole period, representing 4% of the first budget.

Development of greenhouse-gas emissions from the building sector since 1990, in Mt CO_2eq

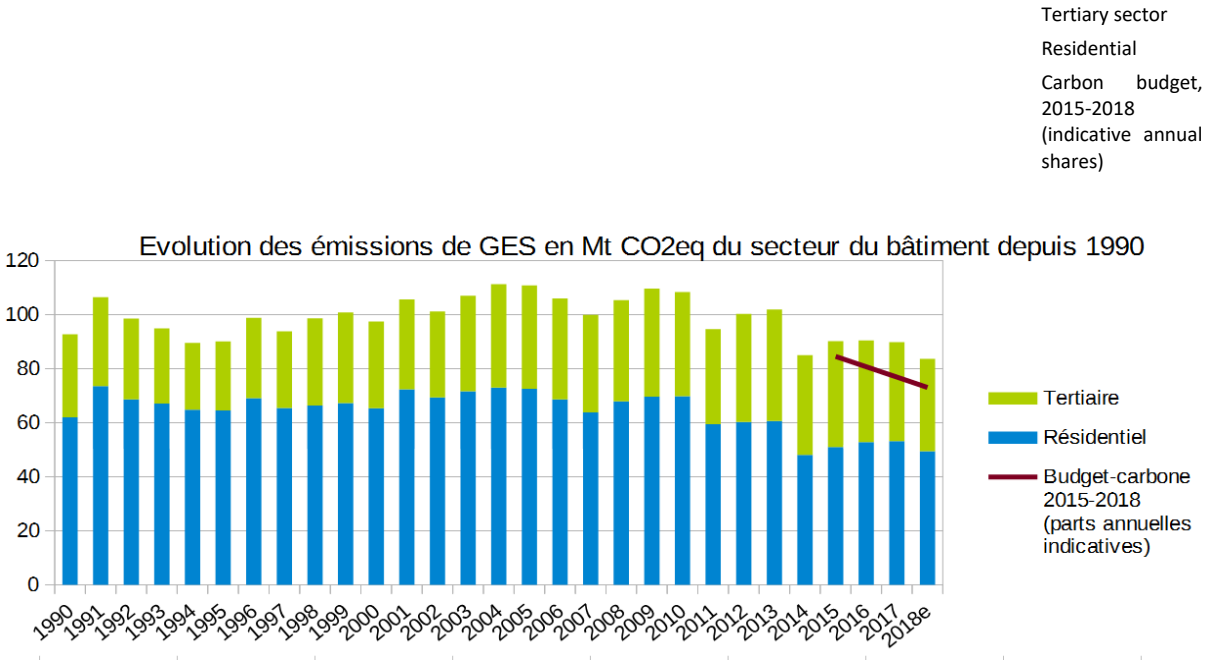


Figure 15 – Greenhouse-gas emissions for the building sector since 1990 (SNBC)

The provisional results of the emission projections for the 2019-2023 and 2024-2028 periods suggest that:

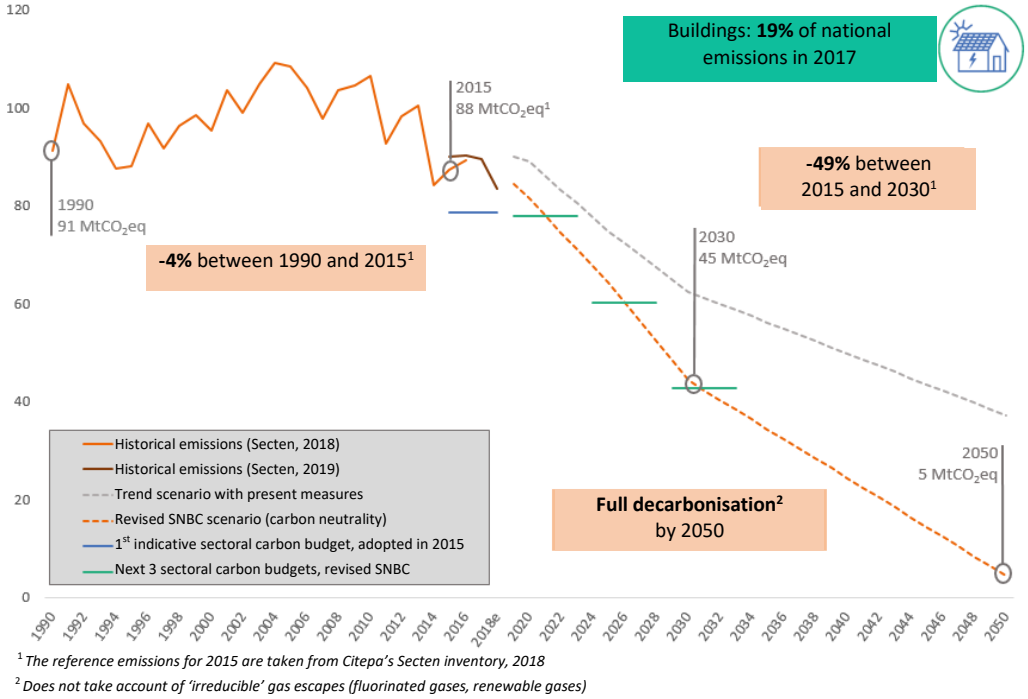
- the second carbon budget set by the first SNBC will be overshot, possibly by about 118 Mt CO_2eq, corresponding to 6% of the second budget and very close to the trend indicated by the first budget;

- the third carbon budget will be in balance with no overshoot, provided that all of the additional measures envisaged in the reference scenario are implemented.

The National Low-carbon Strategy sets out 41 policy guidelines. These measures will have to be implemented fully and effectively and regularly monitored if the budget targets adopted in 2015 are to be met.

5.2 *Residential and tertiary-sector buildings in the SNBC*

The policy guidelines set out in the National Low-carbon Strategy (SNBC) are both cross-cutting and sectoral. As far as buildings are concerned, the Strategy outlines a trend of emission reductions based on a time series of emission data since 1990.



[1] *The reference emissions for 2015 are taken from Citepa's Secten inventory, 2018*

[2] *Does not take account of 'irreducible' gas escapes (fluorinated gases, renewable gases)*

Figure 16 – History and projection of emissions from buildings between 1990 and 2050, in $MtCO_2eq$ (Source: executive summary of the SNBC)

The objectives set by France for residential and tertiary-sector buildings in the National Low-carbon Strategy are as follows:

- Carbon neutrality by 2050
- A 49% reduction of the 2015 level of greenhouse-gas emissions from buildings by 2030

These objectives were set on the basis of a 22% reduction in the energy consumption of buildings by 2030, a 29% reduction by 2040 and a 41% reduction by 2050 in relation to the reference year 2015.

5.2.1 *What are the main levers of action?*

The National Low-carbon Strategy identifies the main sources of greenhouse-gas emissions from buildings. It should be noted that most of the emissions connected with building and renovation works are recorded in the part of the strategy devoted to industry.

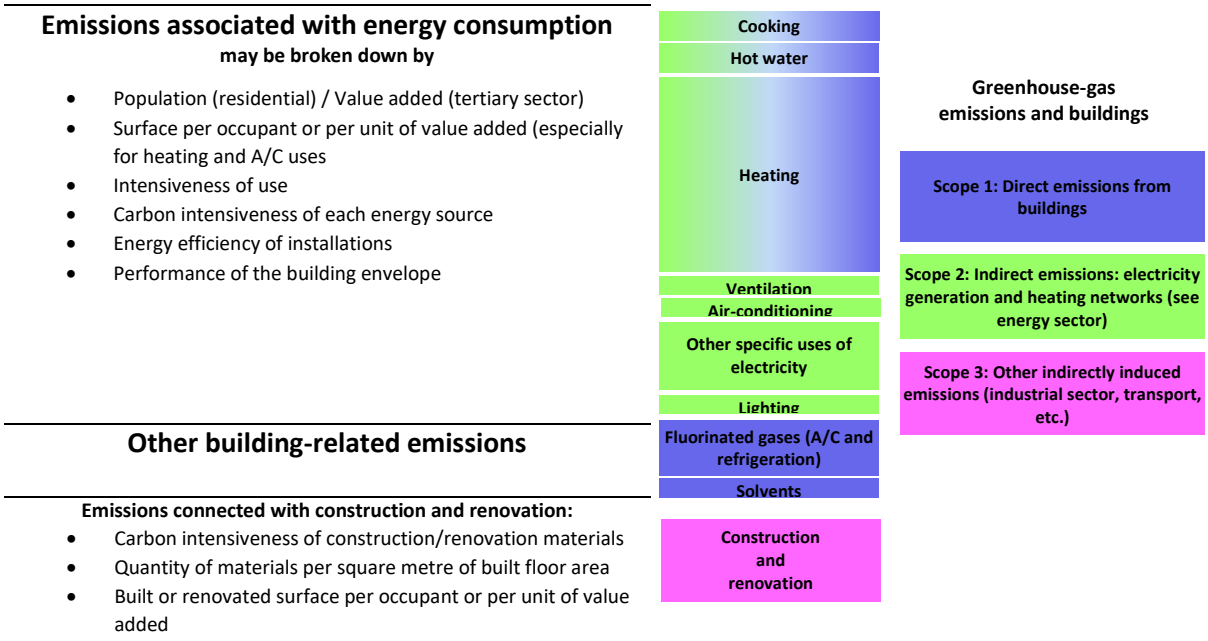


Figure 17 – Sources of greenhouse-gas emissions relating to buildings

In the light of the specific features of the building sector, described in detail in the National Low-carbon Strategy and the National Integrated Energy and Climate Plan (PNIEC), the following main levers of action have been identified. It may be recalled, in the context of the PNIEC, that four major guidelines were proposed in the SNBC, two of which relate to the renovation of buildings.

Guideline B 1: Guide the development of the energy mix over the lifetime of existing and new buildings towards totally carbon-free energy consumption

As a means to this end, the part of the present strategy devoted to policies outlines measures for the abandonment of heating oil and for the transition to carbon-free energy sources through energy renovations.

Guideline B 2: Encourage renovation of the whole existing stock of residential and tertiary-sector buildings with a view to achieving an average level equivalent to BBC across the entire stock

The previous part of this strategy enumerates all of the measures for energy-efficient renovation of the housing stock (support for households, funding schemes, remedial mechanisms, etc.) and of the stock of tertiary-sector buildings (compulsory renovation, model role of public buildings, etc.).

5.3 Method for monitoring the attainment of objectives

The system for monitoring the attainment of energy renovation objectives for the housing stock remains complex and not very robust, thanks to the profusion of objectives and indicators and the absence of a methodological monitoring doctrine. Efforts have therefore been initiated to pave the way for closer monitoring of public policy in this area. In the framework of the National Energy Renovation Observatory, a methodology for monitoring attainment of the SNBC objectives has been validated.

First of all, monitoring these objectives means measuring the drops in consumption resulting from renovation works and changes of energy source. That is a project in itself, which can draw on the work of the Commission-General for Sustainable Development (CGDD), whose output includes the annual French energy balance sheet.[43]

Counting the number of 'renovated dwellings' is more complex. It is necessary **to adopt a figure equivalent to a gain in energy efficiency to define what may be termed a 'renovation'**. It may be remembered that the renovation of building stock to low-energy building (BBC) standard or similar corresponds to the consumption level that the building stock must reach by 2050 in order to achieve the objectives of the SNBC.[44]

Proposals on monitoring are already under examination and will be the subject of discussions with stakeholders. An initial analysis undertaken as part of the process of creating the scoreboard of the National Energy Renovation Observatory is presented below without prejudice to the outcome of work that is currently taking place with partner bodies.

In conformity with the National Low-carbon Strategy (SNBC), consideration could be given to defining a 'renovation equivalent' as the energy saving that is required to take an 'average dwelling' to the performance target defined in the SNBC, in other words annual consumption of about 60 kilowatts of final energy per square metre.[45]

This method would make it possible to calculate the number of 'renovation equivalents' per year by adding together the small-scale renovation measures, including more extensive measures falling short of the SNBC performance target, which would count as fractions of a renovation. This figure could be **one of the main indicators used to communicate and steer renovation policies**.[46]

This indicator alone, however, will not suffice to measure progress towards the various energy renovation objectives, particularly that of a building stock fully renovated to BBC standard or similar by 2050. It is proposed that it be supplemented by the following **three additional indicators**:

Indicator No 1: Total annual consumption of the existing housing stock

This indicator will make it possible to monitor progress towards the overall objective of reducing the energy consumption of the national housing stock.

Indicator No 2: Segmentation of the housing stock by performance level (EPC ratings after revision of the EPC system for greater reliability in 2020)

This indicator is a means of measuring the actual attainment of the target performance level by 2050. It will give an indication of the number of dwellings achieving the final target. It will also serve to measure the achievement of the objective of gradual elimination of 'energy sieves' (dwellings rated F or G) and may, in some circumstances, act as an incentive to take more vigorous action to accelerate renovation works on these particularly energy-intensive dwellings.

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[43] The CGDD's provisional energy balance sheet, *Bilan énergétique de la France en 2018 - Données provisoires*, can be found at reproduced at https://www.statistiques.developpement-durable.gouv.fr/bilan-energetique-de-la-france-en-2018-donnees-provisoires.

[44] Even though the SNBC sets the achievement of BBC standard by 2050 as a renovation objective for the entire building stock, the energy performance to be attained by each building differs, particularly in relation to their initial performance. Some dwellings, in fact, will not be able to achieve the required standards of energy efficiency because of architectural, heritage-related or technical factors, etc. At the same time, other dwellings will achieve levels above that standard (A ratings or even Positive Energy Building status).

[45] This definition will, in any event, have to be adjusted to take account of forthcoming developments regarding the EPC, which is to be reformed to enhance its reliability, and of any accompanying changes in the definition of the *BBC-rénovation* label, measures with an overarching aim of simplifying the landscape of definitions, both for the general public and for the monitoring of public policy. The border between the future B and C ratings of the EPC could serve as an ideal reference point. Harmonisation proposals would then have to be put on the table for discussion with the traditional operators of the BBC label.

[46] This measurement method will shed light on operations counting as more than one renovation, particularly those that bring about substantial efficiency gains for very run-down energy-leaking buildings; for example, if a dwelling with a G rating on its EPC is brought up to C or D standard, that could count for up to three renovation equivalents. More energy-efficient buildings, for their part, could achieve the objective with less than a full renovation equivalent.

Indicator No 3: Distribution of the housing stock by energy system

This indicator will serve to monitor progress towards the elimination of heating oil as an energy source and to oversee the development of the energy mix. In particular, it is intended to provide assurance regarding the gradual eradication of the three million or so remaining oil-fired boilers and to monitor growth in the share of renewables in the energy mix.

In the framework of the National Energy Renovation Observatory, the calculation of these indicators will be based on the data generated by the energy renovation incentive schemes.[47] Some of these incentives are conditional upon gains in energy efficiency, while others depend on the execution of renovation measures.

- The former provide immediate access to the gain in energy efficiency associated with the works as well as to the performance levels before and after.
- The latter require a conversion of the executed measures into a gain in energy efficiency on the basis of the known fact that the measures have been implemented and assumptions regarding the characteristics of the dwelling.

Efficiency gains will be calculated on the basis of the most complete and exploitable databases of the incentive schemes. This means that data from the following schemes will be used:

- the Energy Saving Certificates (CEE);
- the *Habiter mieux Sérénité* scheme;
- the *Ma Prime Rénov'* scheme from 2021;
- the interest-free eco-loan scheme.[48]

The data collected through these schemes are incomplete. It is therefore necessary to work on the basis of assumptions with which the gaps can be bridged. The quality of those assumptions will greatly determine the quality of the result. Accordingly, to provide for the verification of assumptions, studies and supplementary surveys (by sampling, for instance) are conducted alongside the calculation of the efficiency gains. Certain assumptions are especially pivotal, and the following are areas where more reliable information will have to emerge from the work of the National Energy Renovation Observatory:

- precise knowledge of the current building stock;
- the real performance level achieved by renovation measures;
- identification of implemented measures that are recorded under more than one scheme.

Improvement of the reliability of data output and an updating method and frequency will be proposed in 2020.

Note: Since the work of the National Energy Renovation Observatory is not sufficiently advanced, it is not possible in the framework of this strategy to indicate at this stage the expected share of renovated buildings in 2020, as required by point (a) of Article 2a EPBD.

[47] Consumption in the housing sector will also be monitored on the basis of the energy balance sheet, but it would be complicated to isolate the share of consumption reductions resulting from renovation works from those with other causes (DIY renovations, behavioural changes, etc.).

[48] The interest-free eco-loan scheme will end on 31 December 2020, but information will be retrievable until 2023. The exploitable data, in fact, allow assessment of works executed in year *N*-2. They complement the data from the *Ma Prime Rénov'* scheme and may serve to fill information gaps regarding numerous measures implemented outside the scope of the Energy Saving Certificates and ANAH mechanisms.

6 PUBLIC CONSULTATION

6.1 Consultation prior to the revision of the SNBC and the PPE

6.1.1 *Consultation on the National Low-carbon Strategy (SNBC)*

Begun in mid-2017, the revision of the SNBC was opened to consultation at about thirty meetings involving administrations, NGOs, business stakeholders, representatives of local and regional authorities and trade unions. It was also the subject of prior online consultation by means of an online questionnaire, which received almost 13,000 responses. The draft National Low-carbon Strategy was submitted to numerous consultative bodies:

- the Environmental Authority[49]
- the National Council for the Energy Transition[50]
- the High Council on Climate[51]
- the National Regulatory Assessment Council[52]
- the Assembly of Corsica[53]
- the Economic, Social and Environmental Council[54]
- the National Council on Construction and Energy Efficiency (CSCEE)[55]

The people of France were invited to take part in the National Low-carbon Strategy by responding to an online questionnaire in the period from 13 November to 17 December 2017. Isabelle Jarry, dialogue manager appointed by the National Commission for Public Debate (CNDP) and a member of the Special Commission for the Public Debate on the Revision of the Multiannual Energy Plan, ensured that the consultation process was properly conducted. More than 13,000 responses were received. A presentation of the contributions was made public.[56]

The High Council on Climate, established by the President of the Republic on 27 November 2018, will take part in the regular appraisal of the implementation of the strategy and its carbon budgets and in its revision, which is scheduled to take place at five-yearly intervals.

6.1.2 *Consultation on the Multiannual Energy Plan (PPE)*

The Multiannual Energy Plans (PPE), an instrument for steering energy policy, were created by the Energy Transition for Green Growth Act. They relate to continental France and what are known as the non-interconnected areas, that is to say Corsica, Réunion, French Guiana, Guadeloupe, Wallis and Futuna and Saint Pierre and Miquelon. The PPE for continental France is drawn up by the Government, whereas those for the non-interconnected areas are drawn up jointly with the local authorities.

[49] Opinion of the Environmental Authority, dated 6 March 2019 (in French)
[50] Opinion of the National Council for the Energy Transition, dated 18 April 2019 (in French)
[51] *Acting in line with ambitions*, Annual Report of the High Council on Climate, published on 25 June 2019 (in English)
[52] Opinion of the National Regulatory Assessment Council, dated 11 July 2019 (in French)
[53] Opinion of the Assembly of Corsica, dated 26 July 2019 (in French)
[54] Opinion of the Economic, Social and Environmental Council, dated 9 April 2019 (in French)
[55] Opinion of the CSCEE on the SNBC and PPE (in French)
[56] A long and a summarised version of the presentation is available on the MTES website at https://www.ecologique-solidaire.gouv.fr/revision-strategie-nationale-bas-carbone-contributions-des-citoyens

The draft PPE was the product of a process that was conducted through technical working groups with broad stakeholder involvement in the second half of 2017 and public consultation in the first half of 2018, the public discussion being led by the National Commission for Public Debate. Formal consultations were then held on the edited draft of the PPE. Opinions were received from the following bodies:

- the Environmental Authority on Strategic Environmental Assessment;[57]
- the National Council for the Ecological Transition (CNTE);[58]
- the National Energy Council (CDE);[59]
- the Committee of Experts for the Energy Transition (CSDPE);[60]
- the Public-service Charges Management Committee for Electricity (CGSPE);[61]
- the Committee for the Public Electricity Grid (*Comité du système de distribution publique d'électricité*).

In view of the increasing integration of European energy systems, France also wishes to engage in dialogue with its main neighbours – Germany, Belgium, Luxembourg, Italy, Spain, the United Kingdom, Ireland, the Netherlands and Portugal. After all, the PPE project is one of the components of the project for an Integrated National Energy and Climate Plan, which is a European obligation.

The PPE is the subject of post-debate consultation, that is to say a public consultation process held in the aftermath of a public debate. These participatory procedures have taken place under the aegis of the National Commission for Public Debate (CNDP), which is an independent and impartial administrative authority. The National Commission for Public Debate is the guarantor of public information and participation rights with regard to decisions which have an impact on the environment or significant socio-economic implications. In France, while the Environment Code establishes the responsibilities of the CNDP, the rights that the Commission defends are established in Community and international law, particularly through the Aarhus Convention of 25 June 1998, and are enshrined in our Constitution in Article 7 of the Environment Charter. Post-debate consultation on the Multiannual Energy Plan is provided for in the Environment Code.

As representatives of the institution, dialogue managers (*garants*) oversee compliance with the fundamental principles that formalise these rights. In this sense, dialogue managers are neither facilitators nor advisers but prescribers. Their role is to ensure, from the preparatory stage, to the end of the consultation process, that all participants adhere to the principles of the CNDP, namely:

- independence and impartiality;
- transparency;
- an equal hearing for all contributors, whatever their status;
- statements and replies made by the project developer to be open to discussion.

In this context, the following events were held:

- presentations of the draft PPE in several regions of France in the framework of various exhibitions relating to energy policy which were organised by the Government together with the Regional Councils;
- a meeting held to present the draft PPE to representatives of neighbouring countries on 1 March 2019 and a more formal consultation process conducted in writing;

[57] Opinion of the Environmental Authority (in French)
[58] Opinion of the CNTE (in French)
[59] Opinion of the CSE (in French)
[60] Opinion of the CSDPE (in French)
[61] Opinion of the CGSPE (in French)

- various targeted meetings focused on specific problem areas, such as a meeting held on 17 April 2019 with all stakeholders in the biogas industry;
- a meeting held on 14 June 2019 with the promoters of the 86 local debates on the Multiannual Energy Plan; this event was an opportunity to update these stakeholders on the ways in which the fruits of the public debate had been taken into account in the PPE and to collect feedback from the debate promoters on the current draft PPE, which would then be taken into account in the final version, as was the case with the results of the formal consultations held during that consultation phase;
- a discussion meeting in September 2019 with members of G400 Énergie, a group of 400 people from all over France who had been chosen by lot to participate actively in the public debate on the PPE;
- presentation of the draft to a great number of bodies and conferences (the Energy Club of the European Institute of Business Administration (INSEAD) on 5 February 2019, FNCCR, the national federation of local authorities operating energy, water, digital and environmental services, also on 5 February, the Enerpresse debate on 19 February, the Union Française de l'Électricité on 21 February, the colloquium of the Association Française du Gaz on 12 March, the Commission on the Sustainable Development of Urban France on 13 March, Montel Energy Day on 4 April, the Institut Montaigne on 5 June, the General Assembly of the Technical Association for Energy on 27 June, etc.).

6.2 Arrangements for prior consultation on the Renovation Plan

The Plan for the Energy Renovation of Buildings (PREB), which was opened for consultation in November 2017 and published in its final version in April 2018, is the five-year policy route map for the energy renovation of the national building stock.[62] It represents the implementation of the 2017 Climate Plan as regards existing buildings. After almost four months of consultation, the plan was amended, clarified and supplemented. The published document is a product of consensus that offers solutions for everyone. To individuals, it provides support tailored to each situation – tenancy or ownership – with priority support for low-income families. For tertiary-sector buildings, both public and private, which are rich seams of energy-saving potential, the plan provides for innovative form of action as well as new funding sources.

A broad consultation process encompassing all stakeholders served to generate discussion and promote the emergence of new ideas. More than 550 contributions were received online as well as about 60 contributions from operators in the fields of renovation and real estate, including the National Council for Building and Energy Efficiency (CSCEE) and the administration of the Sustainable Building Plan. The CSCEE mainly focused on a number of specific subjects, such as the renovation of multi-owner buildings, the Energy Performance Certificate (EPC) and the Energy Saving Certificates (CEE). The administration of the Sustainable Building Plan particularly encouraged stakeholders to create a common signature, a proposal that culminated in the FAIRE logo.

Finally, then thematic meetings were held nationally, and a total of some 60 workshops, held in every region, delivered feedback reflecting the views of players in the field.

The following lessons emerged from the consultation process:

- The objectives of renovation should be ecological and inclusive and shared by everyone.
- Responsible practices and restraint should be promoted above all else.
- Communication should be persuasive.
- There is a need to create more confidence.
- Diverse situations should be taken into account.
- Two approaches to renovation should coexist – deep and staged.
- There is room for improvement in the overall inventory, and data are insufficiently mobilised.
- Local and regional authorities should be at the heart of the action.

[62] Plan for the Energy Renovation of Buildings (in French)

The consultation process served to unite stakeholders around common projects that are being pursued, particularly in connection with the implementation of the Renovation Plan. Spin-offs from these projects have served to enrich the plan, synchronising it with the efforts of the relevant stakeholders and of sub-national authorities by proposing specific resources and instruments to match the objectives.

6.3 Consultation throughout the implementation of the PREB

In addition to the consultation on the actual strategic document enshrining the Plan for the Energy Renovation of Buildings, specific consultations have been held in connection with the implementation of measures under the PREB. Rather than provide an exhaustive account of the process, it is worth taking a closer look at the consultations on three specific matters.

6.3.1 *Development of incentive schemes*

The consultation on the PREB served to highlight the weaknesses in the incentive schemes for energy renovation. The incentives for energy renovation were judged to be too numerous, complex, badly interlinked and often unfamiliar to the French public and to sectoral specialists. In order to mobilise households and make the incentives more effective, a radical simplification drive was undertaken.

In connection with the development of the interest-free eco-loan into a grant, a technical study was commissioned from the Scientific and Technical Centre for Building (CSTB) and ADEME. The findings of this study were presented to sectoral specialists through the National Council for Building and Energy Efficiency (CSCEE).

Thereafter, consultation of the building trades, of delegates and contracted parties from the Energy Saving Certificates scheme, support providers and environmental and consumer associations took place in the summer of 2019. This process delivered more than 90 written contributions and concluded with a national meeting attended by about 30 participating organisations.

The establishment of the grant, which will be administered by the National Housing Agency ANAH, has also benefited from a dialogue with future users involving experimental tests that served to improve the application process so as to guarantee inclusive and optimum use of the scheme.

This type of consultation was also carried out with banking representatives and renovation specialists in connection with the development of the interest-free eco-loan.

6.3.2 *Regulations regarding compulsory renovations of tertiary-sector buildings*

The Energy Transition for Green Growth Act specifically provides for action on the stock of tertiary-sector buildings with the aim of reducing their total energy consumption by 40% by 2030 and 60% by 2050.

So that it could accommodate a decree fleshing out this objective, the legal basis of the Housing, Planning and Digitalisation Development Act (*Loi ELAN*) was consolidated and enhanced. While upholding the aims for 2030 and 2050, the decree provides for more targeting of the most energy-intensive sectors and for the modification of requirements in the event of any technical, architectural or heritage-related constraints, of a disproportionately high cost in relation to potential energy savings or of a change in the use of a building or in the volume of activity in a building.

The drafting of the decree and the associated statutory orders led to the organisation of numerous consultation meetings and the appointment of numerous thematic and cross-cutting working groups involving almost 200 stakeholders and supported by the Building Plan network.

It is also planned to drive this scheme forward nationally by holding a colloquium, initially at yearly intervals to launch the campaign, and to propagate it in the regions through information and technical briefing days hosted on the one hand by the regional authorities and on the other by the private sector. This regional drive will be led by the decentralised government directorates (DREALs and DDTMs), with the support of the ADEME and PBD agencies in the regions as well as by associations of elected officials and sub-national authorities – the Association of French Mayors (AMF), the Association of French Departments (ADF) and the Association of French Regions (ARF) – in the case of meetings intended for local and/or regional authorities and with the support of the Chambers of Commerce and Industry in the case of meetings intended for the private sector.

6.3.3 *Establishment of the common signature FAIRE*

Action 4 of the Plan for the Energy Renovation of Buildings (PREB), proposes persuasive communication through reiterated messages as well as the creation of a common renovation signature that inspires confidence. Under the aegis of ADEME and the Sustainable Building Plan, a working group was launched in the spring of 2018 with stakeholders from the renovation sector, especially the associations of local and regional authorities, with a mandate to define conditions for awarding and using the common signature.

Presented in September 2018 by the Government, the FAIRE campaign – 'FAIRE' being an acronym for *Faciliter, Accompagner et Informer pour la Rénovation Energétique* ('facilitating, supporting and informing for energy renovation') – has the aim of providing individuals with better information about energy renovation and simplifying their renovation effort. The FAIRE logo has served, since the end of the summer recess in 2018, to bring all public stakeholders in the sphere of energy renovation under one umbrella. In particular, the public information centres that existed under various names – Espace Info Énergie, PTRE and PRIS – have been merged into the FAIRE network.

Thereafter, cooperation with stakeholders in the sector served to unify national public communication with the activities of the private sector through a communication charter entitled *Engagé pour FAIRE* ('Committed to FAIRE').[63]

In particular, the voluntary signatories undertake to develop measures and commercial services that are conducive to achievement of the national goal of carbon neutrality by 2050, to communicate on the network of FAIRE advisers and to encourage good business practices.

6.4 Consultation arrangements for the long-term strategy

The present long-term strategy for the energy renovation building was the subject of public consultation during the first half of 2020.[64] The following bodies were consulted:

- the National Council for the Ecological Transition (CNTE);[65]
- the National Council for Building and Energy Efficiency (CSCEE).[66]

[63] The *Engagé pour FAIRE* charter (in French)
[64] Summary in French of the observations received in the public consultation process and of action taken in response to the public consultation and to the consultation of the mandatory bodies
[65] Opinion of the CNTE
[66] Opinion of the CSCEE

In addition, the measures presented here are based on the following strategic plans and programmes, which for their part have already been the subject of broad public consultation processes:

- the National Low-carbon Strategy (*Stratégie Nationale Bas-Carbone* – SNBC), open for public consultation between December 2018 and the summer of 2019, with a public consultation on the final draft at the beginning of 2020;
- the Multiannual Energy Plan (*Programmation pluriannuelle de l'énergie* – PPE) for 2019-2028, open for public consultation between January 2019 and the summer of 2019, with a public consultation on the final draft at the beginning of 2020;
- the Plan for the Energy Renovation of Buildings (*Plan de rénovation énergétique des bâtiments* – PREB) was the subject of stakeholder consultation at the end of 2017 and the beginning of 2018.

7 ANNEXES

Annex 1: Cost of modelled works

Type of works	Unit cost	Maintenance cost (%)	Life cycle in years
Glass wool, 120mm thick, internal insulation (R-value = 3.7m².K/W)	€63	0	50
Internal insulation with 40mm vacuum insulation panels (R-value = 6.1 m².K/W)	€348	0	50
External rockwool insulation, 160mm thick, rendered over (R-value = 4,4 m².K/W)	€200	0	50
Polyurethane on flat roof – 180mm (R-value = 7.83 m².K/W)	€146	0	50
200mm glass wool between rafters in the roof space (R-value = 6.25 m².K/W)	€72	0	50
Mineral wool, 300mm thick, on floors of lost attic spaces (R-value = 7.5 m².K/W)	€42	0	50
Glass wool, 240mm thick, blown or laid onto the floor of the lost attic space (R-value = 7.5 m².K/W)	€48	0	50
Flocking on the unheated premises, 140mm thick (R-value = R=3,0 m²K/W)	€88	0	50
Rockwool, 140mm thick, on undersides (R-value = 4.05 m².K/W)	€132	0	50
Low-emissivity 4-12-4 double-glazed windows (excluding shutters), argon-filled, Uw-value 2.3 W/m².K / U-value with shutters 2.1 W/m².K	€242	0	50
Low-emissivity 4-16-4 double-glazed windows (excluding shutters), Uw-value 1.4 W/m².K / U-value with shutters 1.4 W/m².K	€461	0	50
Communal gas condensation boiler – Atlantic Condenseco 100 KW – heating and hot water	€53,904	1.5	20
Communal gas condensation boiler - Condenseco Atlantic 300 KW – heating only	€70,096	1.5	20
Condensing storage combination boiler, gas - IdraEco Condens Micro 5000 (Atlantic) – heating and domestic hot water	€4,830	1.5	20
Communal air-source heat pump, AUER HRC 70 (4 x 35 kW in a cascade system) for heating and hot water	€143,000	1.5	20
Air-source heat pump - AUER HRC70 – heating and domestic hot water	€15,000	3	17
Air-source heat pump - AUER HRC70 – heating only	€14,000	3	17
Storage radiators with control accuracy of 0.15°C (Thermor Mozart Evolution type)	€540	1	20
Installation of more efficient DHW cylinders and removal of existing cylinders	€1,555	1	20
Thermodynamic water boiler with energy recovery from ambient air (Atlantic Odyssée)	€3,700	1	20
Replacement with water-filled radiators with certified thermostatic valves	€501	1.5	35
Installation of thermostatic valves	€120	1.5	35

Note: The cost of systems using renewables could be higher if a radiator circuit is installed