CONCERTED ACTION
ENERGY PERFORMANCE OF BUILDINGS

Implementation of the EPBD France

Status in 2020

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NATIONAL WEBSITES
www.ecologie.gouv.fr*, *http://rt-re-batiment.developpement-durable.gouv.fr*, *www.ademe.fr

1. Introduction

In France, the implementation of the EPBD has been the responsibility of the French Ministry for an ecological and solidary transition and the Ministry of territory cohesion. Aiming at replicating the successful transposition of Directive 91/2002/EC, France has been working on implementing Directive 2010/31/EU since 2010. Law 2010/788 of 12 July 2010[1] and the regulation that followed have significantly improved the energy performance certification process, while the implementation of the new thermal regulation, *RT 2012*[2], has brought energy efficiency of new buildings to NZEB level. The Energy Transition for Green Growth Act (*LTECV*) of 17 August 2015[3] provided also new tools, e.g., requirements for insulating envelope parts in case of restoration, aiming at increasing thermal renovation.

France is now focusing on transposing the Directive (EU) 2018/844. Several rules, such as those on electro mobility, have already been applied on French ground. To continue the implementation process, Art. 39 of the Law 2019/1147 of 8 November 2019 allowed the government to take acts to finalise its transposition. Furthermore, the *ELAN law*[4] (voted in the late 2018) introduced new targets for energy consumption reduction for all existing non-residential building of more than 1,000 m².

This report is giving an overview of the current status of the implementation of the EPBD, structured around four main topics:

- requirements on energy performance for new buildings;
- requirements on energy performance for existing buildings;
- Energy Performance Certificate (EPCs);
- smart buildings and building systems.

Finally, one last additional part highlights the setting of the Energy plus Carbon minus (*E+ C-*) testing scheme, which serves as a preparatory function for the future thermal regulation that is being enlarged to a real environmental regulation taking into account greenhouse gas (GHG) emissions on a lifecycle basis.

2. Current Status of Implementation of the EPBD

2.I. Energy performance requirements: NEW BUILDINGS

2.I.i. Progress and current status of new buildings (regulation overall performance)

The current thermal regulation in response to the EPBD is the *RT 2012 (Réglementation Thermique 2012)*[4]. It has been mandatory only for some public buildings since the end of 2011, and for all new buildings since 2013. This regulation is the result of a two year-long dialogue with all stakeholders, including seven consultative conferences, where the work in progress was presented. The next thermal regulation, RE2020, is planned to be released in January 2021. It will contain even more ambitious objectives, since it will also include environmental requirements, based on a life-cycle analysis. Indeed, in France, different simulations have shown that about two thirds of a new building carbon impact occur during the construction phase and not during the use phase, meaning that reducing construction climate impact also requires to regulate construction itself.

In order to anticipate this new regulation, a testing scheme called '*E+C-*' (standing for Energy plus Carbon minus) was launched for volunteering contractors in late 2016.

2.I.ii. Format of national transposition and implementation of existing regulations

The structure of *RT 2012* is based on three performance requirements:

- The requirement for minimum energy efficiency of buildings, which imposes a limitation on energy demand (heating, cooling and lighting) based on the bioclimatic conception (B_{bio}) of the project, whereby the B_{bio} value has to be lower than a maximum value called B_{biomax}.
- The requirement for primary energy consumption, which imposes a limitation on primary energy consumed (C_{pe}) for the combined use of heating, cooling, domestic hot water, lighting and auxiliaries (pumps and fans), whereby the C_{pe} has to be lower than a maximum value called C_{pemax}.
- The requirement for summer comfort, where the ambient indoor temperature of the building, reached after the 5 hottest days of the year (T_{ic}), cannot exceed a reference level calculated for each project, whereby T_{ic} has to be lower than a maximum reference value called T_{icref}.

These three coefficients are calculated through *TH-BCE*[5], a dynamic hourly methodology (calculations are run every hour of a full year), which describes each component of the building envelope, as well as its energy systems.

The values of B_{biomax} and C_{pemax} are absolute values, based on standard benchmarks depending on the building type (Table 1) and are modulated by local climate, altitude and immediate environment factors.

Additionally, in order to ensure that residential buildings are correctly built, qualified experts have to check that airtightness upon their completion does not exceed 0.6 $m^3/h/m^2$ for single-family houses and 1 $m^3/h/m^2$ for apartment buildings.

Finally, the *RT 2012* includes requirements for renewable energy use. It takes different forms depending on the energy type, but it should amount to at least 5 kWh_{EP}/m^2.year.

Type of building		B_{biomax}	C_{pemax} (kWh/m².year)
Individual House	EC1	60	50
	EC2	80	60
Apartment building	EC1	60	57.5
	EC2	80	69
Office building	EC1	70	70
	EC2	140	110
Secondary education building (day time)	EC1	40	55
	EC2	50	70
Secondary education building (night time)	EC1	60	90
	EC2	90	105
Shop	EC1	140	320
	EC2	250	520
Catering 2 meals/day 6 days a week	EC1	110	300
	EC2	180	410
Hospital (day time)	EC1	230	270
	EC2	270	330
Hospital (night time)	EC1	120	130
	EC2	180	190

EC1: AC not required | EC2: AC required

B_{biomax}: Maximum bioclimatic need (without unity) | C_{pemax}: Maximum primary energy consumption

Table 1. B_{biomax} and C_{pemax} for various new buildings typologies.

2.I.iii. Action plan for progression to NZEB for new buildings

In France, the label 'Low Consumption Energy Buildings' (*Bâtiments Basse Consommation* - BBC) is used to describe buildings with very low energy consumption (NZEB), and in the case of individual residences also includes a great proportion of RES. Since 2013, all new buildings, including public buildings are mandatorily NZEB, since requirements for Low Consumption Energy Buildings are the same as in *RT 2012*. Therefore, the cost-optimal level for NZEB has been evaluated along with the RT 2012 one. The future regulation, based on the feedback from the *E+C-* testing scheme will bring energy performance for new buildings one step further.

The new regulation in preparation is about to seek energy performance but also aims to reach ambitious carbon emission reduction. Predicted to be released in January 2021, the regulation will be named *RE2020* (for Environmental Regulation of 2020).

2.I.iv. Requirements for building components for new buildings

As explained before, the thermal regulation for new buildings sets general performance objectives. Therefore, it does not include any requirements on systems efficiency nor on building components. However, the requirements on B_{bio} entail a minimum performance of the envelope, which is different for every construction project. Indeed, B_{bio} is a modulated combination of the energy needs of the envelope for heating, cooling and lighting.

2.I.v. Enforcement systems new buildings

National building regulations pursue two general goals: people safety and well-being as well as energy and environmental performance. Two kinds of controls have been introduced to verify regulation enforcement all along the building process:

1. Technical control operated by competent authorities accredited by the government.
   The environmental inspectors are responsible for controlling compliance with environmental rules, e.g., for rules concerning heating and cooling systems. With their request for a building permit, project owners have to attest that their project is compliant with the requirements on B_{bio}. They have to transmit another attestation upon completion of the building, proving that the constructed building is compliant with the whole thermal regulation. This second attestation is to be signed by a recognised professional.

2. Construction regulation control operated by the State
   Finally, the State operates a construction regulation control by sending technical officers to inspect a sample of buildings up to 6 years after their completion. They control compliance with the accessibility, security, ventilation, acoustics, energy performance, seismic and termites' rules. This control is very useful for the government to observe the difficulties and practices on the field.

Failure to comply with the law can lead to economic and juridical sanctions.

2.II. ENERGY PERFORMANCE Requirements EXISTING BUILDINGS

2.II.i. Progress and current status of existing buildings (regulation overall performance)

There are two thermal regulations for existing buildings. The first one, called '*RT par élément*' (Regulation by Building Component), was published in late 2007 and the second one, called *'RT globale*' (Global Thermal Regulation), in April 2008. Figure 1 shows how to determine the necessary regulation, depending on the renovation type (major or minor). Both regulations were reviewed in 2016 and the new requirements were set to come into force in 2018, followed by supplementary requirements in 2023 for envelope components.

The Global Thermal Regulation is based on the overall consumption with minimum requirements for each component of the building (envelope and technical systems). Energy performance is assessed using a complex hourly methodology, called *TH-CE ex*[6], based on the new buildings' methodology. The *TH-CE-ex* methodology is currently under review, the main purpose being to make it consistent with the *Th-BCE* methodology for new buildings.

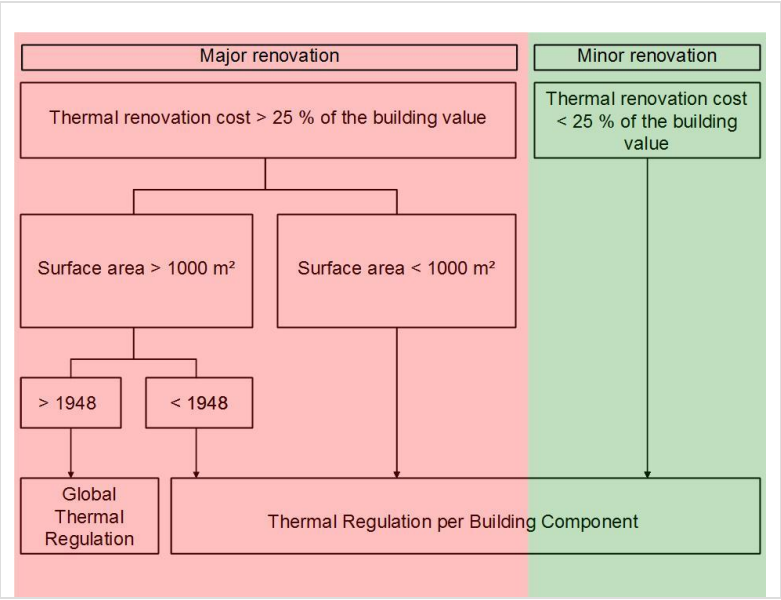

Figure 1. Thermal Regulations for existing buildings.

Lately, the *ELAN* law (which stands for 'Housing, spatial planning and digital evolution') also introduced a new article in the Housing and Construction Code making it mandatory for tertiary buildings to reduce their final energy consumption by at least 40% until 2030, 50% until 2040 and 60% until 2050 compared to 2010. This regulation is called 'Eco-Energy Tertiaire'. Published in July 2019, the decree determines all the application modalities, such as:

- scope;
- objectives of energy consumption reduction calculation method;
- modalities in case of activity change;
- modalities for the establishment of an online platform displaying the energy consumption data for every building;
- possible sanctions.

The objective of energy consumption reduction can be reached by two methods. First, the building can reach the relative reduction included in the law (-40% by 2030). Second, objectives in terms of an absolute value are defined for each type of activity. This means that for each tertiary building type, an energy consumption threshold will be defined by an upcoming order. The government works with professionals to define the thresholds that are to be achieved by 2030, 2040 and 2050. Those thresholds will vary with different indicators, e.g., temperature level, economic activity level, presence or absence of certain types of activities.

Therefore, this regulation gives a long-term vision of what can be expected of any tertiary building in the coming decades in terms of energy performance. It is not a classical regulation with sanctions and control. It also helps owners and tenants understand what is expected from them in this energy transition, allowing them to compare their building against other buildings used for similar activities and providing them with a rating based on the building's performance. The regulation is thus intended to lead them into action.

2.II.ii. Regulation on individual parts, distinct from whole building performance

As previously described, there are two regulations for existing buildings. The appropriate regulation to be implemented is determined by the building size and the extent of the renovation (see Figure 1, where the Regulation by Building Component is based on minimum requirements for the different components of the building (envelope and systems)). Table 2 shows current and future maximum U-values for envelope elements.

These two regulations have some rules in common, especially regarding domestic hot water, setting maximum heat loss depending on the boiler size, and giving European Norms 89 and 26 as a reference for some systems' performance.

The Regulation by Building Component sets a minimum efficiency around 90% for boilers of more than 400 kWh of thermic power and a coefficient of performance of 3.2 for heat pumps on heating mode. For AC units below 12 kW, the energy efficiency rating should be at least 3.0. For other AC systems, the efficiency should be between 2.6 and 3.0. Ventilation unit consumption should not exceed 0.25 Wh/m^3 for residential buildings, and 0.3 Wh/m^3 for non-residential buildings. These requirements are set for systems with nominal power not covered by the Ecodesign Directive 2009/125/EC.

Component	Climatic zone	Maximum U-Value (W/m².K)		
		2016	2018	2023
External opaque walls	H1, H2	U = 0.44	U = 0.35	U = 0.31
	H3	U = 0.5	U = 0.45	U = 0.45
Terrace roof	H1	U=0.4	U=0.3	U=0.22
	H2	U=0.4	U=0.3	U=0.23
	H3	U=0.4	U=0.3	U=0.25
Attic floor	H1, H2, H3	U=0.22	U=0.21	U=0.19
Roof	H1	U=0.25	U=0.22	U=0.19
	H2	U=0.25	U=0.23	U=0.22
	H3	U=0.25	U=0.25	U=0.25
Windows	H1, H2, H3	Uw=2.6	Uw=1.9	Uw=1.9
France is divided in 3 climatic zones from the coldest H1, to the warmest H3				

Table 2. Current and future maximum U-values for envelope elements in the Regulation by Building Components.

2.II.iii. Initiatives/plans to improve the existing building stock

Although regulations for the renovation of existing buildings are quite ambitious, they are still below NZEB requirements, so that renovated buildings do not systematically reach the NZEB level. The French Government has therefore developed several quality seals in order to encourage owners to go beyond the regulation requirements.

For existing residential buildings there are two quality seals: 'High Performance Energy 2009' (*HPE 2009*), demanding a level of 150 kWh/m².year, and 'Low Energy Consumption Renovation 2009' (*BBCR 2009*), demanding a level of 80 kWh/m².year. These levels are expressed in primary energy. They are also modulated with climatic zones and altitude:

$$C_{epmax} = 80 \times (a+b).$$

where 'a' is a coefficient representing the climatic zone:

Climatic zone	a
H1a et H1C	1.3
H2b	1.2
H2a	1.1
H2b	1
H2c et H2d	0.9
H3	0.8

and 'b' is a coefficient representing the altitude:

Altitude	b
<=400 m	0
400 m < x <= 800 m	0.1
> 800 m	0.2

For existing non-residential buildings there is only one quality seal, also called 'Low Energy Consumption Renovation 2009' (*BBCR 2009*). It certifies that the consumption of energy of the renovated building is at least 40% less than the reference building (the same building, with specified envelope and systems).

By the end of 2016, 56,000 residential buildings and about 1.35 million renovated m² of non-residential buildings were given the 'Low Energy Consumption Renovation 2009' quality seal.

Regarding non-residential buildings, a charter[8] has been signed by the French Government and major companies, showing a commitment for energy efficiency by everyone involved.

To encourage professionals to build-up their skills, there is some financial support to owners whose renovations are made by certified workers. This certification, called *RGE*[9] (standing for recognised environmental guarantor), proves that workers are fully qualified to carry out renovation works.

In order to implement Article 5 of the EED, France has chosen an alternative option. Indeed, in the '*Grenelle de l' Environnement*' laws (voted in 2009 and 2010), there is a goal for a 40% primary energy reduction by 2020 for all the buildings owned by the French Government. Based on the results of energy audits on a representative sample of the relevant building stock, this would represent 10,131 GWh (primary energy) saved. In comparison, the 3% renovation proposed in the EED would lead to only 2,477 GWh (primary energy) saved.

Three types of action will help to reach this ambitious goal:

- renovation carried out by French authorities;
- a better use of the buildings;
- selling the unused buildings in order to have them renovated by a private landlord.

2.II.iv. Long Term Renovation Strategies, status

The French Long-Term Renovation Strategy is established to meet both the 'Paris agreement for climate', which requires lowering greenhouse gas emissions, and the EPBD that sets a goal of carbonless and high effective energy building stock by 2050. It determines several intermediate objectives, e.g., -49% greenhouse gas emission and -29% building energy consumption by 2030, compared to 2015.

It foresees the establishment of a national observatory for energetic renovation. This will be made possible, thanks to opening of access to energy performance data, creation of a unique housing ID and standardisation of the procedure of building geolocation. Therefore, the observatory will be able to analyse the following data:

- energy performance of the building stock by observing the evolution of the EPCs;
- building stock distribution by type of energy production systems;
- annual global energy consumption of the existing building stock;
- an index comparing the building renovation levels to a '*BBC renovation*' performance.

Furthermore, in order to improve the connection between the multiannual energy consumption objectives and the building energy performance levels, the final energy will be better featured in the French EPC from 1 January 2021.

The new strategy provides also the main guidelines for energy renovation support; this includes the creation of a direct aid for the energy transition of low-income households '*MaPrimeRenov*', paid at the time of the energy renovation works (maximum delay of 10 days). The previous energy transition tax credit was paid to households until 18 months after the renovation works were completed.

In addition, the strategy presents a detailed analysis of the building stock based upon data produced within the cost-optimal report (Report from the French Authorities, Transposition of Article 5 of Directive 2010/31/EU, Calculation of cost-optimal levels of minimum energy performance requirements). It also covers funding programmes financed by Energy Saving Certificates, which are usually targeting strategic building stock sections, e.g., the *ACTEE* programme for public buildings or *CUBE.S* for schools.

Finally, the strategy lists coercive measures recently introduced or detailed in the national law:

- obligation of energy saving actions in tertiary building of more than 1,000 m² before 2030, 2040 and 2050;
- obligation of energy audits before the selling or the renting of each excessively consuming housing from 1 January 2022;
- prohibition, from 2023, to rent the most consuming housing, the so-called '*thermal sieves*' i.e., dwellings ranked in the two lowest categories of the country's Energy Performance Certificate scheme;
- obligation to realise renovation works on thermal sieves before 1 January 2028.

To support residential and small non-residential building energy renovation, a huge simplification of the subsidies request process has been engaged. For instance, the *SARE* programme (Energy renovation support service) aims at informing and supporting the realisation of renovation actions toward residential and small non-residential buildings. The realisation of a toolkit referencing all the works compatible with Low Consumption Building Renovation level (named '*B2C2*') has also started with *ADEME*.

2.II.v. Financial instruments and incentives for existing buildings

For private home and building owners

Until 2019, the energy transition credit tax (*CITE*)[10] was a tax benefit following the purchase of the most efficient materials and equipment in terms of energy saving and reduction of greenhouse gas emissions. The amount of the credit depended on the system type and its price (deduction of 30% of the price). The only proof needed to get the tax benefit was the sales receipt, provided the equipment had been installed by a professional holding the required qualification/certifications (*RGE*).

As it was mentioned above, this tax credit is gradually replaced by '*MaPrimeRenov*', a new direct aid for energy transition of low-income households, available since 1 January 2020. The tax credit, fixed at a lump sum, was henceforth paid at the time of the energy works (maximum delay of 10 days). The tax credit was maintained only for one year, in 2020, towards middle-income households. In 2021, all low and middle-income households will benefit from this new aid.

In response to Article 7 of the EED, energy suppliers have to promote and support energy savings among consumers (Energy Saving Certificates Scheme). These Energy Saving Certificates can be awarded for complying with the energy saving standards, or they can be more specific, and often imply heating system-based action, e.g., financing of a heating system refurbishment.

Since 2009, the 0% Eco-Loans (loans with a 0% interest rate) have enabled financing of building renovations, in particular to improve heating systems. In order to access the 0% Eco-Loans, the renovation must be substantial (roof or wall insulation, replacement of at least half of the windows, installation of a high-performing HVAC system, RES heating or domestic hot water system), or achieve a minimum energy

performance of the building. These loans are designed for property-owning individuals to finance major renovation works. The maximum amount is 30,000 € over a 15-year period.

In addition to that, financial support provided by the National Agency for Housing Improvement (*Anah*)[11] is helping low-income households to finance renovation works if they reduce their energy consumption by at least 25%. The level of financial support varies depending on the income of the beneficiaries (50% of the investment can be funded), with a maximum amount of 19,000 €.

Finally, a reduced VAT (5.5%) applies for renovation works in residential buildings. To take advantage of this VAT reduction, materials used must respect technical characteristics adopted by a ministerial order[12].

A special tax credit, '*Denormandie dans l'ancien*', was created in 2019 to encourage energy renovation of housings in areas where housing demand is low. Around 240 cities are targeted, essentially with the planning programme called 'Action Coeur de Ville', where rental investment is supported by a tax credit of 25% of the energy renovation costs. In return, home owners have to rent their housing at a capped price.

For public building owners

Very low interest loans ('*éco-prêt logement social*'), European subsidies (*FEDER*) and tax reductions on property tax are proposed to social housing companies, in order to encourage energy renovation of their building stock.

Low interest loans ('*Ambre*' loan) and public subsidies are also proposed to public local authorities.

2.II.vi. Information campaigns / complementary policies

To inform and support energy renovation actions for housing and small non-residential buildings the *SARE* programme (which stands for Energy renovation support service) was created. The service is led by *ADEME* (Environment and energy management agency), both at the national as well as at the regional level, and is a declination of a larger programme, so-called '*FAIRE*' (Expedite, support and inform on energy renovation). *FAIRE* aims at supporting every information action but also gathering all the resources on a single and easy to access website. On the platform, individuals can find a multitude of advice on how to reduce their energy consumption and resolve issues which arise during renovation operation, and contact a professional to provide them with specific answers for free.

Both the ministry and *ADEME* (the French Energy Agency) publish guides which aim either at providing information about all new financial schemes or at facilitating the understanding of new regulation.

On top of that, several television programmes, e.g., '*consomag*', are financed by the state, in order to reach the largest possible number of households.

As a complementary policy, there is an obligation to insulate the roof or the facade of a building whenever other restoration works are undertaken. This obligation aims at lowering the cost of a thermal renovation by including it in a package of planned renovation works. However, this obligation does not apply in case of light restoration (e.g., cleaning), or when the façade is of remarkable architectural or patrimonial value.

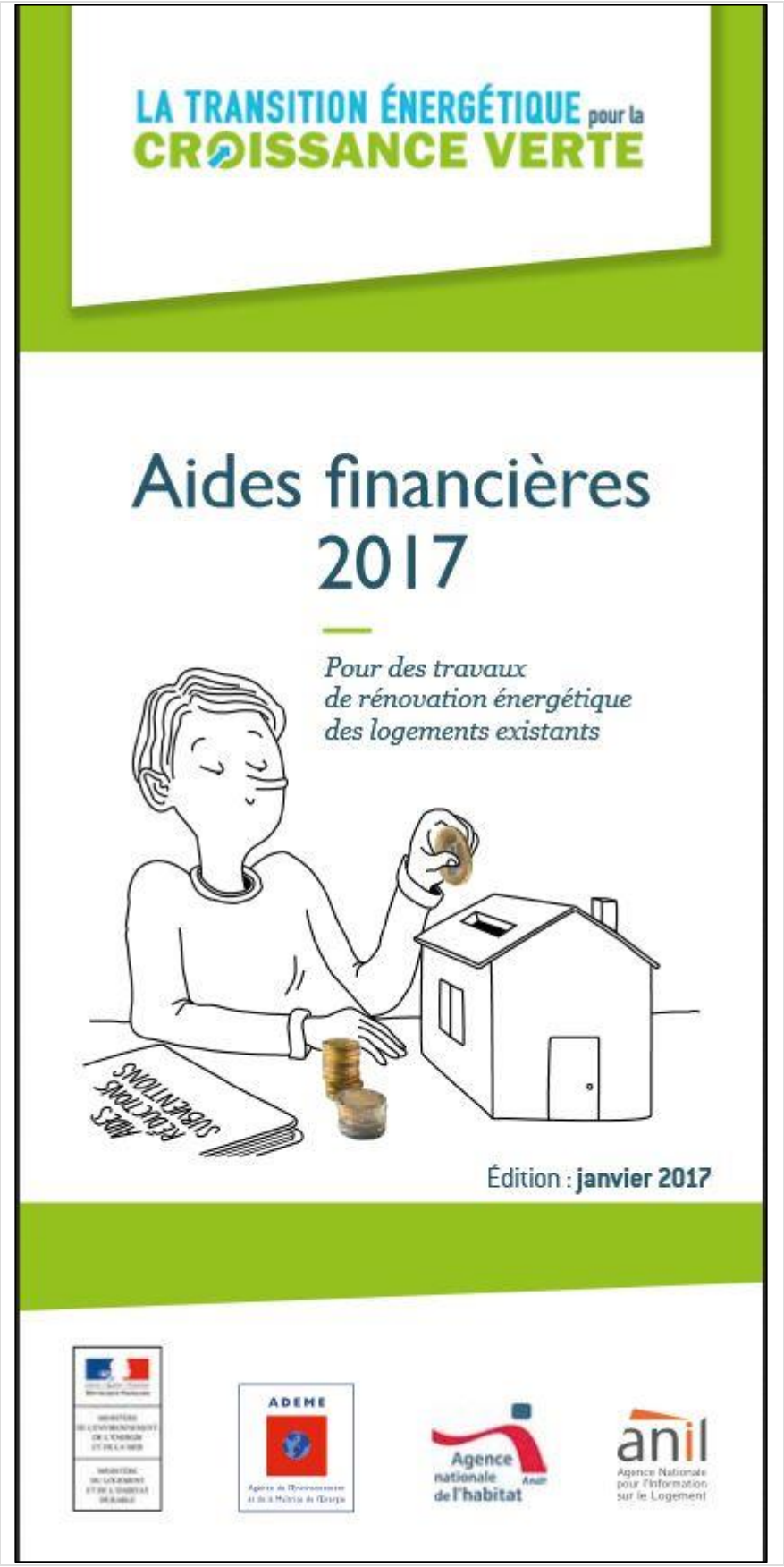

Figure 2. Example of information guide about financial incentives.

2.III. Energy performance certificate requirements

2.III.i. Progress and current status on EPCs at sale or rental of buildings

The French EPC, called "*Diagnostic de Performance Energétique" (DPE),* was introduced in 2006 and is issued by a qualified expert. Issuing an EPC for both existing and new buildings requires the qualified expert to assess the thermal efficiency of the building following an on-site visit, by inspecting the envelope, HVAC and domestic hot water systems. Once issued, the EPC is automatically sent to the EPC national database (mandatory since 2013), and is valid for 10 years. The energy performance can either be estimated (using a calculation methodology) or measured (using energy bills), depending on the building's type.

	Residential building						**Non-residential** building
	EPC for the **whole** building or house		**Flat** with **collective heating system** when there already is an **EPC for the whole building**	EPC **not** concerning the whole building			
				Flat with individual heating system		**Flat** with **collective heating system**	
	Building built **before 1948**	Building built **after 1948**		Building built **before 1948**	Building built **after 1948**		
Performance **assessed**		X	**EPC** for the **whole building**		X		
Performance **measured**	X			X		X	X

Table 3. Methods used for assessing compliance with EPC standards.

The precise number of EPCs issued as of April 2013 can be determined based on the data provided by the national EPC database. Table 4 shows a total of nearly 3.8 million EPCs registered on the database. The number of EPCs before 2013 can only be estimated.

The total figure (before and after 2013) is estimated to circa 13 million EPCs for all building types, which represents more than a third of the national building stock.

Type of Building	Individual House	Flat	Apartment Building	Non Residential	Total
Number of EPCs issued since 2013	3,669,630	4,183,093	705,783	421,691	8,980,197

Table 4. Total number of EPCs issued since 2013.

2.III.ii. Quality assessment of EPCs

Experts who want to become '*diagnosticians*' (experts qualified and certified to issue EPCs) much justify theoretical knowledge of buildings, go through a 2 to 3 days training and pass a final exam. Once accredited, the expert has the right to deliver EPCs for a period of seven years. According to a regulatory requirement, the work of each qualified expert must be checked on a continuous basis.

The certifying body must verify that each point of the regulation is abided by and can withdraw the expert's certification, either temporarily or permanently, in case some fields in the EPC are not properly filled.

The EPC database is also a useful tool for landlords, allowing them to check the accuracy of their EPC. Finally, there is a directory of qualified experts available, so landlords can check that the qualified expert is certified.

2.III.iii. Progress and current status of EPCs on public and large buildings visited by the public

Since 2007, all buildings over 1,000 m² occupied by public authorities and frequently visited by the public must have a valid EPC. The threshold was successively lowered to 500 m² in 2013 and to 250 m² in 2015. Once issued, the EPC must be displayed near the entrance point of the building, clearly visible by the public.

As for the general activity level, the exact number of EPCs issued for each type of building since April 2013 is determinable (Table 4). Since August 2015, a 1,500 € fine can be imposed to non-compliant building administrators.

2.III.iv. Implementation of mandatory advertising requirement - status

Since 1 January 2011, it is mandatory for real estate agencies to include some information provided by the EPC in their advertising. Every type of advertising is affected, but not in the same way. Advertisements published in newspapers should display at least the energy class letter, while advertisements published on the internet or at the real estate office must display the full energy label. The picture of the label should be at least 180 X 180 pixels on the internet and should occupy at least 5% of the advertisement displayed at the real estate office.

In case of non-compliance, there are two types of sanctions: based on the civil law, the client can demand the cancellation of the sale; based on the criminal law, the sale can be considered as fraudulent and can lead to a prison term of two years without remission and a 37,500 € fine imposed by the 'General Directorate of Competition, Consumption and Fraud Repression' (*DGCCRF*). Such penalties have not been applied so far. A simple call to order has always been sufficient to bring non-compliant parties to compliance. Yet, the *DGCCRF* estimates that in 15% of the real estate dealings the EPC is not displayed.

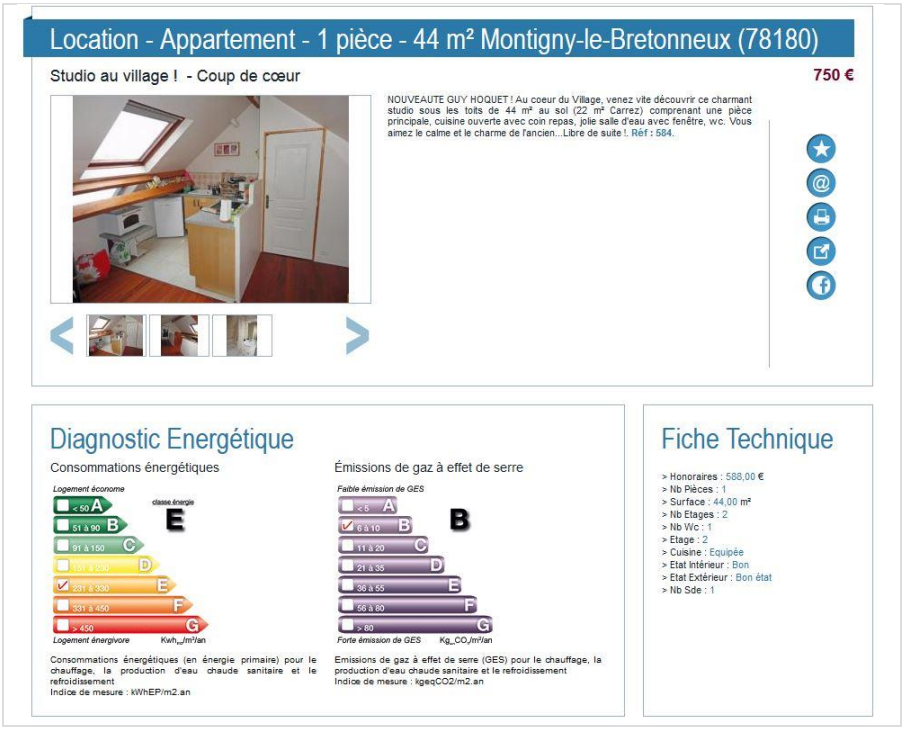

Figure 3. Example of property advertising on the internet including information provided by the EPC.

2.IV. Smart buildings and building systems

2.IV.i. Status and plans on smart buildings

If there is not any '*Smart Building*' definition yet in France, the topic is being studied by the government alongside the French stakeholders. For instance, on 7 December 2017, a charter pushed by the Ministry of Territories Cohesion & Relation with Territorial local Communities, was signed by 127 companies to develop more connected and more inclusive buildings.

This document led to the creation of a voluntary label, the so-called '*Ready to services*' (*R2S*) for non-residential buildings and the '*NF Habitat HQE*' certification for residential buildings but also the creation of a Massive Open Online Course (MOOC) meant to improve building actors' skills. All those works were made possible with the help of stakeholders, represented by the Smart Building Alliance (SBA) and Alliance HQE-GBC.

2.IV.ii. Smart buildings and building systems

Smart Buildings and building systems are not specifically taken into account in the regulation, but rather diluted in the French energy performance laws. For instance, in the French EPC, the presence of thermostatic valves influences the final score of the energetic evaluation. In the new buildings, the installation of this equipment is even required per individual room.

Apart from these technical adaptations, the law also enables companies to submit their innovations to an independent expert commission, the commission '*titre V*' (named after its localisation in the corresponding ministerial order), so that they can be recognised as a solution to meet the building energy requirements.

2.IV.iii. Building Automation and Controls Systems (BACS)

In 2018, the EPBD introduced an all-new rule making it mandatory for non-residential buildings powered by a heating or cooling system with an effective rated output reaching more than 290 kW to be '*equipped with building automation and control systems by 2025*.' (Art. 15).

A decree led by the Ministry of Territories Cohesion & Relation with Territorial local Communities, currently going through mandatory consultation, is about to transpose these articles in France. This text sets all the technical requirements that automation and control systems must meet in accordance with the EPBD and, as set by the Directive, will allow exemptions for existing buildings when meeting the requirements is technically or economically impossible.

The Directive also provides that Member States shall require buildings '*to be equipped with self-regulating devices for the separate regulation of the temperature in each room*' (Art. 8). As seen in part 2.IV.ii, for new buildings, the French laws are already asking for such equipment. The decree mentioned above will extend this rule to existing buildings when technically and economically feasible.

2.IV.iv. Status and encouragement of intelligent metering

Intelligent meters for both electricity ('*Linky*') and gas ('*Gazpar*') are being widely deployed, with a target of full national coverage by 2021. The Electricity and Gas Networks of France (*Enedis* and *GRDF*) carry out the deployment. There are no requirements for intelligent metering for individual technical building systems.

Wide installation of these meters has started in mid-2015 and by the end of 2016, 2.7 million meters were installed. *Enedis* set a target of 7 million meters installed by the end of 2017.

2.IV.v. Progress and current status on heating systems (Inspection / Equivalence)

For boilers between 4 and 400 kW, according to Paragraph 3 of Article 14 of the EPBD, France has taken alternative measures involving an annual maintenance visit. For boilers of more than 400 kW, France has chosen to adopt the default approach, which consists of a periodic inspection scheme.

The alternative measures were chosen for boilers between 4 and 400 kW, after comparing the hypothetical inspection scheme (the reference scheme) and the annual maintenance visit (alternative scheme). The main differences between the two calculations were the following:

- The scope of the alternative scheme is larger (the default approach targets only boilers of more than 70 kW, while maintenance concerns boilers of more than 4 kW).
- Inspections will not systematically lead to renovation work and thus energy saving, whereas a maintenance visit would, because the person in charge can act directly on the system.

The alternative measures applied in France allow more energy saving than the implementation of a regular inspection scheme, as explained in the report submitted in the context of Article 14 of the EPBD.

Boilers between 400 kW and 20 MW: inspection scheme

Boilers between 400 kW and 20 MW are subject to inspection at least every 3 years between 400 kW and 5 MW, and every 2 years between 5 MW and 20 MW. During the inspection visit, the qualified expert must check and measure the same elements as regard to boilers from 4 – 400 kW. For boilers of more than 400 kW a '*boiler-room logbook*' has to be kept, recording all information about the system.

A ministerial order[13] from 2009, and the articles R.224-21 to R.224-30 of the environment code[14] set these requirements.

Boilers between 4 and 400 kW: alternative measures

France took alternative measures to improve the energy performance of heating systems under 400 kW, as follows:

- An annual maintenance visit by any professional in the field of maintenance. During the maintenance visit, the professional must check the boiler (clean and tune it if necessary), measure the concentration of CO, evaluate the energy performance of the boiler, provide advice on best use, improvement of the boiler and of the heating system in place, and issue a certificate of maintenance within 15 days after the visit.
- The Ministry of Energy together with *ADEME*, have prepared a guide for the public[15] in order to explain the new provisions regarding the annual maintenance of boilers. They also conduct publicity campaigns in relation to the most efficient heating systems and to financial support for replacement (see information website 'Energy Info Sites'[16]).

2.IV.vi. Progress and current status on AC and heat pumps systems (Inspection / Equivalence)

The French regulation on AC systems (imposed by one decree[17] and two ministerial orders) has been in force since 16 April 2010 and was adapted in 2020 to match the new EPBD requirements and to consider heat pumps. France has chosen to implement Article 15 of the EPBD by inspecting at least every 5 years AC systems and heat pumps with an output of 12 kW or more. The officer of the inspection is the owner or the manager of the building.

A report on the results and advice for best use is issued within one month after the inspection. The inspection should include:

- inspection of the AC logbook;
- assessment of system performance;
- assessment of the sizing of the system in relation to the cooling and heating of the building;
- provision of the necessary recommendations concerning proper use of the system in place, possible improvements to the installation as a whole, any benefit from its replacement and other potential solutions.

An extent of the boilers' maintenance is currently set in place for heat pumps with rated output power between 4 and 70 kW.

2.IV.vii. Enforcement and impact assessment of inspections

Enforcement and penalties

Penalties are set in the regulation (Art L.226-2 et L.226-8 of the environment code). Controls can be performed by officers of the General Directorate for Competition Policy, Consumer Affairs and Fraud Control. If the regulation has not been properly adhered to, the relevant authority can apply several types of measures:

- carry out a new inspection of the AC system at the owner's expense;
- oblige the owner to deposit the equivalent of the inspection cost as a guarantee until compliance is achieved, whereby the sum is returned;
- oblige the owner to pay a fine;
- force the owner to disconnect from the AC system.

Impact assessment, costs and benefits

AC inspection reports are not collected in a central database so it is challenging to assess precisely the impact of the inspection scheme. The extent of energy savings after an inspection may vary, depending firstly on the decision of the owner to do something or not, and secondly on the extent of the work performed.

Concerning cost-effectiveness of the inspections, an expert, needs one day to perform an inspection, which costs 600 €. Given that inspections occur every five years, this is equivalent to 120 €/year.

3. A success story in EPBD implementation

Following the previous thermal regulation (*RT 2012*), stakeholders expressed mixed feelings towards an even more ambitious regulation, stating that the current one was already quite complicated and burdensome. In the process of defining new regulation, there was thus a strong need to bring stakeholders together from the start. This led to the creation of a testing scheme called '*E+ C-*' (standing for Energy plus Carbon minus), for voluntary developers, which started in late 2016.

This scheme allowed the government to see the impacts of taking into account the carbon emission amounts alongside energy consumption rates in a building regulation. Not only did it show different thresholds of carbon emission allowance during the active life of the buildings; it also offered to include a mandatory life cycle analysis. In addition, it encouraged builders to seek for even more energy efficient projects than what *RT 2012* required, by defining four different levels of energy performance categories.

All along this scheme, the government led concertation with builders to experience the technical and financial feasibility of building construction in accordance with future regulations. In this respect, public developers intend to pave the way of integrating renewable electricity production systems into their buildings and developing low-carbon construction processes. A test observatory collected feedback and best practices to refine indicators and establish future regulatory thresholds.

To reward the first buildings constructed under the new regulations, the Government has introduced a new label that is awarded after the assessment of the technical and economic feasibility of the new requirements. Intended to distinguish positive energy buildings in the same way as low-carbon buildings, this label incorporates several performance levels.

There are four different levels based on the energy consumption and two on the carbon footprint, set by the scheme. The energy performance assessment relies on the currently used calculation methodology, with the first two levels corresponding to the energy performance expected by the *RT 2012* but with a higher share of RES. The third level involves a higher energy performance than the current regulation, and the fourth level matches the positive energy building (meaning that the energy performance is lower than zero).

The new regulation in preparation is about to seek energy performance but also aims to reach ambitious carbon emissions reduction. After 4 years of work, the regulation will be named *RE2020* (for Environmental Regulation of 2020) and is predicted to be released in January 2021.

4. Conclusions, future plans

Even though the last update of the EPBD is about to be fully transposed, France has the will to continue to position itself at the forefront of energy performance of buildings, and plans to make sustainable development the driving force of national growth.

In fact, France carried out ambitious works and adopted strong regulation to go beyond the requirements for energy performance at a European level. For instance, as already written in this report, the government has just published the tertiary regulation that will give a long-term vision to these buildings by specifying clear energy performance goals for 2030, 2040, 2050. This regulation will lead tertiary activities in the energy transition through incentives, e.g., rating or comparison to similar buildings.

France also seeks to reinforce existing tools, e.g., the French EPC to make it more accurate, allowing to use it for future public policies such as those targeting renovation of '*thermal sieves*'. The new EPC will also be made more comprehensible for the general public. This will help developing citizens' interest in their buildings energy and climate performance. Several strands of work are currently being led to improve the EPC. This reform is expected to start by 2021. Its main goals are to:

- Make the EPC a reliable tool for **Energy performance evaluation in order to guide public renovation policies**;
- Ensure its **reproducibility** by making it **legally opposable** from 2021;

- **Strengthen its role as a communication tool** and make the future owner or tenant aware of possible energy savings and potential for reduction of greenhouse gas emissions, as well as of the challenges and benefits of energy renovation.
- **Strengthen its role in the massification of energy renovation of housing** by eradicating '*excessively energy-intensive*' dwellings in the short term (by 2028).

On top of that, France decided to go beyond this single energy performance goal by seeking low carbon emitting buildings on its territory with the help of its upcoming regulation *RE2020*. To put all the odds on its side and make sure that it will be applicable and applied, the conception of this new, ambitious project has started four years ago, alongside all the construction field actors. As it is about to be released, *RE2020* is expected to have a huge impact in seeking energy and carbon efficient new buildings in France

Endnotes

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Annexes -Key Indicators & Decisions

Key Indicators & Decisions – General Background

no	Key Implementation Decisions – General Background	Description / value / response	Comments
01.01	Definition of public buildings (according to article 9 b)	No	
01.02	Definition of public buildings used by the public (according to article 13)	R. 123-2 of Construction and Housing Code: '*every building or room where people are allowed for free or in exchange of a payment, or where public or on invitation meetings take place*.'	
01.03	Number of residential buildings	36.6 M housings	
01.04	Number of non-residential buildings	1,000 Mm² of heated surface	
01.05	If possible, share of public buildings included in the number given in 01.04		
01.06	If possible, share of commercial buildings included in the number given in 01.04		
01.07	Number of buildings constructed per year (estimate)		
01.08	If possible, share of residential buildings constructed per year (estimate, included in the number given in 01.07)	400,000 housings	
01.09	If possible, share of non-residential buildings constructed per year (estimate, included in the number given in 01.07)	26.5 Mm² initiated	
01.10	Useful floor area of buildings constructed per year in million square meters (estimate)	62 million m²/year	

Key Indicators & Decisions – New Buildings

no	Key Implementation Decision – New Buildings	Description / value / response	Comments
02.01	Are building codes set as overall value, primary energy, environment (CO_2), reference building or other	Yes	
02.02	Requirements for energy performance of residential buildings in current building code	See table 1 in 2.I.ii	
02.03	Requirements for energy performance of non-residential commercial buildings in current building code	See table 1 in 2.I.ii	
02.04	Requirements for energy performance of non-residential public buildings in current building code	See table 1 in 2.I.ii	
02.05	Is the performance level of nearly zero energy (NZEB) for new buildings defined in national legislation?	Yes, see 2.I.iii	
02.06	Nearly zero energy (NZEB) level for residential buildings (level for building code)	See table 1 in 2.I.ii	
02.07	Year / date for nearly zero energy (NZEB) as level for residential buildings (as indicated in 02.04)	Since 2013	
02.08	Nearly zero energy (NZEB) level for all non-residential buildings (level for building code)	See table 1 in 2.I.ii	
02.09	Year / date for nearly zero energy (NZEB) as level for non-residential buildings (as indicated in 02.06)	Since 2013	
02.10	Are nearly zero energy buildings (NZEB) defined using a carbon or environment indicator?	Until the new *RE2020*, the *E+C-* experimentation sets an environment indicator	Carbon indicator is not mandatory yet but will be from 2021.
02.11	Is renewable energy a part of the overall or an additional requirement?	Both overall requirement and an additional requirement	An overall requirement through the C_{ep} requirement
02.12	If renewable energy is an additional requirement to NZEB, please indicate level	5 kWh/m².year production in single houses	
02.13	Specific comfort criteria for new buildings, provide specific parameters for instance for airtightness, minimum ventilation rates	Minimum ventilation rates or minimum windows surface are defined by the law	

Key Implementation Decision – Existing Buildings

no	Key Implementation Decision – Existing Buildings	Description / value / response	Comment
03.01	Is the level of nearly zero energy (NZEB) for existing buildings set in national legislation?	No	It is set by seals (80 KWh/m².year)
03.02	Is the level of nearly zero energy (NZEB) for existing buildings similar to the level for new buildings?	It depends on the seals	
03.03	Definition of nearly zero energy (NZEB) for existing residential buildings (if different from new buildings)		
03.04	Definition of nearly zero energy (NZEB) for existing non-residential buildings (if different from new buildings)		
03.05	Overall minimum requirements in case of major-renovation	To reach a minimum energy performance standard set depending on the location of the building	
03.06	Minimum requirements for individual building parts in case of renovation	When an element of a building is being replaced, the new element must meet specific performance requirements set by law	
03.07	National targets for renovation in connection to Long Term Renovation Strategy (number or percentage of buildings)		
03.08	National targets for renovation in connection to Long Term Renovation Strategy (expected reductions and relevant years)		

Key Implementation Decision - Energy Performance Certificates

no	Key Implementation Decision – Energy Performance Certificates	Description / value / response	Comment
04.01	Number of energy performance certificates per year (for instance average or values for of 3-5 years)	1,300,000	Average on 2016-2019
04.02	Number of EPCs since start of scheme	13,000,000	
04.03	Number of EPCs for different building types	-	See Table 4.
04.04	Number of assessors	7,500	
04.05	Basic education requirements for assessors	Bachelor degree + 2 years	
04.06	Additional training demands for assessors	2 to 3 days of training	
04.07	Quality assurance system	Control of assessments by the certifying body	See 2.III.ii
04.08	National database for EPCs	Observatoire DPE	
04.09	Link to national information on EPCs / Database	https://www.observatoire-dpe.fr/	

Key Indicators & Decisions – Smart Buildings and Building Systems

no	Key Implementation Decision – Smart Buildings and Building Systems	Description / value / response	Comment
05.01	Is there a national definition of smart buildings?	No	
05.02	Are there current support systems for smart buildings?	The government is supporting the sector's development	
05.03	Are there currently specific requirements for technical building systems (for instance in building codes)?	Not specific but diluted	
05.04	Are there current requirements for automatics (for instance in building codes)?	Not yet, but a decree is about to set relevant requirements	
05.05	Chosen option A or B for heating systems (inspection or other measures)	It depends on the system's effective rated output	
05.06	Number of heating inspections; reports per year (if option A)		
05.07	Chosen option A or B for cooling systems (inspection or other measures)		
05.08	Number of air-conditioning / cooling system inspections; reports per year (if option A)		
05.09	Is there a national database for heating inspections?	No	
05.10	Is there a national database for cooling / air-conditioning inspections?	No	
05.11	Are inspection databases combined with EPC databases for registration of EPCs and inspection reports?	No	
05.12	Link to national information on Inspection / Database	https://www.ecologique-solidaire.gouv.fr/entretien-et-inspection-des-chaudieres-appareils-chauffage-et-systemes-climatisation	

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