Sustainable Construction in Rural and Fragile Areas for Energy efficiency

REGULATORY MONITORING

Foreword

Energy management is essential due to the depletion of fossil resources, energy price increasing, and global warming that we need to deal with.

With 46% of national consumption, and 25% of green house gases emissions, building trade is an overriding sector in order to achieve an efficient energy policy.

1.Energy and regulation: context

1.1 European law

Directive n°2002/91/CE of the European Parliament and of the Council of 16 December 2002 on **the energy performance of buildings** has set a common framework designed to promote buildings global energy consumption performance.

This directive has been recast by directive n°2010/31/UE of the European Parliament and of the Council of 19 may 2010 dealing with building energy performance, which provides higher requirements and specific dispositions for the improvement of existing buildings. It specifies:

- ✓ A calculation method for the integrated energy performance of buildings;
- ✓ Energy performance minimum requirements for new buildings and existing buildings, if there are major renovations. New buildings will be powered by renewable energy, heat pumps or cogeneration;
- ✓ Certification for energy performance of buildings. The certificate will be issued for all buildings constructed, sold or leased to a new tenant, and all buildings, including a total floor area over 500 m² is occupied by a public authority and frequently visited by the public;
- ✓ Inspection of heating and air conditioning systems in buildings;
- ✓ The independent control systems for energy performance certificates and inspection reports.

Furthermore, by 31 December 2020, the directive requires that all new buildings consume almost zero energy.

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1.2 French law

Pursuant to European regulations, directions of energy policy of France were set in the Planning Act No. 2005-781 of 13 July 2005.

In compliance to European rules, the energy policy of France was set in the blueprint law No. 2005-781 of 13 July 2005, providing framework for government program.

This policy aims:

- → To ensure security supply;
- → To maintain a competitive energy price;
- → To preserve human health and environment, especially with the fight against global warming;
- → To guarantee social and territorial cohesion, with an equal access to energy for everybody.

(Article L.100-1of the energy code)

Made under the Act, the **"2005 thermal regulation"** (RT 2005) - consists of Decree No. 2006-592 and May 24, 2006 decree for new buildings, is required for new buildings that are given a building permit since September 1, 2006.

For existing buildings, Decree No. 2007-363 of 19 March 2007 dealing with the feasibility of energy supplies, the thermal and energy performance of existing buildings, and the display of energy performance, implement for the first time a thermal regulation for existing buildings. The application of this decree is specified by the order of 3 May 2007 on the thermal characteristics and energy performance of existing buildings, and by order of June 13, 2008 on the energy performance of existing buildings with an area bigger than 1000 m², which are subjected to major renovation.

The Environment Grenelle, launched in summer 2007, led to the adoption of Grenelle 1laws (providing framework for government program) and 2 (law allowing the implementation of the Grenelle 1) which institute a new sustainable development model with particular priority given to the **fight against climate change**.

The Grenelle 2 law has defined new thermal regulation objectives, the "thermal regulation 2012" (RT 2012), relevant to new buildings, and will be effective:

- From October 28, 2011 for units that operate in a ANRU area (urban renewal), for offices or education and care institutions of early childhood buildings;

- From 1 January 2013 for other new residential buildings.

2. Current thermal regulation by shift

In order to improve the building energy performance, the designer can:

- enhance the envelope thermal insulation (§1)
- reduce its air permeability (§2),
- improve the ventilation (§ 3) and cooling (§ 4) equipment performance
- and finally, use renewable energies (§ 5), as promoted by regulators.

2.1. Buildings thermal insulation

What is the building envelope thermal insulation?

The characteristic of the envelope thermal insulation is expressed by the coefficient: Ubat [W / m². K], which corresponds to the thermal resistance in square meters. Kelvin per watt. This coefficient is determined by the method of calculation Th-CE.

Thermal isolation and RT 2005 for new buildings

The coefficient must comply with the limits specified in the decree of May 24, 2006. These values are functions of climate zones in which the building is located.

Thermal insulation and RT 2005 for existing buildings

2005 thermal regulations apply to the walls of heated rooms, walls whose surface is bigger than or equal to 0.5m², to the outside, on an unheated volume or in contact with the ground.

When installation or replacement of thermal insulation are undertaken on a wall, they must be constructed so that the wall has an insulated thermal resistance greater than or equal to the minimum value given in the order of **May 3, 2007**, or in the order of **June 13, 2008** in the case of existing buildings with an area bigger than 1000 m², when it deals with an important work.

2.2. The building airtightness

What is building airtightness?

Air leakage or air permeability of a structure characterizes the sensitivity of the building towards the ventilation flow interference caused by leaks on its envelope, or simply the absence of any sealing unrelated to a specific ventilation system. It is quantified by the leakage flow value under a given difference of pressure.

Air tightness of new buildings and thermal regulations

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The airtightness of the building is an important parameter in order to characterize a building envelope. It is characterized by a permeability coefficient which represents the leakage rate per square meter of surface area loss (excluding low-floor) in a vacuum of 4 Pa and is quantified in m3 / (h.m ²).
Thermal regulations 2005 sets targets for the building envelope by reference and allows enhancing an airtightness quality assurance. As part of BBC-label Effinergie, the air permeability treatment is required for residential buildings. The air permeability measurement of a building is recoverable, under this label, if it is performed by a licensed operator.

The reference values of the RT 2005 are:

- → 0.8 m3 / m². H for detached houses;
- → 1.2 m3 / m². H for residential or other buildings used for offices, hotels, catering, education and health facilities.
- → The default values are taken at 0.5 m3 / m². H above the previous values. The BBC Effinergie thresholds are taken at 0.2 m3 / m². H below (except tertiary 1, 7 m3 / m². h).

- The protocol in order to measure tightness

The following standards are used to perform tightness calculations:
- Standard EN 832 on the calculation of energy needs for heating (Section 5 Losses to internal temperature constant)
- Standard EN 12831 for the calculations of heat losses
- Standard EN 13829 Determination of air permeability of buildings, and its implementation guide GA P50-784

2.3. Ventilation

- What is the purpose of buildings ventilation?

Ventilation meets a need of hygiene and health for occupants:

- Fresh air contribution for breathing of the occupants
- Elimination of indoor pollution related to the presence of human activities

The building conservation also requires a controlled ventilation so as to prevent excessive moisture, especially for tighter envelope.
Finally, especially in housing, ventilation ensures that the combustion air, for combustion appliances and to contribute to the occupants safety in case of toxic fumes.

- *What are the constraints to consider?*

Building ventilation must be designed and installed taking into account the following constraints:

- The acoustic equipment and / or facades;
- The consumption and energy losses;
- Weather conditions (wind. ..)
- Sustainable Development (Eco design);
- Fire protection.

- *Ventilation and thermal regulation 2005*

The decree of May 24, 2006 provides that the outdoor air is used to ventilate successively contiguous premises or separated premises, only by air circulation, within the frame of existing regulations.

- For new buildings (decree of May 24, 2006)

Devices that need to be implemented in new buildings are described in Articles 44-50 of the decree of May 24, 2006.

- For existing buildings (decree of May 3, 2007)

For existing buildings, the auxiliary ventilation installed or replaced in private houses will have a maximum consumption of 0.25 Wh/m3 fan, which may be increased to 0.4 Wh/m3 in the presence of filters F5 to F9. These two values of maximum power can be increased by 0.05 Wh/m3 fan until June 30, 2009.
The auxiliary fan installed or replaced on the premises for other than residential buildings will have a maximum consumption of 0.3 Wh/m3 fan, which may be increased to 0.45 in the presence of Wh/m3 filters F5 to F9. These two maximum power values can be increased by 0.05 Wh/m3 by fan until June 30, 2009.
In the case of buildings or parts of buildings for other than housing and subjected to replacement or installation of a ventilation system for an area of more than 400 m², a device will manage automatically Vacancy / occupation rates.

2.4. Cooling

Cold production can be achieved with a refrigeration unit or an heat pump compressor driven by an electric motor, a refrigeration unit or an absorbing heat pump (e.g. gas heating) or from a distribution network of ice water.

Cooling and thermal regulation: what type of premises?

For summer comfort, the regulation makes the distinction between two categories of premises:

- The premises known as CE1 whose consumption reference linked to cooling are null and must meet the requirements of the decree of May 24, 2006 for new buildings, and orders of May 3, 2007 and 13 June 2008 for existing buildings;

- Other premises, category CE2, where the baseline associated with cooling are calculated according to the reference values. These premises are not subjected to the requirements of summer comfort.

Cooling and thermal regulation: new buildings features

Baseline characteristics defined in the decree of May 24, 2006:

1. Generation:

The efficiency of electrical thermodynamic power generators is corrected under the calculation method Th-C-E EER corrected equals 2.45. the other features are defined in the calculation Th-CE.
For devices producing cold with gas, efficiency corrected for the purposes of the calculation Th-EC is 0.70 kW / kWep until 31 December 2008 and 0.95 thereafter.

2. Exchange:

In the case of a cooling system connected to a district cooling network, the components of the substation of reference have the project features.

3. Distribution:

The distribution system of reference is composed of two pipes for the purposes of the calculation Th-CE. It's

a Class 3 insulation as defined in the calculation method Th-CE. The network length is the default value as defined in the method of calculation Th-CE.
The distributed fluid temperature is low according to the calculation method Th-CE.
Pumps of reference turn at constant speed and are interlocked when cooling stops.

4 : intermittences programming

For premises which are not used continuously, serving an area bigger than 400 square meters, the distribution of reference cold values is set by an automatic device, controlled by a clock, and takes into account the internal temperature directly, or through a setpoints change of the terminal regulation.

5. Emission and Control:

The couple formed by the issuer and its regulation have a class B spatial variation and a - 1.8 K time variation under the calculation method Th-C-E.
The transmitters are supplied with low temperature water under the calculation method Th-CE.
Losses on the back of the transmitters equal to zero.
The transmitters are equipped with fans whose power is 2 W / m².

The **minimum requirements** specified in the decree of May 24, 2006 are:

> In the case of non residential buildings, the cooled premises shall be provided with specific ventilation devices.
> The access doors to a cooled zone must be equipped with an automatic closing device.
> Pumps for cooling facilities must be equipped with devices allowing them to stop.
> In every premise, a cooling system must be equipped with manual and automatic devices depending on the indoor temperature.

However

- When cold is provided by a system with variable air volume, this device can be shared for premises of a maximum surface of 100m² , if the total circulation flow control is done without increasing the pressure drop- When cold is provided by an underfloor cooling, this device can be shared for premises with a maximum total area of 150 square meters;
- for "fan-coil units with only two cold tubes" the obligation of the first paragraph shall be considered satisfied when each fan is controlled by the indoor temperature and the production and distribution of cold water are provided with a programming device;
- For residential and housing buildings cooled by refreshment of new air, without increasing the flow beyond the double of hygiene requirements, the obligation of the first paragraph is satisfied if the cold supply, on the one hand regulated according to the return air temperature, and on the other hand regulated by outdoor temperature, is prohibited during heating periods.

Before the final emission in the room, except in the case where heating is obtained by recovering the production of cold, air can't be heated then cooled, or cooled then heated by devices that use energy and intended by design for heating or cooling the air.

2.5. Renewable energy (ENR)

Thermal regulation for new buildings but also for old buildings, forces the inclusion of renewable energy, by introducing it as reference.
The integration of renewable energy, particularly **geothermal**, **solar thermal** and **wood-energy** is a key in order to reduce fossil fuels consumption, in both new buildings and existing buildings.
Thus, the calculations for wood boilers and heat pumps are taken into account, solar energy for hot water production is calculated in reference for certain buildings.

3. Thermal regulation to come: RT 2012

The implementation of the Grenelle objectives generalizes the "low energy buildings" in 2012 resulting in the adoption of a new thermal regulation, known as "RT 2012", which will replace the current regulations ("RT 2005 ").
The objective of the RT 2012 is to limit the primary energy consumption of new buildings to a maximum of 50 kWh / m²/ year on average.

So as to achieve this objective, two texts specify the thermal and energy performance requirements which are subjected to new buildings and new parts of buildings: Decree No. 2010-1269 and the Order of October 26, 2010.

3.1. Thermal characteristics and performance requirements: the decree

The decree stipulates that buildings should be constructed and equipped so that they meet thermal requirements and the three requirements following:

- **primary energy consumption limitation** "Cep" to:

o heating,
o cooling
o production of hot water,
o light,
o Auxiliary heating, cooling, hot water and ventilation;

- **building's design optimization regardless of energy systems implemented** so that the building's conventional energy needs for heating, cooling and lighting does not exceed a maximum value called conventional bioclimatic need energy "Bbio ";

- **Summer comfort with the limitation of overheating in the building during summer**, conventional internal temperature of a room achieved in summer "Tic."

The coefficients Cep, Bbio and Tic are determined in the decree of October 26, 2010.

The buildings concerned are:

- those whose construction permit or prior notification were filed after October 27, 2011 for the following buildings:
  - new buildings for **office or educational purposes**
  - institutions for **early childhood**
  - and **residential buildings** built in urban renewal zones (ANRU)
- those whose construction permits were filed on after 1 January 2013 for **other new residential buildings**.

Exclusions: These provisions do not apply to buildings and parts of buildings whose normal operating temperature is less than or equal to 12 °C and tem porary buildings with a planned life of less than two years.

3.2. Thermal characteristics: mode of enforcement of the decree

Energy performance requirements

The order states that new buildings must comply with all the following conditions:

- → maximum conventional energy consumption **Cep ≤ max**
- → maximum energy conventional bioclimatic need Bbio **Bbio ≤ max**
- → internal conventional temperature achieved in summer **Tic ≤ ref**

Cep max and Bbio max coefficient are set out in Title II of the order, according to the following criteria

o Type of building or part of a building and category CE1/CE2

o Geographical location and altitude

o Average size of housings

o Greenhouse gas emissions (for the Cep only)

For **Tic**, the parameters to consider are set out in Annex 10 of the Order.

Requirements means

The order specifies **requirements means** that housing must meet. It is:

- ⇨ the use of a **renewable energy source** for any adjoining house or via one of these solutions:
  - domestic solar thermal hot water production,
  - connection to an heat distribution system, supplied with more than 50% of renewable energy or recovery,
  - demonstration of the renewable energy contribution in the building Cep, is greater than or equal to 5 kWhEP / (m². year).
- ⇨ the envelope airtightness;
- ⇨ thermal insulation;
- ⇨ access to natural light;
- ⇨ summer comfort (choice of windows).

Justification of the input data for the coefficients calculation and application of means requirements.

The contractor must document the characteristic values used as input to the calculation of coefficients Cep, Bbio and Tic (chapter IV of the Order) and establish, a computer version, before works are done, a standardized summary of thermal study (Annex VI).

At the latest from 1 January 2013, software used to perform Cep, Bbio and Tic calcultaion must have been assessed by the Minister in charge of building and Housing and the Minister in charge of energy, according to the procedure set out in Annex X.

Controls and Measurement

- The detached or terraced houses and the buildings or parts of residential apartment buildings are equipped with **systems in order to measure or estimate energy consumption of each dwelling**.
- Heating and cooling devices include **manual shut-off and automatic adjustment** depending on the temperature inside the room.
- The corridors, public areas and parking lots, include **automatic adjustment of the illumination.**

Approval of a system or a specific project

It is possible to apply for approval to the Minister of Construction and Housing and the Minister for Energy application modes for simplified single-family houses (Annex IV) if the method of calculation Th- 2012 BCE does not take into account the specificities of a system, a construction project or a heat or cold distribution system (Annex VI).

4. Territorial Planning Tools

4.1. At the regional level: the regional pattern for climate, air and energy

Grenelle 2 law provides that each region needs to develop a regional pattern for climate, air and energy (SRCAE).

A decree was published in the Official Gazette on June 18, 2011 that defines the content and modalities of these planning tools.

The SRCAE consists of:

- **a report on the state of play in all areas covered by the scheme,**
- **a guidance document that sets guidelines and regional targets:**
  - o to reduce emissions of greenhouse gases,
  - o in order to fight against air pollution,
  - o so as to develop renewable energy sectors,
  - o in order to anticipate the adaptation to climate change
- **an appendix entitled "Wind regional plan", which covers parts of the regional territory where will be located proposals for wind development area.**

The contents of those documents are detailed in Article R. 222-2 of the Code of the environment.

The decree states:

- How **the prefect and the president of the Regional Council must develop together the scheme**, **supported by a steering committee and a technical committee** (the Environmental Code, Article R. 222-3);

- Arrangements for **public consultation** on the draft scheme (Environment Code, Article R. 222-4);

- Organizations to which SRCAE is submitted **for an advisory opinion**, at the beginning of the provision to the public of the proposed scheme (Environment Code, Article R. 222-4);

- **Approval procedures and provision to the public** of the scheme established by the prefect (Environment Code, Article R. 222-5);

- The **evaluation and implementation conditions of SRCAE**, five years after the order publication by the prefect (Environment Code, Article R. 222-6);

- The method for the preparation of the regional plan in Corsica, given to the Territorial Assembly (Environment Code, Article R. 222-7).

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4.2. At the local level: the territorial energy climate plan

The development of a Territorial Energy Climate Plan (PECT) is the result of a voluntary territorial approach to define and harmonize all of its policies to fight against the emission of greenhouse gas emissions. The PECT is the result of a sustainable development thought process which focuses on the greenhouse effect. It is a framework that mobilizes all partners and local stakeholders of a local authority.

Issues that a community can tackle with the PECT are multiple and can move towards the following objectives:

- ✓ Ensure local economic development and employment
- ✓ To fight against energy poverty
- ✓ To reduce energy and climate vulnerability
- ✓ Strengthen the attractiveness of the territory

In parallel to the PECT, a tool provides a framework for local authorities and their inhabitants for the practical implementation of the sustainable development concepts including energy management and fight against climate change: this is an **Agenda 21**.

An Agenda 21 is a sustainable land development plan. It is carried by the community and conducted in consultation with stakeholders: elected officials and staff, residents, associations, companies, decentralized structures of the state, education and research networks...

The ADEME provides on its website a methodological guide to assist communities in this process which is entitled "Sustainable Development Objectives: understand and act on the territory"

5. Certifications and labels

5.1. Energy labels

Based on the current thermal regulations (RT 2005), the decree of May 8, 2007 describes the method of allocation, and the content of the' high energy performance" labels.

The principle of this Order is to allow project owners who surpass regulatory requirements for energy performance to enhance their operation. This is the reason why the decree envisages five levels:

- High Energy Performance (HPE): 10% lower energy consumption than regulation,

- High Energy Performance - Renewable Energy (HPE EnR): 10% inferior to the regulation and 50% of heating provided by a biomass district heating system powered by 60% of renewable energy

- Very High Energy Performance (THPE): 20% inferior to the regulations,

- Very High Energy Performance - Renewable Energy (THPE EnR) or consumption of less than 30% to the regulation and use of renewable energy for the 5 regulatory positions using either biomass, solar thermal, photovoltaic pumps Heat in amounts specified in the order,

- Low Consumption Building (BBC) 50% inferior than the regulations for commercial buildings, or less than an absolute value of 50 kWhep / m² shon. for housing. (This value of 50 is modulated according to climatic zones and altitude).

In addition to the energy performance, these labels are given by organizations that have been accredited by the state, which certifies the accuracy of the performance displayed.

To this day the following organizations are accredited (Certivéa, CEQUAMI, and Cerqual Promotelec).

Energy labels associated with the 2012 thermal regulation are not defined yet.

Foreign energy labels (Minergie in Switzerland, Passiv'Hauss in Germany, ...) can be substituted for French thermal regulations.

5.2. Environmental certifications

In France the HQE (High Environmental Quality) was the first to set 14 targets to transcribe the environmental quality of a building.

Various organizations were then created based on these 14 reference targets:

- Certivéa, a subsidiary of CSTB, created the NF HQE office buildings with a repository for various products (offices, schools, hospitals, logistics platform, hotel, trade, ...) for new construction or renewal programs.

These benchmarks are based on 14 targets:

o the building and its environment,

o Integrated choice of products, systems and construction processes,

o Workshop with low environmental impact,

o Energy Management,

o Water management,

o waste management activities,

o Maintenance and sustainability of environmental performance,

o Hygrothermal comfort,

o Acoustic comfort,

o Visual Comfort,

o olfactory Comfort

o Sanitary quality of spaces,

o Sanitary quality of air,

o Sanitary quality of water.

Certification is obtained at the building delivery after three audits at the end of the programming phase, design and implementation.

- Cerqual, which is a subsidiary of Qualitel, created brands *Housing and Environment* and Heritage and environment for housing renovation collective or individual group. The reference is based on 7 topics:

    o Environmental management of the operation,

    o Clean site

    o Energy / reduction of greenhouse

    o construction / material selection,

    o Water

    o Visual Comfort,

    o Green Actions.

Certification is obtained after the design, on the basis of an audit, and a market files review of companies. Then Cerqual performs inspections in situ.

- CEQUAMI has created a reference for the individual house.

Then all foreign reference relevant in France, among the best known English BREEAM, LEED North American or German DGNB.

These references help to demonstrate by an external and independent organization the environmental quality of buildings, and also allows these references to enhance the implementation of exemplary operations that outreaches the regulatory framework for all environmental issues related to the building.

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REFERENCES

Decree No. 2006-592 of 24 May 2006 on the thermal and energy performance of buildings (OJ of 25 May 2006)

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Order of 3 May 2007 on the thermal and energy performance of existing buildings (OJ of 17 May 2007)

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