May 2023

HANDBOOK

Building Energy Efficiency Regulation for the Benefit of Caribbean Countries :

Guadeloupe Case Study

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TEC TRANSITION ÉNERGÉTIQUE DANS LA CARAÏBE

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TRANSITION ÉNERGÉTIQUE DANS LA CARAÏBE

IN SHORT

The INTERREG “Energy Transition in the Caribbean” (ETC) project aims to promote cooperation in energy management between Guadeloupe, the other French overseas territories and the members of the Organisation of Eastern Caribbean States. The project addresses the need to strengthen the resilience of Caribbean island energy systems to major crises induced by climate change. It also supports the emergence of a regional energy transition market with the identification and the communication on investment opportunities. The cooperation project addresses **three areas of action: energy efficiency of buildings, clean energy in transport and the regional development of geothermal energy**.

Partners

"Energy Transition in the Caribbean" is an INTERREG cooperation project carried out by an international partnership consortium between the Regional Council of Guadeloupe, the Organisation of Eastern Caribbean States (OECS), the French Agency for ecological transition (ADEME) and the French Geological Survey (BRGM). The project is led by the Regional Council of Guadeloupe.

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INTRODUCTION

CAISSE GÉNÉRALE DE SÉCURITÉ SOCIALE (CGSS), GUADELOUPE
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ENERGY CONTEXT IN THE CARIBBEAN

The energy context of the Caribbean has specificities that primarily stem from the tropical climate and the insular nature of the countries. The energy consumption observed in most of the Caribbean islands is proportional to their GDP, in growth, and 80% - 95% is attributable to buildings. The energy vector used in buildings is practically entirely electricity, produced locally, mostly from fossil energies, and with the constraints of fluctuations in demand. Because of this, this energy is both expensive and a high greenhouse gas emitter. In addition, within the buildings, cooling the premises constitutes a significant part of the demand for electricity, which is 60% for most buildings of the office type.

Energy efficiency in building sector is a significant challenge for Caribbean countries that are particularly exposed to climate change, in addition to decarbonisation efforts in the production of electricity.

To achieve this, the Member States of the OECS Commission have taken collective initiatives borne in a concerted manner by CARICOM and CROSQ, aimed at improving the energy efficiency of buildings, and compatible with the specific objectives of the different States. In the area of new construction and existing buildings, mention can be made of the CARICOM Regional Energy Efficiency Building Code (CREEBC), the OECS Building Code (OECS BC) as well as the Minimum Energy Performance Standards (MEPS), which set down minimum requirements in terms of energy efficiency for buildings by using normative measures linked to performance (the envelope of the building and the energy systems). The actions taken to date are primarily of an incentive nature, based on a corpus that includes performance targets, reference standards and standards. However, the first actions based on an obligation were adopted in Saint-Lucia, Saint-Kitts and Nevis and are in the process of being adopted, particularly in Montserrat, Grenada and Saint-Vincent-and-the-Grenadines.

ENERGY CONTEXT IN GUADELOUPE

Guadeloupe (as well as Martinique) of which the global electricity consumption is close to that of all the Member States of the OECS Commission, shares these specificities, with few differences:

- A cost of energy regulated by indexing on the French cost;
- A consumption in electricity declining slightly (–5% over the last 5 years, after a period of high growth);
- A third of the electricity production from renewable sources (in 2021, renewable energies represent 33.70% of Guadeloupe's electricity generation mix);

Since 2008, the Regional Council of Guadeloupe has defined and implemented an energy policy that is specific to its island context, structured by its energy roadmap. Action on new construction is carried out by the Guadeloupe's Building Energy Efficiency Regulation ("RTG") aimed at bioclimatic quality, supplemented by prohibiting excessively ineffective equipment on the market. Furthermore, action on buildings is based on incentives and grants defined by the Energy Management Commission of Guadeloupe ("Comité MDE") and more recently on the Building Energy Retrofitting Service ("programme SARE") to support owners in the retrofitting their buildings. The Energy Performance Certificate of Guadeloupe ("DPEG"), which is required during real estate transactions, aims to enhance the value of high-performance buildings by explaining their performance profile. Finally, the action on the decarbonisation of production of energy includes a vast programme of renewable energy integration.

THE PURPOSE OF THIS HANDBOOK

In 10 years of existence and continuous improvement, the Guadeloupe's Building Energy Efficiency Regulation ("RTG") has been the testing ground for multiple technical and organisational innovations, able to inspire other territories. Through this handbook, the Regional Council of Guadeloupe today wants to share its experience with the Caribbean countries.

Constructing a public energy policy gives rise to many questions. Moreover, the impact of it is seen over a long period. This feedback on the Guadeloupe's Building Energy Efficiency Regulation ("RTG") sheds light on the policy options retained and their consequences in the middle term.

By targeting the main issues and decrypting the mechanisms, this handbook assists to decision-makers in projecting themselves in their specific context and plotting out their own path.

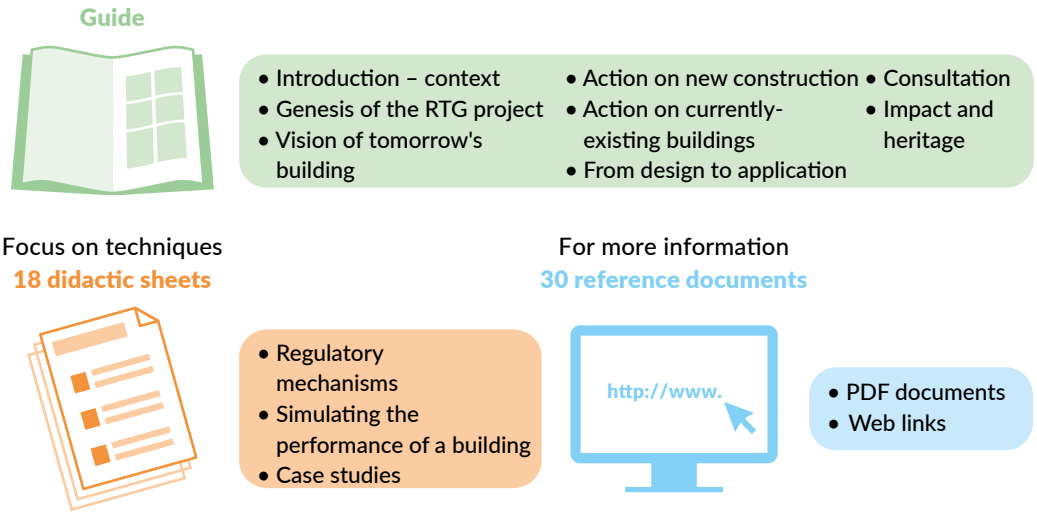
WHO WAS THE HANDBOOK WRITTEN FOR?

Political decision-makers: *this feedback decrypts the political issues, the decisions retained and their consequences over the long term. It will allow you to project yourself in the specific context of your country in order to assist you in plotting out your own path.*

Technicians in charge of energy standards: *this handbook reveals the methods for manufacturing regulation that are specific to the tropical climate. It provides an overview of the technical options retained, the support tools developed, and the associated processes for implementation. It will also allow you to access, if needed, information on a more detailed level.*

SCOPE

The handbook provides readers with relevant information in an accessible format that will help develop comprehensive and effective governance mechanisms.



Using this handbook:

In order to facilitate reading, important passages are highlighted in the following sections:

Reflection on a pure policy nature

these are issues raised during defining or implementing of the regulatory scheme. They stem from a political decision because the technical analysis does not make it possible to answer them directly. These issues are likely to be raised in similar regulatory approaches. The options taken by Guadeloupe are explained.

Problem or difficulty

these are difficulties encountered during defining or implementing of the regulatory scheme. It is recommended that they be anticipated because they are likely to arise in similar regulatory approaches.

Feedback

illustration through mentioning a concrete case or through a testimonial from a professional stakeholder or an expert.

To find more information

links to more detailed resources, inside the guide, to the focus sheets, or to the reference documents that supplement the handbook.

WHAT THIS HANDBOOK DOES NOT DO?

This handbook does not offer definitive solutions to how decision-makers should organise to implement their Building Energy Efficiency policies, regulation and programmes. Rather, the handbook:

- Highlights the critical questions that require decision-makers' attention when dealing with building energy performance policy issues; and
- Offers successful feedback and guidelines for addressing these questions based on Guadeloupe's experience.

Decision-makers should find these feedbacks, guidelines, and questions useful in developing their own country-specific building energy performance regulation approaches.

2

GENESIS OF GUADELOUPE'S BUILDING ENERGY EFFICIENCY REGULATION ("RTG") PROJECT

LYCÉE DE PORT-LOUIS, GUADELOUPE
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In 2008, the Grenelle de l'environnement (national consultation on the environmental policy) had just ended and set a course for energy independence for the overseas territories. It was at this time that the Regional Council of Guadeloupe established the Energy Roadmap for the Prospection and use of Renewable Energies and the Rational use of the Energy of Guadeloupe by 2020 ("PRERURE"). The PRERURE highlights Guadeloupe's dependency on fossil fuels and concludes that it is necessary to take action simultaneously on the development of renewable energies and on energy efficiency in the transport, industry and building sectors. At this time, and despite the obligations that stem from the European Energy Performance Building Directive ("EPBD"), no energy efficiency regulation restricts constructions in the overseas territories. The PRERURE identifies this lack as a major obstacle to be removed by the local public authorities.

In March 2009, the Regional council of Guadeloupe decided to take on the establishment of a regional building energy performance regulation and requested from the French parliament the authorisation provided for in Article 73-3 of the constitution to promulgate its standards in the area of energy based on Article L.O. 4435-10 of the CGCT. The return from parliament was positive. Nevertheless, concurrently (April 2009), the State published a regulation entitled "RTAADOM" of which one of the decrees regulates the thermal performance of housing units, thus forming the very first energy performance regulation for buildings that applies in Guadeloupe. However, this regulation does not cover commercial and institutional buildings[1] set obligations of which the rigidity is reproached by most of the local stakeholders in the building sector.

The local regulation project is therefore ongoing, but with the idea of a performance approach (such as practised in France with "RT 2012"). Constrained by the deadlines inherent with the regulatory authorisation (2 years to publish the texts), the project started in 2010 came to a close one year later with the publication of the Guadeloupe's Building Energy Effiency Regulation ("RTG") (new construction of housing units, offices, shops) and of the Energy Performance Certificate of Guadeloupe ("DPEG"). Specific deliberation also supervised the systems for producing cold and domestic hot water. This was the very first version of the Guadeloupe's Building Energy Effiency Regulation ("RTG"), which would then change progressively, until today.

"The Energy Roadmap for the Prospection and use of Renewable Energies and the Rational use of the Energy of Guadeloupe ("PRERURE") forms a starting point: it sets down the major lines of Guadeloupe energy policy for the 2010 decade: rebalancing interventions in favour of energy control, reinforcement and expansion of existing partnerships, expanding the set of tools in favour of energy efficiency (and in particular the regulatory tool) form the keywords of this policy."
PRERURE Guadeloupe, 2008

Focus on the regulatory authorisation

The French Constitution provides that certain overseas collective units (governed by Article 73) can be authorised by law or by the regulation "to set down rules themselves that apply on their territory, in a limited number of subject areas [...]". The authorisations are granted for a limited period, generally 2 years. At the end of this period, if the collective unit does not request renewal for the authorisation, the State regains jurisdiction over the area that was previously delegated. The State remains the executive power in charge of applying texts. The regulatory texts taken by the collective unit remain applicable on its territory but the latter can no longer modify them. The Regional Council of Guadeloupe has used of this possibility to conduct local policies in matters of energy planning, energy management, energy performance of buildings regulation and the development of renewable energies. The Regional council of Guadeloupe was granted authorisation for the first time through Article 69 of law 2009-594 of 27 May 2009 for the economic development overseas. This first authorisation lasted for two years. It was renewed several times and the latest renewal request was filed in 2022.

1 To avoid linguistic confusion, the term "commercial and institutional building" will be used throughout the study to refer to what is called "bâtiment tertiaire" ("tertiary building") in French. This sector includes all buildings that are neither residential nor industrial, i.e. office buildings, public administration buildings, supermarkets and small shops, hotels and restaurants, primary, secondary and higher education buildings, hospitals and care facilities, airports, etc

3

A VISION OF HIGH-PERFORMANCE BUILDINGS IN TROPICAL CLIMATE: FUTURE TRENDS

KANN'OPÉ, GUADELOUPE
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TECHNICAL APPROACH OF THE PERFORMANCE FACTORS OF A BUILDING

This chapter presents the main qualities expected of a high-performance building from a thermal and energy stand-point, in the Caribbean climate. The building energy effiency regulation aim to promote these constructive techniques, in new constructions as well as in improving existing buildings.

PROTECTION FROM SOLAR RADIATION [PRIORITY CONCERN]

The Caribbean climate is characterised more by the intensity of its solar radiation then by its air temperatures which, although high, are rarely excessive and cool down during the night. Nevertheless, surfaces exposed to the sun can however reach very high temperatures, and the first quality expected from the building envelope is its ability not to allow this radiant heat to penetrate inside the volume.

The key physical magnitude of this concern is the solar factor (ratio between the energy transmitted and the energy received by a wall).

A high-performance building, according to this concern, will essentially have the following characteristics:

- The façades and the roof will have a light colour in order to reflect the rays of the sun
- Glazed walls will be provided with effective solar shading. In the absence of shading, there will be a genuine “haemorrhage” of the incoming heat that will degrade the building’s performance, regardless of its other qualities.

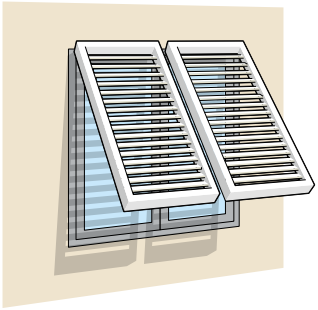


FIGURE 1.
Solar shading.

FIGURE 2.
Example of solar shading of glazed walls.

- Masks: protruding architectural elements create an additional shading effect on the glazed or opaque walls of the façades.

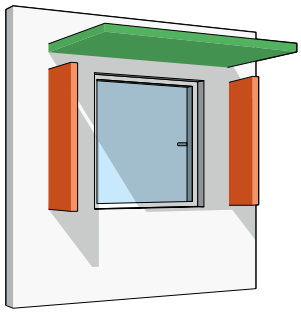


FIGURE 3.
Cheeks, caps.

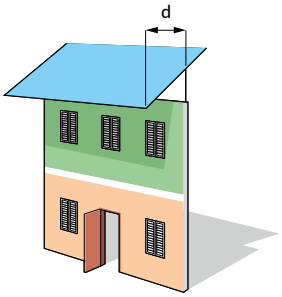


FIGURE 4.
Roof overhang.

FIGURE 5.
Examples of eaves and caps.

- An air gap circulates between the interior and exterior walls in order to evacuate the storage energy in the thermal inertia masses to avoid the gradual overheating of the building.

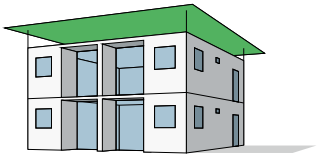


FIGURE 6.
Ventilated roof.

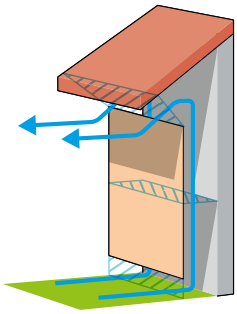


FIGURE 7.
Ventilated facade.

- The thermal insulation of the roof, and possibly of the façades can also slow down the penetration of the heat. However, this arrangement must be chosen with precaution and requires a simulation (see expert recommendation hereinbelow).

FIGURE 8.
Reflective insulation.

FIGURE 9.
Polystyrene.

FIGURE 10.
Mineral wool.

"Studies conducted by Cerema (Public expertise for the ecological transition and regional planning, France) and CSTB highlights the caution to be had on wall insulation: on simulated models, it could have an impact over the thermal comfort felt in unairconditioned buildings."
Lucie CHEVER, Ministry of ecological transition

LIVING WITHOUT AIR CONDITIONING

By creating an air flow inside the housing unit, the sweating of the skin becomes more effective and the temperature becomes more bearable. The trade winds present on the Caribbean islands allow creating of this air current, and with high-performance solar shading, acceptable comfort can be achieved without air conditioning.

The key physical magnitude associated with this concern is the ratio between the interior and exterior air speeds.

A high-performance building according to this concern will essentially have the following characteristics:

- The building is constructed on a windy site.
  The façade exposed to the dominant wind and the opposite façade are equipped with large windows to "capture" the wind.

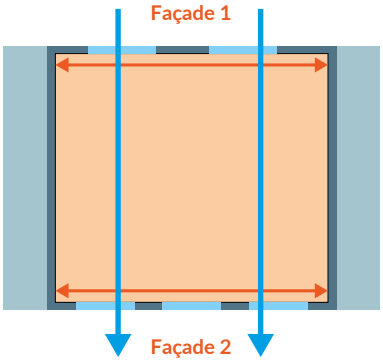


FIGURE 11.
Facade windows.

- The interior partitioning does not obstruct the air flow. Transoms are added to the doors.

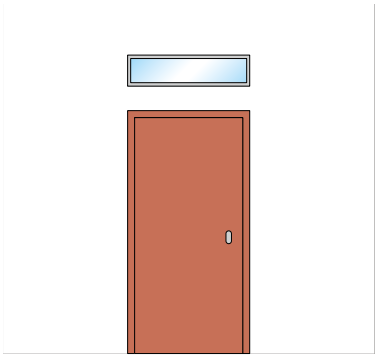


FIGURE 12.
Door with transom.

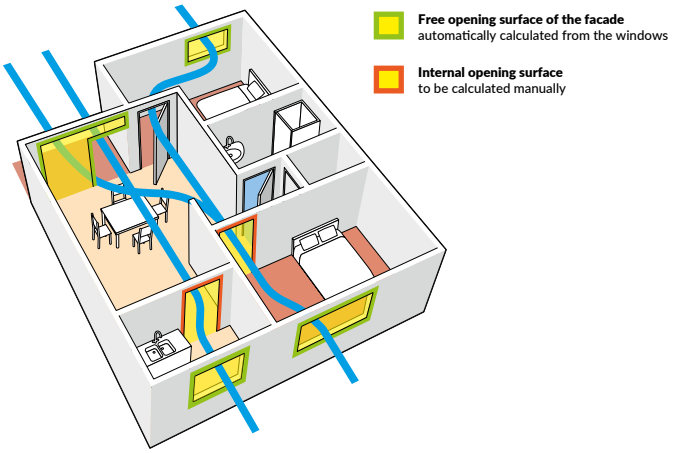


FIGURE 13.
Air flow circuit.

- The rooms are designed to allow for an effective sweeping by the air flow.

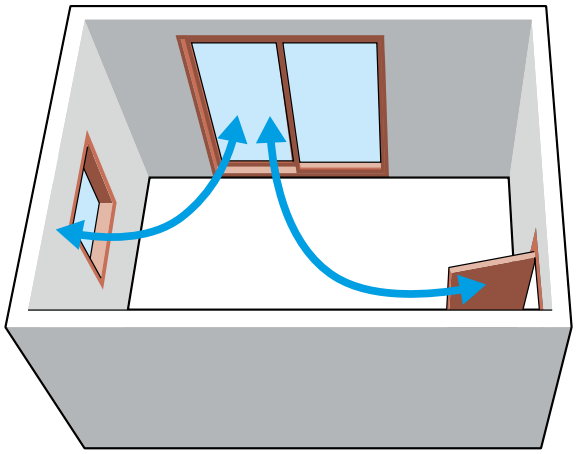


FIGURE 14.
Sweeping by air flow.

- Ceiling fans supplement the natural ventilation, in particular in poorly ventilated rooms.

FIGURE 15.
Example of premises equipped with ceiling fans.

COOLING WITH LOW ENERGY CONSUMPTION

The key physical magnitude associated with this challenge is the conventional consumption of cooling.
A high-performance building according to this concern will essentially have the following characteristics:

- The efficiency of the air conditioner is high.

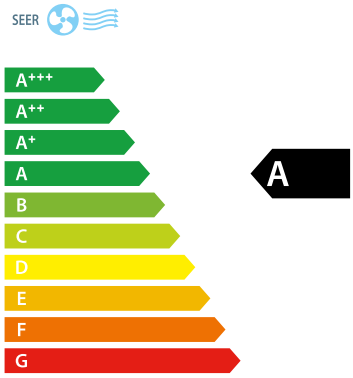


FIGURE 16.
Energy label.

- The control device makes it possible to program the setpoint temperatures in hourly brackets.

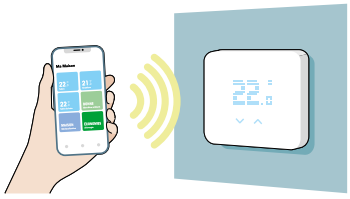


FIGURE 17.
Control device.

- The openings (windows and doors) can be airtight to reduce cold losses. In particular, the blinds are provided with seals.

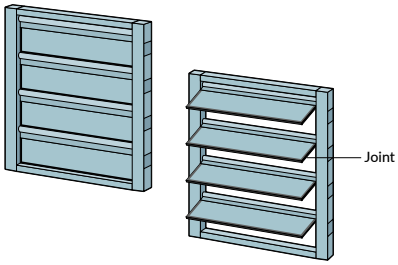


FIGURE 18.
Open and closed blinds with seals.

FIGURE 19.
Example of an airtight blind.In the closed position, the slats are tightened on a horizontal riser provided with an elastomer seal that provides airtightness..

FIGURE 20.
Example of a non-airtight blind. In the closed position, a space can still be seen between the slats and airtightness is not provided.

- The thermal inertia of the premises is adapted to the period of use (low inertia for night-time premises, high inertia for daytime premises).

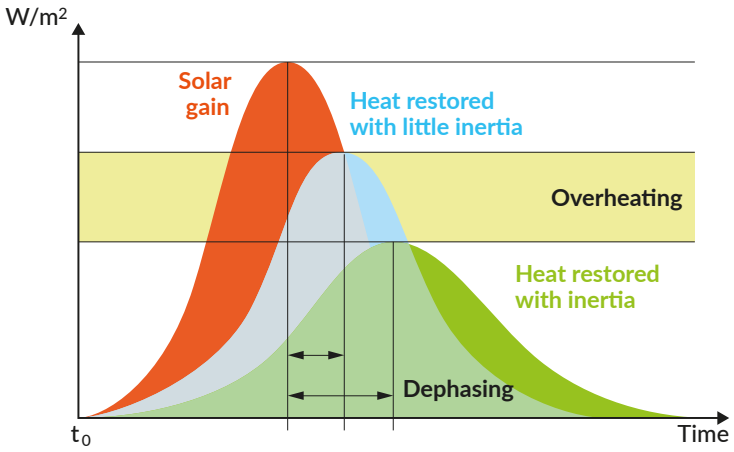


FIGURE 21.
Thermal inertia of the premises.

- The thermal insulation of the roof and the façades limits losses of cold. *This arrangement must however, be chosen with precaution and can, in some instances, degrade comfort.*

FIGURE 22.
Reflective insulation.

FIGURE 23.
Polystyrene.

FIGURE 24.
Mineral wool.

PEAK DEMAND REDUCTION

The use of solar energy reduces the demand on the electrical grid. These renewable energies reduce the building's carbon footprint and help to reduce peak demand.

A high-performance building, according to this concern, will essentially have the following characteristics:

- Domestic hot water is produced from solar thermal system provided with a storage tank

FIGURE 25.
Example of a solar thermal system provided with a storage tank.

- The photovoltaic production on the roof is self-consumed.

FIGURE 26.
Rooftop PV system.

THE NOTION OF THE OVERALL PERFORMANCE OF THE BUILDING (ACCORDING TO GUADELOUPE BUILDING ENERGY EFFICIENCY REGULATION "RTG")

The concept of "overall performance of the building" is the basis of regulation with a performance obligation such as the Guadeloupe's Building Energy Efficiency Regulation ("RTG"). Its definition is based on scientific knowledge but also requires political choices to be made. This chapter describes the main questions put forth, the thought given to them, and the positions that were finally adopted by the Regional Council of Guadeloupe.

THE POLICY CONCERNING AIR CONDITIONING AND THERMAL COMFORT

Let's examine the following two performance concerns:

1. capacity of the building to be comfortable without using air conditioning (building compatible with natural ventilation);
2. capacity of the building to consume little electricity for cooling it (building compatible with air conditioning).

These two concerns are a priori in line with the environmental concern. However, if the design of the building is optimised according to concern 1, on the one hand, and concern 2, on the other hand, we end up with different projects. While the protection of the building envelope from solar radiation (beneficial for both), the design of the openings and even of the overall volumetry of the project will be very different in terms of the sections, orientations and techniques of the openings. In other words, a building optimised for concern 1 cannot be optimal for concern 2, and reciprocally.

There is also the problem of "a posteriori" air-conditioning: housing units initially designed to be comfortable without air-conditioning are likely to be equipped with air conditioning during their life-cycle. Unfortunately, this change is often made by the tenants, at a low price and without consulting the landlord, and can result in energy leaks due to air porosity of the building envelope. At the construction stage, it is ultimately not possible to determine with certainty whether a building will be air-conditioned or not one day.

This issue of "a posteriori" air conditioning seems to be unsolvable, but it is necessary to take a stance before defining the performance indicators.

The Regional Council of Guadeloupe in the end established the following rule:

- For residential buildings: the construction of comfortable housing units without air conditioning must be encouraged, without prohibiting the use of air conditioning. Concern 1 applies to all housing units (whether or not air-conditioned). This measure in particular aims to slow down the development of air conditioning and, in the presence of an air-conditioner, limiting the use of it. Concern 2 furthermore applies to housing units that have made the initial choice of air conditioning. Simply foreseeing an expectation for air conditioning classifies the housing unit as air-conditioned.

- For offices and shops: it was found that there were few references to passive building with satisfactory comfort in Guadeloupe. Therefore, only concern 2 is retained. The comfort parameters do not need to be evaluated because, in an air-conditioned building, the comfort threshold is always achieved. All buildings are systematically considered as air-conditioned (whether or not air-conditioning is actually installed).

A significant disagreement between the ambitious and the realistic, this subject was the object of heated debates during consultations. It seems impossible to take an ideal decision, either from an environmental standpoint, or the standpoint of the consensus between the stakeholders. The position of the Regional Council of Guadeloupe is relatively straightforward, but even so, it has been criticised by reproaching the Guadeloupe's Building Energy Efficiency Regulation "RTG" as promoting air conditioning.

THE POLICY CONCERNING PHOTOVOLTAIC SYSTEM PRODUCTION

Producing electricity from photovoltaic (PV) solar systems should be developed as it contributes to the transition towards renewable energies. To what extent must this be taken into account in evaluating the energy performance of the building? The possible options are: deduct this production from the building's energy needs:

1. Entirely.
2. Partially: for example, by limiting the deduction of the PV production in the calculation of the regulatory consumption via a maximum deduction threshold, as in the BBC Effinergie+ label.
3. With certain implementation conditions, for example the setting up local storage equipment.
4. No deduction.

In the Caribbean region, sunlight conditions are highly favourable. However, the time of return on investment for a PV system is less than that for a temperate zone such as France, which is why the need for a financial incentive is less obvious, although PV system production remains the first renewable energy source that can be mobilised.

Moreover, PV system production being installed to offset a building with poor performance must be avoided: consultations with professionals in the building sector have concluded on the desire to produce new buildings with high bioclimatic quality (whether or not they are provided with PV system), in order to improve the quality of Guadeloupe's buildings progressively.

Finally, the volume of Guadeloupe's PV system production is already high (primarily due to photovoltaic farms) and the issue now is the capacity of the electricity grid to integrate these intermittent flows.

For all these reasons, it was decided that PV system production is not taken into account in assessing the overall energy performance of the new building specific under the Guadeloupe Building Energy Efficiency Regulation ("RTG"). On the other hand, it is valued in the Energy Performance Certificate of Guadeloupe ("DPEG") via a partial deduction (option 2, with a deduction threshold). The notion of self-consumption is mentioned in the Energy Performance Certificate of Guadeloupe ("DPEG") and is, moreover, the object of incentives defined in the national framework; it was therefore not deemed necessary to promote it again via the regulatory scheme. The presence of self-consumption does not make it possible to obtain a better score in the performance indicators of the Guadeloupe's Building Energy Efficiency Regulation ("RTG") and the Energy Performance Certificate of Guadeloupe ("DPEG").

THE POLICY REGARDING THE PRODUCTION OF HOT WATER VIA THERMAL SOLAR ENERGY

The sunlight conditions are favourable for the thermal solar production. Therefore, the Guadeloupe Building Energy Efficiency Regulation ("RTG") initially imposed a minimum coverage rate of domestic hot water needs by thermal solar production of 50%.

Over time, this obligation proved to be restrictive in some instances of collective housing units. It indeed requires the installation and maintenance of an additional plumbing network, and requires specific management work. The consultation made it possible to reach a compromise in which, and in accordance with the performance principle, other technical solutions are acceptable as long as the demand on the power grid does not exceed the threshold of 50% of the overall building's domestic hot water needs.

PRIMARY VS. FINAL ENERGY

The notion of primary energy, recommended in the EPBD directive, accounts for the losses in the production and distribution of the electricity grid and therefore penalises the electricity energy vector.

In Guadeloupe, electricity is the only energy vector (there is no gas grid, fuel grid, district heating, no domestic use of wood, etc.). However, this notion is not of the same concern as in metropolitan France because there is no energy competing with electrical energy.

It was thus decided to express the consumption indicators of the Energy Performance Certificate of Guadeloupe ("DPEG") as final energy, which has the advantage of being coherent with the energy invoices. The notion of primary energy (as moreover the notion of carbon equivalent) does remain, however, mentioned for information and education, through the application of conversion coefficients:

- final to primary energy: 3.5 kWhep (primary energy) /kWhef (final energy);
- final energy to greenhouse gas (GHG): 0.8 $kgCO_2$/kWhef (final energy).

4

ACTION ON NEW CONSTRUCTION

LOGEMENTS MALDYVES, GUADELOUPE
© Laurent Darviot.

The action on new construction is operated by the Guadeloupe Building Energy Efficiency Regulation “RTG” whose principles are described in this chapter.

THE CONCEPT OF PERFORMANCE REGULATION

There are two types of energy performance regulation for buildings:

- Regulation **with obligations of means** (example: pre-existing RTAADOM[2]). Principal: impose characteristics of each building component (type, performance, etc.) and prohibits certain constructive arrangements. Advantages: low-tech because it is formed from a set of rules to be applied.
- “Performance” regulation, **with the performance obligation** (example: Guadeloupe Building Energy Efficiency Regulation “RTG”). Principal: impose an overall performance of the building by leaving the designer with the choice for the elementary solutions. Advantages: less restrictive for the designer, and less expensive in construction because it is possible to search for the best suited solution.

The choice of performance regulation is a strong bias of Guadeloupe Building Energy Efficiency Regulation (“RTG”). Professionals perceive this principle of a performance obligation as progress because it allows for a technical-economic optimisation of projects and leaves more freedom in the design. Generally, it is observed in Europe that the most advanced regulation with a technical nature opt for this principle (in particular in terms of fire safety); this is a strong trend. Moreover, the energy performance regulation for buildings of the Member States of the European Union are governed by the EPBD directive (Energy Performance of Buildings Directive) which recommends a performance approach.

Here are a few examples that illustrate this concept.

Table 1 : Examples of performance approach

	RTAADOM (Obligations of means)	Guadeloupe Building Energy Efficiency Regulation – “RTG” (performance obligations)
Solar factor of the envelope	A Smax threshold value is imposed for each type of wall (wall, roof, window).	For the global building, the threshold value is imposed on the two “BBIO” and “ICT” compliance indicators (cf. 4.3).
Cross ventilation of the housing unit	A minimum opening rate is imposed for façades windward and leeward, as well as interior partitions.	
Roof window	Roof windows are prohibited	

It is important to note that the choice of 100% performance approach has certain risks. Indeed, as the regulatory scheme includes neither obligations, nor prohibitions, it acts in a less radical way on the constructive arrangements that one wants to favour or eradicate. Moreover, the level of the risk is linked to the local context, in particular the level of training of the stakeholders in building and the means for controlling the application of the regulation.

In Guadeloupe, it took 10 years to reach Guadeloupe Building Energy Efficiency Regulation (“RTG”) with 100% performance approach, through progressive integration of the obligations of means into the calculation method.

To find out more

The annexed sheet n°8 explains how the latest obligations of means were integrated into the calculation method.

2 Thermal, acoustic, and aeration regulation specific to the five overseas territories and in effect in Guadeloupe before the setting up of the Guadeloupe Building Energy performance (“RTG”)

TARGETING OF THE PUBLIC POLICY

The scope of energy effiency for buildings is very vast, in terms of building typology, components of buildings and energy consumption items. For perfect compliance with the EPBD directive, this would require full application, but then the effort required for the designing as well as putting it into application by professionals would be considerable. Right from the origin of the approach, and faced with the extent of the project, the Regional Council of Guadeloupe considered targeting its policy on the levers with the highest impact. The limited means of Guadeloupe and its climatic specificities are enough to justify this decision which is based on common sense and which, furthermore, was understood and accepted by the European Union.

This chapter describes the main targeting decisions adopted to substantially reduce the regulatory complexity subject to a low reduction in impact.

BUILDINGS USE TYPOLOGY

Residential and similar buildings (residences, shelters, etc.) are primarily non-residential buildings of which each use constitutes a type. In 2010, the analysis of the flow of new constructions showed that the four largest typologies of use our residential and collective housing units, offices and shops. They represent more than 87% of the flow of new construction. It was therefore decided to target the regulation on these four uses.

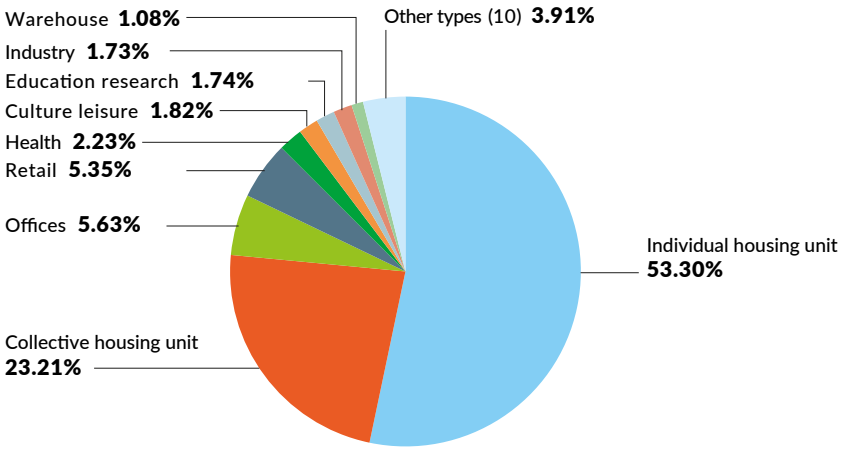


FIGURE 27.
Breakdown (in Surface Area) of the Flow Of New Construction in Guadeloupe

DIMENSIONAL THRESHOLD

Consistent with the national regulation, new constructions are subjected to the regulation, regardless of their surface area. The extensions applied to an existing building are subject to regulation when they exceed 150 m^2 or 30% of the existing surface area.

BUILDINGS ENVELOPE AND ENERGY SYSTEMS

The components of a building that have an impact on its energy performance are classed into two categories:

- The Envelope: façade, roof, doors and windows, masks and solar shading. The performance sought above all solar shading (solar factor). The lifespan of these components is rather long (more than 20 years).
- The energy systems: technical HVAC (Heating, Ventilation, Air Conditioning) equipment for air conditioning, domestic hot water, ventilation, photovoltaic production, lighting, regulation. The performance sought is above all the energy efficiency. The lifespan of these components is rather short (10 to 20 years).

In the method for assessing the performance of the building, these two categories can easily be processed in two separate regulatory sections, as illustrated in the following diagram.

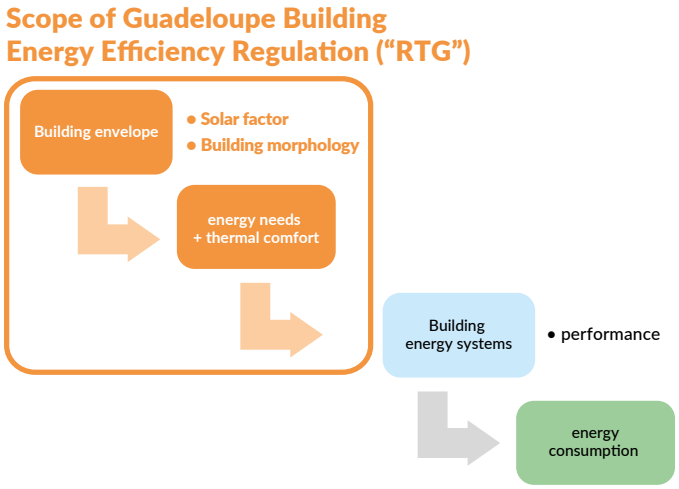


FIGURE 28.
Scope of Guadeloupe Building Energy Efficiency Regulation ("RTG").

Observing that the "energy systems" section is the most complex technically, concerns components with a short lifespan, and has little impact on the performance criterion of passive comfort, it was decided to target the regulation on the building envelope. On this perimeter, the performance factors on energy needs and comfort can be established, but not the consumption.

This decision is not definitive because the system section can be regulated, if needed, in a future version of Guadeloupe Building Energy Efficiency Regulation ("RTG"). While waiting, the performance of systems is regulated by a deliberation that prohibits putting air-conditioners that have insufficient efficiency on the market. Therefore, only equipment of the A+ class and higher are authorised.

USES OF ENERGY

The usual nomenclatures of the uses of energy in France is:

1. Heating
2. **Air conditioning**
3. **Domestic hot water**
4. **Lighting**
5. Heating and ventilation auxiliaries (pumps, valves, fans, etc.)
6. Other uses (household appliances, processes, safety, motorisations, low currents, etc.)
7. Renewable energy production

In a tropical climate, the "heating" use is generally not applicable (except in some instances of altitude, but even in this case, it is suitable to question the interest of regulating this use, of which the volume remains low). The auxiliary consumptions are negligible because most of the air conditioning is provided by independent appliances (splits). The "other uses" are not determined by the building but by the occupant. It was therefore decided to target the regulation on the air conditioning, domestic hot water, lighting and photovoltaic production uses.

ADAPTING THE PRECISION TO THE REGULATORY EXERCISE

The building's performance is evaluated according to the regulatory calculation method defined specifically for Guadeloupe Building Energy Efficiency Regulation ("RTG"). Of mandatory application, this method must be as simple as possible, while still being precise enough to conclude on the conformity of a project.

The complexity and precision of the method stemmed directly from the selection of input data of the calculation, not from the calculation algorithms. The other data is, therefore, implicitly constant (conventional values) and the associated constructive qualities are therefore not valued in the conformity assessment.

For example, Guadeloupe Building Energy Efficiency Regulation ("RTG") chose to ignore the site's characteristics in terms of the mask to the wind and to the radiation, to determine only the intrinsic performance of the building.

Simplicity vs. precision

Judiciously positioning the degree of precision of the regulatory method is an important prerequisite in defining the calculation method. This issue is, above, all a matter of policy arbitration.

Here again, this entails positioning on a happy medium, keeping in mind that an excessively precise method would be unrealistically expensive in engineering, training (with a risk of rejection), and development of the building energy performance regulation, while a method that is too simple will insufficiently value the qualities of the project and risks being contested.

Guadeloupe Building Energy Efficiency Regulation ("RTG") has sought to minimise the complexity: with respect to applying the pre-existing RTAADOM regulation, the "RTG" calculation does not require additional data other than the metres of the exterior envelope. Moreover, a system for simplifying input data, of optional use, allows for simplified key entry of the project into the calculation tool.

VERIFYING REGULATORY COMPLIANCE OF A BUILDING

THE OVERALL COMPLIANCE TEST PROCESS

The compliance test process, typical to all regulation of the performance type, is diagrammed in the following way:

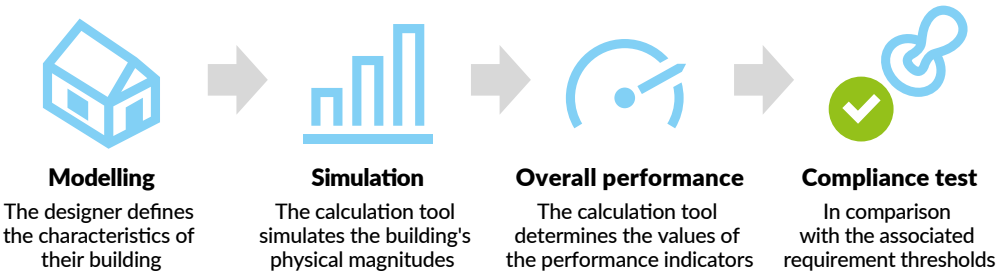


FIGURE 29.
Compliance test process.

DEFINITION OF THE PERFORMANCE INDICATORS

Performance indicators are an essential principle of performance-based regulation, and they materialise the vision of the "overall performance" of the building, and set direction for the stakeholders in the construction sector. They must serve as faithfully as possible the local concerns of public policy. Their definition necessarily results from joint work between political decision-makers and technical experts.

With the concern for legibility and effectiveness, they must be in a number that is as limited as possible, ideally being a single indicator

In order to translate the vision of tomorrow's high-performance building of Guadeloupe, disclosed in chapter 3, it was necessary to define a set of three indicators.

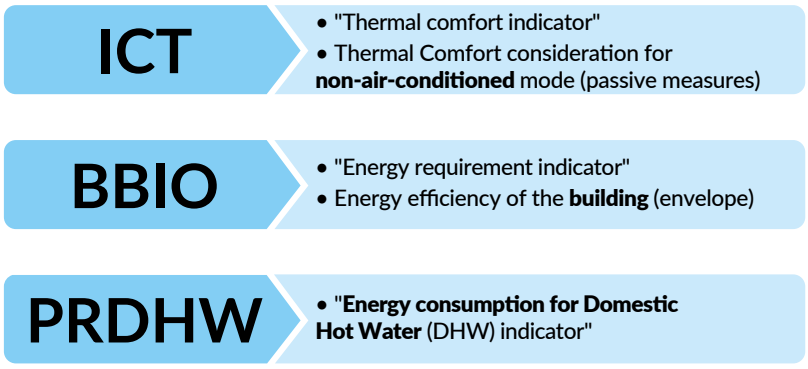


FIGURE 30.
Indicators for a high-performance building.

- **ICT = Thermal Comfort Indicator:** expresses the comfort level of the housing unit when used without air conditioning (passive measures). It is therefore applied exclusively to housing units. It is based on the physiological principles of perception of comfort by the human body, which makes it possible to value both the thermal performance of the building envelope and its capacity for natural ventilation. Expressed in °C, it represents the average overheating with respect to a reference temperature. This indicator constitutes a genuine innovation created specifically for the Guadeloupe's Building Energy Efficiency "RTG", with possible applications in a tropical climate.

- **BBIO = Energy Requirement Indicator:** expresses the thermal quality of the building envelope. It represents the energy needs of the building in order to ensure the air conditioning and lighting thereof in conventional conditions. It does not have a unit but corresponds to a ratio per m^2 of surface area.

- **PRECS = Energy Consumption for Domestic How Water:** expresses the capacity of the building to provide for its Domestic Hot Water needs via its means, without using the power grid. It ,therefore, values the mobilisation of local renewable energies, and the recovery of unavoidable energy or high energy-efficient production systems. It is expressed as a percentage, independently of the quantification of the building's Domestic Hot Water (DHW) needs which is calculated conventionally.

To find out more

About the calculation formulas of the indicators, see the sheet in appendix n°3

The scope of this set of indicators is diagrammed in the following table.

Table 2 : Scope of the indicators

	ICT	BBIO	PRECS
Housing unit	Always calculated regardless of the air conditioning configuration	Always calculated taking account of the actual air conditioning configuration	Always calculated
Office or shop	Not applicable	Always calculated by considering the zone to be 100% air-conditioned (independently of the actual air conditioning configuration)	Calculated in case of local production of DHW

DEFINITION OF THE REQUIREMENT THRESHOLDS

For each one of the three performance indicators, a regulatory threshold is set and makes it possible to conclude the project's compliance if and only if the three conditions are satisfied.

Defining requirement thresholds determines the requirement level of the regulation. It can be revised at any time by the legislator, independently from the rest of the scheme.

This is one of the most compelling policy decisions. A determining factor for the relevance of the regulatory scheme, it is perceived very differently according to the stakeholders and their specific interests.

The Regional Council of Guadeloupe has defined its requirement level progressively. During versions 1 and 2, the Guadeloupe's Building Energy Efficiency regulation "RTG" needing to be compatible with the RTAADOM, the level of requirement was defined by equivalence with that of the RTAADOM, which limited the debates. The thresholds were set with respect to a reference building (see the sheet in annex n°4) which responds exactly to the minimum requirements of the RTAADOM. During version 3 (2019), there was enough feedback to make it possible to set its own thresholds while still measuring the impact and the effort required of the stakeholders of the construction sector. The thresholds were re-balanced so that none of the requirements prevailed over the others, and were defined in an absolute manner:

- $ICT_{project} \leq ICT_{max}$;
- $BBIO_{project} \leq BBIO_{max}$;
- $PRECS_{project} \leq PRECS_{max}$.

ICT_{max}, $BBIO_{max}$ and $PRECS_{max}$ are adjusted slightly according to the climate zone of the site.

The notion of equity of the requirement with regards to performance and effort

Introducing a climate modulation of the territory (different climate zones, effect of the altitude) is progress making it possible to calculate the indicators more realistically. Howerver, then, the regulatory level of requirement becomes variable according to the geographical location, and consequently the extra cost of the construction induced by the regulation is not the same according to the zones. This effect can cause an issue from a policy standpoint, because the effort required can vary greatly. There are three possible positions:

1. Require a **constant level of performance** regardless of the location: the effort required will then be higher in zones with an unfavourable climate (prejudice for the constructor).
2. Require a **constant level of effort**: the level of performance will therefore be lower in zones with an unfavourable climate (prejudice for the tenant).
3. All intermediate positions are possible by modulating the requirement thresholds.

Regulation with an obligation of means such as the RTAADOM are generally positioned at the constant effort level. The Regional Council of Guadeloupe has chosen an intermediate position — about in the middle — between the extreme positions 1 and 2.

COMPLIANCE WITH THE REGULATION

A regulation has meaning only if it is applied in the field. This evidence is regularly recalled by the stakeholders in construction sector during consultation sessions — and rightly so because it is indeed the thorniest section encountered by Guadeloupe in its regulatory project.

INCENTIVE

French law prohibits any public financial assistance to support compliance with the regulation. The Regional Council of Guadeloupe has offered assistance to project initiators aiming for performance that exceeds the regulatory requirement. In addition, four "exemplary building" call for projects were organised so as to financially support the studies for designing very high-performance buildings, selected by a jury.

Outside this program, the main incentive effort consisted in progressively improving the ergonomics and the simplicity of the regulation, primarily by listening to suggestions from the stakeholders of construction during consultation sessions.

CONTROL

The means of enforcement control are always limited for technical regulation, decorrelated to the risks on persons, therefore a non-priority. In this context, coercive measures cannot suffice to apply the law. At all stages of the scheme, it is necessary to focus on the acceptability of the constraints imposed upon the stakeholders. The objectives have to be reasonable, the changes have to be progressive, the efforts required have to be equitable, etc.

Attentive to the stakeholders, Guadeloupe constantly adapts the scheme by revising, step-by-step, the constraints that are deemed excessive by the stakeholders in construction, while still progressively reasserting the overall level of requirement.

In its first version, the control scheme of Guadeloupe's Building Energy Efficiency regulation "RTG" includes four points:

1. **In the Building Permit phase:** Obligation to provide with the Building Permit a certificate of "good consideration of Guadeloupe's Building Energy Efficiency regulation "RTG"" established by the Project Owner itself. Purely declarative, this document is intended to ensure that the Project Owner is informed of their obligations, but is ineffective against fraud.
2. **In the work acceptance phase:** obligation to control compliance by a third party independent of the project owner team
3. **In the work acceptance phase:** obligation to establish an Energy performance Certification of Guadeloupe "DPEG/new" on air-conditioned buildings. This DPEG must be established by a certified diagnostician.
4. **The enforcement control mission** does not fall under the competence of the Regional Council of Guadeloupe's responsibility, but of the French State, via the DEAL (Directorate of the Environment, Planning and Housing).

An audit conducted in 2017 revealed the following malfunctions:

- The application rate varies according to the profile of the project owner. This creates a distortion in the competition to the detriment of those who comply with the law.
- The certificate attached to the building permit is ineffective because it is purely declarative and poorly verified by the building permit authorities.
- The control in the acceptance phase is hardly applied. The cost of it is deemed excessive by the stakeholders.
- The social housing unit applies Guadeloupe's Building Energy Efficiency regulation "RTG" that needs an exception scheme (simplified) in order to streamline the construction process.
- The enforcement controls are insufficient.

Based on these observations, version 3 of the "RTG (2019)" includes a control scheme that is entirely revamped, simpler and more legible, with:

1. **At the building permit stage:** the certificate is no longer declarative but is delivered automatically if the calculation demonstrates compliance. The urban planning services are informed of these obligations and now effectively filter out incomplete dossiers. *Note: social housing units are exempted from this obligation, in order to avoid slowing down the production of housing units.*

2. **The enforcement control mission:** is still the responsibility of the French State, via the DEAL. Control is facilitated by searching the project database and viewing the calculation file (without travel or contacting the designer). The controllers are trained by the Regional Council of Guadeloupe.

However, the rate of the application controls is still insufficient in order to be dissuasive.

SANCTIONS

Defining and applying sanctions does not fall under the competence of the Regional Council of Guadeloupe, but the French State. The French Building Code defines the rule that applies to the different regulation of building:

"Non-compliance with the French Building Code constitutes an offence, subject to criminal sanctions. The sanctions can range up to a fine of €45,000, increased to €75,000 and 6 months of imprisonment in the event of a repeat offence" (Ministry of ecological transition, RT-building site)

This measure is disproportionate. In practice, it is never applied. Its dissuasive effect is low.

Overall, the control/sanctions scheme is still too ineffective and constitutes one of the main points for progress that remains to be done in the Guadeloupe's Building Energy Efficiency regulation "RTG" scheme.

COMMUNICATION

Project owners who are unaware of their "RTG" obligation see their building permit refused, which results in additional delays. This point must therefore be anticipated via a systematic information campaign for building permit requesters.

Communicate with the general public: the project managers of individual homes are often private individuals. Non-professionals have little knowledge, and for the most part will assume the role of project manager only once in their life, which leaves little time to get information and to get trained. However, they have the responsibility of applying the "RTG".

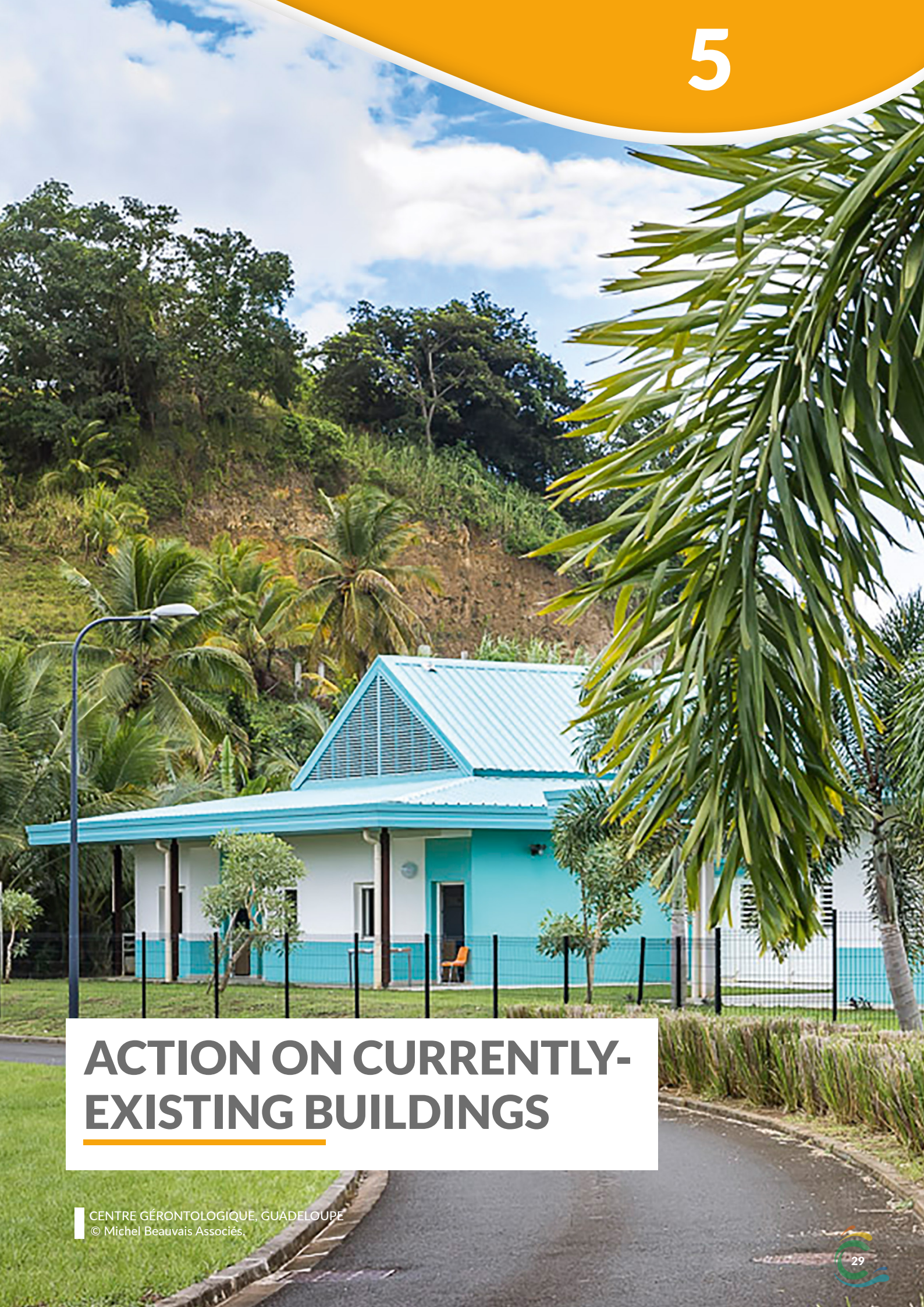
Concern no. 1 is to get the "RTG" obligations known by presenting the concept in a simplified manner and by encouraging private individuals to get support from a professional. The www.guadeloupe-energie.gp website, the general public media and the information relays of the urban planning services form the main vectors used for this purpose. The information system seeks to answer the following questions:

- What is the Guadeloupe's Energy Efficiency Regulation "RTG"?
- Why was it set up?
- Is my project subjected to the "RTG"?
- What application tools are available?
- What qualified professionals can give me support?

For professionals, the information is also relayed by the professional unions, generally represented during consultation sessions.

5

ACTION ON CURRENTLY-EXISTING BUILDINGS



CENTRE GÉRONTOLOGIQUE, GUADELOUPE
© Michel Beauvais Associés.

The action on currently-existing buildings is operated by the DPEG (Energy Performance Certificate of Guadeloupe) of which the principles are described in this chapter.

DO NOT RESTRICT BUILDING ENERGY RETROFITTING

The two types of building projects are new construction and retrofitting buildings. In France, these two types are subjected to 2 separates regulation ("RE 2020" and "RTex"). In Guadeloupe, statistics show that the rate of retrofitting buildings is low with respect to the national rate. The priority of the public action is above all to promote the act of retrofitting, and setting up constraints induced by a renovation thermal regulation would have the opposite effect. It was thus decided that building retrofitting would be outside the scope of Guadeloupe's Building Energy Efficiency regulation "RTG". On the other hand, existing buildings are subjected to the Energy Performance Certificate of Guadeloupe "DPEG" which clarifies the performance of the building and encourages retrofitting (see chapter 5 "action on currently-existing buildings").

DISCLOSING THE PERFORMANCE OF BUILDINGS VIA THE ENERGY PERFORMANCE CERTIFICATE "DPE"

The European EPBD directive asks European Member States to set up an energy performance certificate ("DPE"). The objective is to encourage thermal renovation by making use of the natural means of pressure of the law of the real estate market.

This certificate, which must be provided by the owner during a real estate transaction (rental or sale), informs the acquirer of the property's energy performance. An energy label (rating from A to G) facilitates reading it by the general public.

A statistical study conducted by the CSTB in 2020 shows that the energy label has a real impact on the value of the property, with this impact being less in zones that have a high real estate pressure.

Starting in 2024, French law will progressively impose constraints on properties that have the least energy performance (rated G then F): freezing of rents, obligation of an energy audit, prohibition to sell and to rent.

ADAPTATION TO THE TROPICAL CLIMATE

The Regional Council of Guadeloupe set up a "DPE" as early as 2010: the Energy Performance Certificate of Guadeloupe "DPEG" (DPE of Guadeloupe). Getting its inspiration from the "DPE" scheme in place in France, it was necessary to define solutions specific to the tropical climate, in particular on the following aspects:

- The scope: restricted to housing units effectively equipped with air conditioning. This measure has the advantage of reducing the cost of the "DPE" scheme but does not make it possible to detect potential "thermal wrecks".
- The energy consumption indicator (ECI) expressed in kWhep/m²/year (primary energy) is not enough to determine the performance of the building. Therefore, it is necessary to supplement the assessment with a thermal comfort indicator in the absence of air conditioning.
- The production of photovoltaic electricity, which is easier than in France due to the high sunlight rate, must be encouraged without however masking the poor thermal performance of the building. The production of electricity is therefore partially deducted from consumption and makes it possible to gain a maximum of one energy label level.

The ECI indicator can be calculated based on the actual consumption at the meter (source: electricity bills) or by thermal simulation. With a concern for simplicity, version 2010 of the Energy Performance Certificate of Guadeloupe "DPEG" is based on actual consumption. Feedback has revealed the difficulty in collecting consumption data. Indeed, in most cases, the tenant has already left the housing unit at the time the diagnostic is carried out, and the invoices can no longer be recovered. On the other hand, actual consumption is substantially affected by the behaviour of the occupant although the objective is to determine the intrinsic energy performance of buildings. For all these reasons, the calculation method of the "DPEG 2020" was entirely modified and is now based on a thermal simulation.

THE REGIONAL OBSERVATORY FOR ENERGY AND CLIMATE CHANGE (OREC) IN GUADELOUPE

In its most recent form (2020 VERSION), the regulation scheme is based on a method and common tools between new construction and “DPEG”. This arrangement makes it possible to gain in simplicity, coherency, but also to capitalise the calculation data (the digital models of buildings) and thus form an observatory of the existing buildings. The database is operated by the OREC (Regional observatory for energy and climate change) with the purpose of reinforcing the state of knowledge on the condition of buildings in Guadeloupe and producing decision-making elements for public policies.

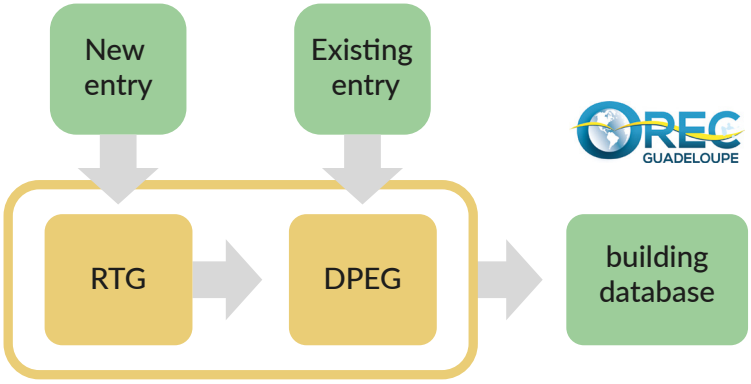


FIGURE 31.
OREC observatory.

6

FROM DESIGN TO APPLICATION

MAISON CRÉOLE
© Adobe Stock, Pyarnaud_116.

Various application measures were necessary to implement the regulatory scheme by the stakeholders in construction. We shall describe the main measures here.

THE "RTG/DPEG" CALCULATION PLATFORM

Any regulation of the "performance" type, regardless of its level of complexity, will always remain too complex to be applied manually (without a calculation tool). Therefore, producing of a computing core that implements the regulatory method is an indispensable enforcement measure. This tool eliminates the risks of calculation erros while still reducing the study time.

The principle of the application tool is represented in the following diagram:

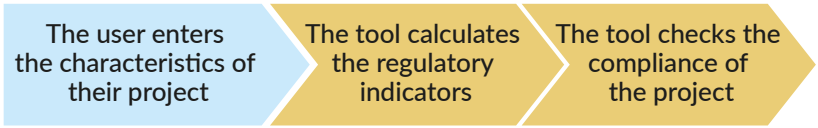


FIGURE 32.
Application tool process.

The characteristics of the project to be entered primarily include:

- site location data: climatic zone, altitude, solar masks, etc.
- configuration data: zoning, use of the building, orientation of the windows, etc.
- data on the elementary components of the building: thermal performance of the façades of walls and roof, energy efficient equipment, etc.
- surfaces: floor, windows, walls, etc.

To fulfil its role as support, the application tool has to be identical for everyone. It is then the responsibility of the public authorities to produce it free of charge. Two options are possible: the complete software including a user interface, or a simple calculation module (.dll) to be integrated by private software publishers. Although the French State has opted for the second solution in the framework of the regulation in France, the Regional Council of Guadeloupe has opted for the first option, which has the advantage of being free for the users.

The application tool of Guadeloupe's Building Energy Efficiency Regulation — version 1 "RTG V1" was carried out with Microsoft Excel. This choice of format was made for reasons of rapidity in development, in order to comply with very tight deadlines. This format was retained in the "RTG V2". The tool was made available for free download from www.guadeloupe-energie.gp website.

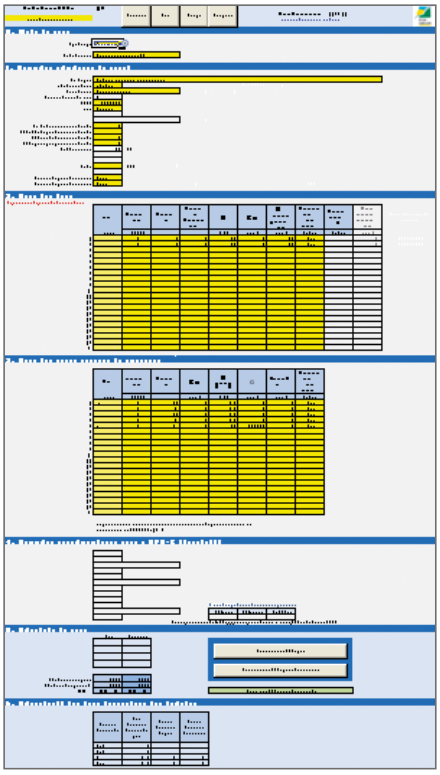


FIGURE 33.
Excel RTG V1 spreadsheet.

After a few years, this choice showed its limits because the changes in Microsoft Windows required frequent adaptations to the tool. Moreover, the tool did not work on Apple computers, which however is highly used by architects. With this observation, the Regional Council of Guadeloupe decided to develop the application tool for Guadeloupe's Building Energy Efficiency regulation – version 3 "RTG V3" in the form of a web application. This technological choice also made it possible to offer better working ergonomics and to ensure traceability, capitalisation and the sharing of calculation data.

In their latest version v3, the calculation methods are identical for "RTG" new construction and the Energy Performance Certificate of Guadeloupe "DPEG", and are implemented on a single tool: the RTG/DPEG calculation platform.

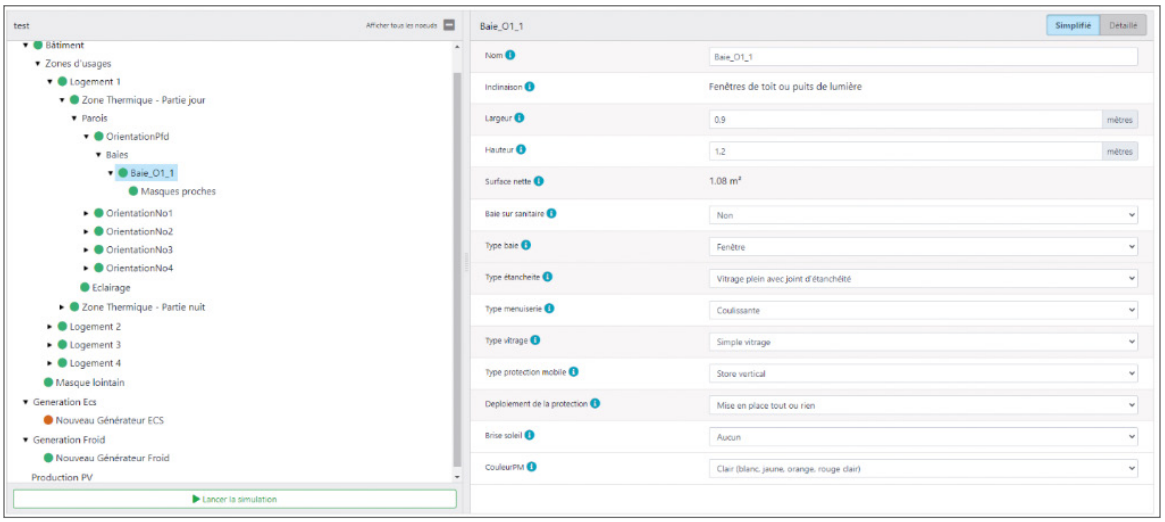


FIGURE 34.
Screen for modelling a project from the RTG/DPEG V3 calculation platform.

To find out more

About the technical aspects of the application tool: see the Appendix: the RTG/DPEG calculation platform

THE APPLICATION GUIDE

The regulatory text published in the French Official Journal "JORF" are not enough to ensure proper application of the regulation. An application guide was developed as a supplement to the official texts. Intended for stakeholders in construction in charge of applying the "RTG", its purpose is to comment on the text in order to facilitate interpretation, and formulate methodological recommendations. It, above all, has a pedagogical virtue, and forms a communication vector making it possible for the legislator to clarify texts that are a bit too technical and legal, but also to justify certain policy choices. This tool further makes it possible to react to recurring issues stemming from feedback, and to provide concrete solutions to them. For this reason, it is constantly changing. Published for the first time in 2011, the guide is today in its 10th edition (revision J) and has 170 pages. Its content includes primarily:

- the references of the texts and their latest changes;
- an application tutorial, step-by-step;
- clarifications on how to establish the input data for the calculation;
- instructions on how to use the application IT tool (RTG/DPEG calculation platform);
- examples of calculations with comments.

To find out more

The RTG/DPEG revJ application guide

TRAINING FOR STAKEHOLDERS WHO ARE TO APPLY IT

Publication of each one of the versions of the regulatory scheme is accompanied by a set of freely-accessible official events, allowing professionals to know and master the new rules and the new tools, with:

- An information day: the objective is to provide an overall vision and understanding over the regulatory scheme; the target is all professionals.
- One or more technical workshops: the objective is to train the professionals who will need to apply the regulation directly. The contact, is, therefore, more technical, and the target is more restricted. The training includes practical exercises. Two types of workshops have come to light:
  - "RTG" new construction workshops: devoted to professionals who perform thermal calculations for compliance verification (design offices, architects, constructors of individual houses, etc.);
  - "DPEG" workshops: devoted to candidates who want to take the diagnostician exam.

A private training offer supplements this scheme, with similar pedagogical content and expanded to the basics of thermal performance of building.

APPROVAL OF DPEG DIAGNOSTICIANS

The Energy Performance Certificates of Guadeloupe "DPEGs" must be established by diagnosticians who have specific approval. The Regional Council of Guadeloupe has set up an approval scheme through a certifying body (QUALIXPERT) selected based on a public consultation. The public consultation was launched based on an imposed template for certification of diagnosticians describing the major principles of the approval, examinations (theoretical and practical) on the scoring and the rule for attribution. The certifying body was selected based on the criteria of an examination subject project, the proposed organisation and on the terrace practised with the candidates.

The process for approving a diagnostician includes the initial approval (valid for 2 years), then a re-certification audit every 5 years.

To find out more

The certification template for diagnosticians

The public authority has leverage over the approval scheme, allowing it to ensure a balance in supply and demand, as well as a minimum level of technical competence, a guarantee of credibility for the DPE.

Guadeloupe (384,239 inhabitants in 2021) currently has 31 approved diagnosticians of which 50% are really active.

TECHNICAL SUPPORT

Technical support is provided via an email hotline (**info@guadeloupe-energie.gp**). Professionals and well as private individuals can freely ask questions of a technical or regulatory nature. The Regional Council of Guadeloupe and its technical assistance generally respond within 48 hours.

This scheme is highly appreciated by professionals. It makes it possible to provide specific solutions to particular cases rather than complicate the general regulatory scheme. It also makes it possible to identify malfunctions.

Technical support has never been submerged with the number of requests. Since the release of the RTG 2020, technical support has recorded 50 questions in 18 months.

The questions asked generally fall within the following themes:

- issues with IDs for connecting to the "RTG/DPEG" platform;
- need for someone to look at their project from the outside (in order to identify an error, to find a compliance solution, etc.);
- request an opinion on the applicability of the regulation in terms of their project;
- difficulty in modelling a project that has an unusual configuration.

A FAQ that can be downloaded includes recurring questions/answers or that are particularly interesting.

MOBILISATION OF INDUSTRIAL STAKEHOLDERS

Guadeloupe's Building Energy Efficiency regulation "RTG" has defined a new performance grid for construction products, corresponding to the criteria that come into play in calculating the overall performance of buildings. Furthermore, to facilitate regulatory application, but also to promote products coming from the local industry, the "RTG" has encouraged industrial stakeholders to evaluate and publish the performance of their products via a methodological guide "verified thermal characteristics". In the absence of this information, the design office in charge of the "RTG" calculation has to estimate them, which is expensive and less reliable.

To find out more

"Verified" thermal characteristics of components - Specifications intended for industrial stakeholders and verifying bodies

Moreover, CSTB has created the "GEPETO programme" (Handbook to Envelope Processes for the Energy and Thermal Performance of French Overseas Buildings), an initiative aimed at stimulating innovation in the local industry of construction products. The principle of this initiative is to highlight the R&D orientations that respond to the new needs in the building sector due to the "RTG".

To find out more

GEPETO handbook

Despite the emergence of a few innovative products, the impact of the "RTG" on the industrial fabric remains low and below expectations. One of the factors that can explain this is the size of the Guadeloupean market, too small to justify specific R&D investments. The harmonisation of the regulatory schemes in the Caribbean region would without a doubt, make it possible to remove this block by creating a "common market" that exceeds the critical size.

7

CONSULTATION WITH THE STAKEHOLDERS

LYCÉE DE PORT-LOUIS, GUADELOUPE
© Région Guadeloupe.

The capacity for consultation between the public authority and the economic stakeholders is an asset of small territories with respect to large States. The proximity with the decision-makers clarifies the discussions and accelerates decisions.

In 10 years, the Regional Council of Guadeloupe has shown its ability to drive and accompany changes, as closely as possible to the expectations of professionals and citizens. A consultation path punctuated with exchange sessions accompanied this change. It followed the trajectory in which the front of the debates moved little by little, showing a progressive “rise in maturity” in the profession but ,above all, the step-by-step construction of a climate of reciprocal trust between stakeholders and decision-makers.

To find out more

Appendix: Chronology of Guadeloupe’s Building Energy Efficiency regulation “RTG” project

PRINCIPLES

The main principle of the consultation is taking local expectations into consideration:

- reciprocal listening between the parties;
- adversarial discussion based on argumentation.

Thermal regulation constitutes one of the five consultation themes setup revolving around the energy policy.

When the approach was launched, the consultation group was formed by inviting professional bodies representing the stakeholders in the construction sector, public and private.

Thanks to the climate of confidence acquired, the circle of guests progressively got more significant.

Today, the consultation sessions are freely open to all professionals, which makes it possible to make the exchanges even more direct than via the representatives of rational unions. The stakeholders that apply the RTG on a daily basis actively participate in the consultation. Hence, the centres of interests substantially moved towards more operational issues.

GOVERNANCE

The governance comprises three levels:

- Level 1 - Energy service: the project team including technicians and legal experts defines and proposes the regulatory provisions. Certain decisions of a purely technical nature that are necessary for the overall coherence are taken at this level;
- Level 2 - the main decisions with the technical, economic and organisational nature are put into consultation. The positions of the various stakeholders are identified, and the decisions that are not of a policy nature are validated;
- Level 3 - The elected officials in the Regional Council of Guadeloupe are called to rule on the questions with a strong policy nature, by taking account of the positions expressed by the various stakeholders. Final arbitration remains in the hands of the regional council which can, if necessary, debate in a plenary meeting.

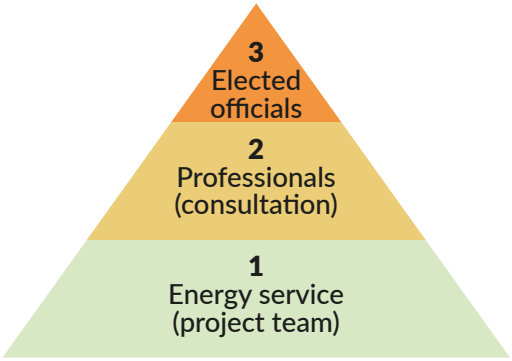


FIGURE 35.
Level of governance.

Get everyone to agree

When a consensus cannot be obtained, a policy position must be taken and defended. The latter can be based on the various strata of the governance pyramid, particularly with the technical feasibility constraints, recommendations from the project team, and the positions of the various professional stakeholders. Residual disagreements can be addressed if needed by accompanying measures, such as:

- Social housing units exempt from a compliance attestation at the building permit stage: in order to avoid slowing down the production of social housing units, keeping in mind that the issue of compliance with the "RTG" does not arise for this category of stakeholder.
- Efforts for training architects to accompany the change.

CONSULTATION METHODOLOGY IN PRACTICE

Two consultation processes were used:

CONSULTATION MEETINGS (GENERAL PROCESS)

The consultation meeting is the favoured process. The following diagram describes the process that is generally implemented for a consultation iteration.

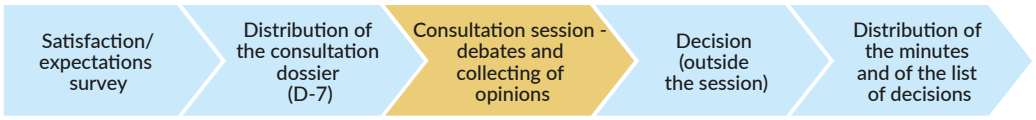


FIGURE 36.
Consultation process.

A prior study, such as a survey type is used to establish a state of the current situation and to launch discussions on factual bases. In certain cases, a consultation dossier is sent on D-7 to the participants so they can prepare their opinions on the proposals (in particular the professional organisations). This document is a reminder of the decisions that have already been enacted, and it presents the points submitted for debate: issues, possible options, advantages and disadvantages, and technical appendices.

The debates are led by a policy and technical duo, with, in certain cases, the presence of legal experts.

To find out more

Example of a consultation dossier "Preparatory dossier for the consultation session of 19 February 2013"

WRITTEN CONSULTATION (ALTERNATIVE PROCESS)

Written consultation is an alternative mode used to quickly rule on highly targeted questions, generally of a technical nature. A consultation note is distributed to the stakeholders, with the following:

- a presentation of the problem;
- possible decisions;
- assistance in making the decision (restrictions, advantages and disadvantages, etc.);
- recommendations on the response.

To find out more

Example of a written consultation "DPEG memo – indicator"

8

10 YEARS LATER: THE IMPACT OF GUADELOUPE'S BUILDING ENERGY EFFICIENCY REGULATION "RTG" ON THE CONSTRUCTION SECTOR

GUADELOUPE, THE SAINTES ISLANDS, TYPICAL HOUSES IN THE VILLAGE
© Adobe Stock, Pascale Gueret.

In 10 years of application, Guadeloupe's Building Energy Efficiency regulation "RTG" approach conducted by the Regional Council of Guadeloupe has induced direct and indirect transformations in the building sector.

THE BUILDINGS

The "RTG" has set down the bases for a progressive transformation of the buildings. The climatic design of the envelope is today anchored in constructive practices, with particular effort given to protection against solar radiation (solar shading of the glazed parts, thermal performance of the walls, effects of shading, etc.) as well as to the natural ventilation capacity of the housing units, whether or not they are air-conditioned.

The "RTG" has also introduced the "measurability" of performance, according to criteria accepted by the sector and adapted to the specificities of the tropical climate.

The setting up of a control during the building permit procedure has systematised the application of the obligations, regardless of the profile of the project manager. As a result, it has resolved the problem of compliance with the regulation.

The "RTG" today guarantees a minimum level of performance for all new constructions. The Energy Performance Certificate of Guadeloupe "DPEG" scheme has reached a stage of maturity that allows Guadeloupe to serenely address the future obligations of the French "climate and resilience" law that aims to absorb "thermal wrecks" starting in 2024.

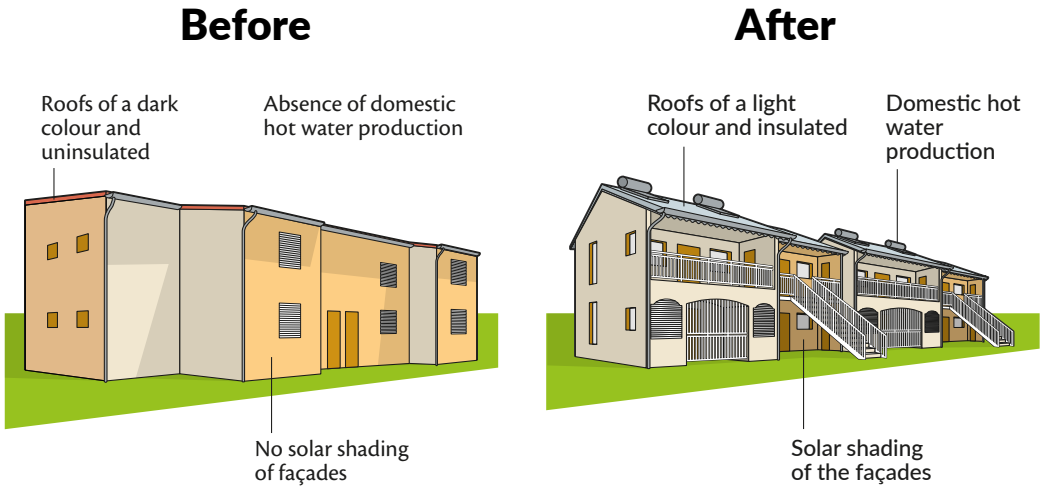


FIGURE 37.
Excerpt on feedback concerning RTG.

To find out more

In order to illustrate the impact of the RTG on the design of buildings, cases of recently-constructed buildings are presented in appendix n°14 to 17 focus files: case study of "RTG 2020" buildings.

STAKEHOLDERS IN CONSTRUCTION

The regulation has accelerated the rise in collective skills concerning sustainable construction. Reserved in the past for just a few experts, this know-how and the corpus of scientific and technical knowledge that accompanies it have largely spilled over into the different professions (project managers, engineering, architects, constructors, control bureaus, etc.). The regulation has also made it possible to harmonise practices and standpoints concerning the regulatory method.

Guadeloupe now has strong skills in sustainable construction firstly through the design offices. Due to the generalisation of thermal calculation on new projects, this profession has gained legitimacy (within project ownership) and in the market size. A new profession has appeared: diagnosticians specialised in the exercise of the Energy Performance Certificate "DPE". Guadeloupe today has 31 certified diagnosticians.

A performance regulation particularly has an impact on the value chain of construction, in particular for the stakeholders in the design. The design calls upon the skills of a thermal technician. The presence of a design office within the project ownership, although it is not mandatory, is becoming increasingly frequent. As a results, sharing of the value of project ownership is modified. This change has to be assumed by the public authorities.

COST OF THE CONSTRUCTION

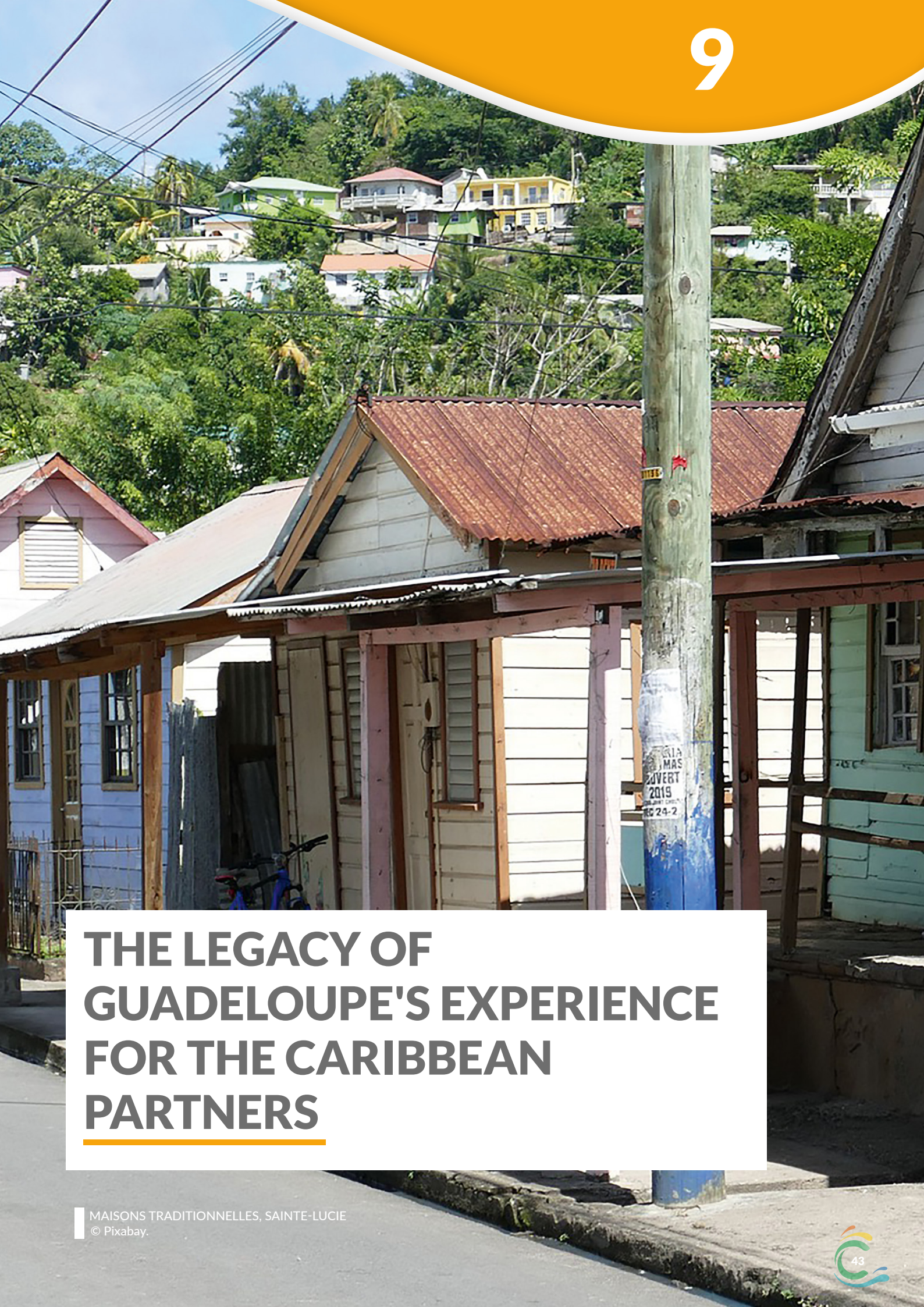
The impact of the regulation on the overall cost of the construction is extremely difficult to quantify. One-off studies have been conducted based on pilot projects but do not make it possible to produce statistically reliable figures. From a qualitative point of view, thermal regulation generates extra cost. But this extra cost is clearly as high in a performance approach than in a conventional approach with means, because of the designer has a lot of room for optimising their project, with the condition that they want to invest in it. In the end, the cost of the studies is higher, but is very largely offset by the gain on the cost of the work.

To find more information

In the first version of Guadeloupe's Building Energy Efficiency regulation "RTG", it was possible to choose between the pre-existing regulation (RTAA-DOM) and the performance-based "RTG", with the performance thresholds being designed to be equivalent. This measure made it possible to resolve the problem of complaints from project owners regarding extra construction costs, as application of the performance-based version is on a voluntary basis. Afterwards, the "RTG 2020" abrogated the RTAA-DOM without any dispute from the stakeholders. Indeed, after several years of application, it was now obvious ftoeveryone that the performance approach is less expensive.

9

THE LEGACY OF GUADELOUPE'S EXPERIENCE FOR THE CARIBBEAN PARTNERS



MAISONS TRADITIONNELLES, SAINTE-LUCIE
© Pixabay.

FOR THE FRENCH OVERSEAS TERRITORIES

After 10 years of existence, experiments and changes, the “RTG” has convinced many stakeholders of other French overseas territories (professionals and public authorities) of its relevance. It forms a reference that is taken into account in future regulatory projects. The French State is in the process of setting up a “performance-based” version of the RTAADOM, for the stakeholders who so desire, based on the “RTG” method and tools. An Overseas territories’ Energy Performance Certificate “DPE” is also being defined, with a specific design but highly inspired by the “DPEG” (Energy performance certificate of Guadeloupe). New Caledonia is also setting up a simulation tool for the performance of buildings, inspired by the “RTG” tool.

FOR THE CARIBBEAN PARTNERS

The path taken by the Regional Council of Guadeloupe in the approach to the thermal regulation of buildings made it possible to highlight the issues and to understand the mechanisms involved. It is precisely these elements of comprehension that we have sought to clarify and transmit in this document.

The construction of a regulatory or incentive scheme is a long process that requires the making of many decisions, with the constant risk of choosing bad options. Therefore, it is desirable to be able to make use of prior feedback. However, a first regulation does not benefit from prior experience, and can only get inspiration from other territories. In this exercise, the transposition can be complex and even risky if the contexts differ greatly (climate, economy, training of the stakeholders, resources and energy vectors, construction products available, etc.). It is as such that Guadeloupe's experience constitutes a rare and valuable legacy for the Caribbean States. The partners of the project, Member States of the OECS, share many points in common with Guadeloupe, in particular island context, the climatic conditions, the energy resources, etc. In light of this proximity in terms of context, we hope is that these elements of analysis and feedback can effectively feed the reflection of partners regarding the orientation given to their own energy policy.

Without prejudice to the target objectives, or the path to take, which must remain specific to each State, we are formulating the desire that this initiative favours the emergence of points of convergence between the various regulatory frameworks. Indeed, harmonisation will act in favour of streamlining the sharing in terms of knowledge, know-how and economic activities.

10

TECHNICAL SHEETS

CAISSE D'ALLOCATION FAMILIALE (CAF), GUADELOUPE
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CHRONOLOGY OF GUADELOUPE'S BUILDING ENERGY EFFICIENCY REGULATION "RTG" PROJECT FROM 2008 TO TODAY

The main events punctuating the RTG project are included in the figure hereinbelow.

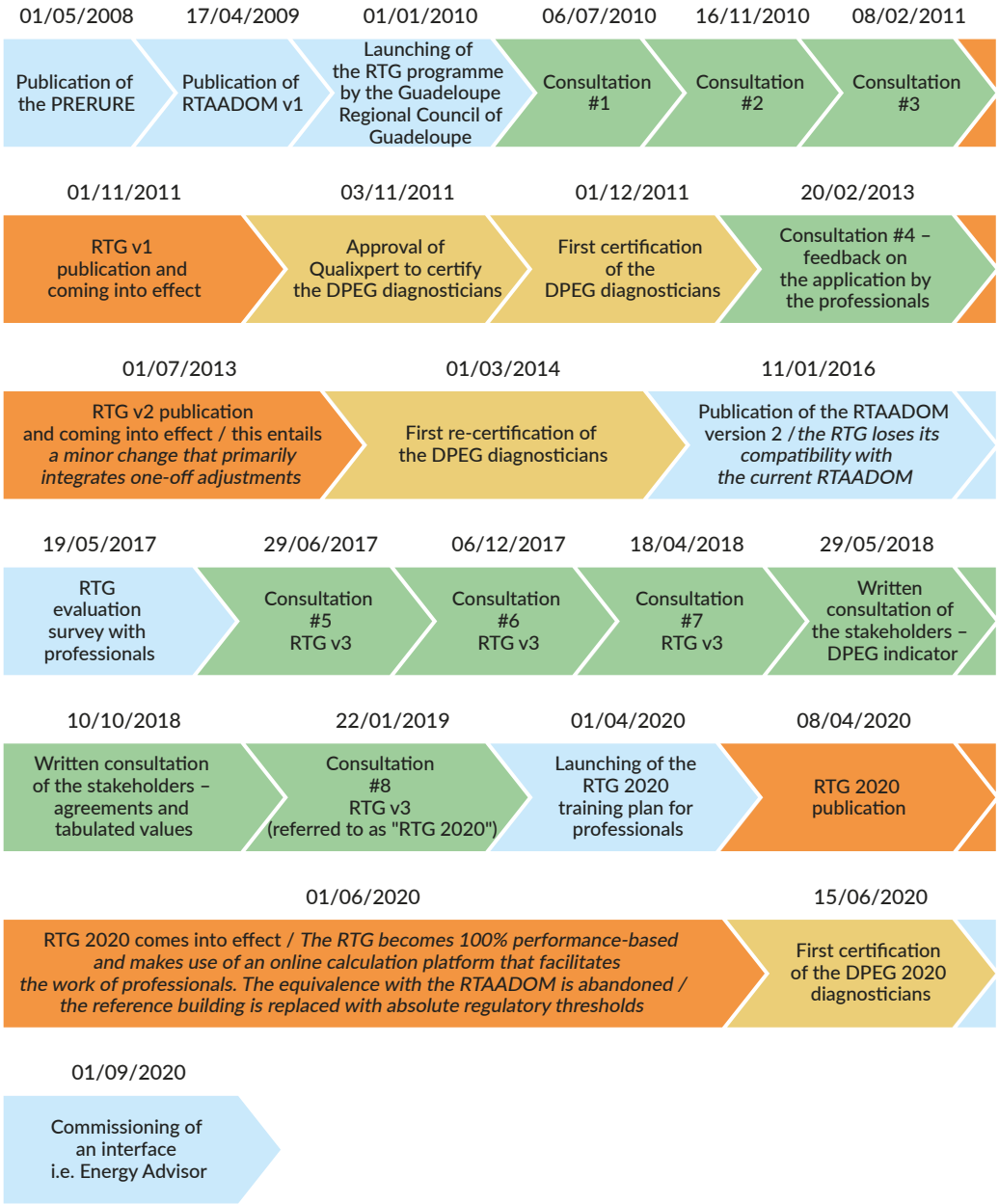


Figure 1: Chronology of the main events

OVERVIEW OF THE REGULATORY SCHEME

The term "RTG" refers - as a whole - Guadeloupe's Building Energy Efficiency Regulation. The "RTG" can be broken down into two sections: new buildings and existing buildings.

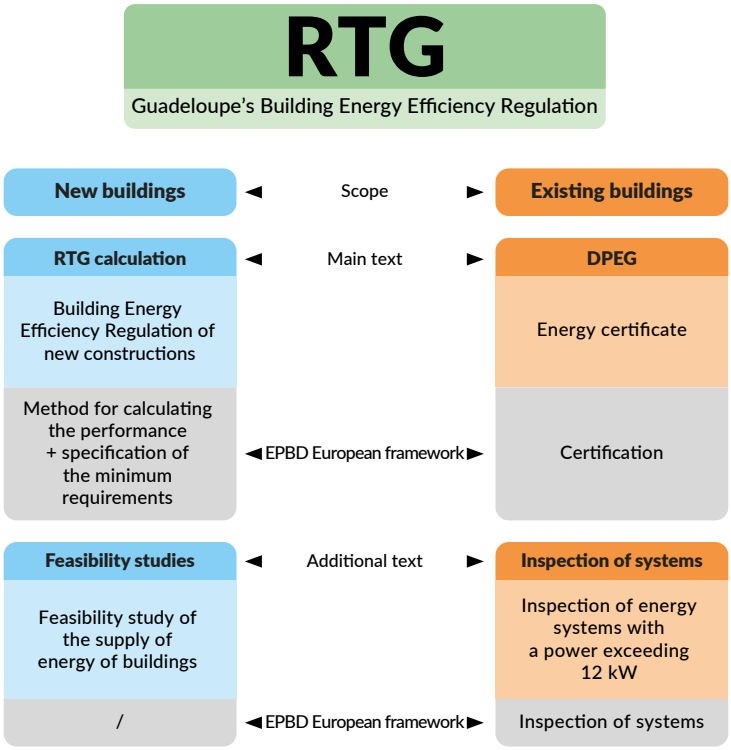


Figure 1: Regulatory scheme

This diagram stems directly from the European regulatory framework defined by the European EPBD (Energy performance of buildings directive).

This report develops the primary texts exclusively: "RTG" and "DPEG" calculation.

For information, the secondary texts cover the following subjects:

- **Inspection** : the text imposes an inspection operating procedure for certain air-conditioning systems so as to guarantee their energy performance. The examination must be carried out every five years on air conditioning systems with a nominal power greater than 12 kW. The periodical examination in particular includes the evaluation of the efficiency of the system, its size and recommendations on the use. The inspectors in charge of these examinations must be certified.
- **Feasibility study** : the text imposes the analysis of certain technical solutions concerning the production of hot water, air conditioning and the energy production for buildings with a surface area exceeding 1,000 m^2.

THE PERFORMANCE INDICATORS

The regulatory compliance conditions for the "RTG" calculation (new construction) are expressed through the following three performance indicators:

ICT	• "Thermal comfort indicator" • Thermal Comfort consideration for **non-air-conditioned** mode (passive measures)
BBIO	• "Energy requirement indicator" • Energy efficiency of the **building** (envelope)
PRDHW	• "Energy consumption for Domestic Hot Water (DHW) indicator"

Figure 1: Indicators for a high-performance building

CLARIFICATIONS ON THE CALCULATION

- ICT quantifies the occupied degrees.hours of discomfort (exceeding a threshold of 28°C).
- T_{felt} = f ($T_{operative}$, HR, V_{air}) : temperature correction according to the Givoni chart. We thus switch from the operative temperature to the temperature corrected for the hygrometer then to the temperature felt by introducing the interior air speed. This physiological approach stems from standard 7730.
- The calculations are carried out via dynamic thermal simulation in non-air-conditioned mode.
- Only the hours occupied are taken into account.

- **ICT** (Thermal comfort indicator) :

– Quantifies the thermal discomfort perceived by the occupants if the housing unit is not air-conditioned, but takes account of the effects of natural ventilation.

– Expressed in °C. An ICT of 1°C can be interpreted as a building that on the average exceeds by 1°C the comfort temperature during the period of occupation (amplitude of the excess in °C.h spread out over the number of hours of occupation in h).

– Formula :

$$ICT = [Degrees.Hours_{occupied} \text{ with } T_{felt} \geq 28\ °C] / N_{hours\_occupied}$$

- **BBIO** (Energy requirement indicator) :
  - – Quantifies the energy needs of the building for air conditioning and lighting.
  - – Expressed in kWhef/m² (final energy).
  - – Results directly from a dynamic thermal simulation.

CLARIFICATIONS ON THE CALCULATION

- **GCDHW:** Grid Consumption for the production of DHW (kWh_{ef}/year).
- **NDHW:** DHW annual conventional needs (calculated by adopting the conventional DHW needs profiles) (kWh_{ef}/year).

- **PRECS** (Energy Consumption for Domestic Hot Water – DHW – indicator) :

– Quantifies the dependence of domestic hot water production on the electricity grid. This indicator shows a concern linked to the peak of electrical consumption at the end of the afternoon.

– Expressed as an annual %.

– Formula :

$$PRECS = CRDHW/NDHW$$

The "DPEG" uses the two ICT and BBIO indicators in the "RTG" calculation, and introduces two additional indicators: C and ICE

CLARIFICATIONS ON THE CALCULATION

- The consumption magnitudes are calculated by dynamic energy simulation.
- The energy simulation takes account of the energy efficiencies of the systems (not used in the RTG calculation).

- **C** (energy consumption of the real zqtate uses of the building in kWh_{ef}/m^2_{floor}/ year) :

– Quantifies the conventional energy consumption required for the air conditioning, lighting, Domestic Hot Water and mechanical ventilation uses.

– Expressed in kWh_{ef}/m^2/year.

– Formula:

$$C = C_{aircon} + C_{DHW} + C_{light} + C_{ventil}$$

CLARIFICATIONS ON THE CALCULATION

- The photovoltaic production is partially deducted.

- **ICE** (consumption indicator) :

– Quantifies consumption and makes it possible to determine the building's energy label.

– Expressed in kWh_{ef}/m^2/an.

– Formula:

ICE = C – partial deduction of the PV prod

THE REFERENCE BUILDING MECHANISM

INTRODUCTION

CLARIFICATIONS ON THE CALCULATION

- I_{projet}: performance indicator calculated by the regulatory method on the project building
- $I_{référence}$: performance indicator calculated by the regulatory method on the reference building (see hereinafter)
- I_{max}: maximum value of the performance indicator

There are two ways to formulate a performance requirement. First, it's take a performance indicator I:

1. **Relative method:** $I_{projet} \leq I_{référence}$ – you must have at least the performance of the reference building.

2. **Absolute method:** $I_{projet} \leq I_{max}$ – you must have at least the performance as the regulatory threshold.

These two modes were successively experimented with, in the "RT Guadeloupe" as in the "RT" France. The absolute method is more delicate to develop and requires more maturity of the regulatory scheme.

In France, the relative method was adopted until 2012, the RT 2012 is based on the absolute method.

In Guadeloupe, the relative method was adopted until 2020, the RTG 2020 is based on the absolute method.

THE REFERENCE BUILDING

The reference building is a virtual building reconstructed from the real building, by replacing some of its characteristics with regulatory reference values. The model of the reference building makes it possible to calculate the reference indicator $I_{référence}$.

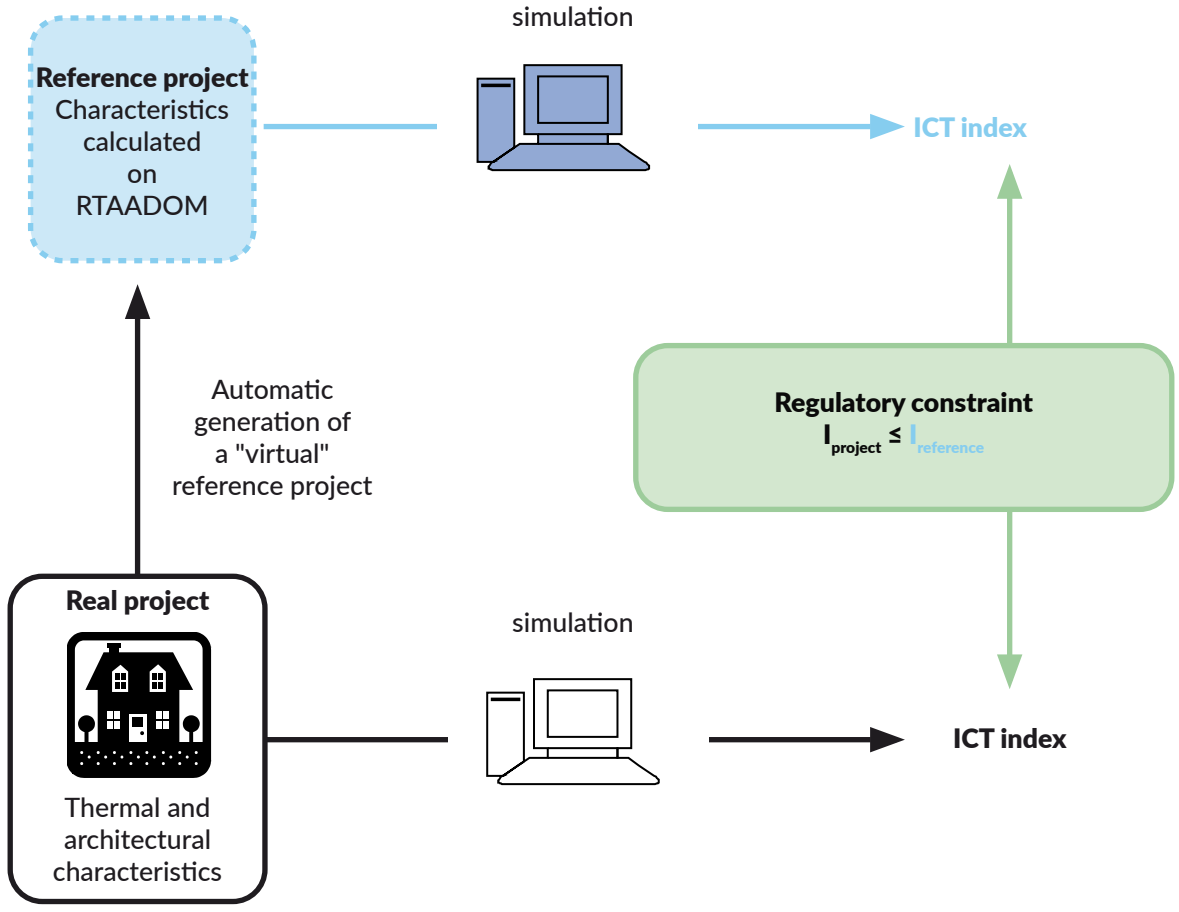


Figure 1: Reference building mechanism

CHARACTERISTICS OF THE REFERENCE BUILDING

The following table explains how the reference project was established in the first version of the "RTG". The obligations of means of the RTAADOM (RTAADOM thresholds) were used to constitute the reference values.

Table 1: Constitution of the reference project

Characteristics of the project	Characteristics of the reference
Solar factor "S" of the opaque and glazed walls	Smax RTAADOM thresholds
"Alpha" Thermal absorption coefficient of opaque walls due to colour	0.6
"U" heat transmission coefficient of walls	U deducted from S and alpha
"Cm" mask coefficients on walls and openings	No additional masks
Surfaces of vertical and horizontal opaque walls	Same as the project
Free opening surfaces of vertical openings (per premises)	RTAADOM thresholds (per premises)
Orientation of the façades	Same as the project
Surface of vertical openings (per premises)	Equal to the free opening surface of the openings (per premises)
Surface of the horizontal openings	0
Characteristics of the actual site (weather, altitude, far away masks)	Same as the project
Conventional usage scenarios	Same as the project

THE ADVANTAGES OF METHOD 1 (RELATIVE)

- The model errors are diminished by the reference mechanisms.
- The impact of the architecture of the building on its capacity to comply with RT is diminished (focus on elementary thermal performance).

THE ADVANTAGES OF METHOD 2 (ABSOLUTE)

- The performance objective is rigorously the same for all buildings.

THE "DPEG" 2020 CERTIFICATE

The Energy Performance Certificate of Guadeloupe ("DPEG") is formalised by a certificate generated by the RTG/ DPEG platform. This document is in the form of a printable PDF, and contains 3 pages:

CERTIFICATE DESCRIPTION

- **Page 1** is the main page, containing the energy label and the main ICE indicator as well as intermediate indicators, and the main information on the project.
- **Page 2** provides a multi-criteria evaluation aimed at identifying the building's strong and weak points. It further makes it possible to explain the building's DPE score.
- **Page 3** is a blank page to be filled out freely by the diagnostician with proposals for improvement intended for the tenant (*energy conservation measures*). These proposals concern the building's envelope and HVAC equipment, and the daily eco-gestures.

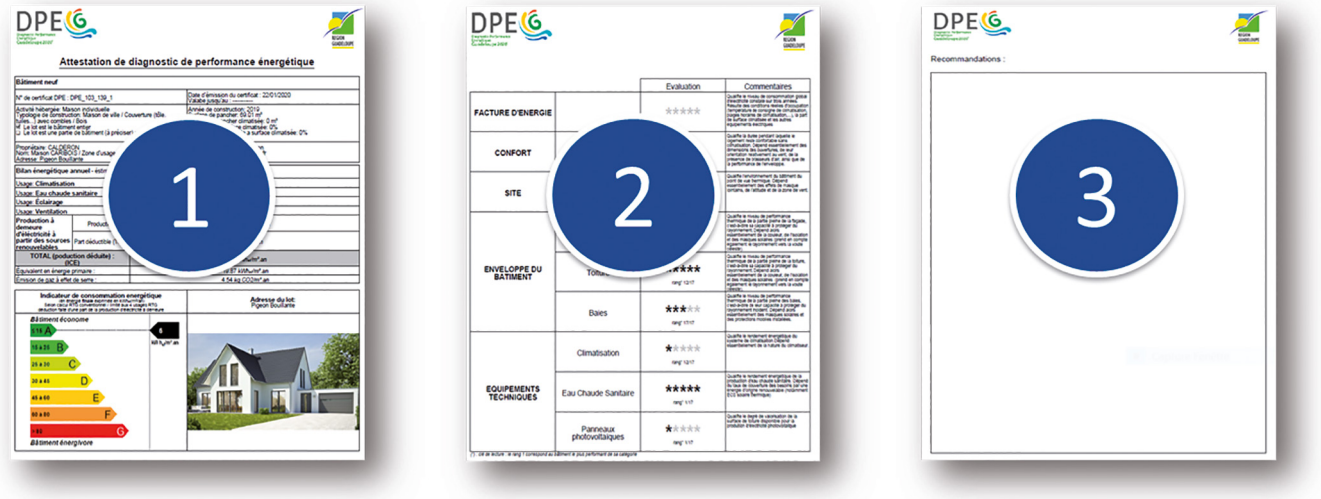


Figure 1: DPEG 2020 certificate

DETAILS OF PAGE 1

Bâtiment existant	
N° de certificat DPE : DPE_155_25_1	Date d'émission du certificat : 09/12/2019 Valabe jusqu'au : ----------
Activité hébergée: Maison individuelle Typologie de construction: Maison de ville / Terrasse / Béton ☑ Le lot est le bâtiment entier ☐ Le lot est une partie de bâtiment (à préciser) :	Année de construction: 2020 Surface de pancher: 150 m² Surface de pancher climatisée: 150 m² Part réelle de surface climatisée: 100% Part conventionnelle de a surface climatisée: 100%
Propriétaire: RP Nom: Bâtiment / Zone d'usage Adresse: Pointe à pitre	Diagnostiqueur: Raphael Peronnet Adresse: raphael.peronnet@cstb.fr Tel.:

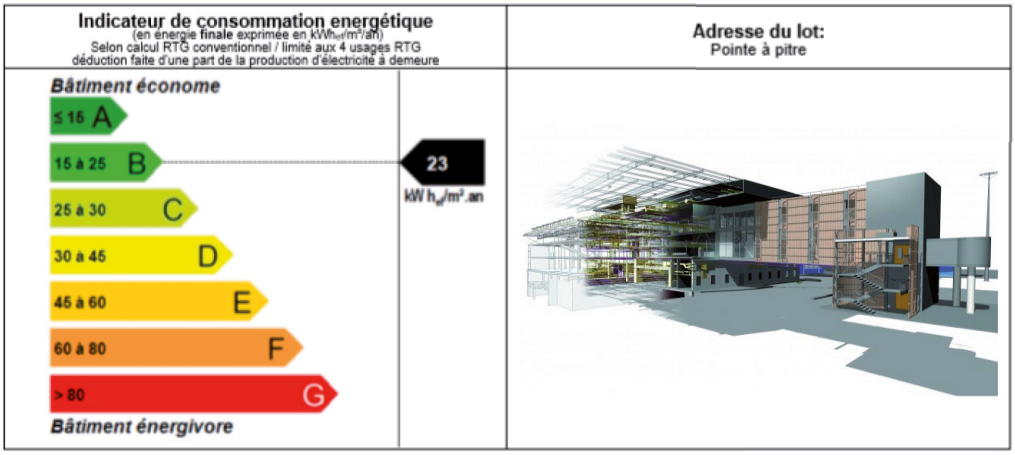
General information on the building

Bilan énergétique annuel - éstimé par le cacul RTG (conventionnel / 4 usages RTG)		
Usage: Climatisation		15,55 *kWhef/m².an*
Usage: Eau chaude sanitaire		5,71 *kWhef/m².an*
Usage: Éclairage		7,07 *kWhef/m².an*
Usage: Ventilation		0,00 *kWhef/m².an*
Production à demeure d'éléctricité à partir des sources renouvelables	Production	27,45 *kWhef/m².an*
	Part déductible (TRC)	5 *kWhef/m².an*
TOTAL (poduction déduite) : (ICE)		23,33 *kWhef/m².an*
Équivalent en énergie primaire :		81,65 *kWhef/m².an*
Émision de gaz à effet de serre :		18,66 *kg CO2/m².an*

Energy assessment resulting from the dynamic thermal simulation

Facture moyenne réelle - tous usages confondus (pour information)		
Consommation privative du lot		- *kWhef/an*
Consommation d'équipements collectifs imputables au lot		- *kWhef/an*
TOTAL factures réelles	en kWhef	Numéro de compteur edf non trouvé
	équivalent en euros	- *€/an*

Energy assessment resulting from the analysis of the actual electricity invoices (if available)



Official DPEG score (ECI indicator) and associated energy label

Figure 2: Details of page 1 of the certificate

DETAILS OF PAGE 2

The score over 5 stars is established by an automatic analysis of the components's performance.

The rank is a classification of the building with regards to buildings of the same typology within the project base archived in the RTG/DPEG platform.

Table 2: Scoring the performance

		Assessment
ELECTRICITY INVOICE		★★★★★
THERMAL COMFORT		★★★★★ rank★ 6/6
SITE LOCATION		★★★★★ rank★ 6/6
BUILDING ENVELOPE	Façades	★★★★★ rank★ 6/6
	Roof	★★★★★ rank★ 6/6
	Windows	★★★★★ rank★ 1/6
TECHNICAL EQUIPMENTS	Air conditioning	★★★★★ rank★ 1/6
	Domestic Hot Water	★★★★★ rank★ 1/6
	PV Solar Systems	★★★★★ rank★ 1/6

THE RTG/DPEG CALCULATION PLATFORM

This sheet describes in more detail the "RTG/DPEG" set up since the RTG 2020.

OVERVIEW OF THE FEATURES

Freely accessible from the www.guadeloupe-energie.gp web site, the "RTG/DPEG" platform allows each user profile to carry out its operations necessary for applying the regulatory scheme.

The main operations proposed per profile are described in the following table.

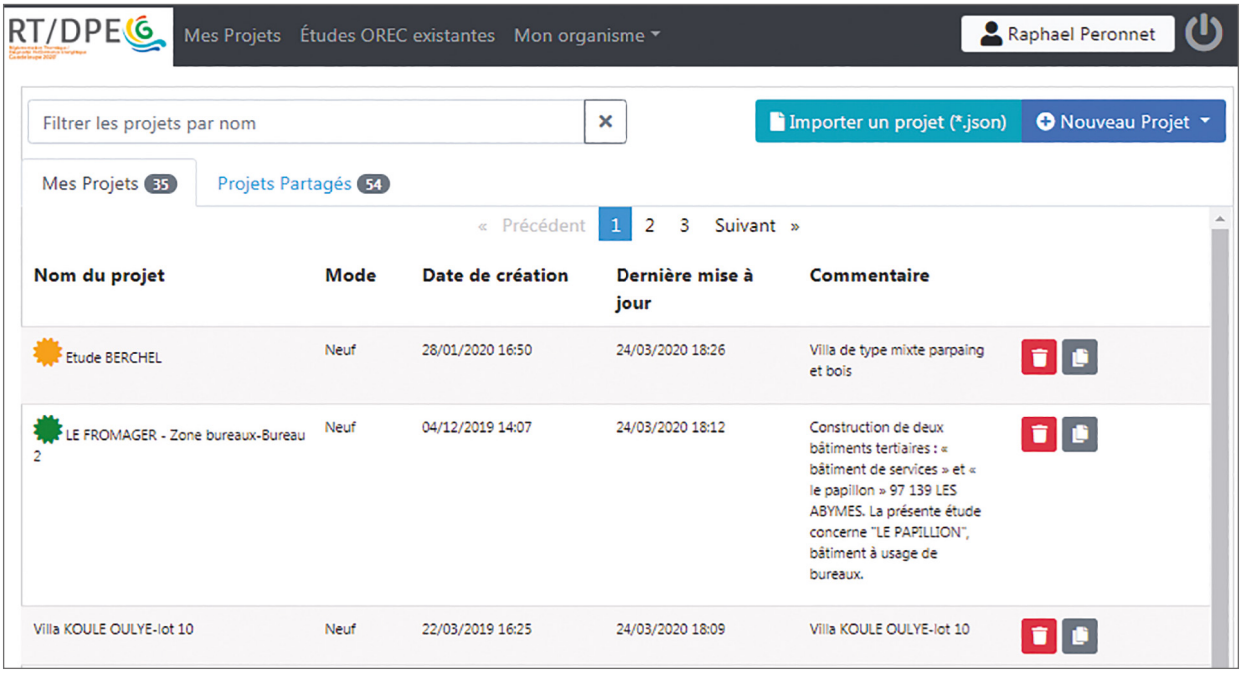
Table 1: Main operations proposed per profile

	Type of building	*New construction*		*Existing building*		
	Status of the building	*Subjected to new RTG*		*Subjected to DPEG*		*to be renovated*
	User account profile	*Common*	*Inspector*	*Diagnostician*	*DPEG certifying body*	*Advisor*
	Access conditions	*Open to all*	*Services of the State*	*DPEG certified*	*Approved by the region*	*Ademe & region*
Calculation	Modelling a building	•		•		•
	Conduct various studies (variants) of a project, select the «official» variant	•				
	Save the modifications (design, work) of a project	•				
	Calculate the indicators	*BBIO ICT PRECS*		*CICE*		*BBIO ICT PRESC CICE*
	Simulate the impact of renovation work					•
Editing	Edit the RTG compliance attestation	•				
	Edit the DPEG certificate	•		•		
	Edit a renovation audit report					•
Control	Consult and retrieve prior modellings of the building			•		
	Ensure RTG compliance of a new construction	•				
	Control RTG compliance of a new construction		•			
	Audit/re-certify a diagnostician				•	

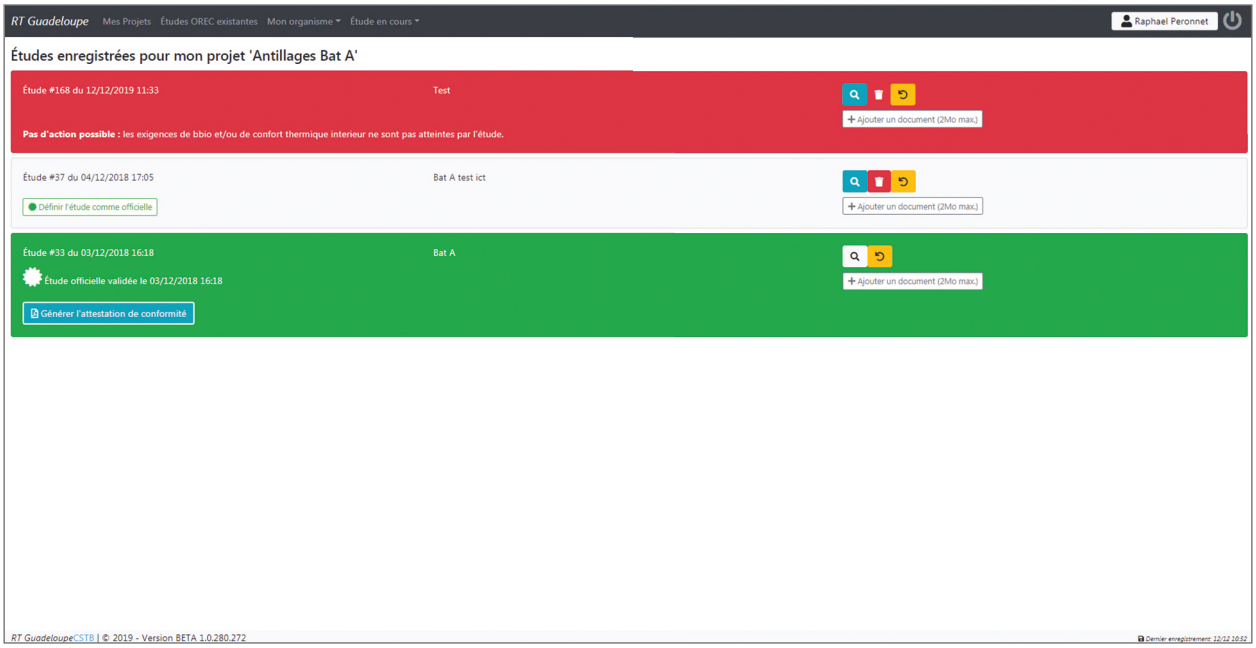
THIS SCHEME HAS MANY ADVANTAGES

- It entails a free application tool for the stakeholders in construction.
- The maintenance of the calculation tool can be done in a centralised manner and the user has the guarantee of using the latest updated version.
- The modellings are capitalised in a complete manner in a central database.
- Control operations are facilitated, including for the Regional Council of Guadeloupe that can easily monitor the application statistics of the regulation.
  Note that private individuals can use the RTG calculation tool, in the same way as professionals.

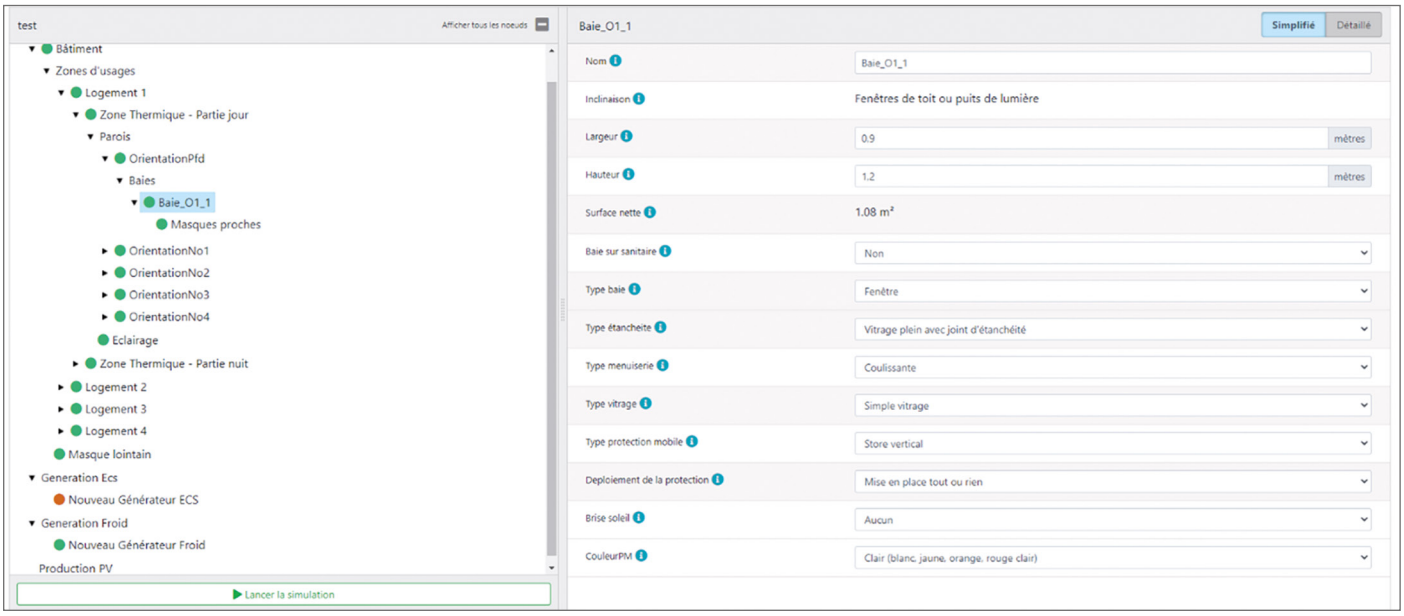
A GUIDED TOUR OF THE RTG/DPEG PLATFORM



Each user has their own dashboard which includes the history of their projects. The platform also allows sharing projects within the same design office. The projects are automatically saved on the platform, but can also be downloaded in ".json" format. The new project is created either from a blank sheet, or by duplicating and modifying an existing project.

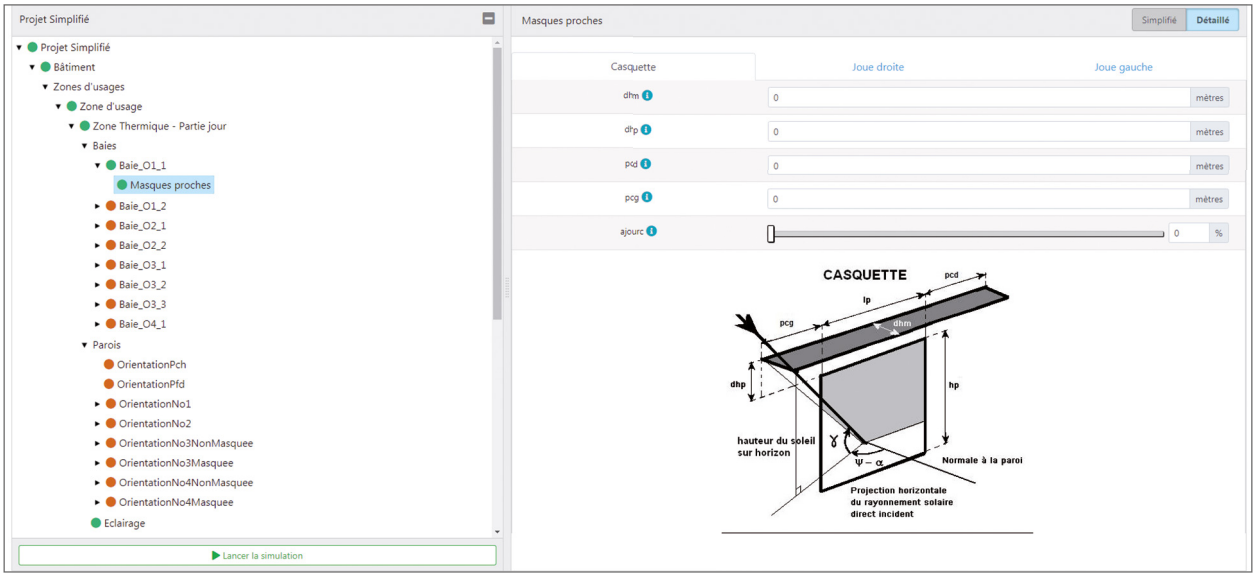


The project gives rise to one or more "Studies" which correspond to variants of the same project. This screen shows the three studies attached to the "Antillages bldg A" project. A colour code indicates the status of the study (Red = non-compliant with the RTG, white or green = compliant with the RTG). First, the user must select the study that will be considered as "official" with the characteristics of the building such as the designed and built. Then, this study must be chosen from among the compliant (white) studies and appears in green.

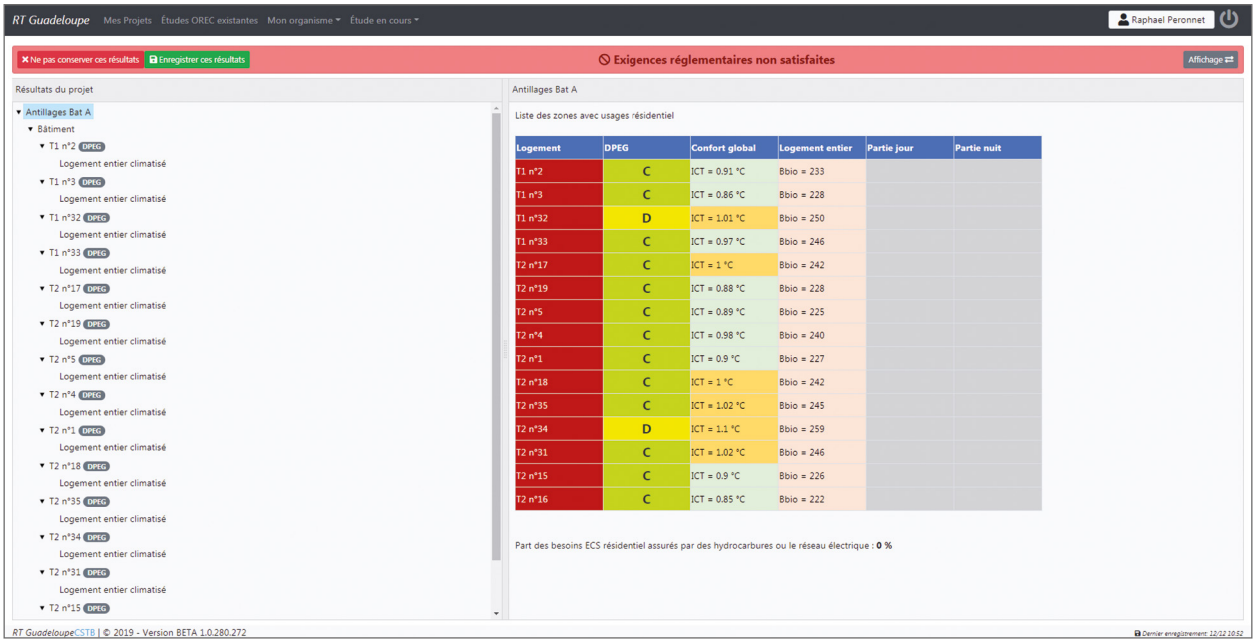


The model of the building has a tree structure of objects (left window). Each object has to be described in a questionnaire (right window). If the description of the object is complete, the dot is green. Otherwise it is orange.

Note: the platform offers two levels of detail for key entry: detailed mode and simplified mode (see the switch in the upper right-hand corner). The simplified mode requires less time and less technical precision, but results in less precise calculation. Therefor, it is particularly suited for the diagnostics of existing buildings.



Questionnaire example: description of a horizontal solar mask of the "cap" type.



The results page makes it possible to view the values of the indicators as well as the compliance status of the project. Here, this entails a collective building of housing units, each line of the table corresponds to one housing unit. The project is not compliant with the “RTG” because 6 housing units have an ICT that is too high ("overall comfort" column in orange). It is also possible to access the results of the intermediate calculations in order to understand any issues better.

To find out more

We suggest you test the RTG/DPEG platform from the address http://rtg.dimn-cstb.fr Create an account, create a new project then run a modelling test for a fictitious building.

CONSULTATION THEMES

This sheet presents the main themes debated in the framework of the consultation with the stakeholders in construction. We distinguish between the initial and the later development phases, because the stakes and concerns are different.

IN THE INITIAL PHASE

At this stage, this entails defining the major structural principle that constitute the regulation. The questions are potentially very numerous, and it was necessary to make a selection, with the other decisions being proposed by the Regional Council of Guadeloupe in its regulatory corpus project.

- **General principles of the regulation**
  - The position of the regulation regarding air conditioning.
  - The position of the regulation regarding photovoltaic system production.
  - The comfort/energy duality: in a tropical climate, energy performance cannot be assessed independently of hygrothermal comfort in natural ventilation. How can these two approaches be reconciled?
  - The energy unit: final or primary?
  - Progressiveness of the requirements: what constraints to impose on constructions that are close to the limit of conformity?
- **RTG calculation method**
  - Formulation of the regulatory indicators – for new construction (see sheet 3) – capable of translating the expected performance criteria of new constructions.
  - Formulation of the main indicator used in the “DPEG”.
  - Definition of the regulatory requirement level: definition of the reference values (see sheet 4) from the requirements of the RTAADOM, the definition of the maximum threshold based on a panel analysis of projects.
- **Calculation conventions**
  - Climatic conventions: meteorological files, taking account of microclimates through modulation of the meteorological file (climatic zone, wind correction, temperature correction according to the altitude, etc.) – definition of "policy" coefficients associated with these zones
  - Usage conventions (occupation scenarios, air conditioning setpoint temperature, usage of artificial light, etc.)
  - Calculation conventions (internal gains, airtightness of the envelope, conventional albedo, etc.)
- **Additional minimum requirements for the “RTG” calculation**
  - How should ceiling fans be valued in the regulatory calculation?
  - Airtightness of the structural openings, roof windows, airflow restriction of the interior partitioning, etc.
- **Regulatory corpus**
  - Texts of the law: new construction, “DPEG”, domestic hot water, inspection, feasibility.
  - Format of the DPEG certificate (information, units, energy label, etc.).

IN LATER DEVELOPMENT PHASES

After a preliminary application, the local professionals in construction are again solicited in the framework of feedback. The issues encountered in the field are expressed, discussed, debated. The consultation themes are largely inspired from these difficulties, so as to collectively search for solutions.

- **Regulatory corpus:**
  - Definition of building typologies: experience has shown that it was sometimes difficult to determine if certain limit cases were included or not in the application scope. These revisions consisted in specifying the definitions of building typologies.
  - Modifications to be made to the texts following application difficulties in actual cases. In most cases this entails removing ambiguities in interpretation. The regulatory text has progressively changed by becoming simpler, in order to facilitate understanding and appropriation by the stakeholders in construction.
  - Improvement in the format of the "DPEG" certificate, in particular from the standpoint of legibility by the owners of the buildings.
- **Calculation method**
  - Revamping of the calculation method for the DPEG indicator: switching from a method using invoices to a method via simulation.
  - Methodological recommendations in modelling cases of particular constructive configurations reported by stakeholders in construction (non-closed premises, buildings delivered crude, etc.). The recommendations were capitalised in the application guide of the "RTG".
- **RTG/DPEG calculation platform**
  - Building libraries: these preconfigured elements simplify modelling on the platform. They were introduced progressively after validation by the stakeholders in construction (in particular the associated performance).
  - Adding of advanced functions: based on suggestions formulated by the users. The targeted objectives are generally to simplify and accelerate the modelling of projects, or to avoid errors.
- **Settings and adjustments based on feedback**
  - Application scope: was adjusted in order to take account of the issues reported by the stakeholders.
  - Calculation conventions, in particular usage conventions of the building which have shown to strongly influence the optimisation orientations conveyed by the calculation tool.
  - Revision of the "RTG" requirement thresholds: the thresholds were lowered during RTG 2020 (elimination (20%) of the least performing projects). The thresholds were also adjusted in order to balance the weight of the thermal (BBIO) and comfort (ICT) constraints.
  - Revision of the "DPEG" energy certificate thresholds: based on a statistical analysis of the first DPEGs carried out.
- **Compliance with the regulation**
  - Solutions make it impossible to ensure application of the RTG and compliance with the RTG calculations: communication plans, means of control, coercive means, incentives, etc.
  - Proof of compliance for the building permit: adjustment of the processes so that the scheme is more effective and less restrictive.

FOCUS ON INTEGRATING RESIDUAL REQUIREMENTS FOR MEANS

Certain requirements for means: (inherited from the RTAADOM) work complex to convert in a performance form. This entails a technical complexity of valuing in the calculation, but above all a complexity in terms of consultation because the opinions are divided on the pertinence of switching them to performance.

Arguments in favour of switching to performance	Arguments in favour of maintaining requirements of means
• Holds the designer accountable and prevents them from "hiding" behind the texts. • Makes it possible to seek an economic optimum with equivalent performance, or to improve the performance at an equivalent cost.	• Prohibiting makes it possible to definitively bar constructive principles that degrade performance (e.g. roof windows). • Easier to control (prohibitions/obligations are visible while the calculations must be subject to an expert control). • Less demanding in terms of thermal competence of the professionals.

This sheet provides details on two cases among the most problematic: roof windows and ceiling fans.

THE CASE OF ROOF WINDOWS

At the origin, the RTAADOM prohibited the use of roof windows in housing units (requirement of means). Roof windows receive very much sunlight due to their quasi-horizontal orientation. Although they do not have an excellent solar factor, they constitute a genuine breach in the solar shading provided by the envelope of the building. For this reason, their use was prohibited in the RTAADOM.

In the framework of the performance RTG, the question was put to consultation, with three possible options:

1. No restriction on the use of roof windows, with the associated reference solar factor is highly penalising (0.03) which encourages constructors to recommend high-performance openings or to offset the loss of efficiency induced by the use thereof.
2. Roof windows are prohibited except in wet rooms for hygienic ventilation.
3. Roof windows are entirely prohibited.

This question was highly debated between the professionals of Guadeloupe and Martinique. One of the major arguments is that roof windows are so harmful to the thermal assessment that the encouragement coming from the objective for results is not strong enough. Prohibition forms a clear and strong policy message, that can be understood by everyone, independently of their level of technical competence. There is also a substantial risk of cheating in the modelling which remains complex to control. In the end, it was not possible to find a position where there was a total consensus.

POSITIONS TAKEN

On this delicate subject, the various positions taken were the following:

- RTAADOM: prohibition.
- RTG v1 and v2: prohibition except in bathrooms.
- RTG v3 (2020): considering that professionals have gained in competence and that the control scheme is more effective than at the outset, roof windows are finally authorised, but remain highly penalised in the calculation. The thermal impact has to be offset via superior performance on the rest of the building. They cannot however be valued as an opening surface that participates in natural ventilation (ICT calculation).

THE CASE OF CEILING FANS

At the origin, the RTAADOM imposes the presence of reservations for ceiling fans in the main rooms, and in certain cases the presence of fans (requirements of means). However, we have observed that the position of the stakeholders regarding ceiling fans was highly variable, and it again is a subject on which it was difficult to reach a consensus.

Let's recall a few observances relating to this type of equipment:

- The thermal impact is very difficult to calculate due to the spatial variations of the air speed and the operating intermittency.

- The ceiling fan makes it possible to delay the use of air conditioning, but also to raise the setpoint temperature of an air-conditioned premises (double effect).
- When the fan is operating, the calculation of its impact on comfort shows a value that is predominant with respect to all the other bioclimatic arrangements of the building.
- The minimum ceiling height to receive a ceiling fan is not standardised and this subject is still under debate. However, using a ceiling fan can require a more significant ceiling height which has significantly impacts on the cost of the construction.

The following questions were put to consultation:

1. Must the "RTG" recognise the contribution of this equipment (or are they considered as furnishing elements making it possible to overcome the lack of comfort)?
2. If this equipment is recognised by the "RTG", how should its impact to be quantified without it becoming the dominant performance factor?
3. Is it necessary in certain cases to impose recourse to this type of equipment?

POSITIONS TAKEN

The position of the "RTG" was finally the following: this equipment is never imposed but its presence is valued in the calculation (ICT and BBIO). The calculation method allowing for this valuing is more conventional than scientific so as to retain a relative weight that is acceptable regarding the other performance factors of the building. In the situation of natural ventilation, this results in a bonus for the air speed and thus affects the ICT indicator. In the case of air conditioning, this increases the conventional air conditioning setpoint temperature and thus affects the BBIO indicator.

OVERVIEW OF THE CALCULATION METHOD

The "RTG" calculation method consists of simulating the physical magnitudes of interest in order to calculate in a second step the three regulatory indicators.

CALCULATION ENGINES

Taking the effects of inertia into account is required, which is why the calculations are conducted dynamically, with an elementary time step of 1 hour over the typical full year, with 8,760 values calculated for each magnitude.

The following diagram highlights the three main calculation engines developed:

- The thermal engine predicts the interior temperature conditions. It feeds the calculation of the cooling needs (BBIO) and thermal comfort (ICT) indicators.
- The natural ventilation engine predicts the interior air speed when the opening structures are in the open position. It feeds the calculation of the thermal comfort (ICT) indicator.
- The simulation engine of solar systems predicts the production of renewable energy. It feeds the calculation of the PRECS indicator.

The natural ventilation engine was entirely developed for the occasion and forms a technological innovation. Indeed, in terms of natural ventilation, the existing calculation methods fall under CFD (*Computational Fluid Dynamics*) and have a high level of complexity, reserved for engineers specialising in fluid mechanics, therefore unsuitable for a regulation. The "RTG" natural ventilation engine performs a simplified calculation with a level of precision that is sufficient to compare the performance of different layout configurations.

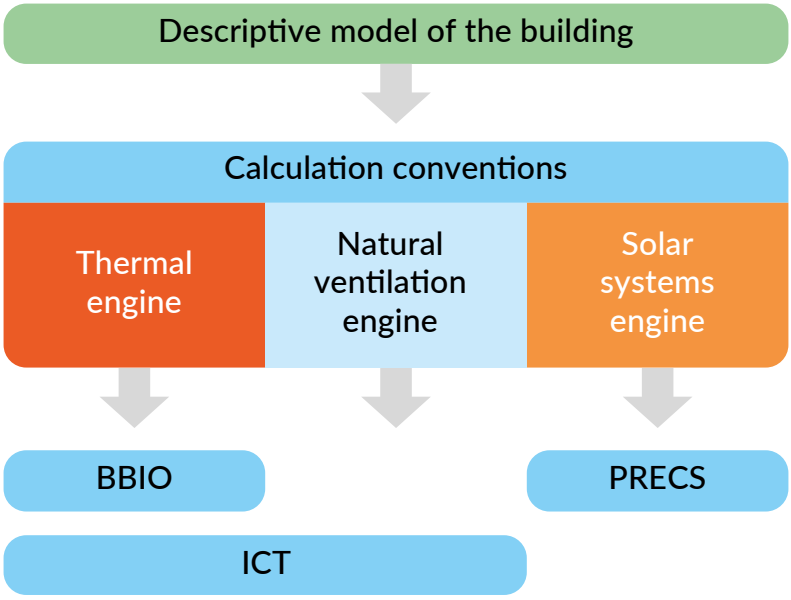


Figure 1: Modular diagram of the calculation code

ELEMENTARY MODULES

The method is implemented in a computer calculation code developed in the C# language, formed from 15 elementary modules described in the table hereafter.

Table 2: Elementary modules of the calculation code

NAME OF THE MODULE	DESCRIPTION	OUTPUTS TO THE MODULE
M1_Climat_Ext	Correction of the hourly meteorological data for the study site: temperature (according to altitude) intensity of the wind (according to the climatic zone), calculation of the illumination in steps of 1h	M2 – M6- M7- M9 - M10
M2_Near Environment	Calculation of the solar radiation and illumination in the direction of each wall of the project (opaque wall or structural opening) taking any masks into account, to finally end with the incident radiation and illumination on the wall. Each wall can be protected by 1 to 4 masks: • vertical close mask, to the right into the left of an exterior observer facing the structural opening; • horizontal close mask; • for vertical mask via azimuth bracket.	M3 – M4
M3_Structural openings	Calculation: • of the thermal transmission coefficient; • of the total solar radiation (energy and light) transmitted to the zone; • of the light flow transmitted to the area; • of the cold radiation to the sky.	M9 – M5 – M6
M4__Opaque_Walls	Same function as M3 but for opaque walls	M9
M5_Lighting	Calculation of the needs and consumption of lighting of the zone and the internal lighting gains.	M9 – M14
M6_Nat_Ventilation_ICT	Quantification of the natural ventilation capacity of the zone studied when its windows are open (non-air-conditioned mode). In the common case of a housing unit that comprises several rooms, the interior partitioning is simplified by considering a single internal opening surface	M7
M7_Ventilation	Calculation of the total interior air renewal and calculation of the interior air speed (for ICT)	M9 – M15
M8_Occupants	Calculation of the magnitudes linked to the occupant and their uses: • the internal gains of heat and humidity of the occupants and of the processes; • the needs in domestic hot water • the triggering or not of the air conditioning in the time step considered; • the renewal rate of air depending in particular on their presence.	M7- M9 – M14
M9_Thermal_Model	Dynamic calculation with the time step of 1h of the temperature and/or of the cold flow to be supplied by the air conditioning system, primarily according to: • the exterior climate; • the occupation scenarios; • the setpoint temperature; • the physical characteristics of the building's envelope; • the air renewal flow rates; • the gains (solar and internal).	M14 – M15

NAME OF THE MODULE	DESCRIPTION	OUTPUTS TO THE MODULE
M10_Humidity	Water balance and calculation of the humidity. Calculation of the latent cold needs	M14
M11_Other_Uses	Calculation of the consumption of other uses	M14
M12_Thermal_Solar	Solar DHW production system simulator. Calculation of the rate of solar coverage	M14
M13_Photovoltaic	Photovoltaic solar production system simulator. Self-consumption indicator calculation	M14
M14_Postpro_BbioConso	Calculation of the energy needs and consumption required at the output of the RTG/DPEG calculation platform: • the regulatory indicators of the RTG and DPEG calculations; • the calculation outputs at a time step of 1h (table with 8,760 lines); • the DPEG additional indicators (used in page 2 of the DPEG certificate).	
M15_Postpro_ICT	Calculation of the ICT indicator	

THE DESCRIPTIVE MODEL OF THE BUILDING

The descriptive model of the building is the data structure used to describe the building. It is established with an "object" logic with a tree structure form.

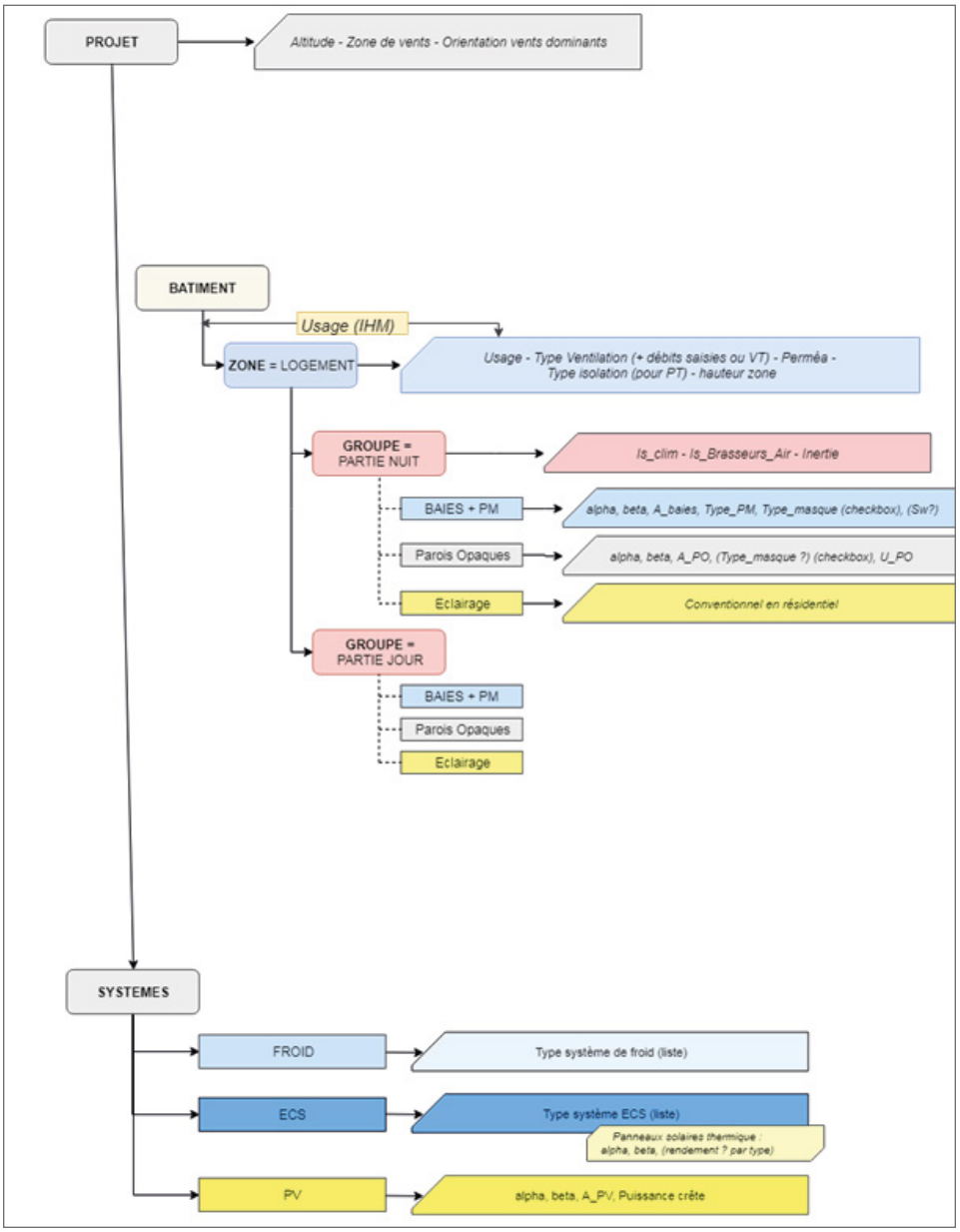


Figure 1: Descriptive model of the building (screenshot)

The model of the building comprises 4 hierarchical levels for a residence and 3 levels for commercial and institutional. The technical equipment (air conditioner, DHW production and photovoltaic solar panels) are described in separate objects, then connected to the spaces of the building, in order to adapt to the multiple configurations possible.

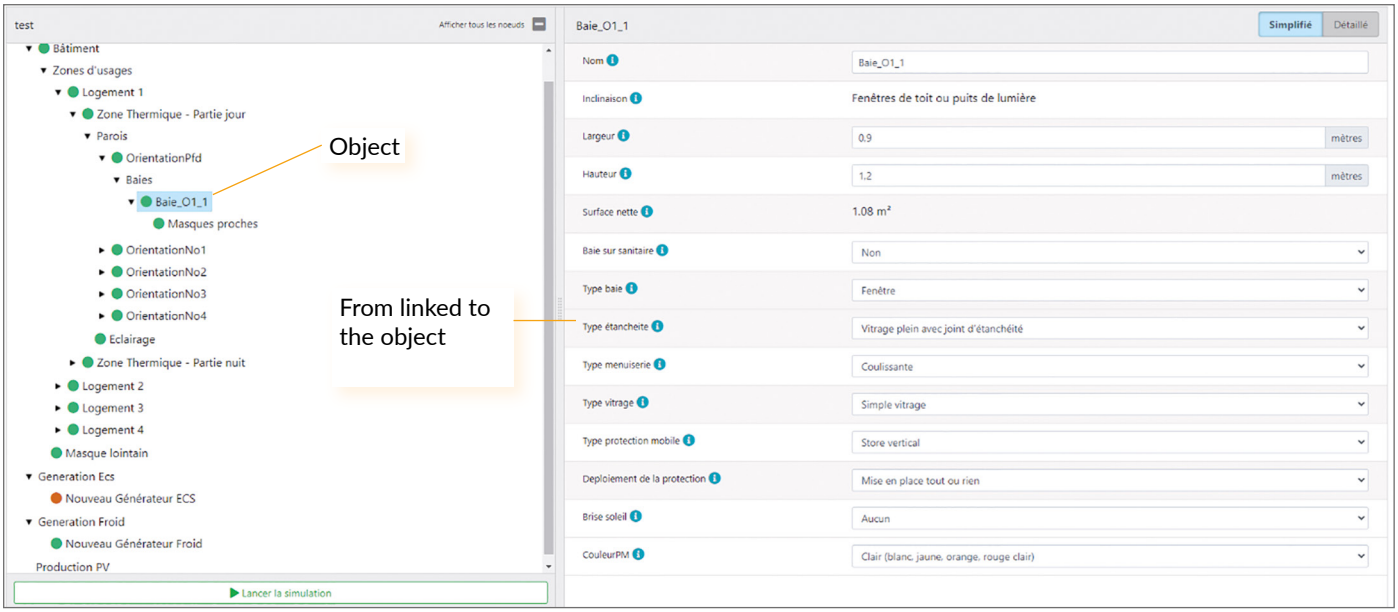


Figure 2: Creation of objects (screenshot)

Implemented in a digital file in "JSON" format, the user enters information into the model via the interface of the “RTG/DPEG” platform. During the modelling of the building, the user can create objects and enter their attributes using the linked forms.

SIMULATE THE THERMICS AND THE NATURAL VENTILATION OF THE BUILDING

SIMULATING THE THERMICS OF THE BUILDING

THE CORE OF THE MODEL (MODULE M9)

The core of the thermal model was developed based on the core of the THBCE calculation method used for the "RT 2012" thermal regulation in effect in France. It is based on simpliflying the transfer of heat between the interior and exterior environments according to the principle of the thermal/electric analogy. The model is described via the following diagram.

CLARIFICATIONS ON THE CALCULATION

- T_i: temperature of the interior air in °C;
- T_s: average of the temperature of the air and the average radiant temperature weighted by the convective and radiative exchange coefficients at the walls in °C;
- T_m: mass temperature in °C;
- T_{eieq}: equivalent temperature of the air entering into the group in °C;
- T_{es}: equivalent exterior air temperature of the structural openings in °C;
- T_{em}: equivalent exterior air temperature of the opaque external components in °C.

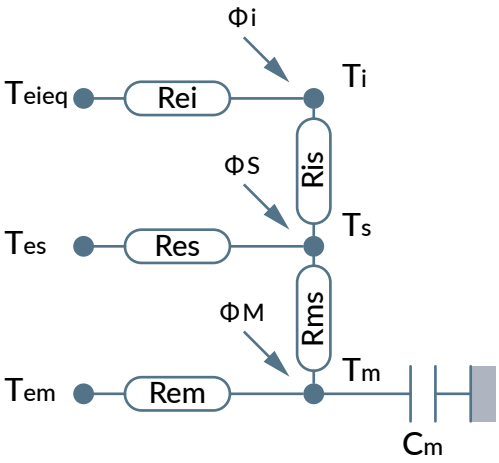


Figure 1: Thermal model

The equivalent conductances and the thermal capacity are thus defined:

- H_{ei}: thermal transmission factor due to the renewal of air, in W/m²K (= $1/R_{ei}$) ;
- H_{is}: thermal transmission factor due to the internal exchanges via convection and radiation, in W/m²K (= $1/R_{is}$) ;
- H_{es}: total thermal transmission factor between the interior and exterior environments, in W/m²K (= $1/R_{es}$) ;
- H_{ms}: internal transmission factor (= $1/R_{ms}$) ;
- H_{em}: transmission factor between the exterior environment and the interior surface (= $1/R_{em}$) ;
- C_m: thermal capacity of the group (in kJ/K).

The heat flows (W) considered are:

- Φ_i: convective heat flow at the air node T_i due to the internal sources and to the convective heat gains due to the ventilated interior airspace of the glazing, in W/m² ;
- Φ_s: radiative heat flow at the node T_s due to internal sources, in W/m² ;
- Φ_m : radiative heat flow at the node T_m due to internal sources, in W/m².

The operative temperature is deducted from this according to the equations:

CLARIFICATIONS ON THE CALCULATION

- h_r et h_c: convection coefficients variable according to the interior air speed.

$$T_{rm} = \frac{(h_c + h_r) \cdot T_s - h_c \cdot T_i}{h_r}$$

$$T_{op} = \frac{h_c \cdot T_i + h_r \cdot T_{rm}}{h_c + h_r}$$

The operative temperature is then corrected in order to take account of the impact of the hygrometry in the perception of comfort, according to the following simplified formula:

CLARIFICATIONS ON THE CALCULATION

- $T_{adjusted}$: the temperature felt after taking the humidity into account (°C);
- T_{op}: the operative temperature for a humidity of 50%;
- H_R: the local relative humidity (%).

$$T_{adjusted} = T_{op} + 0.06 \cdot (HR - 50)$$

Finally, the interior temperature felt is calculated T_{felt} corresponding to the operative interior temperature corrected for the air speed and the hygrometry:

$$T_{felt} = T_{adjusted} - max(\Delta T ; \Delta T_{fan}):$$

VALUES OF THE CEILING

Value of V	Value ΔT
From 0 to 0.3 m/s	Constant 0°
1 m/s	Value 4°

ΔT is the drop in temperature felt induced by the ventilation of the housing unit, according to the interior air speed. It has a ceiling of 4°C and is of the piecewise type, from the values of the table hereinbelow.

The second term ΔT_{fan} corresponds to the drop in temperature felt induced by the possible presence of a ceiling fan.

THE PROCESSORS

Upstream of this core, modules referred to as "pre-processors" make it possible to calculate the input variables of the core from the descriptive model of the building, conventions and meteorological data.

Other modules perform annex calculations such as the technical equipment simulators or the module for calculating solar masks.

SIMULATING NATURAL VENTILATION

The challenge is to estimate the air speed inside the housing unit when the windows are in the open position. This physical magnitude is taken into account in the calculation of the temperature felt of the thermal calculation engine, and therefore of the ICT indicator.

This speed is primarily the result of the natural ventilation flow rate, which is quantified according to the following calculation steps:

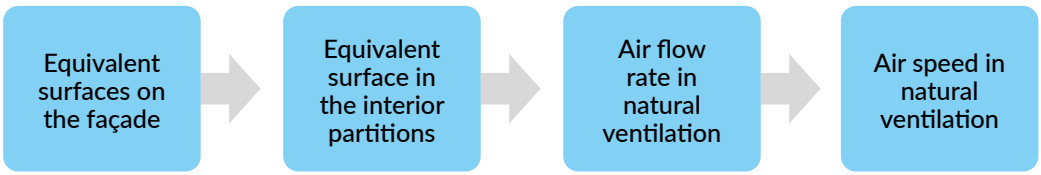


Figure 2: Steps in calculating the interior air speed

CALCULATION OF THE EQUIVALENT FREE OPENING SURFACES ON THE FACADE

Buildings include multiple openings, distributed over different orientation faces. The equivalent free opening surface is a virtual surface for the air passage corresponding to a single opening, with a potential for equivalent natural ventilation. The general calculation formula is as follows:

CLARIFICATIONS ON THE CALCULATION

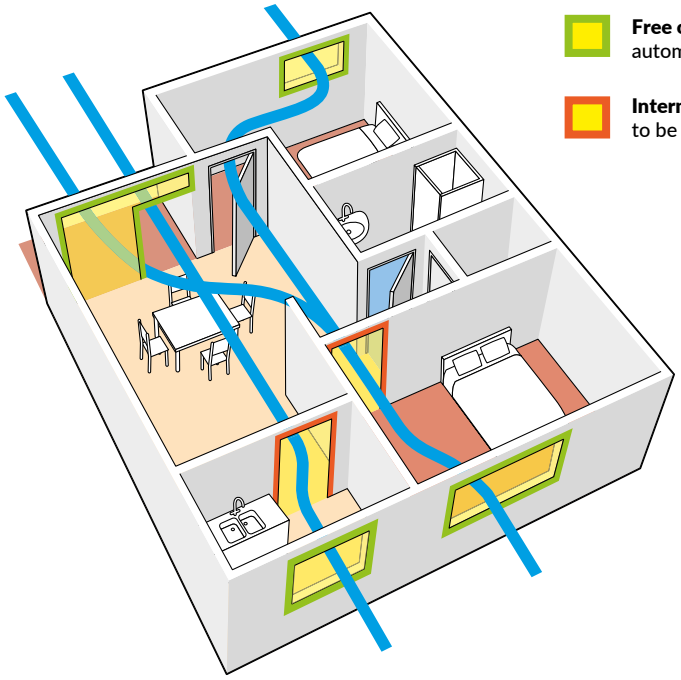
- A_{eq}: equivalent free opening surface in m²;
- $A_{windward}$: free opening surface of the orientation to the dominant wind, in m²;
- $A_{teeward}$: free opening surface of the orientations outside the dominant wind, in m²;

$$A_{eq} = \frac{1}{\sqrt{\frac{1}{A_{windward}^2} + \frac{1}{A_{leeward}^2}}}$$

The equivalent surface is calculated successively on the direction of the dominant wind, then according to the crosswise direction. The structural openings with a horizontal orientation (roof window) are never accounted for.

EQUIVALENT SURFACE IN THE INTERIOR PARTITIONS

The housing unit's interior partitioning restricts the flow rate of natural ventilation. It is taken into account through a single magnitude corresponding to the section of the most limiting air passage. This magnitude, expressed in m², has to be calculated by the user based on the housing unit's architectural plan, with the doors in the open position.



Free opening surface of the façade
automatically calculated from the structural openings

Internal opening surface
to be calculated manually

Figure 3: Air flow circuit

CALCULATION OF THE AIR FLOW RATE

The general calculation formula is as follows:

CLARIFICATIONS ON THE CALCULATION

- Q: natural ventilation flow rate created by the wind on the façade, in m3/(h.m²floor);
- V: speed of the wind in m/s;
- SPL: Surface area, in m²;
- A_{eq}: equivalent free opening surface, in m²;
- k : conventional coefficient of the speed caused by turbulence, without dimensions, generally taken at 1.5;
- dCp : pressure coefficient corresponding to the natural ventilation configuration, without dimensions. This varies according to the distribution configuration of the openings on the faces, relative to the direction of the wind considered.

$$\frac{Q}{V} = k \cdot 2160 \cdot dCp^{0,5} \cdot \frac{1}{SPL} \cdot A_{eq}$$

The formula can differ in the limit configurations such as non-cross through housing units.

In the meteorological file of Guadeloupe, the direction of the wind is, at each time step of 1h and per convention, at 80% according to the dominant direction (East) and at 20% according to the crosswise direction. Overall, the wind rose is complied with. For this reason, the flow rate Q is calculated successively on the direction of the dominant wind, then according to the crosswise direction. The two flow rates obtained are then added.

CALCULATING THE AIR SPEED IN THE HOUSING UNIT

Passing from the interior air flow rate to the interior air speed is impossible to do in a precise way without a fine modelling of the housing unit and of its interior partitioning, including the furniture. The approach is therefore conventionally simplified, by considering an "average section" of the housing corresponding to a rectangle with a width of $\sqrt{S}$ and a height Hzone.

CLARIFICATIONS ON THE CALCULATION

- V_{int}: average interior air speed, in m/s;
- Q: interior airspeed in $m^3/h/m^2$floor;
- S: surface area of the housing unit;
- $k_{turbulence}$: amplification coefficient of the speed caused by turbulence, (without dimension);
- H_{zone}: floor height conventionally set to 2.5 m.

$$V_{int} \sim \frac{k_{turbulence} \cdot Q \cdot S}{3600 \cdot H_{zone} \cdot \sqrt{S}}$$

In addition to the simplification of the interior aeraulic phenomena, one must remain aware of the limits of this restricted approach to the building, which does not take into account the wind modulations in the area around the building.

"Taking natural ventilation into account in the public policies on the quality of construction is always an issue, whether concerning average requirements or on the requirements for results. In addition to the architectural characteristics of the project, the location site of the building plays a major role in the ventilation potential. This subject must therefore also be treated with other means on the scale of the site"
Lucie CHEVER, Ministry of ecological transition

CLIMATE AND MICROCLIMATES

The "RTG" calculation method requires having a typical meteorological data file, with a time stamp of 1 hour.

REQUIRED MAGNITUDES

- Te: temperature of exterior air in °C;
- W: absolute humidity in g/kgdryair;
- dir_N: normal direct solar radiation in W/m²;
- diff_H: diffuse solar radiation in W/m²;
- T_sky: temperature of the sky in °C;
- T_water: temperature of the cold water in °C;
- V: intensity of the wind in m/s.

Ideally, a complete file should be available for any potential construction site, which is obviously not possible. Guadeloupe has only one reliable meteorological station and that includes all of the required magnitudes (Raizet airport, altitude 0). The principle implemented therefore consists in using a single meteorological file and adapting it to the site concerned by adjusting the most sensitive magnitudes to the location:

- Sunlight is assumed to be uniform over the island, which is not rigorously true due to relief around which the nebulosity is more substantial.
- Absolute humidity is assumed to be uniform on the island, but the relative humidity is calculated and varies according to the temperature.
- The temperature is corrected for the altitude, according to a formula that takes into account the temperature gradient observed locally by Météo France (french national meteorological service).
- The speed of the wind is modulated by a coefficient, according to a map of the local microclimates.

The map of microclimates was developed by using a modelling of the wind on Guadeloupe from the effects of the roughness. The map of the winds was established according to a fine meshing, then a zoning at the communal scale was proposed, which showed three zones: zone windward (maximum wind), zone leeward (minimal wind) and continental zone (intermediate wind).

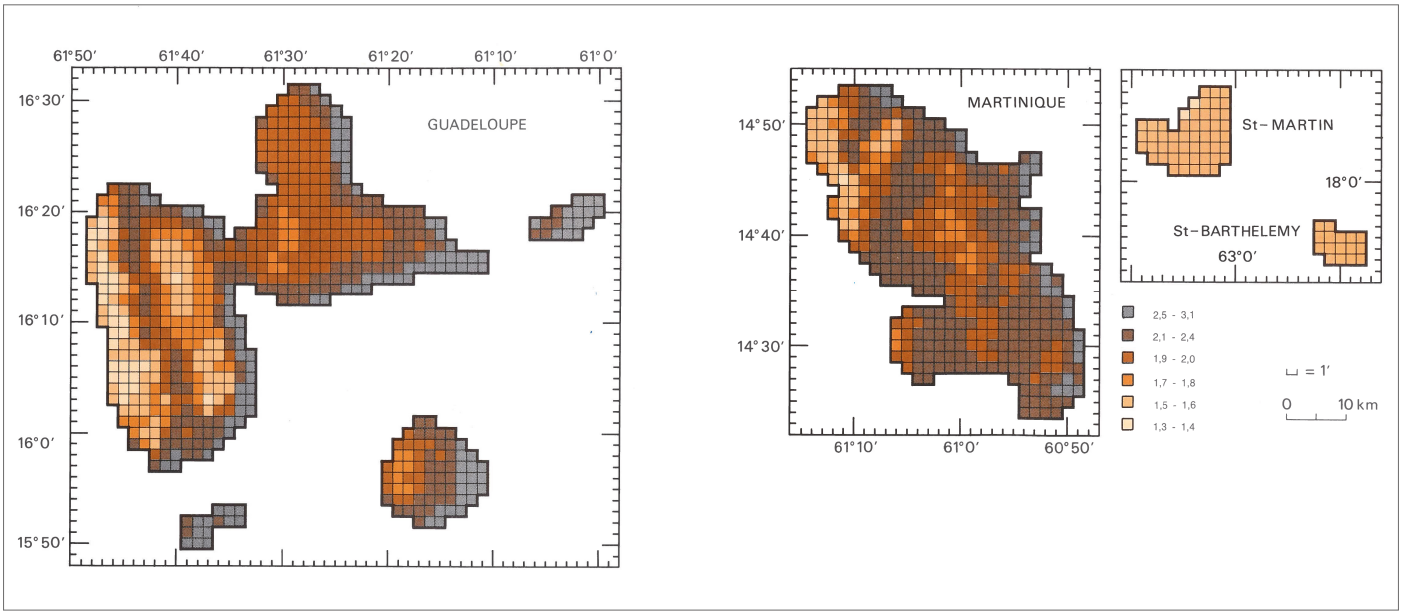


Figure 1: Map of the microclimates

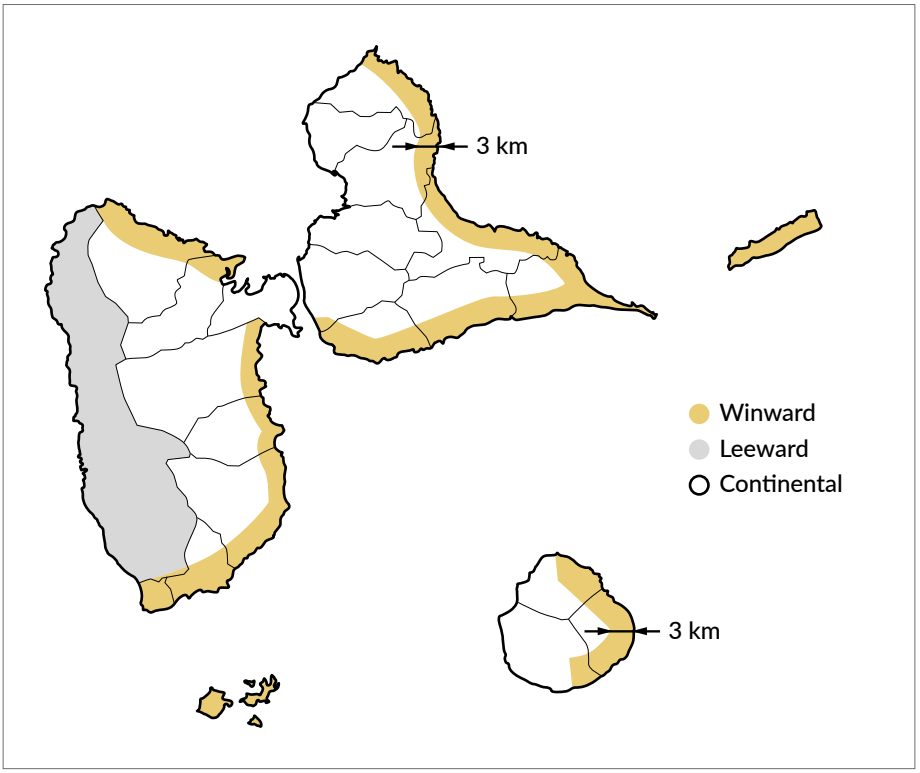


Figure 2: Wind zones

USAGE SCENARIOS: THE CONVENTIONAL MAGNITUDES

The usage scenarios correspond to the input data of simulations that describe the occupant's behaviour in the building.

PRESENTATION

So that the additional evaluation covers the intrinsic performance of the building, these scenarios must be set conventionally. Then, they can no longer be modified by the user who can no longer use these variables to influence the performance calculation.

They primarily include:

- **The occupation**
  - the occupation density of the building;
  - the presence scenario: occupation rate for each hour of a typical week;
  - the holiday scenario: weeks of inoccupation.
- **The physical magnitudes directly deduced from the occupation:**
  - the internal heat and humidity gains;
  - the opening status of the windows (open during the hours of non-air-conditioned presence);
  - the status of the lighting;
  - the ICT indicator is calculated only on the hours of presence.
- **The behaviour of the occupants:**
  - the status of the air conditioning;
  - the air conditioning setpoint (currently set to 24°C in the "RTG");
  - the needs of Domestic Hot Water (DHW).

APPROACH

The usage scenarios are defined specifically for each usage typology of the buildings.

Experience shows that the choice of these conventions is not neutral in the trends displayed by the calculation tool. However, these same conventions are applied indifferently to the project calculation and the reference. It can indeed modify the relative importance of different phenomena. For the purpose of illustration, if the conventional temperature for the air-conditioning setpoint is lower, the interior/exterior temperature gradient is higher. Consequently, the thermal insulation of the façade has more impact on the regulatory indicator (here: BBIO).

The most satisfactory definition method consists of using statistical observation data on the set of buildings and occupants.

This approach can be advantageously supplemented by a study of the sensitivity of the regulatory indicators to the conventional magnitudes.

A third approach consists of displaying a highly virtuous usage scenario, with the desire to encourage the occupants to follow this example. The use of the building indeed constitutes a source of saving energy. This practice was often used, particularly in the RT 2012, which, "recommends heating at 19°C". This is of course a political stance, but which (as explained hereinabove) will have harmful consequences on the relevance of the calculation.

CASE STUDY OF RTG 2020 BUILDINGS

BUILDING WITH COLLECTIVE HOUSING UNITS

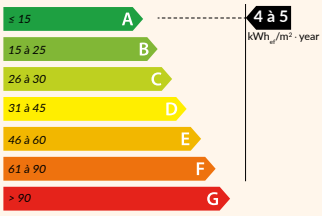
NEW CONSTRUCTION

IDENTITY

- **Type of building:** Collective Housing unit
- **Date of publication:** 6 May 2021
- **Location:** 97111 Morne à l'eau
- **Architect:** Véronique HIRTH
- **Climate zone :** Continental
- **Floor area of the building:** 360 m²

DPEG CLASSIFICATION

between 4 and 5 $kWh_{ef}/m^2 \cdot year$ (differs by dwelling)



RE & ENERGY SYSTEMS

- **No air conditioning**
- **100 % solar Domestic Hot Water (DHW)**
- **Presence of reservations for ceiling fans**

GOOD PRACTICES

- Ventilated horizontal and vertical walls offer effective solar protection
- Shade effect provided by the balconies

EXPLANATORY NOTE

Le Grippon is a collective housing units, a T4 and three T2 on the ground floor, as well as three other T2 on F+1. This building has the particularity of having **an envelope that is particularly effective against solar radiation**.
First of all, the attic space is naturally ventilated by air inlets and outlets. The opaque walls of the façades are also ventilated via the circulation of an air gap between the interior skin and the exterior skin.
Large balconies and roof eaves also create shade effect on the front façade of the housing unit and therefore additional protection against solar radiation.
The passageways and the roof eaves play a role in horizontal solar shading for the façades and glazings.
The designer has opted for crosswise ventilation along the North/South axis. This choice has the advantage of avoiding large structural openings on the East and West façades which receive a lot of sunlight. The solar shading of the façades of the South and North structural openings is also easier to carry out with horizontal shadings such as roof eaves, exterior passageways or caps
Thanks to excellent solar shadingas well as a reasonable capacity to naturally ventilate the rooms, the housing unit does not require air conditioning in order to offer acceptable comfort (as shown by the low values of ICT/ICT_max). **The presence of reservations or ceiling fans offers the possibility to add an additional thermal comfort element, for the hottest days or in the absence of wind.**
The housing units are equipped with thermal solar panels system that cover 100% of the DHW needs.

THERMAL PERFORMANCE

Roof:

- U_{roof} = 0.49 W/m² · K
- S_{roof} = 0.007

Façades (opaque parts):

- $U_{façades}$ = 3.27 W/m² · K
- $S_{façades}$ = 0.05

Structural openings (solar shading deployed):

- $So_{opening\_bedroom}$ = 0.09
- $So_{opening\_living\ room}$ = 0.48

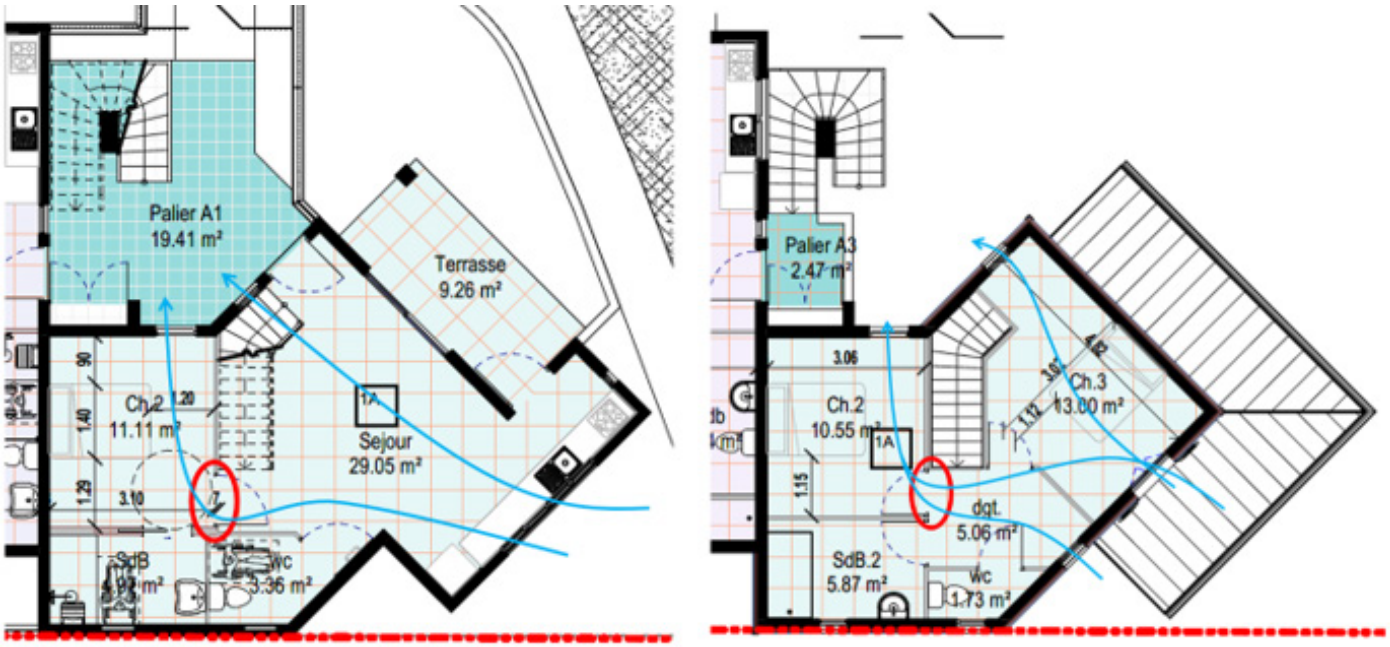
ICT/ICT$_{MAX}$ for T4 :	ICT/ICT$_{MAX}$ for R+1 T2 :
56%	58%
ICT/ICT$_{MAX}$ for RdC T2 :	PRECS
49,30%	0%

Reminder: *The lower the values are, the better the building perform.*

U = *Heat transfer coefficient of a wall, expressed in W/m².K. Characterises the quantity of heat passing through a wall in permanent regime, per unit of time, per surface unit and per temperature difference unit between the atmospheres located on either side*

S = *Solar factor of a wall, expressed by a coefficient between 0 and 1. The solar factor of a wall is the ratio between the energy due to the solar radiation transmitted and the energy received by the wall.*

PLAN : BUILDING "LE GRIPPON"



CASE STUDY OF RTG 2020 BUILDINGS

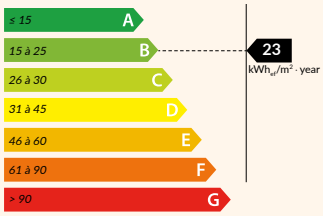
INDIVIDUAL HOUSE: LOCALISATION LAMENTIN

NEW CONSTRUCTION

IDENTITY

- **Type of building:** Individual house
- **Date of publication:** 7 July 2021
- **Location:** 97129 LAMENTIN
- **Architect:** Jacques SEBERT Architecture Studio
- **Design office:** GreenAffair
- **Climate zone :** Continental
- **Floor area of the building:** 94m²

DPEG CLASSIFICATION



RE & ENERGY SYSTEMS

- **Cooling:** Split System A+++ Air Conditioning in the night zone
- **Passive comfort:** Ceiling fans in the day zone
- **100% solar DHW**

GOOD PRACTICES

- Large openings oriented towards the wind for effective natural ventilation
- Shading effects by eaves and loggia on the East façade (19% opening rate)

EXPLANATORY NOTE

This individual house comprising 3 bedrooms is representative of a Guadeloupe's Building Energy Efficiency Regulation "RTG 2020" house.
The night zone is equipped with an air conditioning system, but **all the living areas are designed to allow for effective passive cooling via natural ventilation, without recourse to air conditioning**, in particular by setting up structural openings with a large surface. Most of the three opening surfaces (air flow in surface in the structural openings) exceed 1 square meter. The largest opening services are located on the East (in the dominant wind) and North faces. **Ceiling fans installed in the living room and the kitchen effectively complete the natural ventilation scheme.**
The building has **an effective protection against solar radiation**. The roof, which is the facade that is most exposed to the sun, is white and insulated by 60 mm of rock wool. **The façades are of a light colour: yellow, white and light red, in order to benefit from a low alpha absorption coefficient.**
Roof eaves are present over the entire periphery of the building. They improve the building's solar shading by creating a shading effect against direct radiation.
The East façade is both highly exposed to the sun and the dominant winds. The designer has chosen to place a large structural opening there in order to facilitate natural ventilation, while still reinforcing the solar shading of this façade via a loggia that makes it possible to create a very substantial shading effect. The West façade, the most exposed to the sun's rays, only has one glazed wall in order to limit the rise in temperature in the rooms. **Opaque blinds are also present**; they regulate the passage of light in the living areas, allowing for natural ventilation while still limiting solar gains.
This individual house is equipped with a thermal solar equipment for DHW, but does not have photovoltaic system.

THERMAL PERFORMANCE

Roof:

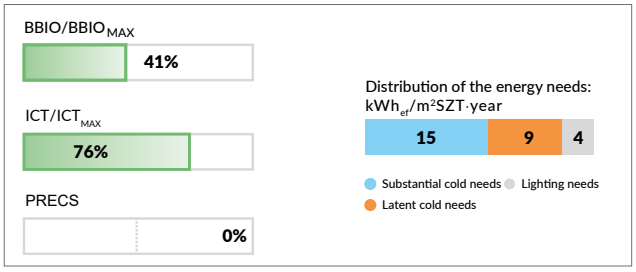
- U_{roof} = 0.61 W/m² · K
- S_{roof} = 0.009

Façades (opaque parts):

- U_{walls} = 3.35 W/m² · K
- S_{walls} = 0.53

Structural openings (solar shading deployed):

- $So_{kitchen}$ = 0.06
- $So_{living\ room}$ = 0.009



Reminder: *The lower the values are, the better the building performs.*

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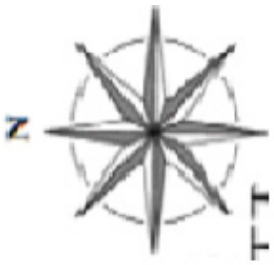
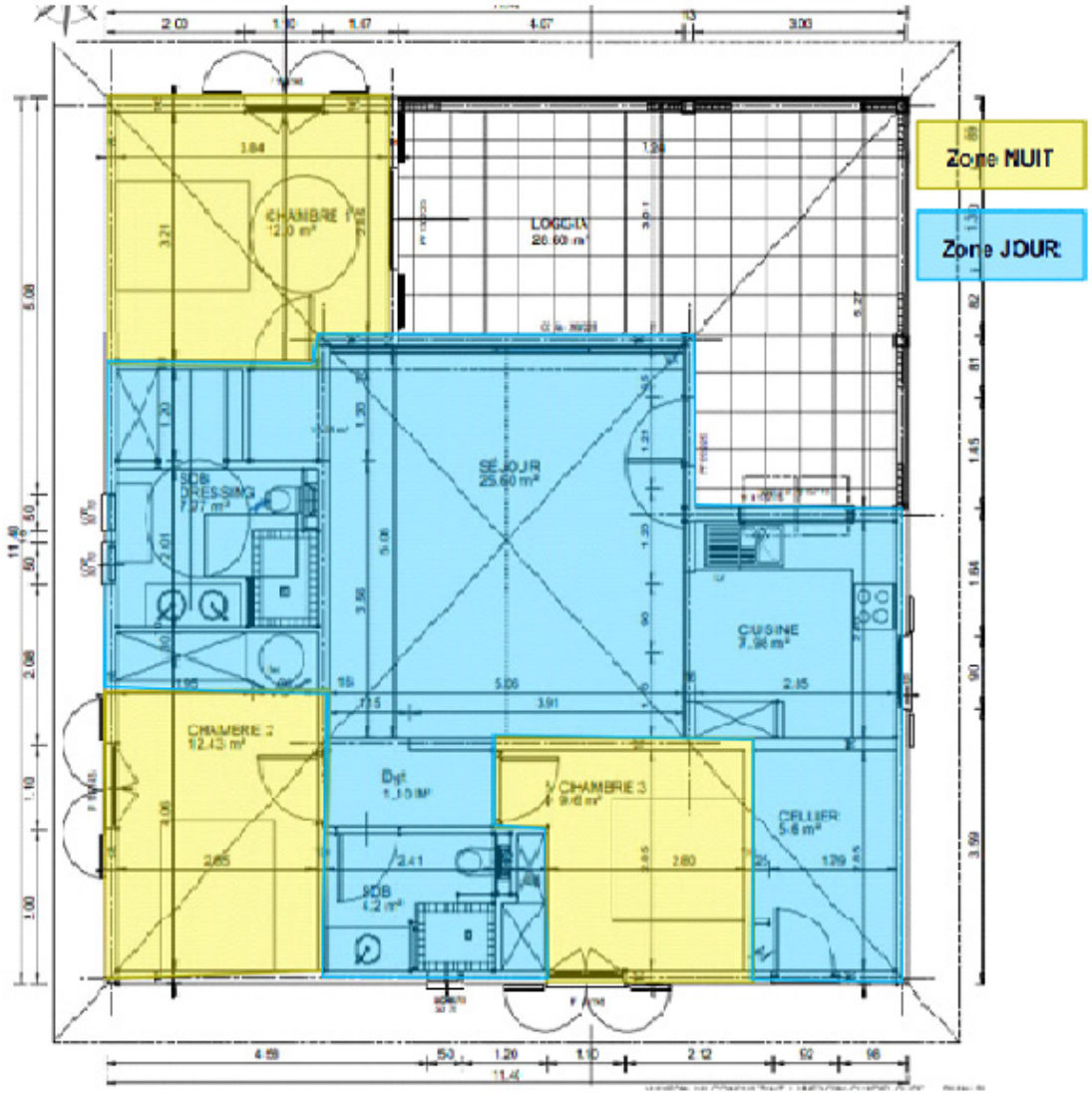
PLAN : INDIVIDUAL HOUSE LOCATED IN LAMENTIN





CASE STUDY OF RTG 2020 BUILDINGS

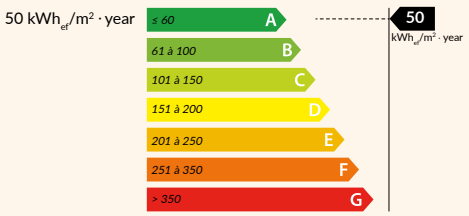
OFFICE BUILDING: HEADQUARTERS OF CASTEL & FROMAGET

NEW CONSTRUCTION

IDENTITY

- **Type of building:** Offices
- **Date of publication:** 11 February 2021
- **Location:** 97122 BAIE-MAHAULT
- **Architect:** Olivier GROS-DUBOIS
- **Design office:** ENERGAYA
- **Climate zone :** Continental
- **Floor area of the building:** 295 m²

DPEG CLASSIFICATION



RE & ENERGY SYSTEMS

- **Cooling:** Split System A+++ Air Conditioning
- **No DHW**

GOOD PRACTICES

- A limited opening rate to reduce solar gains (13 m² to the South)
- Optimisation of natural lighting
- Light colour and insulated exterior walls

EXPLANATORY NOTE

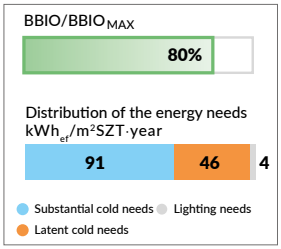
The headquarters of CASTEL & FROMAGET is a F+1 building receiving offices upstairs and a car park on the ground floor. It is therefore the upstairs that is the subject of an optimisation in energy performance. As the offices are air conditioned, the challenge was to minimise the electricity consumption required for the cooling.
The façade has few glazed surfaces in order to limit solar gains while still allowing for natural lighting. The structural openings are all provided with solar shading constituted of exterior sunscreens. According to the simplified calculations performed on the RTG/DPEG platform, 50% of the working areas can operate with natural lighting, which limits the lighting consumption to 2.75 W/m².
The volume occupied by the offices is thermally insulated, at its roof and its façades. The exterior surfaces that open onto this volume are white, therefore with an excellent alpha coefficient.
The air-conditioners, A+++ ranking and have excellent energy efficiency.
In the end, with a relatively simple architecture, the solar factors linked to the envelope are low and a BBIO score at 80% of the BBIOmax is achieved with a controlled structure and cost.

THERMAL PERFORMANCE

Roof:
- U_{roof} = 0.31 W/m²·K
- S_{roof} = 0.007

Façades (opaque parts):
- U_{GF} = 4.17 W/m²·K
- S_{GF} = 0.1
- U_{F+1} = 0.36 W/m²·K
- S_{F+1} = 0.005

Structural openings (solar shading deployed):
- So_{SOUTH} = 0.06



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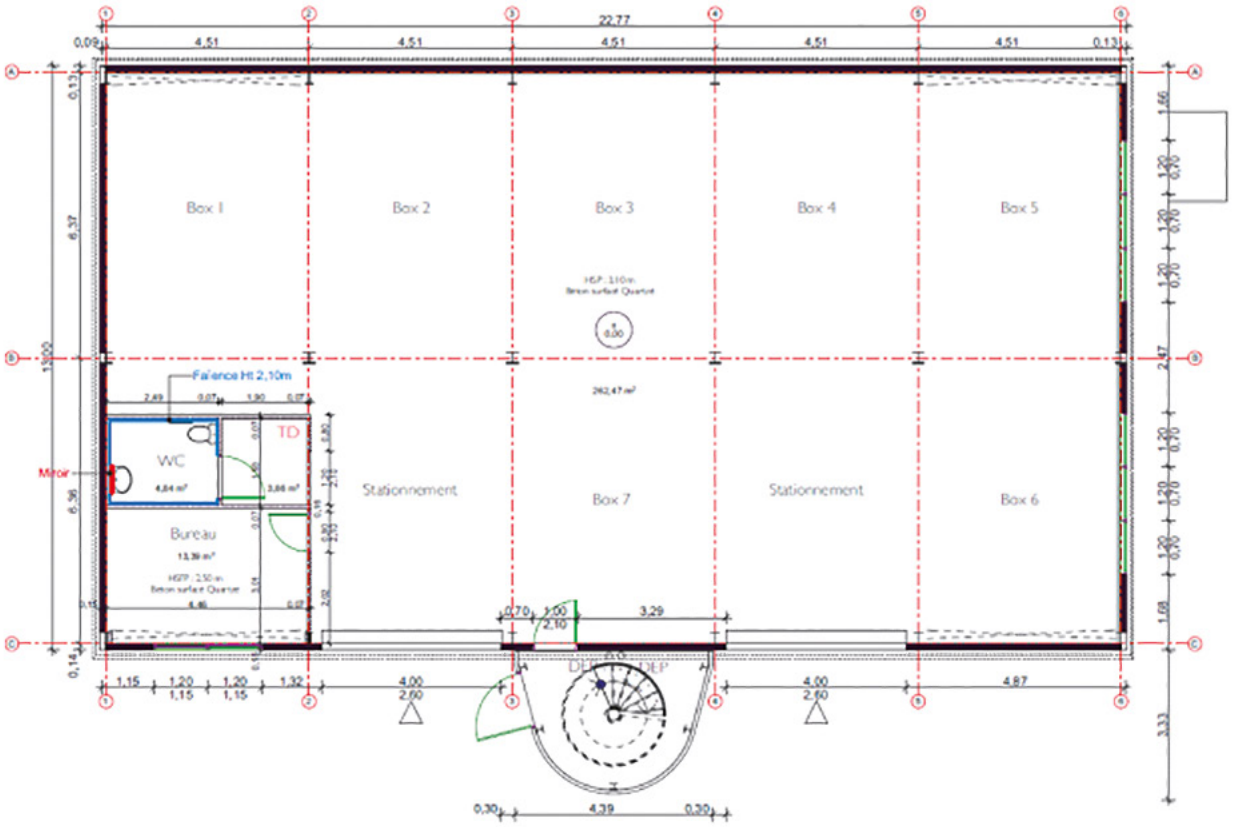
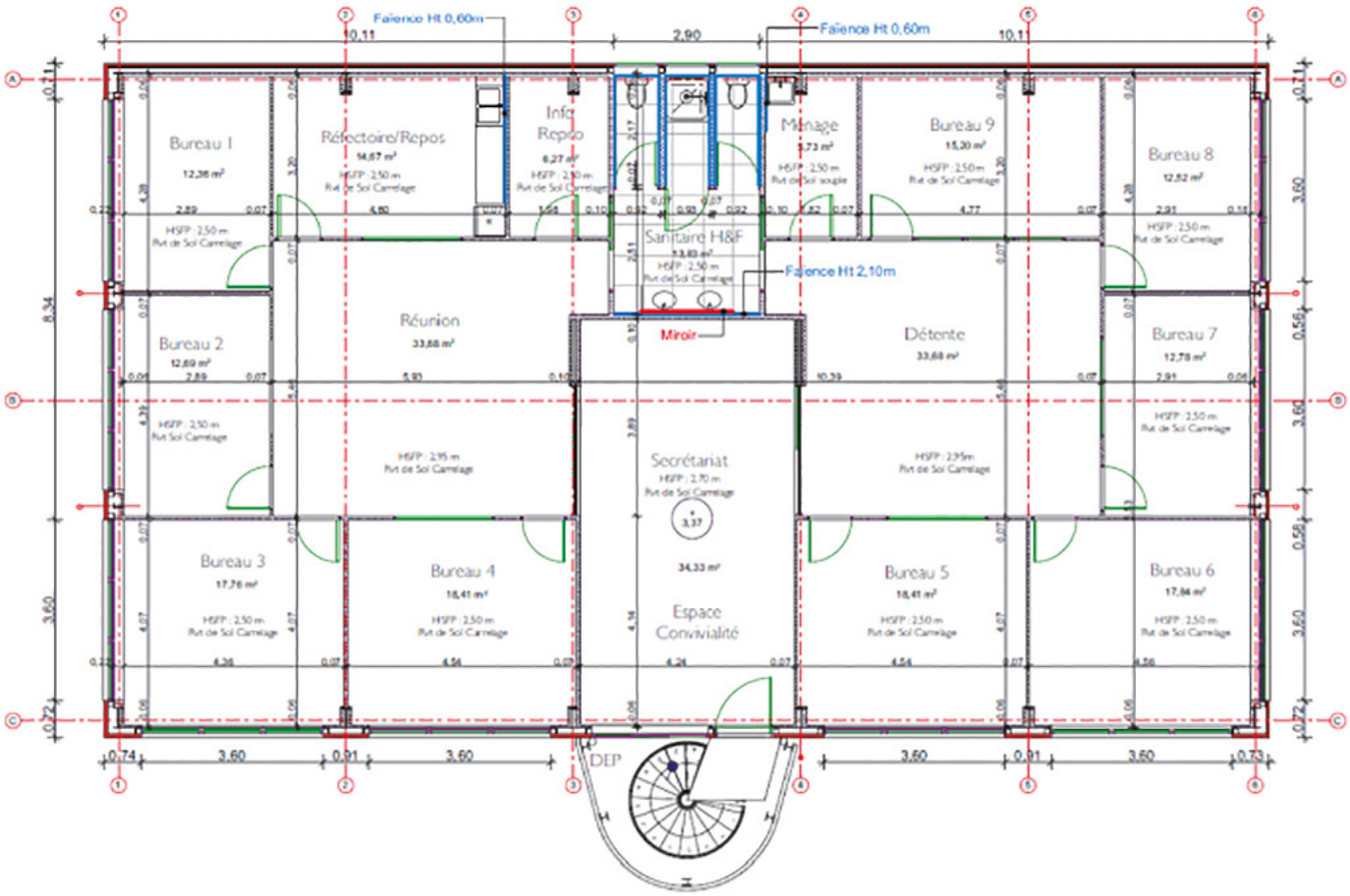
PLAN : OFFICE BUILDING –HEADQUARTERS OF CASTEL & FROMAGET

Niveau RDC



Niveau R+1



CASE STUDY OF RTG 2020 BUILDINGS

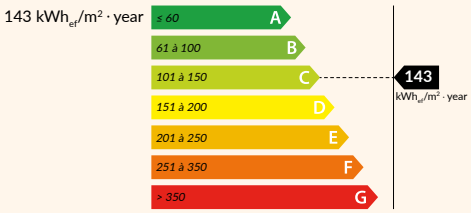
SHOP BUILDING: BOUTIQUE OF THE "JARDIN DE VALOMBREUSE"

RETFOFITTING PROJECT

IDENTITY

- **Type of building:** Shops
- **Date of publication:** 11 July 2020
- **Location:** Chemin de Valombreuse
  97170 PETIT-BOURG
- **Architect:** Olivier GROS-DUBOIS
- **Design office:** ENERGAYA – Conformité RTG
- **Climate zone :** Continental
- **Floor area of the building:** 120 m²

DPEG CLASSIFICATION



RE & ENERGY SYSTEMS

- **Cooling:** Split System A++ Air Conditioning
- **No domestic hot water**

GOOD PRACTICES

- Presence of green spaces (shagind effect) at the approaches to the building
- Use of exterior solar shading to combat overheating
- Optimisation of natural lighting
- Efficiency of air conditioning
- Thermal insulation of vertical walls and roof reducing thermal inputs and improving thermal comfort of the building occupants

EXPLANATORY NOTE

"Le jardin de Valombreuse" classified as a commercial building under Guadeloupe's Building Energy Efficiency regulation "RTG". It houses the ticket office and boutique of a botanical garden.

One of the difficulties that is generally encountered by designers of buildings for commercial use is the designing of the structural openings which have to reconcile solar shading and visibility of the shop windows. Here, this problem was resolved **by carrying out large roof eaves that form caps on the South-West and North-East façades.** The shading effect produced is substantial because the caps have a length of over two metres. Also note that the roof eaves are equipped with vertical strips that provide additional solar shading on the roof. This strip has the shape of a part added at the upper end of the façade, 57 cm high, along the gutter line, in order to hide the box gutter and the eaves of the roof.

The vertical walls and the roof are insulated so as to keep the cool inside the building. The glazings at the entrance and exit of the shop provide **natural light which limits recourse to artificial lighting**: the calculation shows the need of 5.37 W/m³ for artificial lighting.

As the West façade is the most impacted by direct radiation, the designer chose to limit the glazed surfaces in order to prevent solar gains. **Peripheral vegetation provides additional solar shading**, but these masking effects are not accounted for in the regulatory calculation.

The air conditioning has an A++ energy label.

THERMAL PERFORMANCE

Roof:

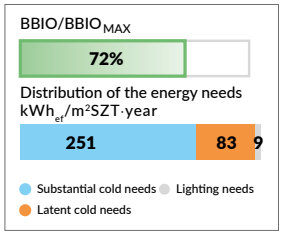
- U_{roof} = 0.59 W/m² · K
- S_{roof} = 0.01
- $U_{terrace}$ = 0.56 W/m² · K
- $S_{terrace}$ = 0.018

Façades (opaque parts)

- $U_{façades}$ = 0.52 W/m² · K
- $S_{façades}$ = 0.016

Structural openings (solar shading deployed):

- $So_{S/E}$ = 0.67



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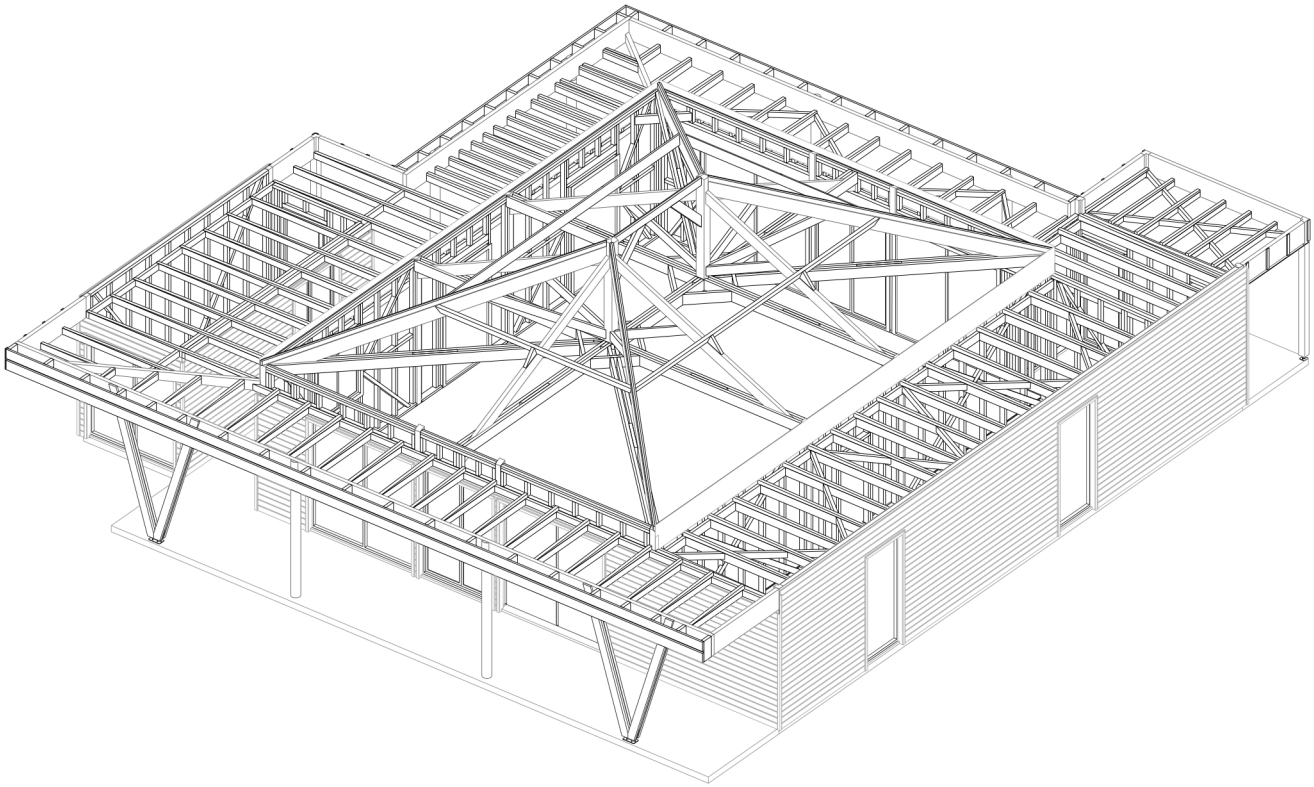
PLAN AND PHOTOGRAPHS OF THE BOUTIQUE OF THE "JARDIN DE VALOMBREUSE"



JARDIN DE VALOMBREUSE PARC FLORAL DE GUADELOUPE	Département de la GUADELOUPE Commune de PETIT-BOURG Jardin de Valombreuse	Maître d'Ouvrage SAS Jardin de Valombreuse 36, rue des Chapelle - ZI Jarry 97122 Baie-Mahault Tel : 0690 32 73 30	AC 09	Maître d'Oeuvre Olivier Gros-Dubois SELARL d'ARCHITECTURE Impasse Samana - Convenance 97122 BAIE-MAHAULT Port : 0690 556999 email : ogd2@wanadoo.fr	Axono Structure	DPC 25 Mai 2019 PRO 9 Septembre 2019 DCE 25 Novembre 2019 **DCE 5 Janvier 2020**

Green spaces around the building

View of roof eaves that form caps

Main shop window shaded by roof eaves

Shading effect induced by the vegetation on the north façade

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ABBREVIATIONS

GUADELOUPE
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ALPHA	Thermal absorption coefficient for a surface exposed to the sun, expressed by a coefficient between 0 and 1
AMO	Assistance à Maîtrise d'Ouvrage (Project Management Assistance) (at the Energy department of the Guadeloupe region). For the development of the RTG, it is comprised of CSTB, Suez conseil, and law firms Bird&Bird, Huglo-Lepage, and Tailor & Wessing
BBIO	Bioclimatic need indicator, used in the RTG calculation, unitless
C	Consumption indicator, used in the DPEG calculation, expressed in kWh/year
CESI	Individual solar water heater
CFD	Computational Fluid Dynamics
CGCT	Code général des collectivités territoriales (General local authorities code)
CSTB	Centre Scientifique et Technique du Bâtiment (Scientific and Technical Centre for Buildings) – www.cstb.fr
HVAC	Heating, ventilation and air conditioning equipment
DEAL	Direction de l'Environnement, de l'Aménagement et du Logement (Directorate of the environment, planning and housing) This administration is the local representation of the services of the State
DPEG	Diagnostic de Performance Énergétique (Energy certificate) – Guadeloupe, developed in the framework of the local thermal regulation scheme
DHW	Domestic Hot Water
EPBD	The Energy Performance of Buildings Directive (EPBD) is the European Union's main legislative instrument aiming to promote the improvement of the energy performance of buildings within the Community. It was inspired by the Kyoto Protocol which commits the EU and all its parties by setting binding emission reduction targets.
GHG	Greenhouse gas
HVAC	Heating Ventilation Air Conditioning
ICE	Indicateur de consommation énergétique (Energy consumption indicator), used in the DPEG, expressed in kWhef/m^2/year
ICT	Indicateur de confort thermique (Thermal comfort indicator), used in calculating the RTG of housing units, expressed in °C
JO	Official Journal of the French Republic
JSON	Data export format
MDE	(Comité de) Maîtrise de la Demande d'Électricité (Electricity demand control (committee)) To act more efficiently and accelerate the energy transition of Guadeloupe, the Guadeloupe region, the services of the State and the grid manager have formed the MDE committee. This committee is in charge of developing and monitoring the actions for controlling the energy demand in Guadeloupe
MOA	Maître d'ouvrage (Project Management)
OREC	Observatoire régional de l'énergie et du climat (Regional observatory on energy and climate)
BP	Building permit
PRECS	Portion of the DHW energy needs taken from the power grid, expressed as a %
PRERURE	Plan Régional des Énergies Renouvelables et de l'Utilisation Rationnelle de l'Énergie (Regional plan for renewable energies and the rational use of energy). Adopted in Guadeloupe in 2008
PV	Production of electricity from solar photovoltaic panels
RE 2020	Thermal and environmental regulation for new constructions, in effect in metropolitan France since 2021
RT	Réglementation Thermique (Thermal Regulation)
RT 2012	Thermal regulation for new constructions, in effect in metropolitan France from 2012 to 2021

RTAADOM	Thermal, acoustic, aeration regulation specific to the five overseas départements, with obligations of means. It became effective in 2009, was revised by the French State in 2016 and was abrogated in Guadeloupe in 2020
RTex	Thermal regulation for renovations of existing buildings , in effect in metropolitan France since 2007
RTG	Réglementation Thermique de Guadeloupe (Thermal regulation of Guadeloupe): designates the complete regulatory scheme developed locally by the regional council of Guadeloupe
SARE	Service à la Rénovation Énergétique (Energy renovation service): support system for owners in the thermal renovation of buildings
S	Solar factor of a wall, expressed by a coefficient between 0 and 1. The solar factor of a wall is the ratio between the energy due to the solar radiation transmitted and the energy received by the wall. This wall can be of any type, opaque (S) or glazed (S0)
ST	Solar hot water production (in particular from CESI)
THBCE	Method for calculating the RT 2012
U	Heat transfer coefficient of a wall, expressed in $W/m^2.K$. Characterises the quantity of heat passing through a wall in permanent regime, per unit of time, per surface unit and per temperature difference unit between the atmospheres located on either side

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BIBLIOGRAPHICAL APPENDICES AND USEFUL LINKS

WINDOW VIEW OF PARADISE IN GUADELOUPE
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1. Guadeloupe Building Energy Policies portal "RTG" (Guadeloupe énergie)
2. RTG/DPEG online calculation platform
3. Regulatory text “RTG 2020 calculation” for new constructions (JO, 2020)
4. DPEG 2020 Regulatory text (JO, 2020)
5. Regulatory text “Solar DHW” (JO, 2020)
6. Regulatory text “air conditioner performance” (JO, 2020)
7. Regulatory text “feasibility studies” (JO, 2011)
8. Regulatory text “air conditioner system inspection” (JO, 2020)
9. EPBD: Directive 2010/31/EU of the European parliament and of the council of 19 May 2010 on the energy performance of buildings
10. Application guide for the RTG/DPEG calculation platform
11. Example of a RTG compliance attestation
12. Example of a DPEG attestation
13. Example of a RTG consultation dossier (Guadeloupe region, 2012)
14. Example of a consultation note of the stakeholders (Guadeloupe region, 2018)
15. FAQ Frequently asked questions (Guadeloupe region, 2020)
16. DPEG diagnostician certification, specifications (Guadeloupe region, 2020)
17. Verified thermal characteristics, specifications (Guadeloupe region, 2014)
18. “Exemplary building” calls for projects, specifications (Guadeloupe region, 2017)
19. GEPETO guide (CSTB, 2019)
20. PRERURE, final report (EXPLICIT, 2009)
21. Mapping of the winds in Guadeloupe and Martinique (CSTB, 1989)
22. Technical state of the situation of the buildings in Guadeloupe (CSTB, 2010)
23. Thesis on “Public policies on the performance of overseas buildings” (L. CHEVER, 2017)
24. Analysis report on residential buildings in Guadeloupe (OREC, 2017)
25. Analysis report on tertiary buildings in Guadeloupe (OREC, 2017)
26. Energy-Efficient buildings in the West Indies (AQC, 2020)
27. Presentation brochure of the RTG (Guadeloupe region, 2011)
28. Presentation brochure of the RTG (Guadeloupe region, 2013)

SUMMARY

Empower Your Caribbean Future with Building Energy Efficiency! In our unique tropical and island territories, this issue is of paramount importance. Public authorities have both incentivizing and binding levers to act on new constructions as well as existing buildings. In this exclusive guide, Guadeloupe shares ten years of experience in implementing innovative thermal regulations for buildings. You will discover the challenges encountered during this regulatory process and be invited, as policymakers and industry professionals, to envision it within your own context. Keeping in mind the ideal profile of the high-performing buildings of tomorrow, new constructions are regulated by a comprehensive framework comprising texts, methods, and verification tools to achieve overall initial performance. The key processes of development, implementation, and continuous improvement are explained in detail, and you will be directed to seventeen comprehensive technical fact sheets. As for existing buildings, establishing a performance diagnosis is one of the flagship measures implemented, aiming to reveal the actual performance of these structures. Regular consultation with professionals ensures full ownership of these issues, as well as a concrete consideration of on-the-ground realities, to continuously enhance our regulations. The impacts of this regulatory approach are now measurable, not only on the real estate sector but also on the expertise of Guadeloupean professionals. So, come aboard with us towards a more efficient and sustainable energy future for the Caribbean! Seize this opportunity to actively participate in the transformation of our region by adopting environmentally-friendly construction practices and promoting building energy efficiency. Together, we can build a greener, more economical, and more resilient future for our magnificent Caribbean region.

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