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Energy efficiency in the envelope of existing building

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Declaration

I, BENYELLES Hakim , hereby declare that this thesis represents my personal work, realized to the best of my knowledge. I also declare that all information, material and results from other works presented here, have been fully cited and referenced in accordance with the academic rules and ethics.

Signed: 15 .... august .... - 2018

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Abstract

The world is in perpetual evolution, this evolution is due to the man in order to obtain a comfort and to facilitate his life, he comes to consume a lot of energy, thus causing an environmental degradation.

The most energy-consuming sector is the building sector, which accounts for one-third of the total world consumption, and this exponential consumption reflects the need of the human being in terms of comfort. The more we consume, the more we release greenhouse gases and the more our bills go up; be it energy consumption bills or the ones we pay on taxes that have recently been put in place for governments with a high rate of CO2 emissions.

So to reduce these bills, we must reduce our consumption, and for this we must improve the way we consume while keeping this comfort of which we can not have passed.

Since the building sector represents a large volume of energy demand, by improving it we will have a great opportunity for economic gain.

The choice of the theme was developed following the new regulations created in Algeria in the field of energy efficiency, we have taken a state building for example to follow in this sector. Among the tools of thermal analysis in the building in Algeria we have the DTR C3.2, C3.4 and C3.31, which include complex mathematical equations as part of the energy audit.

The CT-BAT application is an application based on its regulations, we chose it for our work in order to obtain a detailed analysis of the thermal functioning of our case study, we will then propose applicable solutions for the compared with the existing and bring out feasible proposals and at different costs.

Résumé

Le monde est en perpétuelle évolution, cette évolution est due à l'homme afin de se procurer un confort et de se faciliter la vie, il en vient à consommer énormément d'énergie, provoquant ainsi une dégradation environnementale.

Le secteur le plus consommateur d'énergie est le secteur du bâtiment, il représente le tiers de la consommation totale mondiale, cette consommation exponentielle reflète l'exigence de l'être humain en terme de confort. Plus nous consommons, plus nous dégageons du gaz à effet de serre et plus nos factures augmentent; que ça soit les factures de consommation énergétique ou bien celles que nous payons sur les taxes qui ont été récemment mise en places pour les gouvernements avec un taux élevé d'émission de CO2.

Alors pour réduire ces factures, nous devons réduire nos consommations, et pour cela nous devons améliorer notre manière de consommer tout en gardant ce confort dont nous ne pouvons-nous passé.

Vu que le secteur du bâtiment représente un volume important de demande d'énergie, en l'améliorant nous aurons une grande opportunité de gain économique.

Le choix du thème a été élaboré suite aux nouvelles règlementations créées en Algérie dans le domaine de l'efficacité énergétique, nous avons pris un bâtiment étatique pour exemple à suivre dans ce secteur. Parmi les outils d'analyse thermique dans le bâtiment en Algérie nous avons les DTR C3.2, C3.4 et C3.31, qui englobent des équations mathématiques complexes dans le cadre de l'audit énergétique.

L'application CT-BAT est une application basée sur ses règlementations, nous l'avons choisi pour notre travail afin d'obtenir une analyse détailler du fonctionnement thermique de notre cas d'études, nous allons ensuite proposé des solutions applicables pour ensuite les comparés avec l'existant et ressortir des propositions réalisable et à diffèrent cout.

Acknowledgement

First, I would like to thank warmly my supervisor Prof. Abdellatif Megnounif who never ceased to share his highly qualified advise on the topic and during all the period of supervision.

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1 Introduction

1.1 Introduction:

Today, the theme of energy efficiency, particularly for buildings, has a real development opportunity in the world. The building suddenly becomes a central issue of two major planetary challenges: climate change and energy supply. The building sector in Algeria (residential and tertiary) consumes more than 40% of total energy, compared with 46%1 in Europe, and 19% of CO2 emissions into the atmosphere, compared to 25% elsewhere. This sector represents a huge potential for energy efficiency and reduction of greenhouse gases, since the designer will continue to provide shelter and comfort to the user, but will also need to ensure that the impact of the building on the environment is minimized.

Following the movement of American auto-builders of the sixties who, in the movement of hippie and ecologist movements, laid the groundwork for reflection in this sense, the rise of "solar" and then "bioclimatic" architecture allowed both theorize and concretize this reflection in the normal production of the built environment. The bioclimatic architecture can be defined as "the improvement of the comfort that a built space can induce in a natural way, that is to say, by minimizing the use of non-renewable energies, the perverse effects on the natural environment and the costs of investment and operation. The interest of bioclimatic goes from the pleasure to live or to use a space to the construction economy, making it a fundamental element of the architect's art2.

The evolution of ideas and the concept of sustainable development during the eighties lead to an even more globalized notion that also involves links with health and the management of the various stages of building life (from beginning of construction, until deconstruction). This is called "high building environmental quality". In this broader context, the energy aspects more specifically related to "bioclimatic architecture" remain central.

It is also legitimate to question today the results in terms of architectural and urban production. Indeed, the proven limits of the current modes of development (ecological, financial, economic, societal crisis, etc.) should encourage us to reconsider in depth the objectives and consequently the production models of the framework built. It is likely to work in this direction on innovative ways, respectful of the heritage but will surely influence the references to existing typologies.

The new housing stock of Algeria has more than 7 million homes on January 1st 20073, this significant number continues to increase, does not meet any bioclimatic

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1 (French Strategic Analysis Center "Energy Choice in Residential Real Estate" n ° 172, April 2010.)

2 "(L. Freris et D. Infield, « les energies renouvelables pour la production d'electricite », DUNOD, 2009.)

3 (Source : ONS ; office national des statistiques.)

recommendation, and no longer respects thermal regulations. In the 1990s, Algeria developed several regulatory mechanisms for energy efficiency in habitat. Following a reflection on the active and passive consumption of new housing initiated in 1995, the Ministry of Housing and Town Planning put in place regulatory technical guidelines (DTR) in 1997. These, in particular, determine the reference to heat loss and heat input for new buildings for residential and tertiary use, methods of calculating the limit values of losses and contributions for the indoor climate of the premises and the climatic zonings.

These DTRs were subsequently approved by the Ministry of Energy and Mines and the subject, in 2000, of a decree on thermal regulation in new buildings pursuant to the law on energy management adopted on July 28, 1999.The application of the thermal regulation was to take effect from 2005 and was to allow to reduce by 30% the energy consumption of new buildings, excluding air conditioning. In addition to energy efficiency standards and requirements for thermal insulation in new buildings, the law on the control of energy introduces performance standards electricity, gas and petroleum products, but also the energy efficiency control and the mandatory and periodic energy audit for tertiary sector buildings. This law also provides for the financing of energy management through the establishment of a National Fund, which will allow in particular implementing the various financial incentives provided for in this same law.

In recent years, in Algeria, not only the demand for housing has increased considerably but the way of life has also changed when searching for comfort through the use of new means (appliances, air conditioning, lighting, air and water treatment, cooking etc.), leading to an exponential increase in energy consumption.

The emergence of an ecological awareness of opinion has only been a small step under the pressure of the emergency; it is legible through events such as the Athens Charter, the oil crisis, the Chernobyl disaster, the Rio Conference or the ratification of the Kyoto Protocol, Copenhagen, and recently the Japan disaster. To this end, several countries around the world have rushed to remedy the forcing 'use of energy labels of the building and integrate them into the energy performance diagnosis, or even require, when applying for the building permit. The objective is to move towards low-energy buildings, that is to say 80 or 50 kWh / m2 / year, instead of 300 kWh / m2 / year today4,and arrive at long-term, zero energy or positive energy buildings. On the other hand, in Algeria, it can be said that there is, to date, no technical regulation - even negligible - aimed at the construction of bioclimatic buildings5 but it must be

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4 (SOURCE : WWW. EFFINERGIE.ORG, CONSULTE EN JUIN 2010.)

5 (N.OULED- HENIA, « RECOMMANDATIONS ARCHITECTURALES » ENAG, 1993.)

emphasized, that there were tentative attempts to achieve housing-HPE-high energy performance6 through several wilayas. Faced with this vacuum of regulation, and because of the housing crisis, we witnessed during the 80-90 decades, a massive and unthinking import of industrialized models with high energy consumption and insufficiently mastered by our country.

In our opinion, the realization of energy efficient housing is essential in Algeria, as a compelling need for the control of energy consumption and thinking today of the after-oil. To cope with these future problems, it is therefore necessary to implement several policies: saving energy, increasing energy efficiency, promoting and developing alternative energies, commonly known as "new renewable energies", whose solar photovoltaic, this is the approach of the French association negaWatt7. "Prioritize reducing our energy needs at source while maintaining our quality of life. Better consume instead of producing more”. This negaWatt approach is based on "energy sobriety in our individual and collective uses of energy, energy efficiency in our equipment and means of production of all products and building materials, and in the end, a claimed but controlled recourse to renewable energies ".

The number of people on earth is an ever increasing number, from 1970 to 2017 the world population has almost doubled, we went from 3.6 billion to 7.5 billion, according to UN forecasts in 2050 we will reach the 11 billion still in perpetual increase, this figure more disturbing, in 2015 our global energy consumption according to the international energy agency was 9384mtep CO_2 emissions were estimated by the IEA at 32924MT and it predicts a temperature rise of 2.7 ° C by 2100, in the context of international climate negotiations, all countries are committed to keeping the temperature rise below 2 ° C. To achieve this result, it is essential to refrain from extracting one-third of oil reserves, half of the gas reserves and more than 80% of available coal in the world's subsoil, by 2050.

Is it possible ? Can the man who has sought comfort for decades now do without it?

Can we live without our television without our air conditioner, can we? To save future generations pass us everyday objects that empty our earthly resources?

In my opinion, the answer is no. We cannot, but a solution is possible, a solution that involves a change, in our consumption in waste. It is feasible through the appropriate layout of building structures. The building has become an energy-intensive sector, accounting for almost 40% of overall consumption.

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6 (Programme de 600 logements, lances par l'OPGI, a travers onze wilayas representant les trois zones climatiques : Nord, Hauts Plateaux et Sud, en plus de ce projet, le programme quinquennal 2010-2014 a inscrit la construction de 3000 nouveaux logements HPE et la renovation de 4000 logements existants. Source Aprue.)

7 (www.nagawatt.org, consulté en juillet 2010.)

With the new global regulation of taxes on the emission of greenhouse gases, the bill paid by the state becomes very heavy and this is not the only problem, we also have the effect of the latter on the quality environmental.

These figures have pushed humanity to sound the alarm, something that has prompted researchers to find solutions to change this reality.

As we said before, the building sector is the one that affects the consumption the most and with its control, we control the bill whether individual or state, but keeping the comfort all look.

In some studies, the idea was channeled into several sectors, the source of energy used towards the renewable is a solution, but currently the obstacle we face is the inadequacy of this alternative, its investment and also its technique manufacturing and installation. The other solution to propose which is a more effective solution is the moderation of energy consumption while keeping our comfort to which we are accustomed.

In this research, we focused more on building energy efficiency by improving building insulation.

Algeria has begun to put in place strict regulations to control the energy consumption, through the registration of laws that classifies the building according to thermal efficiency steps. All this allows Algeria to reduce its consumption and taxes bill, and also preserve the bioclimatic and environmental aspect. Its regulations are aimed at energy assessment of the building, which results in an energy audit. This assessment is divided into two parts new and existing building (rehabilitation).

For the new building, the audit is done to know what the choice of material is and even to review the architectural aspect about the volumetric design, opening distribution and check its compliance with the legislation. In the case of non-compliance, it gives us time to react by modifying the material or improving the architectural aspect.

And for the existing building its case is a little tricky, the mode of intervention is complicated since the building is already in place, after the energy assessment we go out the weak links of the building and improve the defective walls by evolving their effectiveness but taking into account its existence.

For this purpose, the project's studies are usually based on the quantification of energy needs of the existing building, subject of the project, including:

The architectural analysis which includes: its situation (to know its environment and its climatic criteria), its details of construction (to establish the failures which tolerates its losses), its orientation, building materials (in order to define their transmission coefficients), and even the distribution which helps us to determine the thermal flux.

Energy analysis: which define the energy needs in relation to the volume of spaces.

Analysis of equipment and devices: in order to propose more effective solutions.

This analysis is done using available softwares such as "TRNSYS" or “CT-BAT” that helps to concretize its problems and solutions.

Our case study is a research laboratory building located at the new pole of the university of Tlemcen. It consists of 3 levels (R + 2) and it contains 4 facades treated by double glazed curtain walls and it is exposed completely without protection from the sun or spaces buffers to keep the energy inside the building.

1.2 Questions

How to reconcile energy measures and preserve the function value during renovations? How to further improve the performance of the old building?

How to define the quantity of the resolutions to be applied in relation to the time, the allocated budget, and the individual economic impact?

What is the policy to adopt to make the project credible in the eyes of the main economic and social stakeholders?

To what extent are governments today able, in a second world, to guide the investment strategies of the actors so that the reduction objectives are achieved while minimizing the total costs incurred?

1.3 Working hypothesis :

The technological advances achieved allow a surface application of new eco-ntelligent materials that constitute an investment quickly depreciable by the expected energy saving rate without altering the function of the building

The definition of the sources of energy loss and the choice of the methods of putting out of state of harm, reduction of thermally influencing equipment.

Promote the intellectual factor of the energy-efficient equipment supplier as well as awareness through interactive incentive prototypes

1.4 Goal:

The objective of this thesis is to highlight the importance of energy efficiency in the building and know its general impact and for that we have gone through stages to better understand the process.

Before we begin our work we must first understand the heat transfer, how a wall exposed to a heat source transmits this heat, why one wall is different from another, and what its parameters are. To have more details it is essential to go through the mathematical equations that are registered in the thermal regulation.

It is divided into three major branches, heat input where we calculate the heat transfer from the outside to the inside, the heat losses to know the rate of energy losses in a building from the inside to the outside and the ventilation of the building. Building, its calculations are based on the nature of the wall, its location and its surface.

After having all the information, we apply them on our case study in order to acquire know-how in the field of the energy audit and to target the points of strength and weakness of our case. Then we go through the rehabilitation of the building in case of nonconformity of the case study.

This learning shows us the importance of, at the same time, the energy audit and the efficiency in the building, finally to build according to the thermal regulation to maximize the energetic gain.

So the importance of this work is to guide the architects towards the right path of an energy efficient design after having the certainty of the gain that we can have in the follow-up of its regulation

2 Buildings, energy and climate impact

2.1 Introduction

For a long time the earth has been abused by irresponsible behavior and practices, there is no more significant than this print of the 17th century8 to explain the climate change that started long ago. Since the late sixties, humanity has realized that it lives in a finite world with limited resources. After the cries of alarm of a few visionaries, and the warning messages launched by many scientists for decades, even if the populations emitting the most greenhouse gases, seem to slowly become aware of the issues, the information is still fuzzy, discreet, sometimes even contradictory or manipulated.

The revelation of the Minamata disaster in southwestern Japan (poisoning due to the mercury concentration of the sea) between 1932 until the onset of illness in 1949, and the first oil spills, the industrial revolution, all these could have made our health and what we began to call our environment in danger.

Corrective or preventive measures are, in any case, still very marginal. Despite the fact that oil is currently in tight flux on the planet, and that its price remains high, on the whole, energy is still relatively abundant and cheap. These two characteristics mean that it is largely wasted, even if the awareness of its scarcity and the consequences of the use of fossil fuels on climate change are becoming more and more perceptible in the mentality of the most consumer-minded individuals, those of the so-called "developed" countries. The challenge is significant, however, because it is about meeting the growing needs of the planet's energies and the economic development of the poorest countries, while reducing greenhouse gas emissions, the abundant energy wastes on the planet, are one of the scourges to eliminate.

The triptych composed of building, energy and environment is certainly reversible, as regards the impact of the building on the external environment, there are three scales generally considered as relevant for a correct environmental approach, namely:

- Global or global scale, related to global atmospheric phenomena and globalized resource management;
- The regional scale, which concerns the geographical area and often climatic;
- The local scale, relating to the buildings, to its implantation parcel and to its close environment.

Concerning the indoor environment, these are the impacts on the user who, on the one will feel a sensation of comfort or discomfort and on the other hand, will risk contracting any diseases caused by the building itself. This explains this impact on internal environments; poorly designed, the building will not have its primary role of

8 (THE SERIES OF THIRTY-SIX VIEWS OF MOUNT FUJI (KATSUSHIKA HOKUSAI, 1760-1849), WIKIPEDIA. ACCESSED IN JANUARY2011.)

shelter and will generate sensations of hygrothermal (atmosphere felt as too hot or too cold), acoustic (majority of complaints of neighborhood), visual (insufficient natural lighting, glare, contrasts too violent, etc.), or olfactory (often related to poor ventilation) discomfort.

2.2 Energy then and now

2.2.1 Historical overview on energy :

Ever since, man has consumed energy. This consumption was relatively linear and the origin almost exclusively renewable (biomass, hydroelectric energy, animal energy, ...) until the industrial revolution. It was during this period, marked by ever more energy-consuming industrial developments, that the rise of fossil fuels (mainly coal at the time) was born. Their consumption began to increase exponentially. The discovery of coal, so abundant in nature and technological advances in its use are at the origin of the industrial revolution. Post-industrial prosperity and post-industrial expansion are undeniably linked to the use of oil and then to natural gas. One of its fruits is the electric energy.

A large proportion of the electricity produced in the world comes from coal and natural gas for more than a century. Electricity is the "first" form[9] energy, thanks to the ease of its use and its distribution. Demand is constantly growing, due to the increasing use of electrical and electronic appliances by consumers, the increase in associated industrial activity and its expansion to the world.

For modern man, the dream of dominating nature has essentially translated into an obsessive tension towards ever greater and more excessive production and consumption. Extracting from nature a maximum of material well-being has been, and remains for a large part, the ideal of industrial societies, let alone developing countries. Everyone then keeps their eyes on the growth rate of GDP, which simple economic indicator has become a real religion, the idol of modern times.

Unfortunately, with the industrial revolution, the economy will assert itself as a mechanistic science, disembodied from nature and a man reduced to the state of homo oeconomicus[10]. By losing all ethical reference, the economy is cut off from conservation, solidarity and transmission to future generations of natural heritage.

2.2.2 Limit of available energy resources:

Often a crucial debate is introduced when there is a peak in oil or gas demand. This is the case when the extraction of these products begins to fall well before the end of the resources. It is very difficult to determine exactly when fossil fuels can be used.

9 (L.Freris and D.Infield, "Renewable Energy for Electricity Generation", 2009.)

10 (Source: http://europe.eu/scadplus/leg/en/lvb/127064.htm,)

Currently, the annual primary energy consumption is about 500 EJ. This is equivalent to about 1.4 x 1017 Wh or 140,000 TWh. By dividing this number by the number of hours, we obtain about 16 TW or 16,000 GW as the average power required for the consumption of the planet.

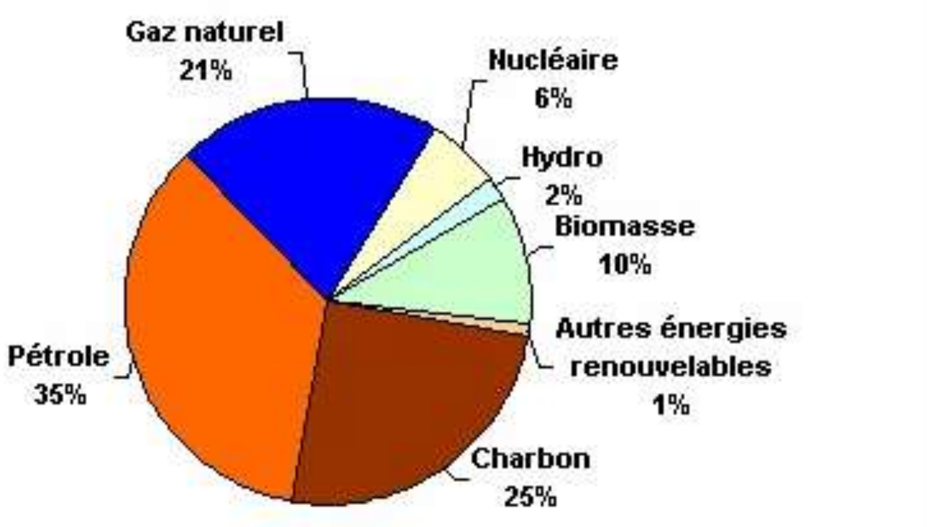

Figure 1 : Share of each energy source in world demand for primary energy11

The figure shows the relative importance of various sources of primary energy worldwide, according to data from the International Energy Agency (IEA).

Every year, global demand for oil and gas increases significantly. According to most oil and gas companies, significant new oil resources can be exploited or remain to be discovered. It is generally accepted that the oil reserves, can satisfy the current demand for another 30 years. For gas, the latest estimates indicate a longer period than oil, ie 60 years.

In any case, this crazy consumption of fossil fuels will undoubtedly have repercussions on future populations. In the next century, the world will be confronted with two main problems. The first concerns fossil fuel reserves; the second is relative to the greenhouse effect.

2.2.3 The efficient use of energies:

There is a diversification of energy sources and this trend is likely to continue over the next century. Electricity consumption will grow because it is an important energy carrier and convenient for the consumer. The choice of the primary energy palette is specific to each country, its own energy wealth and its energy past. There is no one-size-fits-all solution and everything has to be studied in detail, taking into account economic factors, environmental effects, and so on.

11 INTERNATIONAL ENERGIE AGENCY

The world's population is expected to double by the middle of the 21st century. With improved energy intensities, growth in primary energy demand is expected to increase, and electricity demand growth is expected to be stronger, possibly doubling by 2020[12].Obviously, the world is forced to take effective measures, to achieve the greatest effect in reducing climate change. In most countries, including Algeria, financial incentives and regulations are now in place to encourage energy efficiency, but their effect remains modest. The transition to the stage of using renewable energies has become mandatory, to preserve the lack of fossil wealth for our future generations.

2.3 Energy and the environment

2.3.1 Environmental impact :

Carbonaceous fuels of fossil origin all have one thing in common: they all create carbon dioxide (CO_2) during their combustion. They have an important part of the long carbon cycle, which has been fixed durably during the geological periods, when the climate was tropical on the majority of the planet, and the rate of CO_2 very important, the well-known emission rate of 386 g of CO_2 / kWh introduced by gas plants. Although the relationship between CO_2 concentration, temperature change and undesirable climate variations is very complex and therefore very difficult to predict accurately, it is widely accepted that this concentration needs to be stabilized. Other gases with adverse effects, after CO_2, methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), per-fluorinated hydrocarbons (PFCs), and sulfur hexafluoride (SF_6) are importants.

However, electricity generation is a significant source of greenhouse gas emissions due to the large consumption of fossil fuels. For this purpose, essential actions can be carried out immediately:

- Increase the efficiency in the use of energy.
- Impose strict rules for carbon emissions.
- Increase the use of renewable energies.

The development and integration of photovoltaic power generation systems will contribute to the reduction of these atmospheric emissions.

2.3.2 Environmental criteria:

In the late eighties and with the emergence and spread of the concept of "Sustainable development", we come to a more global approach: architecture becomes ecological, green and environmental. It is not only a question of saving energy and promoting comfort, but also of thinking about the health of the occupants, of managing resources (energy and materials) thanks to the study of life cycles, while limiting pollution.

12 (C.NGÔ, "WHAT ENERGIES FOR TOMORROW", EUROPEAN ATOMIC ENERGY COMMISSION, 1999.)

2.3.3 *The greenhouse effect:*

Without the greenhouse effect, the average temperature of our planet would be -18 ° C. The existence of this phenomenon means that the average temperature on earth is 15 ° C. Our planet uses an average of 240 W / m2 to warm up13.

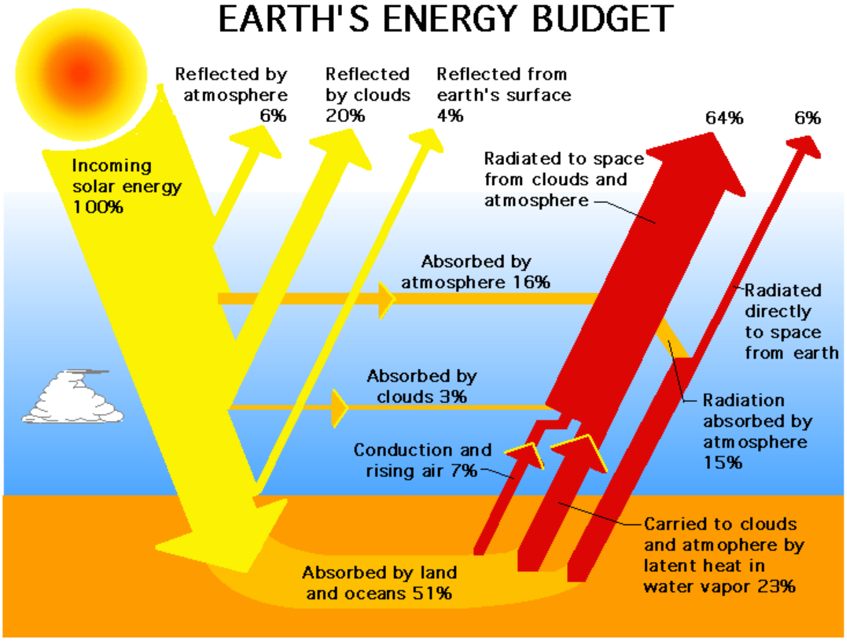

Figure 2 : Radiation effect

Since the beginning of the pre-industrial era, the greenhouse effect has increased by 2.45 W / m2, or 1%. As a result, the average temperature between 1850 and 1995 increased from 0.3 to 0.5 ° C. This increase is worrying.

Several scenarios have been proposed to evaluate the average temperature in 2100. Depending on the scenario, average warming is between 1 ° C and 3.5 ° C. High values would have dramatic consequences for the environment, especially with rising sea levels. The gases responsible for the increase in the greenhouse effect are mainly CO2, which contributes 1.56 Wm2, the CH ~ , for 0.5 Wm2, NO, for 0.1 Wm2 and CFC for 0.3 Wm2.

Fossil fuels all release CO2 by combustion. Better combustion management (eg fluid bed technology for coal combustion) and choice of fossil fuel (for example, for the same amount of energy supplied, the combustion of natural gas emits half as much CO2 that of coal) can optimize the emission of greenhouse gases but we can never make it disappear completely because the combustion of carbon always gives carbon

13 HTTPS://WWW.NASA.GOV/AUDIENCE/FORSTUDENTS/5-8/FEATURES/F_THE_ROLE_OF_CLOUDS.HTML

dioxide. On the other hand, renewable energies and nuclear energy make it possible to significantly reduce the emission of greenhouse gases.

In the context of limited energy resources and a commitment to limiting greenhouse gas emissions (Kyoto, 1998), we must not only increase energy savings but also think about dividing our energy consumption differently.

Renewable energies and nuclear can contribute to this. To illustrate this point, we give some figures concerning the production of electricity by nuclear energy. There is little CO2 emissions (the latter comes mainly from the construction of power plants and transport that occur at all stages of the cycle). For the European Union, for example, the quantities of CO2 avoided by nuclear power, which produces 34% of its electricity, correspond to the emissions of the 200 million vehicles that make up the car fleet. The building and the city remain as polluters and therefore participants in emissions of greenhouse gases.

2.4 Energy and buildings

2.4.1 Relation between building and energy:

The Grenelle Environment Forum has consistently stressed the urgent need to tackle the building sector, which accounts for 40% of the final energy demand at national level, compared to 46% in Europe14, and 19% of CO2 emissions into the atmosphere, compared with 25% elsewhere.

Regardless of the figures given by the various organizations, which is certain, it is that this sector represents a huge potential for energy efficiency and reduction of greenhouse gases, it is good to know that during the lifetime of a building, energy produces 70 to 80% of environmental impacts, it is likewise very important.

2.4.2 The positive energy building:

Among the many successful building concepts, the positive energy building is among the most recent [Disch 2008]15. Because of its high level of requirement, no regulations or standards have yet been incorporated and its definition is not yet clear.

Identifying the specificities of this concept and proposing a definition is necessary, including the analysis of the main concepts of existing high performance buildings.

The examination of some achievements corresponding to these concepts will make it possible to identify the most adapted technical elements (architectural solutions, constructive methods, equipment). Finally, given the objectives of the positive energy

14 (HTTP: //WWW.LOGEMENT.GOUV.FR,)

15 WWW.PLUSENERGIEHAUS.DE

building, it is possible to retain a certain number of technical solutions that are proven or available in the short term that can constitute a positive energy building.

2.4.3 The concepts of efficient buildings

A high-performance building concept is defined by a set of objectives and technical solutions designed to guide the designer. The latter, relying on various design assistance tools, combines techniques, materials, structures and equipment in order to best achieve the objectives set. Finally, after commissioning of the building, an evaluation phase allows the designer and the client to quantify the real performance of the building and compare it to the original objectives.

2.4.3.1 Typology of efficient buildings

The concepts of efficient buildings are most often defined in the context of certifications, labels or regulations. They are then associated with a specification describing their objectives or a method of evaluating their level of performance. Their denominations are varied, each emphasizing a major feature of the building.

Yet the underlying concept is not limited to this simple characteristic; these denominations are necessarily reductive. A typology of denominations encountered in the literature was carried out, in order to highlight the main characteristics of these buildings and the main associated concepts. Two types of approaches stand out: purely energy approaches and broader approaches.

2.4.3.2 Pure energy concepts

The purely energy concepts accompany regulations aimed at the energy performance of buildings, the Energieeinsparverordnung [EnEV 2004] regulation in Germany) or are simply associated with labels (Minergie® in Switzerland1 [Minergie 2008], Passivhaus in Germany [Passivhaus 2008], CasaClima / Klimahaus in Italy [Klimahaus 2008]). In France, the regulation proposes five labels (HPE, THPE, HPE EnR, THPE EnR and BBC 2005) (HPE: High energy performance, THPE: Very high energy performance, renewable energy Renewables, BBC: Low energy consumption building), or several different levels of performance, and encourages the integration of renewable energy sources into the building. For these approaches, the criteria evaluated are few, well defined and quantifiable, which facilitates the identification of the underlying concepts. Those who have been identified are:

2.4.3.3 The low energy building :

This building is characterized by lower energy requirements than standard buildings. This first level of performance can be achieved by optimizing insulation, reducing thermal bridges and increasing passive inputs. This concept does not include a means of local production of energy, without excluding it.

2.4.3.4 The "passive" building (in German: Passivhaus, in English: passive house):

This low-energy building does not require active heating or cooling systems: passive solar and internal inputs and ventilation systems are sufficient to maintain a comfortable indoor environment all year round. This concept also includes a reduction of the specific electricity needs and possibly a production of electricity based on renewable energy sources. In practice, a small auxiliary system is necessary to maintain thermal comfort during the coldest days; it is most often associated with ventilation.

2.4.3.5 Near zero energy house

It is equipped with local energy production means. However, this denomination does not specify either the level of consumption or the part of that consumption covered by production or even the nature of the energy produced. It is therefore more of a building characteristic than a building concept itself. The term "energy-producing building" is nevertheless sometimes used to refer to a "positive energy building".

2.4.3.6 Net zero energy house

This building combines low energy needs with local energy production means. Its energy production balances its consumption if it is considered over a year. Its annual net energy balance is therefore nil [Bernier 2006].

2.4.3.7 The "positive energy" building (in German: Plusenergiehaus):

This energy-producing building goes beyond the "zero energy" level: it produces more energy overall than it consumes. Like the previous one, this building is connected to an electricity distribution network to which it can export the surplus of its electricity production [Disch, 2008; Maugard et al. 2005].

2.4.3.8 The autonomous building

A building is autonomous when its energy supply does not depend on any distant resource. Thus all the energy consumed by the building is produced locally from local resources. In practice, the net energy balance of this building is zero at any time.

Such a building does away with the advantages provided by the supply networks (abundance, security of supply), which imposes the use of energy storage means (storage batteries, thermal inertia, etc.). This type of building is particularly suitable for isolated or insular sites because it avoids the costs of connection to various networks.

2.4.3.9 Wider concepts:

Some concepts derive from holistic approaches that take into account a large number of interactions of the building with its environment, the energy issue being only part of these interactions. This is the case of CASBEE (Japan) [CASBEE 2008], LEED (United States of America) [USGBC 2008] and BREEAM (United Kingdom) [BREEAM 2008], which are aimed at labeling or certification, but also of the R-2000 standard in Canada, which is associated with regulation [R2000 2005]. In France, the HQE® (High Environmental Quality) approach, proposed to building owners, does not set any performance targets [AssoHQE 2006]. Certifying bodies offer standards.

These different global approaches aim to appreciate the "environmental quality" of the building. However, the environmental performance criteria considered are numerous and vary according to the approaches. Other concepts are based on an economic approach. The main concepts identified are:

"Zero utility cost house", "net zero annual energy bill" or "zero energy affordable"housing ": These expressions, rather evoked in Japan or the United States of America, designate buildings whose energy bill is zero: the sale of a part of the energy production of the building offsets the expenses generated by the purchase of the energy consumed (electricity, hydrocarbons, etc.). This approach is favored in the social housing for which the energy bill represents a significant part of the budget of the occupants. The goal is achieved through the reduction of consumption and the use of free renewable energy resources. But the balance sheet depends on non-physical factors such as energy prices or suppliers' commercial offers.

Carbon neutral house or low carbon house: These expressions refer to a building whose operation does not induce any emission of CO2. This orientation, which is part of the Kyoto Protocol's approach, aims to reduce the building's participation in increasing the greenhouse effect. The "zero carbon" approach is generally associated with a way of life whose scope, beyond the building, encompasses the modes of transport, or even the consumption patterns of the occupants of the building. One of the consequences of this approach is the exclusive use of renewable energy resources. The BedZed project in England was carried out according to this principle [BedZed 2008].

Green building: These qualifiers refer to mainly symbolic notions whose associated concepts are poorly defined4. They go far beyond the energy framework and emphasize rather the low environmental impact of the building, for example by the materials used. One of the many facets of such buildings may possibly correspond to one of the concepts presented above.

Intelligent building: This term refers to a building that has a form of "intelligence", usually provided by programmable controllers and computer systems supervision. This equipment is designed to improve the management of some modular functions of the building, such as solar protection, ventilation, heating, lighting or security access. There is a multitude of definitions of this concept [Wong et al. 2005], however the key objective of smart building seems to be to improve the comfort and productivity of the occupants inside the building. As a result, energy and environmental concerns can be secondary or even absent.

2.4.3.10 Evaluation criteria specific to high performance buildings:

It appears a strong convergence of concepts around some main characteristics such as:

- The annual heating energy requirement, referred to a surface, usually the heated surface.
- Energy consumption, also per unit area, which may include heating, but also domestic hot water, lighting, ventilation, auxiliaries, and even other uses of electricity, this indicator being the most often expressed in primary energy
- Energy production from renewable resources:

The concepts differ mainly in the level of requirement of each one of them with regard to these characteristics. These levels of requirements are criteria for verifying that the objectives of the concept are met. Some secondary characteristics may be added to the previous ones, such as:

- The airtightness of the building.
- The performance of equipment and materials used.
- Non-energy elements, such as the nature of the materials (natural or synthetic), the extra cost of the construction, the CO2 emissions, the level of thermal comfort, etc.

2.5 Buildings and environment

2.5.1 Demography and town planning:

These cities more and more energy seekers and continued to pollute the environment, were confronted in the twentieth century, with an increase in the urban population which has been multiplied by ten times16. This galloping approach is nevertheless one

16 (The world urban population from 220 million to 2.8 billion inhabitants in a century, source: UN.)

of the main causes of planetary maleness. Urban congestion, urban sprawl, degradation of our ecosystems, greenhouse gases, insalubrity, poverty ... To understand the emergence of the concern for sustainable development in urban planning, we must first understand the context in which these concerns appeared. We can say that urban growth is the most striking phenomenon of the evolution of the territories since the industrial revolution, and this, almost everywhere in the world. This phenomenon is all the more disturbing as this urban demography will mainly take place in Africa and Asia, where the urban population will double from 2000 to 2030[17], Hosting over 80% of the world's population. Crucible of economic development, trade and miscegenation cities have long been the main income of developing countries. Access to essential goods (health, education, water, sanitation) is generally more favorable, but the landscape is changing. Cities are gradually becoming generators of exclusion, inequality and pollution. Most of them are today condensed evils caused by an uncontrolled development: accumulations of filth, urban congestion, transport, air pollution, insalubrity, malaise, insecurity ...

Poverty is undoubtedly the biggest scourge of cities for decades to come. "Although the majority of the world's poor still live in rural areas, poverty is rapidly turning into an urban phenomenon," said Robert M. Buckley, a housing counselor with the World Bank's Urban Development Division. Poor housing is one of the most visible consequences of poverty. Currently, one billion people do not have adequate housing and it is estimated that more than 100 million people are homeless[18]. 14 million inhabitants will be in our big Algerian cities in 2025.

2.5.2 Impact of urban planning:

All spatial scales must be evoked, from the scale of materials and technologies at the scale of the city or urban fragment, in an eco-systemic approach. Indeed, the understanding of energy issues must today take into account a more global approach, aiming at integrating the climate approach into a sustainable urban development.

The city, the main part of sustainable development, which includes building and urban transport, accounts for more than half of greenhouse gas emissions and about two thirds of energy consumption. Its development is composed of three dimensions: urbanism, building and transport, have become the number one problem of climate change and energy supply.

In terms of urban planning, climatic conditions are not the only factors in the shape of the habitat. So, for example; in southwestern North America, similar sites and climates

17 (The world's urban population will rise from 220 million to 2.8 billion in one century, source : UN.)

18 (UN, Habitat 2006)

have seen both the highly individual Navajo house and the pueblo collective agglomeration develop. However, certain solar constraints have favored grouped habitat forms: Rapport19 cites the grouping of "yokut" dwellings under the same continuous sunshade made of branches, where the compact plan, typical of hot and arid climates, made of elements together with each other, who shame each other, our Saharan cities were good examples. Some historians of urbanism have wanted to see in old cities principles of solar orientation. This theory did not resist an extended statistical study.

More recently, physiologists have wanted to give a scientific basis to the orientation of the streets of our cities; but they are not based on rigorous observations taking into account the apparent movement of the Sun, its variations in seasonal heights, or the value of energy inputs. They generally advocate east-west exposure. With regard to the cities, most of the builders were not interested in the questions of sunshine, difficult to apply to the existing plots and the urban customs of implantation, our subdivisions are the good example.

2.5.3 Impact of the building:

To preserve our environment, the building sector must play a key role because it is responsible for a broad environmental impact (the following data differ from one country to another):

50% of natural resources exploited;

45% of total energy consumption;

40% of waste produced (excluding household waste);

30% of greenhouse gas emissions;

16% of water consumption, including 1 to 2% for human consumption;

Aware of the importance of the challenge, we must mobilize more and more to master and reduce as much as possible these environmental impacts by seeking to take into consideration of all the different phases of the life cycle of construction products and more widely of the building:

Manufacture of construction products;

Construction;

Operation and maintenance;

Rehabilitation or adaptation;

19 (A.RAPOPORT, "FOR AN ANTHROPOLOGY OF THE HOUSE". DUNOD COLLECTION.)

Deconstruction;

At each of these phases, as soon as the construction products are manufactured, the work undertaken will be an important burden for our environment in terms of:

Energy consumption for the extraction of raw materials, transport and production of construction products;

Production of construction and demolition waste (inert material, wood, metals, paint pots ...);

Air, water and soil pollution (exhaust gases, used oils, wastewater untreated ...);

Destruction of existing flora or fauna;

Various nuisances on the nearby environment (noise, dust ...).

However, it is during his life that the building (see illustration below) will be really the most penalizing for the environment. The operation-maintenance phase contributes to a large extent to the environmental impacts of a building: consumption of fuel, gas or electricity for heating, cooling, or lighting, drinking water for food or sanitary facilities, production of household waste, wastewater discharges, emission of greenhouse gases emitted by heating systems (NOX, CO2, SO2, dust) ...

At the end of life, the building must be demolished or even deconstructed in order to selectively recover what will become a collection of waste. The building disappeared, it will be necessary to carry out a restoration of the site (recovery of foundations, soil remediation, replantation ...).20

20 HTTP://WWW.ENERGYLAND.EMSD.GOV.HK/EN/BUILDING/ASSESSMENT/INDEX.HTML

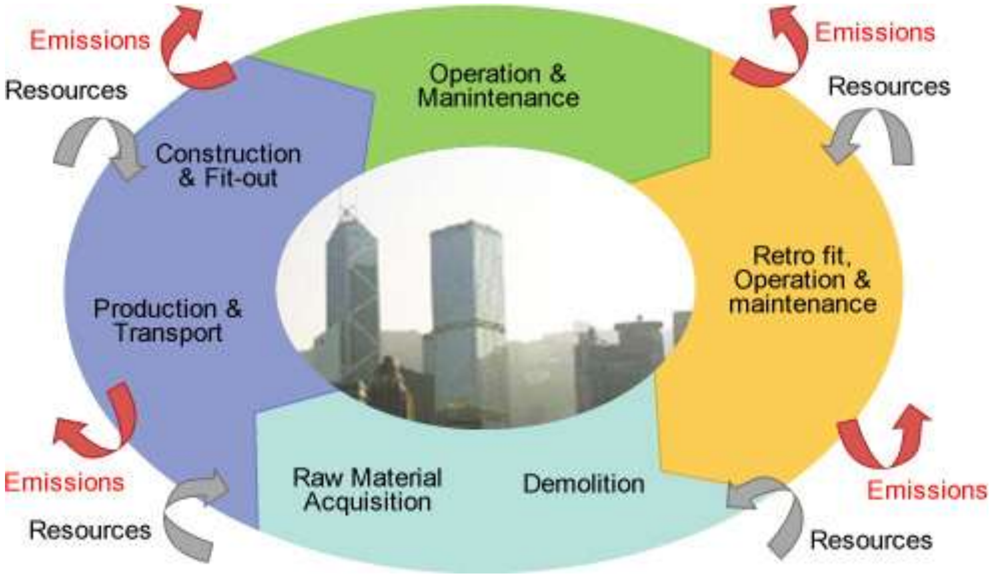

Figure 3 : Life Cycle Energy Assessment (LCEA) of Building Construction

2.6 The bioclimatism

2.6.1 Bioclimatic approach:

The term bioclimatic refers to a part of the ecology that studies more especially the relations between living beings and the climate. In architecture,21 this expression mainly aims at improving the comfort that a built space can induce in a natural way, that is to say by minimizing the use of non-renewable energy, perverse effects on the natural environment and investment and operating costs. The interest of the bioclimatic goes therefore from the pleasure to live or to use a space to the economy of the construction, which makes it a fundamental element of the art of the architecture. All scales of architecture are concerned, from the habitable room to the fragment of city, both by the improvement at each level and by the interdependence of these different scales of intervention. For example, the realization of the conditions of comfort in a building and the use of renewable energies require the taking into account of its environment but modify it in return. It therefore depends on it and it is necessarily integrated. We can therefore consider that the bioclimatic approach is to sublimate a constraint to make it a driving element of the design. Our purpose is not to try to advocate such an approach for all designers. However, it seems necessary for them to know the basics, if only to learn how to better manage the interactions between the climate dimension and the other components of the project. It is, in a way, that the designer appropriates the advances made in this area.

Our planet, which we can neglect the thermal effect of the magma is included atmospheric layer, in thermal equilibrium: it receives heat from the sun and loses it in

21 (P.FERNANDEZ AND P.LAVIGNE: "DESIGNING BIOCLIMATIC BUILDINGS", THE MONITOR, 2009.)

the vacuum which surrounds it taking, as a first approximation, a temperature of balance such that the heat received is equal to the heat lost.

More precisely, we observe that:

- the solar radiation received annually depends on the latitude, for reasons purely geometrical (the equator receives the maximum and the poles the minimum); Solar radiation is a function of the season, for geometrical reasons also;
- The received radiation reaches only partially the ground, according to the nebulosity of the place;
- Heat exchanges take place between different regions of the world by displacements of air, more or less hot or cold, what are the winds;
- Depending on the location, the air is more or less humid, especially depending on the wind movement of waters;
- the air temperature decreases with altitude;

2.6.2 Bio-climatism and sustainable development:

Through both aspects, finite resources and risks associated with an uncontrolled demography, especially in the poorest countries, it is the global management of the planet and its ecosystems that man must implement. Despite ups and downs in political will and especially considerable variation from one country to another, the UN World Commission on Environment and Development could, in its report entitled Our Future for All, say Bruntland report, in 1988, proposing that nations formally adopt the notion of sustainable development is the term consecrated can lead to confusion. Its definition is as follows:

"Sustainable development is a social, economic and political development that responds to present needs without compromising the ability of future generations to meet their own development. "

This notion brings out the need, quite new in its assertion international solidarity, solidarity between all the peoples of the planet and solidarity between the generations. Each actor in each sector of economic life is therefore confronted with the responsibility incumbent on them in the overall management of resources and the environment.

Bio-climatism is an unavoidable solution, for this purpose, the understanding of the basic physical phenomena related to the climate is essential to the good management of an architectural project. However, this must not be considered from an exclusively technical, very reductive angle. In the position of the architect, it must instead be approached as defined in the concept of "bioclimatic architecture" or, more simply, "climate architecture", taking this name in its most large. This conception has become mandatory, in view of the issues-cited earlier-that result.

2.6.3 Urban ecology:

Faced with the phenomenon of sprawl and urban fragmentation, cities are highly generating displacement. They must be aware today of their impacts and development. Our Algerian cities have experienced the same growth.

The international community is increasingly aware of the human, social and political risks posed by urban concentrations to which neither people nor cities are separated. In many developing countries, the meager means, both political and financial, of local authorities do not allow to meet the basic needs: drinking water, sanitation, energy ...

At the end of the sixties, the ecological problem took on a new form and a new dimension. It is becoming clear that industrial development, economic growth and productivism generate nuisances: pollution released into the air and water; deforestation and desertification; threats to soil conservation; flora and wildlife. To respond to these challenges and prevent social and environmental tensions related to urbanization, local authorities decide to engage in a "local agenda 21" by mobilizing all the actors of the urban territory on shared objectives.

The city is a complex system with its own modes of mutation22, metastasis or renewal. This set is strongly constrained by its social, economic and physical environment. Urban development is thus marked by profound changes whose concomitant effects on the environment sector can not be neglected. For example, the expansion and dilution of cities, spatial segregation, new mobility (travel over longer distances, more and more varied uses), time requirements, acceleration, multiplication of environmental impacts (consumption of space, resources or energy, emissions, noise, landscapes, etc.).

2.6.4 The German experience:

Germany as the leading country in the use of energy in the world, and possibly one of the few countries that created the concept of passive houses, this concept was developed from the experiences of the 1970s. So, between 1984 - 1995, energy consumption in need of heating has gone from 220 kWh / m2.year to 100 kWh / m2.year in this country, with the adoption of new standards of protection against loss (insulation,). The objective of this policy is to make low energy consumption housing (<70 kWh / m2.year), a construction standard.

Passive habitat remains a long-term goal. Currently, 3,000 passive house demonstration projects are being evaluated in Europe (www.cepheus.de "passive houses in europe", accessed February 2011).

The standards adopted, as well as the requirements, in terms of loss indicators, are reviewed and corrected periodically. The results achieved by these countries, in terms

22 (P.Fernandez and P.Lavigne: "Designing bioclimatic buildings", the monitor, 2009.)

of energy efficiency, have had a beneficial impact on both the quality of the built environment and the development of the building industry. In photovoltaic, Germany leads Spain and Japan with an installed capacity of 5400 megawatts.

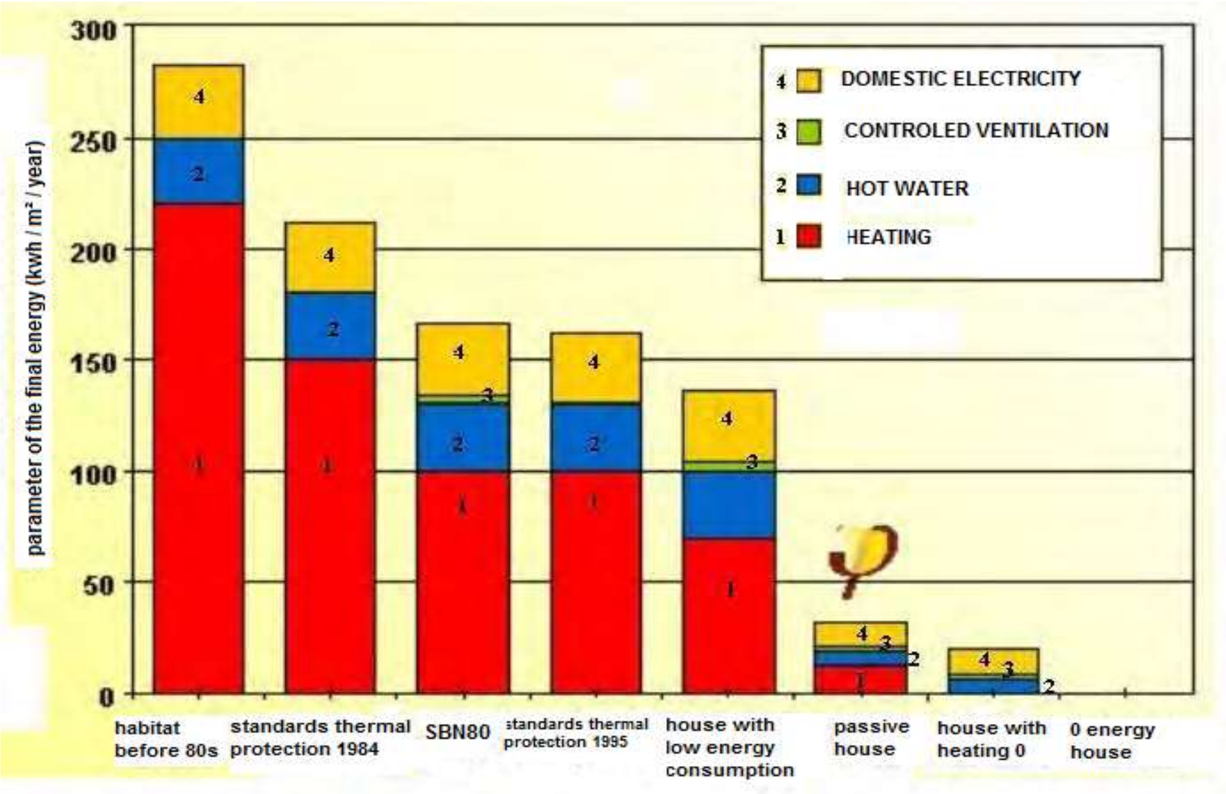

Figure 4 :Reduction of energy consumption in housing in Germany23

2.7 Energy buildings and environment in Algeria

2.7.1 Evolution of energy consumption in Algeria:

The growth of electricity consumption in Algeria reached its highest level in the 1970s, with an average annual growth rate of 13% recorded from 1970 to 1980. In the last decade, this growth has been practically stable around an average annual rate of 5.6%, with a household equipment rate of 70%. With housing stocking around 5,745,645 million dwellings, of which 60% is urban, in 2007, the housing stock has reached 7 million and consequently its consumption has increased, arrived at 52% of final consumption in 2009 , divided between natural gas and electricity with a total of 16.1 MTEP (million oil equivalent)24.

The breakdown by energy product of the consumption of the sector of the households and the others brings out the predominance of two energy products: electricity and natural gas.

23 CEPHEUS

24 (SOURCE:WWW.MEM_ALGERIA.ORG/EN/STATISTIQUES/BILAN_ENERGITIQUE_NATIONAL_2009_EDITION_2010.PDF.)

The growing demand for electrical energy in this sector requires significant investment to meet this demand. Access to energy, at affordable prices and reflecting the real costs of producing energy services, requires the implementation of a strategy integrating new approaches to energy rationalization. The household and other energy-intensive sector is, at the same time, an important energy saving potential.

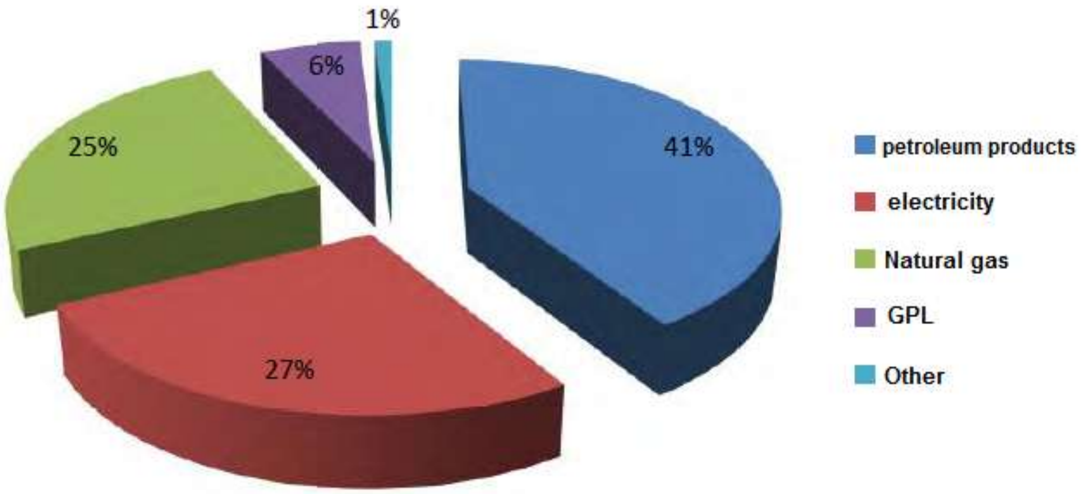

Figure 5 : final consumption ratio by product25

This domination of electricity and gas consumption by the building, forces the imprint of a good energy management policy strategy, by the actors of this sector, because it can induce a fairly significant energy gain, opting for the approach bioclimatic in design, implementation and finally management.

We are looking much more into our research, on the electricity consumption that is increasing every year, in this sensitive sector. The figure below, is the proof, because in the forty years marked on the diagram, the consumption was multiplied by six.

25 2009 NATIONAL ENERGY REVIEW.

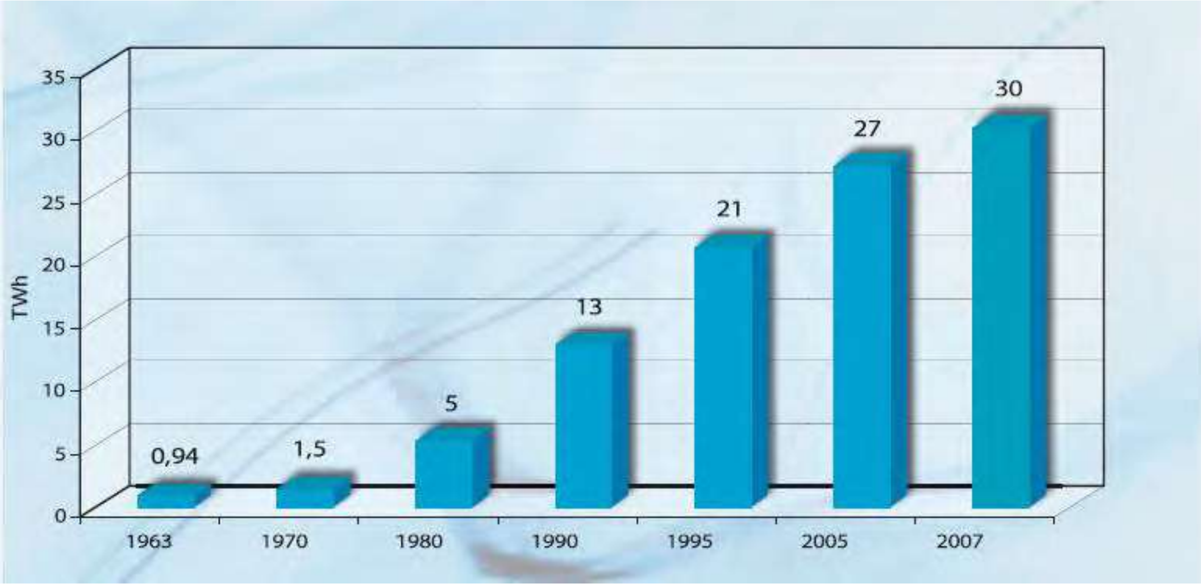

Figure 6 : history of electricity consumption 1963-2007.26

2.7.2 The Labels and the Algerian building:

The energy efficiency of buildings has certainly increased in recent years in Europe, very little or negligible in Algeria, but much remains to be done if we want to achieve the objectives of "Kyoto". Compared to the French housing stock, it has 30.2 million homes, of which 63% were built before 1975, these homes are relatively little or not isolated at all, which means that they suffer a great loss thermal, and therefore consume a lot more energy, so highly emitting greenhouse gases27

Regarding the Algerian park, the phenomenon is reversed, the new park, has more than 7 million homes on January 1, 2007. This figure that has increased these days, does not meet the bioclimatic recommendations, and does not respect demanding thermal regulations (RT). It can be said that there is, to date, no technical regulation for the construction of bioclimatic buildings28

Daily life in the building induces energy consumption, and therefore greenhouse gas emissions, through heating, air conditioning, hot water production, cooking and the

26 Sonelgaz

27 (The different greenhouse gases: carbon dioxide (CO2), methane (CH4), nitrous oxide (N2O), hydrofluorocarbons (HFCs), per-fluorinated hydrocarbons (PFCs) and sulfur hexafluoride (SF6).)

28 (Regarding the Algerian park, the phenomenon is reversed, the new park, has more than 7 million homes on 1 January 20074. This figure, which has increased these days, does not meet the bioclimatic recommendations, and does not respect the demanding thermal regulations (RT) .There is no technical regulation for the realization bioclimatic buildings)

use of electricity, but also the process of construction. More than 10% of CO_2, 20% of sulfur dioxide come from the construction phase, in addition, we can also consider how the used materials and their debris are recyclable. This bill weighs heavily in the budget of the Algerian household. The energy consumption of buildings has increased by 30% over the last 30 years, due to the increase in the park in question. Other countries have quickly forced the use of energy performance labels to achieve new buildings with low energy consumption of 80 or 50 kWh / m2 / year, instead of 300 kWh / m2 / year[29], and define regulatory requirements for the energy performance levels of new buildings: HPE, HPE EnR, THPE, THPE EnR and BBC. Thus, currently in Switzerland, the "Minergie" label targets a global consumption equal to 35% of that of a conventional building and the increased use of renewable energies. The "passive house" standard, of German origin, aims at a consumption of 20%, which even makes it possible, thanks to the use of photovoltaic sensors, to design "positive energy" buildings that produce more energy (thermal + electrical) that they consume.

All these constructions can be labeled by recognized institutions such that: EFFINERGIE, MINERGIE, BPOS, PASSIVHAUS ...

Others aim to be more exhaustive with multi-criteria methods that can use beyond the borders of their country of origin. This is the case, for example, BREAMM (Great Britain, the first used), LEED (United States, Canada), DCBA (Holland), Green Building Tool (developed by Green Building Challenge groups 14 countries). In France, the "HQE approach" is based on the definition of objectives four themes and fourteen targets.

Algerian institutions have not yet arrived at this stage, and the Algerian building always remains subject to classic specifications, neglecting all the climate parameters. This neglect of the energy qualities of Algerian buildings is due to the massive and unthinking import of industrialized models with high consumption energy and insufficiently mastered by our country. As a result, this attempt to transplantation of a type of construction, designed by other latitudes, in our regions to climatic characteristics (highlands, Sahara ...), ran up against a strong rejection phenomenon. Despite all this, attempts began to emerge, OPGI to launch HPE bioclimatic design contests (high performance energetic), in several wilayas, but the operation remains insufficient.

2.7.3 Climate change in Algeria:

29 (SOURCE: WWW EFFINERGIE.ORG)

The future on the climate plan does not bode well for Algeria. Experts in the field of meteorology of the Hydrometeorological Institute of Training and Research of Oran, have painted a blackboard of what will be the next years in our country. Because it is located in the Mediterranean basin, Algeria remains a region very vulnerable to climate change and natural disasters. Based on scientific studies, the same experts believe that rains and thunderstorms like those that characterized the regions of Ghardaia or Bechar will be more and more frequent. They argue that it is to be expected that these meteorological phenomena will be a worsening of desertification, storms, pollution and other phenomena on our planet. We must expect a reduction of about 20% in terms of precipitation in the coming years"30, according to the same sources.

Potential impacts in Algeria include violent phenomena (cyclogenesis, heat waves, sandstorms), impacts on water resources, on agricultural production and on health. Experts recommend putting the package on prevention. In terms of the issues to be addressed, move to regional and local climate variability.

On the political side, we need to move from crisis management to risk management, integrate all causes, sectorial policies, local knowledge and strategy monitoring indicators. It is necessary, in the Mediterranean framework, to establish a better collaboration.

Algeria shares the same climate trends in the Mediterranean basin, arguing that it is a region of "most vulnerable" to climate variability and change and natural disasters. The country's rainfall and heat waves since the 1930s, with some projections for the 2020 horizon, there may be, in the future, a daily maximum of precipitation exceeding the usual annual average in the south of the country. Just as drought and heat waves are expected to increase, "there will be a decrease in the rainy seasons and an increase in temperatures of around 1 ° to 1.5 ° by 2020". In addition, the significant exploitation of hydrocarbons in Algeria is largely responsible for greenhouse gas emissions. However, the dominance of natural gas in the national energy balance is already a mitigation measure for GHG emissions.

2.7.4 Energy and building in Algeria

According to data from 2005 (the only source currently available) from the Ministry of Energy and Mines, national final energy consumption reached 17 million toe25 in 2005 document entitled: Final energy consumption of Algeria, key figures year2005.

It has continued to grow since then, due to the large number of housing units that have been launched in recent years throughout the country, consequences; increase in

30 (SOURCE IHFR: HYDROMETEOROLOGICAL INSTITUTE OF TRAINING AND RESEARCH OF ORAN, MAGAZINE "PROPRAL",)

energy demand and greenhouse gas emissions, until we reach fairly large thresholds, which can have fatal consequences for the environment of our country.

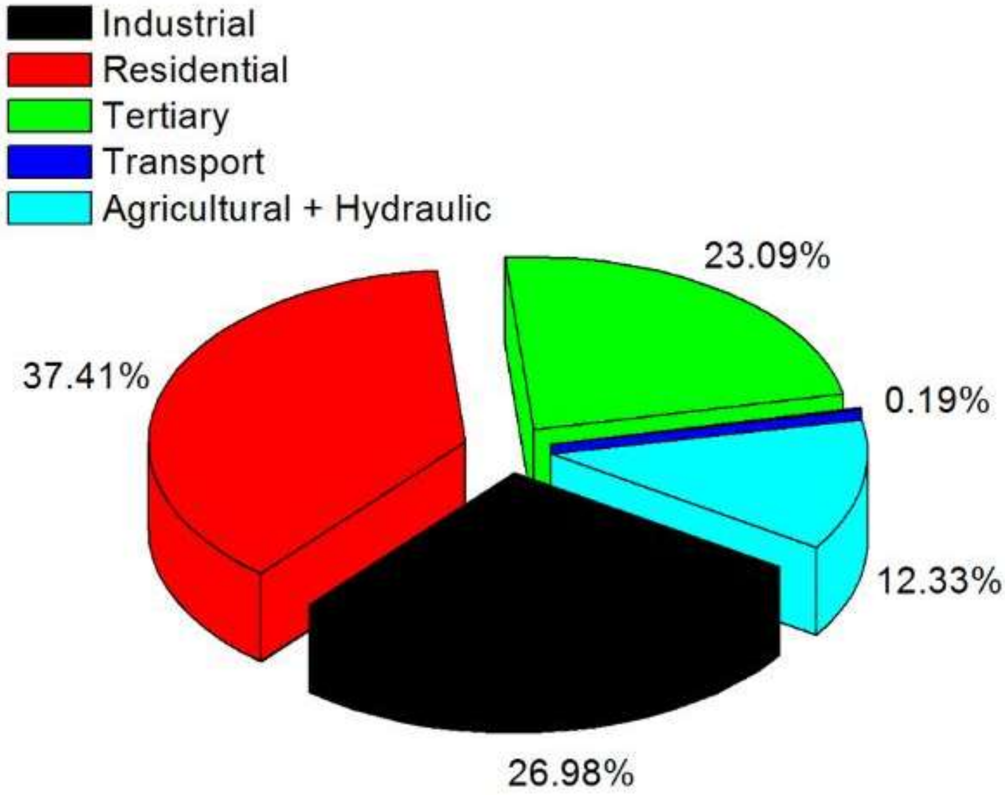

Figure 7 Electrecity consumption by sector in Algeria 2005[31]

The population reached 32,906 million inhabitants in 2005, and 35.6 million in 2010[32], with an area of 2,381,741km2, which means the current high demand for energy. Emissions due to the energy consumed are estimated at 40 000 tonnes of CO2 equivalent.

- Average consumption: 0.694 toe / inhab.
- Emissions due to energy: 1.22kg CO2 equivalent / inhabitant.

Table 1 :The breakdown of final consumption by type of energy, year 2005 . Source: MEM

	Solid	**Gasoline**	**Gas oil**	**Light fuel**	**Heavy fuel**	**GPL**	**GN**	**Electricity**	**Total**

31 APRUE

32 (SOURCE: RGPH (GENERAL POPULATION AND HOUSING CENSUS), APRIL 2008.)

Industry	0	0	546	0	0	72	2078	528	3226
Residential	0	0	1165	54	0	1498	2509	807	6034
Tertiary	0	0	101	0	0	55	360	498	1013
Transport	0	2377	2482	0	334	338	0	4	5536
Agriculture+ hydraulic	2	0	862	0	0	0	0	266	1130
Final consumption	2	2377	5158	54	334	1964	4947	2104	16939

The hydraulics of 7.68%, followed by the residential -tertiary 6.28%, then the industry 5.86% and the transport 4.49%.

• An average annual growth rate (CAGR) for gaseous products of 6.14% followed by electricity 6%, then petroleum products in third position with a rate of 5.20%.

From the previous figures and tables, we can confirm that the building in Algeria is the main consumer of energy and the most polluting after hydrocarbons, and the first in the chain of electricity consumption33, including "specific electricity"34. In general, the final consumption of this sector reached six-6-million tonnes of oil equivalent (toe) in the year 2005.

2.7.5 The context of the Algerian building:

Given the context of strong growth in domestic consumption of electricity, it would be in the interest of households to invest in improving the energy efficiency of their homes and their appliances. According to a recent study by the National Center for Integrated Building Research and Studies (CNERIB), the average consumption of an apartment in Algeria is estimated at 15.2 m3 per m² per year for gas and 2200 kWh per year for electricity. Nevertheless, this trend is not widespread for a variety of reasons. In countries where the price of energy is subsidized, households are in no way motivated by the pursuit of improvements in the energy performance of their homes and domestic appliances, as their energy bill remains low. The price of electricity is indeed a determining factor in the level of consumption.

33 (Source: Sonelgaz, 2005. Available on www.sonelgaz.dz.),

34 (Specific electricity is the electricity needed for services that can only be returned by the use of electrical energy.No specific electricity is taken into account: hot water, heating and cooking which can use different types of energy)

In the 1990s, Algeria developed several regulatory mechanisms for energy efficiency in homes. Following a reflection on the active and passive consumption of new dwellings initiated in 1995, the Ministry of Housing and Town Planning implemented regulatory technical documents (DTR) in 1997. These determine in particular the reference values relating to wastage and heat input for new buildings for residential and tertiary use, methods for calculating heat losses and intakes, limit values for the indoor climate of premises and climatic zonings. These DTRs were subsequently approved by the Ministry of Energy and Mines and were subject, in 2000, to a decree on the thermal regulation of new buildings pursuant to the Master's Law adopted on 28 July 1999. The application of the thermal regulation was to take effect since 2005 and was to reduce by 30% the energy consumption of new buildings, excluding air conditioning. In addition to energy efficiency standards and requirements for thermal insulation in new buildings, the Energy Efficiency Act introduces energy performance standards for appliances that run on electricity, gas and petroleum products, but also the control of energy efficiency and the compulsory and periodic energy audit for the buildings of the tertiary sector. This law also provides for the financing of actions related to energy management through the establishment of a National Fund, which will make it possible to implement the various financial incentives provided for by the same law. The FNME (National Fund for the Mastery of energy) is fueled by taxes on energy consumption (electricity and gas) collected from large consumers (excluding SMEs and households), and can be supplemented by international funds (GEF, FFEM, etc.). Finally, in case of non-compliance the law on energy management, sanctions are foreseen. They may result in taxes, for example on new equipment operating at electricity, gas or petroleum products whose consumption is excessive in relation to energy efficiency standards, fines for establishments that do not do not comply with the energy audit requirement within 6 days, or other sanctions, in particular for the infringement of the provisions relating to labeling and non-compliance with standards established by thermal regulations in new buildings. However, despite all the provisions of the law on energy management and the holding in 2001 of a "National Conference on the control of energy in a context of economy of market "recommending the operational implementation of the various tools, organizations and instruments defined by this law, it would seem that the political will of the public decision-makers the price of raw materials: with soaring prices for hydrocarbons, the craze for the control of visible energy at the end of the 1980s disappeared and this concern relegated to the background by the government. In testifies to the inefficiency of the control mechanism and sanctions and thus the nonapplication thermal regulation in new buildings. In addition, the system of decisions of construction projects wholly dependent on the will of the President, no consultation with the relevant stakeholders. So, to meet the shortage of housing, the priority construction criteria are speed and low cost, and no reflection on the design of the buildings is engaged.

At the end of the concepts used in the world to define the characteristics of energy performance of buildings, some may be quoted below:

2.8 Conclusion:

The first observation is that the acceleration of climate change is brutal, deep, definitive. The greenhouse effect ushered in a new period on the entire surface of the earth and for all peoples; Algeria country belonging to the Mediterranean basin, considered vulnerable will not be immune. Immobilism is forbidden, the effects of this threat are predictable, calculated, devastating, these climate changes unfold before our eyes: considerable disruption, multiplied disasters, whose images should frighten the most incredulous, but one thing is certain, the climate machine has an inertia very strong. Our societies have reached a particular stage in the maturity of their organization, we are in very modern times. This modernity, this hoarding of progress, this quantitative obsession with unrestrained needs, it will be necessary to break the arrangement. This necessity is there, quite new in its official international affirmation, of a double solidarity: solidarity between all the peoples of the planet and solidarity between the generations. Each actor in each sector of economic life is therefore confronted with the responsibility incumbent upon them in the global management of resources and the environment (P. Fernandez, P. Lavigne, "Designing bioclimatic buildings", the monitor, 2009 .). We must be the masters of an art of alarm. We are facing unprecedented phenomena, which for ease we bring some corrections, often technical, sometimes legal, but questioning very little. This fatal dimension that accompanies the greenhouse effect allows us to rewrite all our public policies, which none can escape from this upsurge of ecology, as a datum, a constraint, a means. But at the same time, because it is a gesture, a duty, an awareness and that we evolve more than ever in the civil sphere, to understand this risk, to establish this challenge, is to engage a policy under the sign private. It is not to consider that the State is the only actor, but that the government of this future belongs to everyone, that it is the new writing of ethics, that it is up to each person to be the agent of this action that guides the hope of future generations. Schools, mosques, etc... all must go there. Climate change is everyone's business:

State, local authorities, companies, associations, citizens ... for this purpose the architects and architects must start with a bioclimatic design which aims to improve the comfort that a built space can induce in a natural way. It makes it possible to reduce the use of non-renewable energies and the costs of investment and operation, at the scale of a building as well as that of a neighborhood.

3 Energy efficiency in buildings

3.1 introduction

The multi-purpose energy construction sector is considered in heating, air conditioning, ventilation, lighting, stove, water heater, refrigeration and use of electrical and mechanical devices. The latter cases of higher consumption in global energy consumption with price increases are continuing because of the modernization of cities and the improvement of quality of life. By 2035 and according to the economy of the International Energy Agency, the energy construction sector presents a ratio of 41%.

In order to enhance energy efficiency in the construction and economic promotion sector, we mentioned different technologies, policies and funding in courses and examples for policy makers.

Improving energy efficiency in buildings depends on 3 primary criteria that are:

- Reduce the consumption of heating, air conditioning, ventilation and lighting with architectural and technical reflections for buildings.
- Improve quality of energy-consuming buildings and equipment.
- Energy management.

Interventions in energy efficiency are related to: heating, air conditioning, ventilation and lighting consumption loads depend on the quality of design and monitoring in the construction of a building. A stadium, for a better performance in terms of building energy must introduce and comply with energy efficiency regulations do not allow us to find standards for the building envelope and interior equipment.

The energy rehabilitation of the building is very important to develop energy efficiency in the city by replacing the equipment, the consumption mode and improving the bioclimatic quality of building. This is an opportunity for cities in terms of energy renovation and equipment replacement. To arrive at this result, it is necessary to take the necessary decisions to concretize these ideas.

The establishment of an energy management system is one of the energy rehabilitation mechanisms in the building, but it is to control the consumption and use of energy, to reduce the cost of energy for the productivity of the residential, commercial and public sector of the building.

There are many obstacles in the application of these energy management systems. These problems that we find in the development of the building, the cost of recovery of the energy performance of the building, the lack of effective technical experience of manufacturing buildings (see the domain is brand new); lack of awareness of the importance of energy efficiency in building, access to limited financial resources for this energy rehabilitation sector, difficulty in bringing stakeholders together by regional, national and city authority require parties for regulation in the field of energy efficiency and will be leaders for guides and their means the way, the steps that must be followed in this area are:

Make a rapid and efficient assessment of energy efficiency in the building sector: it must target the environmental criteria of the building which results in energy opportunity, identify the people concerned and determine the priority of realization of energy rehabilitation in the public buildings like hospital schools, exploitation of stakeholder data and use in our country, and start an energy efficiency program in the "residential" building sector.

3.2 **Improving energy efficiency in the building**

The impact of energy efficiency in the building is very important, with passive design that can reduce or eliminate the energy needed. In some countries, good thermal insulation and good management of thermal energy, just 10 to 25% of energy consumed for heating is an active energy activity in the residential building. In the warm country, a bioclimatic design and a significant impact in energy gains, for example, to paint the furniture with white and achieve a well-designed design.

With the political will, and also the competitiveness of the equipment industries in the field of energy efficiency, energy consumption in the building is reduced.

Energy efficiency and energy efficiency in the building is a characteristic compared to a category of total energy consumption or heating, air conditioning and lighting. The total energy consumption is calculated in relation to the architectural design of the building and also to the electrical equipment equipped in the building, an insulation technique and a management of energy consumption.

Energy consumption also influences the internal functioning of the building, the climate, the price of energy and the payment system and the habits of the occupants. These information enable Strategy Managers to track the win-win situation we can have by applying an energy efficiency model. This weight gain has been achieved in the context of improving the energy security of work and improving the quality of the tertiary sector.

Followed by a description of a major problem and obstacle that we can find in a study , the registration of an implementation tool for an energy efficiency policy is more flexible and more reliable.

This orientation provides interventions in three areas: the construction of new energy-efficient buildings, the energy rehabilitation in the building and the management of energy consumption in the building.

3.2.1 The advantages

The application of the concept of energy efficiency in the building is feasible for the type of immobile and exponential city, knowing that the majority of the city has already built ignoring or neglecting the energy efficiency rating in the building who represents significant financial potential in the area of energy efficiency gains.

The authority must guide this ideology to how to make the most of the city's potential by exploiting its strengths as local products and its location. The valuation of the gains can be done simply by calculating the time of profitability of the project of rehabilitation with the investment on the energy efficiency.

The majority of this type of investment makes cost savings in energy efficiency in less than five years, although the cost - effectiveness ratio is highly dependent on the nature of the building, whether new or old, weather conditions, and the price of unit energy. energy efficiency in buildings is based on the distribution of the three main areas: (i) reduction of heating, cooling, ventilation and lighting loads through improved design and construction; (ii) ensure the efficiency of energy-using equipment through upgrades and replacements; and (iii) actively manage energy consumption in buildings.

Reducing heating, cooling, ventilating, and lighting loads for new buildings or when renovating existing buildings : apply local climate-sensitive passive design techniques, such as building form, orientation, surface color, sun shading, building envelope insulation, air tightness, ventilation, etc.

Increasing the efficiency of energy-using devices and equipment : optimize system design and operation to match actual heating, cooling, and lighting loads through commissioning and retro-commissioning Upgrade or replace heating, ventilation, and air conditioning (HVaC) systems, indoor lighting, water heating, home appliances, and other electric and mechanical devices

Manage energy use in public and commercial buildings : Monitor, analyze, and control energy use through energy performance benchmarking establish new maintenance standards, label building energy performance, and communicate energy performance indicators to building owners/tenants organize information and awareness raising campaigns

3.2.2 Obstacle and Barrier:

We find many challenges when applying an energy improvement, and even sometimes, a first seen it can be discouraging. To find out more about the experiences of countries that have passed the three past decisions, we have highlighted several obstacles.

- Lack of exchange of information and publications on energy efficiency and benefits and improving the effectiveness of implementation capacity: lack of technical expertise in local markets to ensure compliance of ee codes Aversion to unknown materials, methods and equipment or uncertain results
- Lack of national and / or local commitment to ee in general, and in buildings especially internal government procedures and lines of responsibility that discourage public buildings protection policies that undermine the price signals for a efficient use of energy (for example, generally subsidized energy prices)
- Local government budget constraints Lack of long-term financing at moderate cost Short-term transaction costs for small individual investments Unattractive financial returns Unreliable repayments
- Shared incentives: investment decisions are made by actors who have direct financial benefits: decisions or suboptimal choices in terms of information on building trades: multiple professions involved in different stages or decision processes.

3.2.3 Solutions

It is very important for city leaders to know the challenges they face before going through an energy efficiency action plan for new or existing buildings. The key to implementing an energy efficiency policy is to assess the entire building sector or part of it, the approach will be defined in an energy efficiency assessment driving note.

It is necessary that the authority represents an example for the inhabitants by the application of efficiency in the municipal building, in order to sensitize them and to initiate. The authority of the city must work in coordination with the general government of the city, and the other officials and stakeholders, such as the bank owners of buildings and buildings, and also the electrical production services to share with them the problems found during the realization of the project.

The most important instruments of implementation of energy efficiency policy are sited there, it must be accompanied by a support program, which defines the action plans, in general it is more rational to have several plan of intervention.

Table 2 : Instruments of implementation of energy efficiency policy

Policy Tools	**Issues Addressed**	**Examples of Intervention**	**What City Government Can Do**
energy	Weak financial	Remove general	support and participate

Regulatory Policies	incentive to invest in EE by consumers Disincentive for energy utilities to invest in DsM activities due to lost sales	price subsidies for public, residential, and commercial users Decouple energy utility revenue from sales*	in national or regional policy reform programs
Mandatory standards and Codes	split incentives, fragmented building trades, fragmented building ownerships, etc. Underinvestment in ee by equipment makers	building energy efficiency codes Minimum energy performance standards for equipment	set and/or enforce standards encourage or mandate (public sector) purchase of ee equipment
labels and Certificates	lack of credible and consistent energy performance information and/or recognition of excellence	energy star label for equipment or buildings Green building rating systems	Promote the adoption of nationally/internationally recognized labels and certificates
financing facilitation	Insufficient financial incentive lack of commercial lending to ee Risk concerns of commercial lenders	subsidies for ee investments Dedicated ee fund and credit line Partial risk/credit guarantee	Use public funds to leverage private and commercial investments
energy Management	lack of transparent and consistent monitoring and control of energy use	energy performance benchmarking and disclosure	Require energy performance benchmarking and disclosure for large public and commercial

			buildings
Public sector financial Management and Procurement Policies	Disincentive for ee efforts in budgetsupported public entities Difficulty for public entities to contract energy service providers, or make ee equipment preferred purchase choices	Revise budgetary rules to allow retention of energy cost savings for other justified public spending Revise public procurement rules to allow for contracting of energy service providers and adopt ee purchase requirements	Make adjustments based on a city's own policy-making authority
Capacity building and awareness Raising	Inadequate knowledge and skills for beeC compliance lack of general awareness and sensitivity to energy waste lack of specific knowledge and skills to perform energy management duties	Train building trades on BEEC requirements and proper approaches Public campaign to promote efficient use of energy Train building managers of large public and commercial buildings	organize trainings and sponsor awareness campaigns

3.3 Energy efficiency in the new building

The building sector represents a good opportunity to reduce energy consumption (heating, air conditioning, lighting, etc.) and to implement an energy efficiency ideology, which will be profitable during its life cycle, and able to pay for their cost of energy production.

We can achieve its gains through the implementation of energy efficiency regulation in the building. Its codes can be achieved through data verification and consultation with domain specialists as well as with the project stakeholders. A conformity assessment system and also critical to ensure that the design follows its regulation of energy efficiency.

Everything depends on the regulation of a finished building, an evaluation of efficiency of equipment is required for the equipment installed within the building for the verified with the existing codes of the regulation of energetic efficiency, to define a minimum of consumption energy and standard for occupants.

A well-built energy-efficient building can gain a lot of energy, but even so, energy consumption also depends on the behavior of the occupants of the building and their building management habits.

Assuming that the components of a well-insulated building are reunited, which are:

1-the reinforcement of a policy and a governmental will of regulation of energy efficiency.

2-investor awareness to put their money in this type of project

Ex 01 | Enforcement of More Stringent BEEC Brings Greater Benefit

The city of Tianjin in China reduced the heating load of residential buildings built after 2005 by 30 percent (compared with those in compliance with the national code) through enforcement of its new and more stringent residential BEEC. Residential buildings built between 2005 and 2009 have saved energy equal to avoided investment in a new 300 MW-thermal district heating plant that would consume 200,000 tons of coal annually. This represents a significantly larger economic benefit than the incremental cost of complying with the more stringent BEEC.[35]

-The putting into practice of its laws passes by a hierarchic way which begins with the supreme authority of the government until the municipal administrations.

The application of its regulations is often voluntary so that the authority representative can verify their compliance with the codes listed, and that procurement stakeholders can meet the needs of the building sector.

The application of its regulations at the level of a city is more effective compared to that of a government provided that it is technically feasible and financially justified, all this contributes to the development of the city.

While some municipalities apply their own energy efficiency regulations themselves, a third-party enforcement option may be of particular interest to developing countries

35 Source | ESMAP 2011

and cities that are in the process of implementing a general system of energy efficiency compliance with the building code. A third party approach, which requires significant efforts to develop private sector capacity, allows a government to:

- Create a building code application service unit with a budget and staff to administer and implement a regulatory enforcement program.
- A compliance process must be established. Key elements will include the development of administrative procedures, compliance forms, checklists and procedures, user manuals or guides, compliance tools and software.
- Programs should be launched to train code makers, designers, architects and engineers, manufacturers and suppliers of energy efficiency regulations in the building
- Funding should be provided to cover additional upfront costs related to the adoption of new codes in the design and construction of more energy-efficient buildings and the installation of more energy-efficient equipment and materials, as well as monitoring and evaluation.
- Set a firm date for implementation. Developers, designers, subcontractors, manufacturers, and suppliers need to know the new regulations as quickly as possible, so that when the rules come into force, everyone will be able to comply.
- Evaluation of energy savings and the effectiveness of its new regulations. For future code revisions, the evaluation of actual results and experiences is important for improving standards and procedures.

This assessment process may include formal investigations, but must also be based on the issues raised by designers, builders and other parties involved.

The supervision of the regulatory audit authority may achieve a general interest in energy consumption mediation while standardizing the application of this assessment. The local energy code evaluation system guarantees the conformity of the building. The government may or may not need to cover the entire process of implementing its regulations (see Table 3).

Cities that have been successful in implementing energy efficiency regulations have strong political support, which is expressed through : the adoption of its strict codes and incentives (Table 4) for building owners to exceed energy efficiency standards, the support from the population by the application and the sensitization of energy efficiency in buildings , with the successful application of this codes the government will allow an extra funding that will help the municipal authority to create more jobs an bring the speecialists in domain of construction , develop the municipal knowledge in the field assume there champion position , creation of an energy compliance assessment process in the building permit filing , the improvement of the application of the codes which evolves the level of analysis of the phase of realization of the project , and lastly, it also results in a thorough training of the persons in charge of the application of its codes which allows the development of their knowledge and their mode of application of its rules.

Table 3 : Institutional Options for Enforcement of Building Energy Efficiency Codes

	1. Government Agency	**2. Private Third Party**	**3. Self-certification to Owner or Public Agency**
Key features	Government department or agency wholly responsible	Private third party is certified by government	builder provides compliance statement to owner or government
support Infrastructure needed	Government inspectors	Trained and certified third-party staff; some training of public-sector staff if spot checking	Checking of compliance statements; perhaps certification of builder
Cost to Government	High but may be recovered from builder	Moderate	Low Moderate if builders are certified
Cost to owner/ Developer	low unless agency charges	High	Low
Information and Infrastructure needs	Trained government assessors	Trained private assessors; certification process	Knowledgeable builders and owners; energy labels and certificates for buildings; some trained public-sector staff to check

			compliance
noncompliance Risk	low, provided adequate funding and training of inspectors	low to moderate. Third party depends on certification for income (but also on satisfied builders)	High, unless owner places high value on ee Moderate if self-certification to government low if builders are certified
Examples	United States: prevailing option	China (with some public oversight), France, Mexico, some in UK, some in US, pilot in Turkey	Germany (to owner)

Table 4 :Market Incentives for Adopting or Exceeding BEEC Requirements

Type of Incentive	**Intended Beneficiary**	**Direct/Indirect Benefits**	**Example of Practice**
Grants (partial) for design costs for homes/ commercial buildings beyond beeC for demonstration of buildings complying with voluntary code for audits	Developer, owner	Reduce incremental costs (of design, of ee building materials, equipment, and construction) Direct: reduce incremental costs Indirect: provide information on costs/ benefits of ee buildings	singapore (Green Mark)
subsidized loans/ Interest Rates	Developer, owner	Reduction of first cost	austria, Germany, Japan, netherlands, south Korea, Usa
EE or Green Mortgages	owner lender	Secure otherwise impossible mortgage Recognition; marketing advantage; lower default	Mexico, USA

		risk	
Tax benefits (e.g., reduced import tax duties or VaT rates for EE equipment)	Developer, owner	Reduction of first cost	USA
nonmonetary Incentives expedited Permits Relaxed Zoning Restrictions (size, density)	Developer	Reduced costs of doing business; increased earnings	south Korea, Usa
Awards	Developer, builder	Public recognition and marketing advantage	China, Usa (energy star buildings)
Rating systems	Developer, owner	Recognition; marketing advantage; higher market value of rated building	energy star (Usa), leeD and other green building rating systems in China, India, european Union countries, etc.

The major disadvantage of its rules and that it was conceived in pregnant counts an average even a minimum of thermal efficiency to connect to the market of the construction.

To solve this problem you just have to create a committee that updates its rules and develops as you refresh your information in relation to the current development.

Unfortunately, there is no concrete encouragement for people who exceed the regulatory threshold. Otherwise the energy audit will automatically cite the leaders of the field of energy efficiency in the building thing that will raise the bar of competition between building companies.

A number of well-established green building assessment schemes can be adopted by cities, such as the UK-based BREEAM and LEED (Leader in Energy). and Environmental Design) of the United States. . Singapore's Green Brand Program Approved by Government and Used as a Tool to Achieve National Green Building Goals (Ex 3)36.

36 A CASE STUDY OF THE GREEN MARK SCHEME IS INCLUDED IN MANAGAN, K. ET AL. 2012. DRIVING TRANSFORMATION TO ENERGY EFFICIENT BUILDINGS: POLICIES AND ACTIONS (2ND EDITION). MILWAUKEE, WI: INSTITUTE FOR BUILDING ENERGY EFFICIENCY, JOHNSON CONTROLS INC. RETRIEVED FROM: HTTP://

Ex 3 | Singapore Building Construction Authority Green Mark Scheme

Singapore's Building Construction Authority (BCA) Green Mark Scheme was launched in January 2005 with a strong focus on energy efficiency. It provides a meaningful way to differentiate the EE of buildings in the real estate market, thereby creating a positive effect on corporate image, leasing, and resale value of buildings.

The Green Mark Scheme is a key component of the government's Green Building Masterplan. It integrates mandatory requirements, voluntary ratings, and financial incentives for high achievers and is used as the basis for technical capacity building and to help determine government financial incentives for new construction or retrofits.

As a result of the scheme, the number of green buildings in Singapore rose from 17 in 2005 to almost 1,700 in 2013. The current Green Building Masterplan aims to green 80 percent of Singapore's building stock by 203037

3.4 Retrofitting Existing Buildings

The stable or slow growing urban city also represents an opportunity for energy renovation and also a major gain. But often the intervention suffered by the building affects the electrical equipment or consumer of energy by its replacement. It is feasible to replace old equipment with new ones that prove its energy capacity over periods of ten to twenty years.

While they do not touch the envelope of the building, except in case of ordinary maintenance, although the envelope is the direct part in charge of the heat loss and transfer. This area therefore represents a significant gain by its insulation, we can consume large sums consumed in heating and air conditioning. Its intervention of course must be guided by the climatic conditions and a financial justification.

It is still very difficult to have long-term bank financing in the area of energy regeneration especially when it is within a large-scale project despite its economic potential. It is important to have the support of stakeholders that represents the authority to be the leader for it to be an example to follow as in the case of several examples like in Chicago and London, the leadership of the municipal authorities has been essential. This section describes how cities can encourage and carry out renovations in the municipal, commercial and residential sectors.

WWW.INSTITUTEBE.COM/INSTITUTEBE/MEDIA/LIBRARY/ RESOURCES/ENERGY%20AND%20CLIMATE%20POLICY/ DRIVING-TRANSFORMATION-TO-EE-BUILDINGS.PDF

37 HTTP://WWW.BCA.GOV.SG/

In order to initiate the subject, municipal authorities must take the responsibility of being an example in the field of energy renovation, starting with state buildings such as schools, hospitals and hospitals. But before it must take into consideration its three criteria for a good mastery of realization of the project which are: the scope and depth of a renovation program; the delivery mechanism of the renovation program; and the financing and repayment terms of the project.

These questions will be treated with the concerned ones such as the persons in charge of the state-owned establishments the owner of the real estates and the person in charge of financial and energetic source. The mode of renovation is chosen in relation to the result of detailed energy audit made by the specialists of the field which are generally the entities realizer of energetic renovation.

For a realization and mastery of the project it is necessary to define the dimension and the scope of the project for that we must collect a maximum of information on the city concerning the cost, the duration, and the profit reported by this project, all that leads us to take the necessary precautions to realize our project. The city can take into account three levels of effort, depending on the availability of resources:

1- The simple work of households that costs absolutely nothing can make us win from 5 to 20% energy wasting

2- The old buildings are usually equipped with old equipment consuming more energy, with the replacement of old equipment (air conditioning, ventilation, lighting, heating, cooking ..ect) we can earn up to 30% energy

3- The rehabilitation of the envelope by isolating the walls of the building leads us savings in heating air conditioning and lighting a structure that saves us up to 40% of energy

Delivery mechanisms:

There are specialists in the field of energy rehabilitation to which we can entrust our projects, for the economic aspect the example of Chicago and London is a good example to follow in the type of contract chosen and even the mode of financing of the project, and it is effective for the city that can organize a separate financing. In this type of project we have to have a guaranteed corporation of realization of the project's profitability and that economic stability so that we can repay the loan. In certain city this type of renovation always remains difficult for them because the city has put rules and codes which prevent these financial aids.

The bank obviously cannot commit itself to cheap credit, and to convince the flow of treasuries it is necessary to have mechanisms which guarantee the economic gains from the energetic gain to repay its debts. An innovative approach used in Armenia is described in Ex 5.38.

Ex 4 | City-Led, Large-Scale Building Energy Efficiency Retrofit Programs

London's public building retrofit program, known as REFIT, aims to retrofit 40 percent of London's public buildings by 2025 through a combination of financing, which includes bank loans, public funds, and the London Green Fund, a dedicated climate investment fund. All retrofits are initiated under guaranteed savings contracts by prequalified energy service companies or ESCOs. A pilot retrofit program to reduce energy use in 42 public buildings, implemented from 2008 to 2010, demonstrated overall energy cost savings of £1 million per year against a total investment of £7 million. This success convinced the Mayor of London to expand the program to all the city's public buildings. As of 2012, the retrofitting of 111 buildings had or was close to being completed at a total investment cost of £13.3 million. The program currently has a pipeline of 400 buildings with estimated investment of £44 million .39

Retrofit Chicago is a municipal government initiative that is retrofitting one million square feet of city-owned assets. The work is being carried out by ESCOs under guaranteed-savings contracts financed by the Chicago Infrastructure Trust, a public-private partnership backed by funds provided by large private investors. The program has also established a voluntary initiative with the aim of reducing energy use by at least 20 percent within 5 years and has created a residential partnership providing a one-stop-shop at which building owners can access free EE measures, receive rebates on new equipment, and take advantage of low-cost financing for other upgrades40.

Ex 5 | Capturing Energy-Savings Cash Flow for Repaying Energy Efficiency Investments

The R2E2 Fund is a national investment facility for renewable energy and energy efficiency in Armenia, which finances municipal building retrofit projects through the scheme illustrated in the chart. It enables municipalities to retrofit their public buildings, using energy-cost savings through an escrow account to repay extra budget investment provided by the R2E2 fund. Two critical conditions are needed for this scheme to work: (i) a dedicated EE fund whose main objective is to invest in

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38 Financing Municipal Energy Efficiency Projects: Mayoral Guidance Note #2 (ESMAP Knowledge Series 018-14) contains more specific advice on how to select appropriate financing options.

39 (http://www.london.gov. uk/priorities/environment/climate-change/energy efficiency/buildings-energy efficiency-programme).

40 (http://www.cityofchicago. org/city/en/progs/env/retrofit_chicago.html)

financially viable public sector EE retrofits and (ii) participating cities' ability to set aside utility payments in a protected escrow account.

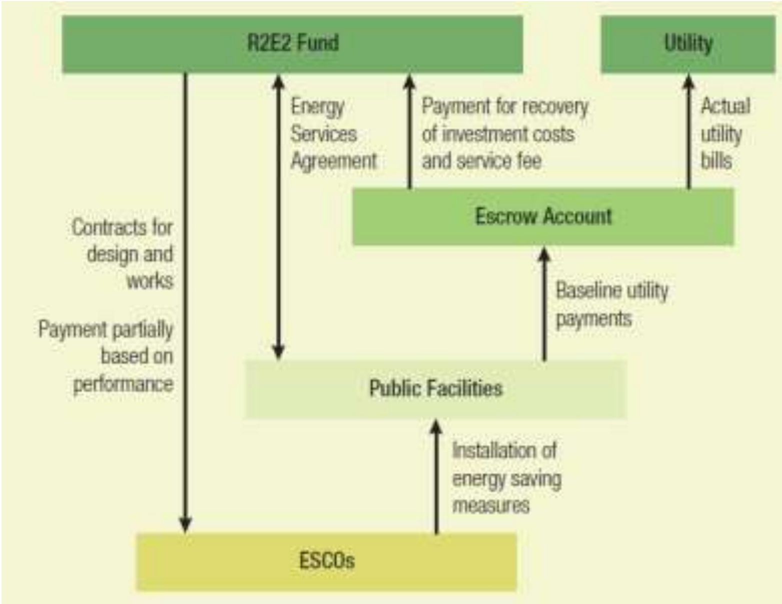


Figure 8: Capturing Energy-Savings Cash Flow for Repaying Energy41

3.4.1 Retrofitting Commercial Buildings

In commercial buildings, to facilitate investment and push banks to engage in such energy efficiency project, it is necessary that the authority inscribes laws that guarantee the gain and then the repayment of debts. The city of Melbourne Australia is a concrete example of the procedures to create for commercial buildings as part of the energy retrofit. Among the interventions made by the government put surcharges to the tenants, who basically have to accept his renovations, and then inject them directly into the financial account that have participated in this renovation until all his debts are repayable.

This surcharge will not create any damage to the tenants because they will recover them from the difference of energy bill42. Government financial incentives such as grant subsidies for commercial retrofits could be used to encourage comprehensive retrofit projects. This can help prevent the cherry picking of partial retrofit projects by market participants.

3.4.2 Retrofitting Residential Buildings

It is a little difficult to renovate the residential building because of several parameters. The difficulty of the site due to the inconvenience of the building work is also low

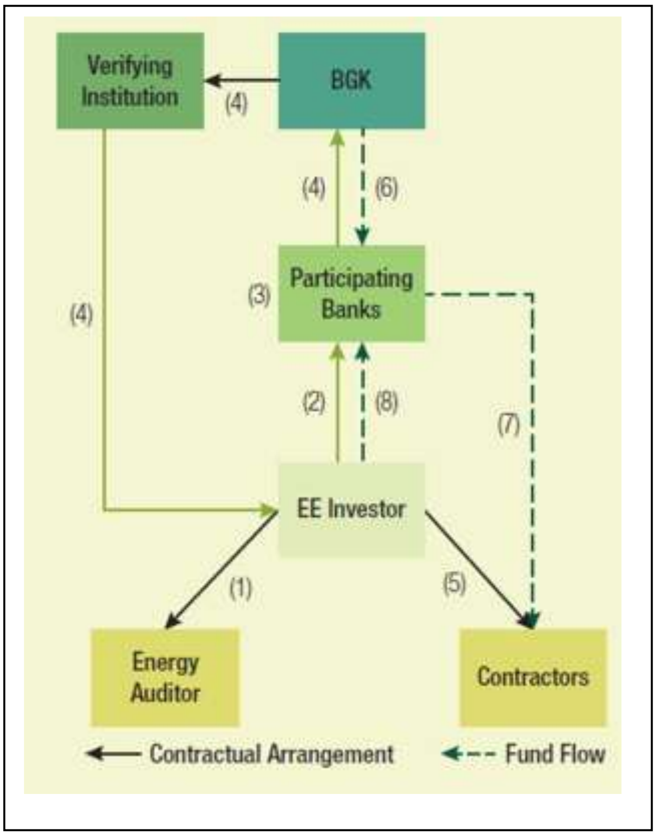
41 WWW.ESMAP.ORG/ENERGY_EFFICIENT_CITIES.
42 HTTP://WWW.SUSTAINABLEMELBOURNEFUND.COM.AU/ SITES/DEFAULT/FILES/ENVIRONMENTALUPGRADEFINANCE BROCHURE.PDF

compared to the other types of building. ect. The majority of its renovations are at the level of equipment such as the replacement of halogen lamps by others in LEDs, refrigerator energy consumer with other more efficient replacement of new types of windows. The issue for pushing homeowners is via media awareness or financial encouragement or regulatory requirements of electricity companion.

The process of complete renovation in homes located in cold areas can generate significant revenue, and it goes through three stages:

Long-term bottom providence, the certainty that the project is not expensive and low-slice repayment, examples of successful financing and delivery mechanisms for large-scale residential renovations in cold climate regions are often associated subsidized national programs, such as Poland's thermal modernization program, which subsidizes commercial loans to businesses Supporting the creation of such national programs would benefit cities

Ex 06 | Implementation Arrangements of Poland's Thermo Modernization Program



1) EE investor (e.g., condominium association) hires an energy auditor to conduct an energy audit and design EE measures
2) EE investor submits both loan and grant application to the participating bank
3) The participating bank appraises application package
4) BGK (the national development bank) reviews whole application package and commissions an independent verification of the energy audit submitted
5) Once approval by BGK, Contractors start to implement EE measures
6) Upon project completion, BGK disburses the grant (up to 20% of

7) Participating bank makes payments to contractors after receiving their invoice
8) EE investors repay bank loan by installments, for example, through increased condo fees

loan amount) to the participating bank

to reduce the outstanding principal of

the EE loan

Successful experience of large-scale residential retrofit at the city level is still emerging. The Property Assessed Clean Energy (PACE) scheme in the US is an innovative financing and repayment scheme that supports EE and renewable energy projects in residential and commercial buildings by providing up-front capital that is subsequently paid back through a special assessment on participants' property taxes or a special surcharge. Two examples of city-level PACE programs are provided in Ex 7[43].

Ex 7 | Innovative Residential Retrofit Programs at the City Level

Babylon, NY: Begun in 2008, the Long Island Green Homes program uses funds from the town's solid-waste reserve fund to provide financing for efficiency or renewable energy projects. After undergoing an audit, the town pays contractors directly; property owners pay back the cost via a trash bill surcharge with 3 percent interest.

Boulder County, CO: The Climate Smart Loan Program provides financing to residential and commercial property owners for efficiency or renewable energy projects. The program was established with S$40 million in funding financed by tax-exempt bonds issued by the county[44].

43 HTTP://ASE.ORG/RESOURCES/PROPERTY-ASSESSED-CLEAN- ENERGY-FINANCING-PACE

44HTTP://ASE.ORG/RESOURCES/PROPERTY-ASSESSED-CLEAN-ENERGY-FINANCING-PACE

4 Methodology

4.1 **Introduction**

In Algeria, as in the world, the concept of energy efficiency has recently been introduced in the building industry; whether it is in a new or existing building it must follow certain regulations and techniques, because energy consumption is the concern of everyone.

To reach this goal; an energy balance is essential when designing or renovating a building. In order to regulate and frame the field of research, regulations were made on the energy efficiency of the building; which is based on formulas that specify the heat losses (in winter), because we must minimize losses to gain energy, also the same for the case of intake in summer, it reduces the energy consumed in air conditioning. The ventilation side is also taken into account in order to manage it and make it useful by channeling it.

To achieve a project that is suitable for energetic regulations it is first necessary to choose the right insulating materials as well as the architectural design itself plays an important role, since the dimensions and types of the wall directly affect the energy balance.

The thermal calculation is a complex and variable calculation according to the nature of the walls. For the sake of simplicity software and applications were developed to help specialists determine the energy needs of the building.

4.2 **Insulation technique**

4.2.1 *Insulation of exterior walls*

Several exterior wall insulation techniques exist: insulation from the inside, from the outside, by filling, use of insulated formwork.

4.2.1.1 Isolation of the walls from the inside

It involves juxtaposing an insulating wall on the inside of the walls.

• Advantages: easy to achieve, economical.

• Disadvantages: reduction of internal volume, difficulty of treating thermal bridges.

The two main techniques are: insulation complexes or sandwiches glued to the wall or fixed on cleats, or the insulators behind the doubling wall; this last technique generally makes it easier to hang the furniture. When using an insulation behind a contrecloison, it is better to use bricks of clay, concrete blocks or blocks (minimum 5 cm). The insulation incorporated between the wall and the partition is generally polystyrene, mineral wool in semi-rigid panels or expanded polyurethane. The space behind the partition is filled with insulation. If there is a risk of rainwater infiltration, it is preferable to provide an air gap between the external masonry and the insulation by means of wedges. In very cold areas (more than 600 m above sea level), a vapor barrier should be placed on the inside of the insulation45.

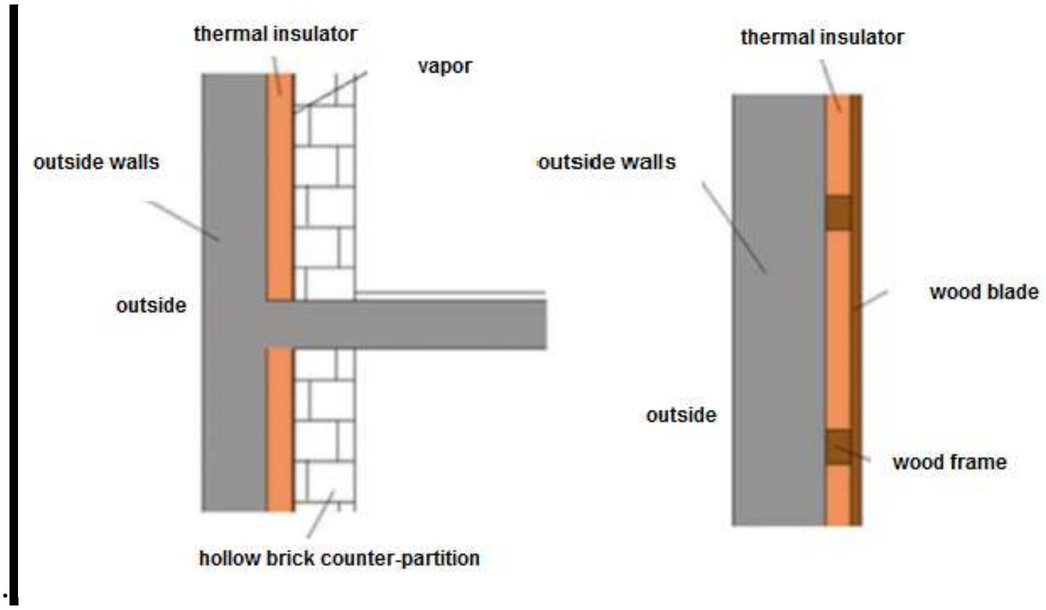


Figure 9 : Examples of interior insulation

4.2.1.2 Insulation of the walls from the outside

The insulation is placed outside the wall:

• Advantages: unchanged internal surfaces, reduction of thermal bridges.

• Disadvantages: high cost, problems related to insulating behavior (detachment).

Several techniques exist; the most common are those using cladding, cladding and

cloaks. The most used cladding are wood or metal framing and cladding made of traditional material: slates, tiles, ceramic, wood, zinc, natural stone, etc. The insulation used is generally made of non-hydrophilic semi-rigid mineral wool panels. Insulation does not include a vapor barrier; it is fixed mechanically or by bonding to the wall.

45 APRUE

The system includes a ventilated air gap with a minimum thickness of 20 mm between the insulation and the underside of the cladding. The anchoring of the frame fasteners in the support wall is generally done by pegs adapted to the wall. The study of the type of fastening and their density must take into account the weight of the cladding and the maximum forces due to the wind. A cladding consists of an insulator and a cladding of similar size to the insulation placed at once on the wall by mechanical fastening. A cladding consists of a cladding fastened through the insulation usually by peg screws, the thermal insulation is posed by gluing or by mechanical fixation. The most commonly used insulation is based on expanded polystyrene.

These systems generally have good durability46.

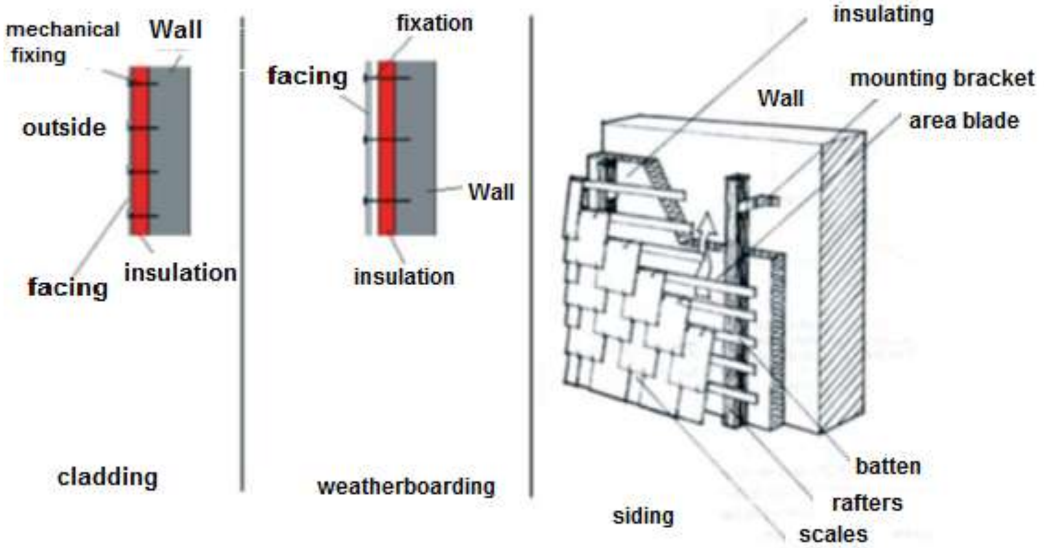


Figure 10 :Insulation from the outside47

4.2.1.3 Insulation of walls by filling

This concerns walls with an air gap. These walls can be insulated by filling by the injection of a foam (urea-formaldehyde, polyurethane), or by insufflation of a loose insulation.

In the case of the use of loose insulation, the insulating material is blown by a machine into the air gap through holes drilled in one of the walls. Bulk insulation is very often made up of extruded polystyrene chips. The air gap must be at least 3 cm thick; the

46 HTTP://WWW.TINFISHCLEMATIS.COM

47 HTTP://WWW.TINFISHCLEMATIS.COM

outer wall must be more than 15 cm thick. In very cold zone (at more than 600 m of altitude), it is advisable to place a vapor barrier on the inside of the insulation48.

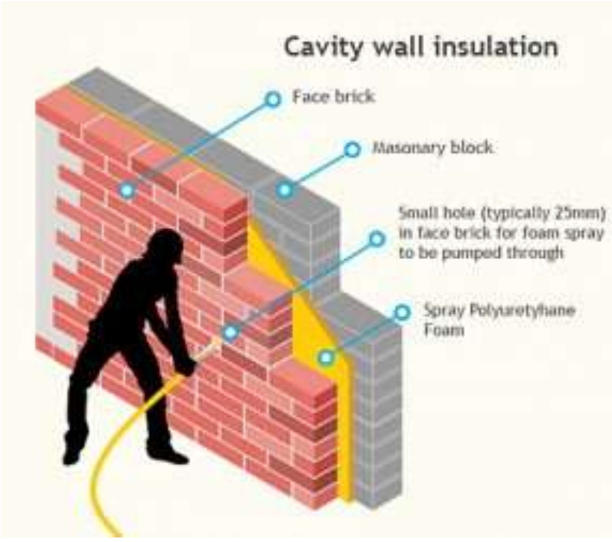


Figure 11 : Insulation by filling

4.2.1.4 Insulating form systems

The construction is carried out with modular systems that serve as starting formwork during taking the concrete, then once the walls made, they provide the function of insulation. The insulation material used is very often polystyrene. Considering the constructive system shown in the figure above, we first put polystyrene sheets and welded mesh sheets. Reinforcements are then arranged at the singular points (angles of the openings). Finishing is carried out by applying two layers of mortar executed by means of a lance49.

48 HTTP://OPTIMALINSULATION.COM

49 HTTPS://THECONSTRUCTOR.ORG

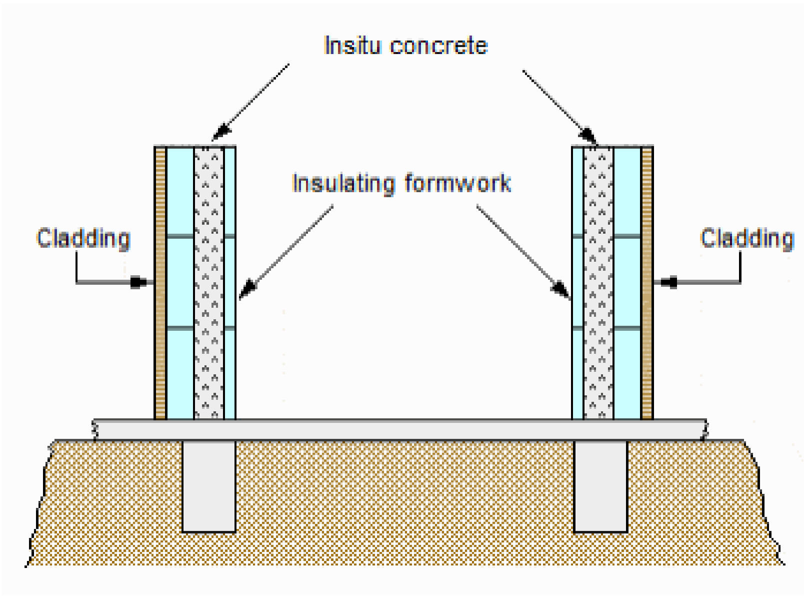


Figure 12 :Insulating formwork

4.2.2 *insulation by vegetal wall*

Designed by Stefan Grass, a Swiss agricultural engineer, the process of making grass insulation follows different steps. The meadow grass is first mowed. Then, the digestive materials are separated from the fibers: the latter are dried before being bonded together by adding 7 to 10% of polyethylene. As in the manufacture of insulation from plant or animal wool, boron salts are then added to the grass insulation to improve fire and fungi resistance.

4.2.2.1 Grass insulation, an approved process

The grass insulation complies with the standards in force and is approved at the European level. Its thermal conductivity is between 0.034 and 0.038 W / m.K, the equivalent of more conventional mineral wools. The grass insulation also comes in different thicknesses and dimensions to allow a variation of the thermal resistance: available densities range from 30 to 80 kg / m3.

Note: grass panels are non-allergenic and are suitable for both indoor and outdoor insulation50.

50 WWW.LENERGIETOUTCOMPRIS.FR

Figure 13 :Details of vegetal wall

4.2.2.2 The benefits of grass insulation

• Interesting performance: the lack of mushroom development and a very low coefficient of resistance to steam diffusion from a grass panel make it an effective insulator for regulating the humidity of a building;

• Easy handling: Grass panels cut and install easily. They do not require any specific equipment;

• Highly affordable price: At equal performance, a grass insulation board costs half as much as a hemp or linen board;

• Fast manufacturing process: 2 hours is enough to produce enough panels to insulate a cottage.

• 1 hectare of meadow is enough to produce 200 m3 of grass insulation, enough to isolate 7 individual dwellings.

4.2.3 Insulation of the floors

4.2.3.1 Floors on crawl space

Three possibilities exist:

- Insulate the wall from the outside; in this case, there is interest in extending the insulation of the walls along the base to the ground to a depth of about 30 cm;
- Isolate at the interior perimeter if the height of the crawl space allows it (> 80 cm); expanded polystyrene panels or polyurethane can be used;
- Place an insulation under the floor as in the case of a non-conditioned floor.

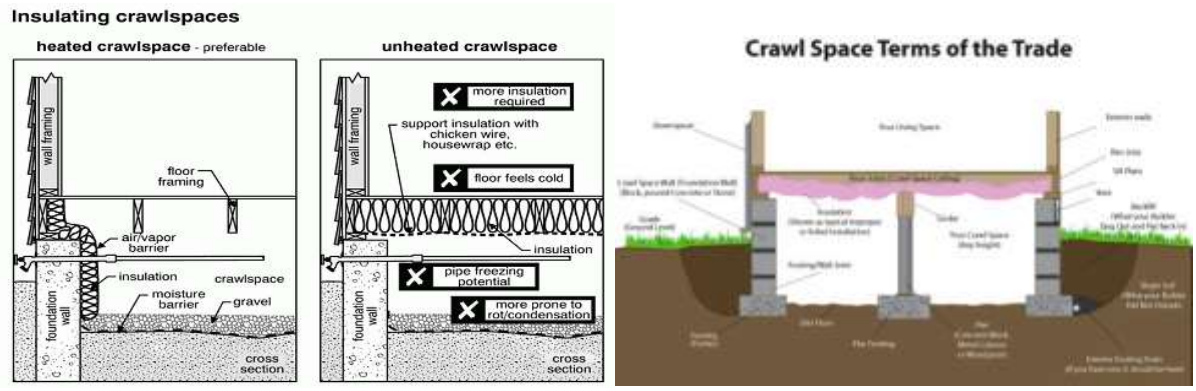


Figure 14 Insulation of the floors51

4.2.3.2 Insulation of floors on unheated premises

The most used techniques are:

• Insulation under the floor by manufactured panels; for this purpose either complex insulating-plasterboard panels or rigid fiber panels minerals are used. These panels are screwed into the floor either directly or via smooth wood or metal;

• Foam projection insulation; rock-fiber projection techniques with hydraulic binder are traditional, and these techniques are well suited to non-planar sub-faces; the support must be dusted and prepared as needed; the floor must be weakly solicited mechanically; no vapor barrier is needed52**.**

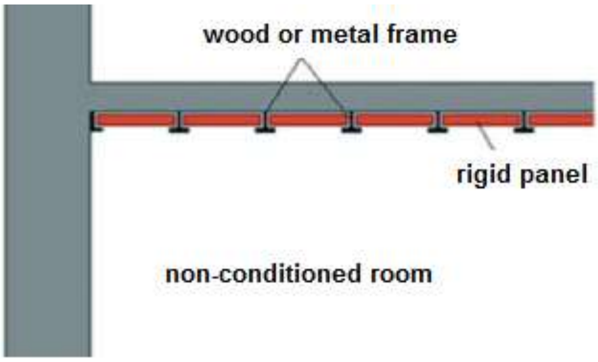


Figure 15 :Insulation of low floors on non-conditioned premises53

4.2.3.3 Floors on the ground

The low floor, very often a reinforced concrete slab rests on the ground or on a lifting of gravel and sand (hedgehog). In most cases, it is difficult to isolate such a bedrock. In addition, the losses through such a bedrock are low and the inertia brought by the

51 CIALISALTO.COM

52 HTTP://WWW.ISOLANTIINDEX.IT

53 APRUE ,GUIDE POUR UNE CONSTRUCTION ECO-ENERGETIQUE EN ALGERIE

median can be interesting in summer. This is why, in the Algerian context, the insulation of low floors is not considered. The most interesting solution is to insulate the walls from the outside, that is to say isolate the basement on its periphery as an extension of the insulation of the walls. This solution makes it possible to limit losses, to eliminate thermal bridges and to benefit from the thermal inertia of the platform.

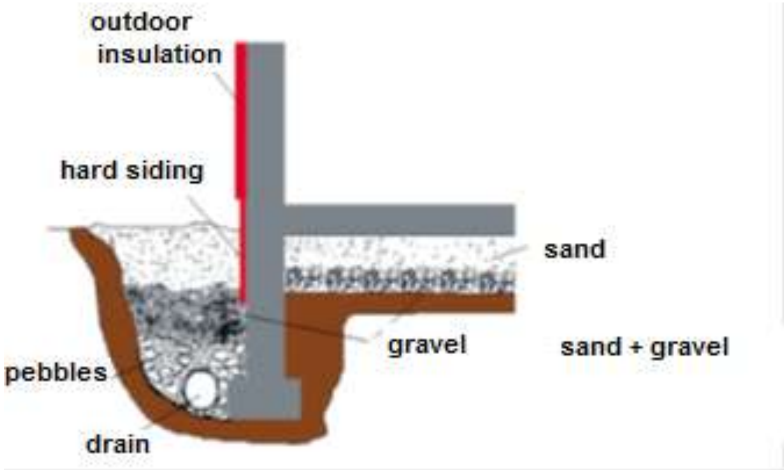


Figure 16 : Insulation of low floors on the ground54

4.2.4 Insulation of the attic

A roof is a part of the building located under a so-called light roof. If the roof is lost, simply deposit one or more layers of insulation on the floor to achieve. Mineral wool rolls or panels of insulation are used. It is also possible to use bulk insulation blown or spread blowing glass wool, rock wool, expanded polystyrene beads or chips, etc.

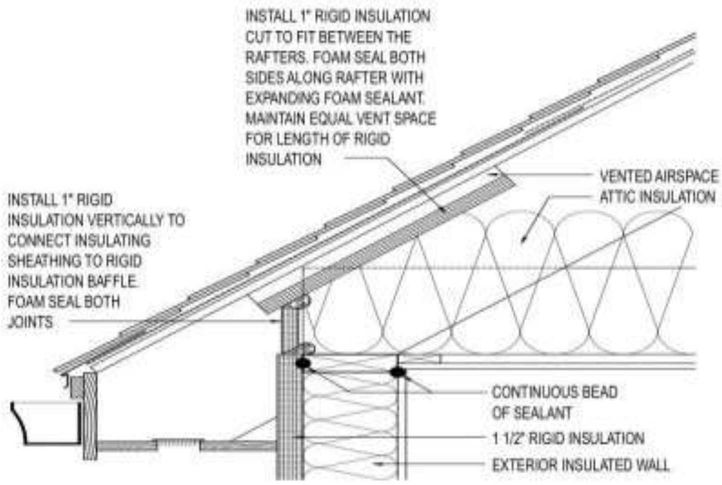


Figure 17 : Insulation of the attic55

54 : APRUE ,GUIDE POUR UNE CONSTRUCTION ECO-ENERGETIQUE EN ALGERIE

55 BASC.PNNL.GOV

4.2.5 Insulation of roof terraces

A roof terrace is a heavy roof made of reinforced concrete or beams and interjoists at very low slope (less than 5% in general). Its insulation is never done under the face of the slab (side inside). If this were the case, the roof slab would be subject to heavy thermal stresses and expansion induced could cause cracking of the walls to the right of the supports. Three solutions exist:

- The insulation is a sealing support; it is the current solution adaptable to all supporting elements; the most widely used insulation is polyurethane in sheets;
- The insulation is over the waterproofing (inverted roof); the insulation is most often composed of extruded polystyrene panels not glued to the support;
- The insulation is in the form of a split slope; this solution is almost abandoned in Europe, but remains very much used in Algeria; the purpose of fractionation is to reduce the shrinkage effect and to reduce the effects of dimensional variations due to temperature variations. In Algeria, the current spacing between joints is 25 m in coastal wilayas and in the Highlands, and 20 m in the South; the installation of a vapor barrier is not essential56.

56 ENERGYGUILD.HUBPAGES.COM/HUB/INSULATING-A-FLAT-ROOF

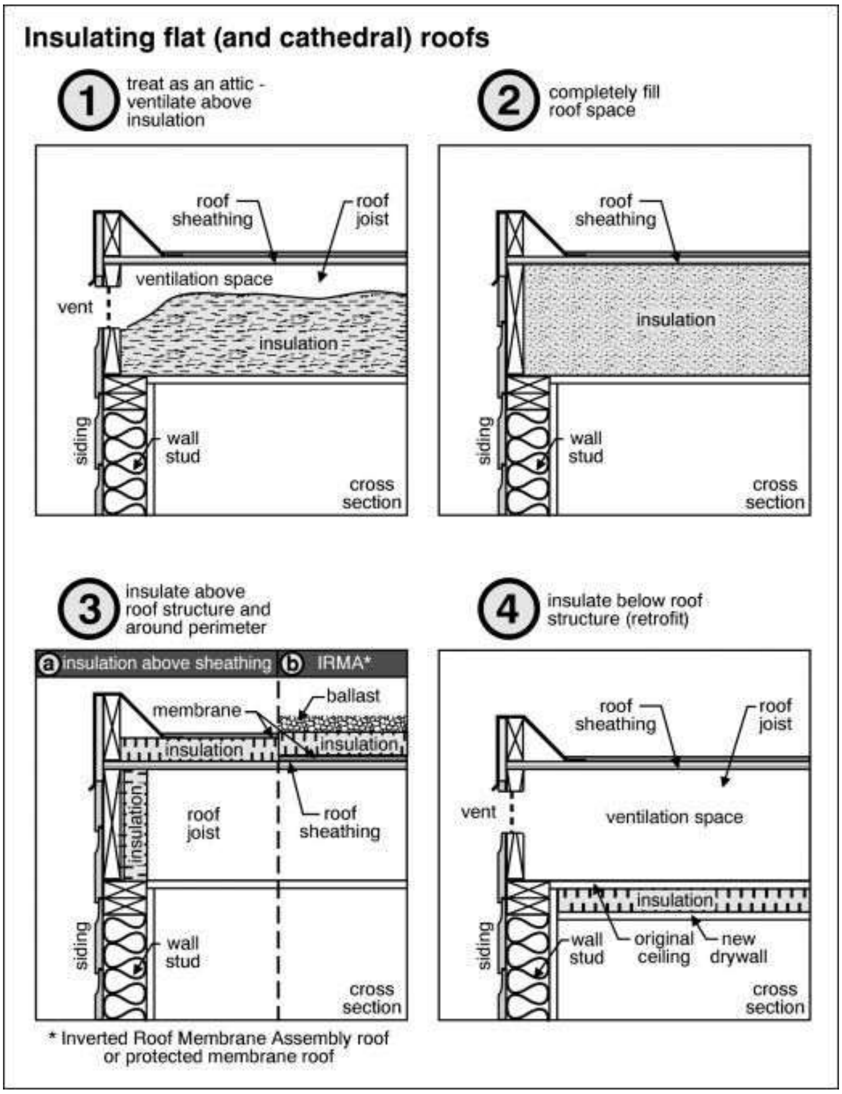


Figure 18 :Insulation of roof terraces

4.2.6 Windows

Windows are weak thermal points. Heat transfers have two origins:

• heat transfer through glazing and carpentry;

• parasitic air passages between opening and sleeping.

To improve the thermal performance of windows, several solutions exist:

• use of caulking products to reduce the airtightness between the opening and the frame (foam seal, silicone sealant, etc.); for reasons of hygiene, it is necessary to caulk in a careless way in order to preserve the renewal of the air of the premises;

• insulating double glazing; composed of two sheets of glass kept at a distance by a frame; the thickness of the latter (and therefore that of the air gap) is usually equal to 6, 8, 10 and 12 mm.

Within the air space, a desiccant material is inserted (silica gel) so that to eliminate the water vapor contained in the air space; the whole is sealed with sealants elastomers; it is possible to improve the thermal performance of a double glazing unit :

• replacing the air with a less conductive gas such as argon;

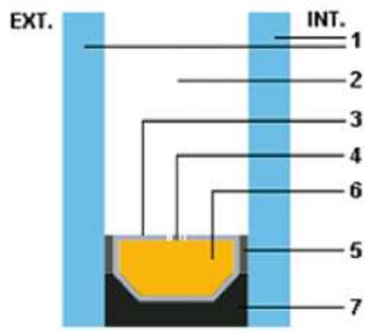
• reducing radiation from one glass to another; the emissivity of the glazing is reduced by depositing a thin film of metal oxides on the internal faces of the double glazing, which is called low-emissivity glazing;

• double windows; this solution is effective both thermally and acoustically;

• Installation of closures (shutters, shutters, etc.), the establishment of a closure allows to create a substantially immobile air space, and thus improve the thermal performance of windows.

• Fabric curtains: This solution is economical, simple and effective. It has a significant effect on the interior temperature of a space because it reduces the absorption of solar rays

The proper functioning of the sealing barriers and desiccant conditions the life of the glazing. The composition of the double glazing is given by three values (in mm): thickness of the outer glass sheet / thickness between glass sheets / thickness of the glass sheet (4/12/4 for example). The guarantee of efficiency of double glazing is 10 years. But the actual life is much better57.



1.glass sheet
2.dehydrated air
3. Spacer fixing between the glass sheet
4.opening for moisture absorption
5.First sealing bar
6.dessicant
7. second barrier made of polyurethane or

.

Figure 19 :Principle of double glazing *58*

As for aluminum joinery, it is preferable to opt for joinery with thermal break. As aluminum is a conductive material, manufacturers introduce into the frames a thermal

57SOURCE : WWW.ENERGIEPLUS-LESITE.BE

58 WWW.ENERGIEPLUS-LESITE.BE

cut-off system consisting of bars. These insulating strips are most often made of polyamide, polyurethane or PVC.

The following figure shows some values of K coefficients of windows. The value of this coefficient K can be halved if double glazing is used. Replacing air with argon does not significantly improve window performance.

The windows are also the source of important contributions due to the sunshine. These contributions, interesting in winter, are no longer in summer. When glazed surfaces are important, it is sometimes necessary to opt for special glazing in order to reduce air conditioning loads.

The special glazing units are characterized by a solar factor, denoted F, which is equal to the ratio of the total flux transmitted by the sunscreen glazing unit (glazing units and protections) to the flux transmitted through an ordinary bare glass (thickness 3 mm).

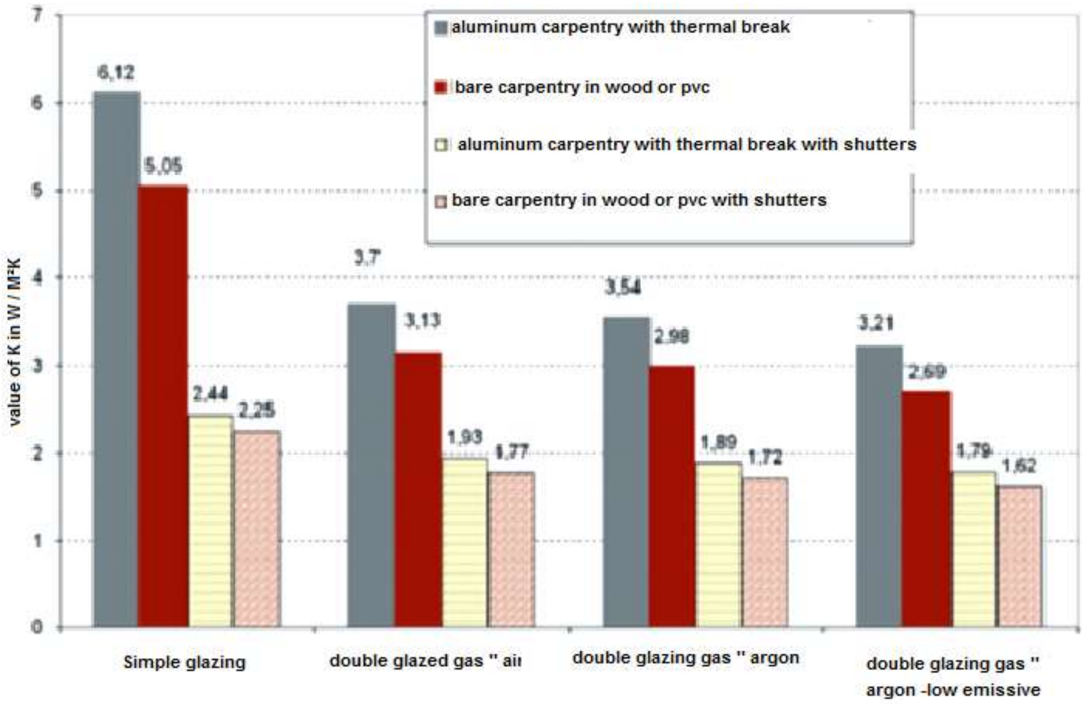


Figure 20 :Coefficients K - Casement windows

For an antisolar glazing unit, F is less than 1 in order to reduce the solar factor of the glazing, several solutions exist:

- The glass used has a large thickness (up to 12 mm), so it absorbs more solar flux;
- The glass can be colored in the mass using metal oxides, which also has the effect of increasing the absorption factor of the glazing; we speak of absorbent glass;

- The outer face of the glazing can be treated by hot application of metal oxides, which has the effect of reflecting part of the incident solar flux; we talk about reflective glazing;
- The outer face of the glazing can be coated with a special reflective film, translucent, very bright appearance in order to reflect a significant proportion of incident solar flux (3M ScotchtintTM sunscreen film).

The following figure shows some values of solar factor of windows. Reflective ice ordinary reduces the incident solar flux by almost 50%. The application of a reflective film makes it possible to reduce by nearly 75% the incident solar flux.

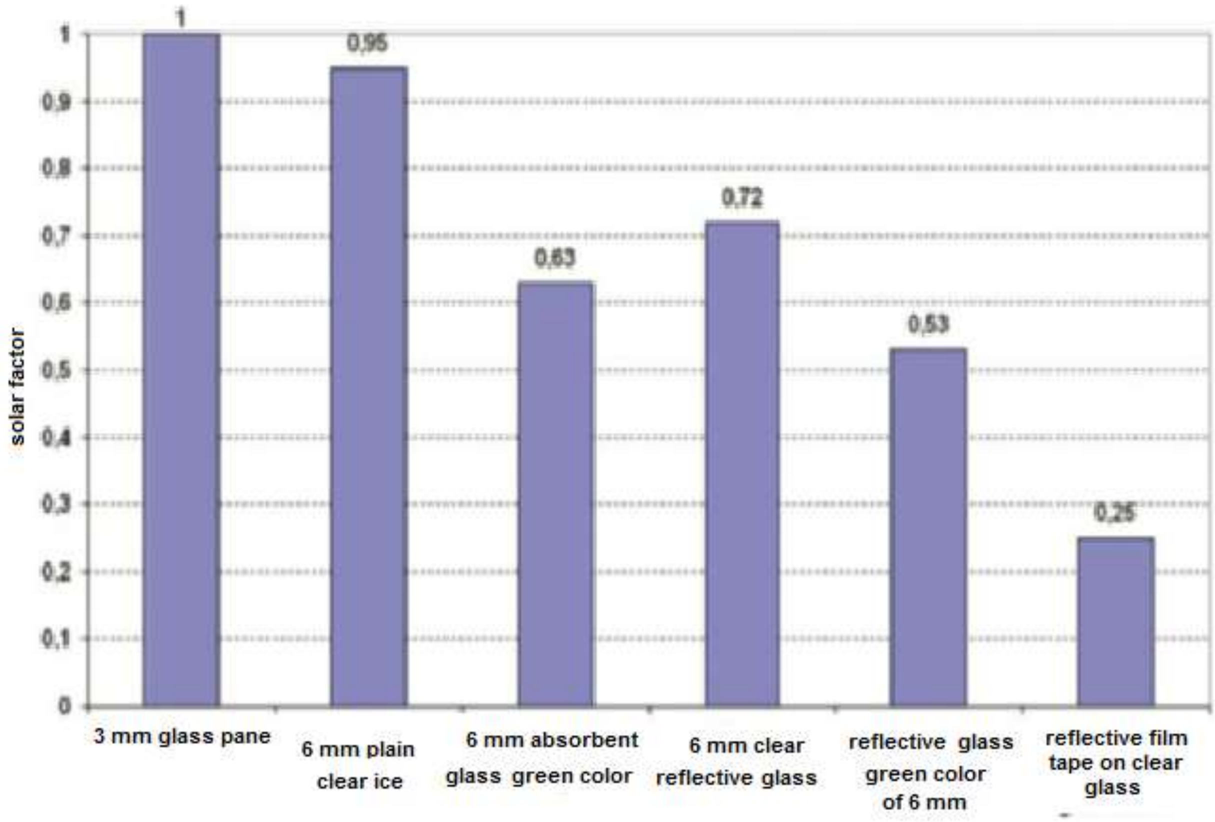


Figure 21 : Solar factor of some glazing

4.3 Thermal Regulation

4.3.1 Introduction

Thermal regulation, often abbreviated as "RT", is a device that determines the thermal characteristics of new buildings. It sets the maximum amount of energy that can be consumed by a building to be heated, lit, produce hot water, be air conditioned and ventilated. These thermal regulations bring increasing demands in terms of energy saving, building insulation and ecology, with the use of materials and renewable energies.

4.3.2 Regulation in the world

The first thermal regulation texts date from 1974 for the residential sector (imposing a coefficient of losses G lower than a reference threshold) and 1976 for the non-residential (imposing a coefficient of losses G1 lower than a reference threshold).

It applies to all new buildings, residential and non-residential, and imposes the simultaneous respect of 3 conditions:

1) a reference energy consumption level (Créf) not to exceed C <Créf (Th-C rules) taking into account:

    - heating
    - ventilation,
    - air conditioning,
    - the production of domestic hot water,
    - lighting of premises (non-residential).

2) an indoor summer reference temperature not to be exceeded (in case of no air conditioning) Tic <Tic ref (rules Th-E)

3) minimum performance for thermal insulation of walls and racks, for heating, ventilation, domestic hot water, air conditioning, lighting and solar protection U pack <1.3 U (average coefficient of losses by walls and bays).

In addition, every building must allow the possibility of changing the heating and energy used (principle of reversibility provided by the law on air).

Two modes of application of the regulation are possible:

- either by justifying the choices by the calculation
- by using approved technical solutions.

4.3.3 Algerian thermal regulations

In Algeria, the 1997 thermal regulation of residential buildings was designed to reduce heating consumption by around 25%. A reflection is currently engaged to bring this level of economy to more than 40%. To do this, numerical simulations were conducted on typical dwellings. The study shows that by acting solely on the limitation of thermal losses by transmission, it is possible to achieve this new objective while substantially reducing the summer cooling load. A new thermal regulation could be based on the following two principles: reserve the 1997 regulation for individual housing, define new regulatory coefficients that are more restrictive for housing in multi-family housing.

The rules for calculating heat losses, DTR C 3-2 and DTR C3-4, define the minimum thermal performance but also include design conventions for the design of heating and air-conditioning systems. The Algerian regulations are largely based on French regulations, but the calculation methods used are simpler, it allows, at least within certain limits, the computerized calculation of heating and cooling requirements. This is a positive point since it allows taking advantage of the thermal inertia of a building; a very important factor given the type of climate and existing buildings differ in Algeria. Regulations that take into account thermal comfort are taken into consideration especially during warm periods. Such regulation is of paramount importance given the problem of comfort in the summer period and the energy consumption due to air conditioning used in many parts of Algeria.

The development of the DTR C3-31 "Natural Ventilation - Residential buildings" responds to the concern for energy efficiency, which is the subject of the concerns contained in Law 99-09 of 28 July 1999 on the control of energy. This DTR makes it possible to define the general principles that regulate the design of natural ventilation systems and to provide the calculation methods necessary to size them. Nevertheless, the present DTR does not deal with flue gases for the evacuation of combustion products from gas appliances, nor with smoke extraction systems (flue gas evacuation in case of fire).

4.3.3.1 Stage of application of the DTR C 3-4 (air conditioning) regulation:

The heat input must be determined according to the following steps:

i. Definition of thermal zones (or volumes);

A thermal zone is a volume of air whose internal conditions are assumed to be homogeneous. In our case, the defined volume belongs to the same zone since it is considered as a unit volume.

ii. Determination of the critical time interval:

For this purpose, for each facade, the time is determined which corresponds to the maximum gains by transmission through the opaque and glazed walls. In our case the critical hours will be determined for each façade in the appropriate steps.

iii. Calculation of effective calorific contributions

This step is the essential part of the rule because it is in this step that the balance sheets and the different powers are calculated in the flowchart that follows. We will summarize the various parameters to calculate and the order of calculation to establish our balance sheet:

1. Contribution through the walls :

- Opaque wall overlooking the outside
- Aerial opaque wall overlooking a non-conditioned room
- Wall in contact with the ground

2. Internal contribution due to:
   - the occupants
   - the devices
   - machinery
   - lighting
   - gas appliances
   - tanks
   - free evaporation
   - the living steam
   - pipes and air ducts
3. Introduction of an area :
   - Introduction of fresh air
   - By infiltration

4.3.3.2 Stage of application of regulation DTR C 3-2 (heating):

4.3.3.2.1 Regulation definition:

It is generally considered that the role of a heating installation is to heat the rooms of the human habitation in winter. Its task is more precisely to regulate the heat release of the human body during the coldest season, by warming its environment, in order to establish a balance between production and heat loss, and to ensure the human being a thermo-physiological comfort. Subsequently, in order to quantify this quantity of equilibrium heat, it will be necessary to proceed to the establishment of loss balances, In this initiative there are several methods to estimate the different losses. For our study we will try to identify the Algerian rule that allows the development of this report.

4.3.3.2.2 Object of the rule:

The regulatory technical document (DTR) was designed to allow:

- The determination of the heat losses of buildings;
- Verification of building compliance with thermal regulations;

- Sizing of heating installations of buildings; we then introduce the concept of heat loss "base";
- Thermal design of buildings.

4.3.3.3 Stage of application of the DTR C3-31 regulation (natural ventilation):

4.3.3.3.1 Regulation definition

The Regulatory Technical Document (DTR) provides the general principles that should be adopted when designing natural ventilation systems The regulatory technical document also provides calculation methods for sizing natural ventilation systems.

4.3.3.3.2 Application domain

- New habitat
- New construction
- Construction transformed into habitat

4.3.3.3.3 Ventilation Natural type

- By the insecurities
- By vertical duct
- By device on the roof

4.4 Energy Efficiency Assessment System

Table 5 : Algerian thermal equation

TYPE	**Equation**	**désignation**	**classification**		
			Nb	**évaluation**	**Check point List**

Contribution of glass panel	**Contribution of glazed panel due to temperature**	AVT = 1, 2 . Kété . Souv . [TSe - TSb,i] [W]	- Souv (in m²) is the area of the opening in the opaque panel, - TSe (in ° C) is the dry outdoor temperature - TSb, i (in ° C) is the basic indoor temperature.	1	Indicator I ≤ 0,25	5
				2	0,25 < Ind I ≤ 0,45	4
				3	0,45 < Ind I ≤ 0,65	3
				4	0,65 < Ind I ≤ 0,85	2
				5	0,85 < Ind I ≤ 1,05	1
				6	Indicator I > 1,05	0
	Provides sunny glass panel	AVE = [SVens . It + (SV - SVens) . Id] . FS . NPVI [W]	- SV (in m²) is the total glazed area, - SVens (in m²) is the glazed glazed surface - It (in W / m²) is the actual maximum total radiation - Id (in W / m²) is the maximum real diffuse radiation - NPVI (t) represents the damping coefficient relative to gains by sunshine through the glass panel - FS is the solar factor of the glazing	1	Indicator II ≤ 0,25	5
				2	0,25 < Ind II ≤ 0,45	4
				3	0,45 < Ind II ≤ 0,65	3
				4	0,65 < Ind II ≤ 0,85	2
				5	0,85 < Ind II ≤ 1,05	1
				6	Indicator II > 1,05	0

Thermal contribution of the opaque panel		APOmur,toit = 1,2 . Kété . Sintmur,toit . Δte(t) [W]	- 1.2 (dimensionless) is a major coefficient taking into account the lateral contributions linear (through the thermal bridges), - Kété (in W / m² ° C) is the transmittance of some parts of the wallconsidered for the summer - Sint (in m²) is the total inner surface of the considered panel; for roofsslope, we will take the horizontal projection of the surface, - Δte (t) (in ° C) is the equivalent temperature difference per hour	1 2 3 4 5 6	Indicator I,II ≤ 0,25 0,25 < Ind I,II ≤ 0,45 0,45 < Ind I,II ≤ 0,65 0,65 < Ind I ,II ≤ 0,85 0,85 < Ind I,II ≤ 1,05 Indicator I, II > 1,05	5 4 3 2 1 0
Apport de vitrage de référence	**Input due to reference temperature gradients**	AVTréf = e' . Souv . ΔTSréf, PVI [W]	- e '(in W / m² ° C) is a coefficient relating to the nature of the rooms- Souv (in m²) is the opening surface in the wall - ΔTSref, PVI (in ° C) is the reference temperature difference of the glass panel Indicator I = AVT / AVTref			

	Contribution due to reference sunshine	AVEréf = [SVens.It + (SV - SVens.).Id] FSréf . NPVI, réf [W]	- SV (in m²) is the total glazed area,- SVens (in m²) is the sunglass surface at 15:00 TSV (true sun time), - It (in W / m²) is the actual maximum total radiation for the considered orientation and latitude- Id (in W / m²) is the maximum real diffuse radiation - FSref is the reference solar factor - NPVI, ref is the damping coefficient relative to the reference gains of glazed panel for the considered orientation Indicator II = AVE / AVEref
Contribution of opaque reference walls	**Horizontal panel**	Aréf,PH = Σ (a . Sint . ΔTSréf,PH) [W] où :	- a (in W / m². ° C) is a coefficient related to the nature of the construction and function of the climatic zone. - Sint (in m²) refers to the area of the horizontal wall counted from the inside - ΔTSref, PH (in ° C) is the reference temperature difference for the horizontal walls
	Vertical panel	Aréf,PV = Σ (c . Sint . ΔTSréf,PV) [W]	- c (in W / m² ° C) is a coefficient related to the nature of the construction and function of theclimate zone- Sint (in m²) means the surface of the vertical wall counted from the inside- ΔTSref, PV (in ° C) is the reference temperature difference for the opaque wallvertical depending on the latitude and orientation of the panel.
Total losses of a volume		D_i = (DT)i + (DR)i	- (DT) i (in W / ° C) represents the transmission losses of the volume i - (DR) i (in W / ° C) represents the air exchange losses of volume i.

Loss by transmission of a volume	(DT) i = (Ds) i + (Dli) i + (Dsol) i + (Dlnc) i	- (Ds) i (in W / ° C) represents the surface losses through the common parts of the walls in contact with the outside - (Dli) i (in W / ° C) represents the losses through the connections - (DsoOi (in W / ° C) represents the losses through the walls in contact with the ground - (Dlnc) i (in W / ° C) represents the losses through the walls in contact with the non heated	1	Indicator I ≤ 0,30	4
			2	0,30 < Ind I ≤ 0,50	3
			3	0,50 < Ind I ≤ 0,70	2
			4	0,70 < Ind I ≤ 1,05	1
			5	Indicator I > 1,05	0
Losses by air renewal of a volume	(DR)i = (DRv)i + (DRs)i [W/°C]	- (DRv) i (in W / ° C) represents the losses due to the normal operation of the ventilation devices - (DRs) i (in W / ° C) represents additional losses due to wind	1	Ind II ≤ ,14	2
			2	0,14 < Ind II ≤ 0,28	1
			3	IndicatorII> 0,28	0

<table>
<tr>
<td rowspan="1">reference losses</td>
<td>Dréf = a x S_1 + b x S_2 + c x S_3 + d x S_4 + e x S_5 [W/°C]</td>
<td colspan="4">- The S i (in m2) represent the surfaces of the walls in contact with the outside, a roof, a crawl space, an unheated room or the ground. They relate respectively S1 the roof, S2 the low floor, including low floors on unheated premises, S3 walls, S4 doors, S5 windows and French windows. S1, S2, S3 are counted from the interior of the premises, S4 and S5 are counted by taking the dimensions of the perimeter of the opening in the wall;
- the coefficients a, b, c, d and e, (in W / m2 ° C They depend on the type of housing and the climatic zone
Indicator I DT / Dref
Indicator II DR / Dref</td>
</tr>
<tr>
<td rowspan="3">Heating power supplied by a boiler room</td>
<td rowspan="3">Q = [tbi - tbe] × [[1 + Max (cr; cin)] DT+ [(1 + cr) × DR]] [W]</td>
<td rowspan="3">-tbi (in ° C) represents the basic indoor temperature, 21 ° C
- tbe (in ° C) represents the basic outdoor temperature
- DT (in W / ° C) represents the losses by transmission of the housing,
- DR (in W / ° C) represents the air exchange losses of the dwelling,
- cr (dimensionless) is an estimated ratio of heat losses due to
pipes, cr = 0.15
possible,
- cin (dimensionless) represents a coefficient of overpower, cr = 0.05

IndicatorIII Q / Q ref</td>
<td>1</td>
<td>Indicator III ≤ 0,50</td>
<td>2</td>
</tr>
<tr>
<td>2</td>
<td>0,50 < Ind III ≤ 1,00</td>
<td>1</td>
</tr>
<tr>
<td>3</td>
<td>Indicator III > 1,00</td>
<td>0</td>
</tr>
</table>

Healing reference	Qref = (21 °C - tbe) x DT,ref [W]				
Heating energy requirements	ECH = (DT + DR) × DJHiver × 24 × 1 / 1000 (kWh)	DT (W / ° C) are transmission losses DR (W / ° C) are the losses by renewal of air Winter is winter day degree (° C / Day)	1 2	Indicator IV ≤ 0,50 0,50<Ind IV ≤ 1,00	2 1
reference heating energy	ECh,ref = 0,03 × DJHiver,15°C × DT,ref (kWh/a)	Indicator IV ECH / ECH ref	3	Indicator IV > 1,00	0

4.5 The CT-BAT app

4.5.1 Introduction

Characteristics to meet at least one of the following two conditions:

• Heat losses calculated for the winter period must be less than at a limit called "reference loss";

• The calorific contributions calculated for the summer period must be less than a limit called "reference intake". The losses or contributions of references are fixed by the DTR C3-2 & C3-4 respectively.

Architectural design offices are then faced with a new challenge, that of integrating the requirements of the aforementioned DTR into the design of buildings.

In this context, a number of consulting firms and researchers have tried to develop their own tools to perform the calculations provided by the DTRs. However, these applications are either incomplete or uncomfortable making their use difficult by third parties.

In addition, thermal calculation software used in other countries does not respond exactly, the requirements of the national legislation insofar as the methods of calculation and the databases used are, in some cases, different.

To facilitate the integration of DTR requirements and minimize the risk of errors for these design offices, as well as other users including energy auditors or researchers both in the interpretation of the data and in the calculations, by introducing hypotheses (see appendix), it was considered appropriate to develop a specific application for Algeria, the CT BAT application.

4.5.2 Presentation

The main objective of the CT BAT application is to verify the compliance of building construction projects with the Algerian standards described in the C3-2 and C3-4 DTRs.

The application presents the user with an intuitive and ergonomic interface allowing him to describe the different components of his construction project and performs for him the thermal calculations needed to verify the building's compliance with Algerian thermal regulations.

The user is therefore completely unloaded from the thermal calculations necessary for the regulatory checks. He must only make sure to describe his project according to the intuitive data structure of the CT BAT application.

4.5.3 Structure and calculation principle

The data structure to be adopted for describing and saving data within the CT BAT application is very simple. It is inspired by the natural hierarchical distribution of construction projects and the segmentation of the entities and components described in documents DTRC3-2 and C3-4. The diagram above shows the basic and basic structure of the data organization within the CT BAT application.

The main entity is the project. It details the basic data common to all other entities. It is mainly positioning data: altitude, latitude, commune,...

Once the project is defined, it is then necessary to create the thermal volumes in accordance with the definitions of DTR C3-2 Chapter 2 (§1.2 on page 14). With each envelope or thermal volume, it is then necessary to define the panel which compose it so as to create a closed space.

The thermal insulation of a building is the first key to increase the energy performance of a building. Studies have shown that around 40% of energy consumption for heating (in the north of the country) could be reduced by improving the energy performance of the building envelope.

Thermal insulation should be considered with some caution: it certainly reduces the losses of heat in winter as well as external heat gains in summer. However, it slows the evacuation of excess heat produced inside the premises in summer, which makes it necessary to install mechanical ventilation (VMC).

4.6 The energy audit

he energy audit must make it possible, based on a detailed analysis of the site's data, to draw up a quantified and well-argued proposal for an energy saving program and to get the client to decide on the appropriate investments.

The energy audit is registered under the Energy Act n ° 09-99. The audit includes "a set of technical and economic investigations, checks on the energy performance of equipment and technical processes, the identification of the causes of overconsumption and the proposal for a corrective action plan".

Executive Decree No. 05-495 defines the energy audit as "the examination and control of the energy performance of facilities and equipment of industrial establishments, transport and the tertiary sector, with a view to optimizing their operation". Thus, the modalities for the implementation of the energy audit are mainly:

- measure the energy performance of facilities and major equipment;
- analyze the evolution of energy consumption;
- to evaluate polluting emissions due to energy consumption;
- evaluate the energy efficiency of operations based on consumption standards;
- identify opportunities for energy saving and / or energy-efficient substitution for energy efficiency and the environment;
- to draw up a corrective action plan including the operations to be carried out and their economic cost. These tasks are sanctioned by a report which must include:
- an overall energy balance;
- an analysis of each consumption item and significant transactions;
- an assessment of changes in energy consumption and polluting emissions
- a presentation of the potential energy savings, energy substitution, pollutant reduction and corrective action plan deposits.

The periodicity of the audit is three (03) years for the industrial and transport establishments and five (05) years for the tertiary establishments.

The Algerian regulatory texts do not include the methods for calculating building consumption and the tolerated thresholds for an evaluation of the results. In particular, the method of calculating the energy consumption index is not provided. The consumption of a building is indeed defined by an index called energy consumption index (ICE). This index is obtained by dividing the total measured annual energy consumption (of all the energy agents or of a certain number of agents defined by the legislator) expressed in MJ (1 kWh = 3.6 MJ) by the heated surface. This index depends not only on the thermal performance of the building (insulation, compactness, passive solar inputs, etc.) but also on the desired temperature set by the inhabitants.

This definition is not unique. Depending on the country, the reference surface used in the denominator may or may not take into account the thickness of the walls, exclude or exclude technical parts (elevator shafts, boiler room), exclude some of the floor space according to the height ceiling, etc. On the other hand, the numerator may include, in addition to heating consumption, air conditioning consumption, electricity consumption, etc.

For the evaluation of the results, the following thresholds may allow a first analysis:

- if the ICE is greater than 250 kWh / m².year: measures to improve energy efficiency must be taken, and it is almost certain that it will result in savings;
- if the ICE is between 194,44 and 250 kWh / m².year: measures for a better energy efficiency can be taken, a technical-economic study is necessary;
- if the ICE is between 138.89 and 194.44 kWh / m².year: this is an average figure for well-designed dwellings;
- if the ICE is below 138.89 kWh / m².year: this is a normal figure for very well designed buildings.

An energy audit is usually carried out in three phases:

- phase 1, familiarization with construction: visit of premises, collection of energy bills, listing of technical equipment, collection of architectural plans, behavioral analysis of occupants, etc. ;
- phase 2, analysis and data processing: analysis of invoices, calculation of consumption trends, thermal simulations, thermal balance assessment, thermography for the buildings that need it, distribution of consumption by item (who consumes what and how?)
- phase 3, production of short, medium and long term "stock cards", calculation of investments, savings possible and therefore, return on investment time, put in relation with the competent professionals for the implementation of technical actions with specifications.

Establishing an energy audit requires a number of experimental measures to be taken. The most important are:

- measurement of energy consumption;
- temperature measurement;
- thermography;

- in situ measurement of the K coefficients of the walls;
- laboratory measurements, thermal conductivity and thermal resistance mainly.

5 Application, results and discussion

5.1 Introduction

The Algerian mutation in the field of energy, and the global change force us to take the necessary actions in energy efficiency, in order to follow this development. Although Algeria is a country with an energy potential, energy savings are in favor of the country's general interest.

The building sector by its dimension is a sector that represents a huge gain, by the application of these standards we can improved not only the quality of the building but the development of the city and the whole country.

In the preceding chapters, we talked about the rehabilitation mechanism and that the government must be the example to be followed in the field of energy efficiency, for that we chose a state building that represents a huge potential for economic and thermal gain, and also it represents an opportunity to prove the usefulness of all these standards.

The choice of case study was also made in relation to the accessibility of the project and information, as it is a building affiliated to the University of Tlemcen, the help of head of university administration was valuable to our research work. Also in the new energy efficiency action plan in Algeria, and the rehabilitation of state buildings, our study case to the perfect profile by these parameters to be an example to follow in the next building.

The work has been divided into several phases, the first being the collection of all the information needed on the building starting with the plan, the area, the orientation, the type of materials chosen in the building ... etc. Then we go through an energy audit based on our bibliographic research that contains all the stages of an energy analysis of a building. After analysis and definition of problem and criterion of the building, we pass by proposing solutions quoted already in our research.

To finally find what is the best scenario whose ratio quality / feasibility is the most interesting and to emphasize the importance of its regulations.

5.2 Energy balance of the existing building

5.2.1 Description of the building

Table 6 :Energy situation of the project

Altitude	**Latitude**	**Winter thermal Zone**	**Summer thermal Zone**
800,00 m	34,53 °	B	B

The building represents a block that is part of the University of Tlemcen, it consists of a ground floor, ground floor and four other floors. The floor space is 1550 m², and the height of the building from the ground floor is 18.7m

The building is composed of the following elements:

- Roof of 1616 m²
- North facade:
  - Opaque wall surface 639.53 m²
  - Entrance wall surface 95.123 m²
  - Glazed window area (double glazing) 1067.496 m²
  - Window area (single glazed) 18 m²
- South facade is:
  - Opaque wall surface 699.2 m²
  - Enclosed wall surface 109.31
  - Glass curtain wall 1067.496
  - Window area 36m²
- South west facade:
  - Opaque wall surface 609.695 m²
  - Buried wall surface 124.967 m²
  - Glass curtain wall 1067.496 m
  - Window area 18 m²

North façade

South west facade

South façade

The general plan of the building

basement

5.2.2 Composition of panels

5.2.2.1 Walls

Table 7: composition of existing walls

Material	**Cond. Λ** W/m.°C	**Thickness (m)**	**Resistance** (m².°C)/W
Cement mortar	1,40	0,02	0,01
Hollow brick	0,48	0,15	0,31
Blade of air for wall of 50 mm	0,00	0,05	0,16
Brique creuse	0,48	0,10	0,21
Cement mortar	1,40	0,02	0,01
	Total	0,34	0,71

5.2.2.2 Glazed windows

Table 8: coposition of existing curtain walls

Composition	**Kvn**	**Resistance**	**Coéf. K winter**	**Coéf. K summer**
Metal / Double Glazing / 5 to 7	Winter: 4.00 W / m². ° C / Summer: 3.97 W / m². ° C	0,00 W/m².°C	4,00 W/m².°C	3,97 W/m².°C

5.2.2.3 Windows

Table 9 : composition of existing windows

Composition	**Kvn**	**Resistance**	**Coéf. K winter**	**Coéf. K summer**
Wood / Single glazed / -	Winter: 5,00 W/m².°C / Summer: 4,97 W/m².°C	0,00 W/m².°C	5,00 W/m².°C	4,97 W/m².°C

5.2.2.4 Doors

Table 10: composition of doors

Composition	**Kvn**	**Coef. K winter**	**Coef. K summer**

Metal door - With single glazing	Winter: 5,80 W/m².°C / Summer: 5,77 W/m².°C	5,80 W/m².°C	5,77 W/m².°C

5.2.2.5 Floors

Table 11: composition of existing floors

Material	Cond. λ	Thickness	Resistance
Bastard mortar	1,15 W/m.°C	0,05 m	0,04 (m².°C)/W
Hollow concrete blocks of heavy aggregates	1,10 W/m.°C	0,21 m	0,19 (m².°C)/W
Solid concrete	1,75 W/m.°C	0,05 m	0,03 (m².°C)/W
Marble tiles mosaic called "granito"	2,10 W/m.°C	0,03 m	0,01 (m².°C)/W
	Total	0,34 m	0,28 (m².°C)/W

5.2.2.6 Roof

Table 12: composition of existing roof

Material	Cond. λ	Thickness	Resistance
Gravel	2,00 W/m.°C	0,05 m	0,03 (m².°C)/W
Felt and carpet boards, impregnated	0,23 W/m.°C	0,02 m	0,09 (m².°C)/W
Solid concrete	1,75 W/m.°C	0,07 m	0,04 (m².°C)/W
Expanded polystyrene	0,05 W/m.°C	0,06 m	1,30 (m².°C)/W
Hollow concrete blocks of heavy aggregates	1,10 W/m.°C	0,21 m	0,19 (m².°C)/W
Cement mortar	1,40 W/m.°C	0,02 m	0,01 (m².°C)/W
	Total	0,43 m	1,66 (m².°C)/W

5.3 Assessment of the global volume

5.3.1 compliance with regulations DTR C- 3.2 and DTR C- 3.4

Table 13: Thermal yiield of the exsiting buillding

Σ DT	**Σ Dréf**	**Verification C-3.2**	**Σ APO + Σ AV**	**Σ APOréf + Σ AVréf**	**Verification C-3.4**
19 900,00 W/°C	25 363,39 W/°C	0,78 **comply**	745 897,65 W	415 674,02 W	1,79 **Non-compliant**

5.3.2 Heating power

Table 14: : current energy consumption in heating

Cin: Coefficient of overpower	**Cr: Coefficient of heat losses due to the possible pipe network**	**Heating power**
0,20	0,20	687,4 kW

5.3.3 Energy analysis of the panels

5.3.4 3-3-1 Walls

Table 15:Thermal existing yield of walls

WallsName	**area**	**DT**	**DTréf**	**DT/DT ref**	**APO**	**APOréf**	**APO/APOref**
north opaque wall	639,53 m²	872,68 W/°C	767,44 W/°C	0.73	6 505,19 W	3 729,74 W	1.74
opaque wall south east	699,20 m²	954,10 W/°C	839,04 W/°C	1.13	7 112,14 W	6 738,86 W	1.05
opaque wall south west	609,70 m²	831,97 W/°C	731,63 W/°C	1.13	6 201,71 W	7 049,08 W	0.89

5.3.4.1 Roofs

Table 16:thermal existing yield of roofs

Name	**area**	**DT**	**DTréf**	**T/DTref**	**APO**	**APOréf**	**APO/APOref**
roofing	1 616,00 m²	1 076,44 W/°C	1 454,40 W/°C	0.74	6 354,62 W	19 765,30 W	0.31

5.3.4.2 Window

Table 17:Thermal existing yield of glazed panels

Name	area	DT	DTréf	DT/DTref	AV	AVréf	APV/APVIref
north Curtain wall	1 067,50 m²	5 123,98 W/°C	4 803,73 W/°C	1.06	117 883,45 W	78 600,90 W	1.49
north window	18,00 m2	108,00 W/°C	81,00 W/°C	1.33	2 141,70 W	1 274,02 W	1.68
south east Curtain wall	1 067,50 m²	5 123,98 W/°C	4 803,73 W/°C	1.06	248 709,76 W	100 818,97 W	2.46
south window	36,00 m2	216,00 W/°C	162,00 W/°C	1.33	8 055,02 W	3 188,61 W	2.52
south west Curtain wall	1 067,50 m²	5 123,98 W/°C	4 803,73 W/°C	1.06	297 434,17 W	176 390,08 W	1.68
south west window	18,00 m2	108,00 W/°C	81,00 W/°C	1.33	4 729,36 W	2 683,34 W	1.76

5.3.4.3 Doors

Table 18:Thermal existing yiel of doors

Name	area	DT	DTréf	DT/DTref	APO	APOréf	APO/APOref
north glazed door	4,00 m²	27,84 W/°C	14,00 W/°C	1.98	263,11 W	23,33 W	11.27
South east glazed	4,00 m²	27,84	14,00	1.98	316,54	38,55	8.21

door		W/°C	W/°C		W	W	
south west glazed door	4,00 m²	27,84 W/°C	14,00 W/°C	1.98	430,24 W	46,25 W	9.30

5.3.4.4 Buried walls

Table 19:Thermal existing yiel of burried walls

Name	Area	DT	DTréf	APO	APOréf
buried north wall	95,12 m²	0,00 W/°C	114,15 W/°C	935,20 W	0,00 W
buried south east wall	109,31 m²	0,00 W/°C	131,17 W/°C	803,75 W	0,00 W
buried south west wall	124,97 m²	0,00 W/°C	149,96 W/°C	1 228,61 W	0,00 W

5.3.4.5 Floors

Table 20:Thermal existing yield of floors

Name	Area	DT	DTréf	APO	APOréf
floor between ground	1 116,00 m²	277,36 W/°C	2 678,40 W/°C	7 809,78 W	0,00 W
high floor	1 550,00 m²	0,00 W/°C	3 720,00 W/°C	0,00 W	16 740,00 W

5.3.4.6 Synthesis

If we divide our building on categories we will have two families, vertical walls and horizontal walls and in each one there are sub-families which are:

Vertical walls:

- ✓ Opaque panel
- ✓ Glass panel

Horizontal walls

- ✓ panel with external contact
- ✓ panel without external contact

We have also said that the wall is in conformity with the energetic regulation if the computation does not exceed the 1.05 * calculation of reference therefore of that one deduces the defective walls according to two other categories

Heat loss (DTRC-3.2)

- ✓ South east wall
- ✓ south west wall
- ✓ All glass panel

Thermal input (DTRC-3.4)

- ✓ North wall
- ✓ All glass panel

For the floors and the buried walls one notices that the loss and the contribution is null since they are buried and thus isolated since there is no thermal exchange.

And we also notice that the roofs comply with the Algerian regulations.

For the improvement of the building we go by improving each wall by proposing solutions and knowing the impact that will have on the building.

5.4 First solution: improve the performance of walls by filling a polyurethane foam

In this proposed solution, we inject polyurethane foam that takes the place of the air knife this is a simple method, from a hole in the wall we inject the products by blowing.

The purpose of this is to improve the thermal performance of the wall by replacing an element that has a low thermal resistance by other more efficient material.

5.4.1 Composition of the walls (from the outside to the inside)

Table 21:Composition of the modified walls

Material	**Conductivity** W/m.°C	**Epaisseur (m)**	**Résistance** m^2.°C/W
Cement mortar	1,40	0,02 m	0,01
Hollow brick	0,48	0,15 m	0,31

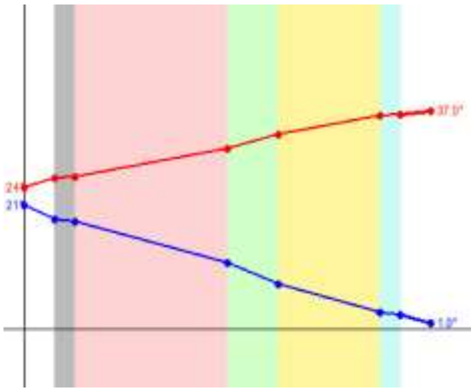
Expanded polystyrene	0,04	0,05 m	1,43
Hollow brick	0,48	0,10 m	0,21
Cement mortar	1,40	0,02 m	0,01
Total		0,34 m	1,98

5.4.2 *Energy balance of the walls*

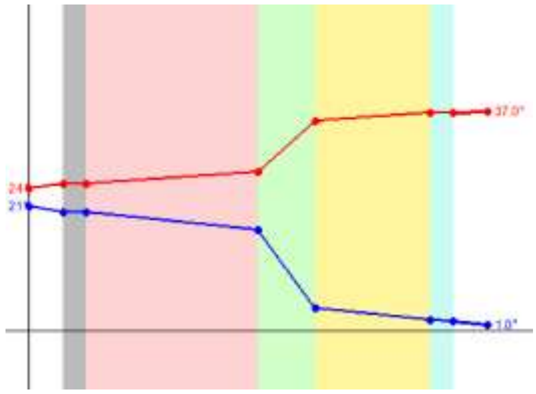
Table 22:Yield of walls (solution 1)

Name	**Area**	**DT**	**DTréf**	**DT/DT ref**	**APO**	**APOréf**	**APO/APOref**
north opaque wall	639,53 m²	357,28 W/°C	767,44 W/°C	0.46	2608.88W	3 729,74 W	0.7
opaque wall south east	699,20 m²	390,62 W/°C	839,04 W/°C	0.46	2852.29W	6 738,86 W	0.42
opaque wall south west	609,70 m²	340,62 W/°C	731,63 W/°C	0.46	2487.17 W	7 049,08 W	0.35

5.4.3 *The improvement of the thermal performance:*



Before



After

Thermal performance of walls before and after improvement

5.4.4 *The thermal efficiency of the walls according to the layers*

Befor

Table 23:efficiency of walls before solution 1

Layer	**Winter temperature**	**Summer temperature**
Indoor temperature	21,00 °C	24,00 °C
Indoor surface temperature	18,50 °C	25,53 °C

1- Cement mortar	18,17 °C	25,75 °C
2- Hollow brick	11,07 °C	30,53 °C
3- Blade for wall from 24	7,43 °C	32,98 °C
4- Hollow brick	2,69 °C	36,17 °C
5- Cement mortar	2,36 °C	36,39 °C
Outside surface	2,36 °C	36,39 °C
Outside temperature	1,00 °C	37,00 °C

After

Table 24:efficiency of walls after solution 1

Layer	Winter temperature	Summer temperature
Indoor temperature	21,00 °C	24,00 °C
Indoor surface temperature	19,98 °C	24,61 °C
1- Cement mortar	19,84 °C	24,70 °C
2- Hollow brick	16,93 °C	26,62 °C
3- polyurethane foan	3,63 °C	35,39 °C
4- Hollow brick	1,69 °C	36,67 °C
5- Cement mortar	1,56 °C	36,75 °C
Outside surface temperature	1,56 °C	36,75 °C
Outside temperature	1,00 °C	37,00 °C

5.4.5 The impact on the overall volume of the building

5.4.5.1 compliance with regulations DTR C- 3.2 and DTR C- 3.4

Table 25:Thermal efficiency of building (solution 1)

Σ DT	**Σ Dréf**	**Verification C-3.2**	**Σ APO + Σ AV**	**Σ APOréf + Σ AVréf**	**Verification C-3.4**
18 329,77 W/°C	25 363,39 W/°C	0.72 **comply**	734 026,94 W	415 674,02W	1,77 **Non-compliant**

5.4.5.2 Heating power

Table 26:Enegy consumption of heating (soultion 1)

Cin: Coefficient of overpower	**Cr: Coefficient of heat losses due to the possible pipe network**	**Heating power**
0,20	0,20	647,8 kW

5.4.6 Synthesis

From the obtained results, we deduce the following:

- ✓ The improvement of the walls increases the building by 8% to the losses and 2% to the contributions
- ✓ Improvement of the wall to increase from 0.71 (m². ° C) / W to 1.98 (m². ° C) / W
- ✓ Improvement of thermal losses of the walls by:
  - • North Walls: 60%
  - • South East Walls: 60%
  - • South West Walls: 60%
- ✓ Improved thermal input by:
  - • North Walls: 60%
  - • South East Walls: 60%
  - • South West Walls: 60%
- ✓ The heating power reduction of: 40 KW

5.5 Second solution: plant screen insertion in south-east and south-west glazed facades

5.5.1 Thermal loss

Table 27:thermal losses of curtain walls (solution 2)

	Existing Curtain wall			Curtain wall with vegetal screen			% improvement
panel	**DT**	**DTref**	**DT/DTref**	**DT**	**DTref**	**DT/DTref**	
Southeastern Curtain wall	5 123 ,98 W/°C	4 803,73 W/°C	1.06	146,51 W/°C	4803,73 W/°C	0.03	98%

Southwest Curtain wall	5 123 ,98 W/°C	4 803,73 W/°C	1.06	146,51 W/°C	4 803,73 W/°C	0.03	98%

5.5.2 Thermal input

Table 28:Thermal input of curtain wall (solution 2)

	Existing glazed windows			**Bay glazed with vegetal screen**			**% improvement**
panel	**AV**	**AVref**	**AV/AV ref**	**AV**	**AVref**	**AV/AVref**	
South eastern Curtain wall	248 709, 76 W	100 818, 97 W	2.46	27 223,67 W	63 631,42 W	0.42	90%
Southwest glazed panel	297 434, 17 W	176 390, 08 W	1.68	229 932,04	174 699,06	1.31	23%

5.5.3 Impacts on the overall volume of the building

Table 29:efficiency of the buildings (solution 2)

Σ DT	**Σ Dréf**	**Verification C-3.2**	**Σ APO + Σ AV**	**Σ APOréf + Σ AVréf**	**Verification C-3.4**
9 945,06W/°C	25 363,39 W/°C	0.39 **comply**	456 909,43W	376 795,45 W	1,21 **Non compliant**

5.5.4 Heating power

Table 30:energy consumption in heating (solution 2)

Cin: Coefficient of overpower	**Cr: Coefficient of heat losses due to the possible pipe network**	**Heating power**
0,20	0,20	436,5 kW

5.5.5 Synthesis

From the results obtained we deduce the following:

- ✓ The improvement of the glazed windows by adding screens plants promotes the building of 50% with the losses and 32% with the contributions
- ✓ Improvement of the heat losses of the kisses by:
  - South east kiss: 98%
  - Southwestern kiss: 98%
- ✓ The improvement of thermal inputs of the bais by:
  - south east kiss: 90%
  - south-west kiss: 23%
- ✓ The heating power reduction of: 250.9 KW

5.6 Third solution: "double glazing"

5.6.1 Thermal loss

Table 31:Therml losses of windows (solution 3)

	existing window				window with double glazing			% improvement
panels	**DT**	**DTref**	**DT/DTref**		**DT**	**DTref**	**DT/DTref**	
North window	108,00 W/°C	81,00 W/°C	1.33		71,28 W/°C	81,00 W/°C	0.88	33%
south east windows	216,00 W/°C	162,00 W/°C	1.33		142,56 W/°C	162,00 W/°C	0.88	33%
southwestern windows	108,00 W/°C	81,00 W/°C	1.33		71,28 W/°C	81,00 W/°C	0.88	33%

5.6.2 Thermal input

Table 32:Thermal input of windows (solution 3)

	existing window				window with double glazing			% d'amélioration
panel	**AV**	**AVref**	**AV/AVref**		**AV**	**AVref**	**AV/AVref**	
North window	2 141,70 W	1 274,02 W	1.68		1664,34W	1274,02 W	1.3	22%
south east windows	8 055,02 W	3 188,61 W	2.52		7100,30W	3188,61 W	2.22	11%

southwestern windows	4 729,36 W	2 683,34 W	1.76		4252,00 W	2683,34 W	1.58	10%

5.6.3 Impacts on the overall volume of the building

Table 33:Energy efficiency of building (solution 3)

Σ DT	**Σ Dréf**	**Verification C-3.2**	**Σ APO + Σ AV**	**Σ APOréf + Σ AVréf**	**Verification C-3.4**
18 856,42 W/°C	25 363,39 W/°C	0.74 **comply**	685 951,47	396 432,93	1,73 **Non compliant**

5.6.4 Heating power

Table 34:Energy consumption in heating (solution 3)

Cin: Coefficient of overpower	**Cr: Coefficient of heat losses due to the possible pipe network**	**Heating power**
0,20	0,20	661,1 kW

5.6.5 Synthesis

From the results obtained we deduce the following:

- ✓ The window improvement promotes the building of 5% to the losses and 3% to the contributions
- ✓ Improved thermal losses of windows by:
  - North windows: 33%
  - South east windows: 33%
  - Southwestern windows: 33%
- ✓ The improvement of thermal inputs of the bais by:
  - North windows: 22%
  - South east windows: 11%
  - South Western windows: 10%
- ✓ The reduction of heating power of: 26 KW

5.7 fourth solution: "fabric curtain"

5.7.1 Thermal loss

Table 35:thermal losses of glazed surfeces (solution 4)

	Before improvement				After improvement			% of improvement
panels	**DT**	**DTref**	**DT/DTref**		**DT**	**DTref**	**DT/DTref**	
North window	108,00 W/°C	81,00 W/°C	1.33		93,91 W/°C	81,00 W/°C	1.15	13%
south east windows	216,00 W/°C	162,00 W/°C	1.33		187,83 W/°C	162,00 W/°C	1.15	13%
southwestern windows	108,00 W/°C	81,00 W/°C	1.33		93,91 W/°C	81,00 W/°C	1.15	13%
curtain wall north	5 123,98 W/°C	4 803,73 W/°C	1.06		4 574,98 W/°C	4 803,73 W/°C	0.95	10%
south east curtain wall	5 123,98 W/°C	4 803,73 W/°C	1.06		4 574,98 W/°C	4 803,73 W/°C	0.95	10%
southwestern curtain wall	5 123,98 W/°C	4 803,73 W/°C	1.06		4 574,98 W/°C	4 803,73 W/°C	0.95	10%

5.7.2 Thermal input

Table 36:thermal input of glazed surfaces (solution 4)

	Before improvement				After improvement			% d'amélioration
panels	**AV**	**AVref**	**AV/AVref**		**AV**	**AVref**	**AV/AVref**	
North window	2 141,70 W	1 274,02 W	1.68		1 960,62 W	1 274,02 W	1.53	8%
south east	8	3	2.52		7 692,86 W	3 188,61	2.41	4%

windows	055,02 W	188,61 W				W		
southwestern windows	4 729,36 W	2 683,34 W	1.76		4 548,28 W	2 683,34 W	1.69	3.9%
curtain wall north	117 883,45 W	78 600,90 W	1.49		110 847,47 W	78 600,90 W	1.41	5%
south east curtain wall	248 709,76 W	100 818,97 W	2.46		241 673,78 W	100 818,97 W	2.39	2.8%
southwestern curtain wall	297 434,17 W	176 390,08 W	1.68		290 398,20 W	176 390,08 W	1.64	2.3%

5.7.3 Impacts on the overall volume of the building

Table 37:Efficiency of building (solution 4)

Σ DT	**Σ Dréf**	**Vérification C-3.2**	**Σ APO + Σ AV**	**Σ APOréf + Σ AVréf**	**Vérification C-3.4**
18 196,66 W/°C	25 363,39 W/°C	0,72 **comply**	728 710,89	396 432,93	1,75 **Non compliant**

5.7.4 Heating power

Table 38:Energy consumption in heating (solution 4)

Cin: Coefficient of overpower	**Cr: Coefficient of heat losses due to the possible pipe network**	**Heating power**
0,20	0,20	644,4 kW

5.7.5 Synthesis

From the results obtained we deduce the following:

- ✓ The addition of curtains to the building of 5% to the losses and 3% to the contributions
- ✓ Improved thermal losses of glazed surface by:

• North windows: 13%

• South east windows: 13%

• Southwestern windows: 13%

• North curtain wall: 10%

• south east curtain wall : 10%

• Southwest curtain wall: 10%

✓ The improvement of thermal inputs of the glazed surface by:

• North windows: 8%

• South east windows: 4%

• Southwestern windows: 3.9%

• North curtain wall: 5%

• south east curtain wall: 2.8%

• south-west curtain wall: 2.3%

✓ The heating power reduction of: 43 KW

5.8 fifth solution: "change by reflective glass"

5.8.1 -Heat loss

Table 39:thermal losses of glazed surfaces (solution 5)

	Before improvement				**After improvement**			**% improvement**
panels	**DT**	**DTref**	**DT/DTref**		**DT**	**DTref**	**DT/DTref**	
south east windows	216,00 W/°C	162,00 W/°C	1.33		216,0000	162,00 W/°C	1.33	
southwestern windows	108,00 W/°C	81,00 W/°C	1.33		108,0000	81,00 W/°C	1.33	
south east curtain wall	5 123,98 W/°C	4 803,73 W/°C	1.06		5 123,9808	4 803,73 W/°C	1.06	0%
Southwest curtain wall	5 123,98 W/°C	4 803,73 W/°C	1.06		5 123,9808	4 803,73 W/°C	1.06	

5.8.2 *Thermal input*

Table 40:Thermal input of glazed surfaces (solution 5)

	Before improvement			**After improvement**			**% d'amélioration**
panels	**AV**	**AVref**	**AV/AV ref**	**AV**	**AVref**	**AV/AV ref**	
south east windows	8 055,02 W	3 188,61 W	2.52	2 791,1520	3 188,61 W	2.41	4%
southwestern windows	4 729,36 W	2 683,34 W	1.76	1 395,5760	2 683,34 W	1.69	4%
south east curtain wall	248 709,76 W	100 818,97 W	2.46	182 974,6224	100 818,97 W	2.39	2.8%
Southwest curtain wall	297 434,17 W	176 390,08 W	1.68	214 158,2486	176 390,08 W	1.64	2.3%

5.8.3 *Impacts on the overall volume of the building*

Table 41:Energy efficiency of building (soution 5)

Σ DT	**Σ Dréf**	**Vérification C-3.2**	**Σ APO + Σ AV**	**Σ APOréf + Σ AVréf**	**Vérification C-3.4**
19 900,00 W/°C	25 363,39 W/°C	0,78 **comply**	592 934,42	396 432,93	1,42 **Non compliant**

5.8.4 *Heating power*

Table 42:Energy consumption in heating (solution 5)

Cin: Coefficient of overpower	**Cr: Coefficient of heat losses due to the possible pipe network**	**Heating power**
0,20	0,20	687,4 kW

5.8.5 *Synthesis*

The reflective glass according to the project analysis does not affect the building in the heat loss side because it plays a role of solar protection and even it does not change the heating consumption but we notice the slight difference in the contribution that either in the glass walls or the whole building:

The benefits obtained from this solution are:

- ✓ The contributions of the glass walls:
  - Thermal reduction of 4% at the window level and 2.3 to 2.8% at the glass level
- ✓ Reduction of the contributions of the overall volume of building by 20%

5.9 Combinations of solutions

To have more energy efficiency in the building, in this phase we tried to combine several solutions to see what will be the most effective combination. But for that the choice of combination was compared to the feasibility of the realization and also on the financial side. In the final solution, we combined all the individually proposed solutions to have the maximum impact on the building compared to the proposed solutions

5.9.1 *First combination:*

We have combined the two solutions " double glazing " and " the reflective glass " the changes obtained on the building are as follows:

5.9.1.1 Impacts on the overall volume of the building

Table 43:Energy efficiency of building (combinaison 1)

Σ DT	**Σ Dréf**	**Vérification C-3.2**	**Σ APO + Σ AV**	**Σ APOréf + Σ AVréf**	**Vérification C-3.4**
18 856,42 W/°CW/°C	25 363,39 W/°C	0,74**Conforme**	536 940,42 W	396 432,93	1,35 **Non conforme**

5.9.2

5.9.2.1 Heating power

Table 44:Energy consumption in heating (conbinaison 1)

Cin: Coefficient of overpower	**Cr: Coefficient of heat losses due to the possible pipe network**	**Heating power**
0,20	0,20	661,1 kW

5.9.2.2 *Analysis of the results:*

The combination of these two solutions would not be enough to make our building compliant but despite that, it helped to develop the performance of the building and allows to have gains on thermal losses to reduce inputs and consumption due to heating:

- ✓ Reduction losses by: 5%
- ✓ Reduce intake by: 24, 6%
- ✓ Reduce electricity consumption due to heating by: 26.3 kW

5.9.3 *Second combination:*

The combination of the vegetable screen (occultation protection) and the presence of curtains; the results obtained from this solution are as follows:

5.9.3.1 *The impact on the overall volume of the building:*

Table 45:Energy efficiency of building (combinaison 2)

Σ DT	**Σ Dréf**	**Vérification C-3.2**	**Σ APO + Σ AV**	**Σ APOréf + Σ AVréf**	**Vérification C-3.4**
4 542,72W/°C	25 363,39 W/°C	0,18 **comply**	391 857,35W	396 432,93W	1,04 **comply**

5.9.3.2 *Heating power*

Table 46:Energy consumption in heating (conbinaison 2)

Cin: Coefficient of overpower	**Cr: Coefficient of heat losses due to the possible pipe network**	**Heating power**
0,20	0,20	300,4 kW

5.9.3.3 *Analysis of the results*

We notice the enormous improvement of the building by making it consistent with the Algerian regulations, the consequences obtained are:

- ✓ gain in heat losses by 77%

- ✓ Reduction of heat input by 41%
- ✓ *Decrease in heating consumption by 387 KW*

5.9.4 *<u>third combination: vegetable screen + curtains + reflective glass</u>*

To improve the results of the thermal efficiency of the building we have added to the previous combination the reflective glass on all the glazed walls the results of this solution are:

5.9.4.1 *Impact on the overall volume of the building*

Table 47:Energy efficiency of building (combinaison 3)

Σ DT	**Σ Dréf**	**Vérification C-3.2**	**Σ APO + Σ AV**	**Σ APO réf + Σ AV réf**	**Vérification C-3.4**
4 542,72 W/°C	25 363,39 W/°C	0,18 **comply**	391 857,35W	378 208,45 W	0.77 **comply**

5.9.4.2 *Heating power:*

Table 48:Energy consumption in heating (conbinaison 3)

Cin: Coefficient of overpower	**Cr: Coefficient of heat losses due to the possible pipe network**	**Heating power**
0,20	0,20	300,4 kW

5.9.4.3 *Synthesis*

The addition of reflective glass compared to the previous solution affects the heat input since we notice the evolution of this criterion compared to this solution by 32% and compared to the existing building by 56% but against compared to the previous solution it did not affect heat loss or annual heating consumption.

5.9.5 <u>Fourth combination: assembly of all the solutions: vegetable screen + curtains + reflective glass + filling + double glazing.</u>

In this phase the goal is to maximize the energy gain in our building by assembling all previous solutions, and finally deduct the total gains obtained, the results obtained are:.

5.9.5.1 *Impacts on the overall volume of the building*

Table 49:Energy efficiency of building (combinaison 4)

Σ DT	**Σ Dréf**	**Verification C-3.2**	**Σ APO + Σ AV**	**Σ APO réf + Σ AV réf**	**Vérification C-3.4**
2 972,38 W/°C	25 363,39 W/°C	0,12**comply**	378 208,45 W	378 208,45 W	0.75 **comply**

5.9.5.2 *Heating power:*

Table 50:Energy consumption in heating (conbinaison 4)

Cin: Coefficient of overpower	**Cr: Coefficient of heat losses due to the possible pipe network**	**Heating power**
0,20	0,20	260,8 kW

5.9.6 *Synthesis:*

The improvement of the overall volume obtained after the simulation of all its interventions and according to the calculation of DTR C-3.2 and C-3.4 are:

- ✓ *Reduce wastage by: 84%*
- ✓ *Decrease heat input by: 58%*
- ✓ *Reducing energy consumption due to heating by: 426.6KW and thus gagging 62% of heating costs*

5.10 Conclusion

After the analysis of the project via the energy audit and the proposal of the solutions to see the effect that it relates on the energy consumption of the building one deduces the following conclusions:

The major problem in the region of Tlemcen that is in the climatic zone "B" is reflected in the thermal contributions. Tlemcen by its location is a hot zone and it does not undergo a remarkable temperature drop. This explains its performance in winter even with uninsulated walls and not very developed in terms of energy efficiency. On the other hand, in summer and with low resistance walls, the contribution is exponential.

Orientation also has an important role in the decision of location, opening size and glazed area. We notice that the building is made up of three facades practically identical in the three orientations and with the same dimensions and glazed surfaces.

Despite the fact that energy efficiency regulations in Algeria are based on a minimum of thermal efficiency, our building is very weak in summer, the weakness mainly affects the vertical walls which have a direct external contact.

This analysis has been done in relation to the performance of the total volume of the building, and we have neglected the inner workings of the spaces, because they are already in place so we cannot have any improvement at the level of internal distribution. But the simple thermal insulation building allows us to eliminate the heat transfer from the outside to the inside it helps us not to waste the energy supplied in heating or air conditioning and it reduces the consumption.

The solutions are proposed based on the conditions of the country vis-à-vis the existing materials and techniques. These varieties of techniques are diversified with respect to feasibility, cost and profitability. The multitude of choices allows us to find the best solution for the budget and time allocated.

The proposed solutions have improved our building in a remarkable way but if we take the economic and financial side, it is preferable that this energy audit is done before the realization of the project and that our architects take into consideration the energy aspect of the project. This should maximize our financial gain, because during the realization for example the fact of replacing the blade of area by adding a layer of insulator does not increase in any case the cost of the realization whereas in the other case in addition to the investment in materials and insulation techniques we will add the cost of realization, and this is only a small example of what happens.

Finally we can say that :

The energy efficiency in building sector represents a huge gain despite the investment price because the expenses earn in our bill are important.

Algerian regulations are registered against a minimum of performance, so it is time to raise the bar of the latter and recomposing the leading directors in the field of efficiency to create competition that is in the general interest.

Architects who represent the designers of our projects in the field of energy efficiency should be encouraged whether by physical or moral rewards.

And finally we must go through the strict and rigorous application of all the regulations because it is beneficial for the individual and the country.

General conclusion

The role of thermal reglementation is very important in several levels, the entire country is affected by its regulations in the framework of minimizing energy production which implies the reduction of greenhouse gases and the economic burden, especially in the case where the country subsidizes the price of consumption.

In Algeria, actions have been taken to reduce its subsidies, because the bill becomes heavy and prevents the development of the country

With the new Algerian energy policy, citizens are also concerned by the application of regulations, and the authority must be the example in the field of application which is reflected in the energy renewal of state buildings.

The example chosen in this work, highlights the importance of energy efficiency in the existing building, and with simple solutions we reduce consumption and we maximize the use of energy.

Any construction goes through an architectural design office, except that they take into consideration only the architectural side and neglect the energetic aspect, because it misses the obligation of application of its rules for lack of follow-up

In the contrary case the gains obtained will be in the general interest of the country, all this will be feasible only by the creation of study committee specialized in the energetic efficiency which will have the authority to evaluate the permits of constuires in order to approve or refuse to carry out projects while leaving a margin of decision.

This procedure can save us more than 50% of expenditure in the energy sector and channel its funds into development.

Finally the purpose of this thesis is to gather all possible information in the field of energy efficiency in the building, but what is the purpose of this collection of information?

If we want a better future for future generations, we must understand that we are all concerned with writing the pages of our future.

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Budget repport

Designation	Expense in dinars	Expense in euro	Expense in dolls
Accommodation in Bonn	/	723.84	/
Data collection (pdf file)	/	/	539.75
Buying a sim card	/	20.00	/
Harvesting and data analysis	172550.00	/	/
Travel insurance	1600.00		/
International transport	500233.00	51	/
National transport	29571.00	/	/
total	253954.00	794.84	539.75