A NEW APPROACH OF LOW ANNUAL ENERGY DOMESTIC BUILDING CONSUMPTION IN ALGERIA ON 'HPE' CONCEPT

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Résumé

Cet article développe un outil de modélisation simple pour les bâtiments verts designer. Le concepteur peut explorer la nature de la construction, la forme, la fenestration, l'orientation et les propriétés des tissus pour minimiser les effets thermiques des bâtiments une 'environnement. Aspects de chauffage, l'éclairage, la ventilation naturelle et mécanique avec récupération de chaleur peut aussi être étudiée. Le modèle est le mieux utilisé pour vérifier que les bâtiments seront observer avec les règlements ou utilisé comme une aide à la conception précoce plutôt que d'un simulateur de conception détaillée de la performance des bâtiments. Le programme devrait donc être d'intérêt particulier pour les architectes, géomètres-experts et les contrôleurs du bâtiment plutôt que les ingénieurs du bâtiment de service. Un programme pilote de projet en Algérie a été déjeuné sur la base faible consommation d'énergie. Il a été de plus en plus rendu compte que la préservation de l'environnement est un gage de pérennité et la stabilité du processus de développement économique et social. La vie quotidienne dans les bâtiments d'habitation (chauffage, climatisation) est responsable de plus de 30% des émissions de gaz à effet de serre. Il apparaît également que la construction de bâtiments appropriés et une mise en œuvre adéquate peut à la fois réduire la facture énergétique et les dépenses des ménages. Agir sur les bâtiments et l'environnement, est de donner toutes les possibilités Algériens de vivre dans un habitat écologique. C'est pourquoi des mesures seront mises en œuvre, qui touche aussi bien les bâtiments existants (plus de 7 millions de foyers le 1er Janvier 2007) au cours de leur réadaptation et les nouveaux bâtiments ainsi. Un grand nombre de constructions résidentielles ne semble pas répondre au confort thermique et les économies d'énergie besoins. Ceci peut être expliqué par l'absence de réglementation thermique spécifique et, également, par le manque de savoir-faire et une connaissance insuffisante sur le sujet par les constructeurs. Une méthode de calcul thermique a été développé en tenant compte de la nouvelle HPE "Haute Performance Energétique" un processus volontaire, qui encourage la recherche de haute qualité dans une perspective de développement durable. Il est également basée essentiellement sur une nouvelle façon de se comporter dans un environnement intérieur confortable, afin de réduire au minimum le coût de l'énergie utilisée pour chauffer les bâtiments neufs ou existants. Les recommandations du centre de la réglementation thermique développé pour le climat algérien sont prises comme références dans le choix du modèle informatique élaboré dans notre étude comme un outil. Un programme personnalisé, nommé "EnergyArch" que les modèles à la fois extérieur et intérieur des paramètres agissant sur le bâtiment, en utilisant la simulation thermique des paramètres architecturaux et les facteurs climatiques de la région. Ce programme a atteint une économie d'énergie d'environ 20% par les ménages en fonction des matériaux de construction utilisés

Mots clés: Energy modeling, Thermal efficiency, Low energy building, Housing sustainability, Green building, Regulations.

Abstract

This paper develops a simple modeling tool for designer green buildings. The designer can explore the nature of building, shape, fenestration, orientation and fabric thermal properties to minimize a buildings' environmental effect. Aspects of heating, lighting, natural and mechanical ventilation with heat recovery systems can also be investigated. The model is best used to check that buildings will observe with the regulations or used as an early design aid rather than a detailed design simulator of building performance. The program should therefore be of particular interest to architects, building surveyors and building controllers rather than building service engineers. A project pilot program in Algeria has been lunched based on low energy consumption. It has been increasingly realized that the preservation of the environment is a guarantee of durability and stability of the process of economic and social development. Daily life in domestic buildings (heating, air conditioning) is responsible for more than 30% of emissions of greenhouse effect gases. It also appears that a suitable building construction and an adequate implementation can both reduce energy bills and household expenditure. Acting on buildings and environment, is to give all Algerians possibilities to live in an ecological habitat. That is why measures will be implemented which affects both existing buildings (over 7 million homes on 1 January 2007) during their rehabilitation and the new buildings as well. A large number of residential constructions do not seem responding to thermal comfort and energy savings needs. This can be explained by the absence of specific thermal regulations and, also, by the lack of know-how and an insufficient knowledge on the topic by the builders. A thermal calculation method has been developed taking into account the new HPE 'High Performance Energy' a voluntary process, which promotes high quality research in a sustainable development perspective. It is also essentially based on a new way of behaving in an indoor environment comfort, in order to reduce to the minimum the cost of energy used to heat the new or existing buildings. The recommendations of the centre of thermal regulations developed for the Algerian climate are taken as references in the choice of the computer model elaborated in our study as a tool. A personal program, named "EnergyArch" that models both outside and inside parameters acting on the building, using the thermal simulation of the architectural parameters and the climatic factors of the region. This program has reached an energy saving of about 20% by households depending on the construction materials used

Keywords: Air pollution, environmental strategy, sustainable transport, tram, Constantine

ملخص

استدركت الجزائر ان الحفاظ على البيئة و الثروات الطبيعية هو ضمان الاستدامة و الاستقرار في التنمية الاقتصادية والاجتماعية.
الحياة اليومية في المباني (التدفئة و التكييف الهواء ...) هي سبب ما يقارب 25% من انبعاثات غازات الاحتباس الحراري . ويبدو ايضا ان تشييد المبنى اللاق واختيار الموقع المناسب بإمكانهما خفض فواتير الطاقة والنفقات المنزلية. ان تطوير المباني والحفاظ على البيئة هما اعطاء كل الجزائريين امكانية العيش في سكن إيكولوجي. ولهذا سيتم اتخاذ التدابير التي تمس كل من المباني القائمة (اكثر من 7 مليون سكن في 1 يناير 2007) خلال اعادة تأهيلها والمباني الجديدة. هناك عدد كبير من المنشئات السكنية لا يبدو انه متجاوب مع الراحة الحرارية و اقتصاد اجتياحات الطاقة. ويمكن تفسير ذألك بسب عدم وجود قوانين حرارية خاصة بالبناء وكذألك نقص الدراية والمعرفة حول هذا الموضوع من جانب البناة. وقد تم تطوير طريقة برنامج من اجل تقليص تكاليف الطاقة المستخدمة لتدفئة المباني الجديدة والقديمة الى الحد الادنى اخذين بعين الاعتبار المبادئ HPE
و قد اتخذ ت التوصيات الصادرة عن المركز مركز البحوث الخاص بالقوانين المتعلقة بالعزل الحرارى في البنايات كمرجع في اختيار النموذج الرقمي المستعمل في دراستنا. طور في هذا البحث برنامج (EnergyArch) لدراسة الوسط الداخلي و الخارجي للمبنى.
و لقد توصلنا في هذا البحث الى توفير في الطاقة من 10% الى 20% حسب مواد البناء المستخدمة.
الكلمات المفتاحية - نمذجة الطاقة ، ونماذج الحرارية ،السكن المستدام ، البناء الأخضر

ntroduction

The habitat is a major issue in the strategy of APRUE for energy management based on option "HPE" which is based essentially on the following objectives:

- The improvement of thermal comfort and reducing energy consumption for heating and cooling
- The involvement of building actors around the issue of energy efficiency
- The implementation of demonstrative action showing the feasibility of energetic high performance in Algeria.
- Provoking a ripple effect of practices in energy efficiency in building design

This has resulted in the launch of the ECO-BAT pilot program for the production of 600 household's implementation, monitoring and evaluating the results which allow us to elaborate a thermal regulation specific to the Algerian context social housing, according to climatic regions. This will culminate in a set of recommendations on housing HPE allowing us to discern a number of well-defined targets, to be scrupulously respected by the contractors, building owners and forming the platform of the future Algerian label.
The energy and environmental balance as published by PNME 2007-2011, (Programme de maîtrise de l'énergie en Algérie); shows the following table briefly the issues related to the implementation sector actions in energy efficiency over the next five years in Algeria. Such a program would allow a deferral of investment with a capacity of 161 MWe (Mega Watt Electric) for electrical production and of 897 000 tep of savings over the period and this, in the context of significant economic growth in the forecast for energy and tones of CO_2 avoided:

	Energy Economy (Tep)	Tones CO_2 avoided
Industry	631 240	1 893 720
Residential	68 929	206 786
transport	176 00	216
collectivities	7 553	22 659
Services	12 822	38 446
Agriculture	518	1 554
Total	897 062	2 163 401

The current high demand of energy consumption in Algeria is mainly due to the increased level of living and comfort, as well as the growth of industrial activities. This calls to a new energy policy and new users' behaviors.
The relationships between the building and its climatic environment as regards to the impact of solar heat have been particularly neglected in Algeria. Because of the energy crisis, the question of environment becomes a major concern of researchers in the field of construction. Today, the thermal behavior of buildings, on correlation with climatic and economic conditions, leads to many studies and research in all countries. But in Algeria, these studies, based mainly on the moderate climate, are not developed yet.
It would be very important to encourage the population to use energy efficient equipment (lighting, heating and air conditioning) and, to ensure the proper study and implementation of building regulations according to the national standards agency (The National Agency for the Promotion and Rationalization of Energy Use. The agency aims is to redefine the national model of energy consumption and therefore has the following missions:

- Identifying the energy consumption and its analysis sector by sector in their prospective evolution.
- Identifying wasting energy home.
- The evaluation of possible gains to be made in each sector and the necessary funding.
- Defining a minimum average practices for the rational use of energy.
- Developing a communication plan and implementation actions of sensitization.

This research aims to obtain a comfortable internal micro climate, while optimizing energy costs. It is based primarily on the actual description of the current existing social residential buildings in the city of SETIF, BOUGAA (collective and individual) and the calculation of energy consumption by the degree-days method which a unit of measurement equal to a difference of one degree between the mean outdoor temperature on a certain day and a reference temperature, used in estimating the energy needs for heating or cooling a building [1], (Durmayaz A, Kadıoglu M, 2000)

An analysis of comfort parameters has been carried out over the existing housing (social housing, old houses). Also a processing of data has been obtained from the company of distribution of domestic energy, (APRUE, National Society of Electricity and Gas, 2005). The cost due to heating and cooling, in addition to improvements of the building envelope in terms of specific insulation and orientation of the facades have allowed this study to reach an important energy savings per household.
The "EnergyArch" program developed in this research as a personal computer tool aims not only to verify the thermal performance of a building but to propose new parameters for comfort and reducing the cost of energy and leading to an appreciable financial gain for the country.
The technical and economic parameters developed are very important because they give the possibility to propose constructions standard from the HPE point of view.
There is no unanimous method recognized by ISO; so far. Each country consolidates its calculation of climatic parameters on its own national rules. Most codes specify the values of calculation based exclusively on

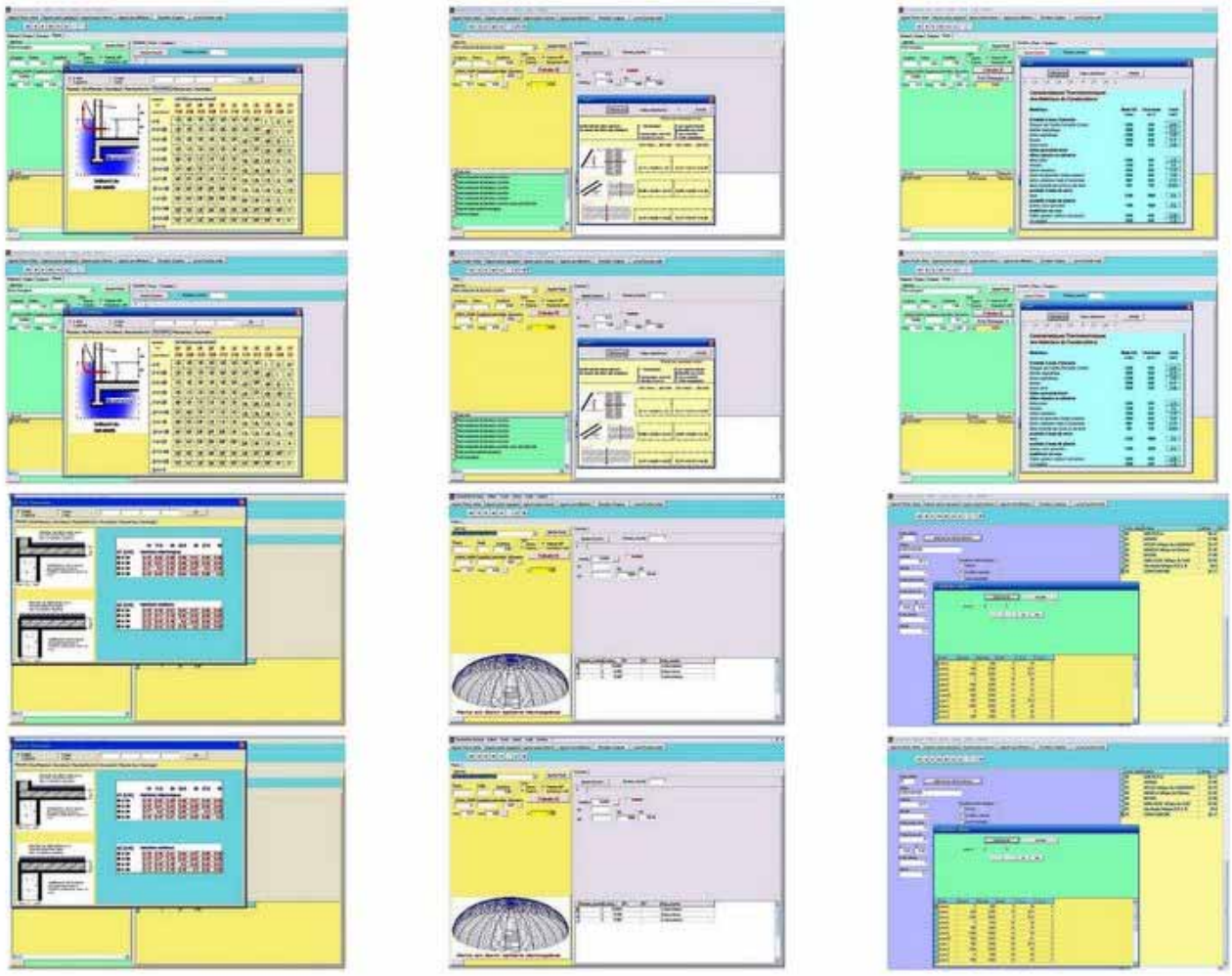
meteorological data, not taking into account the thermal characteristics of buildings.

A database of minimum and maximum temperatures is obtained from the meteorological office (ONM, National Office of Meteorology, 2004) of SETIF, BOUGAA over a period of fifteen years. It feeds the program to better understand the comfort in the interior of a house depending on energy consumption level of heating. The degree-days method calculated from the difference of temperature between inside and outside, of each day, to establish a climate map of the region [2], (CNERIB. 1998).

THEORETICAL BASIS OF THE THERMEL MODEL OBJECTIVES AND INVESTIGATION

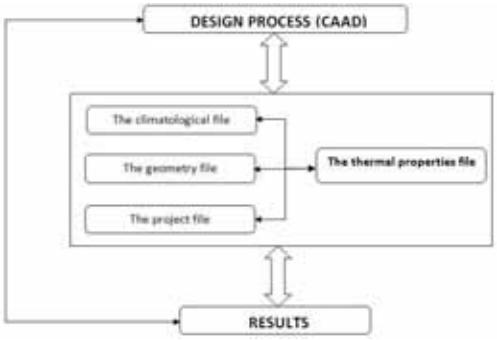
The ultimate objective of the thermal modeling is to approach and to control the relationship between climate and building.

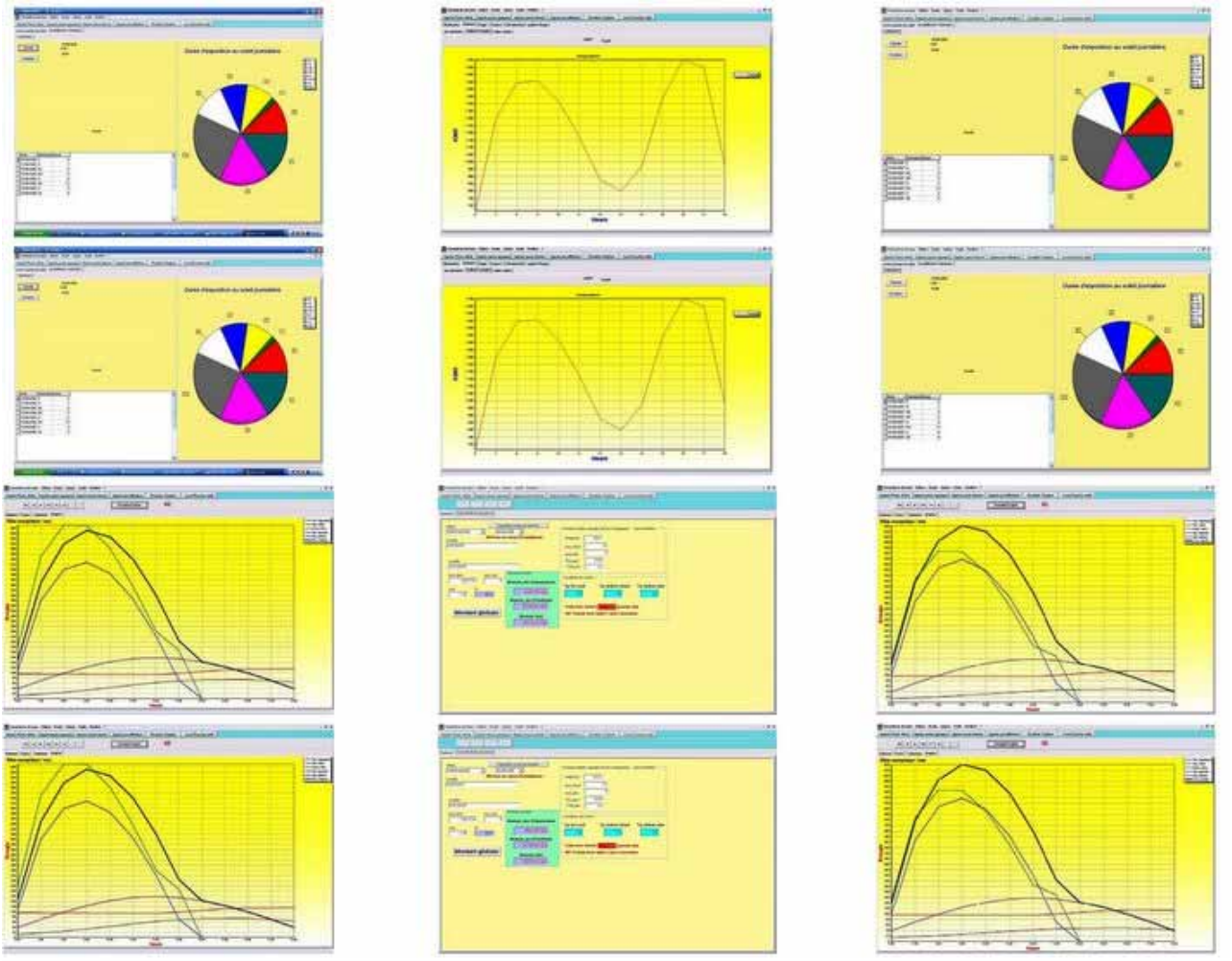
In other words is to define in terms of climate the shape, materials and useful energy to build in an optimal way, without forgetting that one of the key points is economy.The Thermal modeling of the building is supported by two complementary studies. The proposed thermal model is presented as a new code to generate most important features and attributes data instant entered provided building graphical user interface. The problem of thermal analysis of building in the Algerian specific climate is the enrichment of specific technical regulations. EnergyArch performs a new thermal theory based on parameters involving various components. The buildings masses are relatively implemented in a hot environment. The climate data collected shows an average of temperature of more than six months exceeding 22 °C. Relatively, it is a hot climate that could be taken into consideration in this case study.



Dialogue boxes of different level of the thermal model showing the analysis of the shape and fabric

Figure 1: Main Modules





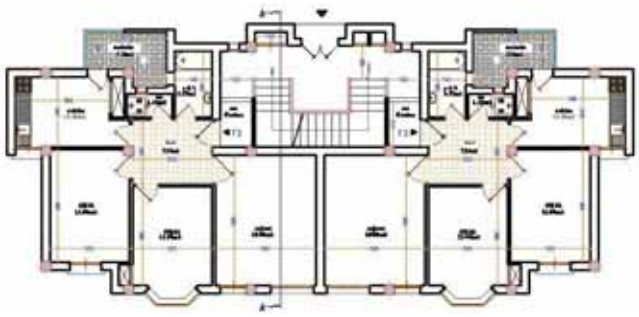
Dialogue boxes illustrating solar energy performance of spaces and energy cost consumption

2. EXPERIMENTAL STUDY, APPLICATION TO A CASE OF NEW BUILDING BASED ON HPE CONCEPT

A Test cell type F3, three bedrooms; on August 20 is taken as case study. In this research we consider that the most important first stage to simulate the thermal performance is the input data provided. This will define the sensitivity of parameters and to verify and validate the computer code developed and comparing its results to data obtained from APRUE. A twenty year database of electricity and gas is analyzed and prepared to be compiled in the model [5], Ministry of Economy Finance and Industry, 2004.

The Site is located in the western outskirts of SETIF, BOUGAA and consists of a four level buildings. The climate (zone B) in the city of SETIF, BOUGAA is hot in summer and cold in winter, ONM , (data base temperature 1990-2004). The city is located at an altitude of 971 m above sea level; the latitude is 36°.19'60N.

sETIF, BOUGAA Pilot Project HPE



The database concerning the geometry of the sample is gathered into a separate file project. Each of those details (width, length, height, thickness, surfaces and volume) are exploited directly by the proposed energy model 'EnergyArch' for calculating the cost of energy spent during a season (summer or winter). The huge amount of geometrical data obtained systematically from this model may contribute enormously to reduce the consumption of energy.

The presented sample above is subjected to weather conditions over the normal, either in terms of ventilation or the transfer of heat towards outside. By running the model partially, we obtain,

- Heat loss by transmission through fabric: 300 Watt/°C
- Heat loss by transmission through glass: 210 Watt/°C
- Heat loss by air renewal: 80 Watt/°C

By improving each of those components:

Before transformations
Insulation
Reducing openings
Double glazing
Both
Reorientation the front northwest to the South East

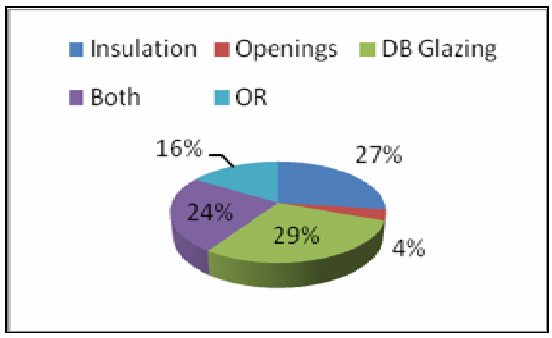


Table 1: Simulation of total losses and average heat gains after simulation parameters before and after transformation

A number of thermal simulations can be made in order to make design decisions. A fine analysis of the building envelope depends also on the accurate geometrical database items.

3. DISCUSSION

After a detailed analysis of the simulation of thermal behavior of the individual house during the cold season (December 2004), and modifying the building envelope with the various parameters of solar radiation and ventilation losses which also dependent on the

permeability of the opening, the losses by transmission through the opaque walls, are about 70%, then the losses through the windows valued to 35% and losses by the renewal of air are estimated to 10%.

This means that heat losses by transmission through the fabric, roof and platform represent twice the total loss of the flat. The insulation has reduced losses to 30%. Consequently, of the heating system bill is reduced due to a rise in the inner temperature faces of the envelope.

The large area of unprotected glazing leads to very high energy consumption and, implicitly, to overheating in summer. The decrease in surface openings in this flat has saved 15% of energy. Important surface of glass results in a considerable loss of heat. Doubling the glass has a positive effect on the consumption of heating. This represents 15% gain in energy if a double glass 3 mm thick each is adopted.

The reorientation of the main facade of the north-west to south-east recorded a heat gain of 45%. A very high temperature difference is produced in the North-West and causing heavy loss of heat.

Consequently, if we adopt multiple solutions by modifying the structure, strengthening the insulation, reducing the openings and adopting the double glazing, we can achieve a reduction in heat losses about 15% to 20%, [7], S.Foura, Zerouala.MS, 2007.

The database obtained from APRUE for the city case study reveals that the mean cost of energy consumed for heating is estimated around 15000 (Algerian dinars) a year (Figure. 3: Annual Energy of a three bedroom flat and the variation of consumption for 103 subscribers). (Source, APRUE). The temperature of a living room should be between 18 and 24°C (it depends on the activity, clothing and intermittency which is highly considered in the code).

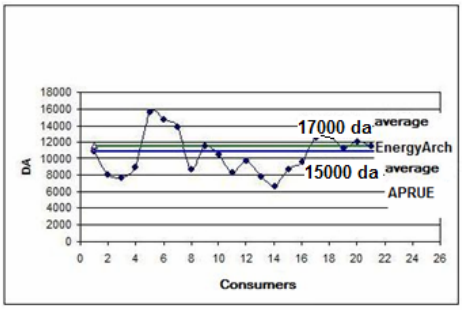


Figure 2: Annual Energy of a three bedroom flat and the variation of consumption for 22 subscribers. (Source: APRUE)

We observe a fluctuation of data showing that the use of the heating system during the cold period is irregular (Figure 5). That fluctuation of data is due to an irregular use in energy consumption for heating for economy measure or by the intermittent use of the heating system (absent subscribers). The analysis of heat consumption of subscribers is based on the following criteria: Type of Accommodation, Spaces, and Energy Heating: GAS, [8], [9], APRUE C.T.I.

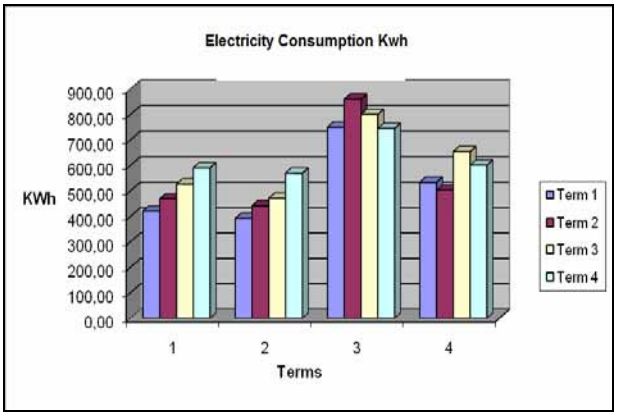


Figure 3: Term Electricity Consumption for a three bedrooms flat, 2004

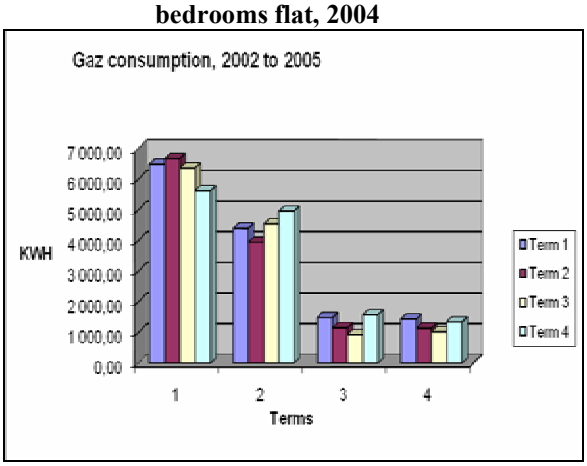


Figure 4: Term Electricity Consumption for a three bedrooms flat, 2004

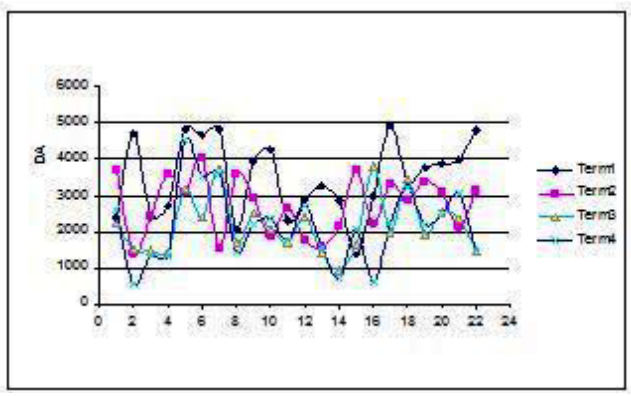


Figure 5: Irregular Electricity and Gas Consumption

The proposed software led us to a very efficient result: the value of 17000 DA/year for heating is obtained under the most normal conditions knowing that the thermo physical characteristics of the theoretical material of the envelope (thermal conductivity, specific heat resistance) do not really reflect the quality of the material. We can see that the quantity of heat calculated by EnergyArch (17000 DA) seems to be valid compared to the average of APRUE value (15000 DA).

CONCLUSION

Properly insulating a building means designing and implementing all elements of the envelope (facade, roof, windows, doors and floors. This to reach a relatively high thermal resistance, resulting to a low cost energy heating). For Lifelong comparisons and benchmarking, investment in insulation should be adopted in constructions, so it will be amortized each year on energy costs for heating and consequently on cooling. 20% savings in consumption for heating leads to a gain in the bill of 3000 DA per households (Source: EnergyArch). Forcing, the gain will be very important when the energy consumers (7 millions) represent a part of the national economy. The case study shows the importance of loss when the building is misdirected, EnergyArch recorded about 40% loss of energy (Source: EnergyArch). That means the reliability of the program is validated by the results obtained on annual cost of energy consumption for heating compared to the same data obtained by APRUE. This is due to the assumed level of comfort developed in EnergyArch compared to the real thermal comfort in the studied flat. The parameter of use of the heating system selected on EnergyArch is regular and intermittent. But we can say that the behavior of individuals in terms of comfort is generally unpredictable. This is also explained by the fluctuation of data (Figure 5). Evidently, the quality of materials available on the market does not reflect the true value of the thermo physical standard characteristics (no homologation). The results obtained from the new code in order to reduce energy consumption will be verified and validated by the all type of data measured (temperatures, radiation …….) on site when the buildings will be occupied.

ARCHITECTURAL RECOMMENDATION

Support resources for thermal regulation control are necessary to achieve the desired levels of comfort for the inhabitants. Some design elements can improve the thermal comfort in the home. These elements are:

- Density and compactness of the urban structure, while providing mechanical access for each construction
- The south-east orientation is desired, but it is difficult to apply for all buildings
- Reducing external surfaces with two fronts maximum
- The construction of maximum two levels to be more tolerable in the winter and summer
- The SAS entrance for more control of heat gains and heat losses, and the penetration of sand and dust
- Protection glass walls from direct solar radiation by shading and blinds
- Dimensions and arrangement of openings facilitate effective night ventilation in summer
- The envelope does not sufficiently protect solar gains and heat losses. Massive buildings or effective insulation of walls and roof are necessary for a time delaying of at least eight hours
- The existence of an interior open space is required for comfortable thermal environment. This space should not have walls to the outside, but good ventilation during hot periods
- The existence of an open space to the living room. In houses, it plays the role combined with the courtyard and terrace. This protected area is covered, used as living space during the sunny days of winter and summer
- The terrace is an appreciated area for its sunshine in winter and for its cooling during the night in summer

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