DESIGNING
FOR A SUSTAINABILITY
(The case of ALGERIA)

S. Foura.   S. Debache
School of Architecture & Town Planning,
University of Constantine, Algeria

Abstract

Algeria, has increasingly realized that the preservation of the environment and the natural assets is a guarantee of durability and stability of the process of economic and social development.

Daily life in buildings (heating, air conditioning ...) is responsible for almost 25% 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. 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 for the habitat 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 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. A personal program, named "SimulArch" 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 10% to 20% by households depending on the construction materials used.

INTRODUCTION

Algeria, producer and exporter of oil and gas has seen a new national oil policy. The state has financed a large industrial, social and economic program, (from 8.3 MTEP (Mega tone of oil equivalent energy dominant) in 1976, either 50.49 TEP per capita to 25.3 MTEP in 1995, or 0.89 TEP per capita).

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 Mediterranean 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 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 aim is to obtain a comfortable internal micro climate, while optimizing energy costs. It is based primarily on the actual description of the current existing construction in the city of Constantine (collective and individual) and the calculation of energy consumption by degree-days method.

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, (SONELGAZ, 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 insulation and orientation of the facades have allowed this study to reach an important energy savings per household.

The “SimulArch” 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 insulation point of view.

There is no unanimous method recognized by ISO; International Organization for Standardization, 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 Constantine 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 (CNERIB. 1998).

1. Algorithms of SimulArch

1.1. Objectives and means of investigation

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

1.2. The thermal simulation, the structure of the model and The climatological file

This has enabled the study of the components or a set of components, to establish the heat balances, levels of comfort, and the sensitivities of some parameters. This is represented by software developed in Delphi programming language (SAMIR FOURA, ZROULA M.S, 2007). The architect starts from a broad concept and converges towards the details of the project. The data are arranged in such a way as to evolve with the design. The data is organized in four main files (Lawson BR, 1987).

The climatological file contains yearly standard data which represent the localities. The user may use this data when it is about an unusual climate or other considerations.

Once the data is prepared in the previous files, the energy performance can then be tested and results be obtained. The results can be displayed graphically or numerically on the screen and the user may see if the design is appropriate or not, otherwise he can modify the data files to obtain others results.

1.3 The thermal properties file

The geometrical file defines the form of the building and the positions of the internal partitions, windows, doors etc… The structure of the geometrical file allows the moving and reorienting of buildings on site with the minimum of data change.

It is also an interactive and graphical database; it accepts data specifications of building plans. The main characteristics of this module are that it develops visualization of building model to be sent to be exploited by the thermal simulation performance module. This program is particularly suitable for the analysis of various types of passive solar buildings. Special provisions would be made for instance for analysis of attached sun-spaces, rock bin, thermal storage, (Menezes, A. and Lawson B.R, 2006).

The project file contains the latitude of the site and other heat gain from internal sources such as occupancy, lighting, etc.

The thermal properties file contains the characteristics of the materials of the building such as density, specific heat and conductivity. They are used to estimate heat flow through the building fabric, the amount of sunlight, the thermal lag of the fabric, etc (figure 1).

2. Experimental study, Application to a case of existing building

Test cell type F3, three bedroom; on August 20, which will define the sensitivity of parameters and to verify and validate the computer code developed and comparing its results to data obtained from SONELGAZ.

The chosen Site is located in the western outskirts of Constantine and consists of a large complex of a four level buildings. The climate (zone B) in the city of Constantine is hot in summer and cold in winter. The city is located at an altitude of 694 m; its latitude is 36.17 degrees and east longitude of 6.37 °.

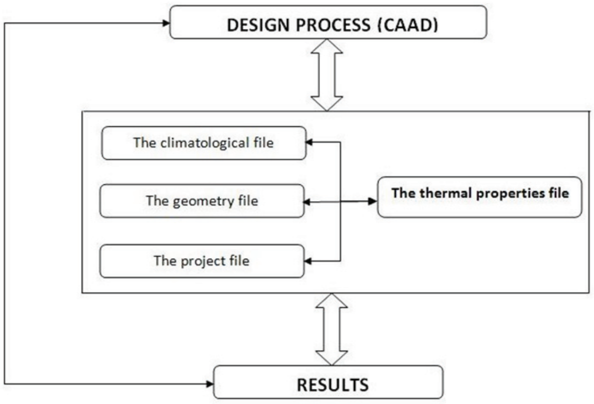

Figure 1: Relationship - Control Flow between the main Modules

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) is exploited directly by the proposed energy model 'SimulArch' for calculating the cost of energy spent during a season (summer or winter). The huge amount of geometrical data obtained systematically (without input data) from this model (SimulArch) may contribute enormously to reduce the consumption of energy and consequently giving internal comfort to the residential building.

We can summarize some of the results by running the model partially:

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

- Heat loss by transmission through opaque walls: 133 Watt/°C
- Heat loss by transmission through the glass: 57 Watt/°C
- Heat loss by air renewal: 10 Watt/°C

As already said above, one of this research objective is to reduce energy losses in buildings. After transformations we obtained the following loss values (table 1):

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

Before transformations of fabric	791.55 Watt/C°	Heat Gain
Presence of polystyrene	590.68 W/C°	25%
Reducing the size of openings (17%+55%)	680.25 W/C°	14%
Double glazing	701.59 W/C°	11%
Strengthening the insulation and reducing the surface of windows.	553.67 W/C°	30%
Reorientation the front northwest to the South East	467.59 W/C°	41%

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. RESULTS AND 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 in conjunction with the various parameters of solar radiation and ventilation losses and dependent on the permeability of the opening, the losses by transmission through the opaque walls, which are about 66%, then the losses through the windows valued to 29% and losses by the renewal of air are estimated to 5%.

This means that heat losses by transmission through the fabric, roof and platform represents twice the total loss of the flat. The insulation has reduced losses to 25% and, consequently, a reduction of the heating system bill due to a rise in the inner temperature face of the exterior wall.

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 14% 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 11% gain in energy if a double glass of 3 mm thick each is adopted.

The reorientation of the main facade of the north-west to south-east recorded a heat gain of 41%. 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, namely strengthening the insulation, reducing the openings and adopting the double glazing, we can achieve a reduction in heat losses about 15% to 20%.

The database obtained from Sonelgaz for the city case study reveals that average energy consumption for heating is estimated around 10800 (Algerian dinars) per year (figure. 2) for a minimum comfort (17000 btu/year for three bedroom flat (Source: SONELGAZ). The temperature of a living room should be between 18 and 24°C (it depends on the activity, clothing and intermittency).

We observe a fluctuation of data showing that the use of the heating system during the cold period is irregular and intermittent (Figure 3). Remember that this fluctuation data due to an irregular use in energy consumption for heating, is due to 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.

Remember that the proposed software SimulArch led us to a very efficient result: the value of 11500 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 SimulArch (11500 DA) seems to be valid compared to the average of Sonelgaz value (10863 DA).

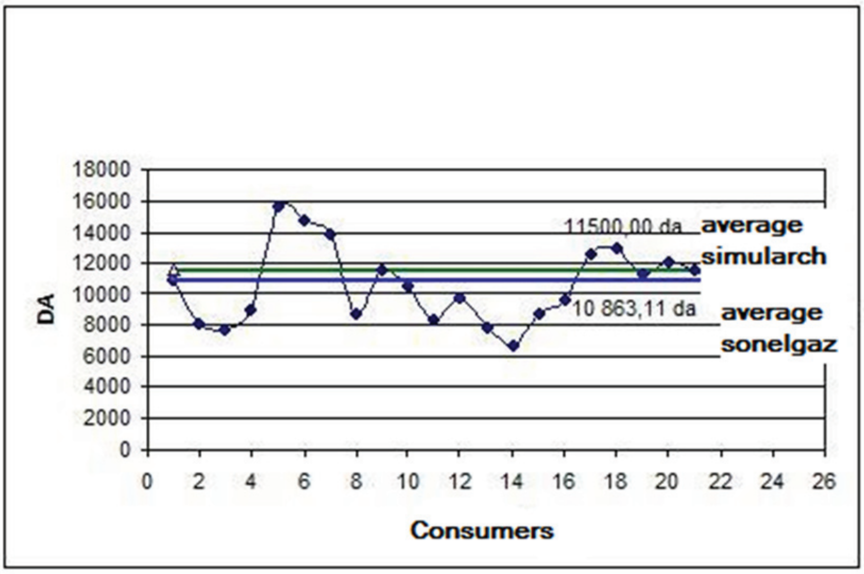

Figure 2. Annual Energy of a three bedroom flat and the variation of consumption for 22 subscribers. (Source: Sonelgaz)

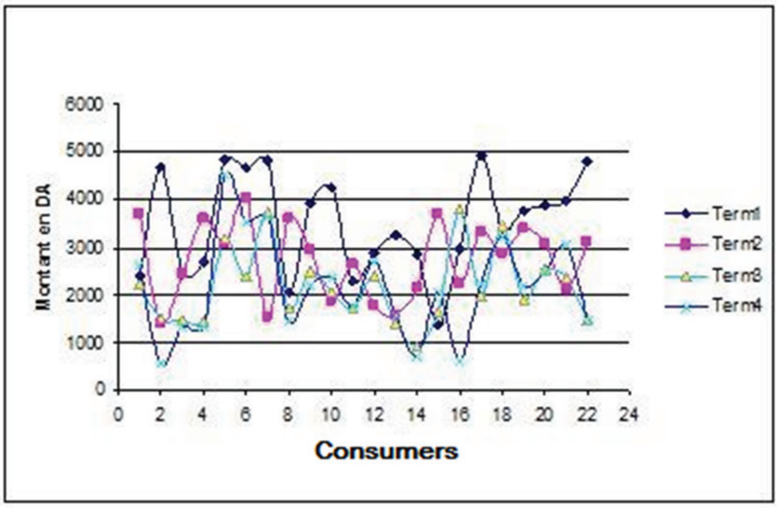

Figure 3. Term Consumption for a three bedrooms flat, 2004

4. CONCLUSIONS

The use of energy is essential to the economic development and contributes to improving comfort. There is no doubt that environmental issues are strongly linked to the production of energy consumption. Some recommendations can submit:

- 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).

- Investment in insulation should be made usually in the construction or renovation of the building, and will be amortized each year on energy costs for heating. 15 to 20% savings in consumption for heating leads to a gain in the bill of 1800 DA 2200 DA (source: SimulArch).
- Bridges heat: losses are estimated at 18% by transmission.
- The design of openings. Approximately 15% gain in energy obtained by SimulArch for a three bedrooms flat.
- Adopting the double glazing in the openings. 2.5% of energy gained from the total loss of the flat.
- The preliminary study on the orientations of the building before implantation. The case study shows us the importance of loss when the building is misdirected. SimulArch recorded about 40% loss of energy.
- The reliability of the program SimulArch developed in this study is validated by the results obtained on annual cost of energy consumption for heating which is about 11500 DA compared to the same data obtained by SONELGAZ (DA 10863 on 2004). The difference is (637 DA).this is due to the assumed level of comfort developed in SimulArch compared to the real thermal comfort in the studied flat. The parameter of use of the heating system selected on SimulArch 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 of SONELGAZ (see Figure 3). The quality of materials for building available on the market does not reflect the true value of the thermo physical standard characteristics.
- The requirement of a specific regulation for thermal use in residential buildings and sufficient knowledge of construction techniques by the owners.

5. REFERENCES

CNERIB, 1998. Algerian Center for Studies and Research integrated of buildings. D.T.R. C3-2 & C 3-4; rules for calculating heat loss, Issue 1 & rules for calculating the heat gain of buildings.

LAWSON, B. R. (1990). From drafting to intelligent systems. In CAD im Architekturburo: ACS-90, (pp. 29- 36). Wiesbaden Germany, ACS.

MENEZES, A. and LAWSON B.R. (2006) How designers perceive sketches Design Studies 27 (5), pp. 571-585)

[On ligne] Ministry of Economy Finance and Industry, 16/11/2004. « 20 ans de chauffage dans les résidences principales en France de 1982 à 2002. *Observatoire de l'énergie. Octobre 2004 »* - http://www.industrie.gouv.fr/energie/statisti/se_stats14.htm#1 *(Consulted Page on 05 march 2006)*

Office national de la météorologie de Constantine, Base de données de température externe moyenne (1990-2004).

SAMIR FOURA, ZEROUALA M.S, 2007; Simulation des paramètres architecturaux du confort thermique d'hiver en Algérie, 2007. Sciences et Technologie D – N°26 Décembre (2007). Pp 76-85 energy program.

SONELGAZ C.T.I Computer Center and Technics of SONELGAZ of Constantine, « Tournée 23 Commune du 20 Août 25501 », 2005.

التصميم من اجل الاستدامة : حاله دراسية الجزائر

سمير على سعيد فورة

سميرة دباش

مدرسة العمارة وتخطيط المدن، جامعة قسنطينة، الجزائر

الملخص:

اصبحت الجزائر في قناعه تامه ان الحفاظ على البيئه والثروات الطبيعيه ضروري لضمان للاستقرار واستمراريه عملية التطوير الاقتصادي والاجتماعي .

فنجد ان المعيشة اليومية في المباني (مثل التدفئه والتكييف...الخ) تسبب نسبة مايقارب ٢٥٪ من انبعاثات غازات الاحتباس الحراري.

ومن الواضح ايضا انه من خلال الانشاء المناسب للمباني والتطبيقات الملائمه يمكن تخفيض فواتير الكهرباء والمصروقات المعتاده للعائله .

الاهتمام بالمباني والبيئة يحقق للجزائريين فرص العيش في بيئة ملائمة . ولهذه الاسباب سيتم تنفيذ اجرأت تؤثر على كلا المباني القائمه (اكثر من ٧ مليون مسكن في يناير ٢٠٠٧) خلال اعاده تأهيلها والمباني الجديده .فنجد ان الكثير من انشاءات المساكن لا تتوافق مع متطلبات الراحة الحرارية وتوفير الطاقة.

ويمكن تفسير ذلك بغياب اللوائح المحدده التي تحكم الاداء الحراري للمساكن وايضا لعدم توفر المعرفة الكافية عن هذا الموضوع لدى العاملين في صناعة البناء.

ولذا تم تطوير منهجية لحساب الاداء الحراري من اجل التخطيط للحد الادنى لكلف الطاقة لتدفئة المساكن القائمة والجديدة . ويتخذ هذا البحث التوصيات التي طرحها مركز لوائح الاداء الحراري في المناخ الجزائري كمرجع لتطوير النموذج الحسابي الذي يتم توضيحه في هذه الدراسة .وهذا البرنامج الشخصي والذي يسمى المحاكاة المعمارية (simulArch) يمثل كلا العوامل الخارجية والداخلية المؤثرة على المبنى وذلك با استخدام المحاكاة الحرارية للعوامل المعمارية وعوامل المناخ والاقليم .

وقد حققت تطبيقات هذا البرنامج توفيرا للطاقة بلغ حجمه مابين ١٠٪الى ٢٠٪ للمسكن الواحد وذلك حسب نوع مواد البناء المستخدمة.