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Analysis of Algerian energy efficiency measures in buildings for achieving sustainable development goals

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Abstract

The building sector is among the most energy consumer with 42 %, it absorbs 44% of the total final energy consumption, the major part of housing, which currently exceeds eight (8) million homes, are "obsolete" in terms of energy efficiency, As a result, energy demand for residential buildings are of a very high level, Unfortunately Algeria faces to major energy challenges, his dependence of fossil resources oil and gas price drop, and the increases of the consumption. The needs of the building sector will be multiplied by 2.7 while the tertiary sector will increase its power consumption by 3.2 ,an increase of 40% relative to current consumption, The policy of energy efficiency in Algeria was concretized by adoption of the new renewable energy program and energy efficiency by 2030, program Eco-bat, the aim is reducing the high consumption in this sector, a new version of thermal regulation for buildings 2016 to introduce a minimum requirement for new buildings, to optimize their heating and cooling needs while improving the high quality of comfort, launching a labelling certificate for equipment's, the building sector represents an energy saving potential of 38%,there are a lot of options to improve efficiency in building , focus to use of renewable energy in heating, cooling and electricity, improvement to the building envelope ,including materials ,natural ventilations and delighting, As a result, this indicates the urgent need to adopt a policy and strategy to reduce the excessive use of energy in buildings.

In the light of the current global challenge of energy which calls for the development of sustainable economies, this paper analyses the approach efficiency policy in the Algerian building, and suggest improvement to reduce the gap between the policy of government and the real situation.

Keywords: Building, energy management, energy efficiency in building, building performance, energy policy, energy audit.

1. Introduction

The building sector of Algeria have the highest value of consumption, 40% of the total energy consumption with internal and external challenges, Energy efficiency in building is today at the

heart of Algeria's energy policy. Whereas, the government has chosen, in its policy on energy transformation, to set a national goal for the reduction of this high consumption, to achieve these goals of reducing, Among the policies we find the National Program for Energy Efficiency [1].

The first energy efficiency program in Algeria, was adopted by the Algerian government in 2011, an update of this program in 2015 of the first version of PNEREE ,the target of this updating is the reducing of the consumption in the buildings sector, encouraged the use of efficient equipment, in particular solar water heaters and energy saving lamps, Thermal insulation with the introduction of new 2016 regulations, but unfortunately this program was not followed from the start The building sector is the largest consumer of energy in Algeria; it absorbs 44% of the total final energy consumption, the major part of housing, which currently exceeds eight (8) million homes, are "obsolete" in terms of energy efficiency, hence the urgency to act on the building sector to moderate this excessive consumption of energy [2].

Algeria is still suffering from housing highest in terms of energy consumption, for this reasonAlgeria has set up energy management agencies (APRUE, FNME, PNME, CDER, CNERIB), its mission is to promote energy efficiency [3].

Algeria is initiating a green energy dynamic by launching an ambitious program for the development of renewable energies (RE) and energy efficiency. This vision of the Algerian government is based on a strategy focused on the development of inexhaustible resources such as solar energy and their use to diversify energy sources and prepare the Algeria of tomorrow. Thanks to the combination of initiatives and intelligence, Algeria is committed to a new sustainable energy policy [4].

The Main objective is to reduce the energy consumption in the building sector from 10% to 15%, the energy efficiency policy focuses on new housing by passing certain standards including thermal insulation of buildings through thermal insulation of buildings through the of the latest thermal regulations version 2016,In Algeria, thermal code for dwelling units has been set up in 1997 to reduce the heating energy consumption in the order of 25%,updating and merging of DTR C 3.2 and DTR C3.4 Take into account the improvements introduced in the field of thermal building and allow more practical use [5].

Respecting these thresholds should allow savings in energy consumption for heating and air conditioning and provide better comfort.

Unfortunately, this regulation concerns new buildings, but it does not concern individual buildings, nor the thermal rehabilitation of the old building [6].

Through this program, Algeria wants to save up to 63 million TOE and generate 120,000 jobs by 2030-2035.

2. Thermal insulation of buildings

In 2019 Algeria launched the second eco-building program, after first one launched in 2011, this program focus on improving the insulation of roofs, walls and windows ,the thermal insulation aim to reduce energy consumption under the new version of thermal regulation for buildings RT 2016

This research aims to analyse the energy consumption in Algerian building conform to RT 2016 and see the potential of energy savings with TRNYS simulation software

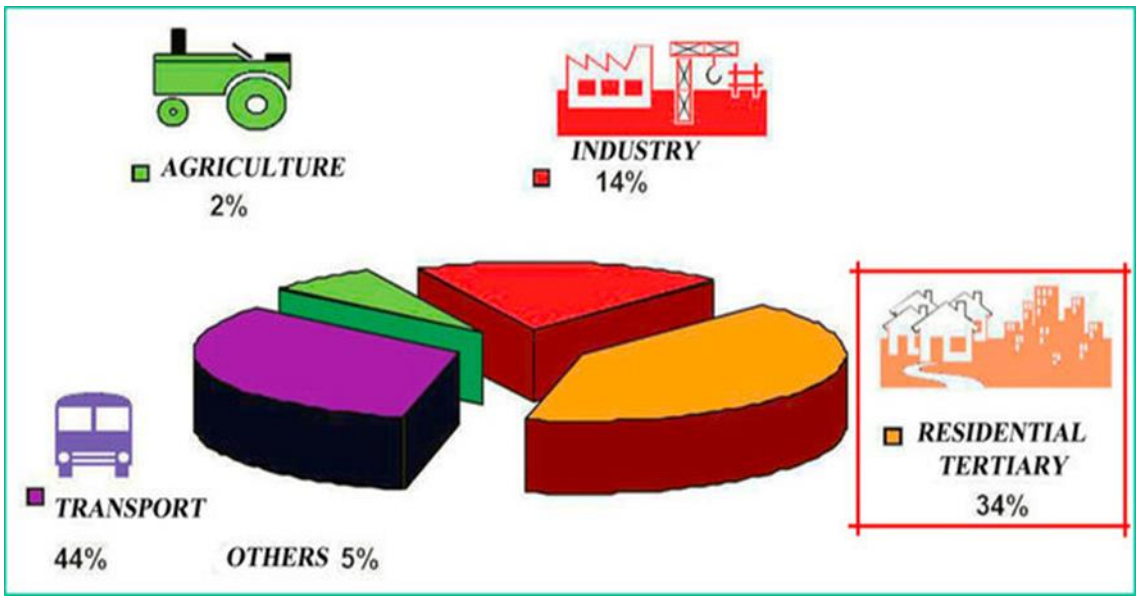

Fig 1. Distribution of final energy consumption by sector in Algeria (Aprue 2017)

2.1 case study

The methodology of this research is to simulate the energy demand, in first case we calculate the energy demand for heating and cooling based in on thermal insulation requirement standards in the thermal regulation 2016, in the second case we define the best insulation material by TRNSYS simulation.

The geographical characteristics of the rouiba city are:

- The latitude=36.72N.
- The altitude which is equal to 20 m above sea level.
- Longitude=3.28N.

The city of rouiba is characterized by a maximum temperature in summer which reaches 31° C in July and a minimum temperature in winter reaching6°C during the month of January

The area of building is 104 m2

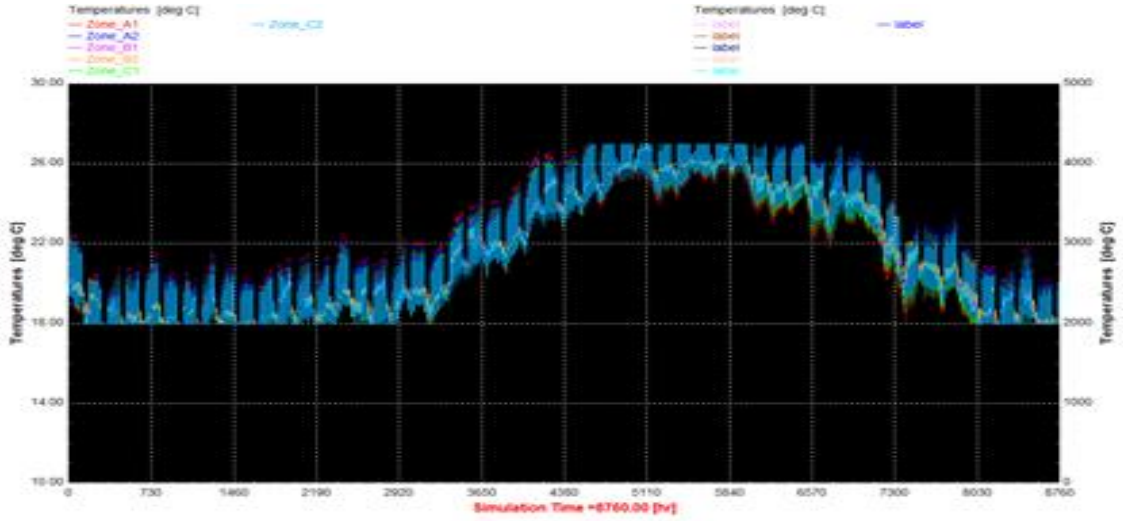

Fig 2. Annual interior temperature variation the city of rouiba

Table 1. Buildings composition

paroi	Characteristics		
	Conform to RT2016	Thickness	U value (w/m^2k)
Interior walls	Enduit extérieur (0.02m) +enduit de finition (0.02m) +brique Rouge (0.2m) +enduit plâtre (0.01)	0.34	0 .28
Exteriorwalls	Enduit extérieur (0.02) +brique rouge (0.4) +enduit plâtre (0.02)	0 .44	0 .36
Roofs	Sable (0.04) +béton lourd (0.2) +hourdis (0.2) +mortier (0.03) +peinture blanche (0.03)	0 .50	0.78
Glazing's	Simple glazing's		3.20

2.1.1Description of trnsys simulation software

The trsnys simulation software 16 is a program used in field of building simulation for passive or active design, this software used to simulate the transient systems; the trnsys have an extensive library of components

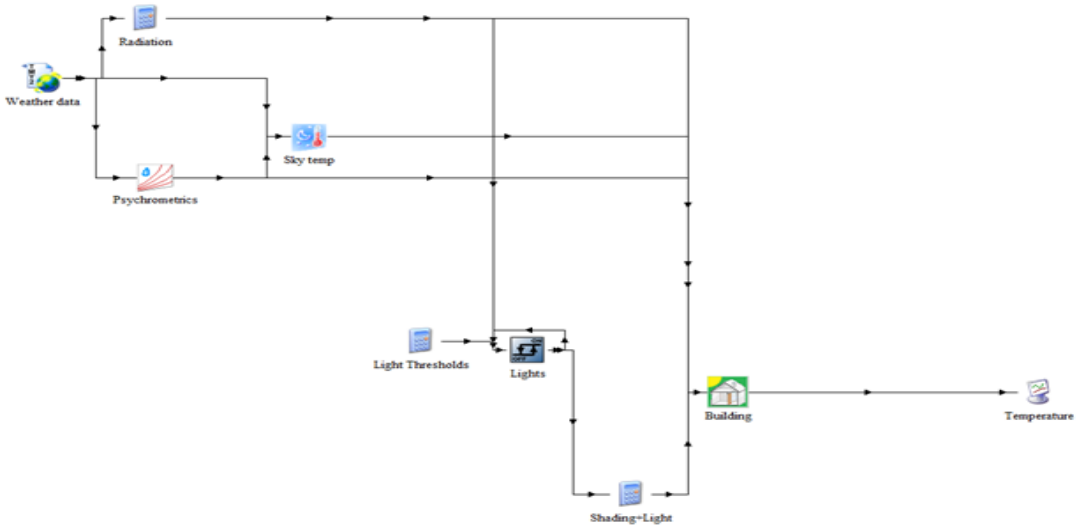

Fig 3.Trnsys modelling of the building

3. Results and discussion

Verification of thermal regulations for Algerian building 2016

a) Summer check

The DTR 2016 required that the heat loses transmission through walls must be inferior to a reference value, as in Equ.1.

$DT \leq 1.05\ D_{réf}$ [7]. (1)

b) Winter check

It is important to note that, the DTR 2016 required a heat gains inferior to the reference value through opaque walls (APO) and glass, as in Equ.2.

$Apo(15h) + Av(15h) = 1.05\ A_{réf}$ [8]. (2)

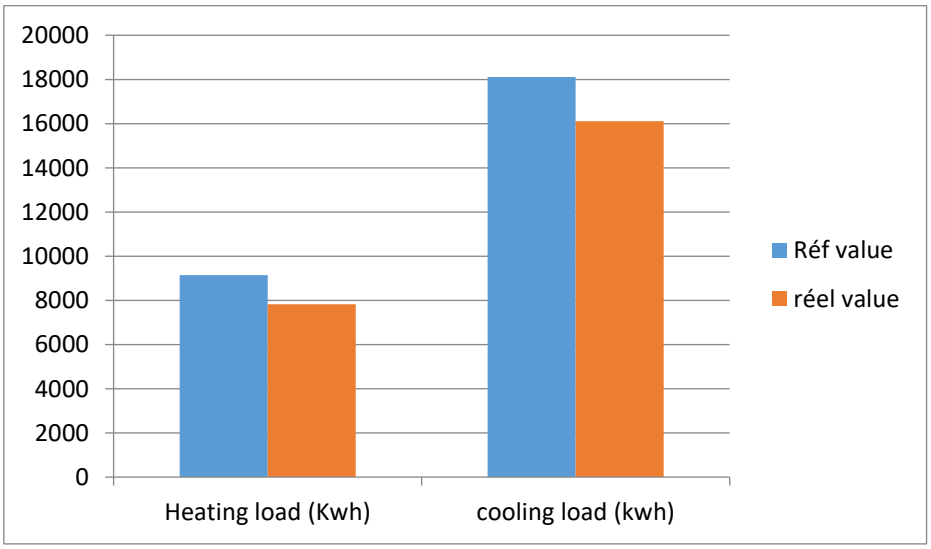

Fig 4. Heating /cooling load

The Fig.4 illustrates the heating and cooling demand compared to the requirement values in the DTR 2016[9]. From the analyses of the results, it can be concluded that our building comply with this DTR.

The table 2 shows the scenario of simulation

Table 2 .Characteristics of the insulating materials

	scenario			
Materials	Thickness (m)	Density (kg/m^3)	Conductivity (kj/hmk)	Capacity (kj/kg.k)
Aerogel	0.02	200	0.027	1.9
Polystyrene	0.02	25	0.141	1.38
Windows	Double	glazing's	3.20	

Aerogel is a Nano insulation material with the structure composed of spherical particles connected by thin links, the aerogel can reduce energy loss, its typically applied for coverage walls, floors, roofs, and windows.

The polystyrene has a high thermal resistance, made from chemical that come from oil and gazes, He have a stable R value, he have a disadvantage the exposure to sun deteriorate the material, he is flammable, requiring proper placement in any utilization.

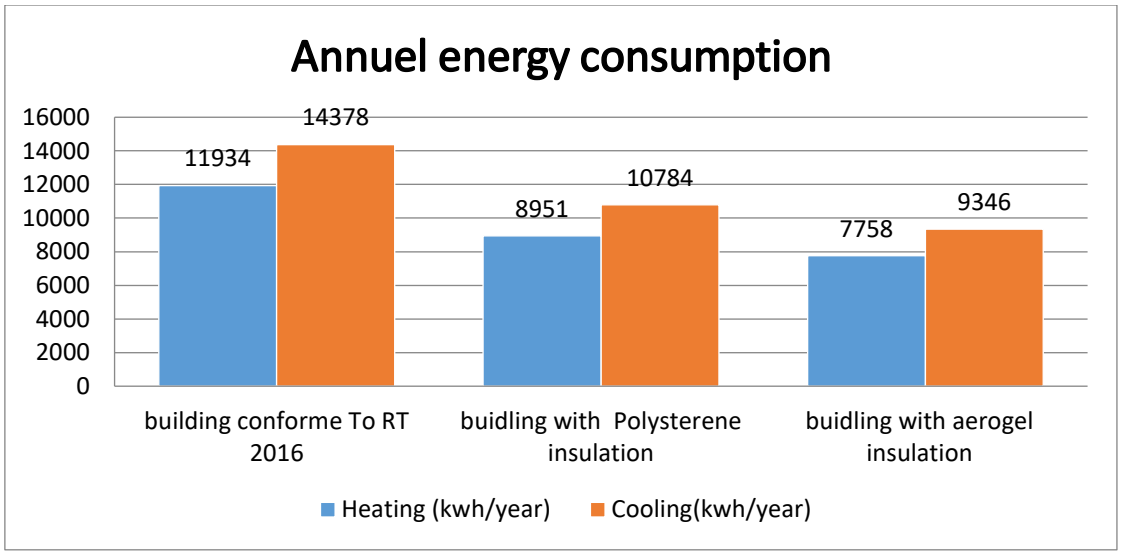

Fig. 5. Annual energy consumption according to the choice of insulation material

From Fig.5, it can be observed that the energy consumption (cooling and heating) achieves its lowest value when simulating a building with aerogel insulation. This latter, show a difference of about 30% compared to the use of a building conform to RT2016. Whereas, a building with polystyrene insulation shows an intermediate value between the aforementioned cases, The

energy efficiency in buildings is dependent on the characteristics of its envelope, therefore the thermal performance in walls, roof, ground represent the key to increase this energy efficiency. Thermal insulation is the best way to reduce the energy consumption in Algerian buildings, in this scenario the selection of the aerogel and polystyrene, its thickness allow to obtain a good results and adequate energy savings potential.

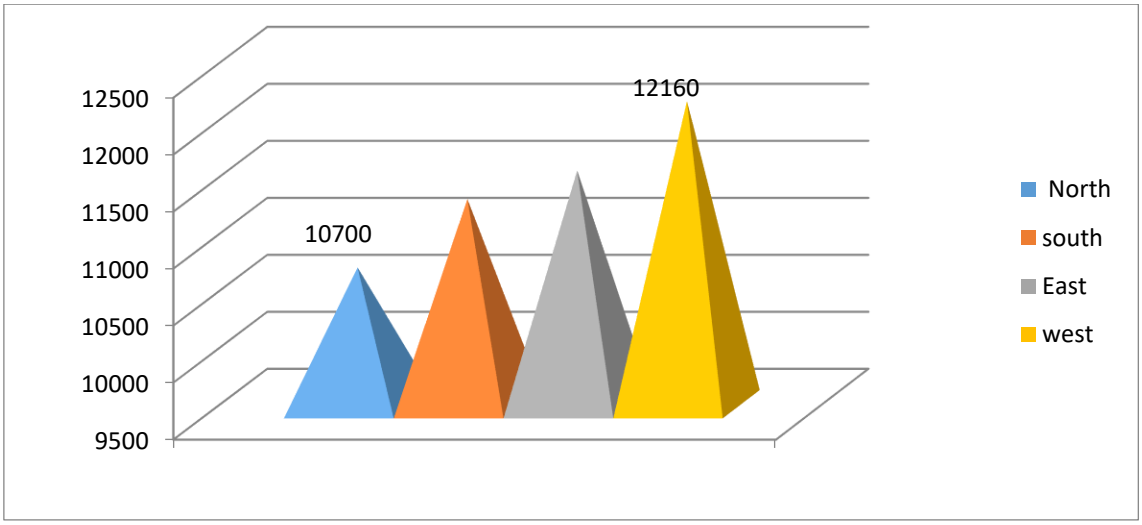

Fig 6. Heating loads in KWh double glazing

The figure 6 shows that the double glazing window is the best solution to optimize the energy consumption, by reducing the cooling and heating energy consumption.

This type of windows can reduce the amount of energy consumption form 10 to 14% in heating demand, It's clear from the figure 6 that the high value of heating loads in the double glazing is in the north façade with 25% opening ratio.

4. Conclusions

In this paper, the relationship between the heating and cooling loads with insulation types , are examined and simulated under different cases.

It can be noted from the obtained results that, when the thermal insulation of envelope is good , the annual energy load decreases too, the lowest total energy of the load is equal to 7758 kWh for heating with aerogel insulation materials , whereas, the biggest load is around 11934 kWh in building conform to RT 2016. So, the gap between the loads value is equal to 4176 KWh. For that reasons, the designers must take in consideration the impact of insulation material type to ameliorate the quality of the energy needed.

That the annual energy load decreases as the windows type and orientation changed to the best, regardless of the window types . The lowest total energy load is 10700 kWh in the double-

glazing, and the biggest load is 12160 kWh in double-glazing. The gap between the two loads is very high.

Consequently, the installation of adequate windows will reduce the heat loss and ameliorate the quality, efficiency and performances of energy in the building. Indeed, an energy efficient window carries out a break to thermal bridges and reinforces insulation in the envelope and the walls. To do that, double glazings are adequate solutions to improve energy efficiency, depending on the window orientation.

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