Journal of Fundamental and Applied Sciences

ISSN 1112-9867

Available online at http://www.jfas.info

Special Issue

In celebrating the 10th anniversary of JFAS

PASSIVE AND ACTIVE SOLAR ENERGY FOR NET ZERO ENERGY BUILDING (NZEB) IN ALGERIA CASE STUDY: SOLAR HOUSE OF BOUSSAÂDA

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Received: 08 December 2019/ Accepted: 23 December 2019 / Published online: 01 January 2020

ABSTRACT

The aim of our work is to conduct a study on the use of active and passive solar energy in the building sector for obtaining a net zero energy building. A solar house of the solar village built in Boussaâda is chosen to carry out simulation calculations in three different climates of Algeria (Algiers, Constantine and Ouargla). The passive system simulation results show that the use of these devices, such as Trombe walls and glazed surfaces, allows significant energy savings (although considered insufficient). A reduction in heating needs of 2.12, 1.7 and 2.64 times respectively for the cities of Algiers, Constantine and Ouargla is obtained. Improving the thermal performance of the structure could lead to a greater reduction in heating and cooling requirements. The reduction is estimated at 38.48, 30.44 and 21.49 % respectively for the cities of Algiers, Constantine and Ouargla.

The use of active solar systems allows covering energy needs of the solar house. High solar fractions of DHW are obtained. The electrical energy produced can cover the extra needs of DHW, HVAC, lighting and household equipment's. Net Zero Building Energy (nZEB) can be obtained for different climates in Algeria.

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doi: http://dx.doi.org/10.4314/jfas.v12i1S.22

Keywords: PV/T Hybrid collectors; energy needs; TRNSYS simulation; passive and active solar systems; Net Zero Building Energy;

1. INTRODUCTION

Final energy consumption in the building sector of developed countries represents 20 to 40% of the total energy produced. This consumption is mainly due to the use of heating and air conditioning processes [1], [2]. In Algeria, the analysis of final energy consumption shows that the building sector is the most energy consumers.

According to statistics carried out by the Ministry of Energy in 2012, the building sector consumes more than 42 % of national production in primary energy, which makes this sector the most energy-consuming [3]. Commercial electricity consumption increased from 6 MTep in 1970 to 40 MTep in 2005 [4-5].

On the other hand, Algeria's renewable energy resources are enormous and un-exploitable for the moment. Algeria has a potential of 169.44 TWh per year in solar thermal, 13.9 TWh per year in solar photovoltaic and 35 TWh per year in wind energy. As a result, the Algerian government is paying special attention to the development of this sector by launching several projects with a target of reaching 10% of electricity production by 2020 from renewable sources and 20% by 2030 [4-5].

In this sense, we conducted a study to assess the impact of the integration of active and passive solar systems on the energy balance of a building. A study of the possibility to obtain net zero energy building is achieved by the integration of this type of solar systems. This study is conducted to evaluate the impact of the use of passive and active solar energy. A solar prototype built in Boussaada is chosen to conduct the calculations in different climates of Algeria. The latter by its architecture integrates several passive solar devices.

2. CHOICE OF THE CLIMATE, DESCRIPTION OF THE STUDIED PROTOTYPES AND SOLAR DEVICES

2.1 Climate choice

According to the thermal regulations DTR 3.2 and DTR 3.4 [6], Algeria is divided into four climatic zones A, B, C and D with 2 sub-zones for the calculation needs in winter and 4 climate zones with 4 sub-zones for the calculation needs of air conditioning. In this study, three cities are chosen (table 1), namely: Algiers (zone A) characterized by a Mediterranean climate, Constantine (Zone B) characterized by a semi-arid climate and Ouargla (zone D1) characterized by an arid climate.

Table1. Geographical and climatic characteristics of the chosen different zones.

Climate zone	**Ville**	**Horizontal monthly global radiation (kWh/m^2)**	**Horizontal monthly diffuse radiation (kWh/m^2)**	**Direct monthly radiation (kWh/m^2)**	**Basic temperature (°C)**
Zone A	Algiers Alt: 25 m Long:3.1E Lat: 36.4N	Max : 227 Min : 65 Annual total: 1651	Max : 87 Min : 32 Annual total : 730	Max : 208 Min : 73 Annual total: 1507	T_{be} winter : 6 T_{be} summer: 34 Annual average 17.4
Zone B	Constantine Alt : 694 Long:6.37 E Lat:36.17 N	Max : 227 Min : 53 Annual total: 1649	Max : 90 Min : 34 Annual total: 733	Max : 208 Min : 40 Annual total: 1496	T_{be} winter : 01 T_{be} summer: 37 Annual average 15.4
Zone D1	Ouargla Alt : 141 Long:5.4 E Lat: 31.9 N	Max : 248 Min : 111 Annual total: 2192	Max : 60 Min : 18 Annual total: 498	Max : 265 Min : 175 Annual total: 2738	T_{be} winter: 05 T_{be} summer : 44 Annual average 23.7

2.2. Description of the studied solar house

The solar village is built under the direction of the Polytechnic School of Architecture and Urbanism (EPAU) in the city of Boussaâda which is a semi-arid zone [7]. The solar village has three houses: 2 houses on one level and 1 house on 2 levels (ground floor + 1). In this study, we will evaluate the operation of a single house described later.

This prototype is designed with a compact and central space facing south with a large bay window in the family living room and two rooms equipped with small windows for ventilation and lighting and a trombe wall to provide heating in cold weather.

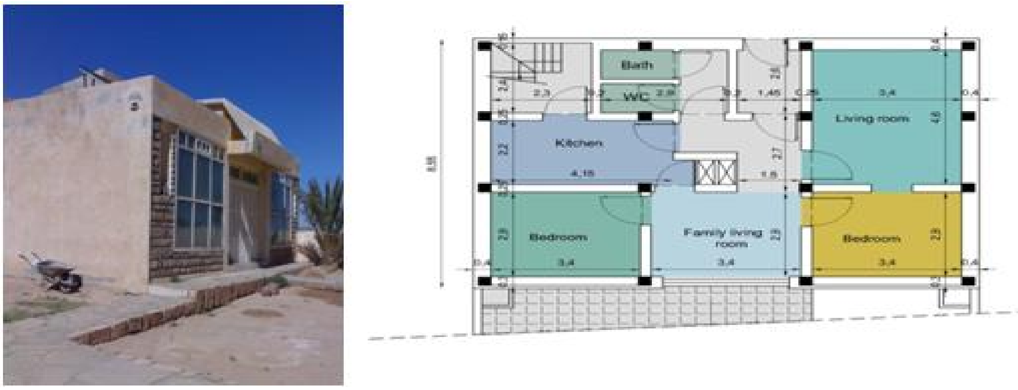

Fig.1. –a) View of the South side, b) Plan view

The characteristics of the solar prototype are given in Table 2.

Table 2. Characteristics of the solar prototype construction

Wall / Windows / door	**Composition**	***U value*** **(W/m².K)**	**Surface (m²)**
North wall	Exterior plaster, 2 cm, Parpaing, 25 cm, Expanded cork insulation, 5 cm, Parpaing, 10 cm, Interior plaster, 2 cm	0.583	*29.40*
East/West wall (without insulation)	Exterior plaster, 2 cm, Parpaing, 40 cm, Interior plaster, 2 cm	1.51	23.80
East/West wall (with insulation)	Exterior plaster, 2 cm, Parpaing, 25 cm, Expanded cork insulation, 5 cm, Parpaing, 10 cm, Interior plaster, 2 cm	0.583	23.80
South wall	Exterior plaster, 2 cm, Stone, 40 cm, Interior plaster, 2 cm	0.668	*20.10*
Floor on the ground	Tiling, 2 cm, Concrete mortar, 4 cm , Dry sand, 5 cm, Tar paper, 0.5 cm, Solid concrete, 16 cm, Heavy Stone, 20 cm	0.949	87.75
Roof	Concrete mortar, 4 cm, Ground clay, 20 cm, Solid concrete, 3.5 cm, Dry sand, 2 cm Multilayer Waterproofing, 1 cm, Slope form of heavy Concrete aggregate, 10 cm, Dry sand, 2 cm, Insulation (compensated cork), 4 cm, Concrete slabs, 20 cm, Interior plaster, 2 cm	1.46	87.75

Trombe wall	Exterior plaster, 2 cm, Parpaing, 25 cm, Interior plaster, 2 cm, Air layer, 10 cm, Glass, 0.5 cm	2.17	9.25 (one wall)

Table 3 gives the electricity needs for lighting and home appliances (except air conditioning and heating systems, the auxiliary heating and the pumps of the solar system) of the prototype. The lights are considered low energy consumption with 15W; the refrigerator is supplied with a DC current and consumes 70 W.

Table 3. Monthly Electricity Needs for different household appliances and lighting.

Application	**Numbers**	**Power (W)**	**Duration of use**	**Total monthly consumption (kWh/month)**
Lighting	10	15	8 h / day (1/3 parallel)	12
Fridge	1	70	24 h/day	50.4
Television	2	80	3 h/ day	14.4
Computer	1	300	3 h/ day	27
iron	1	1500	2 h/week	12
Washing machine	1	400	5h/ week	8
Other	-	2000	6h/ week	48
Total				171.2

Domestic hot water requirements are calculated according to a daily profile. We have for our study considered a family of 5 people with a daily consumption of 45 liters / person at a temperature of 45 ° C. The temperature of the hot water is kept at 60 ° C to eliminate any risk of Legionella formation.

2.3. Passive and active solar system

Making the building more efficient is the most appropriate solution to solve these problems. This solution can be considered by two possibilities [1]: (A) reduce the energy consumption of new buildings by 40 to 50%. (B) The reduction of 15 to 25% of the energy consumption of existing buildings.

Several passive techniques are used in the building to reduce its energy consumption. Edwin Rodriguez-Ubinas et al. [8] illustrates these different techniques as shown in Figure 2.

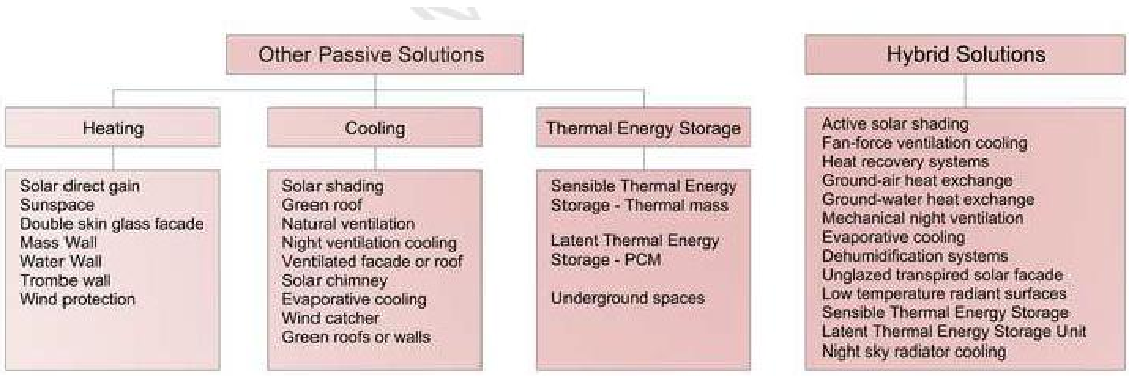

Fig.2. Passive and Hybrid Solutions for Buildings [8]

Active solar energy can be classified into two categories: solar thermal system that converts solar energy into thermal energy and photovoltaic solar systems that converts solar energy into electrical energy [9]. Today, the efficiency of the conversion into electricity of marketed photovoltaic panels is in the range of 12-18%. Over 80% of the incident solar radiation will be reflected or converted into heat [10]. An interesting system for producing thermal and electrical energy consists of hybrid PV / T collectors. Knowing that the heating of the PV cells leads to a drop of 5% of electricity produced for an increase in temperature of 10 °C [11].

Researchers propose to remove this heat by introducing a coolant (water or air) that extracts the heat which can be used in thermal applications. This type of solar collector is called PV/T hybrid solar collector. In addition to electrical production, PV/T hybrid collector has three possible applications: the heating of air [12- 14], the heating of water [15-17] or the heating of water and air at the same time, this type is called Bi fluid [18].

Research has been conducted since 1970 for modeling, improving the design of PV/T solar collectors [19-20], improving the integration and evaluation of the impact on the energy behavior and the economy in constructions [21-22]. All researches have concluded that PV/T systems represent a real and proper solution to reduce the energy impact of buildings.

In this work a PV / T solar installation is used to cover the total needs of the solar prototype.

3. RESULTS AND DISCUSSION

3.1. Effect of using passive devices

- **Effect of adding Trombe walls and glazed surfaces**

In order to show the influence of the passive devices on the heating needs of the solar house, we simulated it without the two Trombe walls and with a glazing surface of the South living room equal to 2 m^2. Figure 3 illustrates the variation of the heating requirements of the solar house for the two cases with and without solar devices for the city of Algiers. An increase in heating needs is obtained for the case of a house without passive devices. The total annual heating requirements are 3620 kWh, an increase of 2.12 times. It is clear that passive solar devices reduce heating requirements significantly.

An increase in heating needs is also obtained for the city of Constantine (Figure 3) and estimated at 6137 kWh or 1.74 times increase.

For the city of Ouargla, the annual heating requirement for solar homes without solar devices is 2119.39 kWh, an increase of 3.07 compared to a solar house with solar devices, under the same climate (Figure 3). The intensity of the solar radiation of this climate zone has a considerable influence on the operation of the Trombe walls and on the glass surface. The increase in heating needs is considerable.

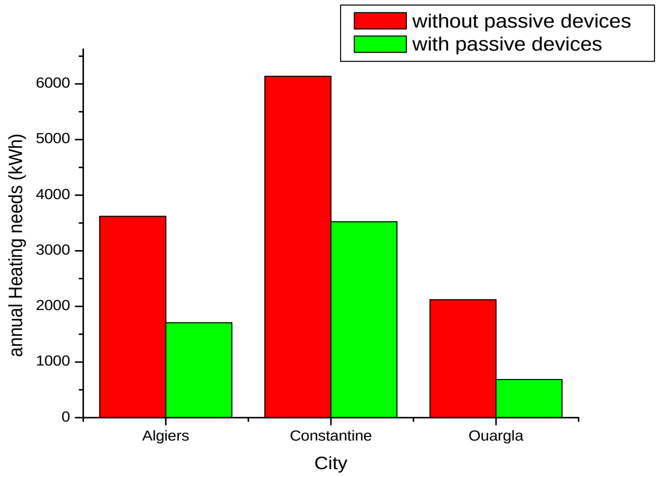

Fig.3. Variation of the heating requirements of the solar house with and without passive devices

- **Improvement of thermal insulation**

Figure 4 illustrates the variation in the heating and cooling requirements of the solar house in different climates of selected cities with an insulated and uninsulated solar house (East and West wall with and without insulation as shown in Table 2).

For the house without insulation and for the city of Algiers, the annual heating needs of 1706 kWh are obtained. While for air conditioning, an estimated annual total of 847 kWh is obtained. Heating needs are 2.01 times more than the need for air conditioning. According to the passivhauss standard, a building is considered passive if the annual consumption of heating and cooling does not exceed 15 kWh/m^2.year. For a total area of the solar house of 87.75 m^2, the consumption is 29.10 kWh/m^2.year.

Regarding the city of Constantine, annual heating needs are 3522 kWh (2.06 times more compared to the city of Algiers). While the annual cooling needs are 1197 kWh (1.41 times more compared to the city of Algiers). The annual consumption is 4719 kWh, which represents 53.78 kWh/m^2.year. A considerable increase compared to the city of Algiers is obtained.

For the city of Ouargla, the heating requirements obtained are 685 kWh. Compared to other cities, the heating needs of the city of Ouargla are lower, because of the availability of solar radiation, resulting in better operation of passive devices, as well as the reduction of heat losses through the walls. For air conditioning needs, a total annual air conditioning of 9207 kWh. The annual consumption of the solar house is 9892 kWh is obtained, which represents 112.73 kWh / m^2.year. Structural and other improvements can reduce the thermal needs of the solar house. For this we will show the influence of thermal insulation on the thermal needs of the solar house. The East and West walls are replaced by other insulated walls (see characteristics in Table 2).

A decrease in heating needs of the solar house in the city of Algiers is obtained. The annual heating requirements are 1075 kWh, a reduction of 36.98%. While cooling needs are estimated at 496 kWh (a decrease of 41.50%). The total needs of the house decreased by 38.48% (17.90 kWh / m^2. Year). The influence of thermal insulation is important and can significantly reduce the thermal needs of the solar house. A house with low energy consumption can be obtained.

Regarding the city of Constantine, the simulation of the solar house shows that the total heating requirements are estimated at 2470 kWh, a decrease of 29.86% compared to the same solar house under the same climate but without thermal insulation. For air conditioning, a total annual air conditioning needs of 812.30 kWh. A decrease of 32.15% is obtained compared to the same solar house without thermal insulation. The total annual needs of the solar house are estimated at 3282.52 kWh, with a decrease of 30.44%. The annual requirements represent 37.40 kWh / m^2.year.

Regarding the city of Ouargla, the annual heating needs of the solar house with insulation are estimated at 389.05 kWh, a reduction of 43.19%. While the needs for air conditioning with thermal insulation are estimated at 7468.46 kWh, with a decrease of 18.88%. The total needs of the house without insulation are estimated at 7765.68 kWh or 88.49 kWh / m^2.year (a decrease of 21.49%).

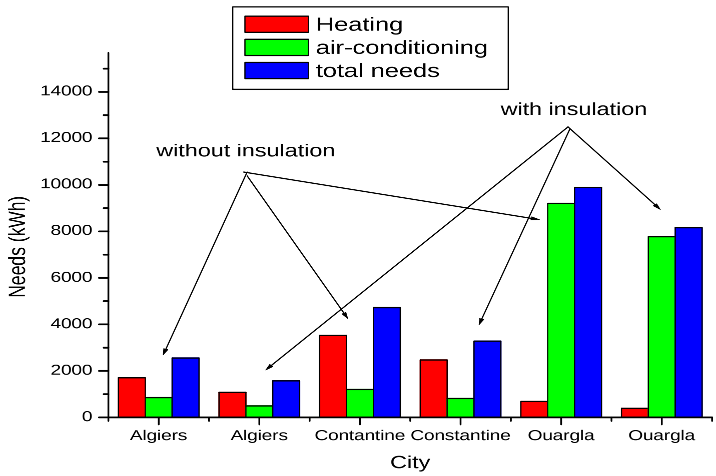

Fig.4. Heating and cooling requirements for solar house with and without insulation

- **Reflective roof effect**

After having demonstrated the influence of thermal insulation on the thermal behavior of the solar house, the influence of the optical properties on the thermal needs of the solar house will be studied. Three absorption coefficients are applied to the roof of the solar house, namely 0.6 (case without modification), 0.4 and 0.2. Figure 5 shows the influence of the variation of the absorption coefficient on the thermal behavior of the three solar houses.

Regarding the city of Algiers, we find that a slight increase in heating needs is obtained when the absorption coefficient is decreased. In fact, the estimated requirements of 1706 kWh for an absorption coefficient of 0.6 reached 1733 kWh and 1760.04 kWh respectively, for the coefficients 0.4 and 0.2, an increase of 1.54 and 3.13% is obtained. This increase in heating needs is due to the decrease in the amount of solar energy absorbed by the roof.

On the other hand, the need for air conditioning of the order of 848 kWh for an absorption coefficient of 0.6 drops to 824 and 801.37 kWh respectively, for coefficients of 0.4 and 0.2 with a reduction of about 2.7% and 5.45% . Moreover, a slight increase in annual requirements (3.03 kWh and 7.33 kWh respectively, for the coefficients 0.4 and 0.2) is obtained. The influence of the optical properties of the roof is minimal because of the composition of the roof itself. The thermal insulation of the roof reduces the influence of these properties on the thermal behavior of the solar house. The availability of solar radiation for this climate zone compared to other areas influences the heat absorption and consequently the thermal balance of the solar house.

For the city of Constantine (figure 5), we can note that heating needs increase slightly with the decrease of the absorption coefficient from 3522 kWh for a coefficient of 0.6 to 3558 kWh and 3593.89 kWh respectively, for coefficients of 0.4 and 0.2, an increase of 1.01 and 2.03% is obtained. As for air conditioning requirements, they decrease from 1197.33 kWh (for a coefficient of 0.6) to 1170 and 1144 kWh respectively for the absorption coefficients 0.4 and 0.2 with a reduction of 2.24% and 4.48%.

There is a slight increase in annual requirements, estimated at 8.59 kWh and 18.04 kWh respectively, for the two absorption coefficients 0.4 and 0.2. Despite the increase in the annual thermal needs of the solar house, only the economic study will show if there is a gain or a loss of money. Indeed, depending on the type of energy and the price of the latter (electric, gas or other), the contribution of reflective roofs could be evaluated.

Concerning the city of Ouargla (figure 5), a slight increase in heating requirements is obtained when the absorption coefficient is decreased. These requirements increased by 684.85 kWh for a coefficient of 0.6 to 702 kWh and 721 kWh respectively, for the absorption coefficients 0.4 and 0.2, which represents an increase of 2.57 and 5.22%. While a decrease in cooling requirements from 9208 kWh (for the initial case) to 9115 and 9027 kWh respectively, for the absorption coefficients of 0.4 and 0.2 is observed, a reduction of 0.99% and 1.95% is obtained. We can also note a decrease in annual requirements of 74.33 kWh and 144 kWh respectively, for absorption coefficients 0.4 and 0.2. The influence of the use of reflective roofs is reversed compared to previous climatic zones because the needs for air conditioning are high (high radiation).

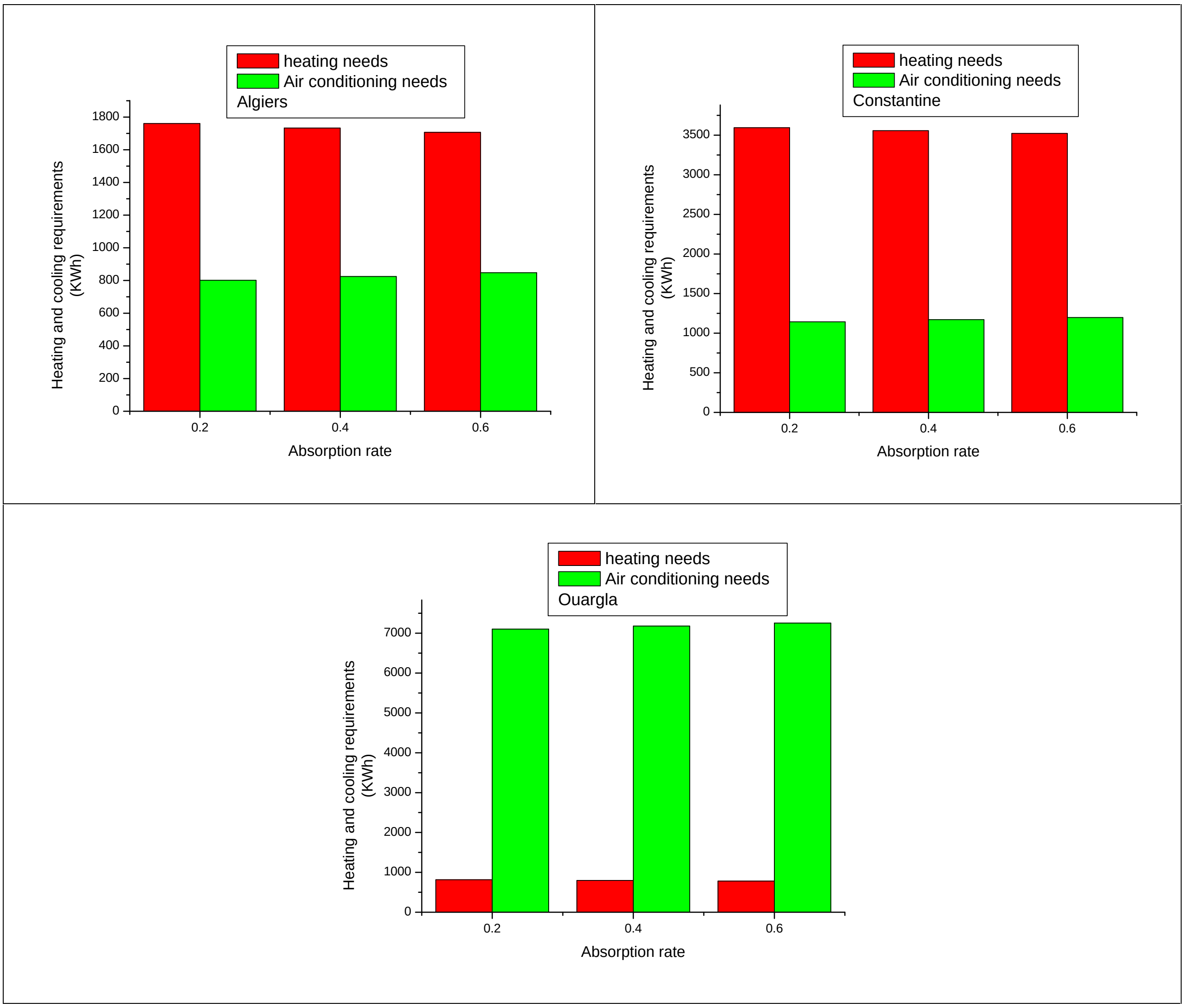

Fig.5. Reflective roof effect on the energy needs of the solar house

- **Effect of thermal and optical properties of glazing**

Another factor that can influence the thermal behavior of the solar house is the glass surface. For this, the thermal behavior of the solar house for different types of glazing will be studied. The living room situated in the south is the only room that has a large surface glazing. Three glazes are used in this simulation, a single glazing (initial case) (U = 5.74 W / m^2.K, τsol = 0.85), a double transparent glazing (U = 2.95 W / m^2.K, τsol = 0.72) and a low emissivity double glazing (U = 1.76 W / m^2.K, τsol = 0.54). Figure 6 illustrates the variation in heating and cooling requirements of the solar house for different types of glazing and in different climate zones.

Regarding the city of Algiers, we note a decrease in heating requirements when using double glazing. The requirements decreased from 1706 kWh (for the initial state) to 1561 kWh which represents a reduction of 8.53%. Whereas for the low emissivity double glazing, the reduction is less important than for double glazing. Indeed the heating needs are estimated at 1590 kWh or 6.86% reduction. The double glazing is more efficient since its solar transmissivity coefficient is higher, although the low emissivity double glazing has a high thermal resistance. For cooling needs, a decrease is also achieved. They are for the initial case of 848 kWh and for the double glazing case of 808 kWh, a reduction of 4.62% is obtained. For the low emission double glazing, the reduction is more consistent. The needs obtained are estimated at 788 kWh, with a reduction of 7.02%. A reduction in the annual requirements of 7.23 and 6.90% respectively for the double glazing and low emissivity double glazing is obtained. The influence of optical and thermal properties plays a role in reducing the thermal needs of the solar house. Although single glazing has a high transmissivity of solar radiation, double glazing allows a balance between the transmission of heat and solar radiation.

For the city of Constantine (Figure 6), a decrease in heating requirements is also obtained, from 3522 kWh for the initial case to 3234 kWh for the double glazing which represents 8.16% of reduction. We can note that for low emission double glazing, the decrease is lower than for double glazing. Indeed, the heating needs obtained in the latter case are estimated at 3242 kWh or 7.94% reduction.

Concerning the cooling needs, a reduction is also obtained. Indeed, the needs for air conditioning for the initial case are 1197.33 kWh, while for the case of double glazing they are only 1139 kWh or a reduction of 4.88%. For the low emissivity double glazing the needs are estimated at 1108 kWh with a reduction of 7.46% (higher than double glazing). A decrease in annual requirements of 7.33 and 7.82% is recorded respectively, for the two types of glazing (double glazing and low emissivity double glazing). The low emissivity double glazing is more efficient for this climatic zone since the heat losses in winter and the heat transfers by transmission in summer are higher. The thermal properties therefore play a very important role in reducing the thermal needs for this city.

For the city of Ouargla (Figure 6), a decrease in heating requirements is also obtained. Indeed, the latter trop from 685 kWh for the initial state to 622 kWh in the case of the use of double glazing, (ie, 9.18% of reduction), and 650.55 kWh (or 5% of reduction) for the use of low emission double glazing (the decrease is lower than in the case of double glazing).

For cooling needs, a decrease is also achieved. On the order of 9207 kWh for the initial case, they are only 8740 kWh for the case of double glazing, with a reduction of 5.08%, and 8484 kWh for low emissivity double glazing with a reduction of 7.86 %. The reduction is higher than for double glazing. The decrease in air conditioning needs is considerable for this climate zone. A decrease in the annual requirements of 5.36 and 7.66% respectively for the double glazing and low emissivity double glazing is observed, which shows that the last glazing is more efficient for this climatic zone, because it makes it possible to reduce the penetration of the intensive solar radiation in summer, while for winter the thermal losses are not high enough. The use of solar energy for passive heating is less important than in other cities.

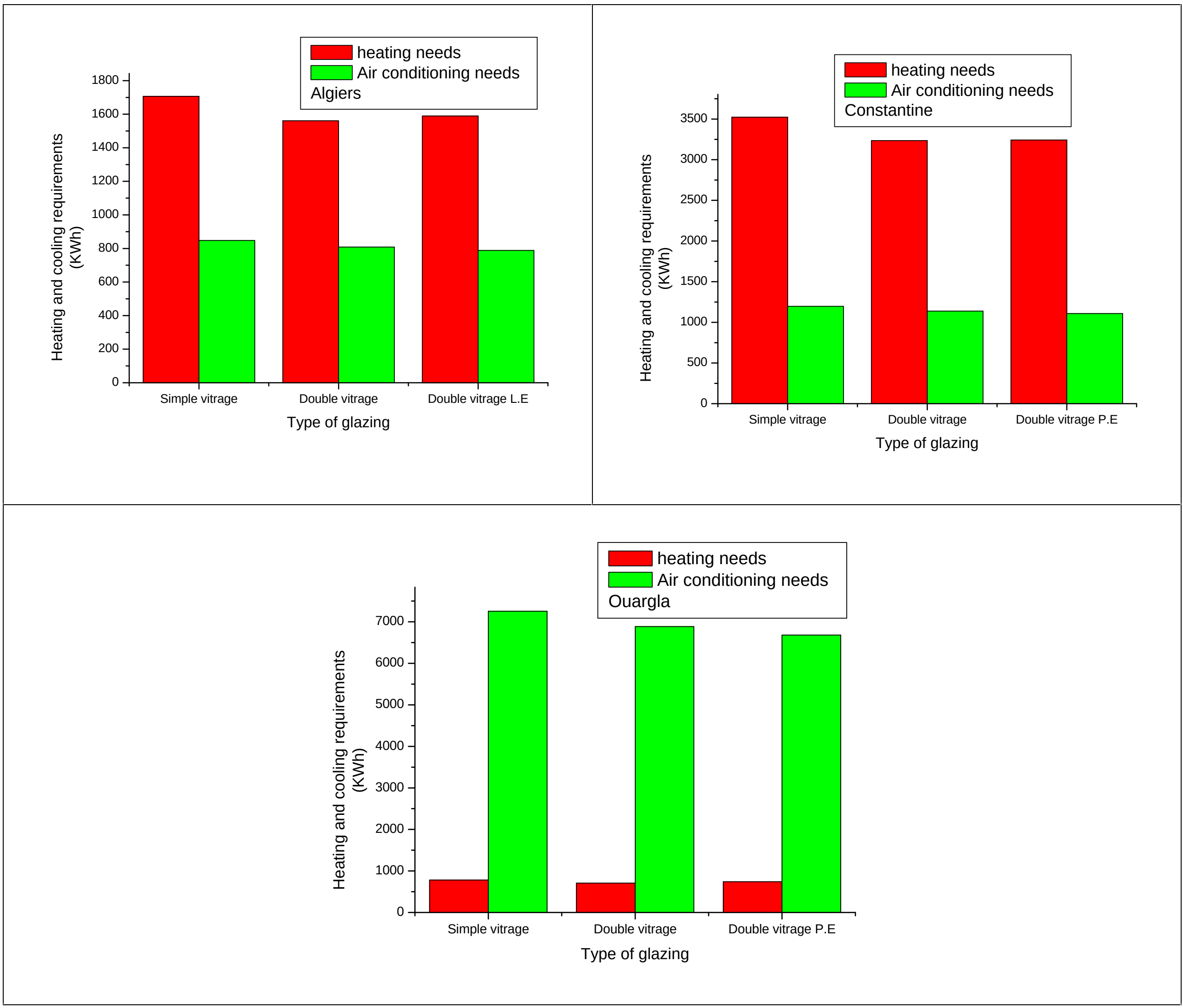

Fig.6. Effect of the type of glazing on the thermal needs of the solar house

3.2. Actives solar systems

Thus and as we have shown previously, the use of passive solar devices can cover a large part of heating and air conditioning needs. However, electrical and hot sanitary needs require other so-called active systems. In what follows, the study of the production of a PV / T solar system for the coverage of total energy needs such as: domestic hot water, space heating, air conditioning by reversible mechanical compression driven by electrical energy from PV cells (coefficient of performance 2.8 with an electrical efficiency of 80%) will be undertaken.

For a total annual electricity consumption of the solar house under the climate of the city of Algiers estimated at 3701 kWh (extra hot water, heating, air conditioning, lighting and household electrical appliances), the necessary surface of the PV / T collectors for cover this consumption is 12 m^2. The examination of Figure 7, which illustrates the different electricity needs and the production of PV / T collectors, shows that after covering part of the domestic hot water needs by the thermal generation of the PV / T collectors, the annual needs which remain to be satisfied by the electrical production of the PV / T collectors is 507 kWh. The cooling and heating needs vary during the year with a maximum of 228.39 kWh in January for heating and an annual total of 1140 kWh. The electrical needs to cover household appliances remain the highest with an annual total of 2054 kWh. The electrical output of PV / T solar collectors varies during the year, with a maximum in July estimated at 416 kWh and a minimum of 237 in December. The annual electrical output obtained is 3857 kWh. We find that the monthly consumption of the solar house is higher than the production of the PV / T collectors in winter despite the coverage of domestic hot water needs. Whereas for other seasons, the production of PV / T collectors is higher than consumption. The use of electricity from the external network is necessary to cover the rest of the needs in winter while for the other months the surplus of electricity will be injected into the external network.

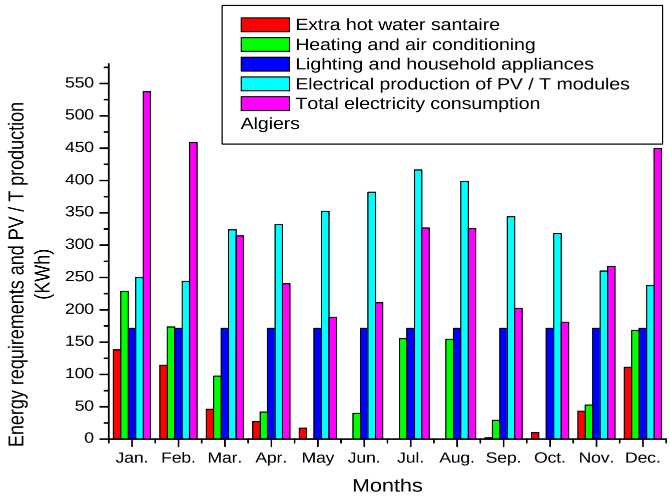

Fig.7. Monthly energy requirements of the solar house and production of PV / T collectors for the city of Algiers (area 12 m^2)

For the city of Constantine (figure 8), the energy needs of the solar house are high in winter with a maximum in January, estimated at 782.87 kWh. It should be noted that in the summer, the consumption of the solar house is higher, unlike the case of the city of Algiers. The increased need for air conditioning affects the energy behavior of the solar house. Solar PV / T collector output exceeds consumption for the months of May, June, September and October. For other months, the use of electricity from the outdoor network is necessary to meet the energy needs of the solar house. The annual electricity production of the PV / T collectors is estimated at 4889.77 kWh.

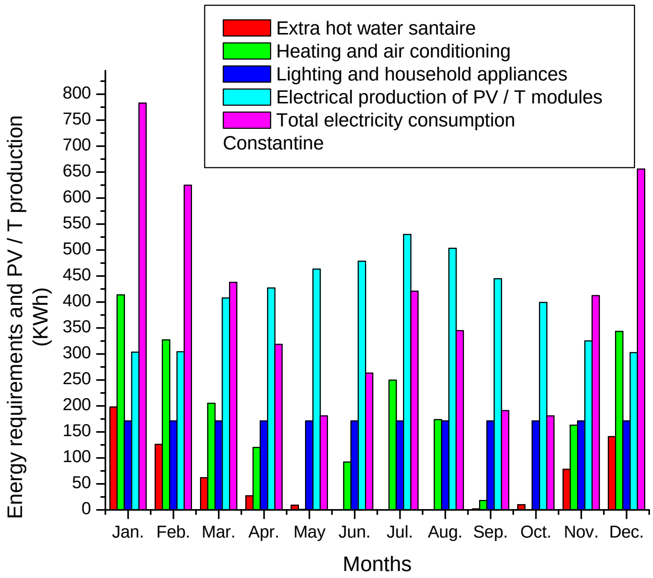

Fig.8. Monthly energy requirements of the solar house and production of PV / T collectors for the city of Constantine (area 14 m^2)

The different energy needs of the solar house under the Ouargla climate and the production of PV / T solar collectors are illustrated in Figure 9. The influence of the climate of the city of Ouargla is very important. The high thermal output in winter can cover the majority of DHW needs and the use of passive solar devices significantly reduces heating requirements. The electrical output of PV / T collectors is markedly high for the months of October to May. For the summer, the increase in energy needs is due to those in air conditioning which are much higher than the other two cities; therefore, the use of the external electricity network is necessary. The solar house is energetically independent for 8 months of the year.

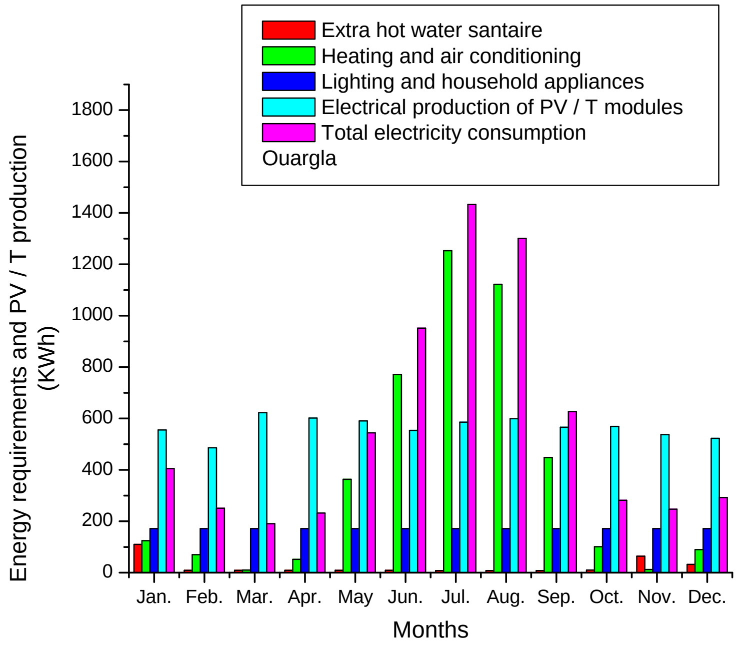

Fig.9. Monthly energy requirements of the solar house and production of PV / T collectors for the city of Ouargla (area 17.2 m^2)

4. CONCLUSION

This work deals with the possibility of obtaining a zero-energy consumption of building under various Algerian climates through the use of active and passive solar systems. A solar house of the solar village built in Boussaâda incorporating two trombe walls and a large glazed area is used for the calculation. The active solar system is dimensioned to cover the needs in domestic hot water, air conditioning and heating, lighting and other household equipment. The numerical simulation is carried out for a period of one year with TRNSYS. The results allow us to draw some observations:

- The analysis of the heating and cooling requirements of the solar prototype for the three cities shows that these needs are low for the city of Algiers compared to the other two cities. The air conditioning needs for the city of Ouargla are excessively high.
- The use of trombe walls and glazed surfaces allows a great reduction in heating needs. An increase of these needs estimated at 2.12, 1.74 and 3.07 times respectively for the cities of Algiers, Constantine and Ouargla is obtained for a prototype not equipped with these devices.

- The use of thermal insulation for the East and West walls reduces the total consumption of the prototype by 38.48%, 30.44% and 21.49% respectively for the cities of Algiers, Constantine and Ouargla.
- The influence of using reflective roof varies with climate.
- The use of a double glazing is better suited for the city of Algiers, while for the city of Constantine and Ouargla the low emissivity double glazing gives a better performance.
- Full coverage of heat and electricity needs is possible with PV/T hybrid collectors.
- The coverage of domestic hot water by solar energy can significantly reduce total primary energy needs.
- The area required to cover the domestic hot water needs is lower compared to the surface of the PV panels required to cover the electricity needs for hot areas and the same sizes in Mediterranean regions. The high intensity of solar radiation in hot zones provides small surfaces to cover the domestic hot water, while higher cooling needs leads to large surfaces of PV cells.
- The amount of CO_2 avoided is important. The generalization of the use of solar energy helps to preserve the environment.

The study of using this type of energy and installation as well as the architecture of the solar house enables us to note that energy savings begins with the architecture of the building itself. An appropriate architecture significantly reduces energy requirements. Then, the equipment used and user behavior are the second criteria in reducing the consumption of energy. The use of solar energy that is available practically throughout the year with a sufficient quantity over the entire Algerian territory is a key element in reducing the impact of buildings on energy, environmental and economic balance sheet of the country. It is imperative to consider encouraging and raising the awareness of using solar energy and improve insulation in new buildings or thermal rehabilitation of old buildings. The building becomes a real economic factor that not only ensures the energy security of the country and to protect the environment but also to be in the heart of its development.

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How to cite this article:
Sotehi O, Chaker A. Passive and active solar energy for net zero energy building (nZEB) in Algeria. Case study: solar house of Boussaâda. J. Fundam. Appl. Sci., 2020, *12(1S), 304-323.*