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Integration of a Solar Thermal System for the Heating of an Office Space

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Abstract

Given its geographical location, Algeria lends itself favorable to solar applications. The global solar radiation varies between 1700 and 2650 kWh/m2/year, for a duration of sunshine which is close to 3500 hours/year. This clean and in exhaustible energy can cover the heating demand of the office space. Our project consists of the integration of a solar thermal system controlled and controlled by a solar controller that will ensure optimal use of the solar heating system. Office heating is provided by low temperature radiators.

Introduction

Given its geographical location, Algeria lends itself favorably to solar applications. The global solar radiation varies between 1700 and 2650 kWh / m^2 / year, for a duration of sunshine which is close to 3500 hours/year [1,2]. It is with this in mind that our project is to take advantage of this energy to cover the heating needs in the building. A solar collection field is installed on the terrace, the heated water is stored in a solar tank, which supplies the radiators for the heat distribution in the building. The building housing offices located in Bouzareah, Algiers (36°47'24" north, 3°01'04" east). The climate is warm and temperate.

The Case Study

The building is considered a local housing offices of 275,20 m^3 of net volume. Solar thermal collectors are installed on the deck of the building, facing south with an inclination according to the latitude (Table 1).

Table 1: Composition of the different walls. It presents the different walls of the building, their surfaces and orientations.

Wall	Orientation	Opaque Surface (m^2)	Glass Surface (m^2)
Wall 1	Southwest (SW)	17.70	2,02
wall2	Southeast (SE)	28.70	6,06
Wall 3	Northeast (NE)	18.70	2,03
Wall 4	Northwest (NO)	14.70	5.48
Roofing	Horizontal	100	-
Floor	Horizontal	100	-

Methodology

Energy demands for heating. The TRNSYS dynamic simulation software [3] was used to estimate the building's energy demands for heating as well as the maximum heating power. The results obtained make it possible to determine the number of radiators to be installed. The sizing of the solar system was carried out using the TRANSOL calculation tool [4]. The orientation of the building, the different surfaces of the walls, the roof and the floor, the building materials as well as their physical characteristics are necessary parameters to perform a dynamic simulation by TRNSYS (Figure 1).

Figure 1: Photos of the studied building.

Heating Power

In order to achieve a comfortable temperature inside the room, it is important to know the power heating required. Sizing of the heating transmitters is calculated for maintaining the set indoor temperature when the outside temperature is at the coldest of the year. Called basic temperature, this value is obtained by averaging the coldest temperatures measured 5 days in the year over a period of 30 years. The recommended power corresponds to thermal losses in these extreme conditions [5] (Figure 2).

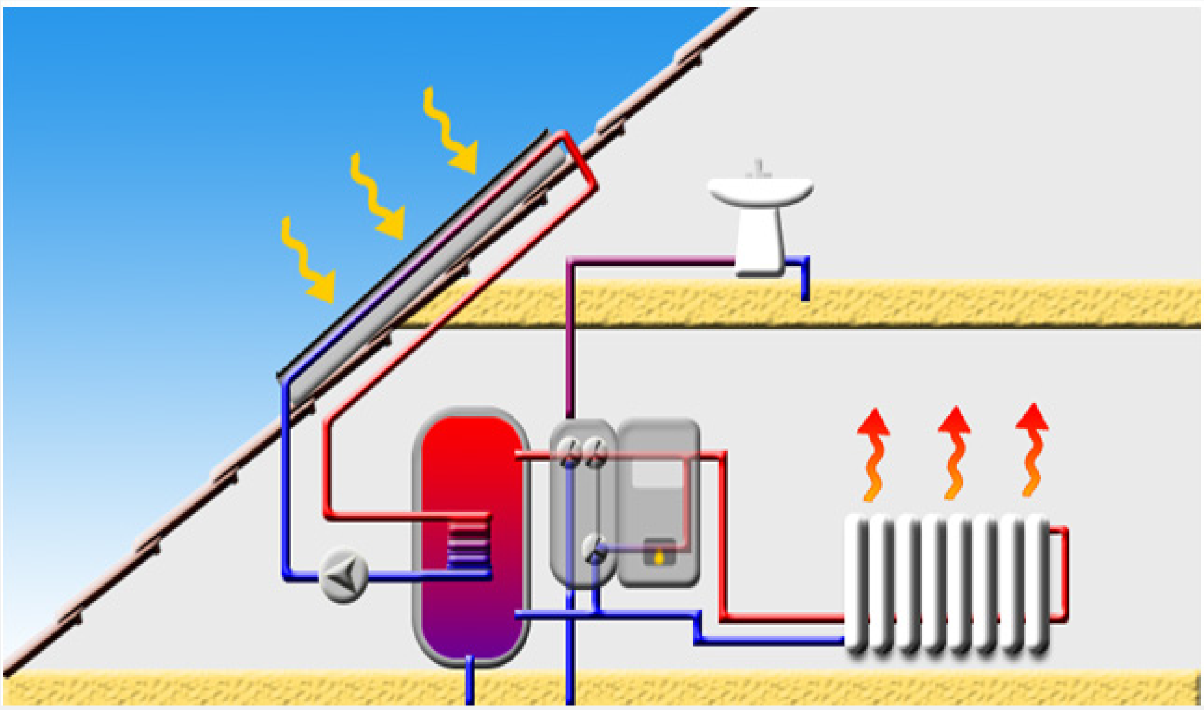

Figure 2: Diagram of solar heating system.

Results and Interpretation

Figure 3 shows the annual energy balance of the study area. The annual energy demand for heating and cooling are respectively 2754 kWh and 3575 kWh. The solar gains, the internal contributions and the thermal losses due to the infiltrations are, respectively 5041 kWh, 3533 kWh and 4817 kWh. Note that for a commercial building, the contributions due to occupants and electrical equipment are importants. Also, solar gains are important due to the large glazed surface. In Figure 4 are presented the monthly energy demands for heating during the cold period. The heating period runs from October to April. This demand is highest in January (747.8 kWh), which is the coldest month of the year. Figure 5 shows the evolution of the maximum heating power needed to maintain the building comfortable during the month of January. It's the cold month of the year. Note the maximum heating power is about 2.8 KW. Based on this power, the number of radiators needed can be determined according to the type of radiators used.

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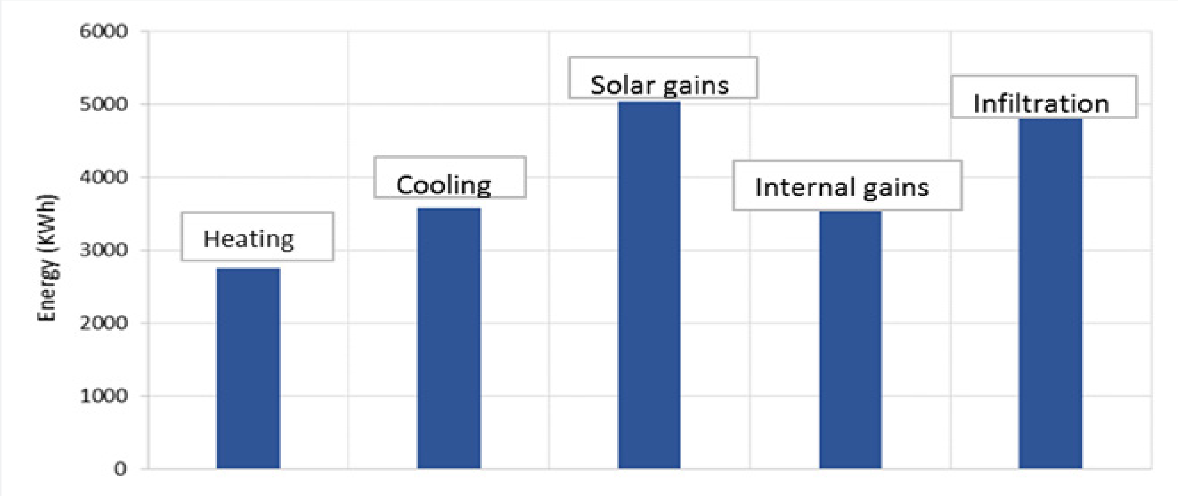

Figure 3: Total annual energy balance of the building.

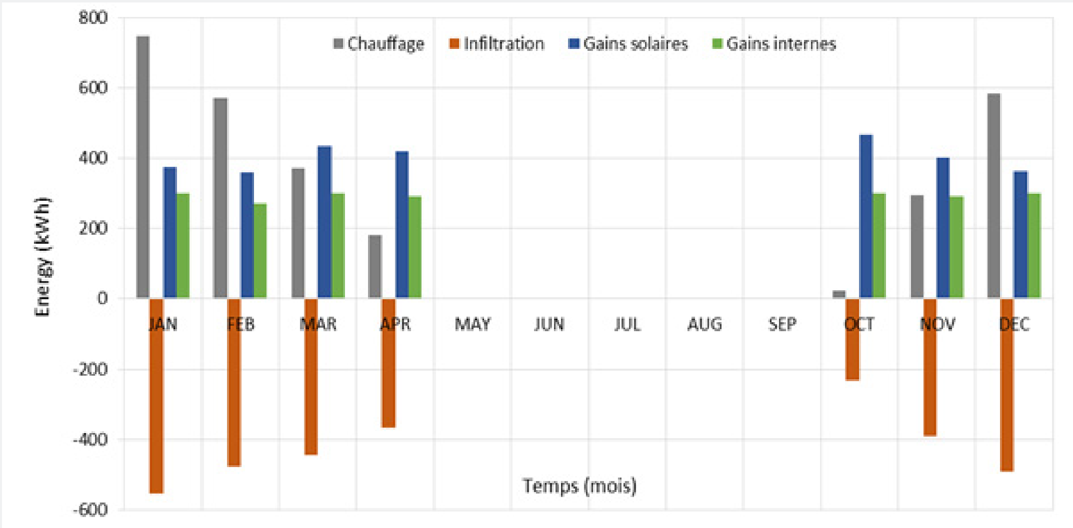

Figure 4: Monthly energy balance for the heating period.

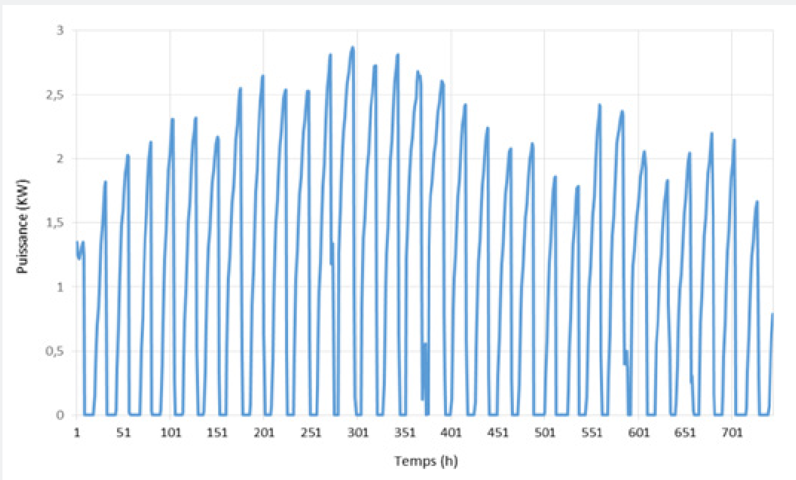

Figure 4: Evolution of the heating power during the month of January.

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Conclusion

It can be concluded that the energy demand of the study area for heating is not very high (maximum value 747.8 kWh), thanks to the insulation of the building envelope and the use of double-glazed windows. Dues to these passive energy measures, the application of active solar systems becomes very efficient.

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