

Building Sustainably, Case Ksar Taghit

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ABSTRACT

This study examines the integration of renewable energy into traditional architecture in Algerian Saharan cities, with a focus on the ksar of Taghit. Through the analysis of environmental data from the Béchar province, the research proposes a model for energy-efficient housing that respects architectural traditions while incorporating renewable energy technologies. The aim of the study is to contribute to sustainable development and promote environmentally friendly construction practices in Saharan cities. Additionally, the research explores the potential for modernizing houses in the ksar of Taghit through complete automation, ensuring they meet the standards of sustainable development. By implementing advanced automation systems, these houses can achieve enhanced comfort, energy efficiency, and environmental sustainability. The findings of this research offer valuable insights into the transformation of traditional architecture into modern, automated homes that align with the principles of sustainable development.

I. Introduction

The integration of architectural heritage, sustainable development, passive design, and automation technologies enables the development of affordable and energy-efficient houses in arid zones. By considering the unique climate, utilizing available resources, and incorporating traditional architectural wisdom, these houses can create a harmonious and comfortable living environment for residents. The incorporation of automation technologies further optimizes energy usage and enhances sustainability, resulting in reduced costs and environmental impact. This comprehensive approach not only addresses the specific needs of the area but also improves the quality of life for inhabitants while promoting a more sustainable future.

Passive architecture is an approach to building design and construction that aims to maximize energy efficiency and minimize environmental impact. Here are some key concepts of passive architecture:

- Insulation: Effective insulation of walls, roofs, and floors helps reduce heat loss or gain, ensuring better energy conservation within the building.
- Orientation: The building's orientation relative to the sun is crucial. A design that maximizes sun exposure in winter (passive solar gain) and minimizes it in summer (solar shading) helps naturally regulate indoor temperatures.
- Air tightness: Air tightness is essential to prevent uncontrolled air leakage, which can result in energy losses. A well-sealed envelope ensures improved energy efficiency.
- Natural ventilation (EL Malqaf): Utilizing natural ventilation allows for the circulation of fresh air inside the building, improving indoor air quality and reducing the need for mechanical cooling.
- Use of thermal mass: Incorporating materials with high thermal mass, such as concrete or earth, can help regulate temperature fluctuations by storing and releasing heat gradually.
- Solar protection: Passive architecture integrates elements of solar shading, such as overhangs, shutters, or low-emissivity glazing, to minimize unwanted solar heat gain during periods of high temperatures.
- Use of renewable energy sources: Passive architecture can be combined with the use of renewable energy sources, such as solar photovoltaic or thermal energy, to meet the building's energy needs in a sustainable manner.

This study aims to reduce energy consumption by implementing an intelligent passive house design. The chosen passive house design in this article is as follows:

- The house is oriented along its main axis, following the south-north direction.
- It is semi-detached and built around a central patio.
- All windows face the enclosed patio space.
- Natural ventilation is facilitated through a wind tower.

Based on (FigureN°3), which illustrates the wind distribution percentages according to different orientations, we will select an east-west orientation for our house. The goal of this study is to analyze traditional housing in hot and dry regions, extract valuable lessons from it, and understand its relationship with the environment. This architecture respects sustainable production and consumption principles and relies on local resources. [1-5]

II. Research Method

The "Sizing" refers to establishing the optimal "size" and characteristics of each component in a system with a known configuration. In fact, sizing may ultimately lead to changes in the system, for example, if it turns out that technically "optimal" elements are expensive or unavailable, etc.

The sizing methodology involves first determining the peak power that provides the necessary electrical energy during the least sunny month (typically December). It involves identifying when you need electricity and measuring your consumption. This step involves minimal calculations but requires considerable thought because an error at this stage can skew your results until the end.

II.1. The electrical photovoltaic generator

Calculating photovoltaic panels depends on the received sunlight and the orientation of the panel. Estimating the solar energy received at the site is straightforward, but it is necessary to consider the specific characteristics of the installation site itself.

The surface area $S(PV)$ of the photovoltaic panels is calculated by the formula in the equation:

$$S(PV) = E_j / (H \times PV \times f_T \times b) \quad (1)$$

Where $PV = 12\%$ is the efficiency of the photovoltaic modules, f_T is the temperature correction coefficient taken as 0.8 (the maximum measured panel temperature did not exceed $60^\circ C$), $b = 0.85$ is the efficiency of the batteries. H is the average solar irradiation received.



Fig.4 : 3D cut

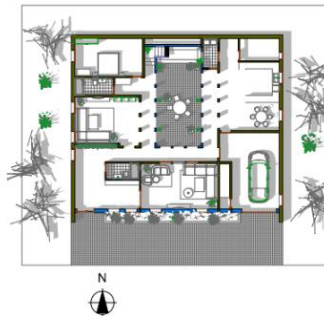


Fig.5: 3D ground floor



Fig.6: Integration of sensors

Load Charge(w)	Power (W)	Time use (h)	Energy/day (Wh/day)
07 lamps (DC)	$7 \times 10 = 70$	08	560
Refrigerator (DC)	25 (en moy)	15h running time	375
2Air conditioners (1. compressor, 1. humidifier)	A Compressor: 3500 Humidifier: 210	10	37100
TV+Demo(DC)	50	06	300
Washing machine	2500	1/2	1250
Pump (DC)	80	04	320
Total	6435		39 905

Table 1. Estimated Energy Requirement

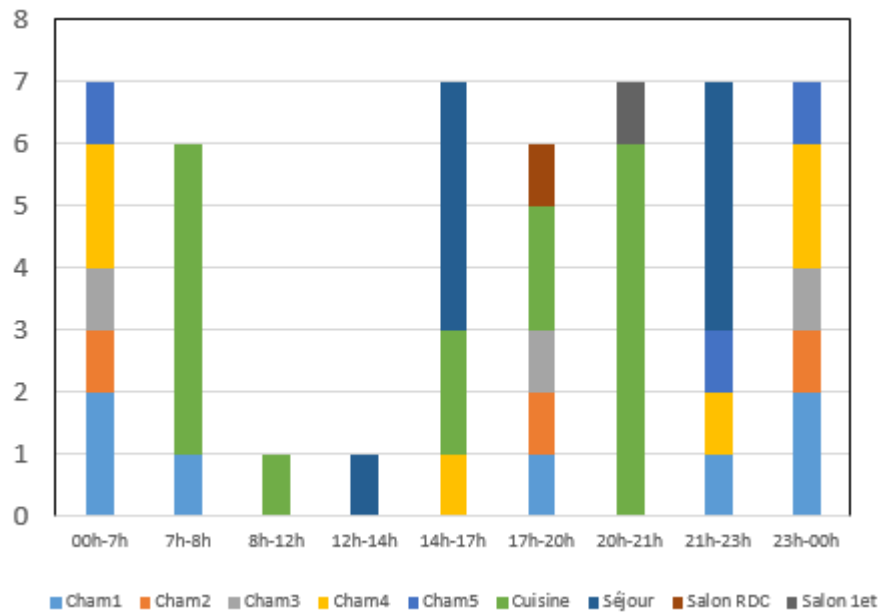


Figure .7: Histogram of room occupancy scenarios in the house.

II.2. The Enhancing Efficiency through Sensor Technologies

The sustainable smart house is equipped with solar panels, which generate electricity and reduce the house's reliance on traditional energy sources. In addition, the house is also equipped with automation system, allowing the homeowner to control and monitor the house's systems remotely. From adjusting the temperature to turning off lights, the homeowner can use their smartphone or tablet to manage their energy consumption and reduce waste.

Here are some examples of how automation can help us save energy:

- Lighting management: Motion and light sensors can be used to detect occupancy in a room and automatically adjust lighting based on actual needs. This avoids energy waste by automatically turning off lights when the room is unoccupied or when sufficient natural light is available.
- Heating and cooling control: Sensors can adjust indoor temperature based on scheduled timings, occupancy presence, and external conditions. This helps maintain comfortable conditions while avoiding excessive operation of heating or cooling systems when it is not necessary.
- Energy consumption monitoring: Automated energy tracking and management devices can collect and analyze real-time energy consumption data. This allows users to visualize their consumption and identify areas where savings can be made, encouraging them to adopt energy-efficient behaviors.

By automating these systems, it is possible to optimize energy usage based on real needs, reduce wastage, and achieve significant energy savings.

These real-life examples demonstrate how automation can contribute to reducing energy consumption in various sectors, including residential buildings, academic institutions, and electrical grids. By optimizing systems and adjusting energy consumption based on real-time needs, significant energy savings can be achieved, promoting more efficient resource utilization.

SENSORS AND COMPONENT	PLACE OF USE
Motion Sensor	Corridor & Stairs
Light Sensor	Garage & Stairs
Gas Sensor	Kitchen & Basement
Temperature & Humidity Sensor	Rooms & Corridor
Servo Motors	Windows
Ultrasonic Sensor	Water Bucket
LCD Screen	The Main Door
Keyboard	The Main Door

Table 2. Sensors and component

In our case we have used a motion sensor, a light sensor, a gas sensor, and a humidity sensor, along with servo motors for the windows. We have also incorporated an ultrasonic sensor, an LCD screen, and a keyboard for the door, as shown in Table 2. [7] [8] [9].

III. Conclusion

In conclusion, Architectural design in Saharan cities must respond to the climatic criteria and environmental context for a way of life adequate to society. In the framework of the themes of architecture and renewable energy and the management of the exploitation of the natural sources of the Algerian Sahara, which constitutes 80% of the country, a solar deposit is considered an advantage in the field of renewable energy and a weakness in the thermal and architectural fields. Our study proposes an automated house in the consumption of energy by the use of photovoltaic panels, which allows respect of the climate according to a calculation of the total loads of the dwelling, including the photovoltaic panels, the batteries, the converter, and the cables, which allows to have an autonomy of the house in terms of electric energy. Thus, an architectural design was adapted to the region through the use of local materials, patio orientation, vegetation, and El Malqaf. To verify the contribution of the passive design to the achievement of thermal comfort and thus the reduction of energy consumption (14% consumption total reduction) of the studied house, the integration of automation technologies in various aspects of energy management offers significant opportunities for energy savings and improved efficiency. Through automated control of lighting, heating, cooling, appliances, irrigation, and energy monitoring, it becomes possible to optimize energy usage based on actual needs, reduce wastage, and achieve substantial energy savings. Automation not only enhances convenience and comfort but also contributes to a more sustainable future by reducing environmental impact and promoting energy-conscious behaviors. By harnessing the power of automation, we can effectively address energy challenges and move towards a more efficient and responsible use of resources.

Electrical Engineering contributed to dimensioning of the PV system while Thermel study allows to have again in energy consumption using different methods. Automation has the role to well control the house that gives more confort and less time using energy.

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