All Sciences Proceedings

1st International Conference on Modern and Advanced Research

July 29-31, 2023 : Konya, Turkey

All Sciences Proceedings
http://as-proceeding.com/

https://as-proceeding.com/index.php/icmar

Zero Carbon Building Methods Based on the Use of Renewable Energy Sources to Reduce CO2 Emissions

Marouane Samir Guedouh[1*], Mohamed Amine Khadraoui [2], Hocine Sami Belmahdi [1] and Salima Amrane[1]

[1] *Institute of Architecture and Urbanism, University of Batna 1, Algeria*
[2]*Department of Architecture, University of Bejaia, Algeria*

[*]*(merouanesamir.guedouh@univ-batna.dz)*

Abstract **–**This research aims to minimize the CO2 emissions emitted by the building of restoration character. Rising global concern about the anthropogenic effects of climate change has helped find solutions to combat this phenomenon. Energy consumption based on fossil fuels is still dominant in the world today, and the reserves of its energy resources are limited. In this regard, several commitments and codes are proposed and adopted for a low-energy world and for desirable environmental conditions. Through the analysis of a restaurant sample and the simulation method, this study focuses on the paths toward a zero-carbon building; the strategies developed are linked to ecological technologies based on renewable energies of a sustainable and economical "Zero Carbon Building" model.

Keywords –Zero Carbon Building; CO_2 Emissions; Energy Consumption; Renewable Energies.

I. INTRODUCTION

The problem of global climate change and its impact is a major concern of the 21st century. Algeria, like other countries, faces frequent extreme weather events that aggravate drought and water scarcity. At the same time, socio-economic development and sustained improvement in living standards have led to a substantial increase in energy consumption. In 2017, the total energy consumption amounted to approximately 59.6 Mtoe. The demand for energy continues to increase. The average annual growth rate has remained around 7% over the past decade6. This trend in energy consumption is reflected in CO2 emissions, which are increasing steadily (about 2% per year) [1].

Algeria, which stands out among most countries on the planet in terms of energy use, rated more than 41% of the average, then 37% in the transport sector and 22% in the industrial sector. The use generates 25% of national CO2 emissions, as these measures are likely to exceed these due to the growing interest in the convenience of the construction sector [2]. This significant level of consumption justifies a point-by-point understanding of the consumption elements of the building sector in order to formulate and direct its energy consumption to stimulate efficiency, conservation, the implementation of technologies and the substitution of energy sources, for example on-site renewable energies [3].

The wilaya of Batna, which is one of the largest cities in terms of population (1,128,030 inhabitants in 2015) [4], its energy consumption is estimated at 4695 GWh EF/year in 2014, i.e. approximately 12.1 MWh EF/year/inhabitant (equivalent to approximately 7.5 barrels of oil per year per inhabitant). Natural gas for residential use, due to the greater need for heating in Batna (temperatures below -10 °C in winter and low in the off-season at night) [3] [4]. GHG emissions in the municipality of Batna are estimated at 1513 kteqCO2/year in 2014, i.e. approximately 3.9 teqCO2/year/inhabitant (equivalent to approximately 20,000 km by car). The difference with the average emissions per inhabitant in Algeria (3.3 teqCO2/year/inhab) is

once again explained by the heating of buildings, and by the high transit of heavy goods vehicles in the agglomeration [5].

II. Materials And Method

The method used is based on theoretical research as well as dynamic simulation to analyze energy consumption and CO2 production. The theoretical part is a literature review on the theme of “Zero Carbon Building” where it includes two parts; the first introduces and explains the definitions and concepts related to the notion of "Zero Carbon Building", and the second interprets design and technology strategies through examples. The second part is The analytical part concerns the identification of problems related to energy consumption and the interpretation of dynamic simulation results, it also contains two other chapters; that which is the presentation of the city of Batna, and the analysis of the problems related to the case study of one of the restaurants in Batna, and the last chapter discusses the results of analysis elaborated through the application of dynamic simulation.

The objectives of the research are:

- Improve the quality of the environment by minimizing air pollution by reducing the emission of greenhouse gases emitted by the building
- Demonstrate better energy performance, reduce carbon emissions and move towards zero carbon buildings
- Increase public awareness and understanding of the zero carbon building concept

III. Consumption And Co2 Emissions In Algeria

A. *Energy consumption*

National energy consumption (including losses) reached 59.6 M toe in 2017, reflecting an increase of 2.1% compared to 2016, mainly driven by that of final consumption (+4.1%) [6].

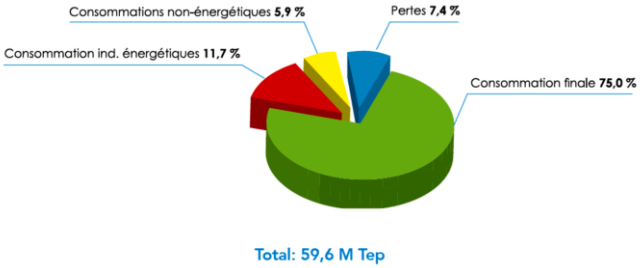

Fig. 1 National energy consumption (Source: National energy balance sheet for 2017).

B. *CO2 emissions*

Sustainable developments in the field of architecture are becoming more and more vital, which requires the use of renewable energies and the reduction of energy consumption. However, Algeria's unsustainable use of energy has contributed to an excessive amount of CO2 emissions.

- Global human emissions: 50 billion teqCO2/year
- Emissions in Algeria in 2017: 160 million teqCO2/year
- Average emissions per inhabitant: 3.87 teqCO2/year

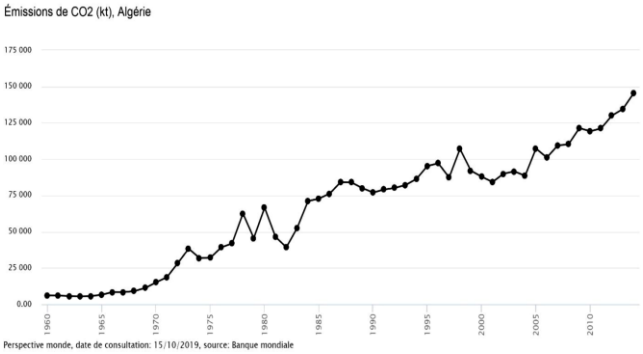

Fig. 2 Evolution of GHG emissions in Algeria (in k teqCO2/year) (Source: World Bank 2019).

The objective set by the IPCC is to reduce global GHG emissions by 2, we note that the average emissions of an Algerian are less than half of the emissions of an average human (about 7 teqCO2/year). Nevertheless, the average emissions per capita in Algeria are constantly increasing and will soon exceed this limit of 3.9 teqCO2/year [7].

IV. Presentation And Analysis Of Case Studies

This part will include the report illustrated by the APC44 of Batna, the solutions that have been proposed to fight against greenhouse gases and the reduction of energy consumption in the city. The analysis of the existing example in the city of Batna is represented by the existing buildings; since this area of catering and food is one of the sources of pollution that directly emit CO2 into the air.

Geographically, the city of Batna belongs to the Haut Constantine plains region, it is an internal city located in the east of Algeria, where it occupies a focal position in the northeast of the territorial area, with an area of 116.41 km2. Located in the high

plateaux of the Aures and characterized by a semi-arid climate.

A. *Guiding principles for the municipal sustainable energy strategy*

The APC of Batna adopts certain basic principles aiming at the integration of sustainable development during all decision-making relating to local development. The APC systematically considers the principles to take into consideration the energy aspects in the future action programs which must frame the new vision.

- Ensure the optimization of energy consumption and the integration of the development of renewable energies in all activities and projects taking place on the territory of the municipality in order to reduce energy consumption from fossil sources
- Use cost-benefit balances of energy aspects in new and ongoing projects
- Partnership: involve individuals, the private sector, non-governmental organizations in the development and management of energy resources and the development of renewable energies on the territory of the municipality
- Inform and educate the population and all operators in the territory about the new vision of the municipality

B. *2030 medium and long-term objectives*

- Reduction of energy consumption in the building sector by 30%.
- Reduction of gas consumption by 30% in heating and water heaters by integrating solar water heaters in individual homes in the municipality, as well as in mosques, schools, showers, and any other establishment.
- Elimination of wild dumps by improving the collection and management of municipal waste up to 95%.

C. *2030 medium and long-term objectives Energy consumption and CO2 emissions in Batna*

Energy consumption in the municipality of Batna is estimated at 4695 GWh EF/year in 2014, or about 12.1 MWh EF/year/inhabitant (equivalent to approximately 7.5 barrels of oil per year per inhabitant) [8]. It is distributed as follows between the sectors studied.

Table 1. Energy consumption in Batna by sector (Source: PAED 2015).

	GWH/year
Building sector	**2784**
Public lighting	11
Industry	524
Transportation	1359
Water Management	6
Waste	8
Agriculture	2

GHG emissions in the municipality of Batna are estimated at 1513 kteqCO2/year in 2014, i.e. approximately 3.9 teqCO2/year/inhabitant (equivalent to approximately 20,000 km by car). The difference between the average emissions per inhabitant in Algeria (3.3 teqCO2/year/inhabitant) is once again explained by the heating of buildings, and by the high transit of heavy goods vehicles in the agglomeration [9] [10].

V. RESULTS DISCUSSION

- There are several parameters (heating, air conditioning, ventilation, equipment, lighting) that influence the production of CO2, and according to the simulation results, it is the equipment and the lighting that influence it the most.

- Reducing the use of heating and air conditioning significantly minimizes CO2 emissions (60%).

- Invest in the energy used, changing the energy supply system by installing solar panels.

- Ventilation is important in this type of building, so it is good to have natural ventilation to avoid installing mechanical ventilation which will consume more energy.

- The goal of designing the "Zero Carbon Building" is to have a zero or negative carbon footprint, and according to the simulation of this restaurant, it has a much more positive carbon footprint (21694 Kg CO2/year).

VI. CONCLUSION

The dynamic simulation of this case study shows the effect that the equipment, as well as the poor management of lights and ventilation, can have on the production of CO2 and the increase in energy consumption.

In order to design a zero-carbon building, it is important that it is also energy-efficient with respect to reducing energy demand through energy-efficient

building construction and HVAC system, improving the energy efficiency of buildings. We need to consider the efficiency of various renewable energy systems and options that are suitable and feasible for the building we are designing. Energy efficiency and carbon emissions analysis, as well as economic analysis, are the essential parameters of this method, which ensure the overall success of a design.

It is important to improve the efficiency of electricity generation and the use of renewable energy to reduce carbon, because it is the most effective measure to reduce future CO2 emissions.

REFERENCES

[1] W.D. Nordhaus, and J.G. Boyer. Requiem for Kyoto: An Economic Analysis of the Kyoto Protocol. 2008

[2] S. Zekai Solar energy fundamentals and modeling techniques. 2008. Pages (35-40)

[3] F. Lecomte and P. Broutin. Le captage du CO2 : Des technologies pour réduire les émissions de gaz à effet de serre. 2015.

[4] E. Cuce, A. B. Besir and P. M. Cuce. Low/Zero-Carbon Buildings for a Sustainable Future, chapter 03. 2018

[5] O. M. El-said Omar. Nanoarchitecture and global warming, Doctorate thesis: Alexandria University, 2012.

[6] A. M. Magdy. Zero Carbon Architecture: The future challenges & the Nanotechnology solutions, Master of engineering in architecture: 2010.

[7] https://climatechange.lta.org/get-started/learn/co2-methane-greenhouse-effect/

[8] World green building council www.worldgbc.org

[9] https://achieving-zero.org/

[10] https://www.dezeen.com/2019/05/28/foster-partners-net-zero-carbon-buildings-commitment-2030/