International Multidisciplinary Research Journal
ISSN: 2424-7073
Available Online at https://imrjournal.info/
Volume:1; December 2021; Page No.1-8
DOI: https://doi.org/10.47722/imrj.2001.05

ICRD
Research Article

TAFILELT KSAR: BETWEEN TRADITION AND MODERNITY, AN EXPERIMENT OF ENERGY ENHANCEMENT HOUSING IN ALGERIA

Benkechkache Imane and Benrachi Bouba

University Saleh Boubnider Constantine 3, La Nouvelle Ville Ali Mendjeli, Algeria

ARTICLE INFO

Article History:

Received 15.03.2021
Accepted 15.11.2021
Published 30.12.2021

Keywords:

Energy Efficiency, Tafifelt Ksar, The M'zab Valley, Adaptable Housing

ABSTRACT

Energy is one of the common determinant factors related to social, environmental and economic problems, which can also contribute to their solution. Among sectors where studies could be done to reduce energy demand, is building. This latter is the largest primary energy consumer and responsible for more than 40% of total CO_2 emissions.

Therefore, improving energy efficiency in buildings represents an economic and ecological challenge. The built environment quality, with good insulation and high-performance building materials, constitutes the first step towards this aim. Yet, this is not enough to make buildings low energy consumption. But then again, a starting point for which, it is necessary to manage how it should be occupied and exploited. Improving energy efficiency of buildings involves several steps through which, coherent actions, will enable energy savings acting on different human and material parameters. The conceptual approach for improving energy efficiency is identical for residential and tertiary sectors. However, in practice this is different due to divergences related to: technical aspects; used tools; operating and maintenance costs and return time of investment.

The purpose of this research is to investigate an example of Energy Enhancement housing in Tafilelt ksar in the M'zab valley in Algeria (an example of ecologic planning with modern habitat perfectly adapted to environment), with the objective of creating adaptable housing according to changing needs of future generations.

Introduction

For multiple decades, high-energy consumption has been and continues to be a worldwide challenge. This increase fundamentally undermines the economic model that is dependent on its development for a colossal amount of energy. This energy remains the overwhelming majority, of fossil origin and therefore non-renewable in the short and medium term. It is the primary source of greenhouse gas emissions in a world that already suffers from the impact of human activity within its environment. (Boursas, 2013).

Considering that buildings are highly energy-intensive, a so-called "sustainable" construction trend has emerged. The most common associated notions are related to the idea of energy performance rather than the relation to time. It considers here the building as a machine, having the capacity to consume more or less energy. Thus, this system puts the inhabitant, as a user who adapts himself to his dwelling, where accumulation of processes linked to new technologies tends to constrain his lifestyle. As a result, the world's energy consumption through heating, ventilation and air-conditioning equipment in buildings varies from 16 to 50% of the total energy consumption. (Karchi, 2013).

Therefore, improving energy efficiency in buildings represents a major economic and ecological challenge. The built environment quality, with good insulation and high-performance glazing, is the first step towards this aim. Yet, this is not enough to make buildings low energy consumption, but a starting point for which it is necessary to manage how it should be occupied and exploited. Improving energy efficiency of a building involves several steps through which, coherent actions, will enable energy savings by acting on different human and material parameters.

Abundance, availability and low cost (oil and natural gas) energy, has moulded for years “the Algerian way of life”. However, this was clearly unsustainable, as their prices have dropped drastically during the last decade. For that purpose, Algerian government created a green momentum by launching an ambitious plan to develop renewable energies and promote energy efficiency, based on not fully exploitable renewable energy resources. This plan leans on a strategy focussed on developing and expanding the use of inexhaustible resources, such as solar, wind, geothermal, hydropower and biomass energies in order to diversify energy sources and prepares “Algeria of tomorrow”.

The plan consisted of installing up to 22 000 MW of power generating capacity from renewable sources between 2011 and 2030, of which 12 000 MW are intended to meet the domestic electricity demand while the remaining 10 000 MW will be exported. This last option depends on the availability of a demand that is ensured on the long term by reliable partners as well as on attractive external funding. It is expected that about 40% of electricity produced for domestic consumption will be from renewable energy sources by 2030. Algeria is indeed aiming to be a major actor in the production of electricity from solar photovoltaic and solar power, which will be drivers of sustainable economic development to promote a new model of growth. (APRUE, 2011, Senouci & Benhabib, 2016).

On the other hand, very old cities in the south of the country, developed within a hot dry climate are using passive energy by enhancing building thermal performances. In this paper, the research proposes to study an example of a new city named Tafilelt Ksar in the M’Zab Valley in the Sahara of Algeria that has been recently built with modern habitat adapted to environment and new inhabitants needs.

Energy Efficiency in Algeria

Over a decade, Algeria has experienced intense and sustained development in building and construction sector. This covers large-scale state projects (2 million social dwellings with all accompanied structures) or large real estate (residential) and tourism projects initiated by private or public developers. However, international requirements and standards for energy and environmental performance of buildings are not yet adequately integrated into the design and construction processes. This has prompted the authorities to seek the best efficiency in building sector through several projects aimed at improving thermal comfort in housing and reducing energy consumption for heating and cooling. (Mecheri & al, 2012; Semahi & Djebri, 2013; Imessad, 2014).

Energy Efficiency and Energy Saving Plan

Three main strategies are the basis of this plan: promote a more responsible use of energy, examine ways to protect the resources and systemise efficient and optimal consumption. Altogether, constitute an integration of life style improvement and energy saving. Their beneficial implications will reflect on national economy, in terms of employment and environment preservation. Moreover, all sectors of activities will be covered by this plan, in particular building, industry and transportation. (APRUE, 2011).

In Algeria, buildings consume 42% of overall energy. To achieve energy efficiency, the proposed measures introduces the usage of thermal insulation in buildings, which will cut home heating and cooling consumption down by about 40%. (Imessad, 2014).

Thus, in this sector, the plan is to:

- Encourage the use of new technologies and practices for thermal insulation both in existing buildings and in new ones through adequate actions in architectural design.

- Support large-scale use of solar water heaters and saving lamps with particular attention to their local manufacturing.

- Incorporate in the Algerian market equipment’s and appliances (air-conditioning, refrigerators

…) generically performing that significantly affects energy balance aiming their national manufacturing.

Solar energy for air conditioning is a technology that should be promoted particularly in the south of the country, as far as the needs for cooling mostly coincide with the availability of solar radiation (conversion of sunrays into energy). Moreover, solar collectors may also be used for hot water production and room heating during the cold season. The overall performance of a solar cooling system is therefore of a great interest. Globally energy savings accrued by the year 2030 for this sector is about 30 million (Tonne of oil equivalent) TOE. (APRUE, 2011; APRUE, 2016).

Eco-Bat Programme

In the context of this plan, a programme for the construction of high-energy performance (HEP) dwellings namely ECO-BAT has been launched by the "Agency for the Promotion and Rational Use of Energy" (APRUE) in partner with the Ministry of housing and planning.

A pilot project for insulating 600 new dwellings with thermal comfort performances and energy saving for heating and cooling systems over 11 Wilayates covering the climatic zones in the country had the following objectives:

- Building different options of bioclimatic dwellings according to local climate;
- Encouraging the use of local building materials demonstrating the feasibility of energy saving whatever the climatic conditions. (Figure 1).

The year 2011 has seen the beginning of realisation of this project. The following are some HEP dwellings examples: (Houidef, 2009; Mecheri & al, 2012, APRUE, 2012).

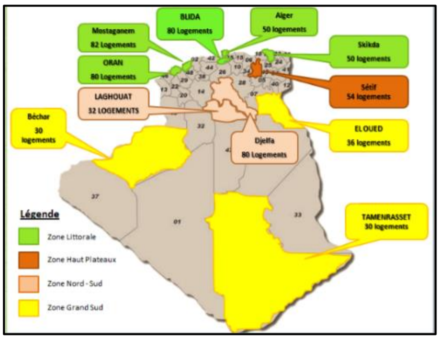

Figure 1: Wilayates and climatic zones concerned by the program of 600 HEP dwellings. Source: APRUE, 2012.

El Oued dwellings: are characterised by: (Figure2)

- Implementing the Cupola to Increase aeraulic movement,
- Using Moucharabias as solar protections and small windows in west façade,
- Combining inertia and ventilation.

Skikda dwellings: are characterised by:

(Figure 3)

- Solar protection through sallies in the façades,
- Usage of double-glazing,
- Thermal insulation of external walls.

Laghouat dwellings: are characterised by: (Figure 4)

- Solar protection through oriented and movable shutters,
- Saharan waterproofing for terrace floors,
- Usage of double glazing and white colour on facades exposed to sun,
- Thermal inertia: external an internal wall in BTS (stabilized earth concrete) and terracotta floor covering

Figure 2: Project of 32 dwellings at El Oued

Figure 3: Project of 50 dwellings at Skikda

Figure 4: Project of 32 dwellings at Laghouat

(APRUE, 2012).

Tafilelt ksar in the m'zab valley

- **The M'Zab valley**

Situation of the Valley

The M'Zab valley is in the northern part of the Algerian Sahara. It is situated 600 kilometres from the Algerian capital Algiers, and it is built on a rocky plateau that is crossed by dry riverbeds. In this valley, the cultivation of the palm grove is vital for the survival of the population and the ecosystem as a whole. The five historic fortified cities (ksours) in the valley – known collectively as the pentapolis of M'Zab – were inscribed on the UNESCO List of World Heritage Sites in 1982. They were founded respectively, El Attef in 1012, Bounoura in 1046, Ghardaia in 1048, Beni Isguen in 1347 and Melika in 1350.

Lying outside the valley, Ibadite settlements nonetheless, are the cities of Guerrara and Berriane, which were founded in 1630 and 1688 respectively after internal conflicts that led to the exclusion of rival groups. The plateau of M'Zab extends 30 kilometres and covers an area of 4,000 square kilometres. The traditional ksours still dominate the valley, despite the growth of many new developments. These Ksours in the M'Zab Valley characterised notably by an original architecture, which has been a source of inspiration for 20th century architects and planners, such as Ravereau, Wright, Le Corbusier or Pouillon. (Mashaty, 2007).

Climatic Conditions of the Region

The M'Zab valley is characterised by a harsh desert climate. There are notable drastic temperature variations form day to night as well as between winter and summer seasons. A high temperature on a July day can reach 44°C, whereas the lowest can reach 25°C. It seldom rains in M'Zab valley, but irregular downpours sometimes cause rivers and streams to flood. The maximum rainfall, in a good year, is 120.5 millimetres while the minimum is 20 millimetres, with an average of twelve rainy days a year. Relative humidity, which is of great importance for human comfort, fluctuates with the temperature, being around 70% from October to February and 50% from March to September. In winter, the prevailing northwest wind may bring rain. In summer, the winds come mainly from the northeast and are very dry, especially the Sirocco. Sand storms occur during March, April and May. (Mashary, 2007).

Tafilelt Ksar: Study Methods and Results

Located in the M'Zab valley, the new ksar Tafilelt of Béni-Isguen is one of the best examples of city construction in Algeria within a particular extreme environment. A unique and intelligent experiment after old ksours, that combines architecture and sustainable environment, is marked by the preservation of environment and social life that characterise this region. It is built within local materials and means and local how know for local use. Achieved in 2006, within respect to sustainable development, it constitutes a good example of sustainable city involving traditional principles of architecture, urban and ecological scales with the aim of responding a great social demand against housing crisis. (Figures 5 & 6).

Figure 5: Satellite view of the ksar Tafilelt.

Figure 6: General view of urban façade of

Tafilelt.

Environmental quality of the Ksar

The main concept of the Ksar was the construction of a new town on a non-arable land, preserving the oasis and the surroundings of the old ksar. The project was inspired by traditional settlements structure, which is designed for community living while respecting the family structure. It balances a precise knowledge of the aspirations and needs of inhabitants with an awareness of the existing potentials as well as the budgetary restrictions.

The urban and architectural concepts were derived from the traditional ksar matching housing inhabitants' modern needs by adopting the traditional style.

Urban characteristics:

It is a very dense urban network with compact and high-density constructions built on hills reducing the distance between the houses with interlaced and narrow streets. Architecturally, the street is enlivened only by the colour of the walls and their play of light and shade. Inside the towns, circulation is via a network of rectilinear lanes that are partially covered and accessible only to pedestrian. Depending on the topography, these lanes are often quite tortuous and steep, and flights of stairs are very common.

Through its location, the ksar is exposed to all wind directions comparing to the palm groves which is protected down in the valley; most of the houses are south oriented, which helps to get more sun in winter (oblique rays) and be protected in summer (vertical rays).

The Ksar is adapted to the natural landscape of the Sahara environment by bioclimatic comfort with introverted house forms and limited construction height, shading circulation paths from the sun, protection against sandstorms and creation of green spaces for energy saving. The layout of streets and their orientation are all factors that greatly favour the penetration of wind, in summer and winter. (Photos 1, 2 & 3) (Mashaty, 2007, Chabi & Dahli, 2011a, Boukhelkhal, 2012).

Certain regulations, relating mainly to the height of the building and the orientation of external openings, which are limited to doorways and occasional windows, did govern the ksar construction. (Figure 7).

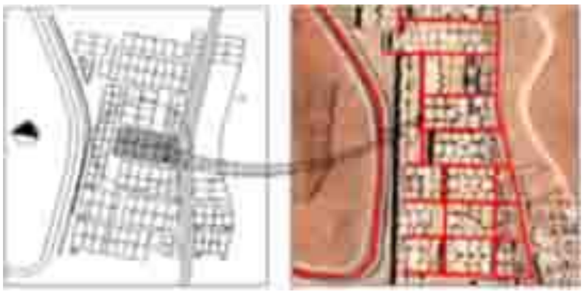

Figure 7: Urban organisation of Tafilelt Ksar (Source: Chabi & Dahli, 2011a).

Photos. 1, 2 and 3: Shading circulation paths and vegetal. (Source: Mashaty, 2007).

Architectural characteristics:

Usually the footprint of a house does not exceed 100 m2. However, houses are built over two storeys, gaining in height the space that is not possible to occupy on plan. Considering the need of privacy and as well climatic considerations the house height should not be more of than 9 m because the only source of light comes from the courtyard and the shebbek, and that no house prevents its neighbors from getting their share of sunlight.

The rectangular form of houses attached to each other supports a minimum loss of heat in winter and a minimum gain of heat in summer if the courtyard is covered in hot and cold weather.

The entrance remains open most of the time to allow cross-ventilation. Near the entrance, away from the family area, a room in which male visitors are received. The entrance leads to the most important space of the house, Ouast Eddar (middle of the house) which is open to the sky through a 1 x 1.5 metre section known as the shebbek. The habitable rooms are organised around it. They are usually multifunctional depending on the family's requirements. The first floor is organised around a central open space (ikomar), with a toilet/ablutions room next to it and sometimes a small kitchen for winter use. The stairs leading to the roof occupy a corner of the central space. During the day, the roof is reserved exclusively for women, who use it for domestic activities with the presence of laundry. In the summer, the whole family uses the roof for sleeping. (Figure 8).

Figure 8: Sample of house plan and elevation. Source: Mashaty, 2007.

The courtyard is entirety for housing bioclimatic aspect. It allows better natural light for closed spaces. It can also play the role of a patio for its capacity of thermal regulator, with the presence of vegetal and water, by producing shades, and cooling air by evaporation. (Chabi & Dahli, 2011a & 2011b; Mashary, 2007; Ali Toudert & al, 2005) (Photos 4, 5 & 6).

Photo 4: The form of attached houses.

Photo 5: Ouat Eddar and shebbak.

Photo 6: The interior of house.

Source: Mashaty, 2007

Building Materials

In regions where night temperatures are important, the used technique is to delay the penetration of heat inside houses, using local building materials with high thermal inertia, such as stone, the rammed, lime or combinations of these materials. Since homes are built with thick stone walls, they are also cool during the day and warm at night. This thermal phenomenon is enhanced by the use of light-coloured plasters in raw or dyed lime, which reflected light and heat. In summer, the interior of the house is cool and dark, and a pleasant breeze would blow between the shebbek of Ouest eddar, the courtyard, the open entrance door, and the openings in walls.

Building materials used in the construction of the ksar are local (80 % stone, lime, plaster and wadi sand and 20% cement and its derivations) and do not need excessive energy consumption for their use, neither give rise to environment pollution. External walls are made of blocks of stone of 0.45 m thickness that compose the house structure of facades. Interior walls are made of hollow concrete blocks of 0.15 m thickness. For external wall covering traditional techniques using a soft mortar made of lime and sand, is spread over the surface to have rough texture that provides shades and avoid excessive heating of the wall. (Mashary, 2007; Chabi & Dahli, 2011a & 2011b).

The use of stone with local lime mortar provides relatively comfortable internal spaces during the day and reduces fluctuation of internal temperature; material of a great thermal inertia that is part of traditional building techniques and bioclimatic architecture. The thickness of walls allows to retain heat during day and release it during night (beneficial for winter) where natural night ventilation interfere for cooling, as air is relatively fresh (summer), via chimney effect of the shebbek and the courtyard volume. (Chabi & Dahli, 2011a & 2011b).

The terrace floor, which is exposed to sun, is made of concrete for slab compression and precast concrete for beams spaced of 0.65 m with plaster vaults that ensure thermal and sound insulation in one hand and is used as formwork in other hand. Hollows between beams are filled with mixture of sand and lime. (Chabi & Dahli, 2011a).

The Adaptation of Tafilelt Ksar to the Climate and Energy Efficient: Discussion

Tafilelt ksar has been the object of many research studies for sustainable environment comparing it to old existing ksars of the valley such as Beni Isguen and Guardaia. As a new ksar designed for modern inhabitants' needs, such as introduction of cars by widening some streets (periphery) and the enlargement of some windows, it was established that the changes made do not influence the adaptation of its urban network and buildings to the regional climate.

However, some techniques are proposed to reinforce thermal insulation of houses where concrete has been used in floors such as terrace floor. Local materials of palm trees branches can be used to cover a partial insulation for the exterior of the terrace floor and the interior of external walls (main facade and courtyard) that are mostly exposed to sun. To protect from sunrays, filtering through the enlarged external windows, Moucharabias are proposed while leaving the entrance of light. The usage of plants helps to guide air movement filtering dust during sandstorms and creating shades on walls and floors. Moreover, according to many researches, the exposition of the kasr to all wind directions and the use of local materials reduce temperatures of about 3°C to 4°C in hot season. (Chabi & Dahli, 2011a & 2011b).

To conclude, the study of Tafilelt ksar shows that some urban and architectural principles for climate integration are an actualisation of those used in the old ksours, considered as a referential source to be reinterpreted. The objective of its design and building is to create within its houses the same thermal comfort conditions with respect to the existing ecosystem.

Conclusion

Good energy efficiency building is a building that aims to balance production and consumption of energy. Furthermore, the objective of energy efficiency is to integrate a solution that allows consumption without affecting users and occupying comfort, nor compromising technical potentials of tools specific to the building activity.

To achieve this objective within a building two types of complementary levers can be activated:

- Passive energy efficiency: avoiding losses by enhancing building thermal performances, as in the example of south Algerian ksours.
- Active energy efficiency: reducing consumption by optimizing the operation of equipment's and systems. Energy efficiency solutions include the implementation of intelligent measurement, control and regulation systems (heating, cooling, ventilation and appliances.

This solution is obviously the most effective and the main source of results for energy renewal.

However, housing of the future will have to take account of social and energy changes, it must be flexible and adaptable to different lifestyles and climatic conditions for better energy efficiency.

References

Agence Nationale pour la Promotion et la Rationalisation de l'Utilisation de l'Energie (APRUE). 2011. Programme des Energies renouvelables et de l'efficacité énergétique, Ministère de l'énergie et des mines, APRUE, Alger, Mars.

APRUE. 2012. Programme ECO-BAT. 600 logements à haute performance énergétique. Ministère de l'énergie et des mines, APRUE, Alger.

APRUE. 2016. Programme de développement de l'efficacité énergétique à l'horizon 2030, Ministère de l'énergie et des mines, APRUE, Alger, Janvier.

Ali-Toudert, Fazia, Djenane, M & Bensalem, R. 2005. Outdoor thermal comfort in the old desert city of Beni-Isguen, Algeria, climate Research -Clim Res-, Vol. 28.

Boukhelkhal, Isalm. 2012. Impact de la morphologie urbaine sur le confort thermique extérieur dans les climats chauds et arides : Cas de la nouvelle ville de Tafifelt à Ghardaia. Magister en Architecture, Option: Architecture Bioclimatique, Université Constantine 3.

Boursas, Abderrahmane. 2013. Etude de l'efficacité énergétique d'un bâtiment d'habitation à l'aide d'un logiciel de simulation. Magister en génie climatique, option; Thermique du bâtiment et de réfrigération, Université Mentouri de Constantine.

Chabi, Mohammed & Dahli, Mohamed. 2011a. Le Ksar de Tafilelt dans la vallée du M'Zab. Une expérience urbaine entre tradition et modernité. eBox.Editions, Février. http://www.eboxeditions.com/121-31-titre-livres-le-ksar-de-tafilelt.html.

Chabi, Mohammed & Dahli, Mohamed. 2011b. Une nouvelle ville saharienne sur les traces de l'architecture traditionnelle. Colloque à Rouen, France 17-18 Mars.

Houidef, L. 2009. Le programme Eco-Bat, Réalisation de 600 logements à haute performance Energétique, Présentation APRUE, Novembre.

Imessad, Khaled. 2014. Pour une construction Eco-énergétique en Algérie, Recherche et développement, APRUE.

Kharchi, Razika. 2013.: L'efficacité énergétique dans le bâtiment : Recherche et Développement, N°28.

Mashary, al-Naim. 2007. Tafilelte Tajdite, Review Report, Ghardaia, Algeria.

Mecheri, S, Semmar, D & Hamid. A. 2012. Efficacité énergétique des logements à haute performance énergétique, 'HPE': Application au site de Béchar ; Revue des Energies Renouvelables Vol. 15, N°2.

Semahi, S & Djebri, B. 2013. La conception des logements à haute performance énergétique (HPE) en Algérie - Proposition d'un outil d'aide à la conception dans les zones arides et semi-arides, Revue des Energies Renouvelables Vol. 16, N°3.

Senouci, Benabbou & Benhabib, Abderrezzak, 2016. Energy Transition challenges in Algeria, 15 MEEA, Doha 23-25 March.

How to cite this article:
I. Benkechkache and B. Benrachi. (2021) 'Tafilelt Ksar: Between Tradition and Modernity, an Experiment of Energy Enhancement Housing in Algeria', *International Multidisciplinary Research Journal*, Volume:1; December 2021; Page 1-8. DOI: https://doi.org/10.47722/imrj.2001.05