

Near Zero Energy House in Palestine:

Identification of the Future Challenges

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Abstract— Most of researches and experiences of the concept of near zero energy buildings (NZEBS) are highly concentrated on the developed countries more than the developing countries due to many reasons related to the different contexts conditions. This paper is a part of a PhD thesis, which is being supervised by the Department of Architecture at the University of Palermo. The paper aims at highlighting the challenges facing the house design in Palestine as a developing country in terms of NZEBs by making a study which is related to discussing different experiences in the field of energy saving strategies in Palestine and some surrounded countries, such as Jordan which shares certain climatic and architectural characteristics with Palestine. The data analysis process is based on the study of several attempts and experiences taking into consideration the contemporary house design situation in Palestine. This study follows a classification of challenges toward near zero energy house (NZEH) into two categories; firstly the organizational challenges; such as costs, policies, and training challenges in effect relates to how society organizes itself and establishes its priorities. Secondly, the technical challenges of the NZEBs. The discussed results should be considered in the influential governmental institutions to provide the requisite leadership decisions for planning better future built-up environment in Palestine, also in other countries which have nearly similar context.

Keywords; NZEBs, Challenges, Mediterranean climate.

I. INTRODUCTION

Within the first decade of the 21st century, several architectural trends have been ranked on top of the world's interests related to the design of environmental friendly buildings by considering the utilization of renewable energy sources, reducing carbon dioxide emission, and limiting costs associated with operating buildings. Accordingly, many researchers have focused on the concept of near zero energy buildings, which is related to the buildings that produce nearly the same amount of energy that they consume. Various design considerations are taken through the design of NZEBs; the passive and active solar design systems, beside many other environmental aspects those are recommended as guidelines to achieve effective environmental designs.

The nonexistent of non-renewable energy resources in developing countries such as Palestine has led to the increase of houses running cost due to the large dependency on fossil fuel import and consumption. On the other hand, utilizing from

renewable energy and natural resources are within reach due to the variety of climatic and geographic features of the Palestinian regions. Renewable resources, represented by solar energy, wind, and geothermal energy, have the capability to be employed and included within any design process once it is easy to obtain them. Some successful attempts and experiments, regarding utilizing from renewable energy have taken place in the region, but on a very limited scale. Thus, it has become an urgent need more than ever before to make a comprehensive study about form and function of the future house in Palestine that does not rely on any form of non-renewable energy.

II. CHALLENGES TOWARD NZEH IN PALESTINE

Several studies were extracted to discuss near zero energy houses in the world countries, but none of them were talking about Palestine, few of them were talking about the developing countries according to the European commission report which was made by ECOFYS et al. (2013). Most of these studies focused on pursuit of net zero energy building to get energy efficiency and energy conservation from a perspective of operation system, but these studies didn't take other impacts of buildings into consideration and often ignored together [1]. Most of these studies include several challenges facing design and implementation of NZEH [2], all of them can be found in Palestine also as the following categories:

A. Organizational Challenges

These challenges include several organizational aspects related to the general context of a country such as :

1. Financial Aspects

The most important aspects that must be the base for any developmental issue are the fund and the cost. The cost must be as less as possible and the fund has to be as much as possible to meet the basic needs of a project. Therefore, regarding both sides (fund and cost), several challenges facing the implementation of near zero energy houses in the world, especially within the developing countries including Palestine. But as a special case, Palestine has very few sources of fund to support the energy saving projects within houses due to some technological issues that cost a lot of money beside the lack of funding sources, despite the few

trials and experiences toward using renewable energy systems in some specific projects there. Instead of the high cost of construction process and building materials relatively with people average income level and the few attention to environmental issues among the labor market.

2. Policy Aspects

On the policy level, Palestinian green building council (PGBC) has been established on the last few years as non-governmental organization (NGO) which involves several qualified professionals from Palestine within this field. PGBC created a manual to be followed by architects of Palestine in the means of designing and retrofitting of buildings in order to fit the international standards of green buildings. This is a valuable achievement, but still there are very few sharp governmental mandatory rules that can be used as a way to apply a comprehensive country policies including the municipal, provincial and national governmental policies that aim at reducing fossil fuel prices and usage, or to facilitate industrial development, international trade, and social services. In addition to the involvement of the public awareness toward NZEBs and their benefits for the communities in the future approaches.

3. Training Aspects

According to the nonexistence of NZE houses in Palestine, stakeholders have no sufficient training related to the technology's market at present and how they should deal with this market changes in the future. The lack of well trained architects or engineers those who learned the context demands for saving energy, design ways, and technologies of NZEBs. The major house's design technologies those used in near zero energy houses are nearly off-the-shelf, the challenge is how to design and integrate various design combinations to achieve the near zero energy goals.

B. Technical Challenges

These challenges generally are related to the existence of technologies and how they perform well. These challenges include several technical aspects related to the house design itself such as:

1. Construction Materials

In the past, construction materials have contributed in determining the house type, and size of the internal spaces. Thus, the architectural and urban styles in the old Palestinian cities were affected by the construction materials that were available, the prevailing climate in that region, geography and people's needs. Dependently, the simple houses were not different from other houses except by their size according to the number of family members and the economic, social and political situation of the family [3]. Most of new houses facades are constructed from natural stone and concrete as the common building envelope layers. In few houses cases, external wall layers contains from:

natural stone, concrete, thermal insulation and concrete blocks successively as a way to enhance the thermal efficiency of the house, but this way of construction might not be used to build the future houses, because the natural stone is considered as unsustainable material, of course it will be depleted in some day. It is worth to mention that stone mining areas in Palestine became an environmental catastrophe due to destroying and changing of all natural mountains' shape to steep and ugly cliffs. Within the same issue, in some regions such as Jericho and Gaza, there are availability to use different materials such as earth due to the suitable climate and geology or due to the cost and lack of building materials which specially can be found in Gaza which suffers from various living obstacles due to the complex occupational situation there.

2. Construction Technologies

Nowadays several architectural and environmental works went to solve energy problems using modern techniques, this issue has made a gap between traditional and modern architectural solutions and designs. Mostly, energy saving technologies are depending now on mechanical and electrical solutions such as air conditioning machines, which neglects the role of architectural design of the house itself. Due to this, some researchers and designers went to focus mainly on the ways of combining traditional architectural techniques (passive designs) and zero carbon energy systems beside other active technologies to design contemporary houses or buildings [4].

Most of new buildings in Palestine are still treated as a structure not as a living space that needs special attention to keep the internal atmosphere and temperatures in comfortable level, during summer and winter times. Insulation materials are sometimes used in a typical detail without thermal calculations; different house's areas and spaces with different orientation have the similar openings and were treated and isolated with the same environmental solutions, similar construction materials, and the same wall section and thicknesses. New construction methods in Palestine pay a little attention to climate, many people build their house without referring to any engineering consultancy. In addition, most of designers do not consider climate as an important aspect to be followed in design process, many buildings do not provide the occupants with the comfortable environment they wish, this comfortable environment can be only achieved by using equipment such as expensive air conditions and heaters. As the case of Palestine, energy is valuable and out of reach for many people, but this became unreasonable. Furthermore, some people are using wood for heating in winter, which lead to a destruction of nature because forests also are few in Palestine.

3. Climatic Zones

Palestine has several climatic zones that have different temperatures and different climatic conditions due to the topographical and environmental varieties. Those zones are classified as the coastal zone, mountainous zone, Negev desert, Jericho and Jordan valley. A design challenge of buildings appears here because changing of climate means change in building design techniques and construction materials. Finding rules for Palestinian near zero energy house means finding several models and solutions in the future for each climatic zone there.

4. Renewable Energy Sources

In Palestine, there is a slightly different context from several countries in the world, due to the fact that Palestine is a developing country under occupation with nonexistence of non-renewable energy sources such as fuel. Therefore, the running cost of the Palestinian house is very high in comparison with others outside Palestine. Due to the occupation, Palestinians do not have the control of existed natural resources, such as water resources, salt mining from the dead sea, fields of producing electricity, and other natural resources. Accordingly, the need to re-thinking of how to apply the basics of zero energy house to the Palestinian context within the available resources that can be refurbished, renewable energies, and architectural elements that can be drawn from architectural heritage as in the rest of the world countries to exploit the passive and active solar solutions in architectural design.

III. LOCAL AND REGIONAL EXPERIENCES

Regarding that no NZEBs experiences in Palestine until now, but it does not mean that there is no attempts and trials related to the environmental designs approach, and low cost houses. The necessity to save energy pushed the ministry of energy to facilitate the use of solar cells within buildings to encourage people to use them within their own houses. Several valuable experiences can be found in Palestine and the surrounding countries such as Jordan and other countries within the Mediterranean region. Some of those experiences can be mentioned as:

a) Local Experiences

Some valuable houses design and construction ideas were created by some architects of Palestine to apply the concept of environmental house or to find low cost solutions of houses. Some examples can be mentioned here:

- Recently, the group of Shams-Ard for environmental design succeeded in designing and building houses of earth in Jericho (Fig.1) as a concept of reviving the earthen architecture with lower cost in comparison to contemporary houses there. This way of building is similar to Hassan Fathy's architecture for "poor" in Egypt.



Figure 1. Earthen house in Jericho by Shams-Ard group
Source: Shams-Ard group photography

- Several attempts were created also by using earth in Gaza strip between 2006 to 2014 due to the lack of construction materials which happened due to the occupation, especially after the last Israeli aggression in 2014. Those attempts were more environmental friendly and social houses that meet people's basic needs as a place to shelter them without cost for a certain period of time.
- Architect Hani Hassan won an international award related to a design concept for an environmental house in Jericho which was a new concept for the desert house that saves energy and achieves environmental equilibrium (Fig.2).

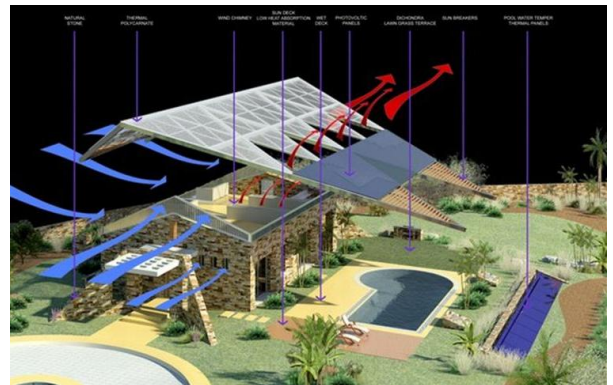


Figure 2. Desert house in Jericho by Hani Hassan
Source: Hani Hassan consultant office website

Those local attempts took the attention as they solve some environmental problems related to Palestinian context such as materials and concepts toward greener architecture with the absence of public awareness of the importance of renewing architectural methods and designs to match the local environment.

b) Regional Experiences

Jordanian context is very near to the Palestinian context by sharing identity, culture, construction materials, technologies, etc. Thus, there are some architectural attempts also in Jordan that can be mentioned in the field of NZEH and earthen architecture as follow:

- Ayoub Abu-Dayieh is a Jordanian architect who designed his own environmental house with very low running cost due to several passive and active solar

technologies were used in this house. He paid other architects attention toward this successful attempt.

- Jana Khalili also designed her own house in Jordan from earth as a way to find low cost environmental friendly houses, to be an example for other people to follow, as a way of finding other low cost materials instead of the natural stone (Fig. 3). At the same time this house is designed to resist earthquakes.

Other architects also assures these problems facing the building sector. But all of these personal or organizational efforts must be followed by intensive public efforts to achieve a group of guidelines for the future of the region.



Figure 3. Earthen house in Jordan by Jana Khalili
Source: Al-Jazeera net website

IV. CONCLUSIONS

To conclude, several challenges are facing the concept of near zero energy houses in the world not only Palestine or Jordan, and may some other challenges appear in the future. Several trials as mentioned in this paper are going to change the stone as a building material due to its high cost, and replace it by earth, but earth doesn't fit all the climatic regions, so it can be maintained to fit the different climates.

Accordingly, the first crucial need that had been highlighted here is thinking of the future of building materials in Palestine, due to that the natural stone is not a sustainable material, it will be depleted one day, beside the negative effects of cut-stone sites on the environment. Therefore, more passive design strategies and concepts can be involved within technical challenges aspect to enhance the house design situation. Also architects must utilize from different NZEBs solutions those can be found in the world countries with different contexts and different variables. Secondly, an important organizational aspect is related to the public awareness starting from architects and engineers until clients to insure the importance of the concept of NZEH and its environmental benefits to reduce CO₂ emission within the environment. Also by going back to the mentioned experiences in this paper, the person can find a huge gap of cost between stone constructed houses and earth constructed houses, the stone ones may cost around 240,000 Euros, while the earthen house cost less than 50,000 Euros according to the designers of those houses themselves. So, the public awareness must take into account the cost issues which

bring people's attention toward low cost designs of zero energy houses that are not easily optimized, and can be developed in some ways in the future [5].

Finally, those mentioned challenges are nearly common in other world countries but in different levels. Also the low cost houses are crucially needed in the developing countries more than other countries due to people's income levels.

V. RECOMMENDATIONS

A series of recommendations can be addressed here to be taken into consideration by architects in Palestine and other related contexts, these recommendations can be shorten by the following points:

- 1- Building materials or structures must be improved to have more thermal performance inside houses.
- 2- More effective methods can decrease nonrenewable energy consumption to near zero with the existing of renewable energy sources, have to be followed.
- 3- Architects have to reuse the traditional architectural elements in future designs to insure the identity and to benefit from the historical passive design solutions.
- 4- Patio house can be reactivated these days due to its enhancing of spatial harmonies and energy efficiency.
- 5- More scientific researches must be conducted in the future to study the future governmental plans for energy efficient house strategies and rules. In addition to the study of the development of sustainable energy policies and strategies to eliminate the barriers to net zero energy housing.
- 6- Playing efforts toward minimizing the cost and maintenance process of construction materials in an effective way, beside the involvement of technologies of active designs.

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