Interdisciplinary Publication
REPA PROCEEDING SERIES

Vol 3 (1): Pages 6-11 (2022)
DOI 10.37357/1068/CRGS2022.3.1.02
ISSN 2435-7308

Check for updates

International Conference on
Contest for Realization of Global Sustainability (CRGS 2022)
22-23 March 2022, Simon Fraser University (SFU), BC, Canada

A review of zero energy residential complex in the smart city environment

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Conference Proceeding
Open Access
Published

Keywords

- Zero energy
- Renewable energy
- Residential complexes
- Smart buildings
- Advanced cities
- Energy efficiency

ABSTRACT

According to the studies conducted by the Energy Consumption Management and Optimization Organization, in the common constructions of the country, energy loss in buildings is often 22% through windows, 22% from floors, and 30% from walls. Applying the principles of energy consumption optimization in coordination with climatic conditions and design uses, as well as the use of active and passive methods, can play an effective role in reducing energy consumption in conventional urban buildings. This research aims to provide solutions that address how to reduce energy consumption while creating quality in the architectural space. These solutions are obtained by recognizing the indicators of sustainable and comparative study with the climate of the desired design context. In the present study, the role of technology and digital tools in the field, which is the first and most important step in locating roles and functions, as well as small-scale designs such as building facades. Then, the architectural recommendations of the climate and international standards were examined, and a total of solutions were presented to reach the zero energy building (ZEB). Finally, the simulation method in Design Builder software analyzed the amount of energy consumption in the residential complex and using the analysis of the researchers' efforts and finding the best answer to the problems of architecture and urban planning; results show a significant reduction in energy consumption to be able to manage available resources in the best way.

Received: November 09, 2021; Revised: November 24, 2021; Accepted: Nov 27, 2021; Published: June 30, 2022 *© 2020 REPA. All rights reserved.*

1. Introduction

Compared to traditional buildings, intelligent complexes can significantly reduce energy consumption, maintenance, and service costs, as well as provide communication and security facilities. The possibility of additional design or redesign of Integrated and intelligent buildings put a new perspective on city managers to realize integrated scientific optimization [1]. The fact that buildings have known for a large share of the world's primary energy consumption. So, many researchers have enforced redefining buildings as zero-emission energy buildings. A zero-emission energy building is generally a building whose energy consumption is significantly reduced by using various methods to compensate for its initial energy consumption using renewable sources. Zero energy buildings are usually built to advance the knowledge of building design and construction in a country as a pilot. Despite the high cost of building a zero-energy building compared to conventional buildings, developing construction knowledge is the most important reason to develop the definition of such buildings [2]. Technological manifestation is common in other careers: it contradicts the housing concept. Buildings require many types of technologies that bring more benefits to residences and improve the quality of life. Therefore, based on the nature-oriented view, moving toward responsive technology can be proposed as a solution to problems born of technology [3]. This smartening is paying attention to technology in the housing design process; In this way, the technology is at the designer's service. Smart housing refers to "technology-based housing" that leads to improving the quality of life of its users; Thus, unlike past technologies that led to lifestyle changes and an impact on architecture, Intelligent technology adapts to lifestyle and serves

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architecture [4]. A smart city is defined as a city of "knowledge", "digital", "cyber", or "eco". Expresses a concept according to various interpretations, considering the goals of smart city planning. It may refer to the smart city as a structural and operational advancement in today's city using information and communication technology (ICT) as infrastructure. Recent results from these activities include a city that is on the way forward in the industry, people, government, mobility, environment, and life and is built on the intelligent combination of definite, independent, and conscious gifts and activities of citizens. Smart cities require careful planning, and in the early stages, city and national governments, citizens, and all stakeholders must agree on the definition of the smart city they aim to achieve [5]. A clear description or strategy should target two key factors: the desired "operation" and "goals" of the city, along with operations that are seemingly functional to the city and the goals of those operations for the benefits promised by the smart city model. Considering these operations as well as the goals of a smart city, perhaps as a "city that strategically uses many intelligent factors such as information and communication technology to impose growth and enhanced urban operations when the happiness and health of our city Guarantees increase [6]. Even though some areas of the world have great biodiversity and geography has provided a good platform for using renewable energy in electricity production; currently, the share of renewable energy in the country's energy basket is minimal and only in the production sector. Electricity, this type of energy is used to some extent. Currently, 5.30% of the total electricity generation capacity of the country is related to thermal power plants, 5.1% by nuclear power plants, 11% by hydropower units, 0.3% by new energy, and 7.3% by scale generating power plants. Small or scattered production. It is observed that the share of clean energy in the electricity production basket is also low [3].

Since more than 03% of the world's total energy consumption is used in residential buildings, improper design and use of these buildings and the incompatibility of materials used with the climate and conditions of the region can cause a lot of energy loss. Entrance to buildings. Failure to comply with the requirements of optimization in the walls and facilities of the building is a significant factor in increasing consumption, to which can be added reasons such as the inappropriate culture of consumption. Currently, the only mandatory law on energy consumption in buildings in the country is the requirements of the National Building Regulations. This issue has created limitations for the thermal resistance of the external walls of the building, but due to the lack of implementation of serious regulatory policies, a small share of the country's buildings, meet these requirements. Weaknesses in the design of architecture and building facilities are other reasons that increase energy consumption [7]. To achieve this goal, solutions such as insulation can be used, and in later stages, the use of renewable energy such as solar and wind energy can be considered as an effective solution. In European countries, which do not have much access to solar energy compared to countries such as African countries, the use of solar energy has been thoughtfully considered. Accordingly, the issue of zero-energy buildings has been raised worldwide [8].

Literature studied the design of a 123-unit residential complex in the 22nd district of Europe. Therefore, adopting strategies to save energy consumption of buildings can significantly reduce the human need for fossil fuels, which has positive consequences for human life in harmony with the environment. Therefore, this research has sought to identify solutions through which an environmentally friendly building can be designed to the extent that it can even provide the energy it needs, and authors in [9] examined the design of a residential complex with an energy efficiency optimization approach. They considered two goals in designing an environmentally friendly environment. First, familiarity with indigenous design methods and their study and application in design, and second, the use of renewable energy instead of fossil fuels for heating, cooling, ventilation, and lighting of the building. And new residential units were trying to design a residential complex. The tools for collecting information were library research and field research, and using Design builder software, the effect of factors that can affect the amount of energy consumption was calculated [10]. In 2017, Marino studied the ratio of windows to walls and significantly affected the energy consumption of buildings. They affect the heat exchange between the indoor and outdoor environments and may contribute to the proper utilization of solar energy. The analyses were performed using the Energy Plus program code and the window dimensions were examined according to the ratio between the glass surface and the large exterior area [11]. In 2017, Ettia et al. Explored the future challenges of near-zero buildings (NZEB) in southern Europe. This paper summarizes the findings of a pilot study of the social and technical barriers to NZEB implementation in seven southern European countries. This study analyzes the current situation and provides an overview of the future of the NZEB in southern Europe. Outline Overview Provides challenges and recommendations based on evidence Experiments are available to reduce barriers in the European construction sector further. This paper shows that most southern European countries are too weak to implement the NZEB, especially to the challenge/opportunity of rebuilding existing buildings [12].

Some studies conducted case studies of small massive buildings in China's cold block. This study aimed to develop a new global multi-purpose optimization scheme for zero-energy buildings (ZEB) by integrating the multi-purpose optimization technique with the comprehensive evaluation method. This study adopts two design optimization methods for renewable energy systems in buildings, including multi-objective optimization (using algorithm non-dominant pure genetics) is applied to the initial design in terms of cost and optimal energy schemes and then a combination of a multi-level comprehensive multi-purpose correlation evaluation method for optimal design including solar energy efficiency, economy, energy conservation, and social aspects. According to the selected decision based on the optimal global design, the "best" solution is presented, which can guide the practical engineering construction plan. Finally, a multi-objective plan is presented for a case study located in Tianjin, China. It has been proven in practice that this method is useful for effective scientific decision-making [13]. Energy efficiency, advanced controls, and renewable energy systems for constructing industrial, residential, and third-generation buildings designed for near-zero energy are examined to examine the performance gap. The analysis involves comparing dynamic and semi-dynamic energy models with data from intelligent monitoring systems, indoor and outdoor environmental measurements, power consumption, and generation data. Specific issues and results have been used to address the performance gap between predicting energy efficiency in the design phase and evaluating measurements in the operational phase [14].

2. Materials and methods

In terms of type, the present study is applied scientific research. A review of library resources and a descriptive analysis of the relationships of independent-dependent variables are discussed. This way, case studies of zero energy buildings and performance analyses of these buildings have been considered. The method of this research is that solutions to improve the thermal performance of the building and in line with renewable energy to achieve zero energy are presented. One of the best methods is to use energy modeling software. Because building energy consumption simulation software is an efficient tool that can consider all the complex interactions of the building with the outside environment and indoor systems, and therefore can be one of the most useful calculation techniques concerning energy saving in the building sector. There are various formulas and methods for calculating the thermal load of a building. One of the best ways is to use energy modeling software. This method can estimate the cooling and heating load to achieve sustainable housing by providing hourly weather data for each climate. Utilizes heating and cooling, enters cooling, and heating equipment installed to compensate for the loads imposed on the building in calculations related to estimating the energy consumption of the building [15].

3. Proposed technologies and requirements of the designing

3.1. Energy management

The first practical step in the initial design or conversion of a building into a ZEB is to use measures that reduce the need for energy consumption:

- Use of BEMS building energy management systems
- Using in Home, Home Control smart home systems
- Programmable systems and heating regulation - cooling building spaces based on the use of Zoning System and time of day and night and different seasons of the year**.**
- Systematic planning for using energy-consuming devices simultaneously (for example, the lack of synchronization of the washing machine with similar consumers) and during off-peak hours**.**

3.2. Domestic consumers

- Maximum use of energy-based appliances with Energy Star standard.
- Using the equipment of heating facilities - Cooling with Energy Star grouping.
- Use of LED and LVD lighting systems and as much as possible with low voltages of 12 and 22 volts.

- Optimal selection and use of sunlight in the building according to the geographical location and seasons.
- Use of continuous prevailing wind direction - seasonal Reuse of hot/cold air inside the building and energy recovery from this duct, exhaust ... Recuperation Concept.
- Use of daylight concepts.

4. Zero-energy building design

Zero-energy buildings are often supplied by solar energy. To design a zero energy building, other special factors in the architecture of the building are better considered.

In this paper, we consider a building energy system, which consists of the components such as renewable energy, energy storage systems (ESSs), and loads. This study has been simulated by Design-Builder software then the result has been demonstrated as the diagram [15].

4.1. Building orientation

The elongation of the building, as well as its orientation, has a great effect on obtaining the thermal energy of the sun as well as the use of natural light in the building. The building has an east-west slope so that most of the building spaces can use maximum solar heating as well as natural light. Depending on the geographical location of the building, using the Design-Builder simulation software, the building should be rotated at different angles to its axis to obtain the best orientation of the building to the sun to use maximum energy absorption. In locating the spaces of the building, try to place the spaces which make better use of solar light energy in the morning time, and the other spaces need to use evening time of irritation of sun [16].

4.2. Insulation design

The optimal amount of insulation for the building has been determined according to the building's initial cost and energy balance. Design of building canopies to reduce the heat load caused by the sun during the peak cooling load of the building, to be optimized according to the maximum passage of solar energy during the heating period of the building. In a way, the exchange of energy is done so that the outside space is in the smallest possible state, and therefore the whole building is considered as a separate part. For this purpose, the optimal standards of building insulation should be observed both in terms of applied materials and the manner of implementation. Also, use double-glazed windows with or without gas to prevent energy loss [16].

4.3. Energy production in the building

No energy produced from fossil fuels (gas, diesel, oil, fuel oil, coal, or even wood) produced solely as firewood is included in this category. For example, the energy produced by the fossil fuel generator, despite being generated in the building and separated from the grid outside the building, is considered as "building energy", which is a violation of the purpose, so in these buildings, zero energy from renewable energy is possible.

Solar energy: The use of solar energy is in the form of heat energy and solar energy photovoltaic (PV) system, which is obtained for the former by installing collectors and for the latter by installing solar panels.

Wind energy: Wind energy is generated on wind turbine blades. Installation of wind turbines with the horizontal axis and long blades in residential areas and even single-family villas is not very pleasant (because of noise and possible damage to residents.) Therefore, for these uses, it is better to design vertical axis turbines that have recently been designed. It has been highly regarded and used in European countries. Beautiful design, convenient dimensions, quietness, and ease of use and installation have been the key to success.

4.4. Building cooling

Proper insulation should prevent the loss of cooling created. The proposed method in this type of building is direct refrigeration. This means that the direct refrigeration cycle with the R-134 board, which is environmentally friendly, is responsible for transferring the cooling load directly. To supply air, for each kilocalorie per hour, it is necessary to consider 133 square centimeters of the opening valve to the open air. The air supply valve is necessary at intervals of 30 cm from the floor and roof [17].

4.5. Sanitary hot and cold water

In residential complexes with zero energy, solar water heaters can be used to provide hot water for consumption. Calculation and distribution of cold water used in the complex based on the type of consumer, including sink, dishwasher, washing machine, bathroom sink, toilets, etc. as well as the number of people in the building and taking into account the demand coefficient, the actual amount of consumption per unit are pure and the distribution network according to the actual amount of consumption and drop in pipes and fittings and according to water pressure standard In the highest consumer supply is provided, the method of calculating water consumption is the same, what is pure covers the water department up to 3 floors at the desired pressure and the need for a pumping station to the floors is necessary and certainly according to distribution conditions Use the reverse method [17].

5. Discussion

Figure 1 shows the amount of corresponding energy flows in the building; as shown, column 2 shows the amount of energy before zero energy design, and column 1 shows the amount of energy based on typical consumption in 12 months of years, for example, from August till December, we can conclude that there is small amount consumption of energy flow from buildings however the large amount consumption of energy flow in February till August, so Figure 1, demonstrate that the behavior of energy consumption in buildings by end-users could be very vital as well as the design of building could be essential for the construction of building to achieve zero energy buildings.

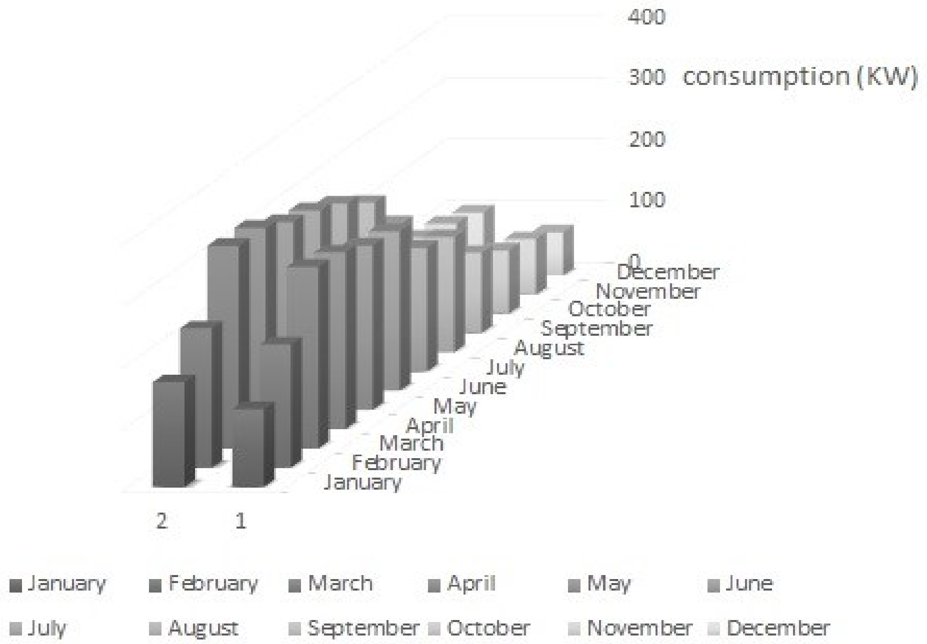

Figure 1. Amount of energy consumption after/before implementing zero energy consumption.

6. Conclusion

The growing trend of urbanization, increasing the phenomenon of migration to cities, policies adopted in the field of housing and restrictions in cities, led to the expansion of residential complexes and reduced open spaces, indoor lighting, and natural ventilation, as an opportunity to connect more with nature and It is a place for social interactions. Energy consumption in the building sector has the highest energy consumption in the world and our country is no exception to this rule and more than 10% of the country's energy is related to this sector. Zero energy buildings have different categories and definitions, the most important of which is the building. Without energy exchange with the grid, it provides all the energy needs, and the other, which includes economic issues, is a building whose annual energy exchange level with the grid is zero. To achieve a zero-energy building, it is necessary to first reduce the energy requirement of the building by using inactive systems and then reduce the energy consumption of the building to a minimum by choosing efficient mechanical and electrical equipment. Finally, using a variety of energy production systems using renewable energy to achieve the zero-energy approach, equivalent to the annual energy consumption of the building, produced energy on-site. According to the studies, it was found that climatic conditions, correct use of solar energy, identification and emphasis on static methods, and destructive environmental effects affect the design of residential complexes, and also using the zero-energy approach in buildings can reduce consumption. Have fossil fuels and their destructive environmental impact. According to these hypotheses, the research found that the application of zero energy method and energy optimization and green architectural model using global techniques and standards and their homogenization with the environmental conditions of design is possible in design of a residential complex.

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