International Journal of Innovative Research in Engineering & Management (IJIREM)
ISSN: 2350-0557, Volume-9, Issue-1, February 2022
https://doi.org/10.55524/ijirem.2022.9.1.12
Article ID IJIRD-1161, Pages 77-81
www.ijirem.org

Concept of Net Zero Energy Building in Kashmir

Shejar[1], and Dr Sandeep Singla[2]

[1]M. Tech Scholar, Department Civil Engineering, RIMT University Mandi Gobingarh , Punjab, India
[2] Professor & Head,, Department of Civil Engineering, RIMT University Mandi Gobingarh, Punjab, India

Correspondence should be addressed to Shejar; shejjj7rather@gmail.com

ABSTRACT - Global Buildings account for up to 40% of world energy consumption and 36% of carbon dioxide emissions. Consumption is anticipated to increase by up to 50% by the year 2030. The construction industry in India consumes 70% of all electricity generated in the country. According to studies, buildings utilize more than half of their energy for tenant comfort, such as cooling and lighting. Building energy consumption will continue to rise unless buildings can be built to create enough energy to meet the growing energy demand of these structures.

A zero-energy building has zero net energy consumption, which indicates that the entire quantity of energy required by the structure over the course of a year is equal to the amount of energy produced on or off the site. These structures produce fewer greenhouse gases and have a lower impact on the environment. This research aims to review some material on zero-energy buildings in India and recommend solutions for tenants to reduce their energy consumption.

A building with zero net energy usage is referred to as a zero-energy building (ZEB). In recent years, ZEBs have gotten a lot of attention in a lot of nations because they are seen as a key technique for achieving energy conservation and lowering greenhouse gas emissions. The concept of going to ZEB via law has sparked a lot of controversy in various nations about whether it is currently feasible. With special reference to Kashmir, the fundamental difficulties for establishing ZEB are examined from both an engineering and an architectural standpoint. Also being considered are the necessary arrangements that must be deployed in Net Zero Energy Buildings in the Kashmir division of the UT of Jammu & Kashmir, India, as well as other crucial issues.

KEYWORDS - Energy, Kashmir, Solar Heater, Solar PV, Trombe Wall, Zero Energy

I. INTRODUCTION

A) Background

The province of Jammu and Kashmir is located between 32° 17' N and 37° 06' N latitudes, and between 73° 26'E and 80° 30' E longitudes (Fig. 1). The semi-arctic cold desert of Ladakh, the chilly and gloomy Kashmir valley, and the sub-tropical region of Jammu are the three distinct climatic regions of the province. Within the province's four degrees of latitude, the altitude rises sharply from 1000 feet to 28250 feet above mean sea level. Kashmir's valley is endowed with renewable natural resources such as plentiful sunshine, rivers, evergreen woods, snow-covered peaks, and so on, distinguishing it from the rest of India.

The region's average daily solar radiation is 5-7 kWh/m^2/day, with roughly 250-300 clear sunny days per year (Mani and Rangarajan, 1982). Jammu and Kashmir province has a total area of 222236 km2, of which Jammu, Srinagar, and Ladakh respectively occupy 19, 11 and 70%. (GJK, 2005). The topography of the three regions is distinct. The Jammu province is located between the outer hills that border the Kashmir valley in the north and the hilly tract that extends to the Punjab plains. It has a total area of 26293 km^2. Jammu has a subtropical climate, which means it is hot and dry in the summer and warm in the winter.

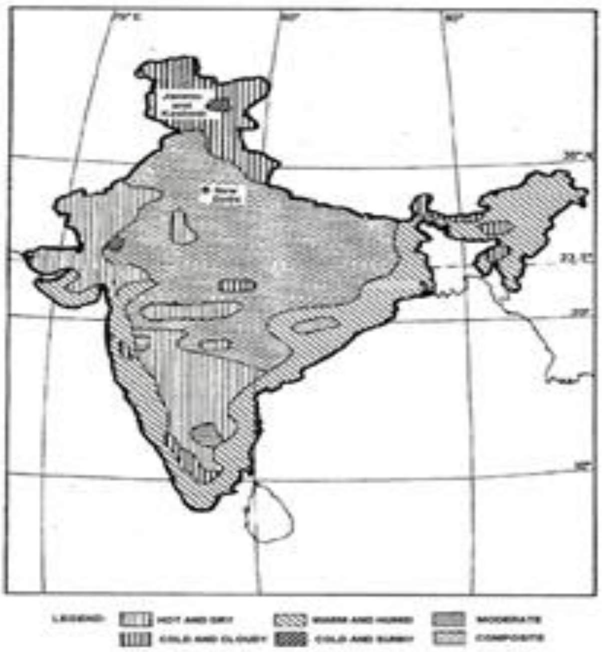
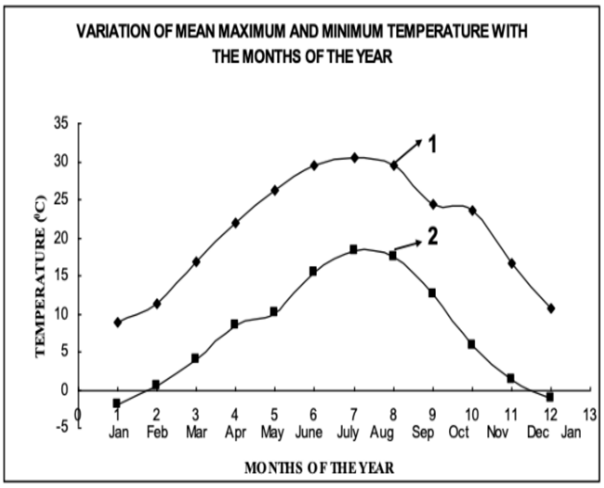


Figure 1: Climatic zones of India and Site location of Jammu and Kashmir

The weather in Kashmir is strongly influenced by the seasons. In the valley, the locals have their own seasonal classification. The classification is based on people's firsthand knowledge of meteorological conditions at different times of the year.

The terminology is technically correct and accurate, dividing the year into six seasons, each lasting two months (Fig. 2).

- Wandah (Winter) 15th November to 15th January
- Sheshur (Severe cold) 15th January to 15th March
- Sonth (Spring) 15th March to 15th May
- Gresham (Summer) 15th May to 15th July
- Wahrat (Rainy season) 15th July to 15th September
- Harud (Autumn) 15th September to 15th November



(Source: India Meteorology Department, Rambagh, Srinagar)

Figure 2: Variation of mean maximum and mean minimum temperature with months of the year for Srinagar

B) Need for ZEBs in Kashmir:

Various household chores in Kashmir valley need a significant amount of energy. Space heating, water heating, cooking, and lighting are the most energy-intensive end-uses in the valley's home sector. All of these end-uses are currently met by commercial and non-commercial energy sources such as fuel wood, kerosene, LPG, electricity, crop residues, dried leaves, and so on. The valley runs out of electricity during the winter months (peak energy demand months), forcing residents to rely heavily on non-commercial energy sources. Second, because the province is hilly and mountainous, it is impossible to completely electrify a large number of villages by simply extending the traditional grid-connected power supply. As a result, non-commercial energy sources such as fuel wood and unprocessed biomass are used to meet energy demand in remote places.

Because the valley's winter season is long and harsh, a large amount of energy is required for space and water heating due to variation of mean maximum and minimum temperature [3]. This section aims to give survey-based results on energy consumption patterns for the valley's primary end-uses. A questionnaire was created to collect responses in order to conduct the survey. A total of 120 households in rural and urban areas were interviewed about their energy consumption and buying patterns, as well as energy source usage for various end-uses and reasons for use. In both rural and urban areas, the poll included households with various income levels.

II. LITERATURE REVIEW

Zuha Maksood et al. [1] presented the effectiveness of smart city implementation in by examining the energy consumption sector through data mining. K - Means clustering technique was used to group residential and industrial energy consumption data into four and three clusters respectively. Energy usages of these clusters were then forecasted using 80% of the total data. Visualization determined that the trend of energy consumption in residential areas stay uniform during summer and decreases towards the end of the year (winters), while in industries, the energy consumption stayed uniform.

Kamal MA [2] analysed various passive cooling techniques and their role in providing thermal comfort and its significance in energy conservation.

H.A. Bhat et al [3] presents the analysis and results of a pilot survey regarding energy consumption patterns for major end-uses in the residential sector of the Kashmir valley in the Indian province of Jammu and Kashmir. The major energy consuming end-uses are space heating, water heating, cooking and lighting. Space heating was found to be the major energy consuming end-use in the residential sector of the valley.

International Energy Agency (IEA) report written by Jens Laustsen in 2008[4], the issue of different interpretation the ZEB definition is further discussed. Laustsen, (2008) gives the general definition for ZEB: “Zero Energy Buildings do not use fossil fuels but only get all their required energy from solar energy and other renewable energy sources”. However, at the same time he emphasizes its weak points by stating: “Compared to the passive house standards there is no exact definition for the way to construct or obtain a zero energy building. In principle this can be a traditional building, which is supplied with very large solar collector and solar photo voltage systems. If these systems deliver more energy over a year than the use in the building it is a zero net energy building”.

He Zhang et al. [5] presents an energy management strategy for a commercial building in supermarket application. Some objectives were established like load shedding, reducing the electricity bill and the CO2 emissions of commercial building, using photovoltaic (PV) and storage systems. They focussed on supervision strategy with the help of fuzzy logic and a graphical methodology to build it. It was shown, with the help of simulations and some economic and ecological indicators that the energy bill cost and the CO2 emissions can be reduced by using the proposed solution.

Natasha Djuric et al. [6] identified driving variables of energy use in a low energy office building by integrating building energy management system (BEMS) and energy use data. Multivariable analysis was used for the data analysis which included occupancy level, control signals, and water and air temperatures.

Esbensen, et al. (1977) [7] describe an experimental ZEB house in Denmark and point out: “With energy conservation arrangements, such as high-insulated constructions, heat-recovery equipment’s and a solar heating system, the Zero Energy House is dimensioned to be self-sufficient in space heating and hot-water supply during normal climatic conditions in Denmark. Energy supply for the electrical installations in the house is taken from the municipal mains [7]”.

Parker et al. (2001) [8] "During times of peak demand, a Zero Energy Home generates more electricity than it consumes, decreasing power demand on the utility supplier”. During power outages, the residence creates its own energy, allowing the homeowner to continue living.
A review of the definitions of essential energy security used by Zero Energy Buildings (ZEB). A prototype Zero Energy Home outperforms a standard model in Florida research by generating nearly all of its own power demands throughout the year.

III. OPTIMIZATION METHODOLOGY

The Kashmir valley features different domestic energy demanding end-uses due to its frigid climate. Space heating, water heating, cooking, and lighting are the most common energy end-uses. To fulfil the key energy end-uses, the residential sector presents a significant potential for the exploitation of renewable energy sources, such as solar energy. The fundamentals of various solar passive design strategies and their classification are highlighted in this chapter. Thermal comfort is a subjective concept that has been covered in this chapter using many definitions. Unlike traditional sensible thermal storage technologies, phase change materials (PCMs) have substantially higher energy storage densities and store and release heat at nearly constant temperatures.

A. Thermal Comfort

Thermal comfort can be characterized in three ways: psychological, thermo physiological, and based on the human body's heat balance (Peter Hoppe, 2002). In other terms, the psychological definition of thermal comfort is "the range of climatic conditions within which the majority of people would not feel discomfort from either heat or cold." In still air, this zone corresponds to a temperature range of 20 to 30 °C dry bulb temperature and 30 to 60% relative humidity. The thermal comfort conditions are also influenced by environmental factors such as wind speed, vapor pressure, and radiation. The bio-climatic chart (a basic tool for analyzing the climate of a specific location) has been developed as a graphical approach as shown in Fig 3.

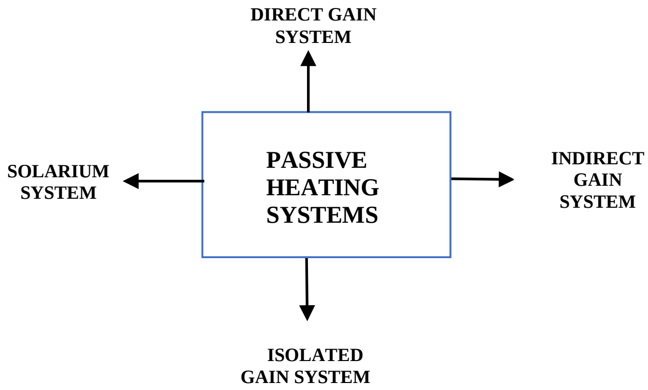


Figure 3: Bio Climatic Chart

B. Direct heating

In direct gain systems, sunlight is admitted through a window or a glass wall facing south, allowing maximal solar radiation to warm the walls, floors, objects, and air inside the living space in the winter. The space becomes a live-in solar collector in this method.

C. Indirect heating

The solar energy is intercepted right behind the glazing by the thermal storage wall in this indirect gain method. The thermal storage wall absorbs energy, which is turned into heat and subsequently delivered to the living space. In the case of home heating, the indirect heating method is chosen. It has the advantage of a more uniform room air temperature over the direct gain approach. A Trombe wall (Trombe, 1974), a water wall, and other materials are utilized as thermal mass for storing thermal energy (Maloney and Habib, 1979).

D. Trombe Wall

The Trombe wall system is an indirect gain passive system with openings at the top and bottom of the wall to allow natural convection to heat the air. The southern-facing wall is painted black to store heat along with the glass. The Trombe Wall System was used to create the Navodaya Vidyalaya in Kargil, Jammu and Kashmir, by CBRI (Central Building Research Institute) of Roorkee (Mittal, 2004).

E. Building Envelope Design:

In the valley, effective building envelope design can be an important aspect of energy efficient house design. Almost all of the valley's structures feature steeply slanted galvanized iron sheet roofing with a timber or RCC false ceiling for quick drainage of rains and snow. The valley's traditional structures had huge low-pitched mud roofs. RCC ceilings have been frequently employed throughout the valley for the past few decades. This style of ceiling is said to be incompatible with the valley's climatic conditions.

F. Orientation and building form

Buildings in the valley should be compact, with low surface area/volume ratios, due to the valley's chilly and gloomy climate (Nayak et al., 1999). This is because the

lower the surface area of the building, the less heat it loses. To encourage direct gain, windows should ideally face south, and the north side should be adequately insulated. Living rooms should be confined to the south, while utility facilities should be kept to the north.
Stores can be kept on the north side with a low human population density. Heat from appliances in rooms like kitchens can be recycled to heat other portions of the building.

G. Daylighting

In the Kashmir region, an abundance of daylighting is beneficial to offset the demand for artificial lighting during the day, especially during the winter. Because the summers in the valley are so lovely, windows must have minimal shade.

H. Solar Water Heater

In Kashmir valley, hot water is used almost throughout the year. In the energy efficient dwelling considered in the present study, the conventional water heating systems are supplemented by solar energy. The main components of a solar water heating system (SWHS) are collectors, storage tanks, piping, insulation, controllers and pump (if required). Two types of SWHS are passive type SWHS and active type SWHS.

I. Solar Photovoltaic lighting system

In the conventional dwellings of the valley, the major source of energy for lighting purposes is
electricity. In the proposed energy efficient dwelling, the lighting requirements are met through an SPV lighting system. These lighting systems can appear to be a promising option for providing good quality illumination in individual households. Two types of SPV lighting systems are being disseminated in India (i) domestic lighting system consisting of two or more fixed light points, an SPV module, appropriate controls and a storage battery and (ii) a small integrated portable system with one lamp popularly known as SPV lantern (Bhargava, 1994).

IV. RESULTS AND CONCLUSION

After comparing the energy consumptions of two buildings; one being conventional and other being the net zero energy building, it was estimated thoroughly that the energy consumption as well as the money spent by Conventional building was way more than the Net zero energy building.
Following is the study that was done to estimate future value cost of zero energy & a conventional building and is quite evident from the study that the total cost required for a ZEB for 20 years including its construction cost, operation cost, maintenance cost and replacement cost is much less than a Conventional Building (Fig. 4). Hence ZEB is much efficient than a conventional building.

Conventional Building

Initial Cost

Construction cost for building = Rs. 2356320/-
Cost for Home Appliances = Rs. 203320/-
Cost for Natural Gas arrangements = Rs. 3000/-
Total Initial Cost for Conventional Building = Rs. 2562640/-

Future Value of Energy Cost, Cost for operation, maintenance and replacement cost for home appliance and Maintenance cost for building for 20 years

Water Charge = Rs. 1830/-
Current Charge = Rs. 2267270/-
Fuel Cost = Rs. 546020/-
Total Future Value of Energy Cost for 20 years = Rs. 2815120/-
The future cost for home appliances including their operation, maintenance and replacement cost = Rs. 131022/-
The future cost of building maintenance for 20 years = Rs. 1020000/-
Total Future Value of Conventional Building = Rs. 6528782/-

Zero Energy Building

Initial Cost

Construction cost for building = Rs. 2970789/-
Cost for Home Appliances = Rs. 161912/-
Cost for Biogas Gas arrangements = Rs. 3000/-
Total Initial Cost for Zero Energy Building = Rs. 3135701/-

Future Value of Energy Cost, Cost for operation, maintenance and replacement cost for home appliance and Maintenance cost for building for 20 years

Water Charge = Rs. 1830/-
Fuel Cost = Rs. 31900/-
Total Future Value of Energy Cost for 20 years = Rs. 33730/-
The future cost for home appliances including their operation, maintenance, and replacement = Rs. 1214282/-
The future cost of building maintenance for 20 years = Rs. 612000/-
Total Future Value of Zero Energy Building = Rs. 4995713/-

Figure 4. Future value cost of ZEB vs a Convention Building

According to the findings, ZEB's performance improved as a result of natural renewable resources, high-efficiency home appliances, and improved building envelope insulation. When compared to typical structures, the proposed ZEB can save roughly 30% on electric energy (Fig. 5) (Fig. 6).

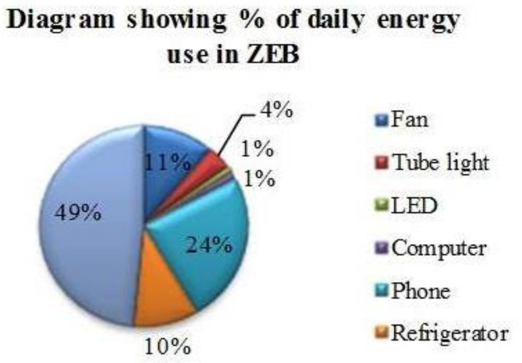


Figure 5: Percentage of daily energy use in existing building

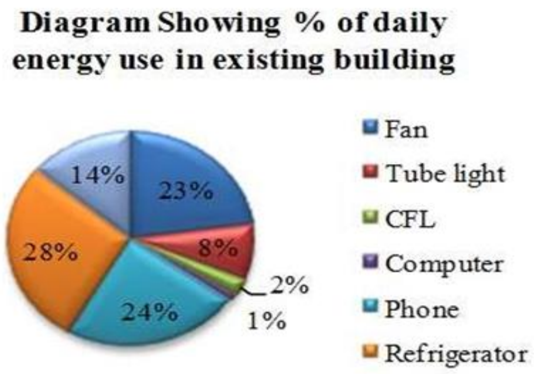


Figure 6: Percentage of daily energy use in ZEB

The overall expenditure needed for a ZEB for 20 years is substantially less than that of a normal structure, as shown by the LCCA of both buildings. The ZEB has a four-year payback period, while the standard building has a three-year payback term. However, when it comes to overall maintenance costs and environmental impact, the ZEB outperforms the conventional building. As a result, this research shows that ZEB technology can successfully adapt to all construction sectors in order to ensure long-term sustainability.

The present study is a modest attempt towards the understanding of Residential Space heating and daylighting in Kashmir valley. The following inferences may be drawn from the study.

a) In the valley, a substantial amount of primary energy is required for space heating end-use. In rural families, the average energy usage for space heating is 16 GJ per year, while in urban families, it is 14 GJ per year. As a result, any energy efficiency effort must prioritize domestic space heating.
b) For the months of January and July, the energy consumption for important end-uses has been presented (typical winter and summer months respectively). For the month of January, overall energy usage is 11.5 GJ, with 82 percent of that going to space heating.
c) The two locations in Kashmir included in the study (Srinagar and Pahalgam) had heating degree days for all months except July and August. The heating degree days in Jammu are minimal, and space heating is only required for three months (November-January). Cooling is required in the Jammu region, whereas heating is required in Srinagar and Pahalgam. A typical construction in the valley (floor area 100 m2) loses a huge amount of heat (602.7 W/^{o}C). The heat loss can be attributable to poor building materials choices and a lack of weatherproofing.
d) The Kangri is the most cost-effective alternative, with an annual cost of Rs 7536 per family and a cost per hour of heating of Rs 4.18, according to a financial analysis of the valley's most common space heating systems. Electric heaters (two utilised in the living area due to the fixed nature of electricians) are the most expensive alternative, with an annual cost of Rs 22,091 per household and a cost per hour of heating of Rs 12.27. The use of these heaters will decrease as the nature of electric tariffs changes. Sun energy appears to be a very promising choice for space heating in the valley's residential buildings due to the ample availability of solar radiation.
e) The following attempts need to be made for the solar energy applications in the dwellings of the valley.

- The meteorological parameters like maximum and minimum ambient temperature, sunshine duration (in hours), relative humidity, incident solar radiation on horizontal plane etc. should be collected at various sites of the valley.
- With the availability of solar radiation and other relevant data, a solar house should be built for experimental purposes. Both active and passive techniques should be incorporated into the house. Such a house is called a hybrid solar house.

REFERENCES

[1] Zuha Maksood F, Achuthan G. Sustainability in Oman: Energy Consumption Forecasting using R. India n J Sci Technol. 2017;10(10):1–14. https://doi.org/10.17485/ijst/2017/v10i10/97008.

[2] Kamal MA. An Overview of Passive Cooling Techniques in Buildings: Design Concepts and Architectural Interventions. Acta Tech Napocensis: Civil Eng Archit 2012;55(1).

[3] H.A. Bhat and Seemin Rubab (2009) A study of domestic energy usage patterns in Kashmir valley: A pilot survey of households, International Journal of Ambient Energy, 30(3) ISSN:21628246, DOI:10.1080/01430750.2009.9675798, Scopus, IF: 2.33

[4] IEA, UNDP. Modernising Building Energy Codes to Secure our Global Energy Future: Policy Pathway. 2013;70. Available from: www.iea.org [Accessed 10th March 2017]

[5] He Zhang et al., “Fuzzy logic based energy management strategy for commercial buildings integrating photovoltaic and storage systems”, Energy and Buildings 54 (2012) 196–206

[6] Natasha Djuric et al., “Identifying important variables of energy use in a low energy office building by using multivariate analysis”, Energy and Buildings 45 (2012) 91–98

[7] Esbensen, et al. (1977), “Zero Energy Building (ZEB) definitions – A literature review”

[8] Parker et al. (2001), “On the path to Zero Energy Homes”