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# Energy Efficient Buildings in India: Key Area and Challenges

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**Abstract.** A common dilemma for developing countries is to balance economic growth and environmental protection. Since the major issue in designing the building is energy conservation. The costing of building project is another issue in applying the principle of energy. A building uses a huge amount of energy during its lifetime. It is greater than the energy consumed in construction. There are numerous causes why building will use more energy during its life. Taking into account the building materials used in the built environment as well as the overall energy use should be taken into account when looking for ways to minimize energy consumption. In light of climate change, by 2030, India has to reduce the greenhouse gas emissions to 35%. Thus, the aim of this research is to find out the measures that can reduce the energy consumption of building not only at the time of construction but also lifetime. The study suggests various energy efficient measures for construction of building and for further functioning. In this paper the concept of green building was discussed to make a building energy efficient. Green building focuses on the reduction of carbon emissions and conservation of energy using a progressive difference-in-differences method. The study suggests the various energy saving concepts. Further, there are many green building rating systems to rate the building on various dimension to measure whether a building is environmental-friendly or not. In the end of the paper various issues involved in energy efficient building's construction are discussed.

**Keywords.** Energy efficiency; green buildings; green building rating system; challenges

## 1. Introduction

Climate change is a major concern for all in the world. It is taking place because of the greenhouse gas emissions from natural activities and human [1]. In recent years, improved living standards, rapid urbanization and continued industrialization have boosted energy consumption. Energy is required to perform all human activity and it is a driving force. The major source of energy is fossil fuels. Energy production relies primarily on traditional energy sources, which are the main causes of environmental pollution. For improving the building's environmental performance, building should be energy efficient. Thus, the consideration of all measures which can make energy efficient building are important. Buildings are large energy consumers throughout their life cycle. Civilized society is based on the buildings and it is an integral part. Buildings account for one-sixth of the world's freshwater extraction, one-quarter of logged timber, and two-fifths of energy flow and material [2]. Building construction is an energy-intensive process that consumes energy at every stage of the entire life cycle, from site clearance to operation and maintenance. This article is the political and social management of the construction of energy efficient buildings. Buildings account for about 40% of land energy consumption. In India, over the last three decades, the construction sector has consumed more energy than any other sector [3]. In the OECD region, the energy consumption in the building sector is very high at 25% to 40 % which is more than other sectors and the consumption of total energy is increasing [4].

India aims to reduce GDP emission strength by 33-35% by 2030 [5]. To achieve this goal, the building's energy efficiency needs to be improved, as all sectors, especially the building sector, consume more than 30% of India's total electricity [6]. Improving the energy efficiency of a building will reduce energy



demand, conserve limited natural resources and control the emission of toxic gases like: CO<sub>2</sub> emissions. This will improve the overall environmental performance of the building. Building construction involves a variety of activities. Planning, planning, execution, operation, and maintenance. Every stage of building construction consumes energy in some way. Energy sources used in building development include coal. It is used to produce building materials, oil and fuel for transportation and operational equipment, and power to power equipment. Many initiatives have taken by India to deal with the issue of climate change. The National Action Plan on Climate Change in India established eight national missions to protect the environment. These are the National Mission for Strategic Knowledge of Climate Change, National Mission for Sustainable Agriculture, National Mission for Ecosystem Conservation, the National Water Mission, and the Himalayan, the National Mission for Improving Energy Efficiency, Green India, National Solar Mission. These missions are operated under the regulatory and voluntary mechanisms and covers a wide range of problems, including forest management, agricultural environmental sustainability, knowledge generation, and demand-side energy management for sustainability.

## 2. Objectives and scope of the study

The main aim of the paper is to find out the measures that can reduce the energy consumption of building not only at the time of construction but also lifetime. This paper discusses green building concepts, green building rating systems, energy conservation measures and implementation and issues in construction of energy efficient buildings.

## 3. The energy consumption in residential buildings

The total energy consumed by residential building sector is less than 25 percent of the total electricity. In terms electricity consumption, building sector is the third largest consumer. 26 percent consumption has increased in between 2014 to 2017 [7]. Energy consumption has increased due to the population growth, urbanization and it created a large gap between the high demand and limited supply of the electricity. The demand of electricity is increasing mainly due to the change in living standards and high reliance on the affordability of the thermal comfort. The ultimate population of India is increasing and it is projected as by 2060, the population of India will be 1.72 billion. Urban expansion and urbanization are increasing rapidly. It is expected that two third population of India will live in urban area by 2050. The population of urban areas will rise 33% of the total population to 50% by 2050. In next twenty years, more than 70 million new urban units of houses will be added. It is estimated that two thirds of the built-up area will be constructed in next two decades [8].

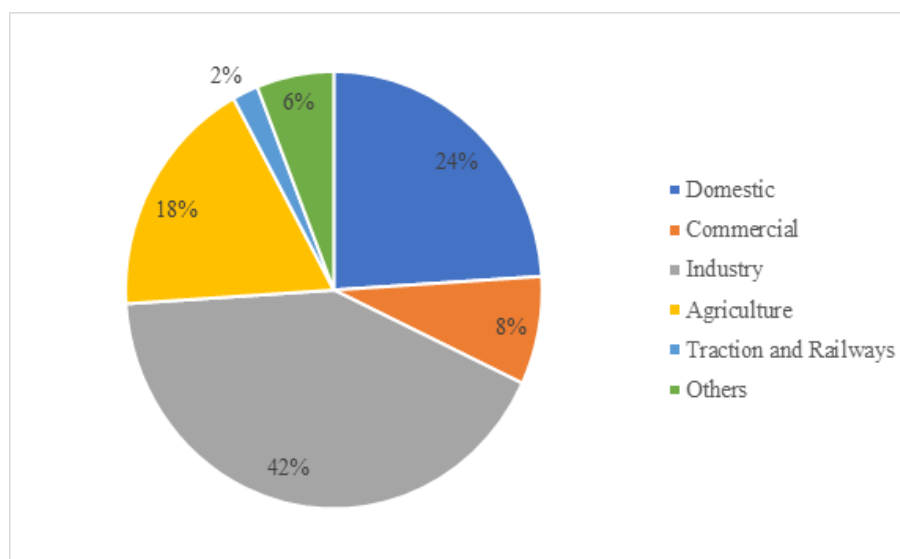


Figure.1 Electricity Consumption by sectors during 2018-19 [9]

#### 4. Energy Efficient Buildings

In order to make buildings more energy efficient building many technological solutions are available. The concept of green building comprises many elements like: occupant's health and safety, Design efficiency, Energy efficiency, sustainable site sustainable selection, Materials efficiency and Water efficiency. A building that assures the healthiest environment during its lifetime is known as green building or an energy efficient building. These buildings represent optimally utilize the water land and energy resources [10].

Green building design utilise the natural resource and conditions of the predeveloped site. Buildings may even become energy producers and can become energy efficient when it uses a properly sized and energy efficient heating/cooling system in a building, use minimum glass on east and west exposures, use solar energy for lighting and for water heating [11], use minimum light colour for roofing and wall finishing materials. Maximize light colours for wall finishing materials and roofing, maximum use of natural lighting and air etc. [10]

There are various benefits from the good environmental quality building that it can reduce the risk of asthmatic diseases and respiratory diseases. Good building design reduces the toxic gases emissions and improve the indoor air quality because the emission of these gases can have negative impact on health and on indoor air quality.

#### 5. Various Energy Saving Concepts

*Orientation:* it is very important to decide the orientation of building in right direction because right orientation can increase the rate of day lighting and solar gain. South-facing windows in the Northern Hemisphere are the most exposed to the sunlight. On the other side, windows should be carefully designed in the west [12].

*Site Selection:* decision of selecting the site is very important and depends on the price. A bad decision can reduce various sustainable features. The main difference between the traditional and high-performance building are in terms of their locations [13].

*Roof and Wall-* the construction of wall and roof can decrease conducive warmth.

*Energy Efficient Appliances-* according to the BEE star rating. Extra performance is required for star rating. Use of energy efficient appliances enhances the energy conservation.

*Ventilation, Heating and Air-Conditioning-* Reducing the warmth load of the shape permits for the setup of a smaller heating and cooling gadget. The significance of amazing air flow structures is frequently disregarded at some point of the layout phase, however is a essential attention in inexperienced constructing.

*Waste reduction-* reduction of waste or proper treatment of waste creates a healthier environment. Proper disposal of cloth can reduce the quantity of cloths going into landfills. Degradable waste should be treated properly and it can be used to make compost.

#### 6. Green Building Rating System

In order to sell the idea of strength green constructing idea, inexperienced constructing score gadget changed into advanced for construction sector. There are various rating systems are governed to rate the green buildings [14]. Green Rating for Integrated Habitat Assessment (GRIHA), TERI (The Energy and Resources Institute). This is mainly used for rating the building on various dimensions like water conservation, energy efficiency, use of renewable resources etc. It rates the building on the basis of building's overall environmental performance on 0-104 scale. SVAGRIHA (Small Versatile Affordable GRIHA) is used for small buildings construction. For Indian construction sector, GRIHA and SWAGRIHA are new constructing score gadget. On the premise of range of factors scored, a constructing may be rated among 1 to 5 stars. GRIHA changed into advanced through TERI and has now been followed through the Ministry of New and Renewable Energy (MNRE) because the National Rating System for inexperienced homes in India and to sell inexperienced homes in India and to supervise the diverse sports related to it, MNRE and TERI at the same time hooked up an independently Registered society referred to as ADARSH (Association for Development and Research of Sustainable

Habitats). ADARSH features as a platform for interplay among diverse stakeholders in addition to promotes GRIHA, SVAGRIHA and different comparable inexperienced constructing score structures in India while SVAGRIHA is a newly developed program specially designed for projects which are not more than 2500sq.mt i.e., homes with constructed up vicinity not more than 2500sq.mt [15].

### **7. Issues in creation of Energy Efficient Buildings**

The primary issue with the construction of energy efficient buildings is non-implementation of the government policies. As an attempt of governance, it ought to be acted upon. There should be a proper implementation of the government policies. In sum, three sets of features are identified that inhibit such translation.

The demand of residential buildings is always high but it is not high in case of energy efficient buildings. The construction of energy efficient buildings is criticized by the cost concerns and short-termism. There is a problem of the balance in opinions of builders and users. Builders want reduce the cost of construction and user wants environmental efficient buildings.

In fact, this has led to concerns about energy costs and a focus on energy investment savings rather than energy. In addition, the cautious government has opted for general and indirect public regulatory activities. Rather than engaging in effective direct regulation, such as passing strict building codes and using the strong position of public institutions as building owners to drive improvement and act as a role model. It is clear that they favour ineffective tools such as financial incentives.

### **8. Conclusions**

On the basis of literature review, the following important points have been drawn. Across the world numerous studies are conducted on the policies, rating systems and the ways to reduce the energy consumption in the buildings. Two groups are created on the basis of different mitigations around the world. First, regulatory viz. legislation supporting environmental protection, taxes, bans, controls on emissions, Subsidies and standards related to the equipment effectiveness, and second, voluntary. The second mitigation is the more effective and important.

Several rating systems are available worldwide. Mostly the focus of all rating systems are on the energy performance of a building, but none have a clear purpose for the environmental performance of a building. Since, the environmental performance of building and energy efficiency of building are interrelated, carbon emissions should be carefully considered when assessing the buildings.

Simulation and lifecycle analysis have proven to be very effective in making decisions among the various options available. The important thing which should be considered when designing an Energy efficient building is passive solar architecture. There should be more renewable sources of energy. Thus, the design of building should be to minimize the consumption of electricity and reduce the emission of toxic gases like carbon. This is the main objective of energy efficient buildings.

Environmental performance of a building can be improved by improving the energy efficiency of a building. There are two forms in which energy in Building is present: Operational energy and Embodied energy. By improving the efficiency and technology of the device, it is possible to reduce large operating energy. Low-energy materials made from solid waste are more advantageous because they save scarce natural resources and helps in reducing environmental pollution. For better results, we need to focus on cement, steel and brick, which have a high mass fraction of building materials.

A system approach is a possible measure to improve energy efficiency which ultimately improves the environmental performance. Therefore, building development's overall parameters need to be interrelated, and the building should be designed to minimize its environmental impact with optimal energy consumption and minimal cost.

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