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Technological development and Prospect of Sustainable buildings

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ABSTRACT

The building sector has a significant influence over the total natural resource consumption and on the emissions released. More than half of the world's population lives in cities; in 2050 the people living in urban areas are expected to increase up to 70%. Cities are the major reasons of pollution; it produces 60% of carbon dioxide and greenhouse gas emissions, through using energy generations, industry, vehicles, and biomass use. Consideration to sustainability principles in building industry is vital for natural environment and human being. Buildings consume a vast amount of energy during the life cycle stages of construction, use and demolition. Green or sustainable building design and construction are increasingly recognised as a clear answer to health, economic and environmental challenge, a large and growing number of government and private entities are requiring sustainable practices in their projects by incorporating green features into structures they are conceiving , designing, specifying, estimating, constructing planning or maintaining.
There are a number of motives to building green, including environmental, economic, and social benefits.

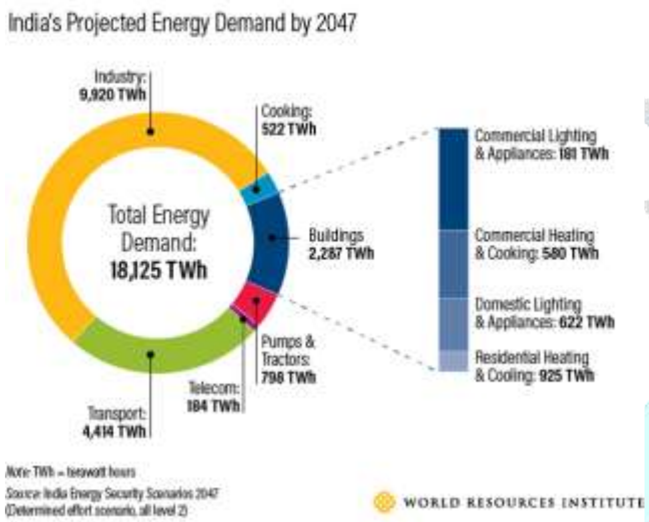
Keywords:
Sustainable building, green building, GHG emissions

Introduction

Natural resources are currently being consumed at twice the rate they are produced. By 2050, this could be three times. Green and sustainable construction is a significant issue because buildings impact the global environment. According to the World Business Council for Sustainable Development buildings account for 40% of global energy use (Tathagat & Dod, n.d.).Buildings play an important role in consumption of energy all over the world.(Akadiri et al., 2012) . A large number of tools for assessing environmental impacts are available . Examples include Environmental Impact Assessment (EIA), System of Economic and Environmental Accounting (SEEA), Environmental Auditing, Life-Cycle Assessment (LCA) and Material Flow Analysis (MFA)(Finnveden & Moberg, 2005).The building sector has a significant influence over the total natural resource consumption and on the emissions released. A building uses energy throughout its life i.e. from its construction to its demolition. The demand for energy in buildings in their life cycle is both direct and indirect. Direct energy is used for construction, operation, renovation, and demolition in a building; whereas indirect energy is consumed by a building for the production of material used in its construction and technical installations. CO2 is emitted throughout the lifespan of buildings from construction through to operation, and eventually, demolition.

In general, buildings contribute approximately 30% to total global GHG emissions (UNEP, 2009). In efforts to reduce global warming, GHG reductions in this area would make a significant contribution (UNEP, 2009). According to the Intergovernmental Panel on Climate Change (IPCC), there are three areas to focus on in reducing emissions from buildings: reducing energy consumption and building embodied energy, switching to renewable energy, and controlling non CO_2 emissions (Levine and Urge-Vorsatz, 2007). Along with GHG emissions, energy consumption is often used to measure the environmental performance of buildings. Recent studies have highlighted the importance of both embodied energy and operational energy use attributable to buildings over their lifetime .(Müller & Sturm, 2001). Embodied energy is the energy consumed by processes associated with the total production of a building, from the acquisition of natural resources from processes including mining and manufacturing, through transport and other functions, and finally, the operational energy, involving the energy utilised by the building's operations and use (air conditioning, heating and lighting, office and kitchen equipment).

Population of China, India and Brazil is growing at an unprecedented level and with this their need for food, housing and energy has increased manifold. In line with this growing urbanization and population, India's building sector is expected to grow five-fold from 2005 to 2050 as two-thirds (about 70%) of the commercial and high-rise residential structures that will exist in 2030 are yet to be built. The construction industry has focused on operational and embodied energy of buildings as a way of becoming more sustainable, however, with more emphasis on the former(Röck et al., 2018). The carbon emissions associated with the built environment represent the dominant fraction of the total carbon footprint of society. This is an important aspect that has often been overlooked when calculating a building's carbon footprint; and its inclusion this approach presents a more holistic life cycle assessment. The solution to the energy efficient or reducing carbon footprints of a building lies in the green building concept. A green building is one which uses less water, optimizes energy efficiency, conserves natural resources, generates less waste and provides healthier spaces for occupants, as compared to a conventional building."



The energy consumption in Indian buildings is expected to rise due economic and human development. The demand for life style equipment like air-conditioners, heaters, refrigerators and TVs will rise due to improvement in standard of living. This rising energy demand can be reduced through energy efficient building strategies. The need for lighting, air-conditioning, heating and ventilation needs to be optimized to reduce the load on energy production and to facilitate an inclusive growth both economically and environmentally.(Kaja, 2015)

Method

Since the early 1990s, an increasing number of methods have been suggested to evaluate the environmental impacts of buildings. The rising cost of energy and growing environmental concerns have pushed the demand for sustainable building facilities with minimal environmental impact using environmental sensitive design and construction practices (Shrivastava & Chini, 2012).Life Cycle Assessment (LCA) is nowadays the dominant assessment method for the embodied impacts that measure the emissions, usage of natural resources, and effect on health that can be related to different products or services over their complete life cycle.(Cabeza et al., 2014) The modern buildings fulfil the requirements of artificial comforts, but in turn consume excess energy and other natural resources. On the contrary, Green Buildings combine various eco-friendly concepts thereby increasing the working efficiency, providing the luxuries with the reduction in costs. It quantifies the interactions with the surroundings, whether they are inputs to the system—such as natural resources, land, and energy—or as an output of the considered system—for example emissions to air, water, and soil.

LCA methods can be directly applied to the building sector – building products, single buildings and groups of buildings. Energy efficiency of houses can strongly influence overall energy use in the building sector. A significant portion of a building's life-cycle impacts are determined by decisions made in the early design stages.

Life-cycle assessment framework Although LCA techniques vary from one study to the next, ISO 14040 has emerged in recent years as the preferred framework for LCA studies and is adopted here. According to this framework, conducting an LCA of a product or process generally involves the following four phases: (1, 2010)

1. Defining the goal and scope of the LCA
2. A life-cycle inventory (LCI) of the materials and their associated environmental impacts
3. A life-cycle impact assessment of the product or process using the LCI data
4. Interpretation of the results

Whole Building Life-Cycle Assessment is a methodology whose importance has been steadily growing in the construction industry, as a reliable way to assess the environmental impacts of a building through its whole life-cycle.

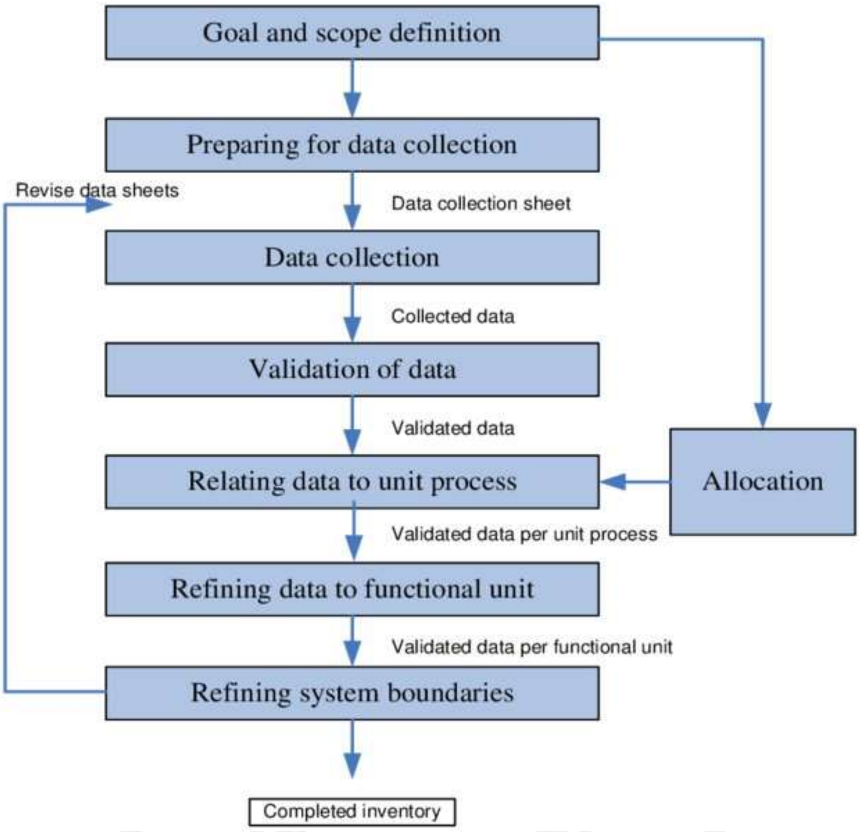


Figure 1 LIFE CYCLE ANALYSIS FLOW CHAT

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Green Building Ratings Criteria Based Performance – As Guidelines [7]

Elements of Sustainable Construction Design Parameters NBC 2016 – Part 11 – Approach to Sustainability Performance VS. Benchmarking (BM Values) Adaptable to Climatic Zone and Geological Conditions (SDI) Human Health & Comfort Address already Locked-in Environmental Impact Inclusive Approach & Not in Parts Use of Technological Advancements Buildings as Material Banks (BAMB) Minimum Natural Resource Consumption Quantify and Manage the Impact (Assessment) Make use of Traditional Wisdom in Design.

Primary and delivered energy. Energy embodied in buildings and building materials is usually reported in primary or delivered energy terms. Delivered energy is the energy generated by processing primary fuels (e.g. electricity), which is also known as "end use" or "final" energy. Primary energy is the energy of unprocessed raw fuel extracted directly from the earth, such as crude oil, coal, and wet natural gas.

Standards and certifications help in achieving the sustainability goals set by governments or organizations. Example, Leadership in Energy and Environmental Design (LEED) requires a certain percentage of energy reduction by buildings beyond an existing energy reference standard such as ASHRAE. he country one of the leaders in green buildings by the year 2015. The Green rating for Integrated Habitat Assessment (GRIHA) is the National Rating System of India. Bureau of Energy Efficiency (BEE).

Green buildings are designed to reduce the overall impact of the built environment on human health and the natural environment

Leadership in Energy and Environmental Design Rating System (LEED), INDIA(Sharma et al., 2011)

LEED, a product of the U.S. Green Building Council (USGBC), provides a complete framework for assessing building performance and meeting sustainability goals. LEED is similar to checklist of credits that can be achieved 7 major categories. Following are these categories.

1) Sustainable Sites
2) Water Efficiency
3) Energy & Atmosphere
4) Materials & Resources
5) Indoor Environmental Quality
6) Innovation & Design Process
7) Regional Priority

Through its use as a design guideline and third-party certification tool, it aims to improve occupant well-being, environmental performance and economic returns of buildings using established and innovative practices, standards and technologies.

LEED Certification is based on point system. The number of points achieved will determine which level of LEED certification the project is awarded. There are 69 possible points and four certification levels.

The maximum possible points are based on:

- Sustainable sites (14 possible points total)
- Water efficiency (5 possible points total)
- Energy and atmosphere (17 possible points total)
- Material and resources (13 possible points total)
- Indoor environmental quality (15 possible points total)
- Innovation and design process (5 possible points total)

BEE:

Star Rating The scheme is based on actual performance of the buildings in terms of energy performance index (EPI, kWh/m2/yr), in which air-conditioned and non- air-conditioned buildings (offices, hotels, hospitals, retails malls and IT parks) are rated on 1 to 5 scale targeting three climate zones (hot and dry, warm and humid, composite).

Result and conclusion

Embodied energy and greenhouse gas emission are the two critical indicators in the impact assessment of environment. While embodied energy is expended in the initial stages of building construction, operational energy accrues over the life span of a building and is distributive in nature. In general, studies have established that higher embodied energy entails higher greenhouse gas emissions and higher global warming.

Potential benefits of green building include:

1. Environmental benefits (intangible)
2. Economic benefits(tangible)
3. Social benefits

LCA methods can be directly applied to the building sector – building products, single buildings and groups of buildings. This facilitates improvements in the overall energy performance of a building under assessment. Real time energy performance values, as compared to baseline values, provide an indication of sustainability level of a building in relative terms - UNEP Benchmarking of buildings provide a set of measurable baseline values that can be compared with real time energy performance values of a building to be assessed(Ahmed & Parashar, 2014).

Looking to the less sources of energy and the danger of climatic deterioration caused by high carbon emissions, energy efficient buildings are the necessity of today. Construction of energy efficient building is a call for every person related to construction industry(Blengini & Di Carlo, 2010).

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