

# Green Building: A Primer

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**Abstract:** *Worldwide, buildings consume a lot of materials, energy, and water. They are responsible for a wide range of impacts on human health and the environment. A green building refers to a structure that is designed, built, or operated in an environmentally-conscious and resource-efficient manner throughout the building's life-cycle. Its aim is to reduce the environmental impact of buildings. Sustainable, green buildings attract a lot of attention worldwide. This paper presents a brief introduction on green building.*

**Key words:** *green building, sustainable building, high-performance building, green construction*

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## I. INTRODUCTION

The building industry is an important component of our economy and social life. Buildings exist for decades and are upgraded many times. Building and construction activities have an enormous direct and indirect impact on the environment. Buildings worldwide account for a large portion of land and are responsible for a huge share of energy, electricity, water, and materials consumption. Commercial buildings in particular are responsible for a lot carbon emissions. There is growing concern for appropriate strategies and actions that are needed to make building activities more sustainable. Planners, developers, architects, designers, engineers, and homeowners work closely to reduce environmental impact at the design stage of a building project [1].

A green building is the one that is good to the environment and also resource efficient throughout its life-cycle from planning to design, construction, operation, maintenance, renovation, and demolition. It gives due considerations to energy use, water use, and indoor environmental quality. It employs a variety of practices, techniques, and skills to reduce or eliminate the impacts of buildings on the environment and human health.

## II. GREEN BUILDING CONCEPT

The idea of green building (also known as a sustainable building, green construction, or high-performance building) has been around for a long time. It originated in the U.S. in the 1970s, during the energy crisis, when people realized that they needed to save energy and to reduce the environmental impact of buildings. A typical green building is illustrated in Figure 1 [2].

Green buildings require the collaboration of the design team, architects, engineers, and the clients/homeowners. They have captured the attention of professional builders and homeowners worldwide. Green building services include construction, architecture, engineering, and town planning aimed at creating sustainable structures.

The US federal government initiated several programs during the first decade of this century promoting energy efficient and sustainable building practices in federal buildings. The Leadership in Energy and Environmental Design (LEED) standards originally were created by the United States Green Building Council (USGBC) through a consensus process in 2000 [3]. LEED program provides a universal framework for implementing green building design and construction.

The major goal of green buildings is to reduce the overall impact of the building environment on human health and the natural environment by [4]:

- Efficiently using energy, water, and other resources
- Protecting occupant health and improving employee productivity
- Reducing waste, pollution, and environmental degradation.

To meet this goal, decisions must be made during the design and preconstruction stages.

### III. GREEN BUILDING ELEMENTS

Investing in green building is not only an eco-friendly concept but also an efficient utilization of energy and resources. The “green” elements incorporated into the design of the green buildings include green architecture, green products, energy efficiency, green roof, and land use.

- *Green architecture:* This is design technique for green building. The design is created with the environment in mind. Green building may be regarded as one of the modern architectural concepts. Green architecture (or green design) gives due consideration to designing energy efficient, eco-friendly houses, healthy, and high-performing houses. It may be regarded as the philosophy of designing a building that is in harmony with the natural features and resources surrounding the site. It can be applied in designing commercial, residential, and office buildings.
- *Green Products/Materials:* Green building brings with it a wide variety of new products, systems and technologies. Efficient building requires that homes be constructed with materials that are sustainable. Figure 2 shows the three phases of the green building material life [5]. Chemical, physical, and mechanical properties of materials dictate the mechanical strength of the building. Sometimes, simply choosing one product over another may be the easiest path to going green. Green products conserve natural resources, save energy or water, and contribute to a safe, healthy built environment. They include lumber, bamboo and straw, recycled stone, and recycled metal. Optimizing material selection is a key component of a green building. The selection of green materials is dictated by multiple criteria from the environmental, socio-economic, and technical perspectives. It may involve an assessment of a product's life-cycle and environmental impacts [6].
- *Energy Efficiency:* This is perhaps the most important element. Green buildings aim to include measures to reduce energy consumption or use less operating energy and reducing water consumption. This is achieved by taking simple measures such as reducing air leakage, maintaining entry door closers, using high-performance windows, and providing extra insulation in walls, ceilings, and floors. Properly design of building's heating, ventilation, and air-conditioning (HVAC) system can reduce the amount of energy used for heating and cooling a building. Onsite generation of renewable energy significantly reduces the environmental impact of the building. The energy system of building is a mix of solar power, wind power, hydro power, and biomass.
- *Green Roofs:* Green roofs, also known as eco-roofs, use plants to improve a roof's performance. Installation of a green roof can beautify the area and extend the lifespan of the building's roof as well as conserve energy. Green roofs have been proven to bring aesthetic value to a building, as well as economic and environmental advantages. They are economically supportive to the building and environmentally friendly [7]. An extensive green roof (on large roofs and existing structures) requires little maintenance.
- *Land Use:* This is one of the most sustainable building practices. It may involve situating buildings to benefit from existing vegetation. A building's location is often selected before its design is completed. Green design must develop a respect for the landscape. A green building is one that represents the most efficient and least disruptive use of land. It minimizes needless destruction of valuable land, habitat, and green space.

Other options for greening buildings and cities include green walls, water efficiency, environment quality,

### IV. ADVANTANGES AND DISADVANTAGES

The list of green building advantages and disadvantage is extensive; it covers the three bottom-line of sustainability which are environmental, economical, and social aspect. Advantages of green building include [8]:

1. *Efficiency:* Green building focuses on increasing the efficiency of four main resources: energy, water, materials, and human health.
2. *Operation Costs:* The cost from heating, electricity and water can all be reduced dramatically.
3. *Maintenance:* Green buildings do not require frequent maintenance.
4. *Eco-friendly Construction:* These buildings are constructed using materials that are renewable, recyclable, reusable, and non-toxic.
5. *Indoor Environment Quality:* Green buildings achieve good indoor environment quality which protects the health of the building's occupants and improves their quality of life.

Some of the disadvantages of green buildings include [9]:

1. *Initial Cost*: Compared with traditional (non-green) buildings, additional upfront cost is incurred due to the increase in the quality of construction methods and materials used. New appliances and modern technologies may cost more money.
2. *Availability*: The materials needed for constructing such buildings are often difficult to find in many parts of the US.
3. *Funding*: Finding a lender who offers loans for non-traditional building may be difficult.
4. *Awareness*: There is lack of knowledge and awareness of green technologies and practices.

## V. OTHER MATTERS

Government can help meet the challenges of green building by adopting economic instruments such as subsidies, lower tax, and lower interest to reduce the cost of green buildings. Government can also increase public awareness and institutionalize green practices and technologies [10]. It can make regulations and ensure accountability.

Green building councils around the globe are actively promoting the awareness of this technology. Green building certification is important in the development of green building since it discloses information on the building's energy efficiency. Several green building rating tools, such as U.S. LEED, U.K. BREEAM, Australia Green Star, South Korea G-SEED, and China's GBL have been initiated to accelerate the transformation of the building sector [11].

## VI. CONCLUSION

Green building has emerged as a new building philosophy or practice that prioritizes environmental responsibility and resource efficiency. It is regarded by some as an answer to the urgent problem of wasteful, irresponsible use of energy and resources by the building industry. Green buildings are designed to protect occupant health; use energy, water and other resources more efficiently; and reduce the overall impact to the environment. The demand for sustainable, green buildings has been highly increasing worldwide over the recent years. As this demand continues to develop, employment opportunities for qualified green builders will enhance the health of our community.

More information on green building can be found in the books in [12-16] and several others available in Amazon.com. One should also consult related journals on green building: *Buildings, Journal of Green Building, International Journal of Sustainable Building Technology and Urban Development, International Journal of Sustainable Built Environment, Journal of Housing and the Built Environment, The International Journal of Building Science and its Applications, and Journal of the National Institute of Building Sciences.*

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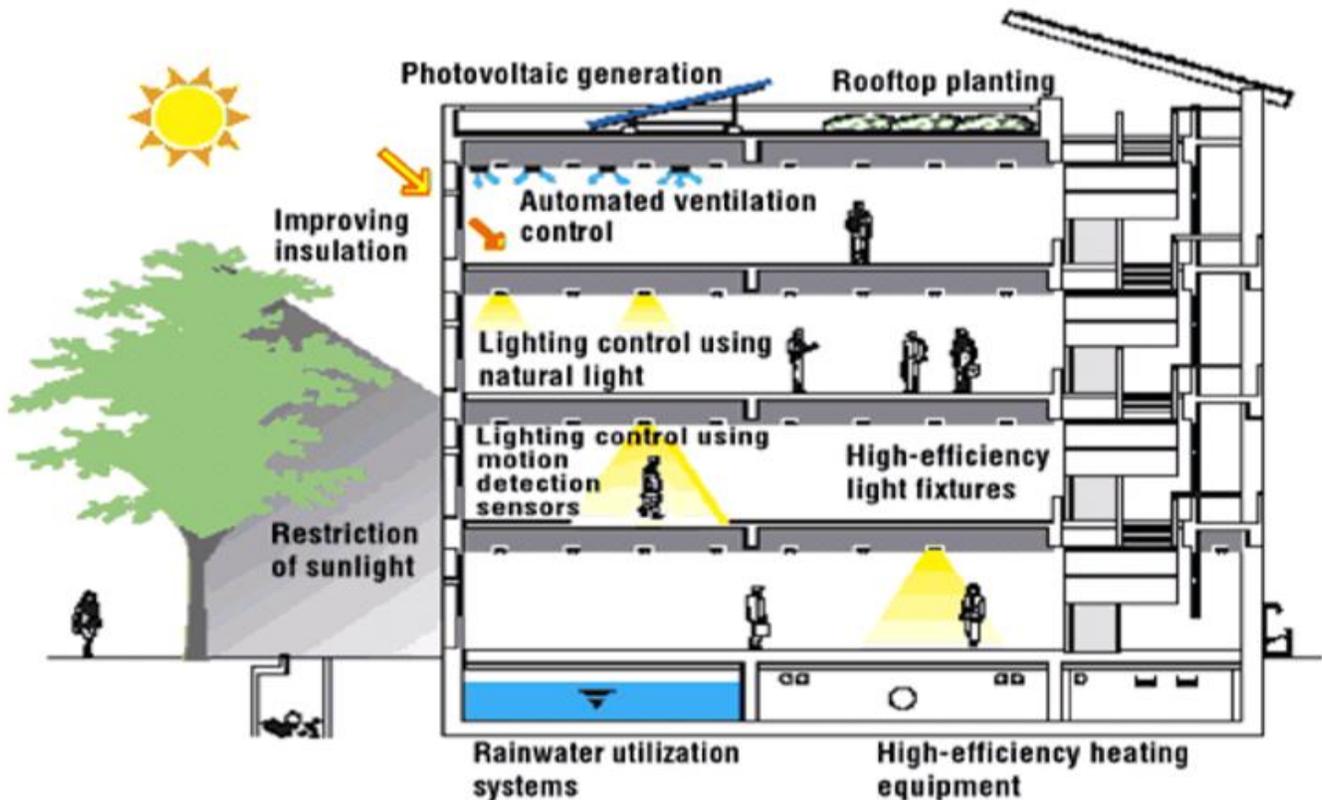


Figure 1 Conceptual drawing of a green building [2].

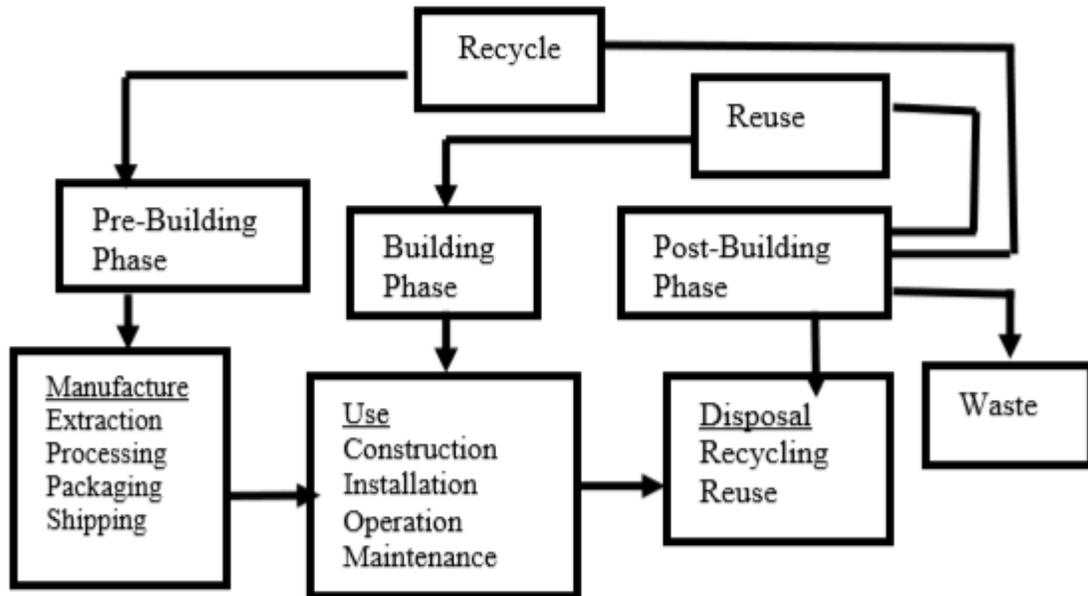


Figure 2 Three phases of the green or sustainable building material life [5].