Green Buildings – Sustainable Construction

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Abstract

With the increase in environmental legislation, during the last three decades, awareness concerning Green Buildings and Sustainable Construction is growing around the globe. Green or sustainable building is the practice of creating healthier and more resource-efficient models of construction, renovation, operation, maintenance, and demolition. The objective of the study is to emphasize green buildings and sustainable construction.

Findings from the study indicate that the practice of green building can lead to benefits such as reduced operating costs by increasing productivity and using less energy and water; improved public and occupant health due to improved indoor air quality; and reduced environmental impacts. It has also been observed that green buildings avoid using toxic PVC plastics and products that produce greenhouse gasses thereby helping to stabilize the earth's climate.

Introduction

One planet and continued increase in demand for basic resources such as air, water, and minerals, increase in population, increasing standard of living, and uneven spread of resources are the major factors considered by today's environmentalists, scientists, engineers, and citizens. These factors facilitate the need for green buildings and sustainable development.

"Sustainable development is a process of change in which the exploitation of resources, the direction of investments, the orientation of technical development, and institutional change are all in harmony and enhance both current and future potential to meet human needs and aspirations. Sustainable development meets the long term needs of the present without compromising the ability of future generations to meet their own needs."[13]

The buildings in which we live, work, and play protect us from nature's extremes: cold, heat, wind, rain, and snow. These structures also affect and shape our environment. Constructing and operating buildings requires enormous amounts of energy, water, and materials and creates large amounts of waste. Where and how they are built affects the ecosystems around us in countless ways. The buildings themselves create indoor

environments that present new problems and challenges. As the environmental impact of buildings becomes more apparent, a new field called "Green Building" is developing to reduce that impact at the source. The main elements of green building are:

- Energy: Designing and operating buildings to use energy efficiently and to use renewable sources of energy, including solar, wind, and biomass.
- Water: Designing and operating buildings to use water efficiently.
- Materials: Using building materials that have a reduced effect on the environment throughout their life cycle compared to competing brands (for example, recycled content, low toxicity, energy efficiency, biodegradability, and/or durability).
- Waste: Reducing the waste from construction, remodeling, and demolition.
- Indoor Environment: Designing and operating buildings that are healthy for their occupants.

Sustainable building (or green building) integrates concerns over the environment, health, and comfort into the design, construction, and operation of facilities. Buildings account for about 36 percent of the nation's total energy use, 65 percent of electricity consumption, 30 percent of total raw material use, 12 percent of potable water consumption, 35 percent of carbon dioxide emissions, and 49 percent of sulfur dioxide emissions. In California, more than 4 million tons of construction and demolition waste are disposed annually, about 12 percent of the total waste stream. Green building practices can also eliminate the use of potentially harmful chemicals. These practices may reduce construction waste by up to 90 percent and can reduce the need for logging or mining resources by using reused or recycled materials.[14]

U.S. Green Building Council (USGBC)

The U.S. Green Building Council (USGBC) is coordinating the establishment and evolution of a national consensus to provide the construction industry with tools necessary to design, build and operate buildings that deliver high performance inside and out.

The council members work together to develop industry standards, design and construction practices and guidelines, operating practices and guidelines, policy positions, and educational tools that support the adoption of sustainable design and building practices. Members also develop strategic alliances with key industrial and research organizations, federal government agencies, and state and local governments to transform the built environment.[1]

Energy and Environmental Guidelines for Construction

The following guidelines are recommended:

- Specify equipment, materials, and products based on performance, not measurements.
- Use recycled materials to reduce use of raw materials and divert material from landfills.
- Use local and regional materials as much as possible.

- Minimize site impact by specifying location of trailers, equipment, storage, and traffic.
- Monitor construction site energy and water use.
- Develop a construction waste management and recycling plan.

Construction

Construction design documents define the contractor's responsibilities during construction, but they typically focus on the design elements of the finished product. They rarely set environmental guidelines to be followed during the construction phase. The design team should work with the construction contractor to adopt environmental guidelines to be followed during construction.

These include the following topics:

- Construction Specifications
- Construction Materials
- Reducing site environmental impact
- Indoor air quality during construction
- Energy and water use/runoff
- Construction Waste Management and Recycling

Contractors seldom follow environmental guidelines during the construction process unless this guidance is built in as a written part of the contract, plans, and drawings for the building. Integrating construction guidelines with other sustainability guidelines is an essential part of the whole building design process. To develop and implement the guidelines, the contractor must work with the team, including the architect, engineers, and contractors. Creating the guidelines as a team is helpful for educating contractors about sustainability issues and getting their early commitment to follow sustainability regulations. Environmental guidelines for the construction process should include construction specifications, material specifications, indoor air quality (IAQ) requirements, and specific measures for reducing environmental impact and energy and water use on the site during construction.

The building's impact on energy and the environment begins during the construction phase. A sustainable approach to construction leads to reduced resource use, reduced disturbance of the site, and can also lower costs. Attention to environmental issues during construction also leads to a safer, healthier working environment for those people constructing the facility, and later for those who occupy it.[14]

Construction Process

1. Planning and Financing the Project

Green, sustainable, high performance - there are many names to describe a growing trend in the industry towards buildings that use less energy and fewer natural resources, cause little impact on the environment (directly and indirectly), and cost less to operate. These facilities also provide healthier indoor environments for the people who live and work in them, leading to increased productivity. Indeed, high-performance buildings benefit building users, owners, communities, states, and our nation. The following steps assist in planning the project:

- Use the whole building design approach
- Evaluate building purpose and uses and set project goals
- Review applicable codes and standards
- Plan for building commissioning
- Explore financing

2. Design, Construct & Renovate

The greatest opportunities for incorporating energy efficiency and sustainability into a building occur in the design phase. During construction, there are additional opportunities to reduce the project's impact on the environment. Renovating an existing building rather than building a new facility is truly an environmental choice that does not disturb the natural environment or require new infrastructure. High-performance buildings use less energy, cost less to operate, use fewer natural resources, and impact the environment less than conventional buildings. However, the process of designing, constructing, or renovating a high-performance building may be quite different than traditional design/build methods. This section explains the key steps to successfully create a green building.

- Plan and finance the project with energy efficiency and sustainability in mind.
- Design, construct, and renovate the high-performance facilities using the whole-building approach and design tools. Topics in this section include:
    - Whole Building Design
    - Building Siting
    - Integrated Building Design
    - Construction
    - Renovation
- Choosing the building components that use the latest in energy-efficient technologies and practices.

3. Building Components

A building's components — from the foundations to the roof are literally the building blocks that make the building. These components can either degrade the energy efficiency of the building or enhance its performance and increase occupant comfort.

Many new energy-saving components are coming to market. These products do double duty, performing their primary jobs while also saving energy. Roof shingles, for example, may be coated with heat-reflective materials that send the sun's heat away from the building, rather than being absorbed and can even generate electricity for the building. Compact fluorescent lights use less energy and put less heat into the building, and advances in HVAC technology mean more comfortable spaces that use less energy.

The benefits from these components will not be realized without being integrated into the design of the facility. Building components influence each other. To make sure they perform optimally, component performance should be modeled during the design phase. This applies to new construction as well as building renovations.

4. Operate and Maintain

When a new building is ready for occupancy, the operation and maintenance of the facility will impact energy use and occupant comfort. As much care should be paid to the operation of the building as was paid to the building planning, design and building component design. For existing facilities, effective operation and maintenance procedures provide opportunities for energy savings. Building components can be replaced with energy-efficient models. In addition the staff can be trained to cut energy use. Specifically the following topics are to be addressed: [14]

- Building Commissioning
- Operation and Maintenance
- Measuring Performance

LEED - Leadership in Energy and Environmental Design

The Leadership in Energy and Environmental Design (LEED) Green Building Rating System is the nationally accepted benchmark for the design, construction, and operation of high performance green buildings. LEED gives owners and operators the tools they need to have an immediate and measurable impact on their buildings' performance. LEED promotes a whole-building approach to sustainability by recognizing performance in five key areas of human and environmental health: sustainable site development, water savings, energy efficiency, materials selection, and indoor environmental quality.

LEED provides a roadmap for measuring and documenting success for various facilities and includes life cycle costs. Specific LEED programs include:

- New Commercial Construction and major Renovation projects
- Existing Building Operations and Maintenance
- Commercial Interior Projects
- Core and Shell Development projects
- Homes
- Neighborhood Development
- Guidelines for Multiple Buildings and On-Campus Building Projects
- LEED for Schools
- LEED for Retail

LEED Certification

The first step in order to obtain LEED certification is to "Register" the project. A project is a viable candidate for LEED certification if it can meet all prerequisites and achieve the minimum number of points to earn a particular level of project certification. To earn certification, a facility must meet certain prerequisites and performance benchmarks ("credits") within each category. Projects are awarded Certified, Silver, Gold, or Platinum certification depending on the number of credits they achieve. This comprehensive approach is the reason LEED-certified facilities have healthier and more productive occupants, conserve our natural resources, and reduce operating costs.[1]

LEED Performance Levels	**Number of points**
Certified	26 to 32

Silver	33 to 38
Gold	39 to 51
Platinum	52 to 69

These points are awarded based on the following parameters

- Sustainable sites: 14 possible points.
- Water efficiency: 05 possible points.
- Energy & Atmosphere: 23 possible points.
- Materials & Resources: 16 possible points.
- Indoor air quality: 22 possible points.
- Innovation: 05 possible points.

Sustainable Siting and Design

The following site selection parameters must be taken under consideration:

- Use appropriate building sites
- Preserve open space
- Reduce sprawl
- Develop brown fields
- Safeguard endangered species
- Restore damaged environments
- Design to optimize sun, wind and light.

Site Integration

During the site integration phase the factors below must be considered:

- Enhance naturally occurring biodiversity
- Minimizing site disturbance
- Manage storm water
- Optimize transportation options
- Reduce heat islands
- Reduce light pollution

Waste Reduction

"Waste reduction" is one of the approaches used to conserve materials in green buildings. Strategies include:

- Prepare and implement a construction waste reduction plan
- Rehabilitate existing buildings
- Demolition/deconstruction waste management
- Design to facilitate recycling and reuse
- Specify products that can be repaired or renovated instead of replaced
- Specify environmentally preferable products and practices

Green Building Materials

Green building materials are those which show least environmental impacts throughout their life cycle, whether measured in terms of energy used, scarce natural resources used, or air and water emissions. The strategies utilized include:

- Prepare a green building product selection plan

- Use salvaged building products
- Use recycled-content building products
- Use locally available materials
- Use rapidly renewable or naturally occurring resources
- Use certified wood
- Use structural insulated panels

Water Efficiency and Sustainable Landscaping

Sustainable water strategies involve every aspect of water use, from stewardship of local sources to reducing use indoors and out and managing wastewater. Conservation strategies include:

- Prepare a water use management plan

Indoor water conservation

- Use low-flow plumbing fixtures
- Use high-performance appliances

Outdoor water conservation

- Use a rainwater collection system
- Use sustainable landscaping techniques
- Use high efficiency irrigation systems

Innovative waste water management

- Use gray water recovery systems
- Use waterless urinals
- Use biological treatment or other “off grid” systems.

Energy Efficiency

Energy efficiency yields increased comfort, aesthetics, and productivity. There are many proven, cost-effective strategies to reduce energy use and cost in all types of buildings in various climates. Application of these strategies may result in a home or commercial space that is vastly more comfortable to live or work in. Strategies include:

Passive solar design

- Optimize the site, design and orientation
- Landscape to provide natural shade
- Use natural day lighting
- Use natural heating and ventilation

Energy management plan

- Evaluate tradeoffs and minimize projected energy costs
- Train building occupants
- Track and optimize performance over time
- Employ an energy management system and commissioning

Energy efficient products

- Use high performance thermal insulation
- Use high performance roofing and glazing
- Use high performance lighting
- Use high performance heating, ventilation and air conditioning system
- Use high performance appliances

On-site Power Generation

While power generation may not be a priority consideration for most projects, changing technologies, price swings, or new incentive programs could arise at any time to make these approaches increasingly economical. The concepts listed below may be utilized.

- Maximize energy efficiency before considering on-site power generation
- Evaluate the feasibility of small–scale renewable-based power generation, Including:
  - Photovoltaics
  - Wind turbines
  - Micro-hydro systems
  - Solar thermal
  - Biomass
  - Fuel cells

Indoor Air Quality

Over the past decade, concerns over indoor air quality have been well documented, along with effective solutions. Indoor pollutants can cause building occupants to experience acute discomfort and negative health effects, such as respiratory irritation, headaches, fatigue, etc. Some substances, such as radon and carbon monoxide, can pose fatal risks. Experience and research shows that these risks can be reduced or eliminated through the following strategies: [14]

- Ensure adaptive ventilation
- Designate indoor spaces as smoke-free
- Implement tobacco smoke controls
- Use low-emitting building products
- Install controllable systems
- Prepare an indoor air quality management plan for construction and early occupancy

Conclusion

Implementing the aforementioned strategies can assist in satisfying LEED certification and is useful in making appropriate use of the land, water, energy, lumber, and other resources efficiently. It enhances human health; strengthens economies and communities, also conserves plants, animals, endangered species, natural habitats and helps in protecting agricultural, cultural, and archeological resources. Hopefully, this approach will become the standard method utilized to construct facilities in years to come.

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