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PERFORMANCE ASSESSMENT FRAMEWORK FOR NET ZERO SUPPLY CHAINA COMPARATIVE STUDY ON THE DIFFERENT FRAMEWORK OF ESG FOR BUILT ENVIRONMENT

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ABSTRACT:
The study aims at identifying different frameworks developed towards ESG goals globally. Organizations adopt these frameworks for sustainability practices in the construction industry. The study provides an overview of different countries adopting different guidelines for best practices. In the Net Zero challenge, the supply chain opportunity insight report 2021 by World Economic Forum, the next level of corporate action was highlighted as decarbonizing supply chains. SBTi has also moved in that direction by developing a focused framework in Supply chain. The finding in the report was that companies can increase their climate impact by decarbonizing supply chains. Eight supply chains like food, construction, fast-moving consumer goods, electronics, automotive, professional services and freight account for more than half of all GreenHouse Gas emissions. The end-consumer cost would hardly increase as a result of adopting Net- Zero supply chains. But the challenge is with respect to companies struggling to get data needed to set clear targets and standards. This chapter tries to explain on the four major areas into consideration namely Construction material, optimising energy efficiency, implementing renewable energy systems and Green Building practices based on which all the frameworks are developed. This chapter also focuses on the different frameworks available and a comparative analysis on the purpose, focus and adaptability of frameworks.

Keywords: ESG, SBTi, Net-Zero, Carbon Emission, GreenHouse Gases, GreenHouse Emission, Construction Materials, Carbon Emission, Carbon Footprint, Energy Efficiency, Green Building.

ESG IN CONSTRUCTION INDUSTRY :

ESG (Environmental, Social, and Governance) frameworks have been gaining significant attention and adoption across various industries, including the construction sector. These frameworks aim to assess and measure a company's or project's performance in terms of its environmental impact, social responsibility, and governance practices.

1.1 ESG CONSIDERATIONS FOR CONSTRUCTION COMPANIES INCLUDE:

E - Environmental	S - Social	G - Governance
a. Sustainable Building Materials: Use environmental friendly and sustainable construction materials that have a lower carbon footprint and are less resource-intensive. b. Energy Efficiency:	a. Health and Safety: Prioritize worker health and safety on construction sites, providing appropriate training, equipment, and protocols to mitigate risks. b. Labor Practices: Ensure fair labor practices,	a. Transparent Reporting: Provide transparent and accurate reporting on ESG performance, including environmental impacts, social practices, and governance structures. b. Ethical Business Conduct: Implement strong

Implement energy-efficient design and construction practices to reduce the environmental impact of buildings and infrastructure. c. Waste Management: Develop effective waste management strategies to minimize construction and demolition waste and promote recycling and reuse. d. Water Management: Implement water conservation measures during construction and promote water-efficient technologies in buildings. e. Climate Change Resilience: Incorporate climate change considerations into project planning, such as adapting to extreme weather events and rising sea levels.	including payment of fair wages, reasonable working hours, and adherence to labor laws and regulations. c. Workforce Diversity and Inclusion: Promote diversity and inclusion within the construction workforce and management to foster a more equitable industry. d. Community Engagement: Involve local communities in the planning and development process to address their concerns and create a positive social impact. e. Human Rights: Respect and uphold human rights in all construction activities and supply chains.	corporate governance practices to prevent corruption and unethical behaviors within the company. c. Board Diversity: Promote diversity within the board of directors to bring different perspectives and improve decision-making. d. Executive Compensation: Align executive compensation with long-term ESG performance to incentivize sustainable practices. e. Supply Chain Management: Encourage ESG principles throughout the supply chain by working with suppliers and subcontractors who also prioritize sustainability and social responsibility.

1.2 CONSTRUCTION MATERIALS - RATE OF EMISSION AND ALTERNATIVES:

The rate of emission and some alternative options for commonly used construction materials:

1. Concrete:

- **Rate of Emission:** High carbon dioxide (CO2) emissions during cement production (a key component of concrete) contribute to its significant environmental impact.
- **Alternatives:** The alternatives for these include low-carbon or carbon-neutral cements, such as those made from industrial by-products (e.g., fly ash or blast furnace slag) and geopolymer concrete. Additionally, exploring innovative materials like hempcrete, which incorporates hemp fibers and lime-based binders, can offer more sustainable alternatives.

2. Steel:

- **Rate of Emission:** Steel production is energy-intensive and emits significant CO2 emissions.
- **Alternatives:** Besides using recycled steel, alternatives include using engineered timber (cross-laminated timber, glulam) as a sustainable and renewable construction material. Other materials like bamboo and composites made from natural fibers are also gaining attention for structural applications.

3. Wood:

- **Rate of Emission:** Wood is generally considered a renewable and environmentally friendly material, as trees can absorb CO2 during their growth phase. However, the sustainability of wood depends on responsible forest management practices.
- **Alternatives:** When responsibly sourced and certified, wood is an excellent alternative to more carbon-intensive materials. Additionally, some engineered wood products, such as laminated veneer lumber (LVL) and oriented strand board (OSB), can be used as substitutes for traditional lumber in certain applications.

4. Insulation Materials:

- **Rate of Emission:** Insulation materials can vary widely in their environmental impact. Foam plastics, like expanded polystyrene (EPS) and extruded polystyrene (XPS), can release harmful greenhouse gases during production and have a high embodied energy.

- **Alternatives:** Environmentally friendly insulation alternatives include cellulose insulation made from recycled paper, wool insulation, cotton insulation, and natural fiber-based options like hemp insulation. Additionally, rigid insulation made from materials like cork or recycled denim is gaining popularity for its sustainability.

5. Windows and Glazing:

- **Rate of Emission:** The environmental impact of windows and glazing primarily depends on the materials used and the energy efficiency of the overall system.
- **Alternatives:** Energy-efficient windows with low-emissivity (low-E) coatings, double or triple glazing, and insulated frames can significantly reduce energy consumption. For more sustainable materials, fibreglass and wood frames may be preferable to traditional aluminium frames. Additionally, some companies are experimenting with smart glass technologies that can adapt to external conditions to optimise energy usage.

6. Roofing Materials:

- **Rate of Emission:** The environmental impact of roofing materials varies depending on the type. Asphalt shingles, for example, have a relatively short lifespan and are not very eco-friendly in terms of production and disposal.
- **Alternatives:** Green roofing systems with living vegetation, metal roofing made from recycled materials, and clay or concrete tiles are more sustainable alternatives. Solar roofing, made from photovoltaic cells integrated into roofing materials, can also contribute to renewable energy generation.

1.3 TABLE SHOWING THE CONSTRUCTION MATERIAL, THE ACTIVITY INVOLVED AND THE DEGREE OF RATE OF EMISSION

Construction Material	Rate of Emission	Activity
Concrete	High	Production of cement
Steel	High	Energy Intensive process
Wood	Medium	Deforestation
Insulation Materials	Medium	Energy consumption
Windows and Glazing	High	Heating and cooling loads
Roofing Materials	Medium	Asphalt shingles or metal roofing

ESG FRAMEWORKS FOR CONSTRUCTION COMPANIES

The frameworks aim to assess and measure a company's or project's performance in terms of its environmental impact, social responsibility, and governance practices. The popular ESG frameworks related to the construction industry:

2.1 Leadership in Energy and Environmental Design (LEED):

LEED is a green building certification program developed by the U.S. Green Building Council (USGBC). It is primarily focused on the environmental aspect of ESG and provides a rating system for the design, construction, and operation of high-performance green buildings. The LEED certification assesses factors such as sustainable site development, water efficiency, energy performance, materials selection, and indoor environmental quality.

Key features and aspects of LEED include:

1. Rating System: LEED uses a points-based rating system where projects earn points for meeting specific criteria within various environmental categories. These categories include Sustainable Sites, Energy and Atmosphere, Water Efficiency, Materials and Resources, Indoor Environmental Quality, Innovation, and Regional Priority[2]. The total points earned determine the project's LEED certification level: Certified, Silver, Gold, or Platinum.

2. Building Types: LEED can be applied to various types of buildings, including commercial buildings, residential buildings, schools, healthcare facilities, data centers, neighborhoods, and even entire communities.
3. Energy Efficiency: LEED encourages the use of energy-efficient design and technologies, such as efficient HVAC systems, lighting, and renewable energy sources, to reduce a building's environmental impact and lower operating costs.
4. Sustainable Materials: LEED promotes the use of sustainable building materials, recycled content, and materials with low environmental impacts, encouraging a more circular approach to resource use.
5. Water Conservation: LEED encourages water-saving strategies, such as efficient plumbing fixtures, water-efficient landscaping, and rainwater harvesting.
6. Indoor Environmental Quality: LEED emphasizes indoor air quality, access to natural light, acoustics, and other factors that contribute to the health and well-being of building occupants.
7. Innovation: Projects can earn bonus points for innovative strategies and practices that go beyond the standard requirements of LEED.
8. Regional Priority: LEED offers additional points for projects that address specific regional environmental priorities.
9. Third-Party Verification: LEED also involves third-party verification, where certified professionals review and assess the project's compliance with LEED criteria.

LEED has played a significant role in transforming the construction industry, driving the adoption of sustainable building practices, and promoting environmental responsibility. It has become a widely recognized and influential certification program globally, with millions of square feet of building space certified under the LEED system.

2.2 Building Research Establishment Environmental Assessment Method (BREEAM):

BREEAM (Building Research Establishment Environmental Assessment Method) is a widely recognized and widely used environmental assessment and certification scheme for buildings. It was developed by the Building Research Establishment (BRE), a UK-based research organization, and is now administered by the BRE Global Limited.

The primary goal of BREEAM is to evaluate the sustainability performance of buildings and provide a standardized framework for assessing their environmental, social, and economic impacts. BREEAM covers a wide range of building types, including residential, commercial, industrial, and public buildings.

Key features of BREEAM include:

1. Assessment Categories: BREEAM evaluates buildings across several categories, including energy, water, materials, waste, pollution, health and well-being, management, land use and ecology, transport, and innovation. Each category comprises a set of criteria that the building must meet to achieve a certain rating.
2. Scoring and Certification: Buildings are assessed based on their performance against the specified criteria, and points are awarded accordingly. The total score determines the building's overall BREEAM rating, which can range from "Pass" to higher ratings like "Good," "Very Good," "Excellent," and "Outstanding." A higher rating indicates a higher level of sustainability performance.
3. Flexibility: BREEAM offers flexibility in terms of building types and geographic locations, allowing it to be adapted to various construction projects worldwide.
4. Continuous Improvement: BREEAM promotes continuous improvement by encouraging building owners and developers to implement sustainability measures and upgrade their buildings over time.
5. Third-Party Verification: BREEAM assessments are carried out by licensed assessors who are qualified to evaluate buildings' sustainability performance objectively. This third-party verification ensures the credibility and reliability of the certification process.
6. Recognition: BREEAM is recognized internationally and is used in many countries as a benchmark for sustainable building design and operation.

BREEAM has had a significant impact on the construction industry by driving sustainability practices and encouraging the adoption of eco-friendly building materials, energy-efficient technologies, and innovative design solutions. The certification process helps developers, investors, and occupiers to make informed decisions and demonstrate their commitment to sustainable construction.

2.3 Global Real Estate Sustainability Benchmark (GRESB):

GRESB, which stands for Global Real Estate Sustainability Benchmark, is an ESG (Environmental, Social, and Governance) benchmark for the real estate sector. It was launched in 2009 and has since become one of the leading assessment tools for evaluating the sustainability performance of real estate assets and companies worldwide.

The primary goal of GRESB is to assess the ESG practices and performance of real estate portfolios and companies, providing investors and stakeholders with standardized and reliable data to make informed decisions regarding sustainability and responsible investing.

Key features of GRESB include:

1. Assessment Process: GRESB conducts an annual assessment where real estate companies and funds voluntarily report their ESG-related data and performance. The assessment covers various aspects of sustainability, including energy and water consumption, greenhouse gas emissions, waste management, social responsibility, governance practices, and stakeholder engagement.

2. Scoring and Benchmarking: Based on the data reported, GRESB calculates scores and ranks participating entities relative to their peers in the real estate sector. The benchmarking allows investors to compare the sustainability performance of different companies and portfolios.
3. Real Estate Sectors: GRESB covers a wide range of real estate sectors, including commercial, retail, residential, industrial, and mixed-use properties.
4. Investor Focus: GRESB is primarily aimed at institutional investors, asset managers, and other stakeholders in the real estate industry who seek to integrate ESG considerations into their investment decisions.
5. Transparency and Credibility: GRESB's assessment process involves rigorous validation and verification to ensure the accuracy and reliability of the reported data. The transparency of the results allows investors to evaluate the ESG performance of real estate assets more effectively.
6. Performance Improvement: GRESB encourages continuous improvement by providing feedback to participants on their performance and identifying areas for potential enhancement.

The GRESB benchmark has become a crucial tool for investors and real estate companies looking to assess and disclose their ESG performance, manage risks, and identify opportunities for sustainable development. It also serves as a platform for knowledge-sharing and best practice adoption within the real estate industry.

2.4 WELL Building Standard:

The WELL Building Standard is a performance-based system for measuring, certifying, and monitoring features of the built environment that impact human health and well-being[3]. It was developed by the International WELL Building Institute (IWBI) and was launched in 2014. The WELL Standard complements other green building certification systems like LEED and focuses specifically on the health and well-being of building occupants.

The WELL Building Standard is based on a set of features and concepts that address various aspects of a building's design, operations, and policies that can influence occupant health.

These features are organized into seven core concepts:

1. Air: This concept focuses on indoor air quality, ventilation, and reducing sources of indoor air pollution to promote a healthy breathing environment.
2. Water: Addresses the quality of drinking water and encourages proper hydration through accessible and clean water sources.
3. Nourishment: Promotes healthy eating habits and access to nutritious foods within the building environment.
4. Light: Considers natural and artificial lighting design to enhance circadian rhythms and support visual comfort.
5. Fitness: Encourages physical activity through the design of active spaces and amenities that promote movement and exercise.
6. Comfort: Addresses thermal, acoustic, and ergonomic comfort to support well-being and productivity.
7. Mind: Considers mental health and stress reduction through strategies that promote relaxation, focus, and positive social interaction.

To achieve WELL certification, projects must undergo performance testing and document compliance with the specified features and requirements in each concept area. Certification levels include Silver, Gold, and Platinum.

The WELL Building Standard has gained significant traction globally, particularly in corporate offices, healthcare facilities, educational institutions, and residential buildings. It has been shown to have positive impacts on occupant health, well-being, and productivity, making it an attractive choice for organizations and developers looking to create healthy and sustainable spaces for their occupants.

2.5. Living Building Challenge (LBC):

The Living Building Challenge (LBC) is a rigorous and aspirational green building certification program that goes beyond traditional sustainability standards. It was developed by the International Living Future Institute (ILFI) and introduced in 2006 as a response to the urgency of climate change and the need for regenerative and restorative approaches to building design and construction.

Unlike other certification programs that focus on incremental improvements, the Living Building Challenge sets a more ambitious goal: to create buildings that are "net-positive." This means that a living building should generate more renewable energy and collect more water than it consumes, while also being built with non-toxic, locally sourced materials, and promoting a positive impact on the surrounding environment and community.

Key features and principles of the Living Building Challenge include:

1. Seven Petals: The Living Building Challenge is organized around seven performance areas, known as "petals." These petals are Place, Water, Energy, Health & Happiness, Materials, Equity, and Beauty. Each petal includes specific imperatives that a project must meet to achieve certification.
2. Imperatives: Within each petal, there are individual imperatives that address specific environmental and social aspects. For example, the Water Petal requires that a living building relies solely on rainwater or recycled water, and the Materials Petal demands the avoidance of toxic and harmful materials.
3. Full Certification: To achieve full Living Building Challenge certification, a project must meet all the imperatives within each petal for a minimum of 12 consecutive months of operation, demonstrating its performance and commitment to sustainability.
4. Red List: The Living Building Challenge has a Red List that identifies chemicals and materials that are restricted or prohibited due to their harmful impact on human health and the environment.

5. Living Building Certification Levels: In addition to full certification, the Living Building Challenge also offers "Petal Certification," where a project meets the requirements of three or more petals, and "Zero Energy Certification," where a project meets all of the Energy Petal requirements.

The Living Building Challenge aims to encourage regenerative design and construction practices that go beyond sustainability and actively contribute to restoring the health and vitality of ecosystems and communities. As of my last update in September 2021, the Living Building Challenge had gained recognition and adoption among leading-edge projects and organizations worldwide.

2.6 ISO 14001:

ISO 14001 is an international standard for environmental management systems (EMS) developed by the International Organization for Standardization (ISO)[5]. It provides a framework that organizations can use to manage their environmental responsibilities effectively and systematically, aiming to minimize their environmental impact and promote sustainable practices.

The ISO 14001 standard focuses on helping organizations identify and control their environmental aspects, establish environmental objectives and targets, and implement programs to achieve these goals. It is applicable to a wide range of organizations, regardless of their size, sector, or geographical location.

Key components of ISO 14001 include:

1. Environmental Policy: Organizations adopting ISO 14001 are required to establish an environmental policy that outlines their commitment to environmental protection and sustainability.
2. Environmental Aspects and Impacts: Organizations must identify and assess their environmental aspects, such as resource consumption, waste generation, and emissions. They also need to evaluate the potential environmental impacts associated with these aspects.
3. Legal and Regulatory Compliance: ISO 14001 emphasizes compliance with applicable environmental laws, regulations, and other requirements relevant to the organization's operations.
4. Objectives and Targets: Based on their environmental aspects and impacts assessment, organizations set specific environmental objectives and targets to improve their performance.
5. Environmental Management Programs: Organizations develop and implement management programs to achieve their environmental objectives and targets effectively.
6. Training and Awareness: ISO 14001 highlights the importance of providing appropriate environmental training to employees and raising awareness about environmental issues within the organization.
7. Monitoring and Measurement: Organizations need to establish a system to monitor and measure their environmental performance regularly and assess progress toward meeting their objectives.
8. Communication: ISO 14001 emphasizes the need for effective internal and external communication related to environmental matters, including stakeholders, employees, and the public.
9. Continual Improvement: The standard promotes a culture of continual improvement, where organizations strive to enhance their environmental performance over time.

ISO 14001 is a voluntary standard, but its adoption can bring various benefits to organizations. It can help improve resource efficiency, reduce waste, lower energy consumption, enhance corporate reputation, and meet the expectations of environmentally conscious customers and stakeholders.

Certification to ISO 14001 is provided by accredited certification bodies, which independently assess organizations' EMS implementation and compliance with the standard's requirements. Achieving ISO 14001 certification demonstrates an organization's commitment to environmental responsibility and sustainable practices.

2.7 COMPARING ESG FRAMEWORKS FOR CONSTRUCTION COMPANIES

Description	LEED (Leadership in Energy and Environmental Design)	BREEAM (Building Research Establishment Environmental Assessment Method)	GRESB (Global Real Estate Sustainability Benchmark)	WELL Building Standard	Living Building Challenge	ISO 14001

Focus	LEED primarily emphasizes environmental sustainability, energy efficiency, and resource conservation in buildings.	BREEAM addresses a broader range of sustainability aspects, including environmental, social, and economic performance.	GRESB focuses on assessing the ESG performance of real estate portfolios rather than individual buildings.	The WELL Building Standard prioritizes occupant health and well-being in the built environment.	The Living Building Challenge promotes regenerative design and construction practices, going beyond traditional sustainability measures.	ISO 14001 is an international standard for environmental management systems and provides a framework for organizations to manage their environmental responsibilities.
Purpose	It assesses various categories, including energy, water, materials and resources, indoor environmental quality, and sustainable site development.	It evaluates categories such as energy, water, materials, health and well-being, pollution, and land use.	It evaluates various ESG factors such as management, policy and disclosure, risk and opportunity, performance indicators, and stakeholder engagement.	It addresses factors like air quality, water quality, lighting, thermal comfort, fitness, and other elements that impact occupant well-being.	It sets stringent requirements across categories like site, water, energy, materials, equity, and beauty.	It focuses on the establishment, implementation, and continuous improvement of environmental management practices.
Adoption	LEED is widely recognized and adopted globally, with a strong	BREEAM is widely adopted, particularly in the United Kingdom and Europe,	GRESB is widely adopted globally, providing benchmarking and comparison	The WELL Building Standard is gaining global recognition and adoption,	The Living Building Challenge has a growing international presence, but its	ISO 14001 is widely recognized globally and adopted by organizations across various

	presence in the United States and many other countries.	but its usage is also growing globally.	tools for real estate investors and companies.	particularly in sectors focused on human health and wellness.	adoption is still relatively niche compared to LEED or BREEAM.	industries, including construction.

3. OPTIMISING ENERGY EFFICIENCY

Optimizing energy efficiency in buildings is crucial for reducing energy consumption, lowering operational costs, and minimizing environmental impact. The various strategies and practices to achieve energy efficiency:

- Improving the building envelope, which includes walls, roof, windows, and insulation, helps reduce heat gain and loss. Proper insulation, high-performance windows, and sealing air leaks can enhance the building's thermal performance.
- Switching to energy-efficient lighting technologies, such as LED (Light Emitting Diode) lighting, can significantly reduce electricity consumption for lighting purposes while providing better quality illumination.
- HVAC systems are major energy consumers in buildings[6]. Optimizing HVAC design, using energy-efficient equipment, regular maintenance, and proper controls (thermostats, occupancy sensors) can enhance HVAC energy efficiency.
- Implementing energy management systems allows building operators to monitor, control, and optimize energy consumption. These systems use data analytics to identify energy-saving opportunities and adjust building systems accordingly.
- Integrating renewable energy sources like solar panels or wind turbines allows buildings to generate clean energy on-site, offsetting electricity consumption from the grid and reducing greenhouse gas emissions.
- Building automation systems enable centralized control and automation of various building systems, including lighting, HVAC, and security. Automation can optimize energy use based on occupancy and external conditions.
- Selecting energy-efficient equipment and appliances, such as Energy Star-rated devices, ensures that the building's operational equipment consumes less energy while providing the same level of performance.
- Commissioning ensures that building systems are installed, calibrated, and operate as intended. Retro-commissioning involves optimizing existing systems for improved performance and energy efficiency.
- Educating occupants about energy-saving practices and engaging them in energy conservation efforts can lead to behavioral changes that significantly reduce energy consumption.

4. IMPLEMENTING RENEWABLE ENERGY SYSTEMS

Implementing renewable energy systems can significantly reduce a building's carbon footprint and reliance on non-renewable energy sources.

- Solar PV systems harness sunlight and convert it into electricity using photovoltaic cells. These systems can be installed on rooftops or as ground-mounted arrays and are a popular choice for generating clean electricity in both residential and commercial buildings.
- Solar thermal systems capture the sun's heat to provide hot water or space heating. They use solar collectors to absorb sunlight and transfer the heat to water or a heat-transfer fluid.
- Wind turbines generate electricity from the kinetic energy of the wind. They consist of large blades connected to a generator and are typically installed in areas with consistent wind flow.
- Geothermal systems utilize the stable temperature of the earth to provide heating, cooling, and hot water for buildings. They extract heat from the ground during the winter and dissipate heat into the ground during the summer.
- Biomass systems use organic materials, such as wood pellets, agricultural waste, or biodegradable waste, to generate heat or electricity through combustion or gasification processes.
- CHP systems, also known as cogeneration, produce both electricity and usable heat simultaneously from a single energy source. This process increases overall efficiency compared to separate electricity and heat generation.
- PPAs allow organizations to purchase renewable energy directly from renewable energy producers. Off-site renewable energy projects, such as solar or wind farms, can supply clean electricity to a building or facility, even if it's not physically located on-site.
- Energy storage systems, such as batteries or pumped hydro storage, store excess energy generated by renewable sources for later use when the energy demand is higher or when renewable generation is low.

5. GREEN BUILDING PRACTICES

- Green building practices focus on creating environmentally responsible and resource-efficient buildings that have a reduced impact on the environment while providing healthier and more comfortable spaces for occupants.
- Sustainable site selection involves choosing a location with minimal environmental impact, close proximity to public transportation, and consideration for storm water management. By doing so, it aims to reduce the ecological footprint, promote biodiversity, and limit the need for resource-intensive infrastructure. Selecting a site with minimal environmental impact and proximity to public transportation reduces the need for car travel and preserves natural habitats. Sustainable site selection also considers storm water management and minimizing heat island effects.
- Energy-efficient building design aims to reduce energy consumption and greenhouse gas emissions. This includes optimizing building orientation, using passive design strategies, and maximizing natural daylight to minimize the need for artificial lighting and heating/cooling.
- Heating, ventilation, and air conditioning (HVAC) systems play a crucial role in energy consumption. Green building practices focus on using energy-efficient HVAC systems, such as variable refrigerant flow (VRF) systems, geothermal heat pumps, and high-efficiency central air systems.
- Energy-efficient lighting solutions, such as LED lighting and occupancy sensors, help reduce electricity consumption and maintenance costs while improving the indoor environment.
- Water-efficient practices involve using low-flow fixtures, rainwater harvesting, and greywater recycling to reduce water consumption and promote sustainable water management.
- Using eco-friendly and sustainable building materials, such as recycled content, rapidly renewable resources, and low-emission products, helps minimize environmental impact during construction and throughout the building's life cycle.
- Good indoor air quality is essential for the health and well-being of occupants. Green building practices prioritize ventilation, air filtration, and the use of low-toxicity materials to create a healthy indoor environment.
- Conducting a lifecycle assessment evaluates a building's environmental impact from construction to demolition. This analysis helps identify areas for improvement in terms of energy consumption, emissions, and waste generation.
- Incorporating renewable energy sources, such as solar photovoltaic panels or wind turbines, allows buildings to generate clean electricity on-site, reducing reliance on fossil fuels and lowering greenhouse gas emissions.
- Implementing building automation and control systems enables real-time monitoring and optimization of energy use, allowing for continuous improvement and efficient operation.

6. CONCLUSION :

Zero Carbon emission has been gaining due importance to make the environment sustainable for future generation. The process and frameworks explained in this chapter will give an overview to construction industry. It will enable them to identify their specific requirements and set standards for continuous improvement. Various factors involved and their comparative analysis would help to identify overlapping metrics and thereby adopt only those essential. In conclusion, addressing the environmental impact of construction materials and practices is crucial for sustainable development. The adoption of alternatives, such as low-carbon cements, recycled steel, responsibly sourced wood, and eco-friendly insulation, offers viable options. ESG frameworks, including LEED, BREEAM, GRESB, WELL, and the Living Building Challenge, play pivotal roles in promoting environmentally conscious construction. These frameworks evaluate and certify projects based on their environmental, social, and governance aspects, fostering a shift towards sustainable building practices. Additionally, ISO 14001 provides a comprehensive framework for organizations to manage their environmental responsibilities systematically. Embracing these practices and certifications is essential for a resilient and eco-friendly construction industry.

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