

# ZERO CARBON FOOTPRINTS: A SUSTAINABLE SOLUTION FOR MODERN BUILDINGS

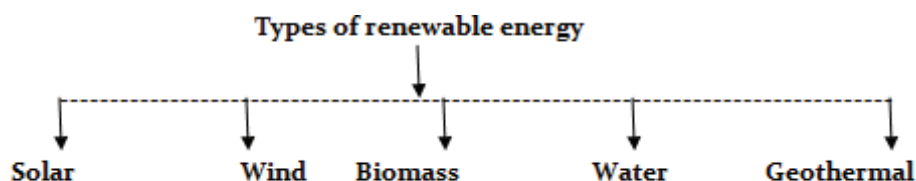
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**Abstract:** Zero carbon buildings are the ones which have zero carbon emissions annually. They set the classic examples of sustainability to be achieved in the modern era. Sustainability is becoming the need of construction industries due to the impacts of environmental deterioration that has happened by humans. Smart city is an emerging trend in India introduced in the year 2015. This paper is an attempt to understand the initiatives taken worldwide to have zero carbon footprints, case studies are carried out for four zero carbon buildings in the world, which includes, The Indira Paryavaran Bhawan- New Delhi, The Bullitt Centre-Seattle, The Edge- Amsterdam, The Legion House-Sydney. The Probable solutions to achieve zero carbon buildings are discussed by analysing materials, construction techniques, advantages, disadvantages. Considering the present scenario of smart city, this concept has the tremendous potential which can be implemented worldwide.

**Keywords:** Case Studies, Smart Cities, Sustainability, Zero Carbon.

**Introduction:** Pollution is the global issue due to various man-made reasons including major contribution from construction industries. Effect of green house gases has affected human lives, ecosystems and bio-diversity which are becoming the reasons for global warming. Therefore, it is a right time to think about sustainable practices in terms of use of sustainable materials, use of effective methods to reduce consequences of pollution, reuse, recycling of materials and many more. To initiate sustainable practices, climate is an imperative factor and therefore it plays a vital role in architectural designs. Many a time's simply adopting a solution which is not co-relating with the context of site proves to be a malfunction, for example choosing glass facades in tropical countries. Hence it is required to analyze various options available which fit into the requirements of climate to have a functional design. Zero energy concepts including zero net energy, net zero energy building, net-zero building or zero carbon building are relatively new however gaining attention due to their numerous advantages in functioning of design. Zero carbon building is one of such approach towards sustainability in which energy consumed is equal to the energy produced through renewable resources throughout year. These buildings have the potential to be a contributing factor to control the effect of green house gases. The strategies to achieve zero carbon emissions includes use of local materials suitable for climate, energy efficient design processes like preserving trees, adopting passive design approach, reducing hard path areas, proper ventilation etc. A smart city mission in India is introduced in the year 2015 by Government of India with a vision to develop the infrastructure and to achieve sustainability. Analysis of such varied approaches to achieve desired design output is essential in Indian context for application and therefore this paper discusses the encouraging case studies of zero carbon energy concepts implementation globally. Climate is an essential thread to start comparing, analyzing the case studies on various parameters. India being a tropical country requires materials suitable for such climate which not only maintains the temperature indoors but also promotes passive design strategies. Passive strategies are those which lessen the use of equipments like fans, air conditioners, coolers to maintain the temperature and endorse use of renewable energy.



Applications these renewable energies are- Solar energy - hot water, generating electricity. Wind energy -generate electricity, to pump water. Biomass - heating, hot water. Water - electricity Geothermal for hot water, space heating.

**Case Studies:** To understand and analyze zero carbon buildings globally, case studies are carried out in various climate zones which are presented.

1. Indira Paryavaran Bhawan,-India's first net zero energy building with 100% on site energy generation located in heart of New Delhi is the classic example of sustainable building who received a lot of recognition and awards for its design strategies and use of local materials. New Delhi has hottest summers in India which suggests utilizing this solar energy in its best possible way. Thus project emphasized on conversing the trees, providing shaded landscaped areas to reduce temperature, recycling of waste water and thus optimizing the overall use of water. This art landmark building has green features which are implemented through site planning by using only ground coverage as 30% of plot area, water efficiency by using low discharge fixtures, using curing compound, drip irrigation, increase in lawn area to reduce requirement of water, planting native trees and shrubs with low water requirement, waste water treatment, rain water harvesting, dual flushing cisterns etc, energy efficiency by using energy efficient light fittings, Integrating building management system (IBMS) for optimizing consumption of electricity, lux level sensors, on site renewable energy system with photovoltaic cells, solar panels exterior lights, materials are used in innovative ways fly ash bricks are used, ready mix concrete with more than 30 % fly ash content, terrazzo flooring from locally available stone, jute bamboo composite for door, window frames- shutters, UPVC windows, high reflective flooring to reflect heat, grass paver blocks to promote ground water recharge, indoor air quality is improved by using low VOC (Volatile Organic Compounds) paints, dust control, noise control, no smoking zone, innovation in design is achieved by regenerative lifts, high efficiency solar panels, low energy bio-digestion for organic waste, active chilled beams mechanized car parking. [1]



**Fig. 1:** Indira Paryavaran Bhavan

**Source:** <http://indiaclimatedialogue.net/2014/06/26/building-power-green-ministry-shows-way/>

2. The Bullitt Centre- This greenest commercial building in the world is located in Seattle USA. The building satisfies the seven performance areas known as petals imperatives which includes site that support pedestrian, bicycle, transit friendly lifestyle, rainwater which is collected at roof level then stored at underground cistern and used throughout the building, solar array system generates energy required for building usage, health of occupants is promoted by providing inviting stairways, operable windows, walkways, resource sharing, building materials doesn't have any red list materials like PVC, mercury, cadmium, lead, hormone mimicking substance, equity is ensured by locating workstations within 30 feet range of operable large windows offering fresh air for occupants and natural ventilation. In addition to that a mesmerizing architectural feature, structural timbers, green roof, photovoltaic array, pocket park adds magnificence to the project. Building uses 26 geothermal wells 400m inside the building which acts as a Battery in summers and winters to keep building temperature user friendly. 275 solar panels connected at roof creates amount of energy required for entire utilization for building.

Interestingly, the toilets use only 2 tablespoons of water with biodegradable soap to form in bowl in addition to that toilets urinals return air to aerobic composter. It has world's six storey composting toilet system which converts human waste into fertilizer by aerobic digestion process due to heating it. Wetland filters are constructed so that plants can only absorb organic matter. [3]



**Fig 2:** The Bullitt Centre

**Source:** <http://www.bullittcenter.org/>

3. The Edge- Located in Amsterdam has iconic 15 storey atrium which supplied ample daylight and acts as a sound buffer from train tracks adjoining to the building. Photovoltaic cells located on the south face of building absorbs energy which and thus reduces consumption of electricity by 70% than other office buildings of European buildings. A concrete tub at below the ground level collects rain water which is further used for toilets and gardening. Workstations are within 7m distance from window. Automated parking is another smart feature. It uses LED sensor lights which brighten up and dims automatically for user. Two 129m deep wells reaching aquifers act as a medium to store thermal energy and to achieve a balance. Ecological corridors are provided to help animals and insects to cross site safely. [4]



**Fig 3:** The Edge, Amsterdam

**Source:** <http://ovgrealestate.com/cases/the-edge>

4. The Legion: This office building with commercial tower, retail spaces and green spaces newly added is located in Sydney Australia comes under humid subtropical climate zone. The building uses gasification system to generate entire electricity needed for operating. This process of gasification uses paper waste which is converted into combustible gas which further used to generate electricity. In addition to this building also have chilled beams, rainwater harvesting, recycling and reuse of water features. [5]





**Fig. 4:** The Legion House

**Source:** <https://jagonal.com.au/office/building/NSW/Sydney/Sydney-CBD/Mid-town/Legion-House>

**Observations:** The observations are made after analysis of all book case studies which are summarized as follows

Sr. No.	Parameter for comparison	Case Study 1 Indira Paryavaran Bhawan	Case study 2 The Bullitt	Case Study 3 The Edge	Case Study 4 The Legion House
1	<b>Purpose</b>	Office	Commercial	Office	Commercial+ Retail
2	<b>Plinth Area</b>	30914 m <sup>2</sup>	4800m <sup>2</sup>	40000m <sup>2</sup>	6000 m <sup>2</sup>
3	<b>Location</b>	New Delhi	Seattle	Amsterdam	Sydney
4	<b>Material Used</b>	Locally available stone, fly ash bricks	Timber for structural supports	Steel columns, glass facades for envelope, wood FSC-Forest Stewardship Council certified	Brick for columns, steel joists, timber for window frames
5	<b>Climate</b>	Hot and sub arid	Temperate marine	Oceanic	Humid subtropical
6	<b>Design Strategies</b>	Solar Panels, Chilled beams, mechanized parking,	Inviting stairways, innovative geothermal wells	ecological corridors, Hot desking	129m deep wells, use of paper waste from office
7	<b>Energy generated</b>	100% on site power generation (Net zero consumption)	Equal to the usage of building generated through solar photovoltaic cells	Energy generated through photovoltaic cells	100% electricity through gasification technique (Net Zero Consumption)
8	<b>Ventilation</b>	Ample daylight and ventilation	82% natural daylight	South facing daylight along with 15 storey atrium	Natural ample ventilation
9	<b>Other features</b>	Rain water harvesting, native plants with low water requirement	Rain water harvesting, No red list materials, reuse and recycling of water	LED sensor lights, automated parking spaces,	Chilled beams, rainwater harvesting, recycling of water

**Conclusion:** Above strategies, design solutions like inviting stairways, foam forming water in toilets, banned red list materials are extraordinary. Gasification technique is new and impressive which has potential to be used in other parts of world. These case studies are also beneficial for smart development of India in coming years and truly inspirational, however suggests further scope of study in terms of innovation in materials, structural systems, systems for security of users in with respect to technology, design are essential to create a healthy environment in a true sense.

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