Reducing carbon emission in buildings to achieve Net Zero

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Abstract:
Due to climate change, greenhouse effect and a lot of energy consumption, a zero-energy building is need of an hour. A building consumes approximately 40% of the total energy. So, this paper helps in understanding the method of coming up with zero energy buildings. The foremost supply of Greenhouse gas (GHG) is carbon emission from buildings which includes 60% of total energy consumption. An average carbon footprint of a building is around 80 ton of a simple 2BHK (Bedroom, Hall and Kitchen). This carbon emission contributes in greenhouse gases. This paper deals with the net zero carbon emission buildings which may facilitate in reducing the carbon footprint on annual basis. The main aim of the paper is to review the method of achieving a net zero carbon footprint and using those technologies/ideology to achieve net zero energy buildings at post construction phase. This paper will also help in finding the major building carbon emission source (energy) and dominant it to cut back carbon emission. Research will cover direct and indirect ways to reduce carbon emission. And additionally, new methods for betterment of designing are discussed and new processes that can help to reduce carbon emission drastically will be discussed.

1. INTRODUCTION

1.1 Background and Significance
Out of the total global emission the buildings use 40% of energy and are directly responsible for CO2 emissions. Almost 60% of the energy is used for construction and maintenance out of which more than 50% of global waste production is taken by electrical energy. Undoubtedly, building sector plays a pivotal role in reducing carbon emission in oriental as well as occidental countries. To analyze direct and indirect impacts that buildings make on the environment, it is segregated into different sectors, like building construction, maintenance, or operation [1].

Based on an extensive research of energy sector characteristics and development progression driven by economic and social development, various policy tools for CO2 emission reduction in the construction sector are explored [2]. Obviously, effect of the building segment is increased multifold with increase in demand for increased population and all of which are intensely impacted by CO2 emission intensively. Thus, decreasing the CO2 generation of the building division beside these other negative impacts is a challenge that should be met rapidly and unequivocally as soon as possible. Fortunately, there are numerous specialized arrangements that as of now exist and specialists all over the world are actualizing unused methodologies that will lead the way in changing how we create and give a present day-built environment. This incorporates finding modern materials and strategies to address some of the time ignored CO2 delivered straightforwardly in building development whereas keeping up center on diminishing the gigantic sums created from building operation.
1.2 Need to reduce carbon emission

Due to increase in greenhouse gases, architects and builders are finding a solution for reducing it. Buildings produce 60% of total GHG and it is due to carbon emission in buildings and construction. To reduce these carbon emissions, building transportation, building design and building demolition all have to be considered. Buildings can reduce these carbon emissions by not only techniques but also by materials and planning process. For instance, in Peninsula Malaysia, 0.684 kg of CO2 emitted to the atmosphere for each 1 kWh electricity generated by power plant. Undisputably, a ZNC (zero net carbon) building may meet its vitality requests or counterbalanced its carbon-based vitality utilization by the taking after:

• Generation of on-site renewable vitality
• Acquisition of off-site renewable vitality from neighborhood providers

In rundown, a ZNC building can accomplish a carbon impartial adjust through (in arrange of need) a combination of plan techniques and materials, vitality proficiency measures, productive gear, renewable vitality generation, and clean vitality procurement. The purpose of this research is to calculate the carbon emission in a building at post construction stage and reduce it by dealing it with energy. As energy will decrease, carbon emission will also decrease. Further it will study about the methods and technologies by which carbon emission can be reduced and will be compared with a building with no carbon reduction techniques.

1.3 Limitations and Methodology

There are many ways of reducing carbon emission but this paper will specifically be dealing with energy calculation, as energy is the major source of it. The result will focus on energy calculation and techniques only at post construction time.

The fundamental center of this survey was to discover writing that communicated what frameworks and plans that had an in general effect of diminishing vitality utilization in buildings. To realize effective vitality, utilize, zero vitality plan withdraws essentially from customary development hone. One of the ways to present net zero vitality is through a straightforward conceptual condition, which states that net zero vitality rises to the aggregation of inactive plan additionally vitality proficient building frameworks additionally renewable vitality frameworks, all over an coordinates process. Understanding net zero energy buildings and carbon emission.

2. LITERATURE REVIEW

Methods of reducing Carbon footprint in post construction introduce in a building to attain Net Zero Energy. A zero-energy house is by definition one designed, built and furnished using recycled materials, smart technology and renewable energy sources that reduce its carbon footprint and lower its energy desires. Mostly there are 3 broad ways of reducing carbon footprint in an exceedingly building in post construction phase-

1. Energy conservation
2. Passive techniques
3. Renewable resources

These ways when applied to a building can’t solely save energy but conjointly to scale back the carbon emission from the building.

2.1 ENERGY CONSERVATION-

2.1.1 PV Panels- (Facing South)

PV boards incorporate clean vitality green vitality. There are no hurtful nursery gas emanations all through the era of power with PV boards, and sun powered PV is ecologically inviting. The costs of sun-based boards are right now on a consistently diminishing way and are anticipated to proceed to diminish within the coming years. – subsequently sun oriented PV boards has without a doubt an exceedingly promising future both for prudent reasonability and natural sustainability. Photovoltaic boards switch out power in a coordinate way through the photoelectric wonder. Compared to other renewable vitality frameworks, working and upkeep costs for PV boards are considered to be negligible, nearly unimportant. A common measure sun-oriented board cluster is ordinarily
around 5kW and takes up around 400 square feet of space. A cluster of this estimate can deliver a normal of 350-850 kWh of AC vitality per month. To put that into viewpoint, a commonplace family employment around 897 kWh per month [3].

### 2.1.2 Solar water heater-

Direct frameworks stream water through sun powered collectors where the sun warms it. The warm vitality of the sun warms the sun-based collectors fluid. At that point, within the capacity tank, this liquid passes through a warm exchanger, exchanging warm to water. At that point the non-freezing fluid returns to the tanks.

![Solar Water Heater](image)

**Figure 2 Solar Water Heater**

Smallest measure of a framework is 100 liter per day, which implies that it can convey 100 liters of hot water in a day at 60 C. A 100 liter per day capacity framework appropriate for 3-4 individuals can spare up to 1500 units of power in a year depending on the amount of hot water utilized. It can moreover spare around 140 liters of diesel in a foundation utilizing oil terminated kettle besides reducing nursery gas outflows within the environment.

<table>
<thead>
<tr>
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<th>Northern Region</th>
<th>Eastern Region</th>
<th>Southern Region*</th>
<th>Western Region*</th>
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<td>Rs. 6/kwh</td>
<td>6000</td>
<td>6000</td>
<td>9000</td>
<td>7500</td>
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</tbody>
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**Table 1 Region wise expected saving**

### 2.1.3 Light bulbs-

Undisputedly, comparing to conventional methods LED’s are now capable of more energy efficient method giving more output. Thus, LEDs consume 90% less power than normal light bulb. As per report if we replace normal light bulb with energy rated light bulb in every home, greenhouse gas emissions would be reduced by 9 billion pounds.
These days the littler or "mini scale" (20 to 500-Watt) turbines are utilized in applications such as charging batteries for leisure vehicles and sailboats. In addition, in applications such as pumping water one to 10kW turbines can be utilized. Turbines utilized in private applications can run in measure from 400 Watts to 100 kW (100 kW for exceptionally expansive loads).

*Figure 4 Wind towers used in a building*
A normal domestic employment a normal of 897 kWh per month, or 10,766 kilowatt-hours (kWh). A wind turbine with a extend of 5 to 15 kW would be essential to create a critical commitment to this request, depending on the normal wind speed within the locale. A 1.5-kW wind turbine will meet the wants of a domestic needs 300 kWh per month in an area with a 14 MPH yearly normal wind speed.

Concurring to numerous renewable vitality specialists, a "crossover" framework that collaborates wind and photovoltaic (PV) advances give a few preferences over either single framework.

### 2.1.5 Highly Efficient Rating Gadgets-

Undoubtedly, Highly Efficient Rating gadgets not only lowers your fuel bills by using less coal, it also decreases your carbon emissions, which is good for the world and generations to come. Obviously, making sure your home and all your electrical appliances function as well as possible is the best way to use less power. Lighting accounts for about 20 percent of the electricity bill in most homes.

Few examples:

- Smart Thermostats
- LED Lighting
- Energy Management Systems
- Energy Star Appliances
- Smart Power Strips

### 2.2 Passive Techniques-

#### 2.2.1 Installing tiles on roof-

On the other side, a cool roof can be 50 to 60 degrees cooler than a traditional darkcolored roof, decreasing your home's cooling load, saving energy and reducing the cost of service. Concrete roof tiles are energy efficient naturally. In fact, concrete tile roofs in comparison to other roofing materials can reduce heat transfer to the attic by up to 50 percent.

In addition, their inherent reflective properties allow sunlight to reflect, releasing the heat instead of absorbing it and transferring it from the roof deck into the structure. This may contribute to the home's limited use of HVAC [4].
2.2.2 Orientation-

Northern light is both high and low energy, making it a perfect opening path. The eastern wall is relatively safe. While light and heat may build up as the day progresses, but this heat dissipates during the day-time. Many solar heat problems can be solved by properly designed sunshades. The southern orientation faces a great deal of solar radiation; thus, simple window top chajjas may not be enough.

Verandahs, trees, overhangs of the built roof and so on are required.
As unlike sunlight, breezes can be diverted so while designing buildings features like fences, outbuildings, plantings and windows that open widely should be implemented as per need of site.
2.2.3- Triple glass-

Windows is currently recognized in an excessively house as "thermal weak spots." Up to fifteen times more heat is lost or gained through windows as is lost and gained through equal wall space. A singlesided untreated window unit is extremely inefficient in terms of energy. A measurement of its heat resistance shows that a value about R1 is included in this single panel window. A double-sided, untreated unit has an R-2.1 value, and a triple-sided unit has an R-3.2 value.

While adding additional untreated glass panes will increase the energy efficiency of the window, it will also increase its window insulation capacity by placing a special coating on the windows. Low-e or low-emission glass is one type of specially coated glass.

2.2.4 Radiant Cooling system-

Radiant cooling systems use cool water to radiate cooling throughout the environment through similar radiant heat tubing or panels. These can certainly remove the need for cooling of forced air. With these devices, the energy needed to transfer the cool air around your home is about 25 percent lower than the normal AC system, meaning that you are not only helping the atmosphere but also saving your money.

Radiant heating systems offer warmth by heating the inside surfaces to minimize the difference in temperature between the clothes and hair, as well as the inside surfaces which reduce the loss of body heat by radiation.
It could be a pre-fabricated framework outlined behind a sheet of drywall. The design of the channeling is composed on the confronting paper so installers don’t inadvertently cut the plastic tubing, that's introduced in aluminum spreaders to warm the gypsum equitably. Extraordinary connectors snap the tubing inside the boards together. Radiant ceilings in cooling retain warm for 60-70% by radiation conjointly the remaining (30-40%) by normal convection. The blend of those two impacts impressively increment the execution of a brilliant ceiling compare to brilliant floor.

2.2.5 Water conservation-

Roof top rain water harvesting system- during this process, the water collected from the roof flows directly into the filter on the first floor (gravity) wherever it is filtered and stored in the tank next to it. Maintaining a tank on the first floor helps to reduce the power used to pump water to the top floors. This water is used for secondary use in ground floors (pump reduction).

Excess freshwater then goes to the underground storage wherever it is processed from dirt, sand, and charcoal and then returns to the overhead tank. Excess water well recharges to the ground floor.

Root zone treatment plant-

Water from washing, bathroom, and washbasins goes to root zone treatment. steps are concerned during this, and water then are often used for washing, flush etc. to keep the water clean and plants healthy, fish are used.

2.2.6 Cavity walls and exposed bricks

Cavity wall may be a sort of divider that incorporates an empty center. They can be portrayed as comprising of two "skins" isolated by an empty (depression). The skins more often than not are brick work, like brick or cinder block. Brick work is a permeable fabric and so gradually draw water or indeed mugginess into the divider.
Two masonry walls divided by an air space are made of a cavity wall. The external divider is made of brick and faces the exterior of the building structure. The inner divider too comprises of brick work units such as concrete square, auxiliary cement, stone and strengthened concrete. These two dividers are secured with steel joins or authoritative cables. The joins fortify the depth divider.

2.3- RENEWABLE RESOURCES

2.3.1 Geothermal Energy-
Using geothermal power to bring your home temperature to earth temperature, tunnels dug underground vertically or horizontally, it helps you go below or above that house temperature which is either cooled or heated [5].

![Figure 15 geothermal Power](image)

The Earth's temperature remains constant between 58 and 60 degrees. For reasonable reduction in electricity bills and achieving desired energy efficiency tunnels are preferred having 5 to 6 feet depth and approximately 400 feet long.

2.3.2 Portland-limestone cement-
It has a smaller carbon footprint that has no disadvantages. To increase the environmental impact along with production as the basic concrete Portland cement is considerable modified to Portland limestone cement (PLC).

2.3.3 Local materials and local furniture-

![Figure 16 Portland cement mix](image)

Use of local materials helps in reducing the energy produced in manufacturing. Thus, selection of material for different components of building design should be shortlisted locally from a nearby manufacturing site. In addition, it will reduce energy consumption by cutting down on transportation distances, consequently which lowers greenhouse gas emissions.
2.3.4 Green roof-

In building sector, cost saving is possible with laying of green roofs which reduce the heat flux from top surface and subsequently less energy for cooling or heating would be required. Research suggest that mean temperature under membrane of conventional roof and that of green roof vary drastically and is very efficient in energy saving.

![Figure 17 Advantages of cool roof over conventional roof](image)

- allows buildings to retain heat during winter months while reflecting and absorbing solar radiation during the hotter summer months.
- reduce building temperatures by up to 20 °C & reduce energy needs for air-conditioning by 25% to 80%.
- Reduce energy to heat a building in the winter.

3 CONCLUSIONS

Using these techniques in a building can save energy and can reduce carbon emission drastically. Small changes can reduce the amount of energy produced and reduction in GHG. A building which uses these techniques can save up to 70% of energy and can be considered as a net zero building. Some of the techniques and their energy saving is listed below:

- PV panels can save 360-850kw of energy/month.
- Solar heaters can save 100l/day
- 1 LED bulb can save 1,05,120 kw/h/year
- Wind towers can generate 300kw/month
- Highly efficient system gadgets can save up to 20% of electricity bill
- Green roof decreases 5degree of temperature
- Triple glass can reduce 25% of heat loss
Reference


