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CASE STUDY ON ZERO ENERGY BUILDING (INDIRA PARYAVARAN)

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Abstract: Indira Paryavaran Bhawan is the office building of the Ministryof Environment and Forest (MoEF) and is built under the concept ofNet Zero Energy Building (NZEB). It is situated at Aliganj on JorBagh Road in South Delhi. This new building was constructed byproviding minimum change to the old building and minimum disturbance to the surrounding ecosystem. The work of designing the building was carried out by the Central Public Works Department (CPWD) and the sustainable design consultants, Architects and Planners. The aim and objective of designing this building was to bring maximum energy efficiency and generate onsite sufficient renewable energy to run the building. Special emphasis was given to reduce energy demand by providing adequate natural light, shading, landscape to reduce ambient temperatures and provision of energy efficient active building systems. Apart from energy efficiency measures, energy conservation measures were also adopted by the design team to reduce the energy loads and generate energy from the onsite solar panels thusmeeting the net zero building criteria. The various strategies involved in designing the building and meeting all the criteria of a net zero building have been discussed in this case study.

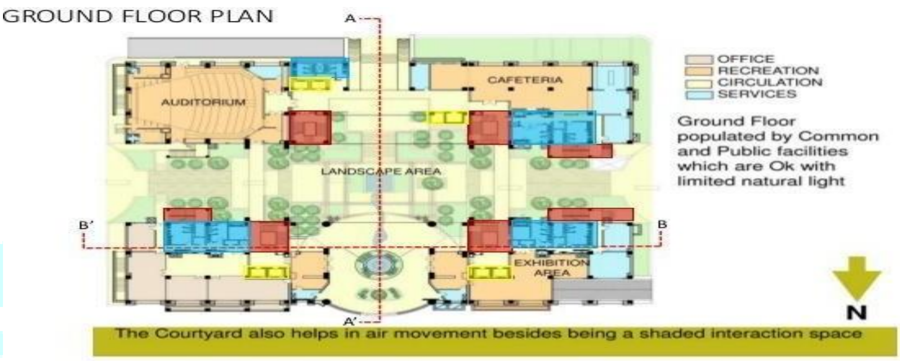
***Index Terms* – Zero energy building, Indira paryavaran building.**

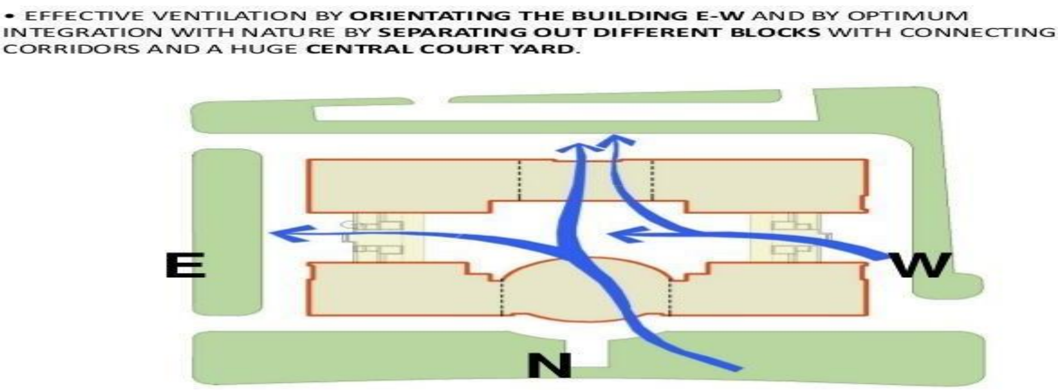
I. INTRODUCTION

India is facing intimidating challenges in meeting its energy needs. If India continues with a sustained growth rate of 8% per annum, its primary energy supply will need to grow by 3 to 4 times, and electricity generation capacity/ supply by 5 to 6 times compared to 2003-04. It is estimated that by 2031-32, the country's power generation capacity of 800,000 MW would be required as against the installed capacity of 160,000 MW inclusive of all captive plants in 2006-07. It has been estimated that the country is currently facing an electricity shortage of 9.9% and a peak demand shortage of 16.6%. Domestic and commercial sectors account for approximately one-third of total electricity consumption and these sectors are likely to consume around 37% of electricity in 2020-21. The worldwide CO2 emission mitigation efforts, the growing energy resource shortage, dependence on fossil fuels, and the fact that buildings are responsible for a large share of the world's primary energy use drives research towards new building concepts, in particular NZEBs. This concept has received increasing attention in recent years, since growing numbers of stakeholders globally are attempting to reduce the energy consumption, operating costs, and embracing targets to diminish energy footprints from their building's stocks. The latest andperhaps the most ambitious of these efforts relate to the development and evolvement of NZEBs. NZEBs are commonly understood as highly energy- efficient buildings that use, over a year, renewable energy technology to produce the same amount of energy they consume. Indira Paryavaran Bhawan in New Delhi is the first zero net energy building constructed in India with passive solar power generation. Due to inadequacy of roof-top area, additional area was provided through cantilever structural arrangement. Net zero energy building is the outcome of energy efficient architectural, structural, material, electrical and air-conditioning design. Plot Area – 9565 sq m. Wider Front Setback (22m) to protect front tree line Preserve the integrity of thegreen street. The building orientation is set in the manner that it favors optimum solar accessand shading. Two blocks facing north south direction have been arranged parallelly having a linear open court in the middle. Building front is a wider setback so that it can protect tree lines for occupant's outdoor view access.

II. PASSIVE DESIGN STRATEGIES

Orientation: The building is north-south oriented, which is favorable for effective ventilation. Two separate blocks connected through corridors for optimum integration with nature and a huge central courtyard provided which again helps in better air circulation and provides skylight also. The courtyard has been provided with natural vegetation which reduces surrounding temperature, enhances air movement thus cool air is preserved and hot air escapes easily and provides a green view. Orientation minimizes heat ingress. Window to wall ratio of the building is optimum according to the energy conservation benchmark.



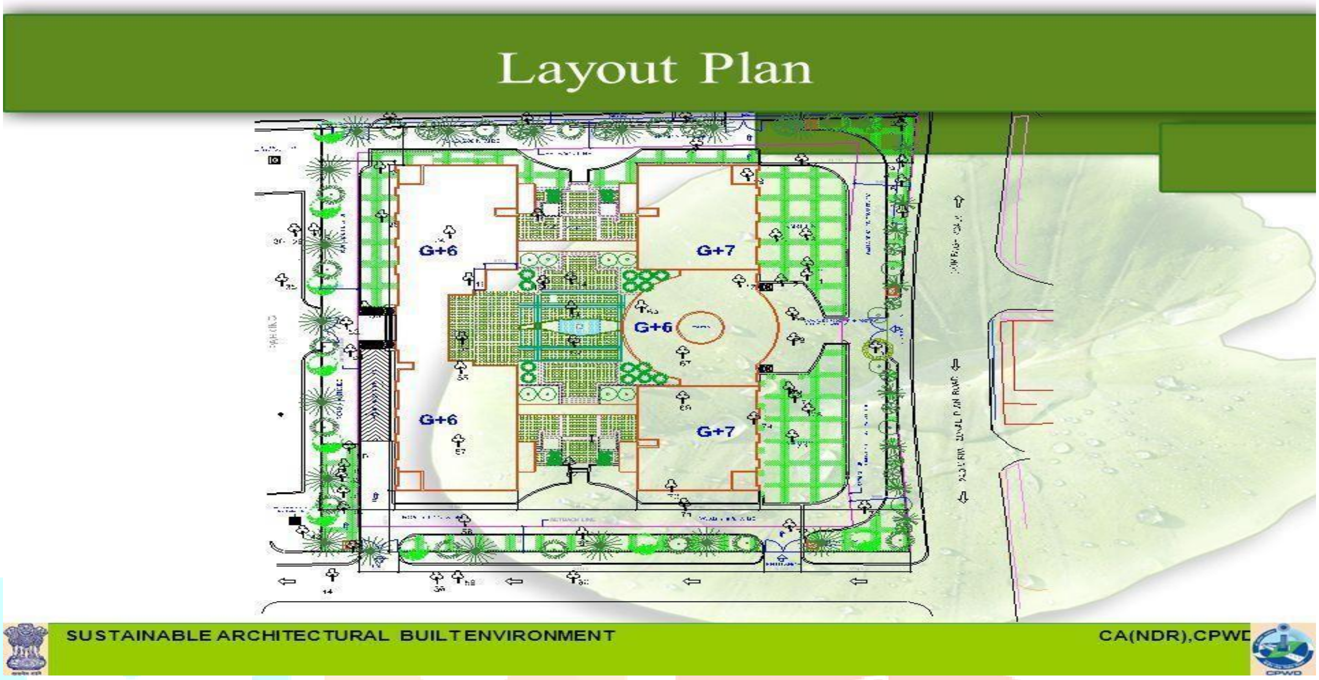


Landscaping: Greater than 50% area outside the building is covered with plantation especially native plants that have been planted to reduce water consumption. Circulation roads and pathways are softly paved to enable groundwater recharge.

Ventilation: Courtyard in the center of the building helps in air movement asnatural ventilation happens due to the stack effect. Windows and jaalis add tocross ventilation.

Day lighting: The courtyard is provided with skylight which provides indoor natural sunlight. 75% of building floor space is provided with adequate daylight, consequently reducing dependence on artificial sources for lighting.

Materials and construction techniques: Building constructed with the use of low embodied energy and a recycled content-based product like AAC blocks with fly ash, fly ash-based plaster & mortar. The building has been constructed by providing local stone flooring, bamboo jute composite doors, frames, and flooring. These products are of low embodied energy. High-efficiency glass, high VLT, low SHGC & Low U-value, optimized by appropriate shading which helps in energy efficiency. Light shelves have been provided for diffused sunlight. Stone and Ferro cement jaalis used.

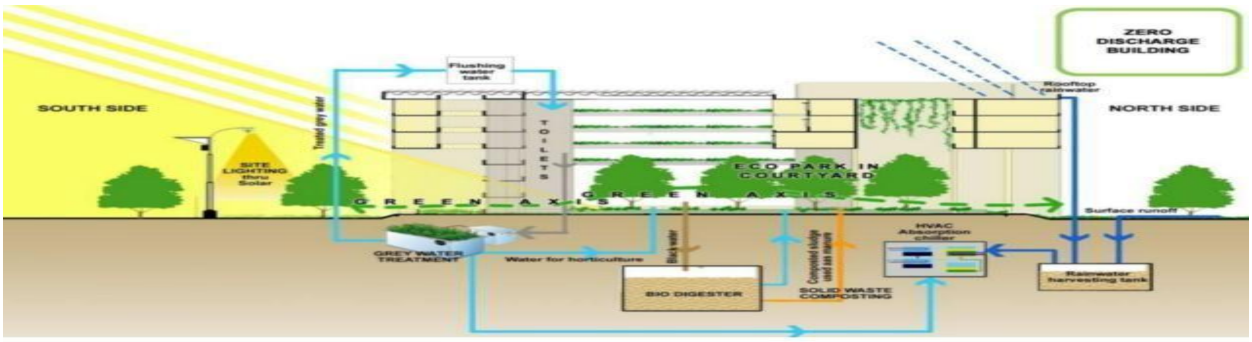


III.Active Design Strategies.

Lighting Design: Building provided with an energy efficient lighting system that uses a level sensor to optimize the operation of artificial lighting. The totallighting power density of the building is LPD = 5 W/m2 which is much more efficient than Energy Conservation Building Code benchmarks. Installed integrated photovoltaic (BIPV) provides energy to the remaining lighting load.

Optimized Energy Systems / HVAC system: Building used chilled beam system to meet 160 TR of air conditioning load. The use of a chilled beam system lessens energy use by 50 % in comparison to a conventional system by saving AHU/FCU fan power consumption by approximately 50 kW. Chilled water is supplied at 16° C and the return temperature is 20° C. This system is used from second to the sixth floor in the building. Water-cooled chillers and double skin air handling units fitted equipped with variable frequency drivers (VFD) which reduces energy consumption on variable load. Chilled water pumping system, cooling tower fans, and AHUs use VFD. All HVAC equipment controlled & monitored through an integrated building managementsystem. Sensible & latent heat energy recovery wheel used to precool fresh supply air from toilet exhaust air. Room temperature is maintained at 26 ±1 ° C which is again a brilliant step towards energy conservation. more efficient than ECBC requirements.

The building used functional zoning to reduce air conditioning loads. With thechilled beams, drain pans are provided to drain out condensed water droplets. The overall HVAC load of the building is 40 m2/TR, which is 50%.



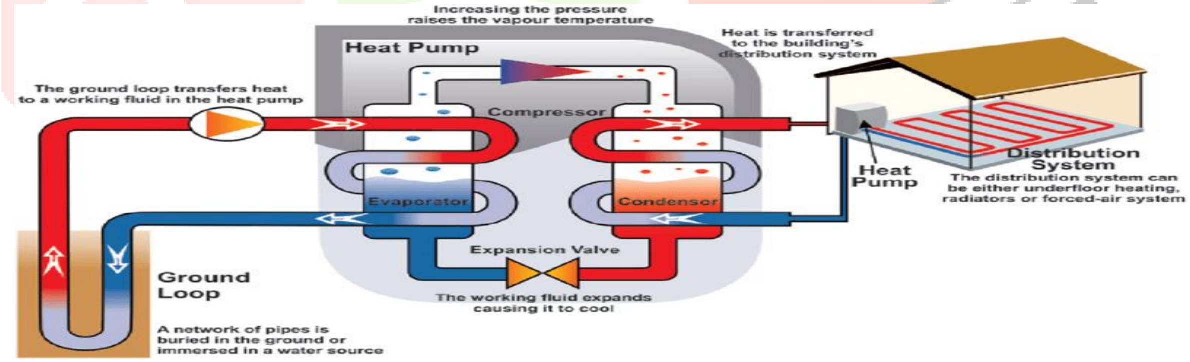
Site and Water Mgmt Strategies
Appropriate Shading from Summer Sun, while allowing in winter sun

IV. ENERGY EFFICIENCY - ECO-FRIENDLY FEATURES.

The building has been made energy efficient through onsite solar power generation, reduction of conventional lighting load by enabling 75% daylight use, generation of energy by deploying thin film transparent PV modules on space frame over the terrace and central courtyard, use of high efficiency lighting fixtures, astronomical/time switches and occupancy sensors.

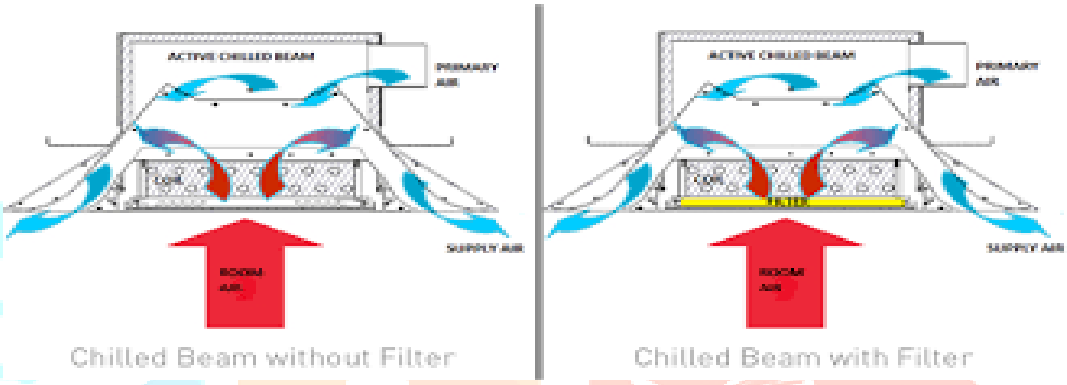
- Geothermal heat exchange system
- Regenerative lifts
- Fully automated car parking in basements
- Building orientation in E-W direction
- Blocks connected with corridors and central courtyard
- Building envelope designed to ensure daylight in 75% occupied areas
- Plantation and grassing in more than 50% area
- Grass pavers in circulation areas
- Terrace garden
- Energy efficient air conditioning system and lighting
- Conversion of braking energy into electricity in lifts
- Chillers and AHUs with VFDs, heat recovery wheels and thermostat controlsfor HVAC
- LED lights, occupancy and Lux level sensors
- 930 KWP rooftop solar power plant
- Low discharge water fixtures
- Landscaping with no hard paving eliminating heat island effect
- Sewage treatment plan for 30kld capacity

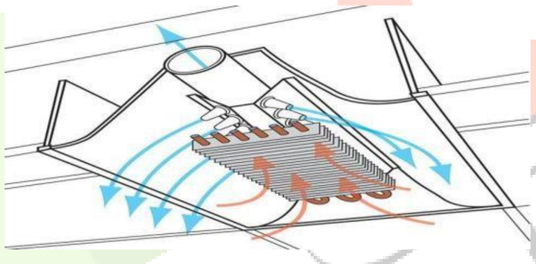
Vertical closed loop system of geothermal heat exchange system to reduce theload on the HVAC system was adopted for the first time in a government building in India on such a large scale. The system utilises the advantage of difference between ambient temperature and the temperature below ground level. The system has a vertical closed loop system done with 32 mm diameterHDPE U – loops, 180 in number and 80m deep each. It resulted in a reductionof 160 TR load on the cooling tower and consequent reduction in consumptionof water. There are 180 vertical bores at the Depth of 80 meter all along the Building Premises. Minimum 3 meter distance is maintained between any two bores. Each bore is lowered with HDPE pipe U-loop (32mm outer Dia.) and groutedwith Bentonite Slurry.



Robotic Car Parking Concept: All three basements have been used for the automatic parking system. First basement was designed for the car entry and exit lobby and puzzle parking system, and the second and third for the robotic dolly parking system. There were two ramps: one for car entry and the other for exit. First basement has a capacity of 49, second basement of 126 and third of 170. A vehicle will alwaysbe parked on steel stalls installed on the floor. The dolly always carries the car,supporting it from the bottom area of the 4 wheels. During the operation, the user keeps his car in the entrance lobby and moves out. The elevator lifts the car from the entrance lobby and moves along Z exit tothe required floors. Floor shuttle dolly picks the car from the elevator and delivers the same on a transfer stall and returns for the next command. The shuttle on the specified floor moves on track along Y exit and the dolly goes outfrom shuttle along the X exit and comes back by the same path. The shuttle withdolly and cars moves (along X exit) and aligns with an empty parking stall and returns to the shuttle. The retrieval operation is exactly as above but in reverse order. Main components of the parking system include robotic dolly, shuttle, elevator, boombarrier and auto gate, car stopper at entry lobby, CCTV and signage, PLC panel,car stall, control room, ticket counter and service voltage transformer panel.

Active Chilled Beams: Supply air flows through nozzles in small air jets which induce room air to flowaround the coil & air gets cooled. Active Chilled Beams have a primary air connection that provides conditioned/dehumidified ventilation air. This primary air is pushed throughthe beam's induction nozzles, which causes the beam to act as an air diffuser. Active beams may be used for both cooling and heating applications.





SOLAR ENERGY: A building integrated photovoltaic (BIPV) Power Plant has been installed on theentire roof surface of the building and court area. This clean and green renewable energy system has helped in meeting the energy demand of the building to achieve the target of net-zero energy.

PARAMETER	**QUANTITY**
Capacity of PowerGeneration	930 kW Peak
Annual EnergyRequirement	14,00,000 Unit (kWh)
Annual Energy Generation	14,00,000 Unit (kWh)
Net Energy Consumption	ZERO
Total area	6000 m^2
Total area of Solar panels	4600 m^2
Type of Photovoltaicpanel	Mono Crystalline 20% efficiency
Number of panels	2844
Nature of PowerGeneration	Grid Interactive

WATER MANAGEMENT: The landscape and horticulture design of planting native species along with efficient irrigation systems are utilized leading up to 50% reduction in water requirement. The remaining water demand is met by recycling and reusing wastewater, and by implementation of rainwater harvesting systems. Additionally, low discharge and efficient water fixtures are installed including sensor urinals and dual flow cisterns.

- 55% Reduction in overall use of water
- Low discharge water fixtures
- Low demand plants in landscaping
- Use of Geothermal Cooling
- Recycling of waste water for ZERO Discharge
- Rain water harvesting
- Recharge wells, supply to NDMC Tankers

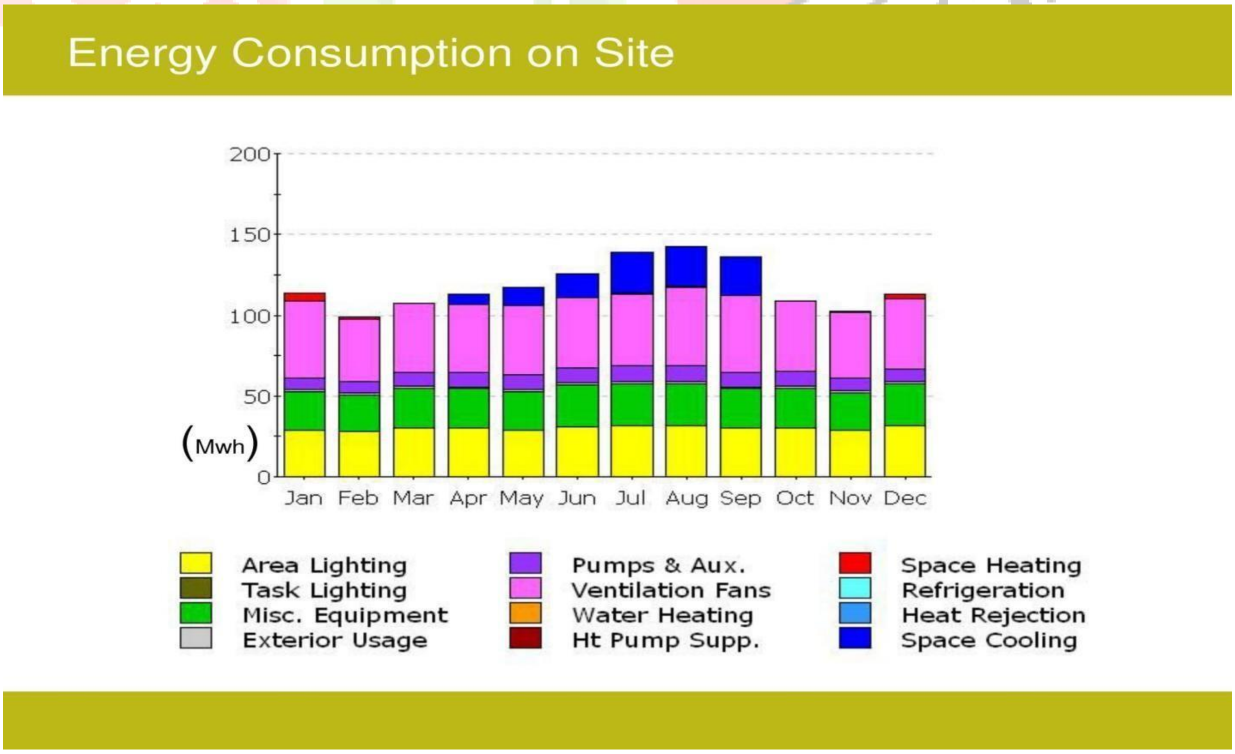
LIGHTING DESIGN:

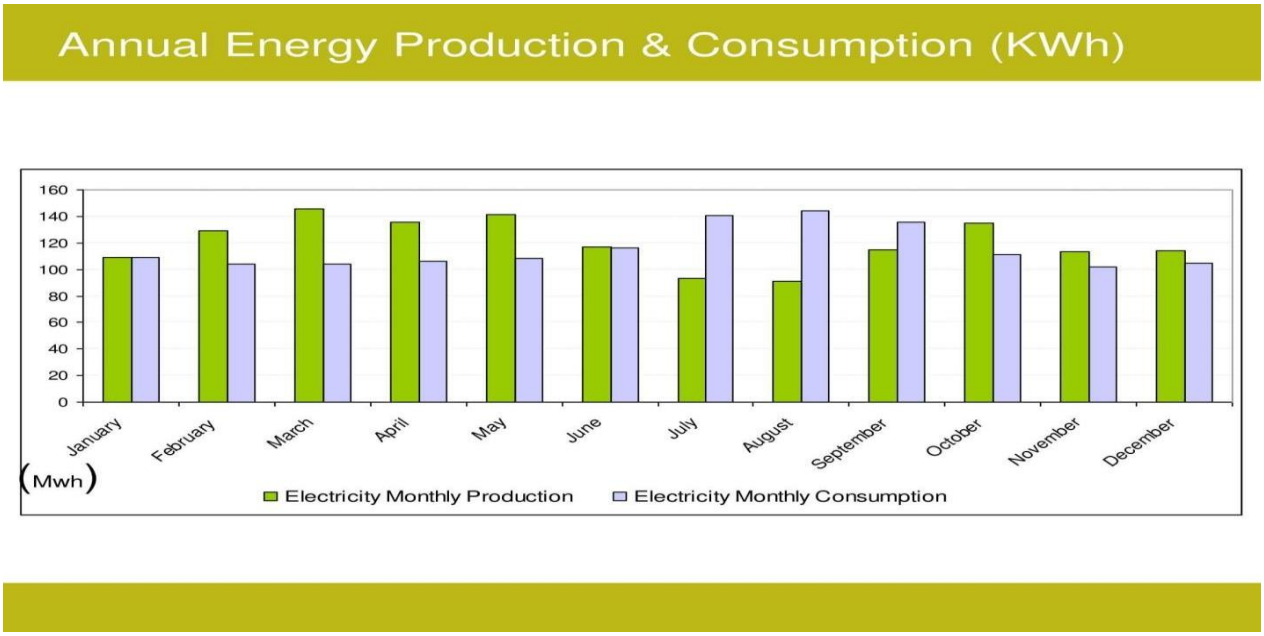
- Energy efficient lighting systems (LPD = 5 W/m2) , nearly 50% more efficient than Energy Conservation Building Code 2007 requirements (LPD = 11 W/m2) reduces energy demand further.
- Remaining lighting load supplied by building integrated photovoltaic(BIPV).
- Use of energy efficient lighting fixtures (T5 lamps).
- Use of sensors to optimize operation of artificial lighting.

Annual Consumption	Conventional Design	Indira ParyavaranBhawan	Saving
Electricity	22,00,000 kWh	14,00,000 kWh	40%
Water	20,000 kL	9,000 kL	55%

Indira Paryavaran Bhawan uses 70% less energy compared a conventional building. The project adopted green building concepts including conservation and optimization of water by recycling waste water from the site.

S.No	Description	Conventional	IPB
1	Air-conditioning Load	150 Sq Ft/TR	450 Sq Ft/TR
2	Lighting Power Density	1.1 W/Sq ft	0.5 W/Sq ft(ECBC)
3	Electrical Load	10 W/sq ft	4.3 W/sq ft





V. CONCLUSION

The case study discloses that Indira Paryavarn Bhawan first govt. building inthe country to achieve the landmark of net zero energy building which has an annual energy consumption of 14.21 Lakh kWh met with equivalent annual energy generation of 14.3 lakh kWh from Solar BIPV installed on-site and one of the very few full-fledged multifunctional office buildings in the world to do so on a tight urban site. Being the highest green-rated building in the country, the project serves as a shining example of high performing government buildings. This building will play the role model of sustainability and will guide the architects, MEP consultants, builders to implement green norms in upcoming building construction. The design parameters adopted in the building will enlighten the academician and professional for defining the design criteria of net-zero energy buildings in composite climate conditions.This building is an Epitome for many high-rise buildings for the future and present to be eco-friendly. This building shows how many other buildingsdespite having various drawbacks can slowly and steadily uplift themselves. They can even contribute towards fighting Global Warming and other severe climate changes.

REFERENCES.

1. Ravi Kapoor, Aalok Deshmukh, and Swati Lal ―Strategy Roadmap for NetZero Energy Buildings in India‖ USAID ECO-III Project, August 2011
2. Case Study: India’s First Net-Zero Energy Building- Indira ParyavaranBhavan Rati Khandelwal, Ravindra Kumar Jain, Mukesh Kumar Gupta
3. Balkar Singh, Research Scholar,Dept. of Civil Engg., NITTTR, Chandigarh,India
4. Marszal A.J., Heiselberg P., Bourrellee J.S. et. al “Zero Energy Building – AReview of Definition and Calculation Methodologies” International Journal Energy and Buildings‟ Vol. 43, pp. 971-979,2011
5. L. Lu, Yang H.X., “Environmental payback time analysis of a roof-mounted building-integrated photovoltaic (BIPV) system in Hong Kong” InternationalJournal „Applied Energy‟, Vol. 87 pp. 3625-3631, 2010.
6. Emmanuel Isaac, “Energy and Motivation through Materials” A compendium of experiences from across the world, International Conference on Energy Efficiency in Buildings, Vol. 1, pp. 123-129, 17-18 December, 2015.
7. Sharma Shivangi, Tahir Asif, Reddy K.S, Mallick Tapas K., “Performance enhancement of a Building Integrated Concentrating Photovoltaic system using phase change material” International Journal (Elsevier) Solar Energy Materials & Solar Cells, Vol. 149 pp. 29– 39, 2010.
8. http://cpwd.gov.in/CPWDNationBuilding/InaugurationPM25.02.2014/archit ectural_design.pdf
9. Deependra Prashad (DPAP) Practicing Architect & Sustainable Design Consultant
10. https://en.wikipedia.org/wiki/Indira_Paryavaran_Bhawan#References