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Net zero buildings in 5 climatic zones in India: Techniques & Guidelines

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Abstract - The world needs to move toward a more carbon-neutral path, as mounting data shows that unchecked greenhouse gas emissions constitute an existential threat. In order to accomplish this, everyone shares responsibility, Policymakers are only one part of the equation. Stakeholders consisting of the public and business sectors, non-profit organizations, and civil society at large. To establish emission reduction goals, a number of methodological strategies have been created, such as the Science-Based Targets Initiative (SBTi). Regarding this, Net Zero buildings have drawn more attention recently and are useful strategies to lower carbon emissions at the fundamental level. India has a tremendous potential for utilizing natural energy, and the Indian government has taken measures and offered incentives to encourage local participation.

***Key Words*:** Net zero energy buildings, Greenhouse gases, Carbon emission, Active techniques, Passive techniques.

1.INTRODUCTION

Recent years have shown that our climate is changing rapidly, with extreme weather events becoming more frequent. This shows the need of world to follow a more carbon-neutral path is clear, with highlights of the existential threat caused by unregulated greenhouse gas emissions at COP21 (Conference of the Parties 21, Paris UNFCCC).
Responsibility for achieving this does not only lie with policy makers but is shared with all stakeholders including governments, private sectors, charities, and civil society as a whole. Universities must also play their part. Higher education establishments must show leadership as they are integral in designing an effective management strategy to achieve the net carbon zero outcome. The need to exemplify academic curiosity-led research & development must also align with targets using testbeds that extend beyond the typical academic or industrial boundaries.
According to a research India is the only country in the world to have an exclusive ministry for renewable energy development, the Ministry of New and Renewable Energy (MNRE) which has launched one of the world's largest and ambitious programs on renewable energy (UNDP).

1.1 Current Scenario of Renewable Energy in India:

Over the years, renewable energy sector has emerged as a massive blast in India especially affecting the power generation capacity. This supports the government's agenda of sustainable development while becoming an integral part in meeting the nation's energy needs. For past two years, the Indian Government has taken several initiatives such as introduction of the concept of solar parks, organizing RE-Invest 2015—a global investors' meet, launching of a massive grid connected rooftop solar program, earmarking of Rs.38,000 crore (Euros 4 billion) for a Green Energy Corridor, eight-fold increase in clean environment cess from Rs.50 per ton to Rs.400 per ton (Euro 0.62 to Euros 5 per ton) , solar pump scheme with a target of installing 100,000 solar pumps and program to train 50,000 people for solar installations under the Surya Mitra scheme, no inter-state transmission charges and losses to be levied for solar and wind power, compulsory procurement of 100 per cent power from waste to energy plants, and Renewable Generation Obligations on new thermal and lignite plants, etc.

*Source: Ministry of New and Renewable Energy (MNRE)

Table 1: Government subsidies and policies for renewable energy implementation projects.

S.No.	State	Policy Incentives	Targets	Target Segments
1.	Telangana	30% subsidy on capital for installation from MNRE (central government) not the state government; with 20% subsidy on installation of RTPV up to 3kW capacity for domestic sector.	5000 MW by 2020	All consumers, govt. is currently aiming for decentraliz ed solar projects.
2.	Chhattisgarh	Capital investment subsidy of 30% provided- given by MNRE (central government). Subsidy of 40% provided by the state government.	500-1000 MW by 2017 (not yet achieved)	Residential, Commercia l & Industrial consumers
3.	Gujarat	MSMEs are now allowed to install solar projects with capacity > 100% of sanctioned load.	8024 MW by 2022	Small-scale distributed solar sector
4.	Karnataka	No limit to residential rooftop capacity (prev. It was 80% of sanctioned load)	3200 MW from rooftop installation s	Domestic consumers

*Source: Various State Governments' Solar Energy Policies

1.2 Advantages of India:

- Robust Demand: With the growing Indian economy, the electricity consumption is projected to reach 15,280 TWh by 2040.
- Increasing Investments: With Indian government's ambitious targets, the sector has become quite attractive to foreign and Indian investors. It is expected to attract investments up to USD 80 billion (Euros 70 billion) in the next four years.
- Competitive Advantage: Indian subcontinent has sunlight available throughout the year and has a large hydropower potential.

2. Renewable Energy Targets:

The Indian Government has increased the target of renewable energy capacity to 175 GW by the year 2022 which includes 100 GW from solar, 60 GW from wind, 10 GW from bio-power and 5 GW from small hydropower.

Table 2: Installed grid interactive renewable power capacity (excluding large hydropower) as of 31 March 2018 (RES MNRE)

Source	Total Installed Capacity (MW)	2022 Target
Wind Power	34,046	(MW)
Solar Power	21,651	60,000
Biomass Power (Biomass & Gasification and Bagasse Cogeneration)	8,701	1,00,000
Waste-to-Power	138	10,000
Small hydro power	4486	
TOTAL	69022	5,000

*Source: Department of energy India

3. Case Studies and Techniques:

The case study presents a summary of the main technical features of the 5 projects selected from the NZEB for analysis. As for the energy net zero-energy performance, 2 projects are plus-energy buildings and 3 are nearly zero-energy buildings. The CEPT & Lodsi community project buildings are the example for Net zero building structures which can produce the required amount of energy on its own and by reducing its energy consumption it can also reduce energy usage to supply excess energy to the other structures onsite and to the grid.

Table 3: Main technical features of the case studies.

NAME	FLOOR AREA	PASSIVE METHODS	ACTIVE METHODS	RENEWABLE ENERGY	EPI
SIERRA'S eFACiLiTY® Green Office Building Coimbatore, Tamil Nadu (Moderate)	2322.55 sq.m.	1. Climate responsive design. 2. Landscape and water efficiency	1. Air conditioners. 2. Artificial lighting and control 3. Water efficiency 4. Energy monitoring 5. Sun tracking shadow management 6. Smart Use of Solar Energy and Lighting Controls	1. solar renewable system to meet the energy demand 2. 60 KW rooftop solar PV, 4.3 KW Amorphous Silicon thin-film Building Integrated Photovoltaic (BIPV) glass panels on the southern façade and recently installed 20 KW bi-facial rooftop solar panel.	56.2 kWh/m2/yr
Unnati Office Greater NOIDA, Uttar Pradesh (Composite)	3,740 sq.m.	1.Orientation 2.Landscaping 3. Daylight 4. Ventilation 5. Building Envelope and Fenestration	1. Lighting design 2.Optimized Energy Systems / HVAC system 3. Metering and Monitoring	1.The building draws 40% of its energy from the roof-top PV plant. 2.The installed 100 kW solar PV generates 146 MWh/yr.	60 kWh/m2/yr
CEPT, A Living Laboratory, Ahmedabad (Hot & dry)	498 sq.m.	1.Orientation 2. Daylight	1. HVAC technology 2. Lighting design	50% of roof covered with 27 kW PV panels tilted at 23 ° facing south for on-site generation equivalent to 70 kWh/m2 /yr.	58 kWh/m2/yr
Avasara Academy Lavale, Pune (Warm & humid)	11,148 sq.m.	1.Orientation 2.Landscaping 3.Daylighting 4. Ventilation	1. Lighting Design 2.Optimized Energy Systems / HVAC system	1. Solar PV System 2. Solar water heater	85% of school's energy need are met

		5. Building envelope & climate responsive massing 6. Material & construction techniques			with solar power.
Lodsi Community Project for Forest Essentials, Uttarakhand (Cold)	929 sq.m.	1.Orientation 2.Landscaping 3.Daylighting 4. Ventilation 5. Building envelope and fenestration	1.Lighting design	1. Draws 100% of its energy from roof-top PV plant. 2. 50kW PV plant harnesses surplus energy 3. Excess energy fed to the state grid.	35 kWh/m2/yr

*Source: NZEB

The selection of all the 5 projects were based on the criteria such as location, methods (active & passive), harness of renewable energy and energy performance index.
The data also suggests the different location of net zero projects throughout India and their success in the respective locations which highlights that India has a capability to adapt the net zero building structures and is a success. It also caters the global climate change caused by reducing the yearly carbon emission and ultimately reducing the emission of unregulated GHG (Greenhouse gases).

The table below presents set of passive and active methods used in various climatic zones to achieve a net- zero setup.

Table 4: Active and passive techniques in different climatic zones

NAME	PASSIVE METHODS	ACTIVE METHODS	RENEWABLE ENERGY
Moderate	1. Climate responsive design. 2. Landscape and water efficiency. 3. Thermal insulation. 4. Passive shading	1. Air conditioners. 2. Artificial lighting and control 3. Water efficiency 4. Energy monitoring 5. Sun tracking shadow management	1. Roof top solar PV cells for energy generation
Composite	1. Orientation 2.Landscaping 3. Daylight 4. Ventilation 5. Building Envelope and Fenestration	1. Lighting design 2. Optimized Energy Systems / HVAC system 3. Metering and Monitoring	1. Roof top solar PV cells for energy generation
Hot & dry	1.Orientation 2. Daylight 3. Wind towers	1. HVAC technology 2. Lighting design	1. Roof top solar PV cells for energy generation
Warm & humid	1. Orientation 2.Landscaping 3. Daylighting 4. Ventilation 5. Building envelope & fenestration 6. Material & construction techniques	1. Lighting Design 2.Optimized Energy Systems / HVAC system	1. Solar PV System 2. Solar water heater
Cold	1.Orientation 2.Landscaping 3.Daylighting 4. Ventilation 5. Building envelope and fenestration	1.Lighting design 2. Optimized Energy Systems / HVAC system 3. Indoor Air Quality using Bernoulli's principle.	1. Solar water heaters 2. Rooftop PV cells.

3. CONCLUSIONS

Based on the study and the opportunities of the availability of renewable energy resources and the net zero energy building methods it is concluded that the scope in reduction of greenhouse gases and ultimately indulging in the greater concern of climate change is very much possible for India through the application of "Net zero energy building" techniques throughout the country.
Although there is no standard approach for designing a Net Zero-Energy Building (due to the numerous possible combinations of active, passive, and efficiency measures, utility equipment, and on-site energy generation technologies capable of achieving net-zero energy performance), a close examination of the strategies and indicators of relative performance of the five case studies revealed that it is possible to achieve zero-energy performance in India using well-known technologies.

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