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ENERGY EFFICIENCY IMPROVEMENTS IN COMMERCIAL BUILDINGS

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Rolling Out Energy Conservation Building Code (ECBC)

Energy Efficiency Improvements in Commercial Buildings (EECB)

Initiated by UNDP GEF and BEE

INTRODUCTION

The building sector consumes about 40% of the total energy produced globally. India's building sector consumes about 31% (882 billion units [kWh]) of the total energy production, as per the 2013/14 figures of the Ministry of Statistics and Programme Implementation, Government of India. Out of this, about 9% is consumed by commercial buildings.

Commercial buildings include offices, hospitals, hotels, retail outlets, educational buildings, government offices, etc. Each commercial building would have a minimum connected load of minimum 100 kW or contract demand of 120 kVA. The total built-up area of commercial buildings is expected to touch 1.9 billion m^2 by 2030 from the 2015 figure (847 million m^2), a growth of three times!

Seen in the context of the fast-growing commercial building stock, the electricity consumption in this sector is set to reach unprecedented levels by 2030. The major fall-out of such high level of energy consumption is the increased greenhouse gas (GHG) emissions from this sector.

With about 1 billion m^2 of commercial buildings yet to be built, there is huge potential of energy conservation. Recognizing this potential and to mainstream energy efficiency in commercial buildings, the Government of India, through Bureau of Energy Efficiency (BEE), has launched the Energy Conservation Building Code (ECBC) in 2007. Until December 2016, while 10 states have made ECBC mandatory for commercial buildings through notification in their state gazettes, another 10 states are in advanced stages of making it mandatory.

ENERGY CONSERVATION BUILDING CODE (ECBC)

The ECBC provides minimum energy efficiency requirements for five building systems: (1) Building Envelope (walls, roof, etc.); (2) Heating, Ventilation and Air Conditioning (HVAC); (3) Service Water Heating; (4) Lighting, and (5) Electrical Power. In other words, an ECBC-compliant building is one in which the energy efficiency requirements of all these five building systems are fulfilled. (Visit <www.beebindia.gov.in> for details of these requirements.)

MOVING TOWARDS ECBC

While the ECBC has been developed by BEE, its implementation and enforcement lie with state governments and urban local bodies (ULBs), as broadly shown in Table 1.

Table 1: Mainstreaming ECBC: Tasks and responsibilities

Tasks related to mainstream ECBC	Responsibilities		
	Central Government	State Government	Local Government
ECBC CODE DEVELOPMENT AND UPDATING	Bureau of Energy Efficiency (BEE)		
ECBC ADOPTION			
Setup ECBC Committee to implement the code		State Designated Agency (SDA)	
Review ECBC and customize the code to suit regional and climatic conditions		SDA	
Define criteria of applicable building types		SDA	
Make legal notification in the state gazette for mandatory implementation of the code		SDA or State Urban Development Department (UDD)	

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Tasks related to mainstream ECBC	Responsibilities		
	Central Government	State Government	Local Government
ECBC IMPLEMENTATION			
Develop enabling mechanisms and processes for mainstreaming ECBC	BEE	SDA and UDD	Urban Local Bodies (ULBs)
Revision of Schedule of Rates (SoR)	Central Public Works Department (CPWD)	Public Works Department (PWD)	
Revision of State General Development Control Rules (GDCR)/ULB's Building Bye-Laws		SDA andUDD	ULBs
Develop ECBC implementation rules, e.g., Third Party Assessor (TPA) Model	BEE	SDA and UDD	ULBs
Develop public online tools/endorse third party simulation software to show compliance	BEE	SDA	ULBs
Develop technical capacity of building sector stakeholders	BEE	SDA	ULBs
Provide incentives to developers/owners for developing energy-efficient building stock		State Government	ULBs
ECBC ENFORCEMENT			
Institutionalize mechanisms for enforcement and compliance checking in ULBs and Electrical Inspectorate		State Electrical Inspectorate	ULBs
Setup robust monitoring and verification (M&V) system		SDA	ULBs

Whether a particular project is ECBC-compliant or not can be verified at four different project stages.

- **Stage 1:** While obtaining the construction permit from ULBs
- **Stage 2:** At the time of obtaining construction completion/occupancy certificate from ULBs
- **Stage 3:** While getting the electrical connection from State Electrical Inspectorate
- **Stage 4:** At the time of review of annual energy consumption for two consecutive years by the State Electrical Inspectorate or State Designated Agency after the building has been fully operational

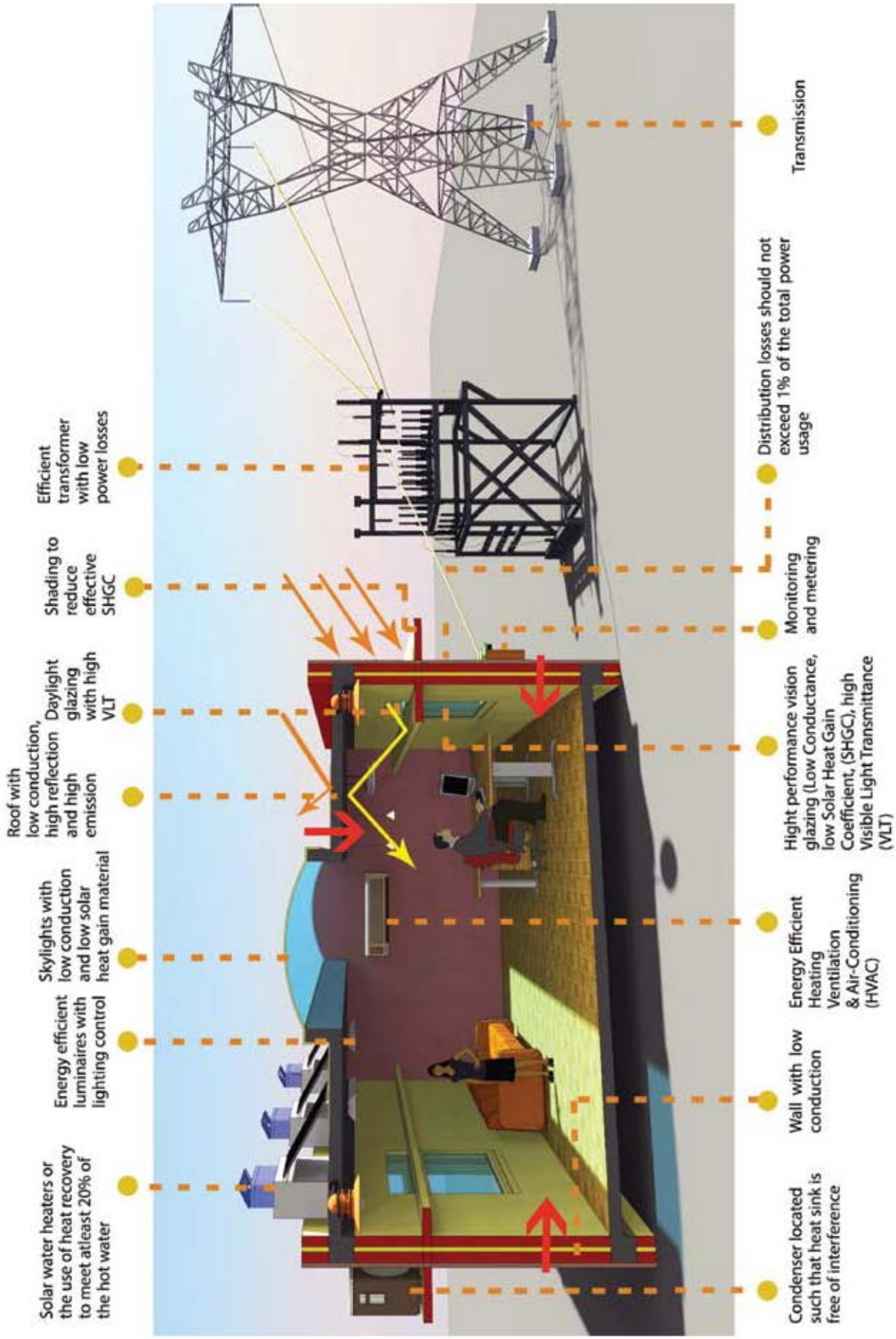
BEE STAR RATING FOR EXISTING BUILDINGS

BEE has introduced the star labelling programme for existing commercial buildings, which provides label to the buildings based on their actual energy performance. The BEE star labelling is applicable to buildings with the connected load of 100 kW or greater or contract demand of 120 kVA or greater. One to five stars are awarded to the buildings based on their specific energy use with five star label recognized as the most efficient building. A standardized format of data collection of actual energy consumption of the building was developed to collect information pertaining to building built-up area, conditioned and non-conditioned areas, type of building, hours of operation of building in a day, climatic zone, and other information related to facility.

Currently, this rating is applicable to office buildings, business process outsourcing (BPO) buildings, and shopping malls and hospitals. In future, the BEE would extend the star labelling to hotels and data centres etc.

DESIGNING AN ECBC-COMPLIANT BUILDING

The figure below captures the main interventions of an ECBC-compliant building in hot climates.



Case Study of an ECBC-compliant building

- Project function: Hospitality sector (162 regular rooms and 40 VIP rooms)
- Built-up area: 19,875 m^2
- Number of storeys: Ground + 7 storeys and one basement for parking
- Conditioned area: 9,405 m^2 (48% of the built-up area)
- Energy Performance Index (EPI) before adopting ECBC: 97 kWh/m^2.year
- EPI after adopting ECBC: 62 kWh/m^2.year
- ECBC-compliant strategies considered
  - Building Envelope: Autoclaved Aerated Concrete (AAC) cavity wall, Overdeck Extruded Polystyrene (XPS) insulation, Heat reflective tiles, Recessed windows, High performance glazing, Unplasticized Polyvinyl Chloride (UPVC) window frame
  - Lighting: Daylight integration, LED lighting fixtures for interior and exterior lighting
  - HVAC: Air-cooled Variable Refrigerant Flow (VRF) system
  - Electric Power: BEE star rated oil based transformer, Automatic Power factor correction panel
  - Service hot water: 25% of the hot water requirement is met by Solar Water Heaters

Cost Details

- Overall Project Construction Cost : ₹ 80 crore
- Additional Cost: ₹ 2,28,86,125
  - Meeting ECBC Mandatory Provisions: ₹ 60,00,000
  - Building Envelope: ₹ 47,64,045
  - Lighting: ₹ 1,09,00,555
  - HVAC: ₹ 10,000
  - Service Hot Water: ₹ 9,61,525
  - Electrical Power: ₹ 2,50,000
- Reduced cost due to optimised design and reduced sizing for lighting, HVAC, transformer and power back-up, etc.: ₹ 68,70,000
- Incremental Cost: ₹ 1,60,16,125 (2% of the project construction cost)
- Payback Period: 3.8 years [₹ 1,60,16,125 /[(35 kWh/m^2.year*19,875 m^2* ₹ 6/kWh)]
- 570 tCO_2 per year

Experience from feasibility analysis of 14 demonstration projects under the Energy Efficiency Improvements in Commercial Buildings (EECB) project shows that implementation of ECBC-compliant building costs 2%–3% more than the conventional building. A significant part of the incremental cost gets compensated against the optimized design and reduced sizing for lighting, HVAC, transformer and power, back-up etc. Feasibility reports of ECBC-compliant demonstration projects also show 30% – 40% energy savings compared to conventional buildings and through the operation energy savings, the incremental cost can be recovered within 3–4 years.

ENERGY EFFICIENCY IMPROVEMENTS IN COMMERCIAL BUILDINGS (EECB)

UNDP in collaboration with Bureau of Energy Efficiency, Government of India is executing "Energy Efficiency improvements in Commercial Buildings". UNDP's intervention with GEF funds, aims to address barriers such as informational, capacity, institutional, financial and assist the Government in implementing and operationalizing the Energy Conservation Building Code (ECBC), through a comprehensive and integrated approach.

Project Information

Area: Environment and Energy, UNDP

Budget: Total: US$ 21,027,660

US$ 5,200,000 (Global Environment Facility)

US$ 2,976,596 (Bureau of Energy Efficiency)

US$ 1,787,234 (Swiss Agency for Development and Cooperation)

US$ 11,063,830 (Others)

Duration: 2010–2017

Government Counterpart: Ministry of Environment, Forests and Climate Change

Implementing Partner: Bureau of Energy Efficiency (BEE), Ministry of Power

Project Goal & Objective:

- Reduction of GHG emissions from new commercial buildings through compliance with ECBC
- Operationalization of the Energy Conservation Building Code (ECBC) for new commercial buildings

Key Project Activities

Support States and Cities through establishment of ECBC Cell

ECBC Cell will

- Develop road map for state to implement ECBC
- Provide technical assistance to design ECBC compliant public buildings
- Provide assistance for notification of ECBC in the state gazette
- Assist revision of state P D Schedule of Rates and Plinth Area Rates PAR
- Update building bye laws to include ECBC clauses and rules

Demonstrate ECBC Compliance in Public Buildings

- Provide technical assistance to public demonstration buildings
- Provide incremental construction cost to demonstration projects

Building Capacity of Stakeholders for ECBC Implementation

- Assist states and cities to conduct training and awareness programme on ECBC
- Develop cadre of professionals, who can effectively implement ECBC

Mobilise Private Sector to Develop Energy Efficient Model Buildings

- Pilot construction of EEMBs with total built-up area of 1 million m^2 in three climatic zones
- Project will provide incentive of 1 USD/m^2 to eligible projects

Proposed EEMBs will be identified in Madhya Pradesh, Rajasthan, Delhi, Punjab, Kerala, Tamil Nadu, Odisha, Andhra Pradesh, Assam, Maharashtra, Gujarat

Appointed Cluster Level Agency will

- Mobilise commitment from potential EEMBs
- Evaluate and endorse building design drawings, specifications for code compliance
- Assess baseline EPI based on building simulation
- Monitor construction progress, provide guidance and recommendations to align with ECBC
- Technical assistance to implement energy efficiency measures in selected buildings
- Review as-built drawings and equipment to show code compliance
- Verify performance data and demonstrate 15% reduction on baseline EPI

Key achievements of the project

- Eighty-nine master trainers have been trained on ECBC, who can provide technical assistance for implementation of ECBC in states and cities
- Ten states have notified ECBC: Rajasthan, Odisha, Uttarakhand, UT of Puducherry, Andhra Pradesh, Punjab, Telangana, Haryana, West Bengal, and Karnataka
- ECBC Cells have been established in seven states: Uttar Pradesh, Karnataka, Chhattisgarh, Punjab, Haryana, Delhi, and Kerala
- Fourteen ECBC-compliant demonstration projects have been implemented: (i) Roads and Bridges Development Corporation, Kochi, Kerala; (ii) Energy Management Institute, Thiruvananthapuram, Kerala; (iii) Academic Block in SMS Medical College, Jaipur, Rajasthan; (iv) Dhanvantri OPD Block, SMS Hospital, Jaipur, Rajasthan; (v) Chhatishgarh SAMVAD Building, Raipur, Chhattisgarh; (vi) Uttar Pradesh Electricity Regulatory Commission (UPERC), Lucknow, Uttar Pradesh; (vii) Hubli Court Complex, Hubli, Karnataka; (viii) K K Guest House, Bangaluru; (ix - xii) Medical College in Tumkur, Bagalkote, Haveri and Chitradurga, Karanataka; (xiii) District Commissioner Office Complex, Mysuru, Karnataka; (xiv) Krishna Rajendra Hospital, Mysuru, Karnataka

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