सत्यमेव जयते
Government of Puducherry

DEPARTMENT OF SCIENCE, TECHNOLOGY AND ENVIRONMENT
PUDUCHERRY CLIMATE CHANGE CELL

ENERGY BENCHMARKING GUIDELINES FOR CLIMATE PROOFING BUILDINGS IN U.T. OF PUDUCHERRY

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INTRODUCTION

Anthropogenic climate change poses risks to many human and ecological systems. These risks are increasingly visible in our daily lives, including a growing number of disasters that already bear a fingerprint of climate change.

As per IPCC reports, limiting global warming to 1.5°C above pre-industrial levels would require major reductions in greenhouse gas emissions in all sectors. With this objective, 195 nations joined hands in their Climate Action in 2015 for the Paris Agreement and the Intended National Determined Contribution (INDCs). The Paris Agreement works with the ambition of strengthening the global response to the threat of climate change by keeping the global temperature rise well below 2 degree Celsius above pre-industrial levels by the end of this century, and to strive towards limiting the temperature rise below 1.5 degrees Celsius.

With this objective, the global governance aims at curtailing emissions rapidly across all major sectors including buildings, industry, transport, energy, and Agriculture, Forestry and Other Land Use (AFOLU). Actions that can reduce emissions include phasing out coal in the energy sector, increasing the amount of energy produced from renewable sources, electrifying transport, and reducing the 'carbon footprint' of the food we consume.

Countries across the nations including India have submitted their Intended Nationally Determined Contributions (INDCs) which delineates the expectations on the type and stringency of emission targets by various countries.

The list of India's NDC are as follows:

- To put forward and further propagate a healthy and sustainable way of living based on traditions and values of conservation and moderation.
- To adopt a climate friendly and a cleaner path than the one followed hitherto by others at corresponding level of economic development.
- To reduce the emissions intensity of its GDP by 33 to 35 percent by 2030 from 2005 level.
- To achieve about 40 percent cumulative electric power installed capacity from non-fossil fuel based energy resources by 2030 with the help of transfer of technology and low cost international finance including from Green Climate Fund (GCF).
- To create an additional carbon sink of 2.5 to 3 billion tonnes of CO2 equivalent through additional forest and tree cover by 2030.
- To better adapt to climate change by enhancing investments in development programmes in sectors vulnerable to climate change, particularly agriculture, water resources, Himalayan region, coastal regions, health and disaster management.
- To mobilize domestic and new & additional funds from developed countries to implement the above mitigation and adaptation actions in view of the resource required and the resource gap.
- To build capacities, create domestic framework and international architecture for quick diffusion of cutting edge climate technology in India and for joint collaborative R&D for such future technologies.

To combat the effects of climate change, India has launched National Action Plan on Climate Change (NAPCC) emphasizing promotion of inclusive and sustainable development strategies that are sensitive towards climate change to protect the poor and vulnerable section of the society. Eight National Missions form the core of the National Action Plan representing multi-pronged, long term and integrated strategies for achieving key goals in the context of climate change. The focus is to promote understanding of Climate Change, framing adaptation and mitigation strategy and promoting energy efficiency and natural resource conservation.

Under NAPCC, National Mission for Enhanced Energy Efficiency has adapted to boost the efforts taken up under Energy Conservation Act, 2001 for energy saving through efficient use by incentivizing the industries and innovations in energy efficiency area.

Building sector (residential and commercial) constitutes 33% of total electricity consumption in India. Reducing building sector emissions requires energy efficiency (EE) improvements and renewable energy (RE) deployment in new and existing buildings. With a view of increasing electricity demand and need of managing it, an effort for energy conservation was initiated by Government of India with introduction of Energy Conservation Act (EC Act) published in the Gazette of India in October 2001. Bureau of Energy Efficiency (BEE) was instituted in 2002, to implement EC Act. BEE also initiated a series of energy efficiency programmes catering to the buildings sector and specifically to the commercial buildings sector to promote energy efficiency.

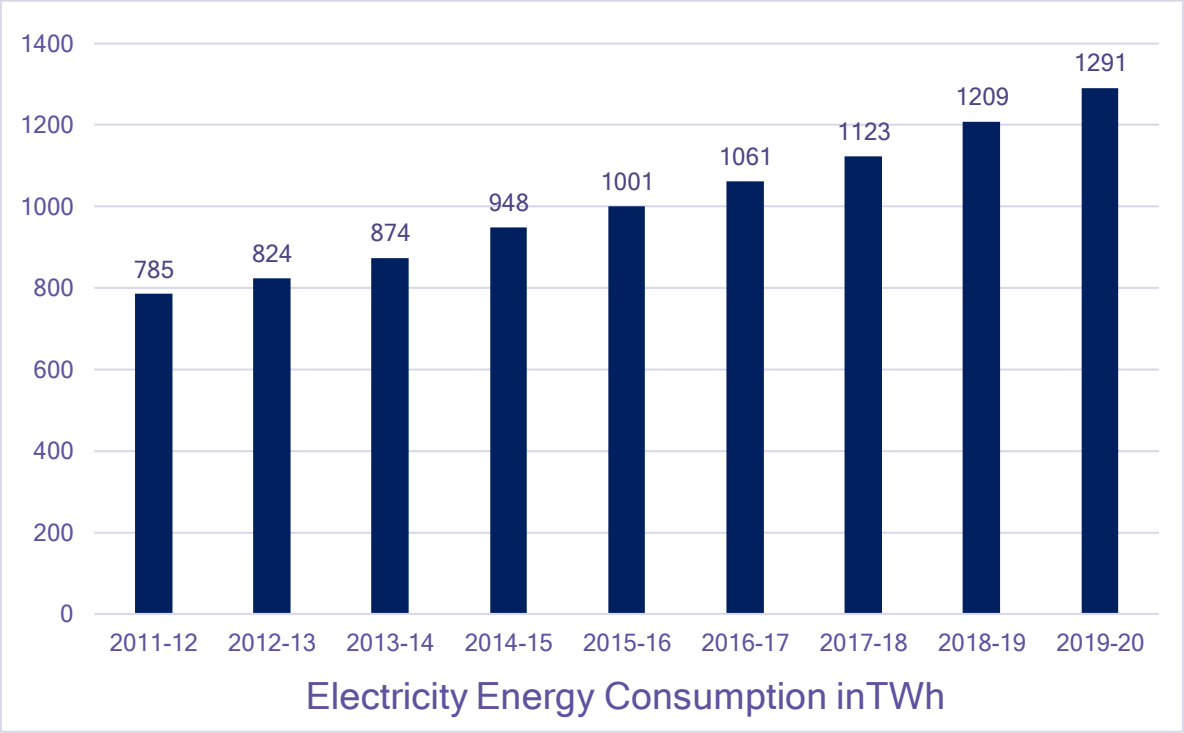
1. ENERGY SCENARIO AND ITS CONSERVATION POTENTIAL

1.1. Introduction

The power sector in India has experienced significant growth in the last two decades including demand sectors from industrial to agriculture as well as domestic (residential). High urbanization levels, increasing in the average per capita income levels, improved electricity access and electrification and increased economic activities impacting these demand sectors have been some of the contributing factors for progression in the power demand.

The electricity consumption in the country over the years is presented in Figure 1:

Fig 1: Electricity Energy Consumption in India

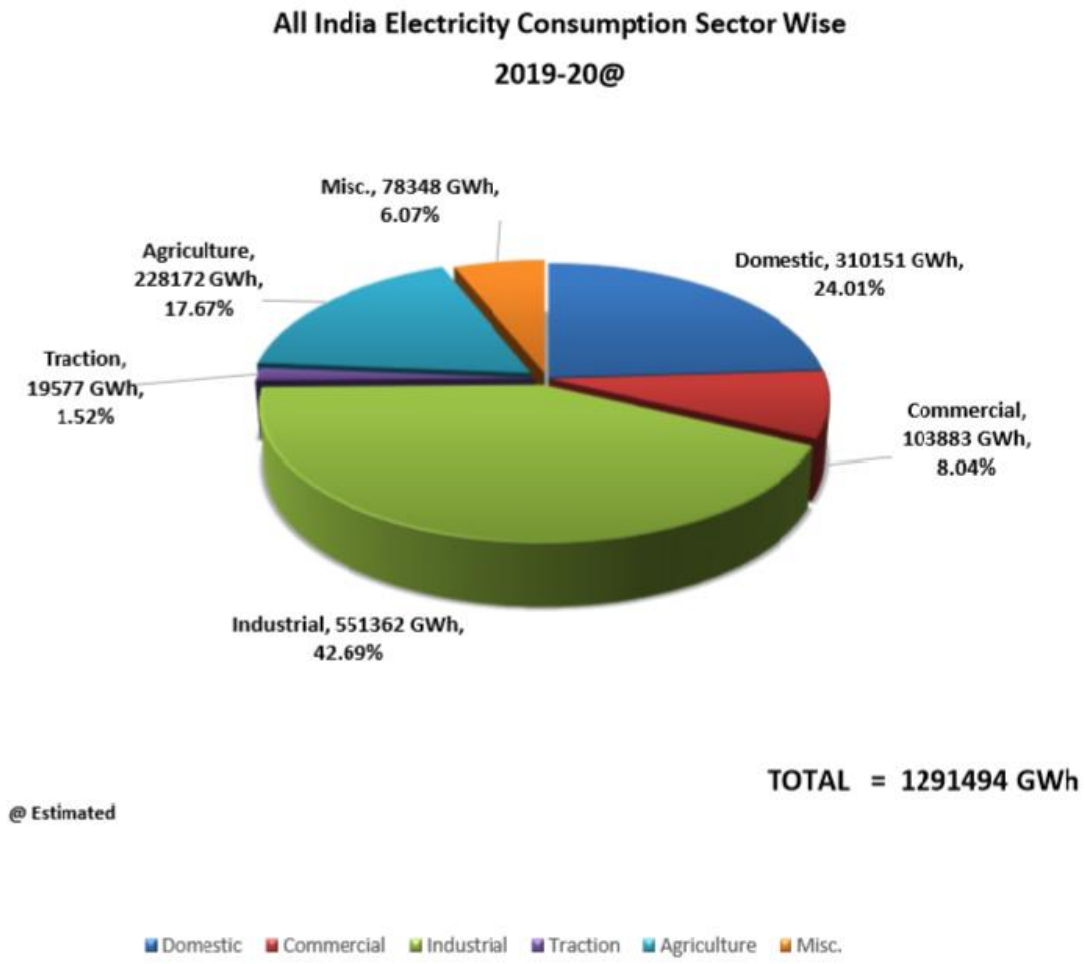


1.2. Energy Consumption Trend in India

The energy demand in India is increasing rapidly by virtue of its growing economy, rapid urbanization and rising income levels. As energy has always been recognized as one of the most important inputs to determine the economic growth of a country, it is prudent to initiate new and innovative policies to curb the unnecessary energy consumption across all the sectors.

The Sector wise electricity consumption in the country over the years is presented in Figure 2:

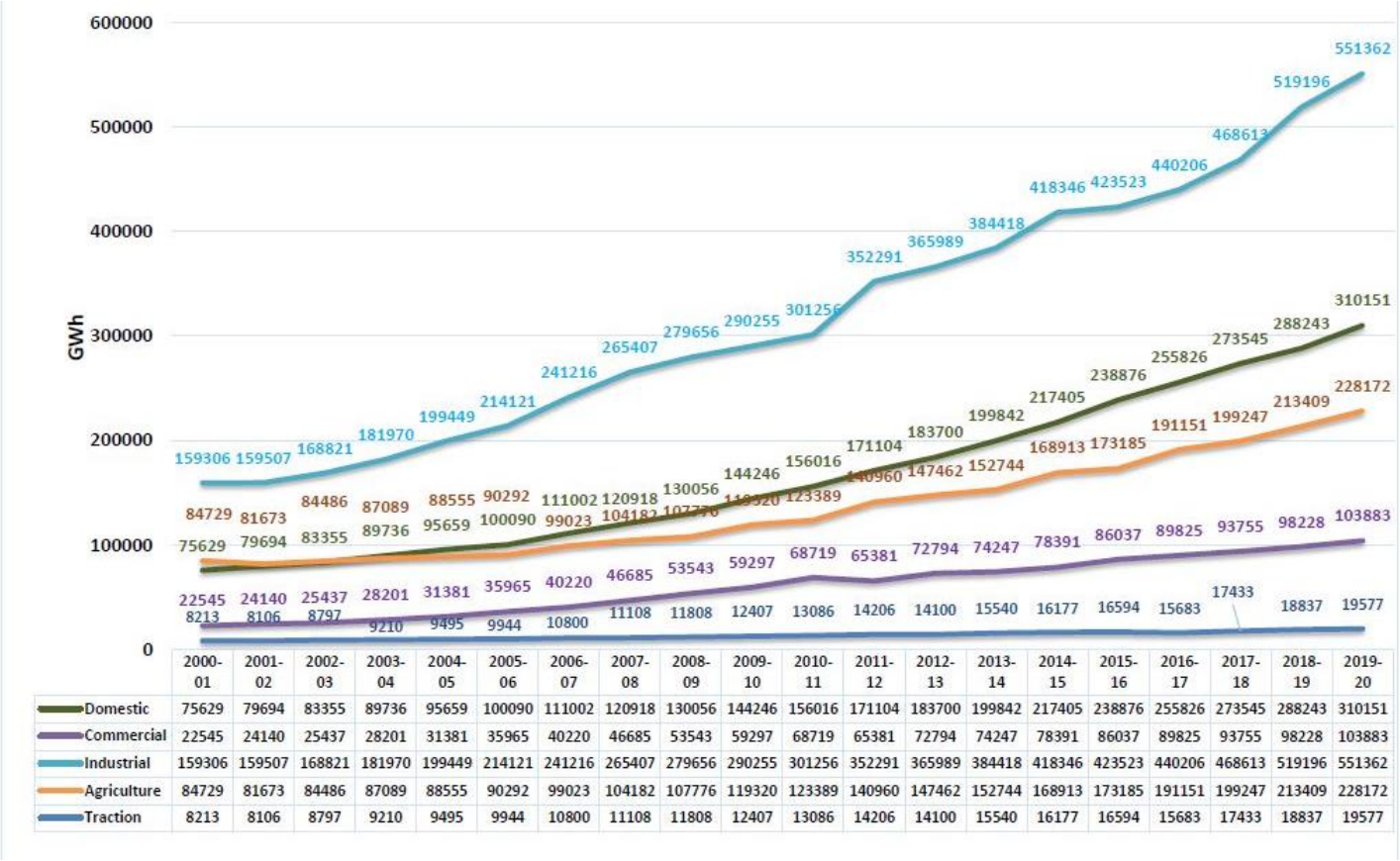
Fig 2: Sector Wise Electricity Consumption in India



The estimated electricity consumption increased from 6,94,392 GWh during 2010-11 to 12,91,494 GWh during 2019-20, showing a Compound Annual Growth Rate (CAGR) of 6.40%. The percentage increase in electricity consumption is 6.31% from 2018-19 (12,09,972 GWh) to 2019-20 (12,91,494 GWh).

The trend of category wise energy consumption in the country from 2000-01 to 2019-20 is presented in Figure 3:

Fig 3: Trend of Category wise Electricity consumption in India



	2000-01	2001-02	2002-03	2003-04	2004-05	2005-06	2006-07	2007-08	2008-09	2009-10	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20
Domestic	75629	79694	83355	89736	95659	100090	111002	120918	130056	144246	156016	171104	183700	199842	217405	238876	255826	273545	288243	310151
Commercial	22545	24140	25437	28201	31381	35965	40220	46685	53543	59297	68719	65381	72794	74247	78391	86037	89825	93755	98228	103883
Industrial	159306	159507	168821	181970	199449	214121	241216	265407	279656	290255	301256	352291	365989	384418	418346	423523	440206	468613	519196	551362
Agriculture	84729	81673	84486	87089	88555	90292	99023	104182	107776	119320	123389	140960	147462	152744	168913	173185	191151	199247	213409	228172
Traction	8213	8106	8797	9210	9495	9944	10800	11108	11808	12407	13086	14206	14100	15540	16177	16594	15683	17433	18837	19577

Of the total consumption of electricity in 2019-20, industry sector accounted for the largest share (42.69%), followed by domestic (24.01%), agriculture (17.67%) and commercial sectors (8.04%).

The electricity consumption in industry sector and domestic sector has increased at a much faster pace compared to other sectors during 2010-11 to 2019-20 with CAGRs of 7.30% and 6.24% respectively as given in below table 1.

Table 1: Consumption of Electricity by Sectors in India

In Giga Watt Hour

Year	Industry	Agriculture	Domestic	Commercial	Traction& Railways	Others	Total Electricity Consumed
1	2	3	4	5	6	7	8= Sum of 2 to 7
2010-11	272589	131967	169326	67289	14003	39218	694392
2011-12	352291	140960	171104	65381	14206	41252	785194
2012-13	365989	147462	183700	72794	14100	40256	824301
2013-14	384418	152744	199842	74247	15540	47418	874209
2014-15	418346	168913	217405	78391	16177	49289	948522
2015-16	423523	173185	238876	86037	16594	62976	1001191
2016-17	440206	191151	255826	89825	15683	68493	1061183
2017-18	468613	199247	273545	93755	17433	70834	1123427
2018-19	519196	213409	288243	98228	18837	72058	1209972
2019-20 @	551362	228172	310151	103883	19577	78348	1291494
Distribution (%)	42.69%	17.67%	24.01%	8.04%	1.52%	6.07%	100%
Growth rate of 2018-19 over 2019-20 (%)	5.83%	6.47%	7.06%	5.44%	3.78%	8.03%	6.31%
CAGR 2010-11 over 2019-20 (%)	7.30%	5.63%	6.24%	4.44%	3.41%	7.17%	6.40%

@ - Estimated

1.3. Growth in the Building Sector and its future trend in India

Rapid urbanization bodes well for the sector. The number of Indians living in urban areas is expected to reach 525 million by 2025 which expected to add 35 Billion square meter of new buildings by 2050. As per a report of the Royal Institution of Chartered Surveyors (RICS), 4127 million square meter of real estate space (which includes residential, retail, offices, hotels, health care and education sectors) is expected to be built between 2012 and 2020 which is on an average construction of 460 Million square meter of real estate space per year.

In India Buildings sector (residential and commercial) constitutes 33% of total electricity consumption. If current scenario continues, electricity demand will rise from 414 TWh/year to 4,697 TWh/year and buildings will demand 55% of total electricity generated by 2047. Electricity demand in residential and commercial buildings sectors is predicted to rise by 5 folds and 3 folds respectively by 2032.

Commercial buildings consume about 9% of total electricity consumption. Commercial buildings include offices, hospitals, hotels, retail outlets, educational buildings, government offices, etc. The total built-up area of commercial buildings is expected to touch 1.9 billion m^2 by 2030. The rate of growth in commercial buildings sector is amongst the highest, and hence, this sector needs to be moderated in its energy consumption.

The key driver for the rapid increase of energy consumption in the buildings sector has been rising ownership levels for appliances such as air conditioners to provide comfortable indoor temperatures in urban areas in the recent years. The factors affecting energy demand in both domestic and commercial buildings sector has been divided into categories:

Lighting and Appliances: Energy consuming equipment in the commercial sector includes Lighting, Heating, Ventilation and Air Conditioning (HVAC) and other office related equipment. HVAC has the greatest share in electricity consumption and its demand is primarily from air-conditioning. In residential buildings, most energy consuming equipment are lighting and appliances. With increase in electrical appliance ownership, increasing income level and reliable access, lighting and appliance loads in residential buildings are also on the rise.

Building envelope optimization: The building envelope pertains to the structural aspects of a building, which acts as a thermal barrier between the enclosed conditioned space and outside environment through which the thermal energy is transferred. By reducing the heat transfer through the building envelope, the need of energy used for space heating and cooling can be reduced significantly.

1.4. Energy Conservation and Conservation Potential

India's Intended Nationally Determined Contributions (INDCs) aim to reduce the emissions intensity of its gross domestic product (GDP) by 33 to 35 percent by 2030 from 2005 level. Any effort to achieve this target is contingent upon the increase in efficiency of energy use across all sectors, especially in the building sector.

Out of the total electricity consumed in the building sector, about 75% is used in residential buildings. The gross electricity consumption in residential buildings has been rising sharply over the years. For instance, the consumption figure rose to about 414 TWh in 2019-20 from about 98 TWh in 2000-01 that is an increase by more than four times in 20 years. Projections show it rising to anywhere between 630 and 940 TWh by 2032. Among various reasons, increased use of decentralized room based air-conditioning units in homes for thermal comfort is an important reason contributing to this rapid increase in the electricity use in residential buildings. The demand for air-conditioning will continue its exponential growth with improvement in household incomes and will become the dominant contributor of GHG emissions nation-wide owing to increased electricity consumption this situation calls for an immediate energy conservation action plan.

With a view of increasing electricity demand and need of managing it, an effort for energy conservation was initiated by Government of India with introduction of Energy Conservation Act (EC Act) published in the Gazette of India in October 2001. Bureau of Energy Efficiency (BEE) was instituted in 2002, to implement EC Act. Further first version of Energy Conservation building Code (ECBC) was launched by Government of India in 2007. BEE has also launched the Star rating of commercial buildings scheme in India in 2009.

EC Act was amended in 2010 with further update of Commercial ECBC in 2017. After this update, ECBC (commercial) was mandated for all commercial buildings falling in its purview (Connected load ≥100 kW or contract demand ≥120 kVA).

A series of energy efficiency programmes catering to the buildings sector and specifically to the commercial buildings sector are therefore initiated. These programmes are discussed in the following sections.

Programme initiatives in Building Sector are as follows

I) Guidelines, Codes and Standards

- ECBC for commercial buildings
- Residential labeling program focusing on energy efficiency
- ECO Niwas Samhita- ECBC for Residential Buildings

II) Energy Efficiency in existing buildings

- PAT scheme for building sectors
- Net zero energy buildings
- EESL Building Energy Efficiency Program

III) Rating Systems

- BEE star rating for existing buildings
- GRIHA National rating system for new building
- LEED and IGBC rating system for buildings

This document is organized as follows:

Chapter 2 describes the Guidelines, Codes and Standards in Building Sector

Chapter 3 describes the Energy Efficiency in existing buildings

Chapter 4 describes the Rating Systems in Building Sector

Chapter 5 introduces Action on Energy Conservation in U.T. of Puducherry

2. GUIDELINES, CODES AND STANDARDS IN BUILDING SECTOR

The building sector in India consumes over 33% of the total electricity consumed in the country annually and is second only to the industrial sector as the largest emitter of greenhouse gases. Building energy codes for new buildings are an important regulatory measure for ushering energy efficiency in the building sector. They are particularly relevant for countries like India where the building constructions are rising rapidly.

Buildings consume significant proportion of our energy resources and the ECBC is an essential regulatory tool to curb their energy footprint. Energy demand by end use in residential and commercial buildings have a distinct pattern. In residential buildings, fans and lights are major consumers whereas in commercial buildings, major part of electricity is consumed for HVAC operation. It is due to this reason that specific energy conservation code is required for each building type depending on its energy use.

Bureau of Energy Efficiency had launched ECBC 2007 to establish minimum energy performance standards for buildings in India. Building energy codes are updated regularly to catch up with the curve of technology maturation and to set higher benchmarks for building energy efficiency.

Accordingly, In June 2017, ECBC 2017 was launched which considers existing as well as futuristic advancements in building technology to further reduce building energy consumption and promote low-carbon growth beyond the codes notified under ECBC 2007.

ECBC has the potential to transform the way buildings are being constructed. Although ECBC is applicable for buildings all over India, States have the authority to adapt and mandate ECBC according to local requirements. ECBC is being adapted with minor additions in different States and

ECBC compliance is now mandatory. ECBC is also being incorporated into local bye-laws and added to Urban Local Bodies (ULBs) building approval process.

2.1 Energy conservation building code (ECBC) for commercial buildings

Adoption of ECBC 2017 for new commercial building construction in India is estimated to lead to a 50% reduction in energy use by 2030 which would translate to energy savings of about 300 Billion Units and peak demand reduction of over 15 GW in a year. This will be equivalent to expenditure savings of INR 35,000 crore and 250 million tonnes of CO_2 emission reduction.

Impact of ECBC Compliance

Few of the benefits of ECBC are:

- Lower HVAC loads
- reduced energy consumption and operational cost
- Lesser addition of power generation capacity
- better building performance
- Climate oriented design practice
- Improved lighting and extensive use of day lighting
- Use of natural ventilation/free-cooling systems
- Market demand for energy efficient products like glass, insulation, HVAC equipment etc.

Based on BEE report, as on 31st March 2020 ECBC has been notified in 15 states and two UTs : Arunachal Pradesh, Andhra Pradesh, Assam, Tripura, Himachal Pradesh, Kerala, Punjab, Haryana, Karnataka, Odisha, Rajasthan, Telangana, Uttarakhand, Uttar Pradesh, West Bengal, Union territory of Andaman & Nicobar Island & Puducherry.

Approval to the cabinet for implementation in 9 states have been processed for Bihar, Madhya Pradesh, Maharashtra, Meghalaya, Manipur, Mizoram, Jharkhand, Nagaland, & Goa. These states will be notified soon.

2.1.1 Scope of ECBC (Commercial Buildings)

This code is now mandatory and applicable to buildings or building complexes that have a connected load of 100 KW or a contract demand of 120 KVA, whichever is greater and are intended to be used for commercial purposes.

ECBC also applies to addition and major renovation

- Where the new connected load demand of the addition plus the existing building exceeds 100 kW or 120 kVA.
- When addition + existing building area > 1000 m^2
- Renovated portions and systems of a 1000 m^2 or larger building

The additions shall comply with the provisions as per ECBC guideline. Compliance may be demonstrated in either of the following ways:

1. The addition shall comply with the applicable requirements, or

2. The addition, together with the entire existing building, shall comply with the requirements of this Code that shall apply to the entire building, as if it were a new building.

2.1.2 Applicable Building Systems

This code addresses the minimum performance requirements in a commercial building covering the following:

a) Building envelope	refers to exterior portico, and is comprised of walls, windows, roof, skylights, doors and other openings, The design features of the envelope affects the

	visual and thermal comfort of the occupants, as well as energy consumption of the building.
b) Mechanical systems and equipment, including heating, ventilating, and air conditioning, service hot water heating	Refers to Heating, Ventilation (natural, mechanical), Air Conditioning (cooling, dehumidification, humidification)
c) Interior and exterior lighting	Refers to Day Lighting, Glazing, Energy Efficient Lighting, Lighting Controls, Interior/Exterior lighting power
d) Electrical power and motors, and Renewable energy systems	Refer to Efficient Transformers, High Efficiency Motors, Power Factor controls, Power Distribution Losses (minimum) Service Hot Water and Pumping

The provisions of this code do not apply to plug loads, and equipment and parts of buildings that use energy for manufacturing processes, unless otherwise specified in the Code.

2.1.3 Building Classification

The following are the classifications of building as per ECBC:

- Hospitality: Star/non Star Hotels, Resorts
- Healthcare
- Assembly: Religious, Recreation, Social, Picture hall, Bus/Rail/Airports
- Business: Large >30000 sq. m, Medium:<30000-10000 Sq. m, small<10000 Sq. m
- Educational
- Shopping Complexes
- Mixed Building

2.1.4 Levels of Energy Efficiency Performance

The ECBC 2017 has incorporated advanced technologies and additional parameters related to renewable energy integration, inclusion of passive design strategies, flexibility for the designers and ease of compliance. The revised ECBC is one of the first building energy codes to recognize beyond code performance. The code prescribes the following three levels of energy efficiency: ECBC Buildings, ECBC+ Building, and Super ECBC Building.

The adherence to the minimum requirements stipulated for ECBC level of efficiency would demonstrate compliance with the code. Other two efficiency levels namely ECBC+ and Super ECBC are of voluntary nature. This feature was added to prepare the building industry for meeting energy efficiency standards in coming years and give sufficient time to the market to adapt.

ECBC Buildings shall demonstrate compliance by adopting the mandatory and prescriptive requirements listed under ECBC Compliant Building requirements, or by following the provisions of the Whole Building Performance (WBP) Method. An ECBC compliant new building should be able to demonstrate minimum energy savings of 25% compared to a conventional building.

ECBC+ Buildings shall demonstrate compliance by adopting the mandatory and prescriptive requirements listed under ECBC+ Compliant Building requirements, or by following the provisions of the Whole Building Performance (WBP) Method. ECBC+ Buildings should be able to demonstrate energy savings of 35% compared to a conventional building.

Super ECBC Buildings shall demonstrate compliance by adopting the mandatory and prescriptive requirements listed under Super ECBC Compliant Building requirements, or by following the provisions of the Whole Building Performance (WBP) Method. Super ECBC Buildings should be able to demonstrate energy savings of 50% compared to a conventional building.

2.1.5 Energy Performance

The Energy Performance Index (EPI) of a building is its annual energy consumption in kilowatt-hours per square meter of the building. While calculating the EPI of a building, the area of unconditioned basements is excluded.

$$EPI = \frac{Annual\ Energy\ Consumption\ (in\ Kwh)}{Total\ built\ up\ area\ (Excluding\ unconditioned\ basement)}$$

EPI Ratio The EPI Ratio of a building is the ratio of the EPI of the Proposed Building to the EPI of the Standard Building:

$$EPI\ ratio = \frac{EPI\ of\ proposed\ building}{EPI\ of\ Standard\ building}$$

Where,

Proposed Building is consistent with the actual design of the building, and complies with all the mandatory requirements of ECBC.

Standard Building is a standardized building that has the same building floor area, gross wall area and gross roof area as the Proposed Building, complies with the mandatory requirements, and minimally complies with prescriptive requirements for ECBC Buildings.

As per BEE report, there are 129 buildings across India that are either in the discussion stage, design stage, construction stage or have completed their construction as per ECBC guidelines across various states in India. Details are presented in Table 2 and Table 3.

Table 2: Details of buildings covered under ECBC

Construction Stage	No. of Buildings	Total Area in Mn. sqm
Completed	54	1.63
Design Stage	75	1.89
Grand total	129	3.52

Table 3: Category of buildings completed under ECBC as on 31st March 2020

Type of Buildings	No. of Buildings	Total Area, sqm
Hospital	2	260,039
Hotel	3	160,345
Institution and IT	21	569,761
Office	23	442,251
Shopping Complex	5	201,228
Grand Total	54	1,633,624

2.1.6 Estimation of Energy Savings

Total 54 buildings out of 129 buildings have completed their construction as on 31st March 2020 and are now operational. The same has been considered for the energy savings calculations. Other 75 buildings were compliant under ECBC during different months of the year; therefore, energy savings cannot be considered for entire one year.

Some of the electrical energy savings obtained under this scheme is due to replacement of inefficient electrical & mechanical appliances with BEE star rated appliances. Therefore, in order to avoid this duplication, only 90% of total energy savings has been considered for ECBC programme. Therefore, total electricity savings for ECBC programme in FY 2019-20 is considered as 0.116 BU and total reduction in CO_2 emission is 0.095 $MtCO_2$.

2.2 Residential labeling program focusing on energy efficiency

"Energy Efficiency Label for Residential Buildings" launched by Hon'ble Minister of State (IC) for Power and Renewable during the conference of Ministers for Power, New & Renewable Energy of States & Union Territories held at Gurugram, Haryana on 26th February, 2019.

The challenge in terms of soaring energy consumption in the housing segment is needed to be tackled with a multi-faceted approach. Making houses energy efficient is certainly a way of avoiding a long-term futile electricity consumption liability in residential buildings. This program helps the country in the same direction by designing an energy efficient residential labeling system. Energy labels help consumers to make efficient decisions through the provision of direct, reliable and costless information.

This program is another step towards realizing the vision of an energy surplus India with 24*7 power to all. Proposed Labelling program will cover all types of residential buildings in India. All the envisaged objectives can be achieved through the proposed labeling mechanism by making it as a mandatory information required in any real estate transaction/leasing.

2.2.1 Objective of the labelling program

The key objective of the programme is to make a transparent instrument over the energy performance of a home which will gradually lead to an effective model taken into consideration while deciding over the home prices in future.

The objectives of the proposed labelling program are to provide:

1. information to consumers on the energy efficiency standard of the Homes

2. a benchmark to compare one home over the other on the energy efficiency standards

3. a consumer driven market transformation business model solution for Energy Efficiency in housing sector

4. steering the construction activities of India towards international best practices norms

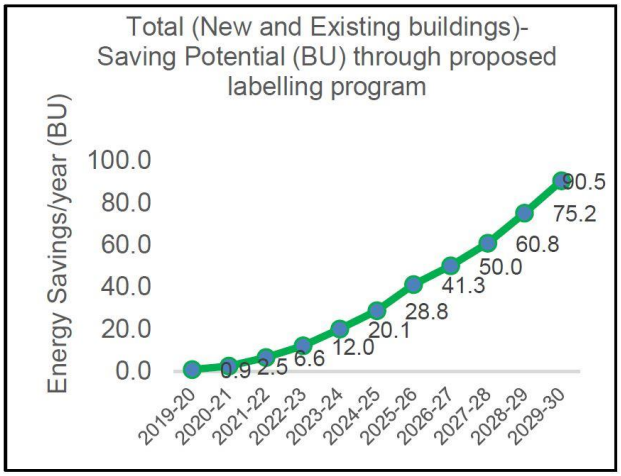
2.2.2 Scope of the program

Proposed Labelling program will cover all types of residential buildings in India. All the envisaged objectives can be achieved through the proposed labeling mechanism by making it as a mandatory information required in any real estate transaction/leasing.

2.2.3 Benefits of the program

The proposed labelling program is expected to save a large amount of energy through imparting energy efficiency to houses nationwide with annual savings of 90 BU in the year of 2030 as given in the figure 4. The estimated cumulative energy saving potential through proposed labelling program is around 388 Billion Units (BU) by year 2030 which is greater than the energy consumption in 2016 (250 BU). Moreover, a five star rated home will be 40% more energy efficient than one star rated home.

Fig 4: Estimated Energy Saving through labelling program



2.3 ECO Niwas Samhita- ECBC for Residential Buildings

Another important aspect: thermal comfort, which is of utmost importance in all kinds of housing, but more so in case of affordable housing, so as to ensure health and well-being of the occupants. BEE envisaged a phased approach for the development of the residential building energy conservation code.

Ministry of Power, Government of India launched the ECO Niwas Samhita 2018, which is an Energy Conservation Building Code for Residential Buildings (ECBC-R). The implementation of this Code will provide a fillip to energy efficiency in residential sector. It aims to benefit the occupants and the environment by promoting energy efficiency in design and construction of single and multi-

dwelling units. ECBC-R will help in making houses energy efficient is certainly a way of avoiding a longterm futile electricity consumption liability in residential buildings.

The provisions of this code apply to all residential buildings and residential parts of mixed land-use projects, both built on a plot area of ≥500 m^2. However, the actual plot area is subjective to the respective states and municipal bodies on the prevalence in their area of jurisdiction.

The following are excluded from the definition of 'residential building' for this code.

- Lodging and rooming houses: This includes inns, clubs, motels, and guest houses.
- Dormitories: This shall include school and college dormitories, students, and other hostels and military barracks.
- Hotels: These shall include any building or group of buildings under single management, in which sleeping accommodation is provided, with or without dining facilities.

Eco Niwas Samhita (ENS), Part -1: Energy Conservation Building Code – Residential (ECBC-R) (Part I: Building Envelope) sets the minimum building envelope performance standards to limit heat gains and to limit heat loss, as well as for ensuring adequate natural ventilation and day lighting potential. The code provides design flexibility to innovate and vary important envelope components such as wall type, window size, type of glazing, and external shading to windows to meet the compliance.

Below five are the key components of ENS Part 1 – Building Envelope

- Openable Window-to-Floor Area Ratio
- Visible Light Transmittance
- Thermal Transmittance of Roof
- Residential envelope transmittance value (RETV) for typically four climate zones: Composite, hot-dry, warm-humid & Temperate
- Thermal transmittance of building envelope for cold climate

Energy Conservation Building Code – Residential (ECBC-R) (Part II: Building Envelope) of the code provides energy efficiency standards for electro-mechanical systems of residential buildings and is in final stage of development.

3. ENERGY EFFICIENCY IN EXISTING BUILDING

The scope for energy-efficiency improvements in buildings is immense. However, there are various factors that discourage the large-scale enhancement of energy efficiency in buildings:

(a) lack of awareness amongst building owners and managers about the specific interventions that could lead to greater energy efficiency;

(b) Non-availability of appropriate delivery mechanism to capture future energy savings because of energy efficiency and energy conservation measures.

Energy savings are determined by comparing energy baseline with energy consumed after implementation of energy efficiency measures. Energy audit studies have revealed a savings potential to the extent of 40 per cent in end uses such as lighting, cooling, ventilation, refrigeration, etc. Energy cost savings resulting from energy efficiency measures directly benefit building owners and occupants over the life cycle of the building.

3.1 PAT scheme for building sectors

Perform Achieve and Trade (PAT) scheme is a market based compliance mechanism to accelerate improvements in energy efficiency in energy intensive industries. The energy savings achieved by notified industries is converted into tradable instruments called Energy Saving Certificates (ESCerts). The ESCerts after issuance by Bureau of Energy Efficiency are traded at Power Exchanges.

The Notification for PAT cycle -IV was issued in March, 2018 and commenced from 1st April, 2018 onwards and it included two new sectors namely commercial buildings, Petrochemical sector in addition to new Designated Customers in existing sectors. The duration of PAT cycle-IV will be from 2018-19 to 2020-21.

The building and the industrial sector in India are consuming approximately 70% of the total energy consumption in the country. It is interesting to note that there are several mandates and programs run by the private and government agencies to strengthen the scheme of carbon mitigation in the industries, however, there are a very only a few in the building sector and which are being implemented in a discreet manner. One of the flamboyant programs launched by the Bureau of

Energy Efficiency (BEE) for the Indian industry is called “Perform, Achieve and Trade” (PAT) scheme with 70% coverage of 36% of total energy consumption by the industrial sector sought in the scheme. After the successful implementation of PAT Cycle I for industries and thereafter successive rolling cycle, it is now time to put our serious thoughts of inclusion of buildings in the PAT scheme.

Initially, it is planned to cover the commercial establishment in the very first phase under PAT regime of building sector as a whole. Although, energy consumption of the residential sector enjoys the share of around 24% from total building sector energy consumption of 35%, however the mandate in Energy conservation Act 2001 proposes for the inclusion of the commercial establishment under PAT because of following reasons

- Ease of Establishment of Specific Energy Consumption
- Data Streamlined for Energy Consumption and Efficiency
- Documents and Data availability
- Data Accessibility
- Regular Energy Audit
- Awareness in Energy Efficiency and Conservation

Under commercial building category, there are further classification of different non-residential building typologies and are broadly based on the National Energy Conservation Building Code (ECBC) of India such as Hospitality, Educational, Health Care, Shopping Complex, Business and Assembly. The energy efficiency depends on many variable parameters in different typologies of building including energy use with technologies and building material. Thus, the potential of energy efficiency under PAT totally depends on technologies used in installed equipment, Appliances and efficient use of power sources. It hardly fetches any savings in the building envelope apart from some innovated shading system, glazing or in insulation. However, the energy conservation and efficiency do have a bigger say in the overall SEC reduction of the total building concept under PAT.

When the zero down begins for searching out the commercial establishment to be included under PAT, following sub-sectors were considered for data audit in terms of energy consumption for finding out the threshold limit.

1. Hotels
2. Data Centers
3. Shopping Malls
4. Airport Terminals

3.2 Net Zero Energy Buildings

Net Zero Energy Buildings (NZEBs) – 100% energy-efficient, sustainable buildings – can be a game changer, not only for India's building sector, but also for the energy sector. NZEBs have lower energy demand than that of conventional buildings and produce at least as much energy as they consume in a year, through onsite renewable energy technologies. NZEBs are commonly grid-connected to save battery costs. This allows them to draw electricity at night and during cloudy days, and return an equivalent amount of electricity to the local grid on sunny days. Thus, it nullifies the net carbon emissions from buildings.

In the Indian context, proactive government initiatives encourage decentralized solar photovoltaic (PV) technologies, such as Roof Top photovoltaic (RTPV) and Building-Integrated photovoltaic (BIPVs). However, this has not evolved into an integrated policy that looks at achieving zero energy consumption from buildings.

Such green buildings can significantly support India's Nationally Determined Contribution target to reduce the emissions intensity of GDP by 33-35% (from the 2005 levels) by 2030. Beyond this, NZEBs can emerge as a beacon for scaling up decentralized solar photovoltaic generation and support the efforts of the Ministry of New and Renewable Energy (MNRE) as well. NZEBs can help mitigate the consequences of climate change by bringing a revolution to both the construction and especially the energy sector.

Net or nearly zero-energy buildings (NZEB) have very high performance. The low amount of energy that these buildings require comes mostly from renewable sources. Such buildings produce as much energy as they consume, accounted for annually.

In order to achieve their net zero energy goals, NZEBs must first reduce energy demand using energy efficient technologies, and then utilize renewable energy sources to meet the residual energy demand. In such buildings, efficiency gains enable the balance of energy needs to be met by renewable energy technologies.

NZEB is aimed at eliminating greenhouse gas (GHG) emissions associated with the operation of new buildings by 2030, and eliminate the GHG emissions from all buildings by 2050. Meeting NZEB objectives will require addressing both active and passive measures along with energy generation/supply from renewable energy such as Solar Photovoltaic, Winds, Biogas, and any other applicable hybrid renewable energy system. Achieving zero energy is an ambitious, yet increasingly achievable goal.

First NZEB in India

The Indira Paryavaran Bhavan in New Delhi (constructed in 2014) is India's first NZEB, built with integrated energy-conservation methodologies and a super-efficient solar PV system of 930kW capacity. This system generates almost 1,491,000 units annually, while the overall energy demand of the building is approximately 1,421,000 units per year. However, in spite of their promising potential to tap solar power and address environmental challenges, only seven Indian states (including Delhi) have constructed NZEBs till now.

Considering India's housing and energy needs, especially its commitments to meet the Sustainable Development Goals, it is time for us to develop a comprehensive policy that looks at reducing the energy consumption of buildings.

3.3 EESL Building Energy Efficiency Program

Energy Efficiency Services Limited (EESL) is driving on a large - scale transformation to retrofit commercial buildings in India into energy efficient complexes. Through these future ready solutions, EESL is creating a market for clean energy in India. The buildings sector consumes over a third of India's electrical energy, to meet the growing demand for lighting, space heating and cooling. In response, EESL has introduced Buildings Energy Efficiency Programme which offers a uniquely designed solution for buildings of the government, industry, and institutions to implement and retrofit energy efficient appliances and systems at affordable prices.

EESL is undertaking implementation of the Buildings Energy Efficiency Programme (BEEP), which was launched in May, 2017 by the Indian Government. EESL's Building Programme enables clients & stake holders to overcome technical & financial barriers to promote energy efficiency implementation in commercial buildings of the country.

3.3.1 Program Overview

EESL has applied its proven model of demand aggregation as a means of ensuring affordability for the energy efficient appliances, implementation, and systems maintenance to the buildings sector. As on 31st March 2021, EESL has signed agreements to unlock the dormant energy efficiency potential of over 15,000 buildings including railway stations across India.

Not only is the programme unlocking their energy efficiency potential at a significant scale, but also ensuring economies of scale for the appliances, systems, and services it offers. The cost effectiveness, and high rates of returns in the form of savings on electricity has created a market momentum in the commercial buildings space.

3.3.2 Program Coverage

EESL aims to bring energy efficiency solutions to 20,000 large Government and Private buildings by 2020. With an investment of around INR 2,000 crore (equivalent to USD 30.8 crore), EESL will retrofit around 2 crore LED lights, 25 lakh energy efficient ceiling fans, and 2 lakh energy-efficient ACs. EESL's programme will be expanded to include centralized air conditioning, Energy Audits, and New Generation Energy Management System.

Under BEEP programme, the Super - Efficient Air Conditioning Programme (ESEAP) is now being executed. EESL has launched Super Energy Efficient Air Conditioners in India which are higher than BEE 5 - star rating. The retrofitting work of Air Conditioners has started under EESL's Building Energy Efficiency Program (BEEP) and is under progress.

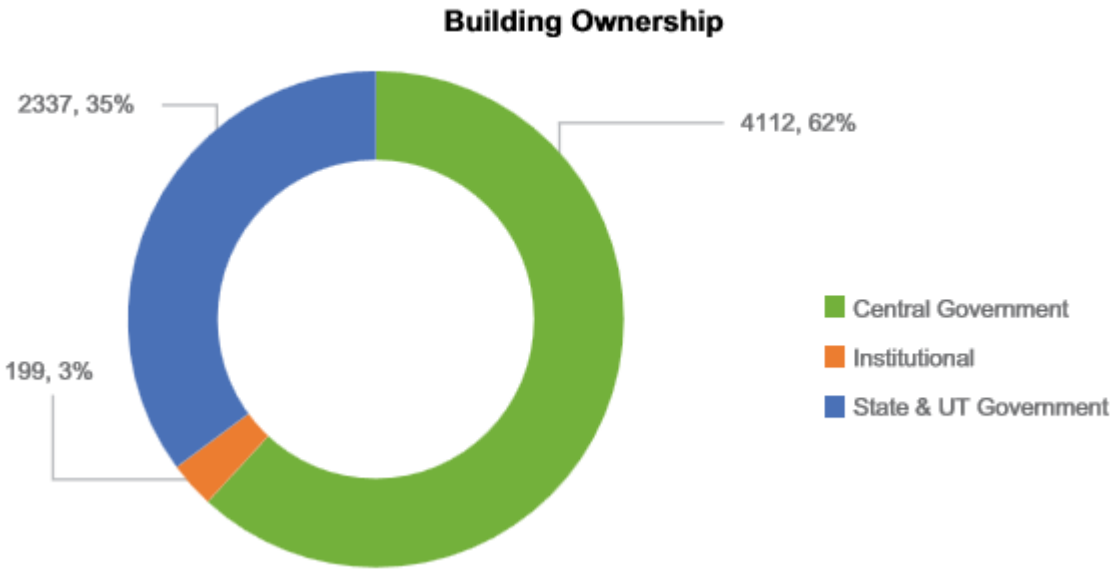
EESL has launched "National Building Dashboard" www.eeslbeep.com, which provides information of real time / deemed energy savings in all buildings on PAN India basis. It also gives information about annual CO2 emission reductions and avoided peak demand due to retrofit of energy efficient equipment.

Government of India has issued an instruction to all Departments and Ministries in August, 2017 to ensure all the buildings become energy efficient. As on date, EESL has completed building energy efficiency projects in 6648 buildings including Railway stations and Airports.

Building Ownership

There are a total 6648 commercial buildings under this programme. The type of commercial building includes, Central Govt. Buildings, District Courts, PWD Buildings and Railway Station buildings. The share of buildings under this programme as on 31st March 2020, presented in figure 5.

Fig 5: Share of builds under BEEP programme



3.3.3 Impact of the Building Energy Efficiency Programme

EESL also conducted energy audits in these buildings and estimated the energy saving potential to the tune of up to 30-50% in these buildings. Prior to FY 2017-18, very few buildings were part of this programme. Almost 6500 buildings became a part of this programme in FY 2017-18, 2018-19 only.

Out of these buildings, more than 5000 commercial buildings covered during FY 2018-19. Retrofitting work in these buildings was completed during different months of the year; therefore, energy savings cannot be considered for entire one year. Therefore, in order to calculate the energy savings for buildings completed in FY 18-19, 50% of total energy savings is considered. The impact of the BEEP in terms of energy (electrical) saved across India cumulatively for last four FY 2016-17, 2017-18, 2018-19 & 2019-20 is presented in Table 4.

Table 4: Appliances and Energy Saving of BEEP Programme

FY	EE Indoor Lights	EE ACs	EE Fans	EE Outdoor lights	Total (MU)
2016-17	1.0	0.3	0.04	0.04	1
2017-18	8.7	2.2	0.2	4.2	15
2018-19	62.7	56.6	35.9	31.5	187
2019-20	3.8	1.0	0.1	3.5	8
Total	**76.1**	**60.1**	**36.3**	**39.3**	**212**

As the electrical energy savings obtained under this scheme was due to replacement of inefficient electrical & mechanical appliances with BEE star rated electrical & mechanical appliances, therefore in order to avoid any duplication, the energy savings of BEEP has been already considered under S&L programme.

4. ENERGY RATING SYSTEM

4.1 BEE star rating for existing building

BEE introduced the Star Rating for existing buildings as a voluntary policy measure to reduce the adverse impact of buildings on the environment. BEE has launched the Star rating of commercial buildings scheme in 2009. The star rating programme is based on the actual performance of a building in terms of its specific energy usage in kWh/sqm/year. This programme rates office buildings on a 1-5 Star scale, with 5 Star labelled buildings being the most efficient. The scheme is propagated on a voluntary basis and the label provided under it is applicable for a period of 5 years from the date of issue.

Under this programme, there are 5 categories of buildings that have been identified viz. office buildings (day use and business process outsourcing (BPOs)), shopping malls, hotels, hospitals and IT parks in the 5 climatic zones of the country. This national energy performance rating is a type of external benchmark that helps energy managers to assess how efficiently their buildings use energy, relative to similar buildings nationwide. Additionally, building owners and managers can use the performance ratings to help identify buildings that offer the best opportunity for improvement and recognition.

4.1.1 Program Overview

Under the present labeling scheme, the buildings are being labeled as per their actual Energy Performance Indices (EPI) on a scale of 1 to 5. The sets of standard EPI bandwidths developed to rate buildings under this scheme for different climatic zones indicate the range of variations in the energy performances of different office building types lying in a particular climatic zone.

To apply for rating of office buildings, a standardized format is developed for collection of actual energy consumption: data required includes building's built up area, conditioned and non-conditioned area, type of building, hours of operation of the building in a day, climatic zone in which building is located, and other related information of the facility.

Based on the data provided by BEE, 264 buildings have been star rated under different categories of buildings as on 31st March, 2021. BEE had launched the Star rating program for Offices (February 2009), BPOs (December 2009), Shopping Mall (January 2011) and Hospitals (July 2014). Memorandum of Understanding (MoU) is also signed between BEE and CPWD on 10th January 2019 for "Energy Efficiency in CPWD managed Buildings". Details are presented in Figure 6 and Table 5.

Fig 6: Share of Star rated buildings

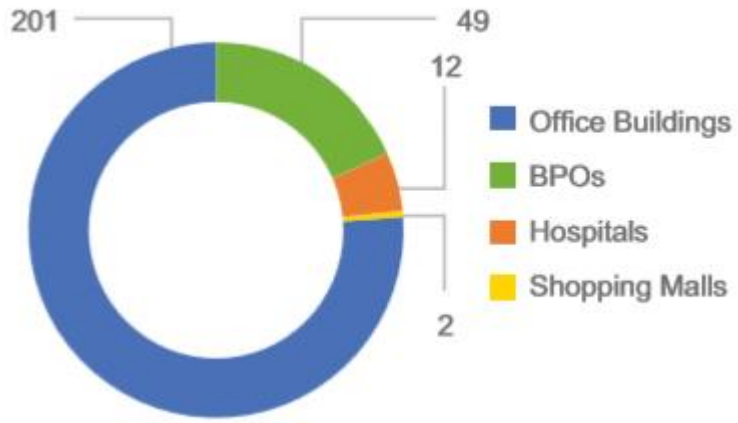


Table 5: BEE Star Rated Buildings

Category	Number of Buildings
Office Building	201
BPOs	49
Hospitals	12
Shopping Mall	2
Total	**264**

4.1.2 Star Rating System

Energy Performance Index (EPI) in kWh / sqm/ year is considered for rating the building. The table 6 and table 7 indicating the EPI with the corresponding Star Label under the various climatic zones are provided in below sections for reference - For buildings having air-conditioned area greater than 50% of their built-up area & For buildings having air conditioned area less than 50% of their built up area.

Table 6: Star Rating for building with less than 50% of their built-up area

Star Label	EPI for Composite Zones	EPI for warm and Humid climate zones	EPI for hot and dry climate zoned
1	190-165	200-175	180-155
2	165-140	175-150	155-130
3	140-115	150-125	130-105
4	115-90	125-100	105-80
5	Below 90	Below 100	Below 80

Table 7: Star Rating for building with greater than 50% of their built-up area

Star Label	EPI for Composite Zones	EPI for warm and Humid climate zones	EPI for hot and dry climate zoned
1	80-70	85-75	75-65
2	70-60	75-65	65-55
3	60-50	65-55	55-45
4	50-40	55-45	45-35
5	Below 40	Below 45	Below 35

Under this programme, the user affixes the building rating label as per the label design and specification (both in terms of size and material), manner of display, and the rating plan as prescribed by the Bureau for the particular building type. BEE is continuously reviewing its technical approach

to the development of the rating system to ensure an accurate, equitable, and statistically robust rating, because each building type has unique features that impact energy efficiency. BEE has also taken up the exercise of standardization of energy data collection which assists in comparative assessment and target setting in existing buildings.

4.1.3 Methodology for Energy Savings

EPI shall be kWh/sqm/year in terms of purchased & generated electricity divided by built up area in sqm. However, the total electricity would not include electricity generated from on-site renewable sources such as solar photovoltaic etc. The rating is normalized to account for the operational characteristics that define the building use, hours of operation, climatic zone and conditioned space.

Methodology adopted for assessing the energy savings of star rated buildings is based on the difference between the reported EPI value and max EPI for star 1 rated building, multiplied by the total built-up area. The bandwidths considered for building energy star rating programme is provided in the above section.

$$\text{Annual Energy Saving} = (EPI_{conventional} - EPI_{imporved}) \times \text{Total Built-up area}$$

Where,

$EPI_{conventional}$ - Max EPI of 1 Star Labeled building for specific category of building in specific climate zone

$EPI_{imporved}$ - Measured EPI of the Star Labeled building

4.1.3.1 Type of Buildings and Climate Zones

The programme targets the following 4 climatic zones for air-conditioned and non-airconditioned buildings:

- Warm & Humid
- Composite
- Hot and Dry
- Temperate

There are total four types of commercial establishments that are part of this report, viz. Offices, Hospitals, BPOs and Shopping Malls.

1 Office Buildings: BEE Star Rating Scheme for Office Buildings is notified in year 2009. The baseline EPIs considered for star rating programme in more than 50 % airconditioned built-up area and less than 50 % air-conditioned built-up area are given in Table 8:

Table 8: EPI for star rated office buildings

Star Label	Climate Zone	EPI (kWh/Sqm/year)	
		< 50% air condiotioned	> 50% air condiotioned
1 Star	Composite	80-70	190-165
1 Star	Warm & Humid	85-75	200-175
1 Star	Hot & Dry	75-65	180-155

2 BPO Buildings: Star Rating Scheme for BPO buildings notified in December 2009. Average Annual hourly Energy Performance Index (EPI) i.e., (AAhEPI) in (Wh / hr/ sqm) has been considered for rating the BPO building. The table indicating the AAhEPI with the corresponding Star Label under the various climatic zones are presented in Table 9.

Table 9: EPI for star label BPO buildings

Star Label	Climate Zone	EPI (kWh/Sqm/year) > 50% Condiotioned area only
1 Star	Composite	350-300
1 Star	Warm & Humid	300-250
1 Star	Hot & Dry	275-250
1 Star	Temperate	450-400

3 Shopping Malls: BEE Star Rating Scheme for Shopping Malls is notified in year 2011. Energy Performance Index (EPI) in kWh / sqm/ year is considered for rating the mall. The table indicating the EPI with the corresponding Star Label under the various climatic zones is presented in Table 10.

Table 10: EPI for star label Shopping Malls

Star Label	Climate Zone	Average Annual hourly EPI (AAhEPI) in (Wh/hr/Sqm) > 50% Condiotioned area only
1 Star	Composite	52-46
1 Star	Warm & Humid	54-48
1 Star	Hot & Dry	37-31
1 Star	Temperate	47-41

4 Hospitals: BEE had launched the Star rating program for Hospitals in July 2014. A benchmarking tool called the ECO bench, available online is used for evaluating the star rating for hospitals. This tool gives the performance distribution curve, EPI, Performance Rank and relevant Stars to hospital buildings.

4.1.4 Impact of BEE Star Rating Programme

As the star rating is valid for 5 years and there are 86 number of buildings that had received star rating from 2016-17 to 2019-20; so, it has been assumed that these buildings have been sustaining the energy savings post the star rating certification.

Out of these buildings, total 44 commercial establishments have received BEE star ratings in FY 2019-20. These buildings were given BEE star rating during different months of the year; therefore, energy savings cannot be considered for entire one year.

As star rated EPIs are calculated on annual basis considering seasonal factors, therefore it cannot be broke-down on monthly basis. Therefore, in order to calculate the energy savings for star rated buildings certified during FY 18-19, 50% of total energy savings is considered.

On account of total number of star-rated buildings in last 4 years, the total energy (electrical) saved by these commercial establishments in the year 2019-20 is 179 MU. This has led to reduction of 0.147 Million Tonnes of CO_2.

As the electrical energy savings obtained under this programme is mainly due to replacement of inefficient electrical & mechanical appliances with BEE star rated electrical & mechanical appliances, therefore in order to avoid any duplication, the energy savings of Star Rating Programme has been already considered under S&L programme.

4.2 GRIHA National rating system for new building

Green Rating for Integrated Habitat Assessment (GRIHA) council is an independent not-for-profit society established jointly by The Energy and Resources Institute (TERI) and Ministry of New and Renewable Energy (MNRE), Government of India (GoI). It promotes and facilitates GRIHA-National rating system for green buildings in India.

GRIHA is a rating tool which evaluates the environmental performance of a building, based on quantitative and qualitative criteria, thereby providing a definitive standard for green buildings and habitat. Rating system was adopted as the national rating system for green buildings by the Government of India in 2007.

GRIHA measures a building's environmental performance on a scale of 1-5 stars. Major areas considered while evaluation of the building under GRIHA are four main categories- Energy efficiency, Renewable energy, Water resources, Waste management, which is further sub divided in 31 categories such as site planning, construction management, occupant comfort and wellbeing, sustainable, and innovation.

GRIHA uses the energy performance index to capture the energy requirement of the buildings. All buildings except industrial complexes with built up area of more than 2,500 m^2 during the design stage are eligible for the GRIHA rating. GRIHA rating is evaluated on 3131 parameters on the scale on 100, with threshold value of 25.

Star rating index with threshold value for the different star category is illustrated in Table 11.

Table 11: GRIHA Rating Thresold values

1 Star	2 Star	3 Star	4 Star	5 Star
25-40	41-55	56-70	71-85	86 or more

Some of the key benefits for adoption of GRIHA rating that supports the thrust for promoting the adoption of the rating across the building are:

- Additional floor area ratio for free across the different states varying from 3% up to 15% depending upon the star label
- Pune municipality provides the discount in development premium and rebate on property tax up to 15% for 5 star rated GRIHA building
- Fast track environmental clearance for the buildings from (MoEF&CC)
- Andhra government provides the subsidy on capital investment up to 25% and also provides the 20% reduction on permit fee for all GRIHA certified 5 stat buildings

As on 31st March 2020, 1933 projects have been registered GRIHA. With all the above measures till (31.03.2021) more than 2073 buildings across the India have been GRIHA certified with 52502869 Sqm footprint.

4.3 LEED and IGBC rating system for building

4.3.1 Leadership in Energy and Environmental Design (LEED)

LEED is an international symbol of sustainability excellence that signifies a building is lowering carbon emissions, conserving resources and cutting costs, while prioritizing sustainable practices and creating a healthier environment. Developed by the non-profit U.S. Green Building Council (USGBC), LEED includes a set of rating systems for the design, construction, operation, and maintenance of green buildings, homes, and neighborhoods that aims to help building owners

and operators be environmentally responsible and use resources efficiently. Under the LEED rating system, the following certification levels are presented in Table 12.

Table 12: LEED Rating Category

Rating	Points Required
LEED Certified	40-49
LEED Certified Silver Level	50-59
LEED Certified Gold Level	60-79
LEED Certified Platinum Level	80 points and above

4.3.1.1 LEED-India

India's commitment to reducing carbon emissions and moving towards efficient measures has gained global recognition. This is in large part due to strong leadership from our government. India has been a long-time leader in green building, and in recent years has become an engine of green growth.

LEED-INDIA is the Indian chapter of LEED International which provides a green rating to a structure, whether an apartment, independent home or office, based on the stipulations provided under the LEED rating system.

4.3.1.2 LEED Certification Check-list

Buildings that are LEED-certified create healthier spaces for people, as well as use less energy and water, reduce air pollution, provide cleaner air indoors and save money for businesses and families. They also generate fewer emissions compared to traditional buildings – not only during the construction stage but also after they are occupied and throughout the entire lifecycle of a building.

The points are provided based on certain criterion for new construction building, which are presented in Table 13.

Table 13: Project Checklist for LEED rating

Project Check-List	Possible Points
Integrative Process	1
Location and Transportation	16
Sustainable Sites	10
Water Efficiency	11
Energy & atmosphere	33
Materials and Resources	13
Indoor environment quality	16
Innovation	6
Regional Priority	4
Total	110

Major parameters covered under "Energy & atmosphere check-list" for the rating criterion is presented in Table 14.

Table 14: Check list for LEED rating

Energy & atmosphere check-list	
Minimum Energy Performance	Advanced Energy Metering
Building-Level Energy Metering	Demand Response
Fundamental Refrigerant Management	Renewable Energy Production
Enhanced Commissioning	Enhanced Refrigerant Management
Optimize Energy Performance	Green Power and Carbon Offsets

4.3.1.3 Major highlights

- India is now the fourth largest market in the world for LEED with more than 2,900 registered and certified commercial projects participating in LEED, totaling more than 1.39 billion square feet (as on 31.12.2019).
- IT Parks, Offices, Banks, Airports, Convention centers, Educational institutions, Hotels and Residential complexes are the major structures that register for a LEED rating.

- Many government buildings have chosen to certify to LEED and several government agencies, including key state governments have started offering incentives around LEED.
- The Top 10 states for LEED are home to more than 840 million Indians, and together include more than 500 million gross square feet of LEED-certified space. From the states mapped, Maharashtra tops the list, followed by Karnataka, Tamil Nadu and Haryana.

4.3.2 Indian Green Building Council (IGBC)

The Indian Green Building Council (IGBC), part of the Confederation of Indian Industry (CII) was formed in the year 2001. All the stakeholders of construction industry comprising of architects, developers, product manufacturers, corporate, Government, academia and nodal agencies participate in the council activities through local chapters. The council also closely works with several State Governments, Central Government, World Green Building Council, bilateral multi-lateral agencies in promoting green building concepts in the country.

Across India, IGBC has launched 24 local chapters, which works closely with the stakeholders in facilitating the growth of green buildings and built environment across the Country. IGBC local chapters are involved in

- Policy Advocacy
- Training & capacity building
- Networking & business opportunities
- Awareness & sensitization programmes

The council offers a wide array of services which include developing new green building rating programmes, certification services and green building training programmes. Green building rating brings together a host of sustainable practices and solutions to reduce the environmental impacts while providing an integrated approach considering life cycle impacts of the resources used.

The IGBC Green Building Rating Systems are present for all type of the buildings including- Government, IT Parks, Offices, Residential, Banks, Airports, Convention Centre, Institutions, Hospitals, Hotels, Factories, SEZs, Townships, Schools, Metros etc.

Green projects rated by IGBC fall under one of the following levels (in ascending order): Certified, Silver, Gold and Platinum. IGBC certifies the green projects which are conceptualized, designed, constructed and operated as per IGBC Ratings. Benefits of adopting IGBC green building rating systems includes:

- Demonstrated and proven savings of 30 to 40 % on energy cost (Approx. 15,000 MWh of energy savings per million sq. ft per annum)
- 20 to 30 % savings in water consumption (Approx. 45,000 kL of less water consumption per million sq. ft)
- Fully indigenized and designed to address National priorities
- In-line with National Standards and Codes including- National Building Code (NBC), Energy Conservation Building Code (ECBC),
- Align with Ministry of Environment Forests Climate Change (MoEFCC) and Central Pollution Control Board (CPCB) guidelines

Started in the year 2003, in last 17 years, IGBC has facilitated the spread and growth of green buildings across the length and breadth of the Country. As on 31st March 2020, more than 5,723 Green Building projects with a footprint of over 7.09 Billion sq. Ft are registered with the Indian Green Building Council (IGBC). Out of these, 1,932 Green Building projects are certified and fully functional in India.

5. ACTION ON ENERGY CONSVERVATION IN U.T. OF PUDUCHERRY

5.1 Introduction

The Union Territory of Puducherry comprises of four regions namely Puducherry, Karaikal, Mahe and Yanam, which are not geographically contiguous and is spread over an area of 490 Sq. km with the total population of 12.48 Lakhs as per provisional results of Census 2011. The basic profiles of four regions are as follows:

- Puducherry is the largest among the four regions and consists of 12 scattered areas interspersed with enclaves of Villupuram and Cuddalore Districts of Tamil Nadu.
- Karaikal is about 150 kms South of Puducherry and is bounded by Nagapattinam and Thiruvarur Districts of Tamil Nadu State.
- Mahe lies almost parallel to Puducherry 653 kms away on the west coast near Kannur District of Kerala State.
- Yanam is located about 840 kms north-east of Puducherry and it is located in the East Godhavari District of Andhra Pradesh State.

The Territory of Puducherry was merged with the Indian Union on 01st November 1954 and is administered under the provisions of Government of Union Territories Act, 1963.

5.2 U.T of Puducherry – Power Scenario

Puducherry has limited power generation capacity of its own and relies mainly on central electricity generating stations to meet its power demand. The Puducherry Power Corporation limited (PPCL) is responsible for power generation for all the four districts of Puducherry, The Department of Electricity (DoE) oversees electricity transmission, distribution and supply. The Union Territory of Puducherry has an extensive network of Power Transmission and Distribution Systems spread along the breath and width of all the four regions of the Union Territory. EDP operates a transmission network of 230 kV & 110 kV and distribution network at 33 kV, 22 kV, 11 kV and at LT levels. The

power sector of UT is regulated by Joint Electricity Regulatory Commission (JERC) for the State of Goa and UTs.

Based on 2011 Census, there were around 7,071 un-electrified households in the UT. However as of FY 15 as per EDP records the number of unelectrified households have increased to 7,948. These households have not applied for electrification due to various socio-economic reasons or there are litigations which prevent EDP to affect service connection. There is no household left un-electrified due to want of electricity infrastructure. All the unconnected households will be electrified within FY 17 itself. The domestic sector (46%) and the commercial sector (31%) are the major consumers of electricity constituting a quarter of the total consumption. The electricity serves almost 4.79 lac consumers off which 3.25 lac belong to the domestic sector. The UT has also witnessed transmission and distribution losses to the tune of 13.25% in 2017-18.

In order to supply continuous power to all the households in the state, the state would see an increase in peak demand from 503 MW in FY 15 to 644 MW in FY 2019 with corresponding increase in energy requirement from 2,777MU in FY 15 to 3,555 MU in FY 2019.

The Gas Power Plant situated in Karaikal with an installed capacity of 32.5 MW is the only state generation plant in the UT owned by Puducherry Power Corporation Limited which supplies power to the DoE, Puducherry. The remaining power demand is met by adjoining Tamil Nadu Electricity Board, Kerala State Electricity Board and Central generating stations. The present longterm availability of the state is 437 MW from all sources including share from unallocated quota from Central Generating Stations. In the present conditions, the peak demand of 503 MW in FY 15 was almost fully met owing to power allocation from central generating stations and Power supplied by TNEB to Karaikal and by KSEB to Mahe. The future demands have been derived by estimating household consumption after taking into account the growth in number of electrified households on the one hand and the growth in average consumption per household on the other hand. It has also been assumed that un-electrified consumers arrived as per census projection who have not applied for electrification would be electrified by FY 17.

Almost 75% of the installed capacity comes from thermal sources followed by 11% from nuclear energy and a limited share from renewable energy sources. High dependence on thermal

power sources contribute to an increase in the greenhouse gas emissions and environmental pollution.

5.3 Energy Conservation in Puducherry

In exercise of the powers conferred by section 47 of the Puducherry Town and Country Planning Act, 1969 (No. 13 of 1970), the Lieutenant-Governor, Puducherry in consultation with the Town and Country Planning Department, hereby makes the following Puducherry Building Bye-Laws and Zoning Regulations, 2012 and published in the Part-I of Extraordinary Official Gazette No. 21, dated 8th March, 2012.

This Bye-laws was amended in the year 2017 with the "ANNEXURE-XXII" in which the "Integration of Environmental Condition in sanction of Building Plans" is provisioned to the category of the building. It includes the parameters such as Energy Use (including all energy sources), Energy generated on site from onsite Renewable energy sources, Water use and waste water generated, treated and reused on site, Waste Segregated and Treated on site, Tree plantation and maintenance, etc. and its levels are mentioned in the Bye-Laws. This Bye-laws and Regulations was renamed as the Puducherry Building Bye-Laws and Zoning Regulations (Amendment), 2017. The ammended Bye-laws was published in the Part-II of Extraordinary Official Gazette No. 49, dated 1st August, 2017.

The Government of India has launched the Jawaharlal Nehru National Solar Mission (JNNSM) under the National Action Plan for Climate Change (NAPCC) to promote ecologically sustainable growth while addressing India's energy security challenges. The objective of the National Solar Mission is to establish India as a global leader in solar energy, by creating the policy conditions for its diffusion across the country as quickly as possible.

The Union Territory is fast developing with significant growth in socio-economic development. There will be a continuous increase in energy demand from all sectors. To meet the increasing energy demand in a sustainable manner, it is essential that the Government of Puducherry formulates and implements energy policies that are driven by a clear vision and implemented through the participation of all stakeholders.

For this, The Solar Energy Policy-2015 was framed by the Government of Puducherry in order to create a framework that enables the development of solar energy in the Union territory of Puducherry. Puducherry Solar Energy Policy was published in the Official Gazette No. 9, dated 1st March, 2016.

Apart from this, promotion of energy conservation practices and showcasing renewable energy technologies in a play way can help raise awareness levels of the masses and inculcate environmental responsiveness. With this intent, REAP in collaboration with MNRE inaugurated the Puducherry Energy Education Park in 2015. The park includes facilities to hold indoor and outdoor exhibitions with the facilities being housed in a 'green building' setup. The outdoor facility contains small models of various renewable technologies like tracks, boats, cookers, windmills etc that enables students to learn in practice. Further, REAP has set up the State level Renewable Education Park at Lawspet, Puducherry.

Puducherry was first in the country to successfully implement Domestic Efficient Lighting Program (DELP), under which 6,09,251 incandescent bulbs were replaced with LED bulbs in domestic households in 2014. This resulted in energy savings of about 80.95 million kWh and emission reduction of about 65.570 thousand tons of CO_2.

LED Village Campaign was held to replace existing incandescent bulbs in households with LED bulbs and existing high power consuming street lights into energy efficient LED Street Lights. It was successfully implemented in four villages Irulanchandai, Bahour Pet, Kuruvinatham Pet and Pudunagar in January 2016. Approx. Energy saved is 190827 kWh/yr.

Demo Street Light Project - 270 Nos. of LED street lights has been installed as pilot project on a 4 km stretch from Pillaichavady to Kanagachettikulam on East Coast Road, Kalapet. Approximate Energy saved is 610923 kWh/yr.

Demo LED Lighting System - A demo LED lighting project on the Energy Efficient Lighting System at Raj Nivas was successfully completed in March 2016. Approx. Energy saved is 75476 kWh/yr.

Also Energy clubs have been established in 47 nos of educational institutions with necessary trainings on energy conservation being provided to the energy coordinators to create awareness for

conducting seminars, models making projects, workshops etc., It inculcate the habit of energy conservation among the Indian Public.

5.4 Energy Conservation and Building Code (ECBC) and ECBC cell of Puducherry

Commercial building sector in India is expanding rapidly at over 9% per year spurred largely by the strong growth in the services sector. It has been estimated that more than 50% of building stock that will exist in the year 2030 is yet to come up in the country – a situation that is fundamentally different from developed countries. Having regard to the fact that the rate of growth in commercial building sector is amongst the highest, and that this sector needs to be moderated in its energy consumption BEE introduced the Energy Conservation Building Code (ECBC) as a voluntary policy measure in 2007 to reduce the adverse impact of buildings on the environment. ECBC defines norms of energy performance for various building components, and takes into consideration, the climatic region. The application of these norms lowers the building's energy requirement without affecting the function, comfort, health or productivity of the occupants.

BEE has launched new version of code ECBC 2017 on 19th June 2017. The newly developed code is futuristic, pragmatic and easy to implement. The new version has three levels of compliance: ECBC, ECBC+, and Super ECBC. These additions are geared to encourage public and private sectors to not only meet the basic ECBC criteria, but to exceed them as well. Long-term success of the ECBC will depend heavily on the collaborative roles various stakeholders would play towards the development, adoption and implementation of building code. Barriers and challenges for implementation of ECBC vary in terms of technical and design aspects, market barriers, policy and enforcement issues.

Puducherry is the first UT to have notified the Energy Conservation and Building Code in 2012. A common ECBC cell has also been constituted for Puducherry, Andaman and Nicobar, Lakshadweep, Daman and Diu and, Goa.

The ECBC helps manage electricity demands to ensure conservation of electricity in buildings. For energy conservation to fructify, the building approval processes and systems in the

cities need to adopt the ECBC compliance checks. Since there is a greater scope for energy conservation, the GHG emissions will naturally be curbed thereby mitigating their impacts.

The UT had adopted the ECBC and has established an ECBC Cell and an ECBC Notification. Under the Smart Cities program of the UT, it was decided to cover restoration of three government schools and heritage buildings. However, the projects have failed to take off. The Proposal for Smart Cities Mission incorporates that at least 80% of the buildings must be energy efficient. For the U.T. It is also imperative to have energy consultants and energy auditors. The Renewable Energy Authority Puducherry (REAP) will be taking steps to notify the ECBC as well as provide energy consultants and auditors.

The ECBC provides for a standard guideline to ensure energy effective designs for government buildings and institutions. For optimal energy conservation in the building sector, there could be a quantification of energy efficiency for a building. This would help the UT compare buildings through setting benchmarks and checking their performance on energy efficiency and conservation. A rating system to compare on the various parameters of the energy efficient design for buildings could be established pooling in the owners, investors, residents and other building associated stakeholders. The In accordance with section 14(p) of the Energy Conservation Act 2001 the purpose of the Energy Conservation Building Code (ECBC) is to provide minimum requirements for the energy-efficient design and construction of buildings. The Code also provides two additional sets of incremental requirements for buildings to achieve enhanced levels of energy efficiency that go beyond the minimum requirements. The draft ECBC was prepared by REAP, Puduchery and submitted to BEE for approval.

GOVERNMENT OF PUDUCHERRY

CHIEF SECRETARIAT (ENVIRONMENT)

(G.O. Ms. No. 2/2016-Envt., dated 19th February 2016)

ORDER

The Government of India has launched the Jawaharlal Nehru National Solar Mission (JNNSM) under the National Action Plan for Climate Change (NAPCC) to promote ecologically sustainable growth while addressing India's energy security challenges. The objective of the National Solar Mission is to establish India as a global leader in solar energy, by creating the policy conditions for its diffusion across the country as quickly as possible.

The Union Territory is fast developing with significant growth in socio-economic development. There will be a continuous increase in energy demand from all sectors. To meet the increasing energy demand in a sustainable manner, it is essential that the Government of Puducherry formulates and implements energy policies that are driven by a clear vision and implemented through the participation of all stakeholders.

This Puducherry Solar Energy Policy intends to creates a framework that enables the development of solar energy in the Union territory of Puducherry. The Solar Energy Policy-2015 framed by the Government of Puducherry which is appended to this Order is published for the information of all stakeholders.

(By order of the Lieutenant-Governor)

S. Thammu Ganapathy,
Deputy Secretary to Government (Envt.).

GOVERNMENT OF THE UNION TERRITORY OF PUDUCHERRY

SOLAR ENERGY POLICY–2015

1.0 Preamble:

1.1. Energy is one of the key driving forces of socio-economic development and change. Long-term energy security is therefore, an essential element of sustainable development. The rapid depletion of non-renewable energy sources and the adverse effects caused to the globe by the process of extracting energy from fossil fuels call for urgent solutions while demand for energy will keep increasing. The universally accepted view is that only energy from renewable sources offer a solution for a sustainable energy future.

1.2. The Government of India has launched the Jawaharlal Nehru National Solar Mission (JNNSM) under the National Action Plan for Climate Change (NAPCC) to promote ecologically sustainable growth while addressing India's energy security challenges. The objective of the National Solar Mission is to establish India as a global leader in solar energy, by creating the policy conditions for its diffusion across the country as quickly as possible.

1.3. The Union territory of Puducherry comprises of four erstwhile French settlements *viz.*, Puducherry, Karaikal, Mahe and Yanam, which are unconnected regions. The Union Territory is fast developing with significant growth in socio-economic development. There will be a continuous increase in energy demand from all sectors. To meet the increasing energy demand in a sustainable manner, it is essential that the Government of Puducherry formulates and implements energy policies that are driven by a clear vision and implemented through the participation of all stakeholders.

1.4. This Puducherry Solar Energy Policy intends to create a framework that enables the development of solar energy in the Union territory of Puducherry.

2.0. Solar Energy Potential in the Union territory of Puducherry:

2.1. The four regions of the Union Territory of Puducherry have an average solar irradiance of 5.6-6.0 kWh / square meter / day and about 300 sunny days in a year, therefore, offering a good solar energy potential.

2.2. The urban areas of the Union territory of Puducherry lend themselves well to the installation of (rooftop) grid-connected solar PV systems.

2.3. The rural areas of the Union territory of Puducherry have excellent electricity grid penetration, therefore, also offering good opportunities for grid-connected solar PV systems.

3.0. Solar Energy Vision:

3.1. Solar energy will be a major contributor to a sustainable energy future for the Union territory of Puducherry.

3.2. Solar energy development will be part of an overall energy strategy that includes demand side management, energy conservation, energy efficiency initiatives, distributed renewable energy generation and smart grid.

3.3. The Union territory of Puducherry will achieve, or exceed, the solar energy portfolio obligations as may be determined by the Joint Electricity Regulatory Commission (for the state of Goa and Union Territories) (the "JERC") from time to time.

3.4. In the Union territory of Puducherry solar energy will be a mainstream energy source by 2025.

4.0. Solar Energy Policy Objectives:

4.1. Define clear and transparent policy governance.

4.2. Encourage public-private partnerships and joint ventures to mobilize investments in solar energy projects, manufacturing facilities, research and technology development.

4.3. Facilitate open access to the public electricity grid of the Puducherry Union Territory and thereby create opportunities for grid-connected distributed generation of solar power and smart grid solutions, such as the propagation of electric transport, in order to reduce the dependence on fossil fuels and urban air pollution

4.4. Encourage to set up solar energy plants in industrial, commercial and residential buildings.

4.5. Establish a 'Single Window System' for technical support, funding support and project clearance.

4.6. Create an investment-friendly environment that provides opportunities for private individuals, companies, local bodies, Government departments and others to contribute to and participate in the generation of solar energy, particularly for the electricity consumer to become a "prosumer" (a producer-consumer).

4..7. Initiate information, communication and education measures for promoting solar energy.

4.8. Encourage and promote solar energy research and development through technical institutions in the Puducherry Union Territory.

4.9. Establish linkages with National and International institutions for active collaboration in development, demonstration and commercialization of solar technologies and systems.

5.0. Scope of the Solar Energy Policy:

5.1. The policy will be applicable to projects, programs and installations relating to both solar photovoltaic energy (solar PV) and solar thermal energy.

5.2. The policy will be in force from the date of notification and shall be reviewed for its efficacy every five years with the sole purpose of considering improvements that may expedite the realization of the Puducherry Solar Energy Vision.

5.3. The Puducherry Solar Energy Policies will be aligned with Various National policies and initiatives relating to the promotion of new and renewable energy

6.0. Solar energy implementation mechanisms:

6.1. The implementation of solar energy in the Puducherry Union Territory will include, but, not be limited to the mechanisms, facilities and initiatives listed below.

6.1.1. *Solar energy gross feed-in and metering*: The solar energy is fed into the grid and sold to Electricity Department, Puducherry ("EDP") or other distribution licensee. In addition to the existing service connection meter that records the consumption of energy at the premises, an energy meter will be installed by EDP or other distribution licensee to record the energy fed into the grid. The solar energy fed into the grid will be purchased by EDP or other distribution licensee at the prevailing solar energy tariff as determined by the JERC. Under the solar gross feed-in mechanism, solar energy may also be sold to another distribution licensee or to a third party under the open access mechanism.

SUMMARY

A series of energy efficiency programmes in buildings sector and its achievement & energy savings are summarized as follows

ECBC

Energy Conservation Building Codes - ECBC 2017 for new commercial building construction in India is estimated to lead to a 50% reduction in electricity use by 2030. As on 31st March 2020, 129 buildings have been registered under ECBC, of which, 54 buildings are ECBC compliant while 75 buildings are under design stage. The 54 constructed and ECBC compliant buildings with total area of 1.63 Million square meter have led to energy savings of 116 MU.

BEE Star Rating for Buildings

Under the BEE star rating scheme, existing buildings are being labeled as per their actual Energy Performance Indices (EPI) on a scale of 1 to 5 stars. The sets of standard EPI bandwidths developed to rate buildings under this scheme for different climatic zones indicate the range of variations. As on 31st March 2020, 264 buildings have been labeled under the programme. During FY 16-20, 63 Offices, 17 BPOs, 5 Hospitals, and one shopping mall have been certified with star label leading to energy savings of 179 MU.

Building Energy Efficiency Programme (BEEP)

EESL is implementing BEE star rated appliances to promote the energy efficiency in public buildings under Buildings Energy Efficiency Programme (BEEP), which was launched in May 2017 by the Indian Government. As on 31st March 2020, 6545 commercial buildings have been covered under this programme. Type of commercial buildings covered under the programme includes Central Government Buildings, District Courts, PWD Buildings and Railway Stations. This programme has led to energy savings of above 212 MU during FY 2019-20.

Other Green Building Programs

There are 3 major Green Building Rating Systems in India, viz. IGBC, LEED and GRIHA. Energy Efficiency is a major component of these rating systems.

GRIHA: As on 31st March 2020, 1939 projects have been registered.

LEED: As on 31st March 2020 there are more than 2,900 registered and certified commercial projects participating in LEED, totaling more than 1.39 billion square feet. During the FY 15-19 total of 1478 buildings have been certified under the programme, having an area of 50 million square meters.

IGBC: More than 5,723 Green Building projects with a footprint of over 7.09 Billion sq. Ft are registered with the Indian Green Building Council (IGBC). Out of these, 1,932 Green Building projects are certified and fully functional in India.

EESL: EESL, under UJALA programme, is promoting energy efficiency through LED lamps, Energy efficient tube lights and energy efficient fans. EESL has sold 27.4 Crore LED lamps during the FY 2016-20. This programme has saved over 35.5 BU and has led to avoidance of 29.1 million tonnes of carbon dioxide emissions annually.

CONCLUSIONS

India is experiencing a construction boom and strong building energy efficiency policies are key to avoiding excessive growth in electricity use and greenhouse gas emissions. Energy codes and green building policies are often used to encourage energy efficient designs of buildings and set an efficient path for new constructions. To translate energy-saving opportunities in buildings to tangible benefits, there is a continuous need to encourage public policies, enhance awareness and capacity building, and adopt new trends and technologies. Since, the growth of commercial buildings is increasing at 8 per cent per year, and as in base year 2010, the GHG emissions contributed to 73 million tCO2, which is approximately 5% of total GHG generated from India. Analysts predict the cumulative area of buildings will triple in the next 15 years by 2030. Thus, it forms an important emergent sector to consider under climate change mitigation actions.

While continued economic growth is an area of focus for the nation, India has also been aware of the importance of sustainable development. Government of India has notified broad policies and regulations for promotion of energy efficiency in India. Additionally, Bureau of Energy Efficiency (BEE) at national level and State Designated Agency (SDA) at state level are also providing the relevant push towards energy efficiency.

In Puducherry, REAP in collaboration with MNRE inaugurated has initiated many energy efficient programs like ECBC, energy codes, and green building programs would generate energy savings, reduce electricity capacity additions, and create economic savings. They can also help alleviate local air pollution and provide health benefits. These policies together can serve as strategies to implement India's Nationally Determined Contribution, and thus achieve climate change mitigation.

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सत्यमेव जयते
Department of Science & Technology
Govt. of India

Puducherry Climate Change Cell has been established with the support of Department of Science and Technology, Government of India under the National Mission for Sustainable Knowledge on Climate Change (NMSKCC)