Energy Conservation Building Directive – 2018

(based on ECBC 2017)

About this presentation

- **Energy Conservation Building Code – one of the most effective tools to curb future energy demand growth**, deliver significant cost energy savings to building owners and users, while improving comfort and air quality;

- While effective development, implementation and enforcement of ECBC require coordinated efforts of multiples stakeholders at different levels, **enforcement and implementation of ECBC lies with the state and local governments**;

- The purpose of this presentation is to provide Urban Local Bodies (ULBs), as well as State Urban Development Departments (or State Designated Agencies) with **key aspects of the ECBC and to help in adoption of ECBC**;

- This presentation is prepared by the Pacific Northwest National Laboratory in partnership with the Alliance for an Energy Efficient Economy.

Presentation Outline

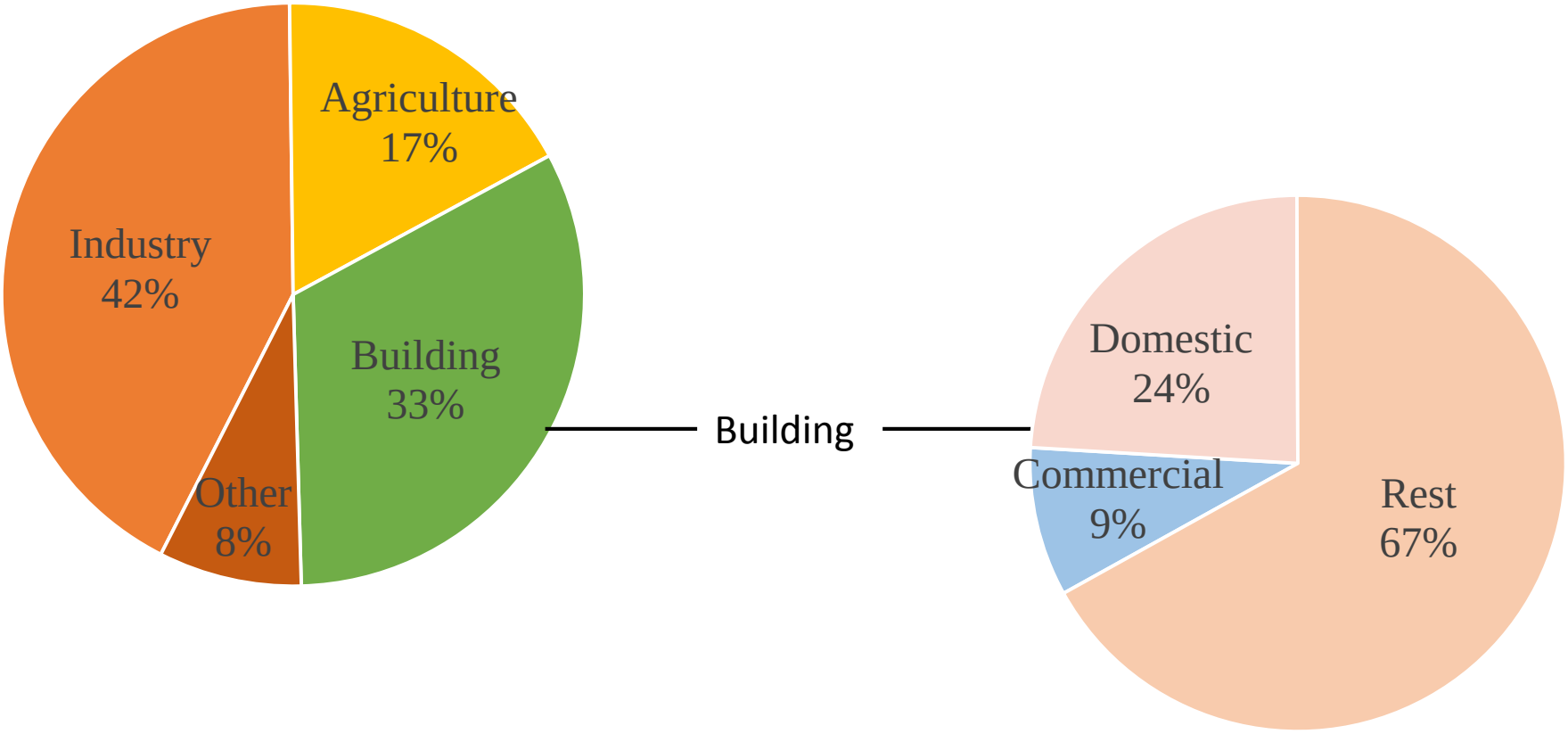
- Introduction
- About ECBC
- Role of State and Local Governments
- Case Studies
- Conclusions

- Introduction
- About ECBC
- Role of State and Local Governments
- Case Studies
- Conclusions

INTRODUCTION

Breakdown of Electricity Consumption in India (2015 - 2016)

- Building sector accounts for 33% of total electricity consumption in India
- Commercial building accounts for 9% of total electricity consumption in India

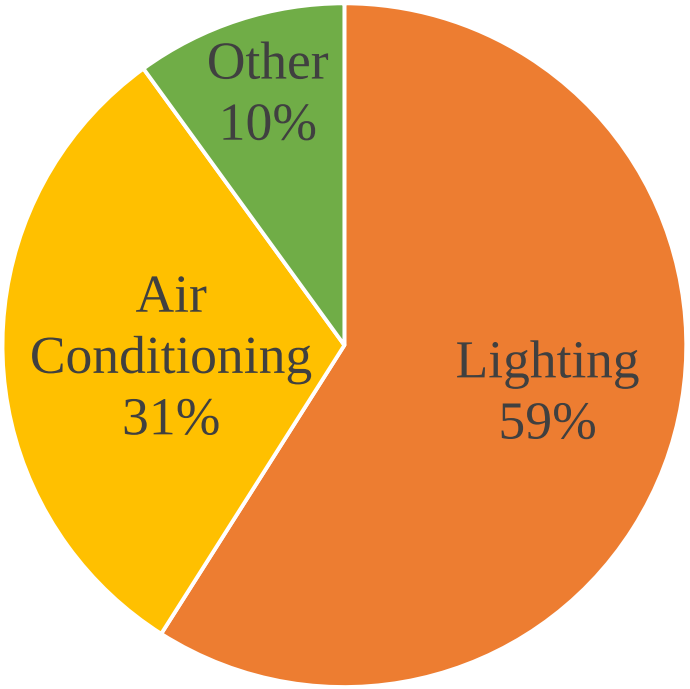


Source: CEA, 2017

INTRODUCTION

Breakdown of Electricity Consumption in Commercial Buildings

- Lighting and Air Conditioning are the largest energy users in commercial buildings

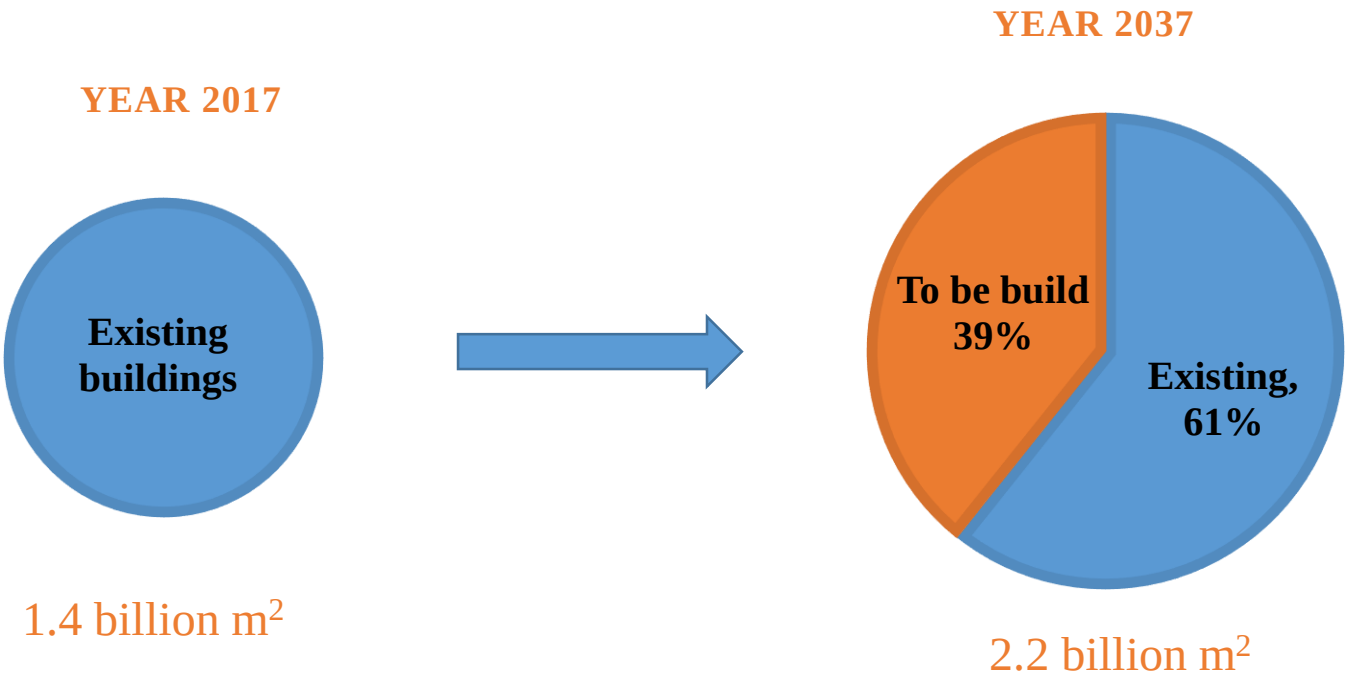


Source: BEE, 2017

INTRODUCTION

Commercial Buildings Growth Forecast

- Currently ~ 1,396 million m^2
- In 20 years ~ 2,211 million m^2 (estimated)*
- 39% of building stock in 2037 is yet to be constructed

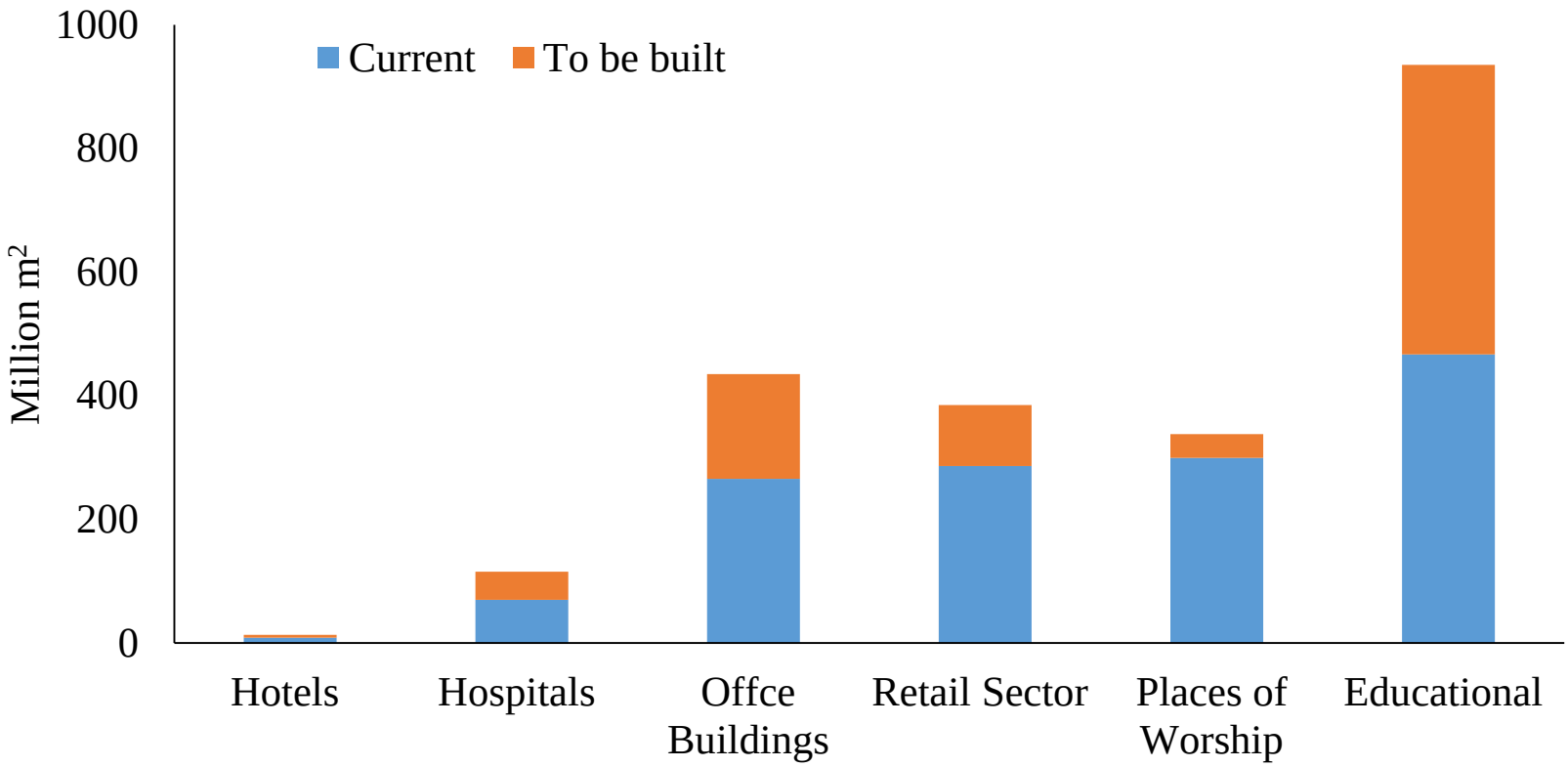


* Source: AEEE, 2017a

INTRODUCTION

Commercial Building Stock Growth Projections

- India will add more than 800,000 m^2 of commercial buildings in next 20 years

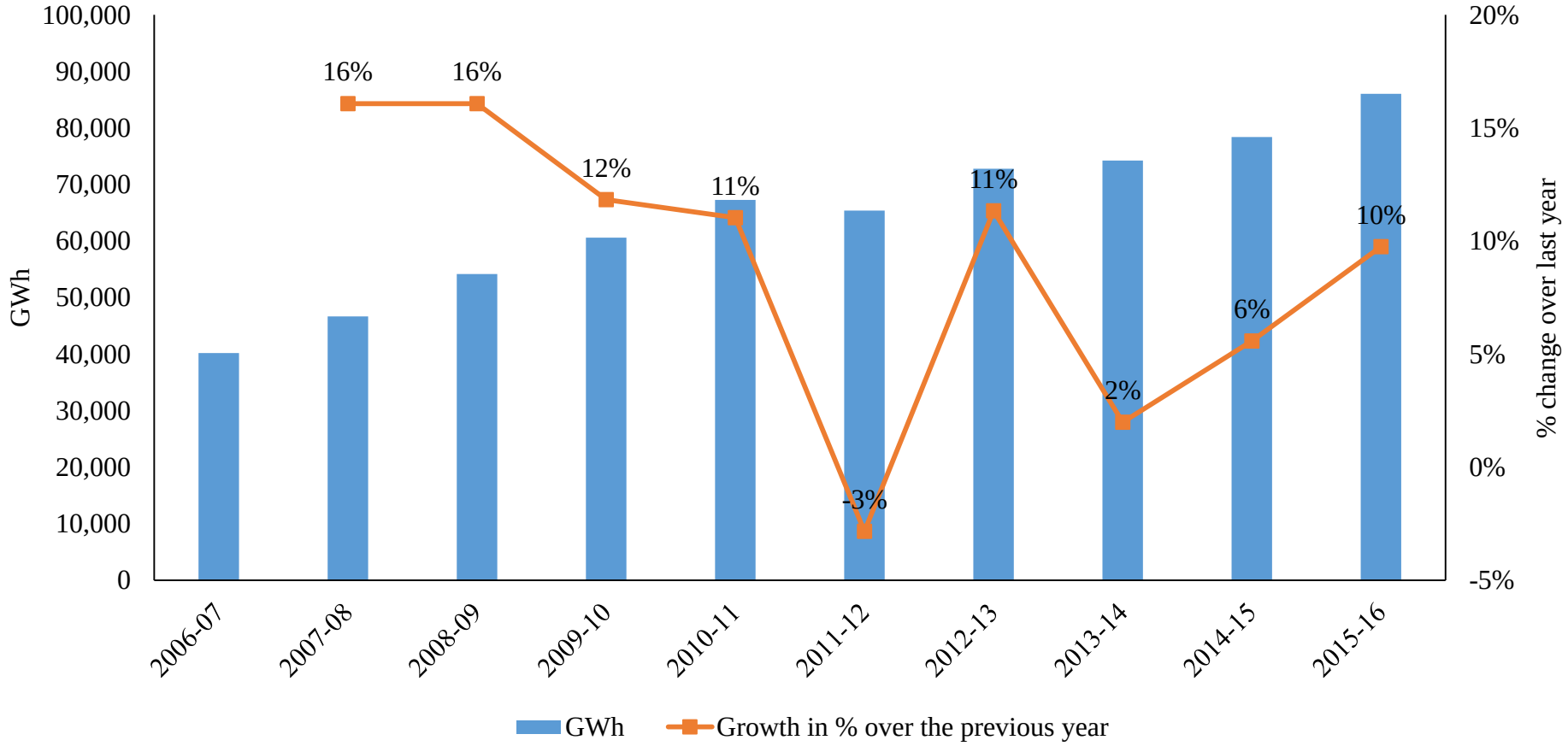


* Source: AEEE, 2017a

INTRODUCTION

Growth of Electricity Consumption in Commercial Building Sector in India

- Electricity consumption from commercial buildings grows at an annual rate of 9-10% on average

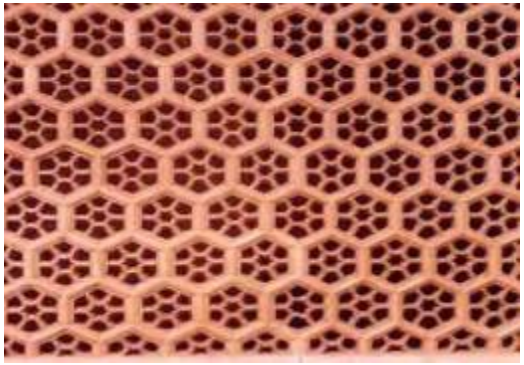


Source: CEA, 2017

INTRODUCTION

Lessons from Traditional Buildings

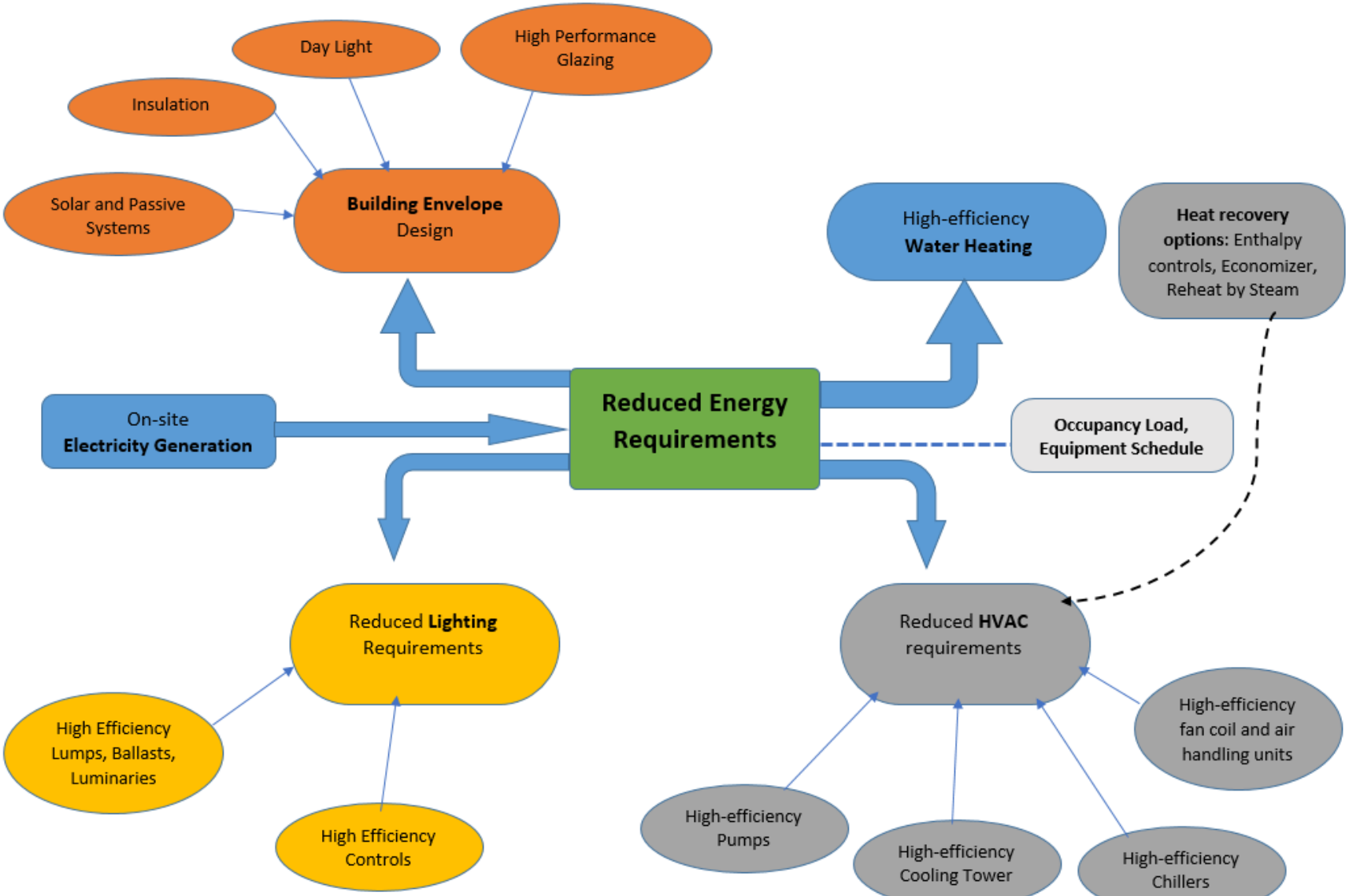
- Dense compact settlement
- Sun controlled by orientation
- Stone texture on wall surfaces decreases effect of solar radiation
- Heavy thermal mass increases time lag
- Courtyards provide shade and ventilation
- Evaporative cooling
- Low window wall ratio
- Zali as a shading device
- Potted roof insulation



Source: http://www.bienvenueaurajasthan.com/city-jaipur.php
http://www.ignca.nic.in/coilnet/asp/showbig.asp?projid=ag03

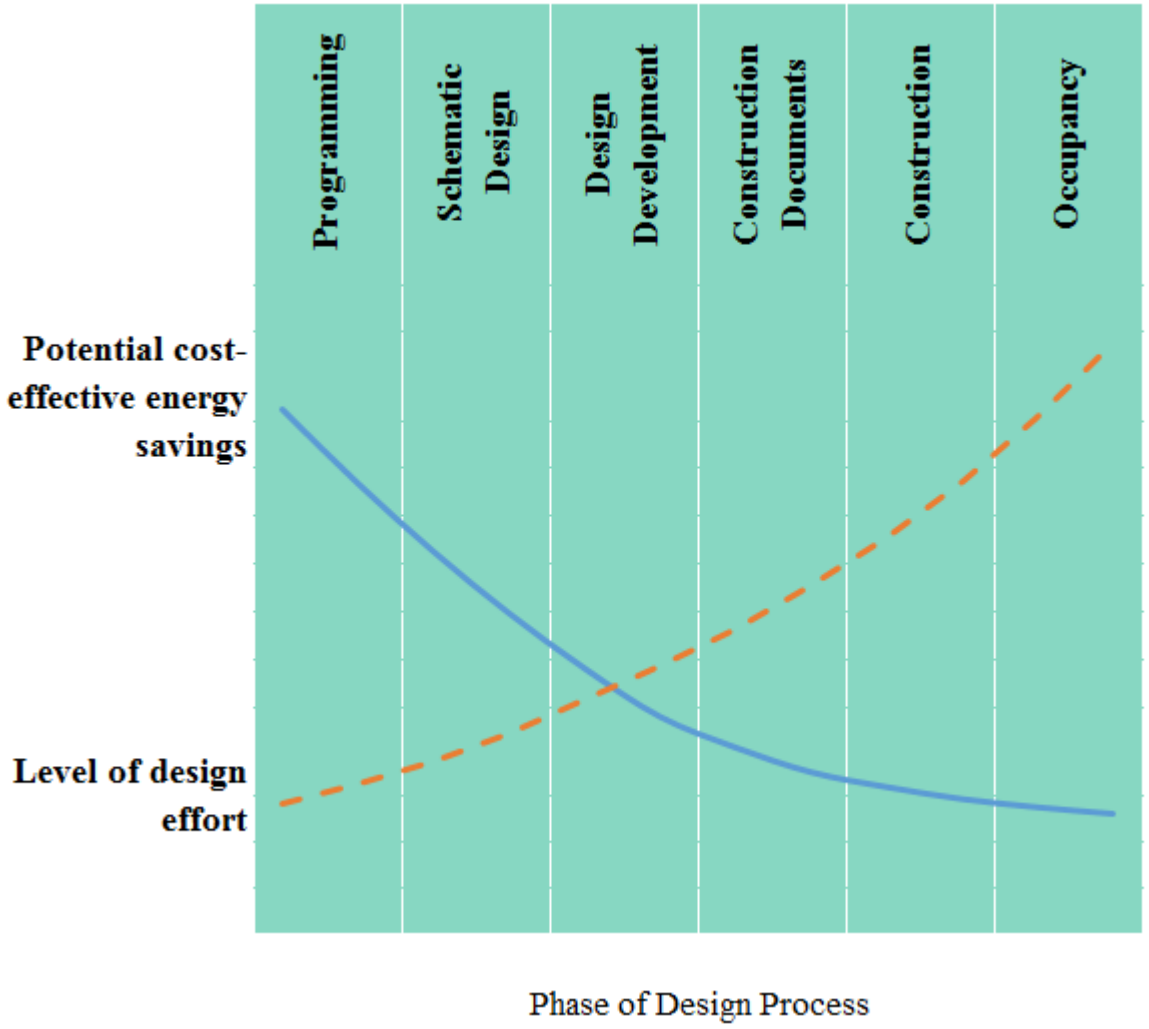
INTRODUCTION

Energy Efficient Buildings



INTRODUCTION

Building Design for Energy Efficiency: Importance of codes for new buildings



Source: BEEP, 2017

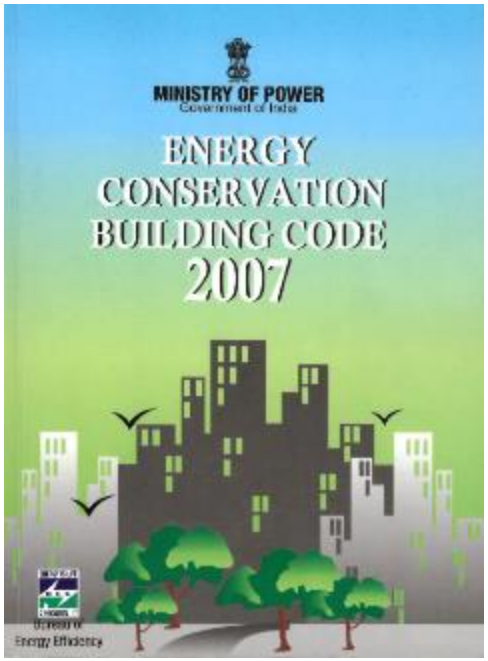
- Introduction
- About ECBC
- Role of State and Local Governments
- Case Studies
- Conclusions

ABOUT ECBC 2017

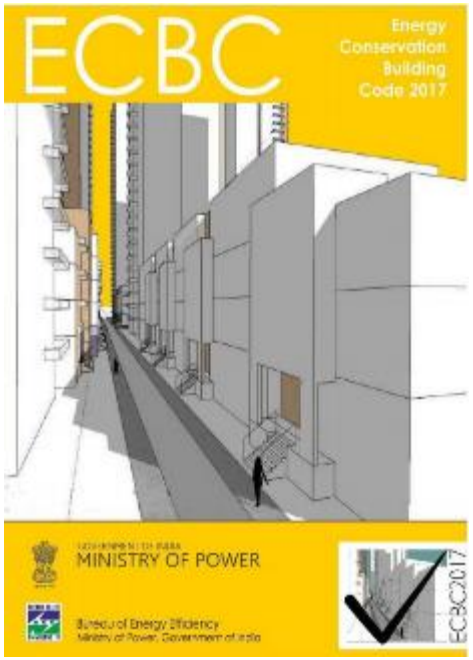
Energy Conservation Building Code, India

- Energy Conservation Act 2001 provides legal framework and institutional set-up for energy efficiency policy, including Energy Conservation Building Code

ENERGY CONSERVATION ACT 2001



ECBC 2007



ECBC 2017

ABOUT ECBC 2017

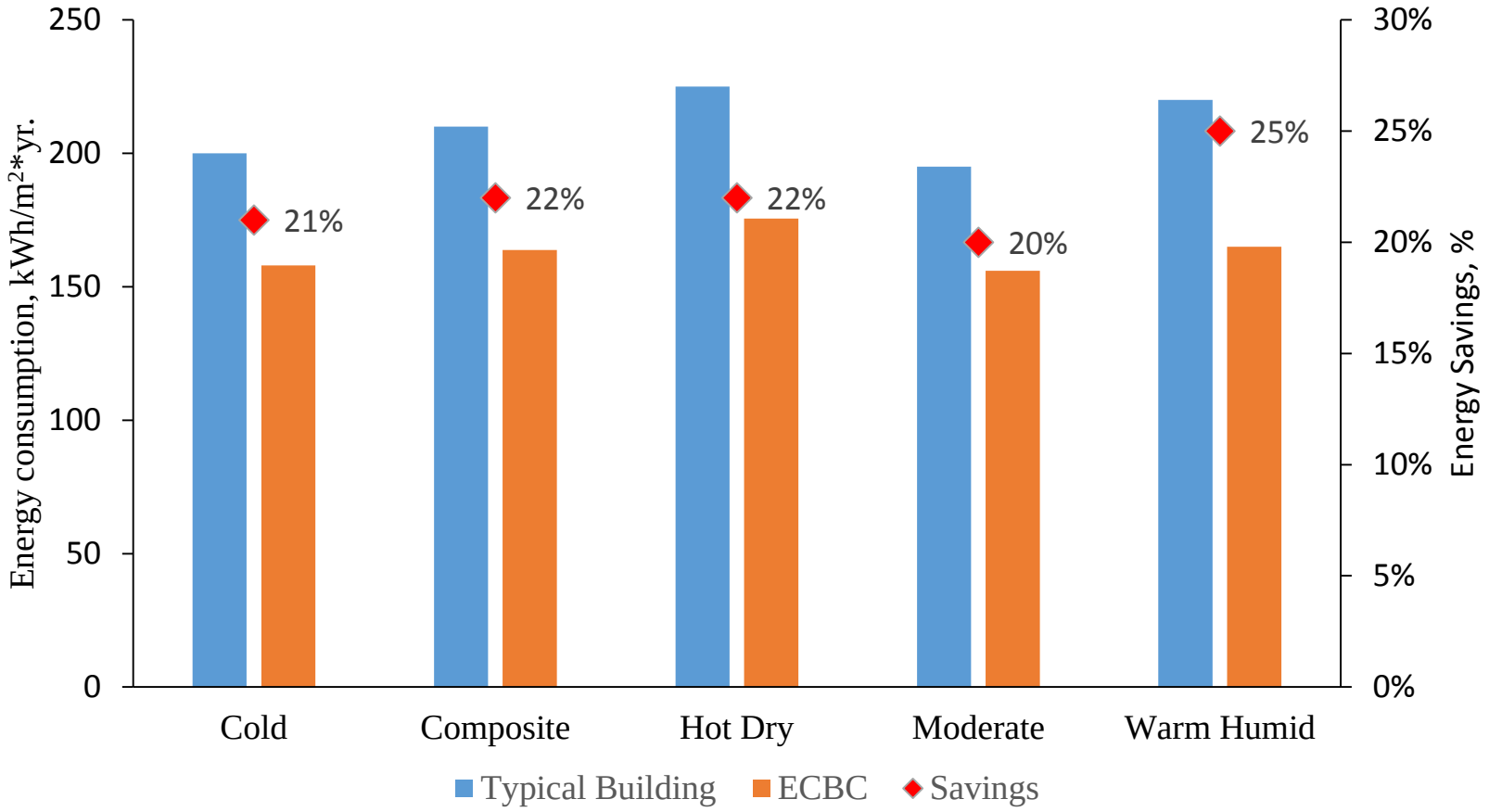
Key features

- Applies to **new commercial buildings** with a connected load of 100 kW & more or contract demand of 120 kVA or more;
- Introduces **passive design features** such as daylight requirements and shading provisions;
- Introduces provisions of installing **Renewable Energy Systems**;
- Sets **minimum energy efficiency standards** for design and construction;
- **Encourages energy efficient design or retrofit of buildings;**
- Pathway toward **Near Zero Energy Buildings**

ABOUT ECBC 2017

Key features

- ECBC-compliant buildings deliver 20-25% of energy savings in different climates, when compared with typical buildings

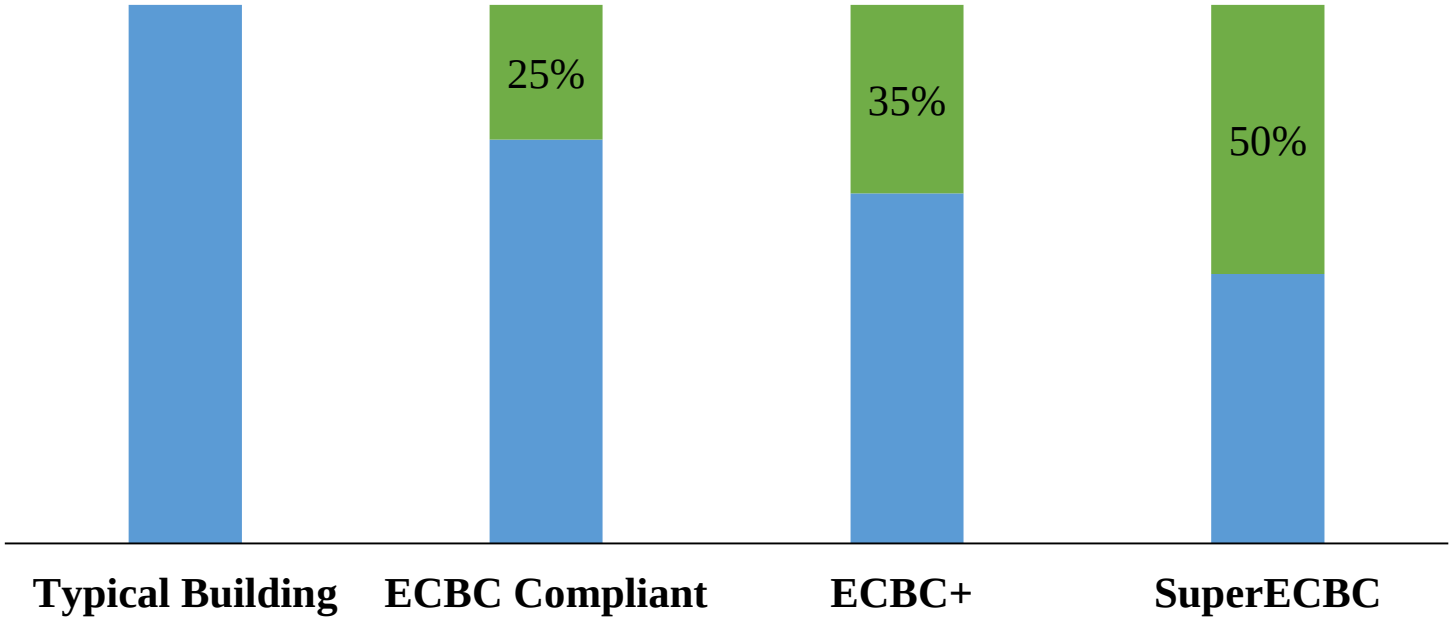


Source: BEE, 2017

ABOUT ECBC 2017

Savings compared with typical building with the same area

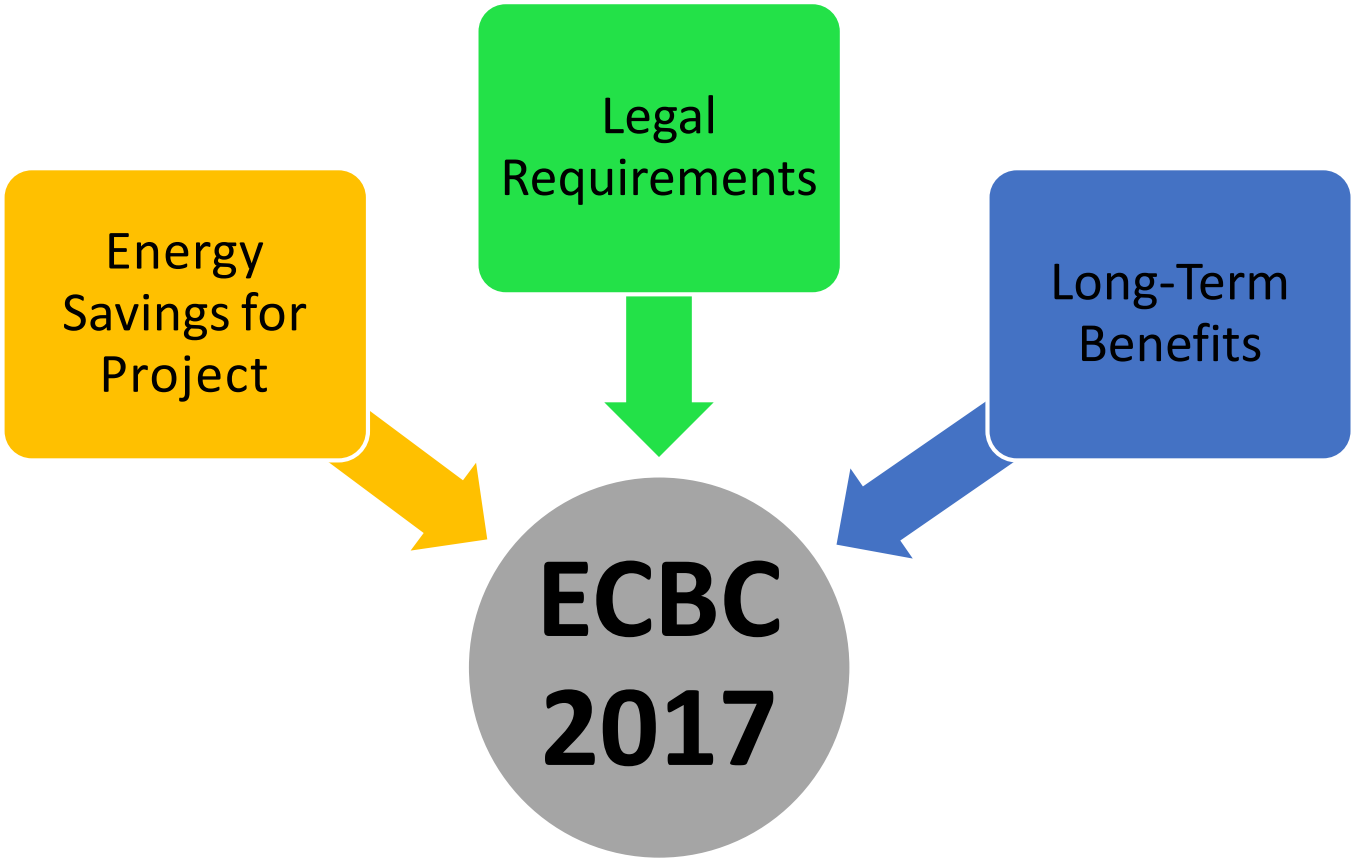
- ECBC 2017 sets three Tiers of Building Energy Performance:
  - **ECBC** (requires 25% less energy than typical building);
  - **ECBC+** (requires 35% less energy than typical building);
  - **SuperECBC** (requires 50% less energy than typical building).



Source: AEEE, 2017

ABOUT ECBC 2017

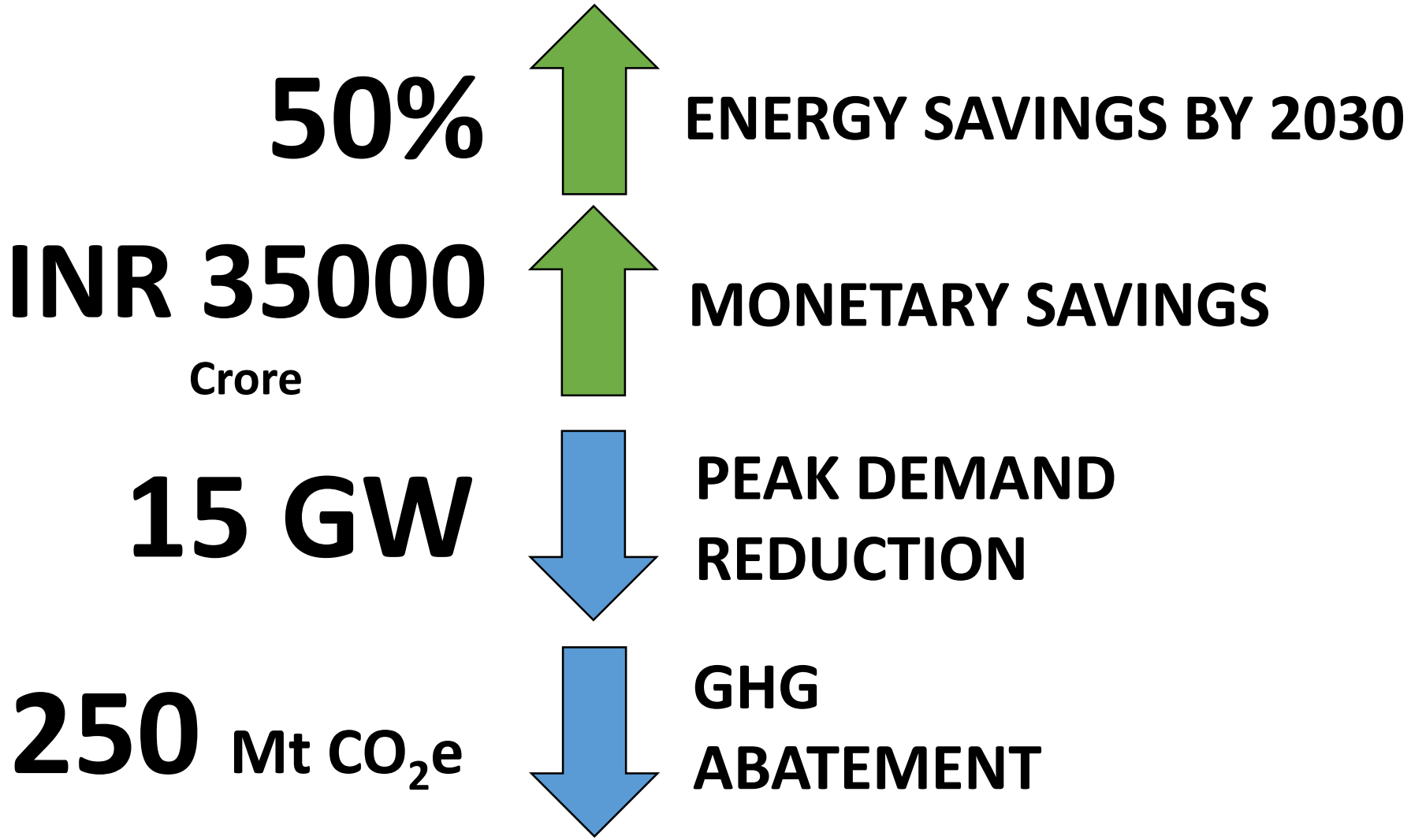
Why Comply



Source: AEEE, 2017

ABOUT ECBC 2017

Potential National Impact of ECBC 2017 Implementation

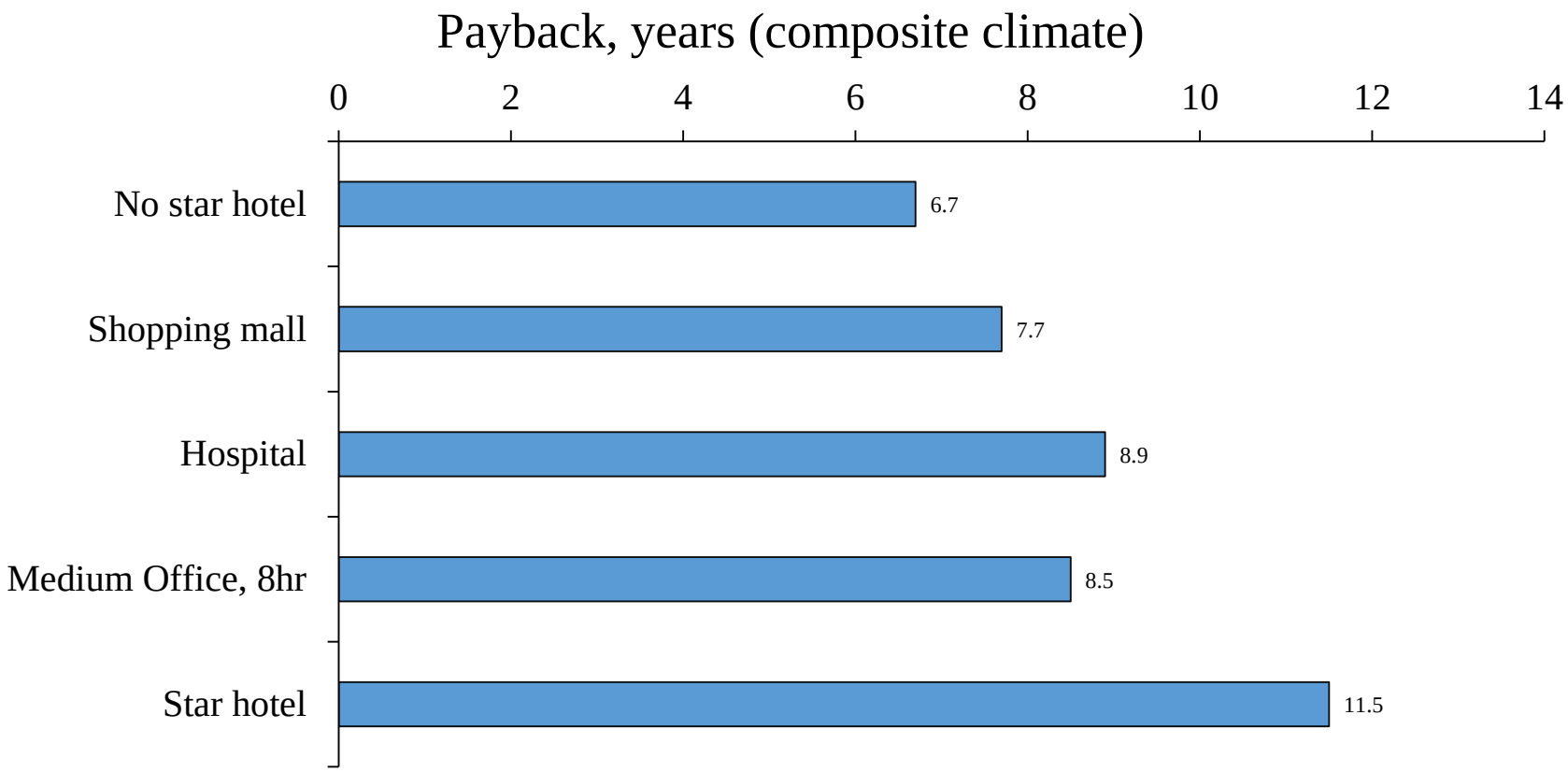


Source: Government of India, 2017

ABOUT ECBC 2017

Economic characteristics. Payback period

Economic performance of ECBC 2017-compliant building varies depending on type of building, operational pattern of office building (daytime use or 24h), location (climate zone)

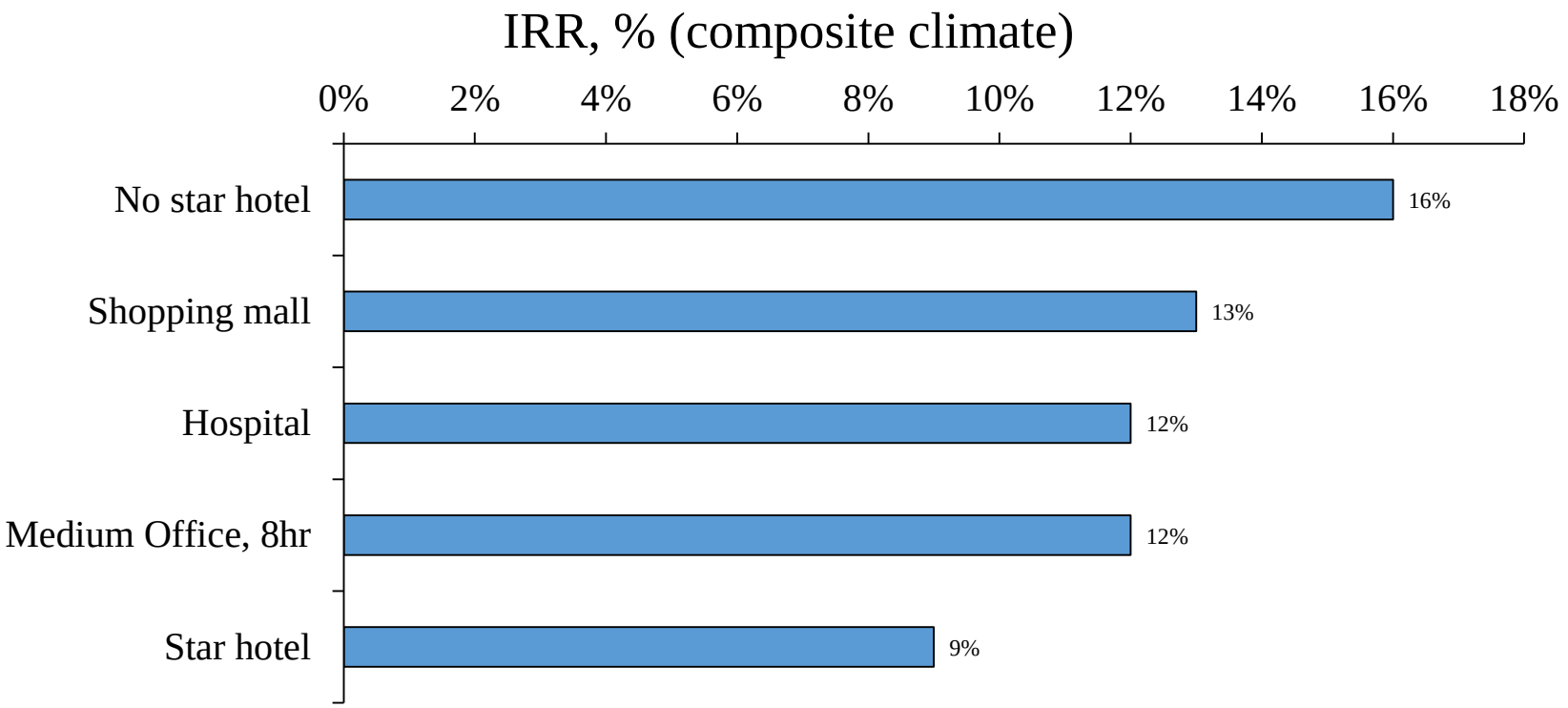


Source: USAID, 2017

ABOUT ECBC 2017

Economic characteristics. Internal Rate of Return

Economic performance of ECBC 2017-compliant building varies depending on type of building, operational pattern of office building (daytime use or 24h), location (climate zone)



Note: IRR – Internal Rate of Return

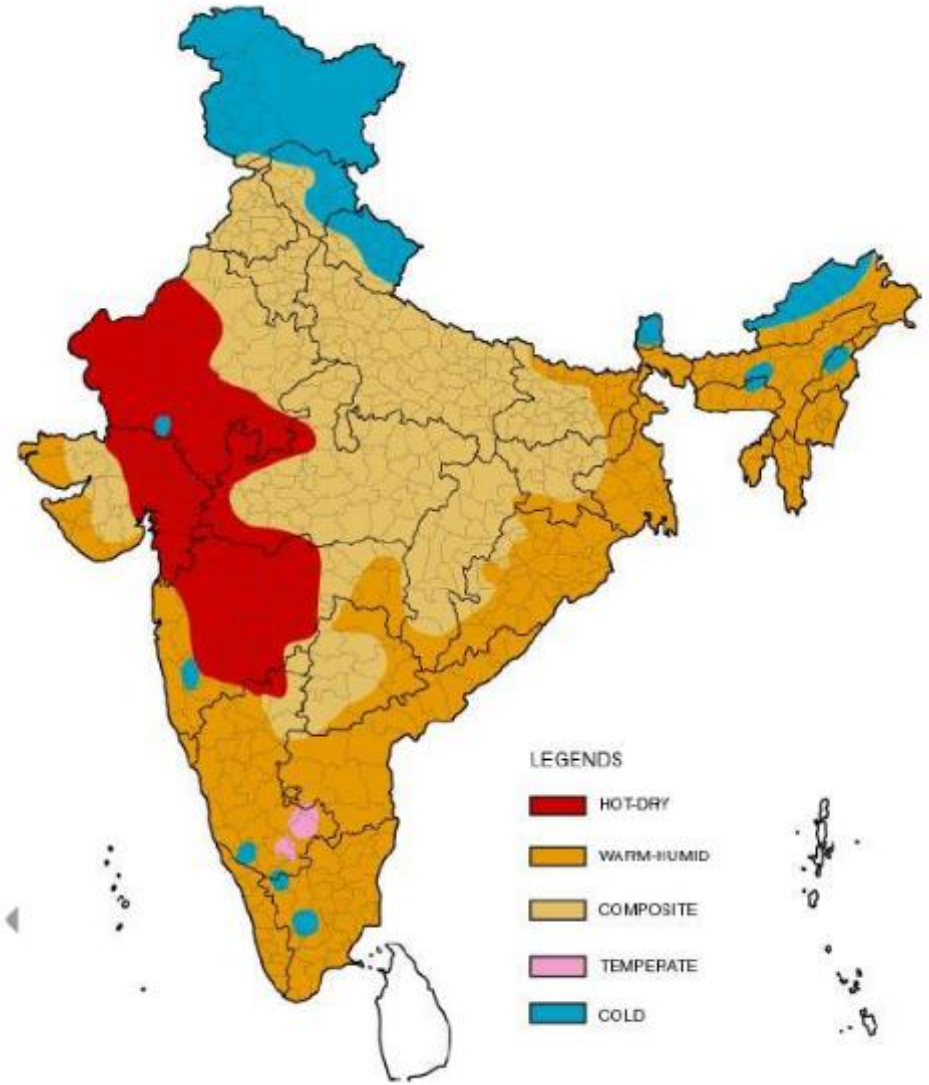
Source: USAID, 2017

ABOUT ECBC 2017

Indian Climate Zones

- Number and geographic distribution of climate zones remained the same as in ECBC 2007

- ECBC 2017 provides climate zone data for major Indian cities



ABOUT ECBC 2017
Compliance Options

Building Systems

- Building Envelope
- Mechanical systems and equipment, including HVAC and water heating
- Lighting
- Electrical power, motors, and renewable energy

Mandatory Requirements

Compliance Options

- ❑ Prescriptive method
- ❑ Building trade-off method
- ❑ Whole-building performance method

☑ Energy Code Compliance

ABOUT ECBC 2017
Compliance Options

- Component-based (prescriptive): requires little energy expertise, provides minimum performance requirements, no flexibility;
- System-based (trade-off): allows some flexibility through the balance of some high-efficiency components with other lower efficiency components;
- Whole building design analysis (performance): allows flexibility in meeting or exceeding energy efficiency requirements (as compared to a baseline building)

Approaches	Mandatory Provisions for ECBC	Flexibility	Expert Knowledge	Use of Energy Simulation
1. Prescriptive	Required	Low	Low	No
2. Trade-off	Required	Medium	Medium	No
3. Performance-based	Required	High	High	Yes

ABOUT ECBC 2017

Applicable Building Systems

Building components covered by ECBC

ECBC 2007	ECBC 2017
• Building envelope; • HVAC; • Lighting; • Power; • Water heating; • Other.	• Building envelope; • Mechanical systems, including HVAC, water heating; • Lighting; • Electric power and renewable energy.

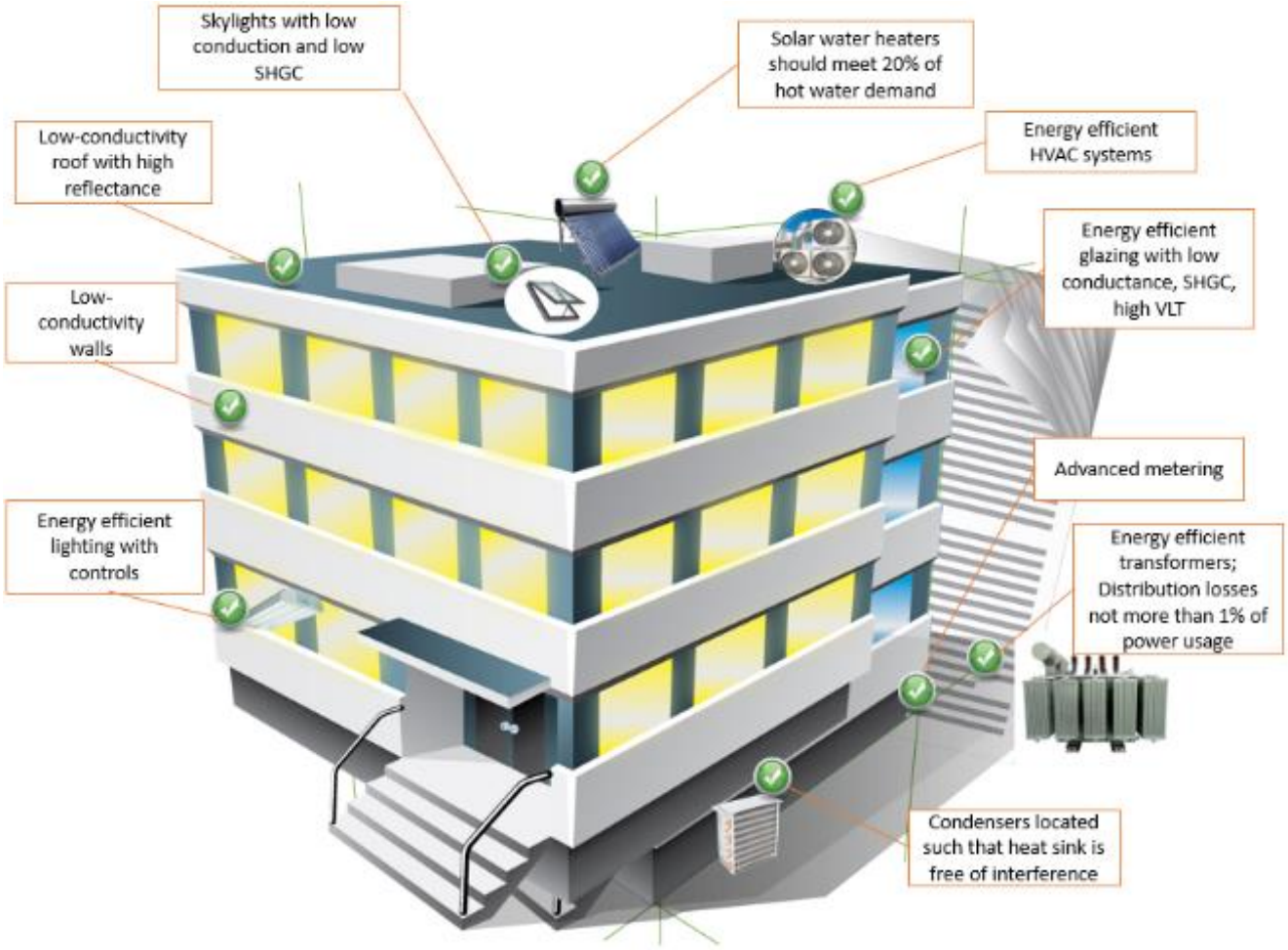
Components not covered by ECBC

ECBC 2017
• Plug loads; • Equipment that uses energy for manufacturing processes; • Parts of the building that use energy for manufacturing processes.

Notes:
HVAC - Heating Ventilation and Air Conditioning

ABOUT ECBC 2017

Applicable Building Systems

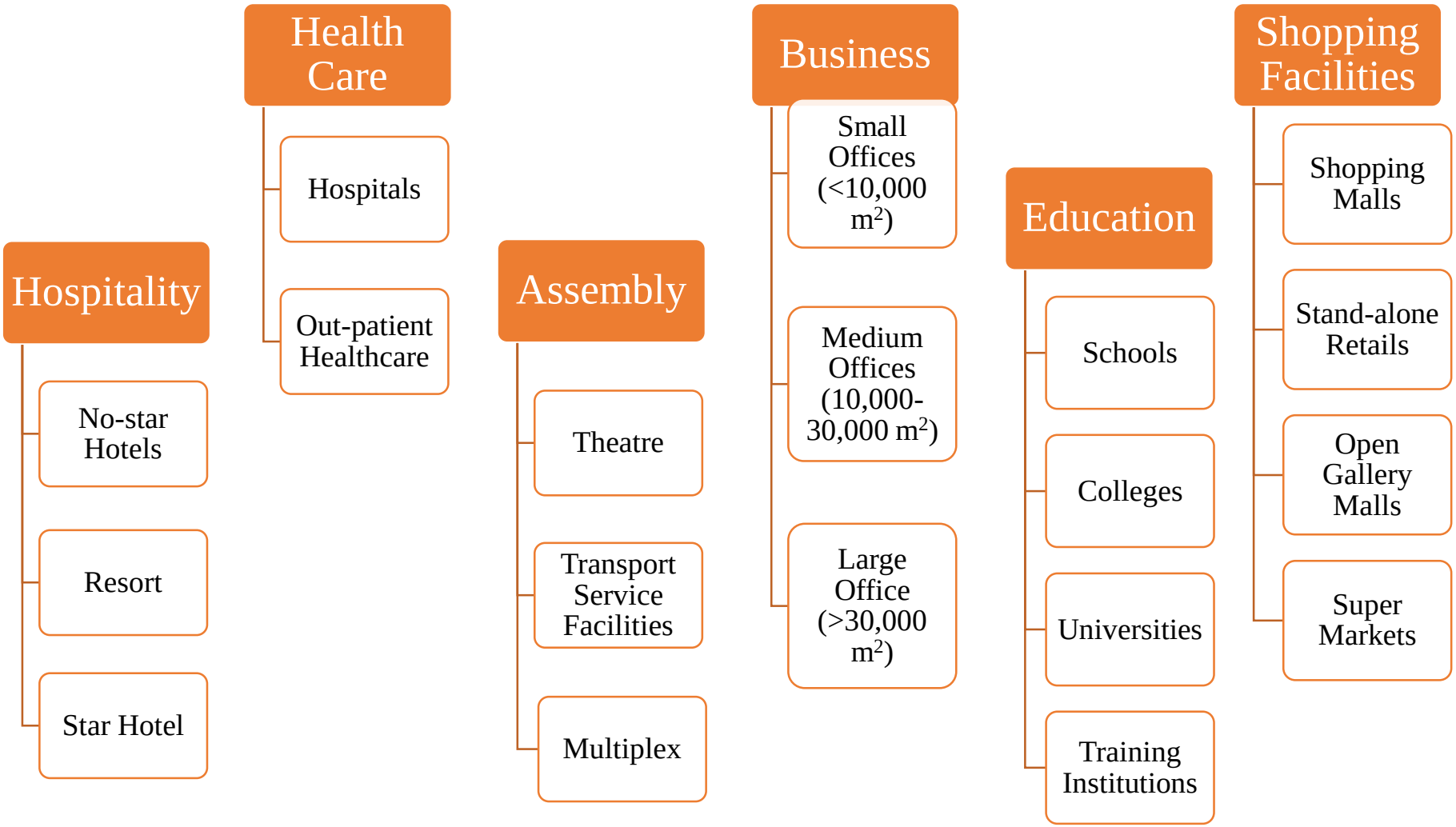


- Building Envelope;
- Mechanical systems;
- HVAC;
- Water heating;
- Lighting;
- Electric power;
- Renewable energy.

HVAC – Heating, Ventilation and Air-Conditioning;
SHGC – Solar Heat Gain Coefficient;
VLT – Visible Light Transmittance

ABOUT ECBC 2017

ECBC building classifications



ABOUT ECBC 2017

Compliance requirements

Building should comply with provisions of ECBC 2017:

- **New commercial buildings** with load demand > 100 kW or 120 kVA;
- **Additions to existing commercial buildings** if connected load demand of building with additions > 100 kW or 120 kVA;
- **Alterations to existing commercial buildings** if altered part of building or systems > 100 kW or 120 kVA of load demand

ABOUT ECBC 2017

Building Envelope

ECBC 2017 prescribes minimum requirements for opaque components (wall and roof), fenestration systems (window, skylight), shading, and day lighting

- The better the insulation of the wall, the higher the energy savings;

- In a composite climate, U-value of 0.4 W/m^2-K for walls yields 17% Internal Rate of Return and provides simple payback period of 5 years;

- Adequate daylighting can result in 20-30% of energy savings;

- The impact of roof insulation 50% higher in buildings operating 24 hours, compared to 8 hours buildings.

Source: USAID, 2017
Credit: PNNL, 2014

ABOUT ECBC 2017

Lighting. ECBC requirements

Lighting is largest electricity consuming end-user within a building in India.

- ECBC 2017 sets minimum requirements for light power density (LPD) of buildings and lighting control systems;
- Maximum LPD defined as per application area as W/m^2;
- Occupancy sensor to automatically switch on/off the lights in buildings >20,000 m^2 after 15 minutes of inactivity;
- 90% of interior lighting of buildings with area >300 m^2 should have automatic control systems

LPD – Lighting Power Density

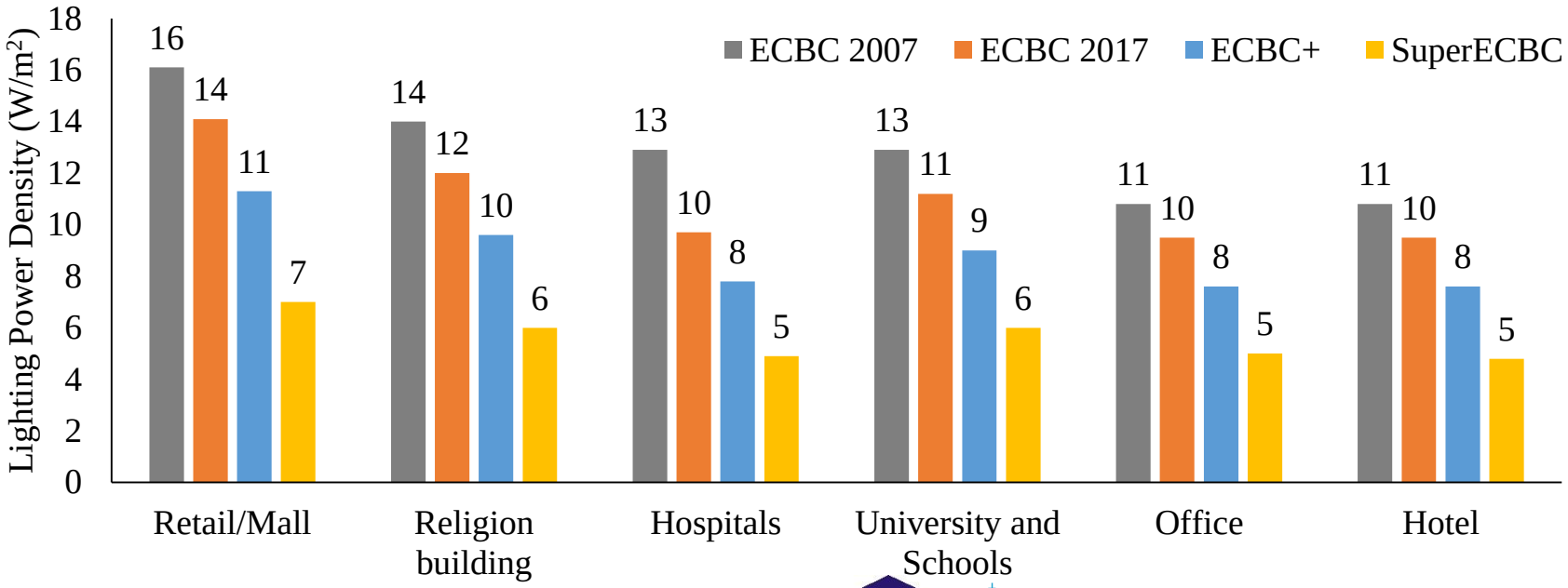
Credit: PNNL

ABOUT ECBC 2017

Lighting. Savings

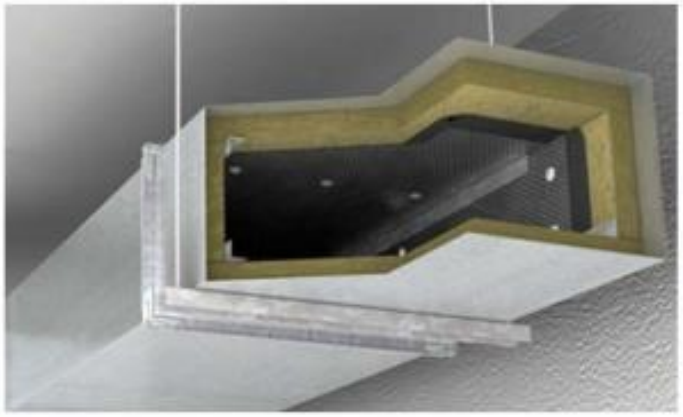
- The lower the LPD value, the higher will be savings;
- Compared to ECBC 2007 minimum requirements, on average ECBC 2017 will deliver following savings in lighting (savings can be higher for typical buildings):

ECBC 2017	ECBC +	Super ECBC
15%	**32%**	**56%**



ABOUT ECBC 2017
Space Conditioning

- ECBC encourage optimal size/capacity of HVAC systems, which helps decrease energy costs;
- Equipment should meet minimum efficiency standards in terms of coefficient of performance (COP) for all tiers of compliance;
- Time clock provisions;
- Controls for cooling towers, condenser fans, chilled water pumps;
- Use of economizer;
- Insulation requirements for the pipes and ducts



Credit: Trane, PNNL

ABOUT ECBC 2017
Comfort Systems

- Natural ventilation should comply with guidelines of the National Building Code (NBC) and have at least 3-star rated ceiling fans;

- Mechanical ventilation systems should ensure air change rate in accordance with NBC and should have CO sensors for car park space > 600 m^2;

- Buildings with area >50 m^2, with occupant density >40 people per 100 m^2 should have demand control ventilation

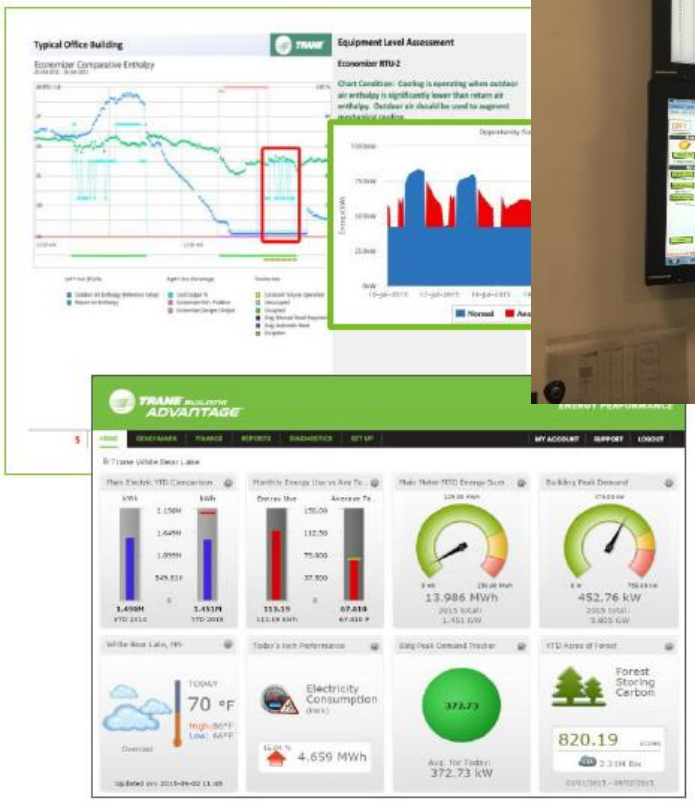
Credit: PNNL, DOE EERE

ABOUT ECBC 2017

Building Management Systems and Controls

Educational and commercial buildings with area >20,000 m^2 and mechanical cooling and heating systems should have building management systems and control systems including:

- Timeclock;
- Occupancy control;
- Fan controls;
- Temperature control



Picture above:
Honeywell building energy management system at ECBC pilot building in Gujarat.

Credit: PNNL, Ingersoll Rand

ABOUT ECBC 2017

Electrical Systems

Transformers

- Power transformers should have efficiency at least 50%;
- Maximum loss values specified for different types and classes of transformers;

Motors

- Power of motors should not > 20% of the calculated maximum load;

Diesel Generators for buildings >20,000 m^2 should have following ratings (BEE rated):

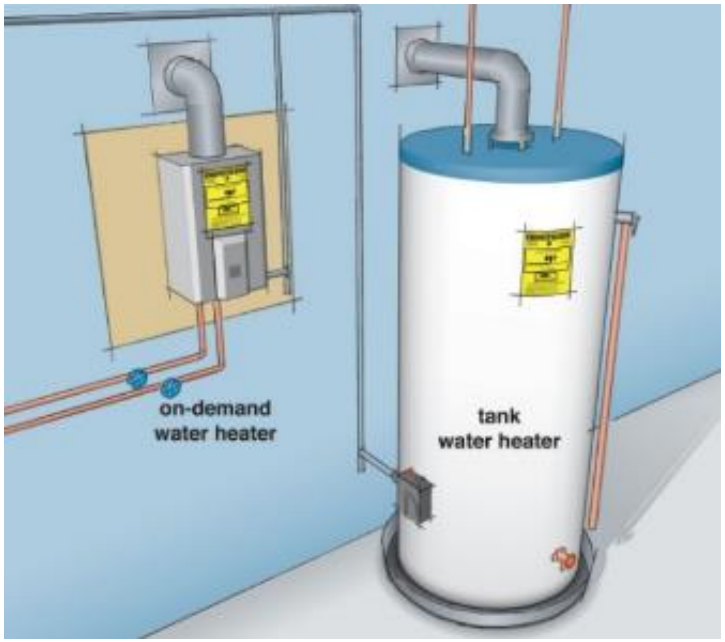
ECBC	ECBC +	Super ECBC
>3 stars	>4 stars	>5 stars

Credit: GE Grid, Directindustry

ABOUT ECBC 2017

Service Water Heating

- ECBC 2017 encourages maximum energy efficiency and heat recovery utilization (for example, condensers of AC units);
- Insulation required for the entire hot water system including the storage tanks and pipelines;
- Heating systems that should meet or exceed MIN requirements set in Indian Standards:
  - Solar water heaters;
  - Gas instantaneous water heaters;
  - Electric water heaters;
- Gas heaters should be used where gas is available;
- Electric systems should be used as last resort;

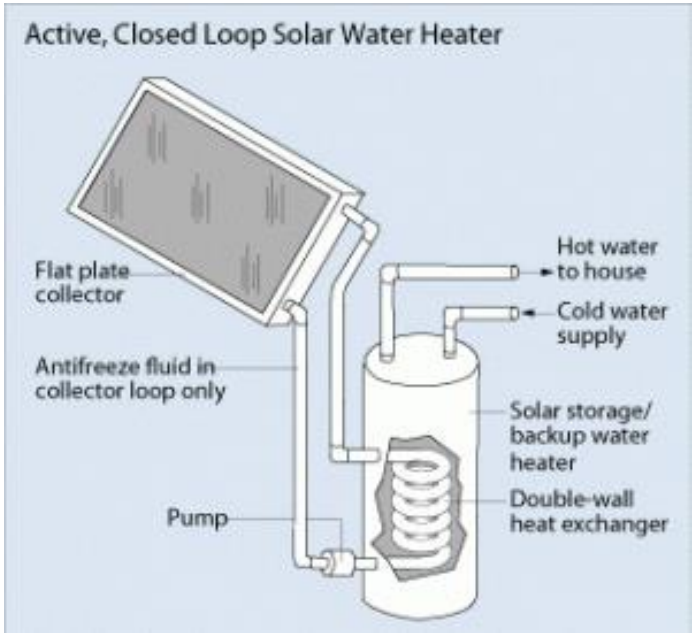


Credit: Energy.gov

ABOUT ECBC 2017

Solar Water Heating

- Solar water heaters minimum design requirements;
- Applies to Hotels and Hospitals in all climatic zones and all buildings in cold climate zone;
- Minimum provisions of Solar water heaters:



ECBC		ECBC +	Super ECBC
Floor area < than 20,000 m^2	Floor area > 20,000 m^2	Regardless of building floor area	Regardless of building floor area
At least 20%	At least 40%	At least 40%	At least 60%
of total hot water design capacity			

Credit: DOE EERE/PNNL

ABOUT ECBC 2017

Renewable Energy Systems

- All buildings should have >25% of dedicated space (rooftop or the site) for installation of renewable energy systems in the future;

- All buildings should have Renewable Energy Generating Zones (REGZ) for installing solar PV on rooftops or on site:

ECBC	ECBC +	Super ECBC
1%	2-3%	4-6%
of total electricity load		

- REGZ should be free from obstructions and shadows.

Credit: PNNL, 2014

ABOUT ECBC 2017

Linkage with Other Programs

- Voluntary building rating programs in India references ECBC for energy requirements:
  - Green Rating for Integrated Habitat Assessment (GRIHA)
  - BEE Star Rating
  - India Green Building Council (IGBC) Rating
  - Leadership in Energy and Environmental Design (LEED)

- These green building programs encourage the Indian building sector go beyond the mandatory requirements from ECBC.

Introduction

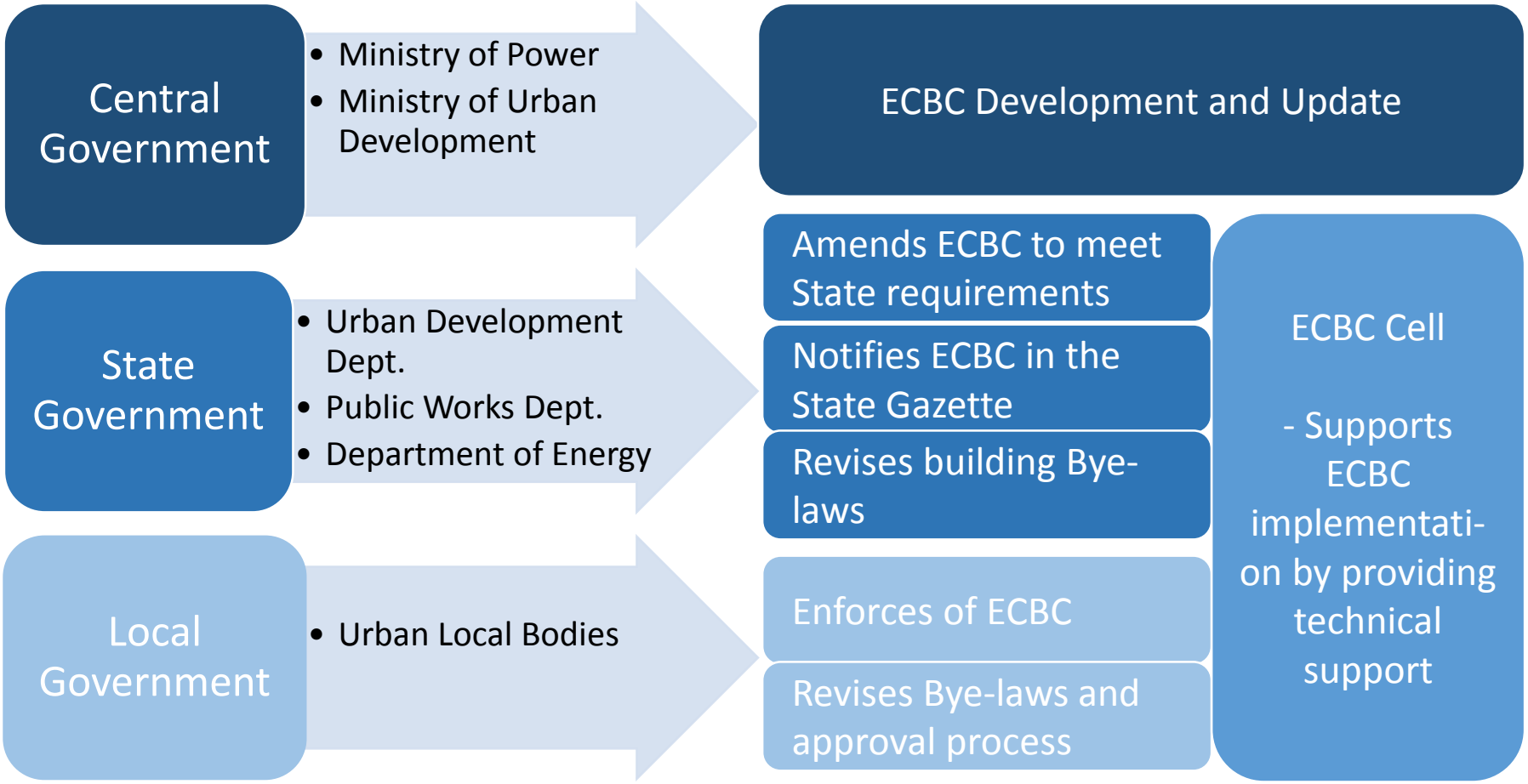
About ECBC

Role of State and Local Governments

Case Studies

Conclusions

ROLE OF STATE AND LOCAL GOVERNMENTS

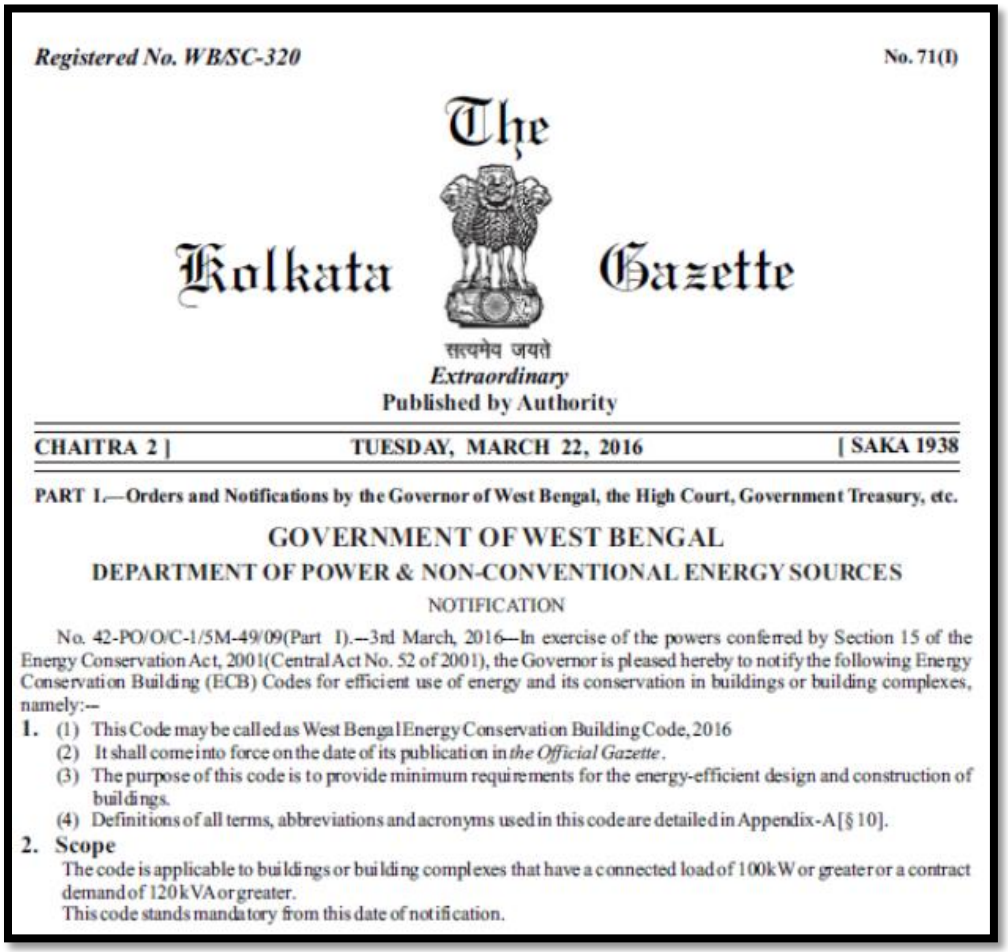


Source: AEEE, 2017a

ROLE OF STATE AND LOCAL GOVERNMENTS

ECBC Implementation and Enforcement

- While ECBC developed by Central Government, it's implementation and enforcement lies with state (Urban Development Department –UDD) and local (Urban Local Bodies - ULBs) governments;
- The Energy Conservation Act, 2001 empowers State Governments (in consultation with BEE) with following:
  - Notify and amend ECBC to suit the regional and local conditions in State Gazette;
  - Prescribe building owner to comply with requirements of ECBC;
  - Set up designated agency to coordinate, regulate and enforce provisions of this Act within the State;



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The Kolkata Gazette

सत्यमेव जयते

Extraordinary

Published by Authority

CHAITRA 2] TUESDAY, MARCH 22, 2016 [SAKA 1938

PART I.—Orders and Notifications by the Governor of West Bengal, the High Court, Government Treasury, etc.

GOVERNMENT OF WEST BENGAL

DEPARTMENT OF POWER & NON-CONVENTIONAL ENERGY SOURCES

NOTIFICATION

No. 42-PO/O/C-1/5M-49/09(Part I).—3rd March, 2016—In exercise of the powers conferred by Section 15 of the Energy Conservation Act, 2001(Central Act No. 52 of 2001), the Governor is pleased hereby to notify the following Energy Conservation Building (ECB) Codes for efficient use of energy and its conservation in buildings or building complexes, namely:—

1. (1) This Code may be called as West Bengal Energy Conservation Building Code, 2016
   (2) It shall come into force on the date of its publication in *the Official Gazette*.
   (3) The purpose of this code is to provide minimum requirements for the energy-efficient design and construction of buildings.
   (4) Definitions of all terms, abbreviations and acronyms used in this code are detailed in Appendix-A [§ 10].
2. **Scope**
   The code is applicable to buildings or building complexes that have a connected load of 100 kW or greater or a contract demand of 120 kVA or greater.
   This code stands mandatory from this date of notification.

Source: AEEE, 2017b

ROLE OF STATE AND LOCAL GOVERNMENTS

ECBC Implementation

Tasks	Responsibilities		
	Central Government	State Government	Local Government
ECBC IMPLEMENTATION			
Develop enabling mechanisms and processes for mainstreaming ECBC	BEE	State Designated Agency (SDA) + Urban Dev. Department (UDD)	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 + UDD	ULBs
Develop ECBC implementation rules, e.g., Third Party Assessor Model	BEE	SDA + UDD	ULBs
Develop public online tools/endorse third party simulation software to show compliance	BEE	SDA	ULBs
Provide incentives to developers/owners for developing energy-efficient building stock		State Government	ULBs

Source: UNDP GEF and BEE, 2017

ROLE OF STATE AND LOCAL GOVERNMENTS

ECBC Enforcement

Tasks	Responsibilities		
	Central Government	State Government	Local Government
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

Source: UNDP GEF and BEE, 2017

ROLE OF STATE AND LOCAL GOVERNMENTS

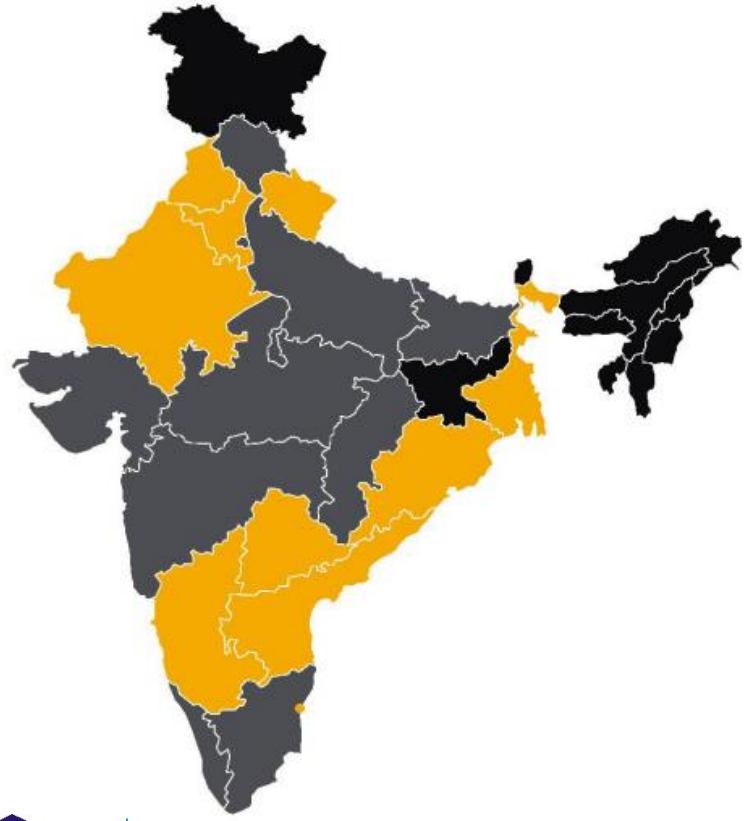
The Status of ECBC Notification

- Although the Government of India developed the ECBC, state and local government are responsible for its implementation and enforcement

ECBC Amendment as of March 2017:
Uttar Pradesh, Kerala, Chhattisgarh, Gujarat, Tamil Nadu, Maharashtra, Bihar, Himachal Pradesh, Madhya Pradesh, and Delhi.

ECBC Notification as of March 2017:
Rajasthan, Odisha, Uttarakhand, UT of Puducherry, Andhra Pradesh, Punjab, Telangana, Haryana, West Bengal, and Karnataka

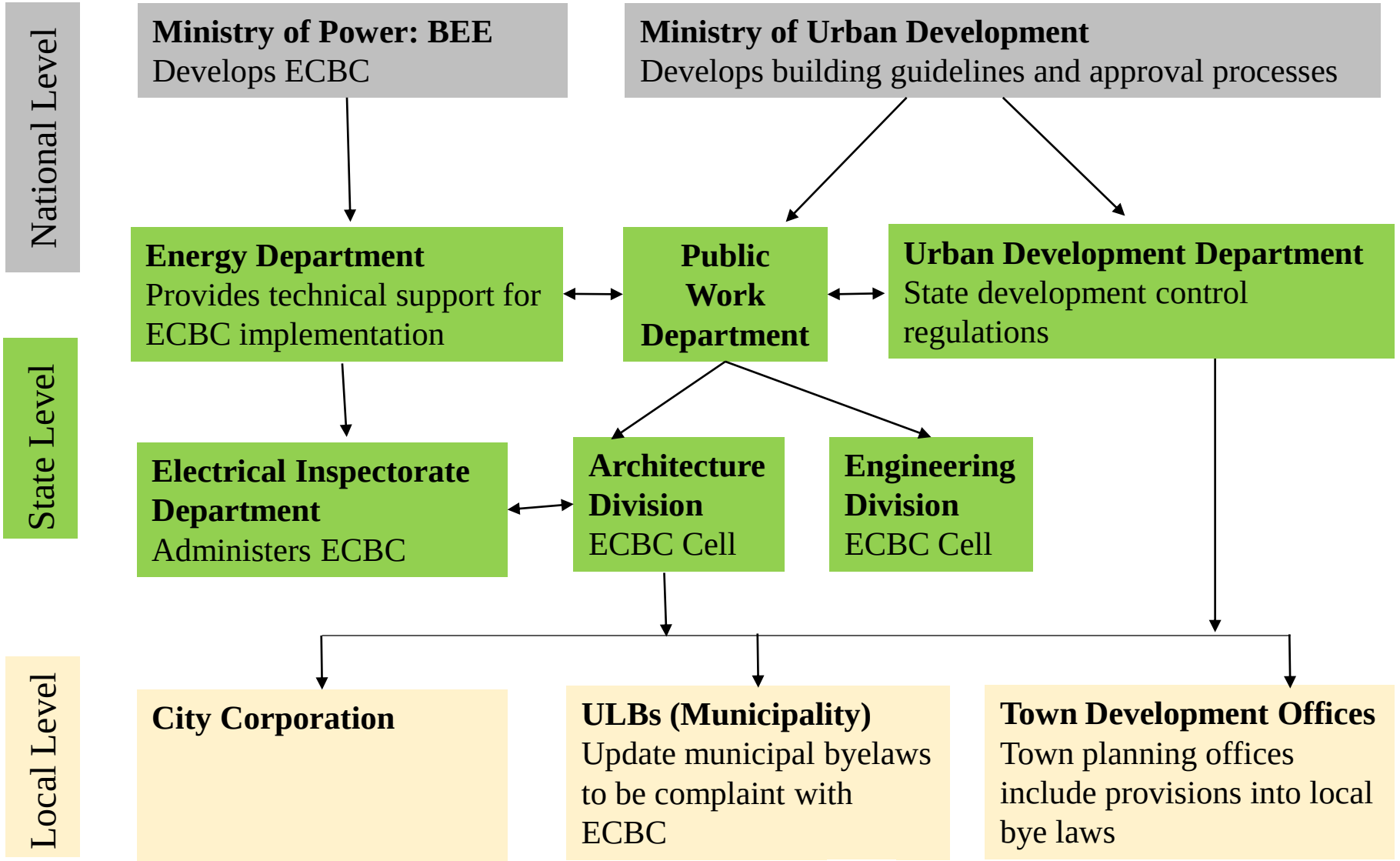
No action as of March 2017



Source: AEEE, 2017b

ROLE OF STATE AND LOCAL GOVERNMENTS

Illustrative example - Karnataka



Source: AEEE, 2017c and Khosla (forthcoming)

ROLE OF STATE AND LOCAL GOVERNMENTS

State and local incentives

- State and Local Governments can provide incentives to encourage compliance and accelerate ECBC enforcement:
  - Expedited plan review and permitting;
  - Property and income tax reductions;
  - Relaxed zoning requirements;
  - Marketing, publicity, training;
  - Utility rate reduction;
  - Low-interest loans;

- Examples include:
  - Rajasthan provides training, marketing programs to advance ECBC implementation and established ECBC award to recognize leaders;
  - Kerala proposed tax incentives for green buildings.

Credit: AEEE, 2017c

Introduction

About ECBC

Role of State and Local Governments

Case Studies

Conclusions

CASE STUDY

Retrofit of two office buildings

Retrofit of two commercial buildings in Bengaluru, Karnataka with floor area of 32,500 m^2 and 41,800 m^2.

Source and credit: Johnson Controls, 2018

- Solution: Installing 9 high efficiency chiller units with variable speed drives (VSD);
- Energy Savings: 5 million kWh of electricity annually;
- Cost Savings: 45% reduction in energy bills;
- Improved thermal comfort and reduction in carbon emissions;
- Result: ECBC 2017 compliant.

CASE STUDY
Retrofit of financial institution

ICICI Bank needed a better solution for its inefficient and heavy maintenance chillers at its headquarters in Mumbai

- Solution: Retrofitting existing chillers with 1 water cooled centrifugal chiller of 500 ton of refrigeration (TR) and 2 air-cooled chillers of 370 TR & 250 TR, all with variable speed drives (VSD);
- Energy Savings: 20% reduction in electricity consumption alone;
- Improved thermal comfort and reduction in carbon emissions;
- Result: ECBC 2017 compliant.

Source and credit: Johnson Controls, 2018

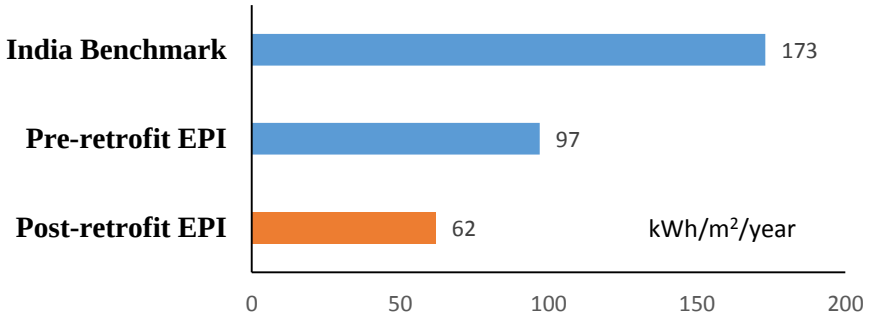
CASE STUDY
Hospitality facility

Pilot Hotel with 200 rooms and 20,000 m² floor area in Bangalore

- Features:
  - **Envelope**: XPS insulation; Heat reflective tiles, high performance glazing;
  - **Lighting**: Daylight integration; LED fixtures;
  - **HVAC**: Variable Refrigerant Flow;
  - **Electric Power**: BEE star rated oil transformer;
  - **Service Hot Water**: SWH provide 25% of hot water demand;

- Incremental costs: 2% of the project construction costs;
- Payback period: 3.8 years.

The impact of ECBC compliance on hotel retrofit strategy



Note: EPI – Energy Performance Index
Source: UNDP GEF and BEE, 2017

Introduction

About ECBC

Role of State and Local Governments

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Conclusions

CONCLUSIONS

- The Energy Conservation Building Code is one of the most effective instruments to improve building energy efficiency and thermal comfort, while reducing peak demand;
- ECBC 2017 applies to all commercial buildings with connected load of 100 kW or contract demand of 120 kVA and higher;
- Potential impact of ECBC 2017 implementation:
  - 50% of energy savings by 2030;
  - 15 GW of peak demand reduction;
  - 250 Mt CO_2e of GHG abatement;
  - INR 35,000 Crore of monetary savings;
- Given ECBC's benefits, states and ULBs should adopt ECBC if they haven't already;
- States and ULBs should also develop robust implementation strategies to maximize the benefits of ECBC.

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Thank You!