ROADMAP TO FAST TRACK ADOPTION AND IMPLEMENTATION OF ENERGY CONSERVATION BUILDING CODE (ECBC) AT THE URBAN AND LOCAL LEVEL

Alliance for an Energy Efficient Economy

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Knowledge partner and author: Alliance for an Energy Efficient Economy (AEEE)

NITI Aayog team:
Mr Anil K Jain (Additional Secretary, Energy), Mr Harendra Kumar (Joint Adviser, Energy), Mr Sathis Kumar (OSD), Mr Sarbojit Pal (Consultant), Mr Ripunjaya Bansal (Young Professional), Ms Ruchi Gupta (Young Professional), Ms Shafqat Mobarak (Young Professional), Ms Simi Thambi (Young Professional)

BEE team:
Mr Abhay Bakre (Director General), Mr Saurabh Diddi (Energy Economist), Mr Arijit Sengupta (Assistant Energy Economist)

UNDP-GEF team:
Dr S. N. Srinivas (Programme Analyst), Ms Archana Bhardwaj (Programme Finance Analyst), Mr Abdullah Nisar Siddiqui (Project Manager), Mr Kanagaraj Ganesan (Consultant)

AEEE team:
Dr Satish Kumar (Executive Chairman), Ms Mohini Singh (Senior Researcher), Mr Sandeep Kachhawa (Senior Researcher), Mr Akshay Pandey (Intern)

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ANIL K JAIN, IAS
ADDITIONAL SECRETARY
Telefax : 011-23096551
E-mail : anilk.jain@nic.in

सत्यमेव जयते

भारत सरकार
नीति आयोग, संसद मार्ग
नई दिल्ली–110 001
Government of India
NATIONAL INSTITUTION FOR TRANSFORMING INDIA
NITI Aayog, Parliament Street
New Delhi-110 001

Foreword

Buildings consumed 31% of the total electricity demand in India as of 2016 (MoSPI, Energy Statistics, 2016). Given that 40% of the buildings that will be in existence in 2030 are yet to be developed, energy efficiency strategies for this sector becomes extremely critical to ensure a sustainable energy growth trajectory for the country. Starting first with commercial building spaces to roll out energy efficiency best practices, one of the key strategies adopted by the Government of India has been to develop an Energy Conservation Building Code (ECBC), targeted at new and upcoming commercial building spaces. However, power distribution and urban development, both being subjects in the concurrent list of the Indian constitution, the onus for the rollout of this strategy lies with the states of India.

A preliminary review of the status of the ECBC implementation across different states in India reveal that while almost all states are at various stages of mandating energy efficiency regulations, there is much inconsistency and incongruence in the approach that states are taking to mandate and formalise these regulations – something that can be minimised with planning and foresight which has already been initiated by the formation of ECBC cells in several states. While 10 states have already notified and made the regulations mandatory, states like Andhra Pradesh, Telangana, Karnataka, Punjab have progressed further by outlining the plan of action and amending their SoR, bye-laws etc. This is, in part, a result of the different state priorities and perceptions about the need for improving buildings energy efficiency. The scenario is further aggravated given the requirement of a complex multi-stakeholder engagement, for adopting these regulations, inhibiting rapid adoption of these programs across different states, even for commercial buildings alone.

While the mandate for bringing about a change in improving the energy efficiency of buildings has been taken up at a Central level by the Bureau of Energy Efficiency (BEE), under the Ministry of Power, the implementation of these regulations at the state level require cross ministerial participation. The state Energy Departments and the state Urban Development Departments are required to jointly coordinate their actions to enable a successful adoption of energy efficiency standards for buildings. Thus, the role of states has, time and again, proved to be crucial for bringing about a change in this sector. So much so, many organizations have identified the requirement of state level actions as the bottleneck in implementing building energy efficiency policies and schemes.

The ECBC rollout exercise has also highlighted the need and importance of adequate planning and interventions at the state level. Without a state prerogative and in the absence of integrated urban planning for its rollout, it would be difficult to make ECBC and other future buildings efficiency plans more effective. Given this background, NITI Aayog with support from BEE, UNDP-GEF and AEEE conducted five regional workshops to sensitise all the States and UTs of India on building energy efficiency policies and help them embark on making their states energy efficient by effective implementation of Government of India's initiative ECBC.

I take this opportunity to thank BEE, AEEE and UNDP-GEF for coming together to promote building energy efficiency campaign under the leadership of NITI Aayog.

Anil K. Jain

स्वच्छ भारत

Alliance for an Energy Efficient Economy

SAIRA TOWER, 4th Floor, N-161A
Gulmohar Enclave, Yusuf Sarai, New Delhi-110049
T: +91-11- 40567344, 46635600, 26527344
E: Info@aeee.in W: www.aeee.in

Preface

The building sector in India is experiencing an unprecedented growth. This sector alone accounts for over 30 percent of India's total electricity consumption. By conservative estimates, India is building 300,000 sq. ft of commercial floor space every day and will see one of the largest commercial and residential building construction boom over the next two decades. India is at an inflection point where 40% of the commercial building stock that will exist in the next twenty years is yet to be built (AEEE, 2017). This would generate greater demand for energy and hence there is an urgent need to optimise building energy demand in upcoming as well as existing building stock.

Ministry of Power, Government of India launched the Energy Conservation Building Code (ECBC) in 2007, its flagship building energy code for improving the energy efficiency of the commercial building stock, whose implementation still poses many challenges even after a decade of its launch. One of the main reasons behind this has been the lack of capacity and focus and absence of coordination that would help ECBC implementation in most Indian states and UTs. While the Government of India has done an admirable job in setting ambitious renewable energy targets, focusing on generation without plugging energy wastage and embracing energy efficiency will be a wasteful exercise.

The philosophy and principles behind the development of ECBC encourage integrated building design approach through which energy use could potentially be cut down by more than 50%. Better building envelope design, optimising window to wall ratio and encouraging a combination of shading, ventilating and insulating strategy can significantly enhance thermal and visual comfort for the building occupants. Infosys, owner of 45 million sq. ft. of prime or Class-A commercial real estate, is a fine example, demonstrating how building energy efficiency espoused by ECBC has led them to reduce their corporate average energy performance index (EPI) from 200 kWh/m2/year to 75 kWh/m2/year and monthly energy consumption per employee from 297 kWh to 145 kWh over nine years at a cost of Rs. 3500/ sq. ft. for completed building, which is in the same range as a typical commercial building.

Mandatory enforcement of ECBC will greatly help India's Nationally Determined Contribution and Sustainable Development Goals commitment. At the same time, lack of mandatory enforcement will have an adverse impact on India's Smart City Mission because its building stock will lock-in inefficiency for the next 30-40 years, putting a negative burden on India's sustainable growth imperative.

Alliance for an Energy Efficient Economy, with support from NITI Aayog, BEE and UNDP-GEF conducted five regional workshops across India and interacted with more than 300 state officials to understand state specific code implementation challenges. ECBC enforcement related administrative aspects and best practices in different states were deliberated at length. The report sheds light on ECBC implementation challenges, workshop deliberations and discusses the high-level implementation process in an effort to help states and make faster and significant progress towards ECBC implementation.

AEEE team would like to express its sincere gratitude and thanks to NITI Aayog, BEE and UNDP-GEF for their guidance and support throughout this project.

Satish Kumar.

Dr. Satish Kumar
(Executive Chairman, AEEE)

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ABBREVIATION

AEEE	Alliance for an Energy Efficient Economy
BAU	Business-As-Usual
BEE	Bureau of Energy Efficiency
CEPT	Centre for Environmental Planning and Technology
CEA	Central Electricity Authority
CS	Chief Secretary
DA	Development Authorities
DCs	Designated Consumers
EC Act	Energy Conservation Act
EC Bill	Energy Conservation Bill
ECBC	Energy Conservation Building Code
ESCO	Energy Services Company
GEF	Global Environment Facility
GoI	Government of India
HVAC	Heating Ventilation and Air Conditioning
IEA	International Energy Agency
IMGW	Inter-Ministerial Working Group on Energy Conservation
kVA	Kilo-volt-ampere
kW	Kilowatts
MC	Municipal Corporation
MoP	Ministry of Power
MoSPI	Ministry of Statistics and Programme Implementation
MoUD	Ministry of Urban Development
Mtoe	Million Tonnes of Oil Equivalent
NDC	Nationally Determined Contribution
PWD	Public Works Department
PCRA	Petroleum Conservation Research Association
PS	Principal Secretary
SDA	State Designated Agencies
SoRs	Schedule of Rates
TCP	Town and Country Planning Department
TPA	Third Party Assessors
TWh	Terawatt-hour
UDD	Urban Development Department
ULBs	Urban Local Bodies
UNDP	United Nations Development Programme
UNFCCC	United Nations Framework Convention on Climate Change
USAID	United States Agency for International Development

INTRODUCTION

ENERGY CONSERVATION EFFORTS IN INDIA

India's interest in energy conservation started post-independence, around 1970, with the majority of efforts directed towards reducing the consumption of petroleum. Over the years, the vision broadened and efforts included electricity conservation, with growing realisation of mushrooming energy demand as India embarked on the development path. Pre-independence, The Electricity Act, 1910 provided the basic framework for electricity generation and supply. During early years of independence, the country's new policies, legislation and programs aimed at progress and development, which included an adequate supply of electricity, oil, coal etc. to support growth. Energy conservation was not a matter of priority during the first 15-20 years of independence until fuel and energy issues became the focus of policy in the mid-1970s.

In 1977, during the fifth Five Year Plan, The Working Group on Energy Policy was constituted, to outline the National Energy Policy. The report submitted by the group in 1979, covered existing and future energy scenarios and suggested measures to optimise energy use in India.

In 1981, Inter-Ministerial Working Group on Energy Conservation (IMWG) was constituted to develop policies to achieve energy savings targets. With the help of 200 energy audits, the group estimated energy savings of INR 19.25 billion by investing INR 36 billion in the industrial sector. The report submitted by group stated, "Energy conservation requires lesser energy inputs for the same level of economic growth". In 1983, the Advisory Board on Energy (ABE) made detailed projections of energy demand in different regions till 2004, under assumptions of different macro-economic scenarios. The group provided precise guidelines of the optimum energy strategy to be adopted by the government. During seventh Five Year Plan (1985-90), the Department of Power (now Ministry of Power) focused on energy conservation strategies, the Planning Commission carried energy modelling to analyse the demand for various resources and Energy Management Centre was also set up as an autonomous organisation to promote energy conservation. While the interest and efforts towards energy conservation were firming, the comprehensive legislation on energy conservation was missing.

To address the depletion of natural resources and encourage alternate sources of energy, the Ministry of Power constituted a working group to formulate legislation on energy conservation and in 1997 the Energy Conservation Bill was drafted.

In 2001, the EC Bill was passed with consent of then President and Energy Conservation Act was published in the Gazette of India in October 2001. With this, in 2002, the Energy Management Centre was reinstituted as the Bureau of Energy Efficiency (BEE). The EC Act identifies BEE as the statutory body under the Ministry of Power, entrusted with regulatory powers for enforcement of various recommendation of the Act (Vasudevan, Cherail, Bhatia, & Jayaram, 2011).

To address energy efficiency in the commercial building sector, Government of India (GoI) launched the Energy Conservation Building Code (ECBC) in 2007. The timeline of the important energy conservation initiatives in India is illustrated in figure 1.

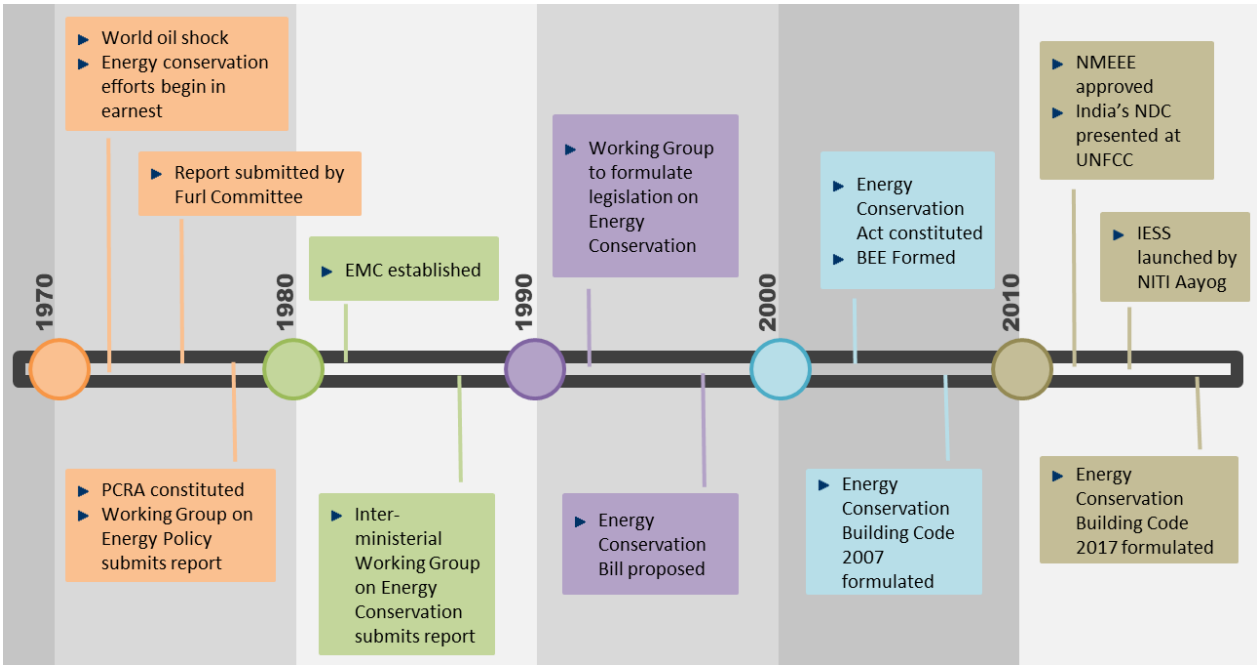


Figure 1: Timeline of important energy conservation initiatives in India (Vasudevan, Cherail, Bhatia, & Jayaram, 2011)

BUILDING SECTOR IN INDIA AND EC ACT 2001

The building sector in India is experiencing an unprecedented growth. It has 38% (~208 mtoe) of India's total annual primary energy consumption and 31% (296 TWh) of the total annual electricity consumption (IEA, 2017) (NITI Aayog & Prayas, 2017). Within commercial sector, the current built-up area is roughly 1.4 billion sq. meters and is expected to 2.2 billion sq. meters in the next 20 years (AEEE, 2017). Further, higher aspirations clubbed with a warming planet will lead to higher energy demand, driven by rising cooling demand. While 40% of the stock is yet to be constructed, addressing human comfort through sustainable and energy efficient building designs is the key.

The current development trend and the Business as Usual (BAU) energy consumption pattern poses a twofold challenge: First, mushrooming inefficient stock with lock-in period ranging from 30-40 years demands more power and energy leading to the higher power generation requirement that is highly capital and resource intensive. With the majority of energy supply still provided by non-renewable resources, how will India address energy poverty in the face of degrading energy security? Second, higher energy demand from non-renewable resources generates higher carbon footprint, posing adverse environmental impacts. The residential sector electricity consumption under the business-as-usual (BAU) scenario is predicted to rise by more than eight times by 2050; however, using aggressive energy efficient strategies the predicted rise would be between three to five times, curtailing the electricity demand significantly (Rawal & Shukla, Residential Buildings in India: Energy Use Projections and Savings Potentials, 2014). This provides the context for imbibing energy efficiency in the current and future building stock and for acknowledging it as a resource.

In 2001, the EC Act was enacted with the primary objective of providing a necessary legal framework for promoting energy conservation measures (BEE, 2017). The key directives of the act included standards

and labelling for appliances, identification of the energy intensive establishments to be notified as Designated Consumers (DC) and their inspection, energy audits by accredited energy auditors, among these were energy efficiency improvement in building sector and amendment of energy conservation building codes to suit local conditions. While listing key directives, the Act also mentioned the power of centre and state to facilitate and enforce the efficient use of energy and its conservation under chapter 5 and 6 respectively. Section 15 of the Act gives powers to states to enforce certain provisions for efficient use of energy and its conservation such as

a) amending ECBC to suit regional and local climatic conditions and may, by rules made by it specify and notify ECBC with respect to use of energy in the buildings;
b) creating awareness and disseminate information for efficient use of energy and its conservation;
c) organize training of personnel and specialists in the techniques for efficient use of energy and its conservation.

Section 16 stipulates powers to establish a fund for the purpose, Section 17 provides the power of inspection and Section 18 declares power to direct

a) regulation of norms for process and energy consumption standards in any industry or building or building complex;
b) regulation of the energy consumption standards for equipment and appliances.

The act, originally specified buildings having connected load of 500kW or contract demand of 600 KVA and above to be under its purview, was amended in 2010 to focus on a larger set of building and now specifies buildings having connected load of 100kW or contract demand of 120 KVA and above (GoI, EC Act, 2001) (GoI, EC Act, 2010).

Developed by the Bureau of Energy Efficiency (BEE), the ECBC sets minimum energy standards for commercial buildings having a connected load of 100kW or contract demand of 120 kVA and above. To fast-track code implementation and address the on-going developments in energy efficiency effectively, the 2nd version of ECBC was revised and launched in June 2017. ECBC came along at a crucial period when India is combatting various development related issues and balancing it against rising energy consumption in the building sector is a key government priority.

ECBC AND ITS RELEVANCE

The focus was on developing and launching ECBC with the objective to make a difference in the commercial building sector that was projected to grow rapidly over the next 2-3 decades. The launch of ECBC promoted significant advancement in domain specific activities such as availability of energy efficient building materials and equipment, development of credible research institutions, laboratory and R&D facilities, uptake of green building rating programs and enlargement of a pool of energy-efficient building experts.

ECBC sets minimum energy standards for commercial buildings having a connected load of 100 kW or contract demand of 120 kVA and above. Code compliance is voluntary in nature with two approaches to demonstrate compliance: Prescriptive approach and Whole Building approach. In ECBC 2007, energy performance specifications were covered under five categories: Building Envelope (Walls, Roofs, and Windows), Lighting (Indoor and Outdoor), Heating Ventilation and Air Conditioning (HVAC) System, Service Water Heating and Pumping and Electrical Systems (Power Factor, Transformers). Along with

prescriptive requirements, the code also lists mandatory requirements. The mandatory requirements must be met for both the compliance approaches. While the code compliance is voluntary in nature; however, few states notified ECBC in their gazette, thereby starting the process of making code compliance mandatory for commercial building stock falling under amended EC Act, 2001.

In June 2017, ECBC 2017 was launched by BEE, with technical support from USAID. During the launch event, it was indicated that an ECBC compliant new building should be able to demonstrate minimum energy savings of 25% compared to a conventional building. Further, ECBC 2017 encourages additional improvements in building energy performance. As per ECBC 2017, a new building can achieve higher grades like ECBC+ or SuperECBC status and these buildings should be able to demonstrate energy savings of 35% and 50%, respectively (BEE, ECBC, 2017). Although the launch of ECBC 2007 helped build a positive eco-system and directed the launch of ECBC 2017; however, even a decade after its launch, only 11 states have notified ECBC till August 2017– a key first step to full ECBC compliance.

Immediate implementation of ECBC in the commercial building sector is crucial for three reasons: First, a significant part of the commercial building construction is yet to happen even though almost 700 million sq. meters of commercial building space has been built over the last 10 years and timely implementation of ECBC will bring along energy efficient stock leading to noticeable rewards in the form of energy savings, reduced greenhouse gas emissions, thermally comfortable habitats for occupants etc. Second, the ECBC success stories will pave the way for residential energy efficiency initiatives to be launched – a much bigger potential waiting to be tapped. The residential segment, with its fragmented nature and daunting institutional challenges, has higher energy and electricity consumption, primarily due to its sheer size, than commercial sector and is facing an urgent need for a focused and sustained national level initiative. Third, the effective implementation of ECBC aligns with India's Nationally Determined Contribution (NDC) commitments presented at the COP21 meeting in Paris as a key lever to mitigate climate change.

If unaddressed and unimplemented, the building sector will have major repercussions on environment and country's economy. While it is estimated that 1.2 gigatonnes of carbon dioxide (CO_2) emissions will be locked in by mid-century, there would also be major implications on India's national missions like Power for All, Housing for All and Smart Cities Mission (Schnapp & Laustsen, 2013).

REGIONAL WORKSHOPS TO FAST-TRACK ECBC IMPLEMENTATION IN STATES

The ECBC implementation progress in the majority of states has been slow as only 11 states have notified till 2017. Also, the status of implementation within states having notified ECBC is questionable. The need for organising high-level dialogues was clearly felt to fast-track ECBC implementation in states. In a first of its kind exercise, AEEE working under the guidance of NITI Aayog and the Bureau of Energy Efficiency, with support from UNDP-GEF programme, conducted five ECBC regional workshops (Chandigarh - February 9-10, Ahmedabad - March 15-16, Guwahati - March 23-24, Ranchi - April 19-20, Hyderabad - April 27-28) covering all 29 states and 7 UTs of India. These regional workshops, focused exclusively on government officials belonging to Urban Development Departments (Town and Country Planning, Roads and Building or Public Works Department, major Municipal Corporations or City government officials - many of them from the initial list of 108 smart cities, Development Authorities and State Housing Boards) and Energy Department (State Designated Agencies, Chief Electrical Inspectorates). The workshops highlighted the dire need to immediately amend and notify ECBC in all

Indian states and UTs and for the state energy & urban development departments to work together to accomplish this task without any further delay.

NITI Aayog conveyed a sense of urgency through a communication sent to all the Chief Secretaries of states, Principal Secretaries of Energy and Urban Development Departments and to the Municipal Commissioners along with Chief Town and Country Planners, Chief Architects and Chief Engineers Office, Chairman and Directors at the Designated State Agencies, Chief Electrical Inspectors and to the city officials responsible for modifying building bye-laws and enforcing its compliance at the design and construction of buildings. Through these five workshops, AEEE and NITI Aayog reached to more than 500 government officials across India involved in various stages of ECBC implementation from notification to enforcement and more than 300 government officials participated in the workshops. They learned about the administrative aspect of ECBC and were also exposed to the best practices among states that have led the ECBC notification and enforcement process. What made the workshop unique was the interactive nature of the discussions as all the state officials shared their experience with ECBC, expressed their knowledge or lack of it in a candid fashion and requested help and assistance from NITI Aayog, BEE and UNDP-GEF in fast-tracking the implementation of ECBC in their respective states. Since the Chief Secretary office has been involved, each of the government departments had been instructed to report back on the learnings and findings from the workshop and submit an action plan on how ECBC implementation can begin without any delay.

BEE reinforced the need for urgency by sharing the details of the launch of 2nd version of the Energy Conservation Building Code in 2017, which is more stringent than the first one launched in 2007 and will have three levels of compliance (ECBC, ECBC+, SuperECBC) to encourage government and private sectors to not just meet ECBC criteria but to exceed it. Because of the availability of building materials, appliances and equipment and advanced technology, along with the availability of trained professionals, it is possible to go beyond minimum code compliance. BEE further communicated that the adoption of ECBC across states and inclusion of residential buildings in the EC Act will ensure integration of energy efficiency practices in all types of buildings in a mandatory fashion. UNDP-GEF, which is committed to extend support for faster adoption of ECBC, has been actively providing technical assistance in the form of awareness and training programme, ECBC cell creation and design assistance to ECBC-compliant buildings, helped organize these regional workshops.

SECONDARY RESEARCH

INDIA'S COMMERCIAL BUILDING STOCK MODELLING

Quantifying energy consumption is the first step in making energy efficiency policy measures, enabling market interventions. AEEE holds energy data disclosure as the foundation of effective, evidence based energy policies and market actions that can fully expand India's energy saving opportunities. Only modest efforts have been or are being made to procure data that characterises electricity consumption in energy intensive sectors of India, namely: Commercial Buildings, Industries, Agriculture and Municipalities. For achieving greater levels of energy efficiency through the growth of ESCO market and diffusion of energy saving technologies, it is imperative to understand the energy performance of each sector and the segments falling within each sector - in current, near and long terms scenarios.

AEEE also pursued this exercise with a broader aim of assisting the energy efficiency community in India - Government, Businesses and Non-Profit organisations - with reliable and customised methodologies for estimating electricity consumption and saving potential. While only a scarce number of market sizing reports are available in public domain, most of the reports do not explain the methodology used for estimation and rely on old sources of data.

OBJECTIVE

There were three components to the objective of market sizing exercise:

- To estimate the electricity consumed savings potential and business potential in Commercial Buildings, Industries, Agriculture, and Municipality Sectors in India.
- To identify addressable opportunities in each sector through deeper, segment wise assessment of electricity consumption and savings potential that elucidates investment opportunities for ESCOs to act upon and to buttress near to long term policy decisions - market-based and regulatory actions - led by key ministries.
- To devise methodologies and illuminate key sources of data for long-term assistance to researchers, policy makers and business community in conducting market sizing exercises in future that remain central to promoting data driven policy measures and market actions.

APPROACH

While the processes of estimating market size were customised based on the sectors, they were consistent in the bottoms-up analysis to get a granular understanding of sectors through segmentation and categorization. Addressable opportunities in mid to longer term have also been highlighted. For agriculture and municipal sectors, energy conservation measure based approach has been adopted to estimate the energy saving and business potential. Four energy intensive sectors were considered for this exercise i.e. commercial, industrial, agriculture and municipal sector. The outcomes of the commercial sector study are elaborated in subsequent section.

OUTCOME

After performing the commercial building stock energy modelling, it was found that as of 2017 commercial building segments, namely Hotels, Hospitals, Offices, Retail, Education and Places of Worship account for a total of 1,400 Million Square meters. Together, they consume approx. 71 Billion Units of electricity annually. The study estimates that there is a 25 - 28% saving potential. Each segment was examined separately to project the growth in energy performance index (EPI) and built up area in the next ten and twenty years. The projections are given in the summary results for each segment.

It is also important to recognise that for certain segments (such as places of worship and small retail shops that are placed adjacent to residential areas) it was not clear whether buildings draws electricity under a commercial or residential connection. CEA and MoSPI statistics were referred for clarification. Secondly, there are additional commercial building segments aside from the ones included in this exercise. These include railway buildings, educational cum retail buildings such as coaching institutes. It has been assumed that the categories excluded will comprise 10% of overall commercial electricity consumption, which as per CEA is 78 billion kWh.

Table 1: Outputs of Commercial Building Stock Modelling - Total built up area and electricity consumption *(AEEE, 2017)*

Commercial Building Segment	Total BUA (Million Sq M)		Total EC (Billion Units)	
	Min	**Max**	**Min**	**Max**
Hospitals	64	75	7.4	10.3
Hotels	7.79	9.03	1.23	1.67
Office Buildings	214	317	14	21
Retail Sector	242	330	17	31
Educational	451	483	7.74	11.34
Places of Worship	256	343	6.68	11.8
Total	1234.79	1557.03	54.05	87.11

PROJECTING COMMERCIAL STOCK BUA

The table 2 below elaborates of the upcoming commercial stock in next 10 and 20 years.

Table 2: Projected built up area *(AEEE, 2017)*

Commercial Building Segment	Total BUA (Million Sq M) – 10 years	Total BUA (Million Sq M) – 20 years
Hospitals	88.63	114.87
Hotels	10.33	12.78
Offices	349.64	435.20
Retail	318.39	385.10
Institutions	552.30	935.12
Religious buildings	317.89	338.13
Total	1,637	2,221

STATUS OF ECBC IMPLEMENTATION

While ECBC was launched at the national level by BEE, under the Ministry of Power (MoP) its implementation lies with state government (Urban Development Department (UDD) and Department of Energy (DoE)) and local government (Urban Local Bodies (ULBs)). Code adoption, implementation and enforcement involve multiple stakeholders and amongst them the role of state and local government is the most pivotal of all. The involvement of multiple government departments, with their overlapping and diffuse roles and responsibilities at various levels, can aggravate issues related to streamlined implementation. This is especially true for codes and standards related to building energy efficiency, as the technical capacity in terms of dedicated staff and knowledge on the subject within the sub-national government is limited. States like Andhra Pradesh, Telangana, Karnataka, Punjab and Kerala are leading by example by making strong commitments and trying to create awareness amongst government officials and other stakeholders, and further amending their bye-laws, revising Public Works Department (PWD) Schedule of Rates (SoRs), building states' capacity and constituting ECBC cells. While the leading states are even developing online tools, to take advantage of technology platforms and capturing advanced knowledge for efficient implementation, there are states where the code implementation

hasn't moved post notification (AEEE, 2017) (Khosla, 2016) (PEDA, 2017). The implementation status of various states is further elaborated in the attached matrix below.

Table 3: Implementation status in various states *(UNDP-GEF-BEE, 2017)*

State/UT	Andhra Pradesh	Arunachal Pradesh	Assam	Bihar	Chandigarh UT	Chhattisgarh	NCT of Delhi	Goa	Gujarat	Haryana	Himachal Pradesh	Jammu and Kashmir	Jharkhand	Karnataka	Kerala	Madhya Pradesh	Maharashtra	Manipur	Meghalaya	Mizoram	Nagaland	Odisha	Puducherry UT	Punjab	Rajasthan	Sikkim	Tamil Nadu	Telangana	Tripura	Uttar Pradesh	Uttarakhand	West Bengal
ECBC Amendment	✓	✓	✓	✓		✓	✓		✓	✓	✓			✓	✓	✓	✓					✓	✓	✓	✓		✓	✓		✓	✓	✓
ECBC Notification	✓									✓				✓	✓							✓	✓	✓	✓			✓			✓	✓
Notification in state bye-laws	✓									✓																		✓				
Notification at Municipalities	✓																											✓				
Enforcement	✓																											✓				
Schedule of Rates -PWD														✓																		
ECBC Cell	✓			✓		✓	✓			✓	✓			✓	✓	✓	✓					✓		✓				✓		✓		
Training & Capacity Development	✓	✓				✓								✓	✓		✓							✓				✓				
Energy Simulation Software						✓				✓				✓					✓					✓						✓		

To achieve energy efficiency in existing commercial building stock and fast-track ECBC implementation, UNDP-GEF initiated 'Energy Efficiency Improvements in Commercial Buildings (EECB)' project in partnership with BEE. The project aimed at strengthening institutional capacities for enactment and enforcement of ECBC and enhancing technical capabilities and expertise of local building practitioners and service providers. During the journey, 10 states notified ECBC, five states established ECBC cells to assist and encourage implementation; and a large number of training programs were conducted to train different stakeholders for both government & private concerns. BEE's Training of Trainer program was supported under EECB, to prepare a cadre of ECBC Master Trainers. The project also supported pilot projects to demonstrate ECBC compliance (UNDP-GEF-BEE, 2017). The trainings specifically focused on the technical aspects of the code, which was needed to create awareness in the technical fraternity.

Code compliance includes a comprehensive understanding of the technical and administrative requirements of ECBC by respective stakeholders. The compliance with administrative requirements falls under the purview of central, state and local government departments; with EC Act 2001 defining their powers to implement code and help achieve the energy efficiency goals that India is committing to, in international forums.

Along the aforementioned UNDP-GEF projects numerous state specific programs such as EU-CECI, BEEP etc. are also launched to fast-track implementation. Many other bilateral and multilateral programs are also working to assist Indian states on ECBC implementation. The attached image illustrates the state, state SDA and active state specific programs for ECBC implementation.

Table 4: List of SDAs, Capacity built ding institutes, and active programs within states

State / UT	SDA	Institutions supporting training and capacity building	Bilateral/ Multilateral/ Foundations/ Programmes active	Active Organizations at State Level
Andaman & Nicobar	A&N SDA ED			
Andhra Pradesh	NREDCAP		BEEP	ASCI, IIIT, NRDC, GKSPL
Arunachal Pradesh	APEDA	APEDA		
Assam				
Bihar	BREDA		EU-CECI	PwC
Chandigarh				
Chhattisgarh	CREDA	Ela Green Buildings and Infrastructure Consultants	UNDP-GEF	AIILSG
Dadra & Nagar Haveli				
Daman & Diu				
Delhi	EEREMC		UNDP-GEF	EDS will
Goa	CEED			
Gujarat	GEDA		Shakti	CEPT, UMC
Haryana	HAREDA		UNDP-GEF; PACE-D	TERI, CSE, NIT-Kurukshetra
Himachal Pradesh	DoE		UNDP-GEF	
Jammu & Kashmir	PDD			
Jharkhand	JREDA			
Karnataka	KREDL		UNDP-GEF, PACE-D, BEEP	AIILSG, GKSPL
Kerala	EMC	EMC		AIILSG will set up the cell
Lakshadweep				
Madhya Pradesh	MPUVNL		Shakti; EU-CECI	CEPT, PwC, UMC
Maharashtra	MEDA	Rachna Sansad Institute of Architecture	Shakti, EU-CECI	CEPT, PwC
Manipur	CE (Power)			
Meghalaya	SEIIE			
Mizoram				
Nagaland	CEI			
Odisha	EIC		EU-CECI	TERI, PwC
Puducherry	REAP			
Punjab	PEDA	IIA- Chandigarh Chapter	UNDP-GEF	TERI, IIA-Chandigarh Chapter, NITTR, CSE
Rajasthan	RRECL		PACE-D, BEEP	GKSPL, EDS, MNIT-Jaipur
Sikkim	ACEcumNO			
Tamil Nadu	Electrical Inspectorate Department		Shakti	ICLEI
Telangana	SECM			ASCI, IIIT, NRDC
Tripura	TSECL			
Uttar Pradesh	UPNEDA		UNDP-GEF	Darashaw
Uttarakand	UREDA			UPES, IIT Roorkee, CSE
West Bengal	WBSEDCL			

ECBC IMPLEMENTATION PROCESS

ECBC overall implementation consists of three key steps: Adoption, Implementation and Enforcement. The responsibility for enabling and implementing lies with the state and local government as discussed in the previous section. Along with government departments, technical experts are likely to play a key role in the overall implementation – first in terms of creating technical awareness and then in terms of design and construction of ECBC compliant buildings.

Code adoption i.e. notification and amendment fall under the purview of the state government. To adopt code at the state level, the State Designated Agency (SDA) has been constituted at every state level by BEE under the provisions of the EC Act. In general, SDAs along with UDD have the collective responsibility of code adoption. While code notification can be solely undertaken by SDA or UDD, amendment of code and it's incorporating in other building design and construction guidelines (bye-laws, TCP rules and regulation, PWD Schedule of Rates (SoR)) require a variety of inputs from technical experts.

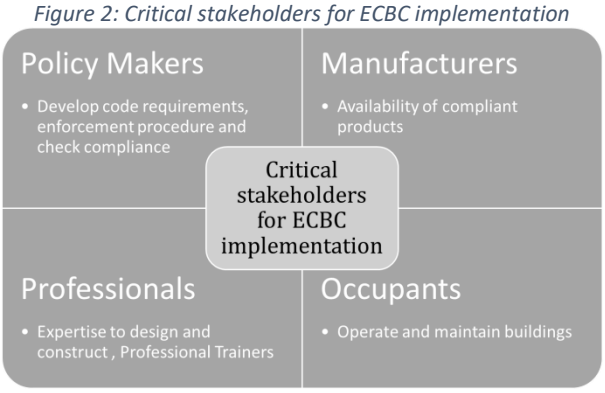
Incorporation of ECBC technical specifications in the building design, which includes demonstrating compliance to ECBC, is typically the responsibility of technical experts and design professionals. This incorporates building design and systems compliance with ECBC's mandatory and prescriptive requirements or demonstrating compliance through whole building performance approach.

The code enforcement includes ECBC compliance check and falls under the purview of ULBs. A building construction and permitting process for the majority of developers consists of two phases: In the first phase, the ULB approval is sought for proceeding with the construction by submitting building's design and construction drawings in accordance with the building bye-laws. This is called design-based compliance. In the second phase, ULBs furnish a No Objection Certificate (NOC) to the building owner or developer after ensuring that the intent of all relevant codes and bye-laws have been met during the actual construction of the project. The inclusion of ECBC in building bye-laws will mandate code compliance check during the building approval process leading to code enforcement. The enforcement process shall include devising inspections for code compliance at periodic intervals during construction.

KEY STAKEHOLDERS – GOVERNMENT & PRIVATE; & STAKEHOLDERS ROLES AND RESPONSIBILITIES

Comprehending the roles and responsibilities at key stakeholders' level is the first step to implementation. The critical stakeholders for ECBC implementation presented in the image below:

Figure 2: Critical stakeholders for ECBC implementation



Government stakeholders' roles and responsibilities:

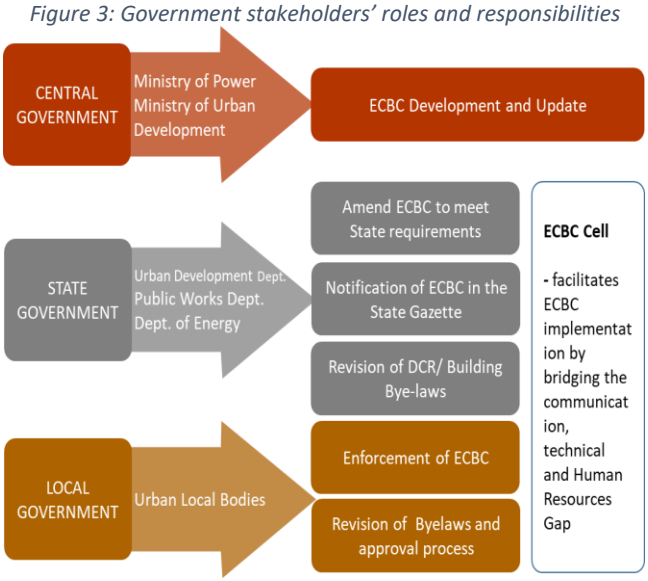
At the national level, ECBC development and update responsibility lie with central government. Consequently, BEE with technical assistance from USAID, launched the first ECBC in 2007 and ECBC V2 in June 2017 (BEE, ECBC, 2017). Ministry of Urban Development (MoUD) also contributes to code implementation by introducing energy efficiency at city and building level through model building bye-laws, smart cities mission, Central Public Works Department (CPWD) design guidelines, National Sustainable Habitat Mission (NSHM) etc. In a significant development, Chapter 10 of the model building

bye-laws (TCPO, MoUD, 2016), encourages incorporation of ECBC guidelines in state and cities bye-laws, although AEEE believes that the language can be more stringent and closer integration of the latest model building bye-laws with ECBC will be even more desirable.

At the state level, the code adoption i.e. notification and amendment need to happen in parallel, once again, with clear delineation of roles and responsibilities based on the expertise available within each department and by aligning with the existing rules and regulations. While code notification can be facilitated by DoE or UDD, the code amendment responsibility lies with the energy department; UDD is responsible for amending Town and Country Planning (TCP) rules and regulation and building bye-laws to incorporate ECBC provisions once it is notified and amended at the state level. This can be facilitated by involving UDD during the code development and discussion stage to get early buy-in, something that did not happen and is now leading to these avoidable delays. The implementation at state level requires inter-ministerial coordination at the national level and inter-departmental coordination at the state and local level. Different states have proceeded differently, wherein some states have amended the code and then proceeded with notification, whereas others notified it first and then amended the code. In some cases, this approach has led to inordinate delay in the implementation. At the state level, the role of the PWD is also very significant, as an amendment of PWD design guidelines can ensure code compliance in all government buildings that are designed and constructed by the state PWD. Given the powers vested with state and the effort that BEE has put in, the authors believe that the code compliance and enforcement can be initiated by state rigorously without further delay.

Once the code is notified at the state level, the enforcement will lie under the local government purview. Local governments (primarily municipality) must start enforcing it in a mandatory fashion; alternatively, more forward-looking local government bodies can themselves encourage the process of implementation through revision of bye-laws and subsequent enforcement of the code. For example, the Chinese local governments, while adopting the national energy codes, often increase the code stringency. (Yu, Evans, & Delgado, 2014). The following schematic helps in explaining the roles and responsibilities of central, state and local government the relationships and their spheres of influence.

Figure 3: Government stakeholders' roles and responsibilities



Private stakeholders' roles and responsibilities:

Private stakeholders include Architect, MEP Consultant, Energy Consultant, Developers, Manufacturers and End User. Private stakeholders play important role in code update and capacity building at the national level. At state level, once the code is notified, private stakeholders assist government to amend code and other relevant building codes like bye-laws, TCP rules etc. to effectual implementation. Further private stakeholders play a crucial role in building design and construction.

SURVEY TO TRACK & ASSESS ECBC IMPLEMENTATION

Alliance for an Energy Efficient Economy (AEEE) conducted a survey on ECBC Implementation Experience to assess the priority actions, notification, implementation and compliance approach, capacity of involved stakeholders in terms of knowledge and manpower, to understand the importance of notifying ECBC in states, divergent methods to adopt in public and private buildings, and the requirements to create ECBC Cell and whom to give the responsibility of heading the Cell.

The respondents are the organizations working to implement ECBC in states across India and the key findings are summarized below:

1. **Priority for ECBC: Amendment or Notification**
   The majority of stakeholders rated notifying ECBC in the state as the priority step to implement it, and then amend the code as per the requirement. The states can also simultaneously amend the building bye-laws and conduct capacity building programs. The need for notifying the code at the earliest was almost unanimous.

2. **Role of ULBs in Construction of new public buildings**
   Almost all the buildings which come under the defined boundary of a city have to get the permit to construct a new building by the Urban Local Body/Municipality of that area, either public or private. As the public buildings are generally built by PWD, CPWD, RITES, NBCC, Police Housing etc., they get permits faster than the private buildings. The ULBs can influence the public and private builders to a great extent by making amendments in the building bye-laws and come up with innovative policy interventions to promote energy efficient buildings in the administered area.

3. **Strategy for Implementing ECBC for private and public buildings**
   Most of the responses indicated a preference for two different strategies to be in place for implementing ECBC in in public and private buildings, as getting a permit from the ULB for a public building is not always required. The responses also suggest prioritizing private buildings for ECBC compliance.

4. **Notification of ECBC: Challenges, Responsibility, Creation of ECBC Cell**
   - The prominent challenge observed from the responses was the lack of awareness about the code among the governmental departments. The second biggest challenge faced in notifying ECBC is the inter-departmental coordination among government bodies (like MOP and MoUD). Lack of technical knowledge and support came out to be the third key challenge in implementing the code.
   - The responses also indicated the responsibility of notification of the Code to be taken up by the State Urban Development Authority, through local/city level urban development

department. Although some responses indicate the Energy Department to take up the responsibility of notification, but considering the mandates of building construction, Urban Development Authority has most of the powers grant clearance for building construction.

- In terms of creating an ECBC Cell in the state, the responses indicated preference for setting them up within the Municipal Corporations to provide technical support and dialogues between state and the BEE. In practice, many ECBC cells have been established with SDAs.

5. Training and Capacity Building

- One of the key issues identified from the responses is the non-willingness of Government Officials to adopt ECBC. The result from the survey shows that 60% of the participants feel that the Govt. official's willingness is middling when it comes to attending the capacity building programs on ECBC.
- There is a critical need for capacity building and master trainer programs according to the results of the survey and that the government departments do not have the capacity to check ECBC compliance. Awareness about BEE's master trainer program and attending them also had mixed response.
- Awards, recognition programmes, grants and other fiscal incentives from Government's side may spur the developers to adopt and implement ECBC.
- Developing third-party assessors to help with the compliance mechanism was one of the key requirements identified from survey responses.

6. ECBC Amendment, Compliance and Enforcement

- The State UD Department and the BEE appointed SDAs were considered jointly responsible for amendment, compliance, and enforcement of the code by the survey participants.
- Major challenges in amending ECBC were lack of awareness about the code and lack of coordination among government departments, along with the lack of technical knowledge and support within the department.
- The result shows 80% of the participants feel that Inclusion of ECBC provisions in the model building bye-laws shall be helpful in the fast-tracking amendment of state bye-laws as per ECBC.
- Including entire ECBC provisions in model building, bye-laws post expert consultation was given considerable support as per the survey. Also, the inclusion of ECBC in model building bye-laws gives ULBs the authority to implement the ECBC.
- Most of the responses suggest same compliance check mechanism for government and private buildings and recommend Third-Party-Assessment (TPA) model to be included. The survey results highlighted the need of appointment of Energy Consultants to prepare ECBC compliance reports to fast track the ECBC implementation process and urged UD department to take lead for the same.

7. Vendors/Manufacturers

The need of having ECBC compliant material and technologies ready for use within a state was considered to be critical for ECBC compliance by fewer participants. Others suggested implementing ECBC is feasible without any extra effort because materials, technology and design expertise is currently available.

8. Miscellaneous

- The response from the survey reflected the presence of high-performance green buildings in the respective states of the participants as providing support to ECBC implementation.
- The need for finance was not considered a very strong driver for ECBC implementation.

ENGAGING WITH STATES

WORKSHOPS DELIBERATIONS – KEY OUTCOMES & IDENTIFICATION OF IMPLEMENTATION CHALLENGES

Implementation challenges highlighted in the section are drawn from the five high-level regional workshops organized by NITI Aayog, BEE and Alliance for an Energy Efficient Economy (AEEE) with support from UNDP-GEF (AEEE, 2017). These workshops with the high-level participation of senior officials from state departments like SDA, UDD, PWD etc., initiated regional and inter-departmental dialogues to fast-track ECBC Implementation in states. Because of the focus of the workshops on cross-learning, and identification of best practices, these workshops witnessed tremendous participation from officials of all States and UTs across India. The common implementation challenges as narrated by state officials in these regional workshops are:

1. Amendment and Notification of ECBC

The first major step towards ECBC implementation is its amendment and notification in the State Gazette. During the ten years that have passed since the introduction of ECBC by BEE, only ten States/UT have notified so far. States need to fast track the ECBC notification at the earliest.

2. Identification of Roles and Responsibilities

One clear message that emerged from the intense deliberations during the workshop was the need for clarity on the roles and responsibilities of key government stakeholders including various state and city level divisions of the Urban Development Department (UDD) and the State Designated Agency (SDA) of the Bureau of Energy Efficiency.

3. Government Leadership

A major roadblock towards ECBC implementation- Notification of ECBC in state's official gazette could be overcome by senior bureaucrats in the state assuming leadership role was re-emphasised in the workshop. It is suggested to form two committees, 1. Apex Committee Chaired by Chief Secretary and 2. Steering Committee Chaired by Principal Secretary – Energy or Urban Development. These two committees can provide the necessary direction and thrash out issues for effective roll out and implementation of ECBC.

4. Restructuring of Capacity Building Programs

Learning from the Telangana experience, different training modules for different stakeholders such as senior bureaucrats, government officials representing different departments of Urban Development and Energy, practicing architects and engineers can be developed. For creating further awareness about ECBC, the need to include ECBC in the curriculum of architectural and engineering courses can be explored. Although some states have run comprehensive training programs on ECBC, there is a need to roll out an extensive training program in all states.

5. Institutional Framework

The State Designated Agencies (SDAs) are the strategic partners for the promotion of energy efficiency in the State. But they have limited focus on energy efficiency, as they have limited resources and are often loaded with other responsibilities. It is vital to strengthen the SDAs with necessary resources to perform their roles as envisaged under The EC Act, 2001.

For large scale implementation of ECBC in states, it is suggested to explore different models such as third-party assessors, in-house capacity building among others. For larger States, it would be ideal to

establish permanent ECBC cells with representation from SDA and UDD (Public Works Dept. / Town & Country Planning / Development Authorities, etc).

6. Need to Develop of Online Tools

Online tools for drawings and document submission, compliance checks and subsequent approvals without human interference for effective and time bound ECBC compliance generated a lot of interest among states' representatives. Citing Greater Hyderabad Municipal Corporation (GHMC) online tool development effort, participants expressed the need for creation of similar online portal (NRDC, ASCI, GHMC, IIIT Hyderabad, 2017) (NRDC, 2016).

7. Inclusion of the Residential Sector

Currently, ECBC only addresses commercial buildings (except group housing projects). Considering the continuously growing energy demands of the domestic sector, BEE should consider exploring the inclusion of residential sector at the earliest, to reap higher energy efficiency benefits in the buildings sector as a whole.

8. Energy Efficiency through ESCO

As ECBC focuses on new buildings, it is equally important to exploit the energy saving potential in existing building stock. Energy savings in the range of 20-25 per cent with additional cost savings towards equipment maintenance is easily achievable in existing buildings. NITI Aayog recently carried out energy efficiency retrofits from EESL through ESCO route and were able to achieve energy savings in the range of 35-40%. Few landmark buildings such as Secretariat, High Courts, Hospitals, and others can be taken up to initiate energy efficiency retrofit on pilot basis through ESCO and based on the results and performance, the exercise can be expanded on a larger scale.

For continuous improvement, monitoring of performance is essential. Mandating disclosure of energy use (Energy Performance Index) for all public and private commercial buildings with a connected load of 100 kW or more will go a long way in ensuring better energy management.

9. International Learning

Learning from the international experiences, Building Energy Passport or Energy Management Information System could supplement ECBC in the near future for the realisation of the EE in the actual energy performance of buildings, since ECBC is primarily a design code and does not emphasise much on the actual energy performance of building once operational.

10. Way Forward

UNDP-GEF expressed commitment to continue their support towards mainstreaming ECBC implementation in states by creating more ECBC cells (starting with Himachal Pradesh and Delhi in the Northern region), enhancement of curriculum and development of educational materials about ECBC and development of online tools among various other ongoing programs.

STATES NEEDING IMMEDIATE SUPPORT

In order to gauge progress made on commitments and requests made by states during the workshops, extensive follow-up have been conducted by AEEE with the support of NITI Aayog. Post-completion of all 5 workshops, the CEO NITI Aayog wrote to the State's Chief Secretaries sharing the key-outcomes of the workshop, urging the top leadership in states to take up ECBC implementation at high priority. Follow-up email communication and telephonic calls were made by AEEE to all participating officials from various state departments. AEEE also shared workshops proceedings with participants and urged state officials to act on commitments made by them during workshops. A summary of state's progress post workshops is enlisted below.

Uttarakhand: UDD have implemented ECBC in Building By-laws and are following PEDA's implementation process. They have notified 12 parameters of Energy Conservation in Building bye-laws and 2 more are under process.

Uttar Pradesh: UPNEDA has asked for an extension for the ECBC cell and are targeting to notify ECBC 2017 in the state by August 2017. They have also got sanctions for construction of Super ECBC compliant buildings in the state. Subsequently, UPNEDA organised a workshop in September 2017 where Minister of Alternative Energy announced that UP will adopt ECBC 2017 from January 2018 and make it mandatory.

Delhi: The MOU for ECBC cell is to be signed shortly. A detailed action plan has been prepared under the leadership of Secretary Power, Ms Varsha Joshi. A significant progress in ECBC V2 implementation is expected in coming months.

Himachal Pradesh: The ECBC cell has been created in Shimla recently. The DoE, HP had put up a request for ECBC cell creation after the Northern Region workshop in Chandigarh on 9th-10th Feb 2017. ECBC cell has been created by GEED with the support of UNDP-GEF-BEE.

Madhya Pradesh: The concerned departments have conducted situational analysis (energy consumption, commercial area, mapping of resources, etc.) and have held a state level steering committee meeting to sensitize stakeholders. Stakeholder consultations shall be conducted with all concerned state departments to discuss ECBC implementation modalities. They aim to Notify ECBC in the state by December 2017.

Rajasthan: RRECL have requested PWD department and Jaipur Development Authority to discuss and brainstorm ECBC implementation modalities in the state.

Gujarat: GEDA having already drafted Gujarat ECBC, sent it to the Urban Development Department for their comments and further UDD asked to amend bye-laws as per ECBC and incorporate the code. The draft code is undergoing final review based the comments of UDD.

Assam: The concerned department has shared request with BEE for the creation of ECBC cell. They have carried out state vide consultations for amendment of ECBC.

Meghalaya: They requested the government to constitute ECBC Committee (including various departments) and have initiated the process of notification.

West Bengal: They have formed the steering committee for implementing ECBC. They also asked for BEE's support on amending WBECBC to incorporate ECBC version 2- 2017 and integration of the same to

existing bye-laws, under the guidance of steering committee formed by WB SDA to implement WBECBC in the state.

Sikkim: The state is making progress on amending the code to make it relevant to the region. SDA, Sikkim has written to UNDP for assistance in retrofitting existing building to demonstrate ECBC compliance. SDA is also planning to organize sensitization program on ECBC with all the HODs of the government's departments through BEE.

Nagaland: The notification of ECBC in the state is under process. The request for ECBC cell shall be made contingent upon code notification by the state government.

Bihar: They are amending Bihar ECBC as per ECBC version 2 released in June 2017. The same shall be put up for notification in the state post review by BEE.

Chhattisgarh: ECBC Advisory committee has been proposed under the leadership of Additional Chief Secretary Energy Department, to steer notification and Implementation of ECBC in Chhattisgarh. They are revising the draft CGECBC -2016, according to new revised ECBC 2017 released by the Govt. of India. They are also revising Town and Country planning model byelaws to incorporate ECBC V2 aspects.

Jharkhand: The state is amending Jharkhand ECBC as per ECBC version 2 released in June 2017. The same shall be put up for notification by the state govt. post review by BEE. They are also working on defining roles and responsibilities within state departments for streamlining ECBC implementation.

Kerala: The state Notified ECBC in State's official gazette workshop vide Kerala Gazette Vol VI, No 936 dated 8th May 2017 after the Hyderabad. They also identified roles and responsibilities and LSGD will be the organization for issuing the building permit after certification from a Licensed Engineer that the building design is fully compliant with the Code.

Andhra Pradesh: A high level committee under the chairmanship of Secretary Power has been constituted. ASCI has been engaged to implement ECBC in line with the Greater Hyderabad Municipal Corporation in the State.

Tamil Nadu: The Electrical Inspectorate has submitted request for creation of ECBC cell at the office of Chief Architect, PWD, vide letter no. 18665/CEIG/D2/2017, dated 15 May 2017.

APPROACH TO FAST-TRACK IMPLEMENTATION

The identified challenges questions the gaps in the existing implementation process, underscores the missing links and subsequently suggests a path forward in response to the questions and explores opportunities in order to fast track the process. The paper suggests high-level implementation process which is likely to succeed based on the feedback gathered during the workshop and subsequent analysis and synthesis. The recommendations are:

1. **Delineating the administrative and technical aspects of ECBC while understanding the functioning of govt. departments at national, state and local level for appropriate delegation of implementation responsibilities to the right stakeholders:** The code requirements can be delineated into administrative and technical requirements. Architects, engineers, energy auditors and green building consultants etc. are responsible for ensuring technical compliance with the code. The growing need to design and construct green and energy efficient buildings resulted in an upsurge of capacity building programs along with significant efforts to create a large pool of ECBC trained professionals and has eased the scarcity of technical experts to demonstrate compliance.

   According to ECBC, "Administrative requirements relating to permitting requirements, enforcement, interpretations, the claim of exemption, approved calculation methods and right of appeal are specified by the authority having jurisdiction" (BEE, 2007). This clearly puts the onus on state and local government for adoption and enforcement. While state and local government have the lead responsibility when it comes to implementation, it requires backstopping and support mechanism from the central government, much more so in the initial phase when experience and expertise are in short supply.

   A broad level classification of roles and responsibilities for ECBC overall implementation is illustrated in Figure 4. It shows that the notification falls under the purview of government. Subsequent to notification and amendment, the stakeholders can be arranged under two heads: first, building design and construction stakeholders which shall look after technical aspects and second, regulatory bodies i.e. Government stakeholders, which shall look after administrative aspects.

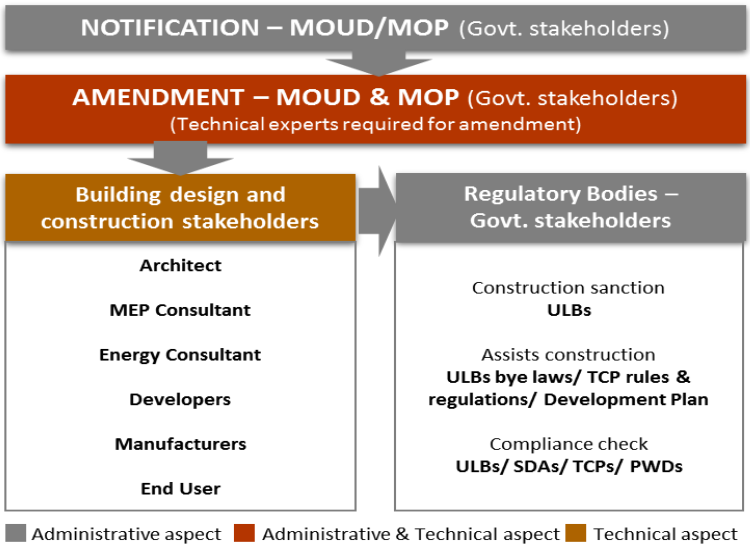


Figure 4: Technical and administrative aspects

Understanding the functioning of government departments at various levels having a significant role in ECBC implementation will lead to an appropriate delegation of implementation roles and responsibilities. A high-level structure and the relationship between different government departments at national, state and local level are illustrated below:

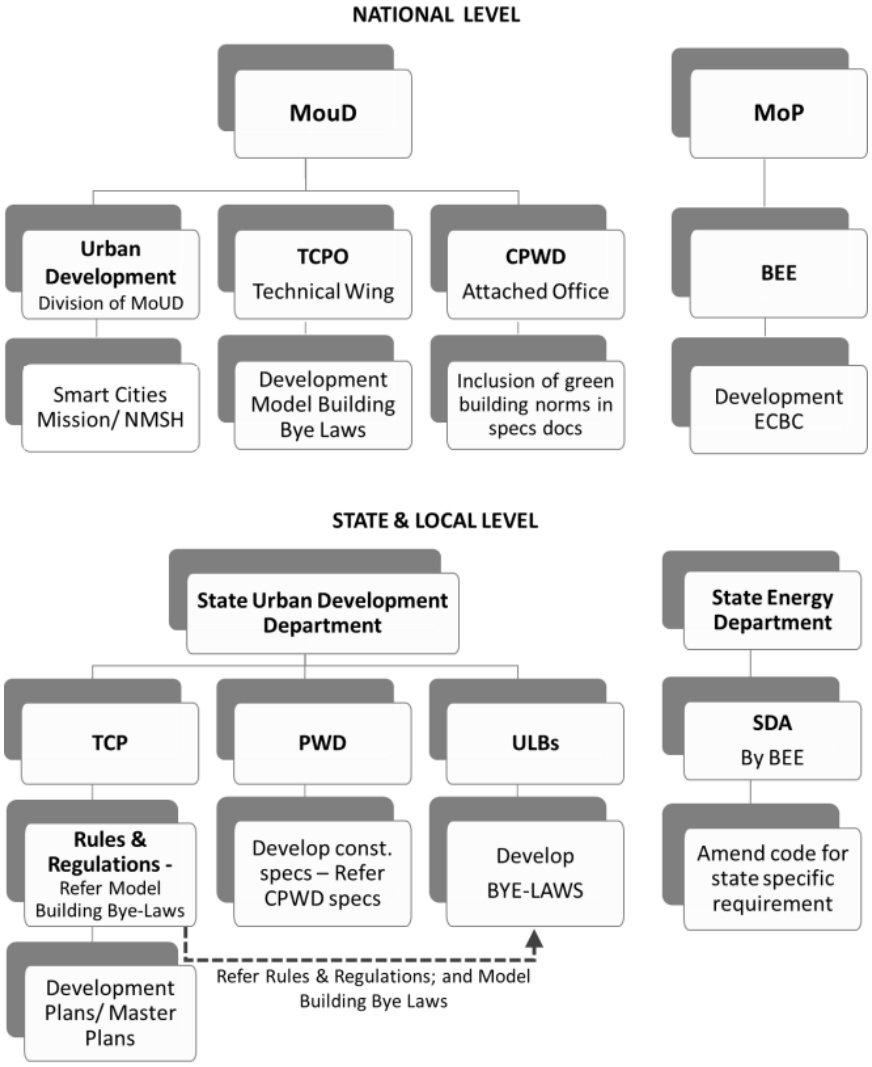


Figure 5: Flow of functions at Centre, State and Local level

The roles and responsibilities of state departments like UDD, TCP, PWD differ from state to state, where some states may follow a typical hierarchy represented above that was derived from the interviews conducted and feedback received from different state govt. officials. For instance, the PWD department follows the code compliance, if mandated by the state; however, they are not dependent on the state to amend their design and construction specs and can set examples by implementing ECBC in the buildings that are designed and constructed by them. Similarly, ULBs under constitution-74th amendment have powers to amend the bye-laws to incorporate energy code and can also enhance its stringency level, if not directed by state's urban development department (MoUD).

2. **Enhancing coordination between key ministries and an urgent need to clarify their roles and responsibilities at different levels:** Enhancing coordination between key ministries and an urgent need to clarify their roles and responsibilities at different levels: The involvement of multiple ministries in the implementation process requires strong and focused coordination at several levels which can be achieved through demonstrated leadership firstly. For example, the formation of a high-powered committee chaired by a senior bureaucrat such as state's Chief Secretary/ Principal Secretary of Power/ Urban Development department with members from all relevant departments will enhance coordination through improved and acceptable delegation of implementation tasks. Under this leadership model, the whole process can be fast tracked through monthly reporting/ meeting. States like Andhra Pradesh and Karnataka progressed under the leadership of senior bureaucrats who had the vision and demonstrated these kinds of leadership. The coordination and implementation process under the leadership of Andhra Pradesh Chief Secretary is delineated in figure 4, clearly indicating the pivotal role of Chief Secretary. During the 5 regional workshops, state officials suggested forming two committees: (1) Apex Committee Chaired by Chief Secretary and (2) Steering Committee Chaired by Principal Secretary of DoE or UDD. These two committees can provide the necessary direction and thrash out issues for effective roll out and implementation of ECBC.

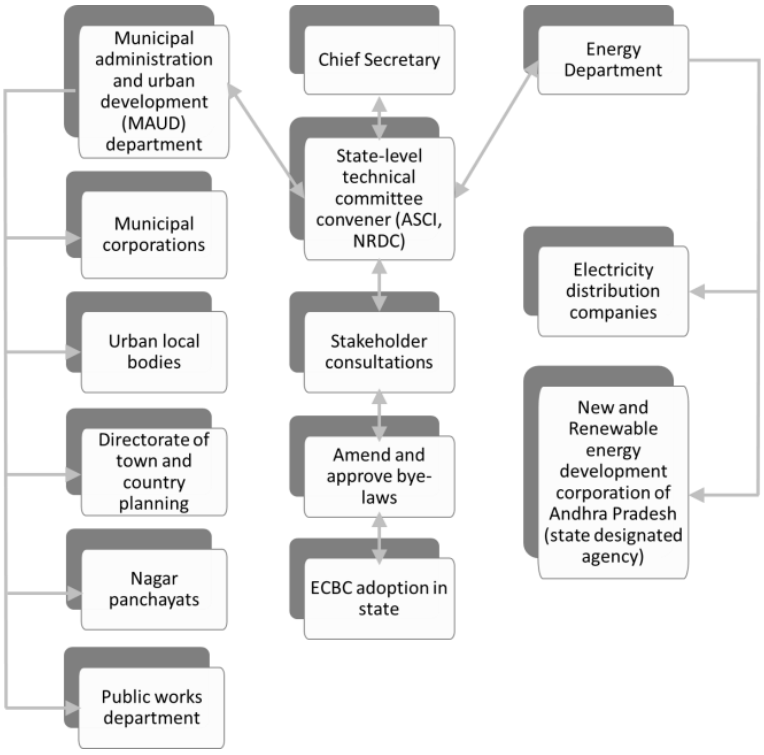


Figure 6: Andhra Pradesh ECBC implementation – government department coordination *(Khosla, 2016)*

A comprehensive delineation of roles and responsibilities of pertinent government departments to build institutional structures leading to effective code implementation on a medium term is the second important point. Each department (centre/ state and local) must be given specific tasks and joint responsibilities must be avoided. This will improve coordination and instil a sense of ownership within each department. Under the proposed approach, challenges shall be

highlighted and addressed. The responsibilities of adoption and enforcement tasks to mainstream ECBC are captured in the following matrix.

Table 5: Proposed roles & responsibilities structure *(UNDP-GEF-BEE, 2017)*

Tasks related to mainstream ECBC	Responsibilities		
	Central Government	State Government	Local Government
ECBC ADOPTION			
Set-up ECBC committee to implement code		SDA	
Review the ECBC and customization of code to suit regional and climatic conditions		SDA	
Define criteria of applicable building types		SDA	
Make legal notification in the state gazette for mandatory implementation of code		SDA/ UDD	
Develop enabling mechanisms and processes for mainstreaming ECBC	BEE	SDA and UDD	ULBs
Revision of Schedule of Rates (SoR)	CPWD	PWD	
Revision of State General Development Control Rules/ ULB's Building Bye-Laws		SDA and UDD	ULBs
Develop ECBC implementation Rules e.g. Third Party Assessor (TPA) Model	BEE	SDA and UDD	ULBs
Use public online tools/ endorse third party simulation software to show compliance	BEE	SDA	ULBs
Develop technical capacity of building sector stakeholders	BEE	SDA	ULBs

Tasks related to mainstream ECBC	Responsibilities		
	Central Government	State Government	Local Government
ECBC ENFORCEMENT			
Institutionalize mechanisms for enforcement and compliance checking in ULBs & Electrical Inspectorate		SDA	ULBs
Set-up of robust Monitoring and Verification (M&V) system	BEE	SDA	ULBs

3. **Use of 3rd-party technical assessors to check for design-based ECBC compliance in the overall building design approval process**: A major challenge in implementation for states having notified ECBC is to check ECBC enforcement by the local government. The task requires compliance check of the technical details of the code on the ground by the local government officials, which sometimes lack the technical capacity to understand and evaluate the building systems. While capacity building programs are running in full swing in many states to ramp-up local government capacity, their benefits may not be felt in the medium-term. To fast track enforcement, TPA model has been suggested by C.E.P.T. University, Ahmedabad, which stresses on creating a cadre of professionals outside the public sector (CEPT University). Under the model, a TPA is assigned to the project, which reviews the project during design stage and construction phase, on behalf of local government and ensures Energy Conservation Measures (ECMs) are appropriately incorporated in the building. The model also suggests the appointment of a technical committee by BEE to further appoint quality assurance (QA) bodies

to oversee the operation of the TPA model. The operating model for third part assessment for ECBC compliance checks is presented in the figure below, indicating the roles and responsibilities at national, state and local level. The government of Telangana has adopted TPAs model, where third-party assessors inspects building in two stages to ensure effective compliance (NRDC, 2016).

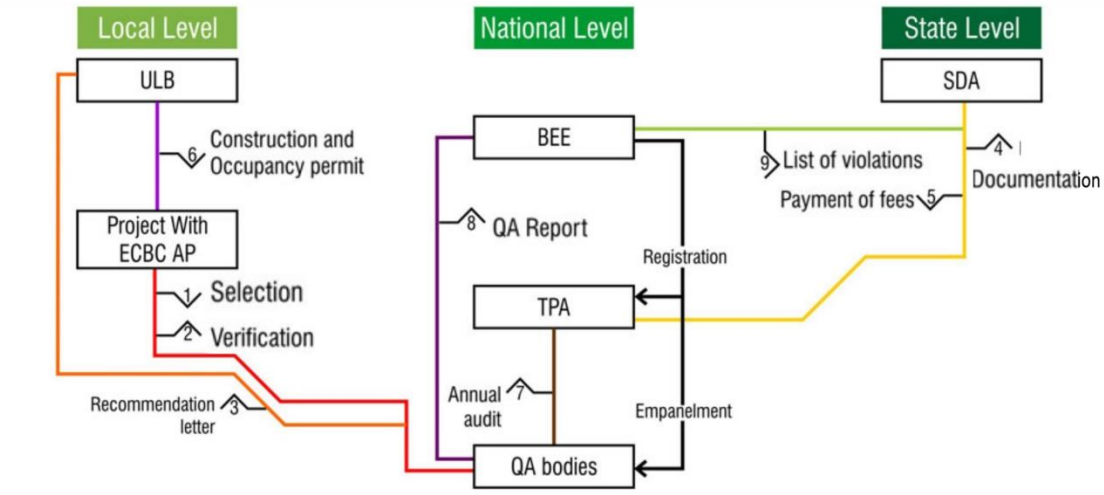


Figure 7: TPA model *(CEPT University)*

4. **Appropriate capacity building**: Capacity building is a long-term solution to fast track implementation and in order to reap higher EE benefits in the buildings sector, undertaking structured training targeting the right audience is a must. Different training modules are needed for different stakeholders such as senior bureaucrats, government officials representing UDD, SDA, PWD, policy makers, practising architects and engineers. Other suggestion to scale-up capacity building and generating awareness about ECBC is by including ECBC in the curriculum of various architectural and engineering courses and organise dedicated events such as regional workshops.

While these are broad level approaches, to fast track implementation, each state is required to address their challenges at state and local level.

ECBC 2017 KEY HIGHLIGHTS COMPARED TO ECBC 2007

ECBC Version 2 was launched by the Government of India on July 19, 2017. The updated version of code is developed considering current as well as futuristic advancements in building technology to further reduce building energy consumption and promote low-carbon growth.

The updated code has defined three levels of energy performance standards. In ascending order of efficiency, these are ECBC compliant, ECBC+ and Super ECBC. Fulfilling requirements stipulated for ECBC compliant, the minimum level of efficiency, is necessary for demonstrating compliance with the code. The other two levels are specified to encourage even higher standards of efficiency. Even though very much achievable with current technology, ECBC+ and Super ECBC are still aspirational and hence voluntary as of date.

The analysis shows that ECBC 2017 compliant buildings demonstrate energy savings of 25%. With additional improvements in energy efficiency, ECBC + building could save upto 35% energy while Super ECBC buildings could lead to 50% energy savings. Adoption of ECBC 2017 for new commercial buildings throughout India will lead to an estimated reduction of 50% energy use by 2030. This will be equivalent to monetary savings of INR 35,000 crore and 250 million tonnes of CO_2 reduction (Press Information Bureau, GoI, 2017).

ECBC 2017 norms are specified under following categories: Building Envelope, Comfort Systems and Controls, Lighting and Controls and Electrical & Renewable Energy Systems, which is a modified version of norms for ECBC 2007 that comprised of: Building Envelope (Walls, Roofs, and Windows), Lighting (Indoor and Outdoor), Heating Ventilation and Air Conditioning (HVAC) System, Service Water Heating & Pumping and Electrical Systems (Power Factor, Transformers). The type of compliance approaches, Prescriptive and Whole Building, are similar in both 2017 and 2007 versions. Similar to earlier version, ECBC 2017 also lists mandatory requirements which are mentioned under Chapter 2 of the code. The mandatory requirements must be met for both compliance approaches.

CONCLUSION

The five high-level workshops reached out to more than 500 government officials across India from various central, state and local level government departments involved in ECBC implementation process. More than 300 government officials participated in the workshop representing departments such as UDD, TCP department, SDA, Renewable Energy Department, Development Authority(s), Municipal/ Urban Local Bodies, PWD and Electricity and Energy Department. The workshops primarily focused on the administrative aspect of the code along with ECBC implementation best practices and initiated regional dialogues among the participants to fast track ECBC in their respective states.

The discussions emphasized the need for government organisations to lead by example in adopting ECBC and mainstream ECBC compliance across India, which is largely missing even after 10 years of its launch by the BEE. One of the main reasons behind the poor ECBC enforcement has been the lack of capacity, coordination and focus on energy efficiency across most of the Indian states and UTs reflected in a handful of staff responsible for all EE activities at the state level. While the Government of India has done an admirable job in setting ambitious renewable energy targets, only focusing on generation without plugging energy wastage and embracing energy efficiency will prove very costly for India. This approach will not serve very well unless demand side efficiency is emphasized and given importance before supply side focus on renewables will start to bear fruit in a carbon and land-use constrained environment.

India will experience massive growth in the commercial and residential building construction over the next two decades. Recognising energy efficiency as a resource and enhancing the energy efficiency of the upcoming building stock is imperative for India's development. Following interventions are suggested:

1. Roll out roles and responsibilities for all relevant government stakeholders at the earliest and publish annual ECBC implementation status report for every state at the state, municipal corporation and ULB level;
2. Make ECBC enforcement mandatory in all Indian states and UTs and direct the development authorities to not issue design approvals until building design show compliance with ECBC;
3. Ask all the government ministries and departments to immediately comply with ECBC for all government building design and construction with a connected load of 100 kW or more;
4. Mandate disclosure of energy use (Energy Performance Index) for all public and private commercial buildings with a connected load of 100 kW or more and immediately install meters to start monitoring energy consumed by air-conditioning and fans, lighting, plug power and elevators to instil a culture of data-driven energy management.

The broad level recommendations are based on the challenges highlighted during the high-level five regional workshops with participation from more than 300 central, state and local level government officials across India. The methodical understanding of the existing efforts, identification of challenges along with rational near and long term solutions for every state is required while drafting strategies to fast track ECBC implementation at state and local level. While some of the recommendations are part of the various states implementation strategy, the adoption is slow paced due to several reasons. The technical experts' role is crucial to devise different and state specific approaches and resource allocation for code Adoption, Implementation, and Enforcement. The tiered approach and resource allocation for

smart cities by CEPT University and PNNL respectively are few of the examples (Rawal, et al., 2012) (Tan, Yu, & Evans, 2016).

Mandatory enforcement of ECBC in India is the need of the hour and it will positively impact its Nationally Determined Contribution and Sustainable Development Goals commitment. At the same time, mandatory enforcement will have a positive impact on India's Smart City Mission because its building stock will avoid a lock-in inefficiency of 30-50 years putting a negative burden on India's energy security situation.

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Alliance for an Energy Efficient Economy, New Delhi

Email : info@aeee.in | Tel. : +91-11-40567344

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