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Strengthening National MRV Systems – Options and Approaches for India

MRV Framework for Energy Conservation Building Code for Large Commercial Buildings

Initiative for Climate Action Transparency

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Initiative for Climate Action Transparency: ICAT
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LIST OF ACRONYMS

BAU: Business As Usual

BEE: Bureau of Energy Efficiency

CAGR: Compound Annual Growth Rate

CIDC: Construction Industry Development Council

CIFF: Children's Investment Fund Foundation

DPIIT: Department for Promotion of Industry and Internal Trade

ECBC: Energy Conservation Building Code

EEA: Empanelled Energy Auditor

EPI: Energy Performance Index (kWh/m2/year)

GDP: Gross Domestic Product

GHG: Greenhouse Gas

GRIHA: Green Rating for Integrated Habitat Assessment

HVAC: Heating, Ventilation, and Air Conditioning

ICAT: Initiative for Climate Action Transparency

IEA: International Energy Agency

IGBC: Indian Green Building Council

KPI: Key Performance Index

LEED: Leadership in Energy and Environmental Design

MEPS: Minimum Energy Performance Standard

MNRE: Ministry of New and Renewable Energy

MoEFCC: Ministry of Environment, Forest and Climate Change

MoHUA: Ministry of Housing and Urban Affairs

MoP: Ministry of Power

MoSPI: Ministry of Statistics and Programme Implementation

MRV: Measurement, Reporting and Verification

NDC: Nationally Determined Contribution

SDAs: State-level Designated Agencies

TCP: Town and Country Planning

TPAs: Third Party Assessors

UDP: UNEP DTU Partnership

ULBs: Urban Local Bodies

UNFCCC: United Nations Framework Convention on Climate Change

UNOPS: United Nations Office for Project Services

UTs: Union Territories

1. Introduction to Buildings Sector in India

1.1 Buildings Sector: Global Perspective

By 2040, the global population is expected to reach 9.1 billion. Accordingly, the infrastructure must improve which would lead to a corresponding increase in the number of buildings and their sizes (IEA 2017). With increasing population, the global gross domestic product (GDP) will also increase at a compound annual growth rate (CAGR) of 3.4% between 2016 and 2040 (IEA, 2017). At par with the GDP growth, the urbanization rate is expected to reach 63% in 2040 in comparison to 54% in 2016 (IEA 2017). It is also anticipated that this increase in urbanization rate will set pressure on cities to provide more living spaces.

Human beings spend 90% of their time indoors (UNIDO 2009) and depend on mechanical ventilation, cooling, heating, and artificial lighting systems for their required comfort. This has significantly increased the energy consumption of the buildings sector. Today, 40% of the total primary energy is consumed by buildings, globally (Cao, Dai, and Liu 2016). Buildings are also responsible for the 40% and 16% consumption of the world's material and water, respectively (Roodman and Lenssen 1995). They also cause 19% of the energy-related greenhouse gas (GHG) emissions (Lucon, Vorsatz, Ahmed, *et al*. 2014).

By 2050, the built-up area is expected to increase by 46%, globally in comparison to 2015 (The Statistics Portal 2016). Presently, the building sector's energy demand is far more than the energy demand of the other two major energy-consuming sectors, i.e. industrial and transport (Lombard, Ortiz, and Pout 2007). Between 2012 and 2040, it is estimated that commercial buildings will witness a steady increase of 40% energy consumption, globally. Whereas, the corresponding value for residential buildings is 20% (Vorsatz, Cabeza, Serrano, *et al*. 2015). Rise in population, more time spent indoors, and increased levels of comfort will cause the energy consumption in the building sector to increase further in the future. Globally, the buildings sector has become one of the most important sectors for achieving energy efficiency and optimizing energy consumption pattern.

In buildings, electricity and natural gas are the two most common forms of energy used. They are used to make the occupants comfortable and meet their functional requirements. The different energy end uses that characterize the energy consumption in a building over its lifetime are: space cooling and heating, lighting, cooking, water pumping, etc. The electricity consumed for heating, ventilation, and air conditioning (HVAC) in commercial buildings ranges from 60% to 70% of the total electricity. The corresponding value for residential buildings is 35–45% (Zia and Sharma 2015). The second largest electricity end use in a building is the lighting system. It consumes 15% to 20% of energy (Lombard, Ortiz, and Pout 2007). The Service Hot Water pumping consumes about 14–20% of electricity and accounts for the third highest electricity end use in commercial buildings (Lombard, Ortiz, and Pout 2007). In residential buildings, the refrigerators and kitchen appliances comprise the third highest electricity end use. Lifts, water pumping equipment, and entertainment equipment constitute the remaining share of electricity consumption.

As per estimates, 75% of the buildings that will exist in 2030 in India are yet to be built (GBPN 2013). Therefore, considering the projected growth in the buildings sector, it has become imperative to tap the sector's energy-saving potential which will result in emissions reduction.

1.2 Overview of the Buildings Sector in India

NITI Aayog (2015) estimates that the per capita residential space in India will increase from 1.8 m^2 in 2012 to 3.5 m^2 in 2047, and the per capita commercial buildings space will increase from 0.7 m^2 to 5.9 m^2 over the same duration. Further, as a predominantly rural population rapidly becomes urbanized, the provision for adequate housing and workspace will become an important public investment. In 2014, the construction sector contributed 8.2% of the national GDP and 11.52% of the national employment (MoHUA 2016). For India, therefore, buildings will form one of the crucial areas buttressing economic development. The Indian construction market is pegged to become the third largest in the world by 2030, by overtaking China and Qatar (Global Construction Perspectives and Oxford Economics 2015).

Statistics on the growth of residential and commercial buildings sectors is a clear reflection of India's increasing economic development. India was short of 18.78 million houses in 2012 in the housing segment (MoHUA 2015). In the commercial buildings sector, 2017 saw a leasing volume of 3.9 million m^2 of floor space, mostly in Bengaluru, Delhi-NCR, Mumbai, Hyderabad, Pune, Chennai, and Kolkata (Surabhi 2018). In the next 20 years, an estimated 800 million m^2 of commercial buildings space, namely hotels, hospitals, offices, retail, educational buildings and places of worship, will be added to Indian cities (Kumar, Singh, Kachhawa, *et al*. 2017).

In contrast to the residential sector, commercial buildings depend heavily on electricity for their energy requirements. The growth of physical infrastructure in the commercial buildings sector will cause an exponential rise in electricity consumption, as each square metre constructed can add anywhere between 100 and 500 units to the annual electricity demand.

It can be clearly seen that the buildings sector in India will have greater contribution in the total energy consumption of the country. In 2013, buildings consumed 41% to the total energy in India. Without intervention, this share will continue to climb rapidly. As per various studies, the implementation of energy-efficient measures brings the energy-saving potential in the commercial buildings sector to up to 21 billion units of electricity (Kumar 2017).

With the global impetus on India to increase the conservation and mitigation of energy consumption, the country has implemented energy-efficiency policies, of which of the largest scales in the world. The implementation of UJALA scheme has led to a rapid decrease in the price of energy-efficient LED bulbs due to demand aggregation. In 2006, the Bureau of Energy Efficiency (BEE) launched the Standards and Labelling scheme for appliances; it has led to an estimated energy saving of 111.68 billion units of electricity till March 2018. The Energy Conservation Building Code (ECBC) was launched in 2007 and revised in 2017. It targets energy efficiency in the commercial buildings sector through minimum energy performance standard (MEPS) and passive design, and has been made mandatory by 13 major states and union territories (UTs) of the country.

However, a lot of work remains to be done. Experience from the past decade has shown a number of glaring challenges in implementing energy-efficiency policies and schemes pertaining to buildings; these range from inadequate technical capacity in institutions to an apparent lack of public and private financial resources. Although India has shown a positive intent towards meeting the global challenges of climate change, the creation of sustainable infrastructure has not kept pace with the urgencies and priorities of development.

In the following sections, we will highlight the role of the buildings sector in mitigating country-related GHG emissions and the support it can give in complying with the commitments made to the UNFCCC. We will also discuss the important policy frameworks responsible for limiting energy use from the buildings and develop an effective measurable, reportable, and verifiable mechanism with the help of ICAT guidance.

1.3 Energy Consumption and GHG Emissions from Buildings Sector

As of 2016, green buildings, of which energy efficiency is a key component, represent about 3% of the total built-up area in India (Chintakunta 2016). This low percentage is a testament to the barriers related to establishing energy-efficient buildings. In India, major initiatives towards green and energy-efficient buildings include the ECBC launched by the Ministry of Power (MoP) in 2007, the Green Rating for Integrated Habitat Assessment (GRIHA) developed by TERI in 2005 and adopted by the Ministry of New and Renewable Energy (MNRE), and the Indian Green Building Council (IGBC) formed in 2001. Although over the past two decades, the concept of energy-efficient buildings has made considerable inroads into the domestic discourse and has been included as one of the key strategies to mitigate CO_2 emissions in India's Nationally Determined

Contribution (NDC) submitted to the United Nations Framework Convention on Climate Change (UNFCCC) following the Paris Climate Agreement in 2015, its adoption at the ground level remains negligible.

India's NDC lays emphasis on non-fossil fuel-based electricity generation along with energy efficiency in the buildings sector as one of the major options for reducing GHG emissions. As of 2013, buildings (including both commercial and residential) consumed 41% of the domestic energy. Of this, nearly 65% has been estimated to be from biomass, while the remaining 35% is from oil and gas and electricity. However, by 2040, the buildings sector's share of electricity in the end-use energy consumption is expected to increase to 45%, making it nearly a tenth of the national end-use energy consumption (IEA 2015). Therefore, one of the ways to achieve GHG mitigation is by making electricity clean as well as by reducing the electricity demand through energy efficiency in buildings.

Economic growth causes urbanization and a shift from biomass to electricity for domestic energy needs, which in turn drives electricity consumption. Despite potential for energy savings and resultant emissions reduction, economic growth, and rapid urbanization are expected to increase electricity consumption substantially. The commercial buildings sector is already highly dependent on electricity, and on a disaggregated scale, may contain great potential for energy conservation (IEA 2015) than residential buildings. Studies have revealed that in some specific contexts, policies targeting energy efficiency in the commercial sector have a 17% to 42% savings potential (Tulsyan, Dhaka, Mathur, *et al.* 2013), thereby enabling mitigation of related GHG emissions. The commercial sector also has comprehensive legal provisions in place that govern the construction as well as operational phases, following the Energy Conservation Act of 2001.

1.4 Key Stakeholders in the Buildings Sector

The key stakeholders engaged in the buildings sector with the objective of promoting energy efficiency are as follows:

1.4.1 Ministry of Power

The Ministry of Power is primarily responsible for the development of electrical energy in the country. The ministry is concerned with planning, policy formulation, processing of projects for investment decision, monitoring of the implementation of power projects, training and manpower development, and the administration and enactment of legislation with regard to thermal, hydro power generation, transmission, and distribution. It is responsible for the Administration of the Electricity Act, 2003, the Energy Conservation Act, 2001, along with the undertaking of such amendments to these Acts, as may be necessary from time to time, in conformity with the government's policy objectives.

1.4.2 Bureau of Energy Efficiency

The Bureau of Energy Efficiency (BEE) is a statutory body under the Ministry of Power, Government of India. It was set up by the government under the provisions of the Energy Conservation Act, 2001. The mission of BEE is to assist in developing policies and strategies with a thrust on self-regulation and market principles, within the overall framework of the Energy Conservation Act, 2001 with the primary objective of reducing energy intensity of the Indian economy. The states and UTs have identified state designated agencies (SDAs) to assist in the implementation of the various schemes and programmes developed by BEE under the Energy Conservation Act, 2001. To promote energy efficiency in both existing and new commercial buildings, several initiatives have been taken up by BEE, such as promotion and implementation of ECBC, energy auditing and implementation of energy-efficiency measures in existing government buildings, and a star rating scheme for existing buildings based on their actual performance. Of these, the ECBC is mainly for new commercial buildings and rest are meant for existing buildings.

1.4.3 Ministry of New and Renewable Energy

The Ministry of New and Renewable Energy (MNRE) is the nodal ministry under Government of India for all matters related to new and renewable energy. The ministry has been promoting energy efficient/solar buildings in the country since its inception through a wide range of programmes.

1.4.4 Ministry of Environment, Forest and Climate Change

The Ministry of Environment, Forest and Climate Change (MoEFCC) is the nodal ministry under Government of India for the planning, promotion, co-ordination, and overseeing of the implementation of India's environmental and forestry policies and programmes. The MoEFCC provides environmental (Environmental Impact Assessment) clearance to large construction projects.

1.4.5 Construction Industry Development Council

The Planning Commission, Government of India, jointly with the Indian construction industry has set up Construction Industry Development Council (CIDC) as an apex organization to take up and promote activities for the development of the Indian construction industry. The council has been functioning since August 1996 and has taken up several important projects related to issues vis-à-vis the industry. The council provides the impetus and the organizational infrastructure to raise quality levels across the industry. This helps in securing wider appreciation of the interests of construction business by the government, industry, and peer groups in society. The council also helps accelerate the implementation of various policy measures through its involvement at the grassroots level of the industry.

1.4.6 State Government

State governments are responsible for the buildings sector's policy implementation. Various state government ministries (energy/renewable energy/environment/housing) have formulated policies and implemented programmes for promoting buildings' energy efficiency in their states. SDAs are the nodal agencies in states, responsible for implementing activities related to the ECBC in their respective states.

1.4.7 Local Government

The local governments at the city level, such as municipal corporations/ municipalities/ development authorities, formulate building bylaws for building construction within the city municipal limits. Local bodies are responsible for actual implementation and compliance with the sectoral policies. The local bodies need to amend their bylaws for implementation of regulations such as the ECBC. Local authorities of a few cities have modified their building bylaws to incorporate energy-efficienct/green building features. The local bodies also amend the building bylaws to implement the environment rating systems such as GRIHA.

2. Introduction to Existing Policies in the Buildings Sector and Policy Selection for MRV Framework

India's buildings sector is governed by various regulations of different state and central ministries. Primarily, the sector is regulated by the Ministry of Housing and Urban Affairs (MoHUA), the Ministry of Environment, Forest and Climate Change (MoEFCC), the Ministry of Power (MoP), state departments such as town and country planning, urban development authorities, urban local bodies (ULBs), etc.

Buildings are listed in state list under the legislative section of the seventh schedule of the Constitution of India, which provides states the power to enact policies and legislations for the sector. From time to time, the central government, as per the national agenda and development goals, enacts model codes and standards for states to adopt as per their regional requirements. These model codes and standards are adopted by the states through different legislative instruments. The state government may adopt these policies as recommended by the centre or may modify the recommendations as per the regional priorities and geographical requirements.

2.1 Listing Policies and their Scope

The buildings sector's energy efficiency is mainly aimed towards building design, construction practices, materials, equipment and system selection, and operation and maintenance. Policy makers have undertaken several policy initiatives to address the buildings sector's energy efficiency and carbon mitigation in the country. These policies directly or indirectly address the issues related to building energy /green measures.

These policies include codes, standards, programmes, and regulations that directly or indirectly affect the buildings sector's GHG emissions and energy efficiency pertaining to new large commercial buildings subsector. The key policies and their scope are highlighted in Table 1.

2.2 Selection of the Policy for Development of MRV Framework

With the objective of developing an MRV framework for assessing GHG impacts, the Energy Conservation Building Code (ECBC), which is applicable to new and large commercial buildings,

Table 1 Types of policy instrument in buildings sector and their scope

Type of policy instrument	Policy/regulation	Scope
Regulatory policy	Energy Conservation and Building Code	New constructions
Regulatory policy	Standards and Labelling Programme	Energy-efficient equipment
Regulatory policy	BEE's star rating for buildings	Existing building's energy rating
Public procurement programme	Bachat Lamp Yojana	Energy-efficient lighting
Public procurement programme	National Programme for LED-based Home and Street Lighting	Energy-efficient lighting
Information policies	Green Rating Systems, Green Rating for Integrated Habitat Assessment (GRIHA) and Leadership in Energy and Environmental Design, India (LEED India)	New and existing constructions
Support policies	National Buildings Energy Efficiency Programme	Existing building's retrofit
Regulatory Policy	Buildings under PAT scheme	Existing building's energy efficiency

has been considered. This is primarily due to its high potential of mitigating GHG emissions from the buildings sector as recognized by Government of India in its second Biennial Update Report (BUR-2) submitted to the UNFCCC. Further, the policies and programmes impacting GHG emissions in commercial buildings include the ECBC (which is a mandatory policy) and voluntary environment ratings, such as GRIHA, IGBC, and LEED. However, isolating the impact of an individual policy may not be feasible since improvements in the energy performance of the buildings would be a combined impact of all the policies related to the commercial buildings sector.

2.3 Policy Description: Energy Conservation Building Code

Under the provisions of the Energy Conservation Act, 2001, the BEE was created under the Ministry of Power, to spearhead energy conservation policies.

The Energy Conservation Building Code was developed by the BEE for new commercial buildings in May 2007 and amended in 2017. The ECBC sets minimum energy performance standards for new commercial buildings having a connected load of 100 kW or contract demand of 120 KVA and above. Further details of the ECBC and its key characteristics are described in Table 2. The code is a model for the state governments to modify, adopt, and implement as a state law. Once the code is amended, it is imperative that the code be notified in the state gazette for implementation.

As per 2018 data, 15 states and 2 UTs (Rajasthan, Odisha, Uttarakhand, Punjab, Haryana, West Bengal, Uttar Pradesh, Assam, Kerala, Karnataka, Andhra Pradesh, Telangana, Gujarat, Maharashtra, Himachal Pradesh, Puducherry and NCT of Delhi) have notified and adopted the code. Further, these states are at a different level of implementing ECBC with many only amending it as per their requirements and only a few have made good progress through notification in the state bylaws, and by enforcement and creation of the ECBC cell for further implementation (refer to Table 3).

Table 2 ECBC policy description

Information	Description
Type of policy	Regulatory instrument
Description of intervention	The code includes mandatory and prescriptive requirements for new commercial buildings to incorporate energy-efficiency measures during buildings' design stage The code recommends minimum performance levels for buildings' envelope, lighting, space conditioning, and other energy-consuming systems 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 such as ECBC+ or Super ECBC status and these buildings should be able to demonstrate energy savings of 35% and 50%, respectively (BEE 2017)
Status of policy	The code was developed by the Bureau of Energy Efficiency, Ministry of Power in 2007 and revised in 2017 Currently, 13 states/UTs have notified the implementation of ECBC and 23 states have made amendments to the code
Date of implementation	The code was launched in 2007 and amended in 2017. The implementation date will differ for each state as per the notification and enforcement of the ECBC in states
Date of completion	Ongoing
Implementation agency	State designated agencies or as notified by the state government
Objectives and intended benefits	Improved energy performance index (EPI) of the targeted building
Level of policy	National and state
Geographical coverage	India
Sectors targeted	Electricity consumption in buildings
Greenhouse gasses targeted	Emissions related to end-use electricity consumption
Key stakeholders	State government, state designated agencies, urban development authorities, local government units

Table 3 Implementation status of ECBC in various states

State/UT	ECBC Adoption	ECBC Cell[#]	ECBC notification	Notificaion by state by-laws	Byelaws/ policy	Enforcement	Energy simulation software
Category 1[a]							
Karnataka	√	√	√	√	Karnataka municipalities model building byelaws 2017	√	√
Andhra Pradesh	√	√	√	√	AP building rules 2017	√	√
Telangana	√	√	√	√	AP building rules 2017	√	√
Gujarat	√	√	√	√	General development Control regulation 2016	√	√
Punjab	√	√	√	√	Municipal building byelaws 2018	√	√
Rajasthan	√	√	√	√	Unified building byelaws 2017	√	√
Haryana	√	√	√	√	Haryana building code 2017	√	√
West Bengal	√	√	√	√	West Bengal Municipal building rules 2007 (2016 amendment)	√	√
Uttarakhand	√	√	√	√	Uttarakhand building byelaws and regulation 2011 (2016 amendment)	√	√
Odisha	√	√	√	√	Rourkela Development Authority Planning and Building Standards Regulations, 2017	√	√
Maharashtra	√	√	√	√	State Energy Conservation Policy 2017	√	√
Nct of Delhi	√	√	√	√	Unified building byelaws 2016 (amendment 2017)	√	√
Himachal Pradesh	√	√	√ (ECBC 2017)	*	*	√	√
Category 2[b]							
Tamil Nadu	√	√	√	√	in process (2018)	√	√
Uttar Pradesh	√	√			in process		
Kerala	√	√	√	√	*	√	√
Madhya Pradesh	√	√	√				√
Pondicherry UT	√	√	√				
Chhattisgarh	√	√					√
Assam	√	√					
Bihar	√	√					
Arunachal Pradesh	√	√					√
Goa	√	√					√

State/UT	ECBC Adoption	ECBC Cell#	ECBC notification	Notificaion by state by-laws	Byelaws/ policy	Enforcement	Energy simulation software
Category 3[c]							
J & K		√					√
Chandigarh UT		√			*		√
Manipur		√					√
Meghalaya		√					√
Mizoram		√					√
Nagaland		√					√
Sikkim		√					√
Tripura		√					√

There is One Ecbc Cell For Andaman And Nicobar Islands, Daman And Diu, Lakshadweep, Pondicherry, And Goa, One For Arunachal Pradesh, Assam, Meghalaya, Sikkim And One Cell For Manipur, Mizoram, Nagaland,And Tripura. (As Per 2018 Data)

* Status not known

[a] Category 1: States which have begun to enforce/implement ECBC locally
[b] Category 2: States which have amended and notified ECBC
[c] Category 3: States which have not yet notified/amended ECBC but have initiated capacity development

Source: https://shaktifoundation.in/wp-content/uploads/2019/07/Handbook-ECBC-compliance-in-Indian-Cities.pdf

As the state government is liable for the ECBC implementation and enforcement, the geographical boundaries of the assessment is considered as the boundary of a State or Union Territory (UT). Subsequently, the climatic zone of the assessment boundary is considered as per the ECBC code adopted and notified by the state government (refer to Table 4).

It should be noted that the ECBC is likely to help in achieving significant savings in the buildings secotor provided that the states effectively implement the code in close coordination with SDAs, ULBs, real estate developers, and other stakeholders. Several states have made progress by taking steps to scale up implementation of the ECBC; however, there is a need to overcome several barriers and learn from the success stories.

Table 4 Selected policy for the development of MRV framework

Item	Remarks
Policy to be assessed	State Energy Conservation Building Code (state ECBC)
Geographical boundary	State
Climatic zone	As per the definition of the state ECBC or national building code
Building type	Large commercial buildings (as per the scope of the state ECBC)
Key emission sources to be included in assessment	As per assessment objective (identified in the ECBC-GHG impacts assessment matrix)
Duration of assessment	As per the objectives of the assessment (for example, reporting period to the UNFCCC)
Base year for assessment	Year of notification of the ECBC by the state

3. Identifying GHG Impacts

- As per ICAT Buildings Efficiency Guidance, in order to assess the GHG impacts of a policy, it is important to understand how the policy is intended to be implemented and how it will achieve the desired GHG outcome. This section explains the steps (refer to Figure 1) for determining the most common intermediate effects and GHG impacts of the Energy Conservation Building Code (ECBC).

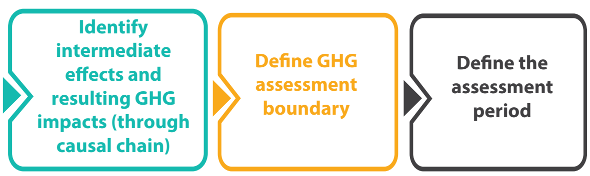

Figure 1: Steps for determining GHG impacts of the state ECBC

3.1. Causal Chain Diagram

- A causal chain is a conceptual diagram useful for tracing the process by which the state ECBC leads to GHG impacts through a series of interlinked and sequential stages of cause-and-effect relationships. It is important to understand how the policy identifies all the possible intermediate effects which ultimately result in GHG emissions reduction. Figure 2 also highlights GHG impacts associated with the following building components covered under the ECBC:
- Building efficient envelop
- Heating, ventilation, and air conditioning
- Lighting
- Electric power
- Service water heating

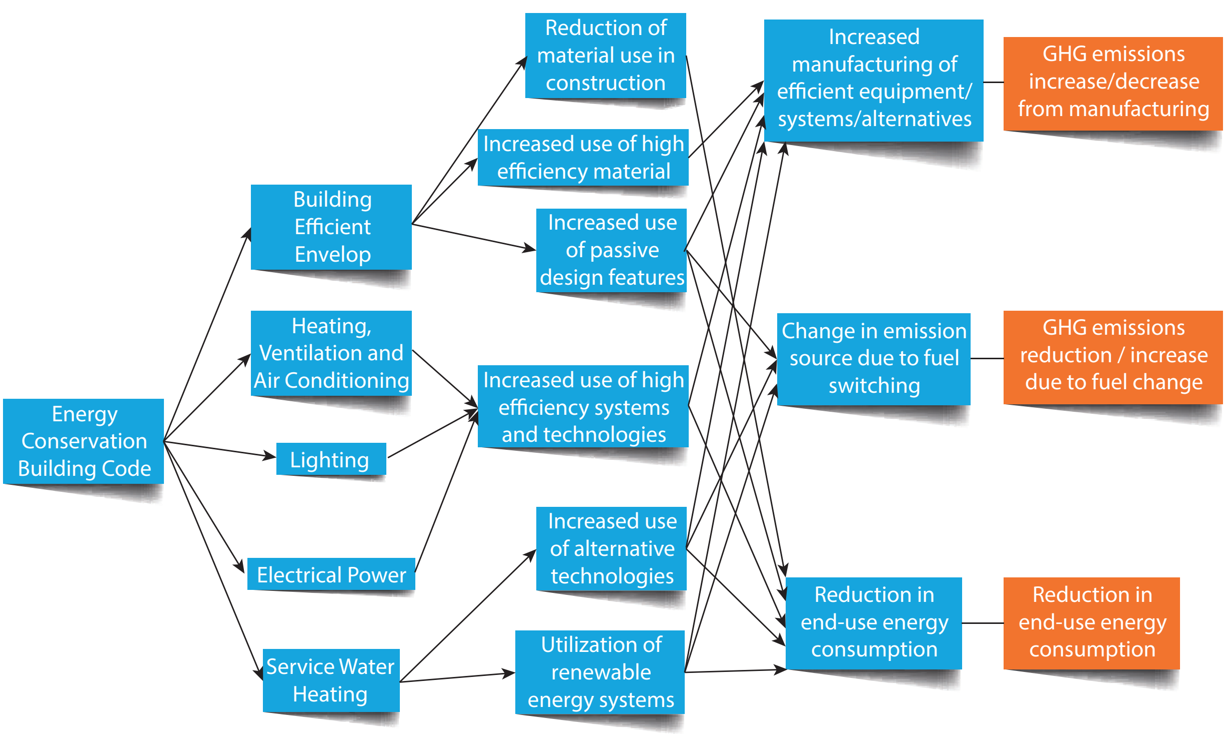

Figure 2: Causal chain diagram highlighting GHG impacts of state ECBC

3.2. GHG Assessment Boundary

As per ICAT Buildings Efficiency Guidance, the GHG assessment boundary defines the scope of assessment in terms of the range of GHG impacts that are included in the policy assessment. Table 5 lists the GHG impacts relevant to the ECBC and indicates whether they are significant based on likelihood and relative magnitude. The categorization of all the possible GHG impacts would be useful to identify the key GHG impacts that should be included in the GHG assessment boundary based on their likelihood and relative magnitude.

As it can be seen from Table 5, there are a few GHG impacts of the state ECBC on different building components which are very likely to occur and have maximum impact on the overall GHG emissions reduction. Therefore, only these impacts will be included in the GHG assessment boundary (refer to Table 6).

Table 5 GHG impact assessment matrix for state ECBC

GHG impact	Likelihood	Relative magnitude	Included?	Explanation
Emissions from building envelope				
Increase in GHG emissions due to equipment manufacturing	Possible[1]	Minor	No	Considered insignificant relative to savings in lifetime of the building
Increase in GHG emissions due to the rebound effect	Likely	Minor	No	Very high uncertainty in impact
GHG emissions reduction due to energy-use reduction	Very likely	Major	Yes	Significant impact of efficient design and material of building envelope on energy consumption
Emissions from heating, ventilation, and air conditioning				
Increase in GHG emissions due to equipment manufacturing	Very likely	Minor	No	Considered insignificant relative to lifetime savings achieved in operation of equipment
Increase in GHG emissions due to the rebound effect	Likely	Minor	No	Very high uncertainty
GHG emissions reduction due to energy-use reduction	Very likely	Major	Yes	Significant impact on GHG emissions from use of efficient equipment
Reduction of direct GHG emissions (from refrigerant leak during operation/servicing)	Likely	Minor	No	Considered insignificant due to high relative savings achieved throughout life cycle of equipment and very high uncertainty on the GHG emissions impact
Emissions from lighting, service water heating, and electrical power				
Increase in GHG emissions due to equipment manufacturing	Possible	Minor	No	Considered insignificant relative to savings in the lifetime of the building
Increase in GHG emissions from rebound effect	Likely	Minor	No	Very high uncertainty in impact
GHG emissions reduction due to energy-use reduction	Very likely	Major	Yes	Significant impact on GHG emissions from the use of efficient equipment
Reduction/increase in GHG emissions due to fuel switching; reduction from offset through renewable energy	Very likely	Major	No	Significant impact on GHG emissions
Emissions reduction due to efficient electricity distribution	Very likely	Moderate	Yes	Significant impact on GHG emissions though considerable uncertainty on the impact exists

[1] The terminologies 'Possible' 'Likely' and 'Very likely' have been referred to from the ICAT Guidance document for evaluating the significance of their likelihood in the GHG assessment boundary. The indicators having minimum significance are classified as 'Possible', moderate as 'Likely', and maximum significance as 'Very likely'.

Table 6 GHG impacts included in the assessment boundary

GHG impact	Likelihood	Relative magnitude	Included?	Explanation
Emissions from building envelope				
GHG emissions reduction due to energy-use reduction	Very likely	Major	Yes	Significant impact of efficient design and material of building envelope on energy consumption
Emissions from heating, ventilation, and air conditioning				
GHG emissions reduction due to energy-use reduction	Very likely	Major	Yes	Significant impact on GHG emissions from use of efficient equipment
Emissions from lighting, service water heating, and electrical power				
GHG emissions reduction due to energy-use reduction	Very likely	Major	Yes	Significant impact on GHG emissions from use of efficient equipment
Emissions from efficient electricity distribution	Very likely	Moderate	Yes	Significant impact on GHG emissions though considerable uncertainty on the impact exists

4. Estimating the Baseline Scenario and GHG Emissions

4.1 Approaches for Estimating Baseline Scenario and Assumptions Used

A baseline is defined as the best assessment of the future scenario in the absence of a proposed regulation or policy action. The baseline scenario is the reference point for any impact assessment exercise. To evaluate the GHG emissions reduction through a policy measure, it becomes crucial to establish a realistic baseline scenario with relevant assumptions. This section defines the methodology for assessing the baseline scenario for implementation of the Energy Conservation Building Code (ECBC) in Indian states as per the ICAT Building Efficiency Guidance document.

In developing and middle-income countries, the unavailability of relevant data is the main setback for any policy assessment (Lagarde 2012). In the case of the Indian buildings sector, the sectoral energy consumption data is available in the governmental database. Data related to energy consumption in all commercial buildings is partially available under different initiatives such as GRIHA, IGBC, and BEE (under PAT scheme). However, complete data is not available for all commercial buildings. The sectoral consumption data (residential, commercial, etc.) can be obtained from different sources such as IEA reports, CEA database, and energy statistics by the Ministry of Statistics and Programme Implementation (MoSPI), among others.

In India, to create a baseline scenario without the ECBC adoption, a simple approach can be used which considers the sectoral energy consumption data. Time series data can be used to calculate the rate of change in energy intensity (energy consumption per m^2) as a result of existing policies in the sector. This rate of change of energy intensity can be used to estimate the baseline consumption during the assessment period, thus capturing the impact of existing policies. It should, however, be noted that this approach assumes that even after the ECBC has been notified, there is no change in the status of any other policy implementation, existing policies do not interact with the ECBC, and no new policy other than the ECBC has been introduced during the assessment period. This is somewhat an unrealistic assumption since the ECBC can subsume some of the existing policies and omitting the impact of those policies (through change in energy intensity in the sector) may underestimate the impact of the ECBC. An alternative can be to not consider any change in energy intensity of the sector in the baseline scenario, which implicitly assumes that change in energy intensity during the assessment is solely due to the policy being assessed (ECBC). The actual impact of the ECBC may lie between the two extremes; this is a typical conundrum associated with the methodology if one attempts to isolate the impact of a single policy in a sector where policies are dynamic in nature.

Another issue in this case can be that the sectoral energy consumption may be available in a state only at an aggregated level for the entire buildings sector or for the entire commercial buildings sector, and not for the large commercial sub-sector, which has been considered for study in this report. In that case, aggregate-level data may have to be used, which could impact the accuracy of estimates.

Another assumption in this report is that electricity is the only energy consumed by the large commercial sector. The justification for this is that the commercial buildings sector's energy demand is mainly in the form of electricity, and only a few applications such as heating in some hotels and hospitals may use gas.[2] Also, data on use of other fuels is not available.

[2] Details available at https://niti.gov.in/sites/default/files/2019-07/India%E2%80%99s-Energy-and-Emissions-Outlook.pdf.

Therefore, the equations presented for calculating GHG impacts do not account for other fuels such as gas used by the large commercial sector.

4.2. Data Requirements for Estimating Baseline

For developing countries like India, availability of reliable data is a challenge while conducting a policy assessment exercise. Therefore, identification of possible data sources is a crucial step. Though energy consumption data for buildings is available at sectoral level, the buildings in India are governed by various state and local government agencies, and there is an unavailability of a central repository of relevant data on building sector.

To implement national-level initiatives, both top down and bottom up approaches are used. A top down approach, where the state-level departments will mandate the ECBC on the recommendations provided by the central ministry, is more predominant in the ECBC implementation. However, for baseline estimation and scenario building exercise (ex-ante and ex-post), a bottom up approach or a hybrid approach (a combination of top down and bottom up) can be followed. This implies that the data as per the identified parameters would flow from urban departments to state designated agencies that would then report them to the central nodal agencies. For the assessment of baseline scenario, data (Table 7) for the key parameters must be collected/estimated to calculate emissions from various building components identified in the ECBC-GHG impacts assessment matrix.

The ECBC classifies a building or part of a building with commercial use and derives energy-efficiency requirements after analysing 16 different non-residential building typologies that are enlisted as part of the code. The data collection exercise can be carried out at disaggregated level in a state depending on the availability of data as per the ECBC building classification; for example, for hospitals, hotels, educational buildings, retail outlets, and places of worship. However, in the case of unavailability of disaggregated data, the average values of the parameters, representative of large commercial buildings, can be considered. In this report, large commercial building types (hotels, hospitals, retail outlets and places of worship) are referred to as 'subsectors'.

In addition to data availability, accuracy and consistency of the available data are other big challenges. In such cases, it is recommended that reasonable assessment be made of required data through literature review and expert consultation process.

4.3. Proposed Methodology for Baseline Emissions Calculation

The baseline represents the BAU emissions scenario prior to the implementation of the ECBC in the state under consideration. In terms of fuel usage, large commercial buildings sector's energy demand in India is mainly for electricity. Some large commercial buildings such as hotels and hospitals require heat energy as well which is generated mostly through gas or electricity. Therefore, only electricity has been considered in this report, and also because data on other fuel use are not available.

Table 7 Data requirements for estimating baseline emissions

Parameter	Remarks
i. Annual energy consumption by commercial building sub-sector (kWh)	Can be calculated from (ii) and (iii) based on data availability using aggregated or disaggregated approach as defined in Section 4.3
ii. Energy performance index (kWh/m^2/year)	Energy used per unit area in a year for each sub-sector (disaggregated approach) or average for all sub sectors (aggregated approach) in the commercial buildings sector
iii. Total built-up area added each year (m^2)	Total built-up area constructed in each sub sector (disaggregated approach) or total built-up area of all sub sectors (aggregated approach), which falls under the state ECBC criterion should be only considered
iv. Annual average grid emissions factor in a year	The weighted average emissions factor of the grid released and updated every year by the Central Electricity Authority could be used. For better precision, grid emissions factor for the state could also be considered (if available with the state electricity regulatory authority)

The baseline emissions of the large commercial buildings sector for a year can be calculated using the data on electricity consumption, energy intensity of the buildings, built-up area of the buildings in the sector, and grid emissions factor for that year.

The baseline emissions from the existing large commercial buildings in year *t* can thus be calculated using the following equations to establish the baseline or the BAU scenario:

$$GHG_{BAU(t)} = EC_{(t)} \times EF_{Grid(t)} \qquad ...(1)$$

where

$GHG_{BAU(t)}$ = GHG emissions in year *t* for the BAU scenario (tonnes CO_2e)

$EC_{(t)}$ = Total energy consumption of the large commercial buildings sector for year *t* (MWh)

EF_{Grid} = Grid emission factor for year *t* (tonnes CO_2e/MWh)

t = 0 to *n*; where *t* = 0 represents base year (the date of the ECBC notification in the state energy intensity of the buildings, which is usually defined as energy use per unit of floor area; kWh/m^2, is calculated on an annual basis, and is thus the average annual specific energy use per m^2. It is also referred to as energy performance index (EPI), calculated on an annual basis and used here in the equations).

The $EC_{(t)}$ can be calculated either at disaggregated level or at aggregated level depending on the availability of the data as follows:

- **Disaggregated data approach**: In the case of availability of subsector-wise data within large commercial building sector, the $EC_{(t)}$ can be calculated using the following equation:

$$EC_{(t)} = \{(EPI_{Avg\ Type\ 1} \times BUA_{Type\ 1(t)}) + (EPI_{Avg\ Type\ 2} \times BUA_{Type\ 2(t)} + ... + (EPI_{Avg\ Type\ n} \times BUA_{Type\ n(t)})\} / 1000 \qquad ...2(i)$$

where,

$EPI_{Avg\ Type\ 1}$ = Average energy performance index (energy used per unit area measured as kWh/m^2) in the base year for building sub-sector (type 1) within large commercial building sector.

Type 1 and Type 2 are the building subsectors, for example, offices, hospitals, hotels, educational buildings, retail, and places of worship, etc., as per the ECBC. EPI also changes each year even without the ECBC due to autonomous energy-efficiency improvements, but it has been neglected here.

$BUA_{Type\ 1(t)}$ = Total built-up area of building sub-sector (Type 1) within large commercial building sector in year t

Aggregated data approach: In the case of the absence of disaggregated data at the level of building sub-sectors (i.e. hotels, hospitals, retail outlets and places of worships), $EC_{(t)}$ can be calculated using the following equation:

$$EC_t = (EPI_{Avg} \times BUA_t)/1000 \qquad ...2(ii)$$

where

EPI_{Avg} = Average energy performance index [energy used per unit area measured as kWh/m^2 in the base year (*t* = 0)] for all the sub-sectors or building types within the large commercial building sector

BUA_t = Total built-up area of all the buildings constructed in the large commercial building sector in year *t*

Illustration 1: Estimating baseline emissions using aggregated approach

Equation 1 and Equations 2(i) and 2(ii) are customized as per the data available in the commercial buildings sector in India. The proposed methodology does not cover the GHG emissions of various fuels as the energy demand in the buildings sector is primarily from electricity.

As per the Alliance for an Energy Efficient Economy (AEEE) study, it was found that as of 2017, the commercial buildings segments, namely hotels, hospitals, offices, retail, educational buildings and places of worship account for a total of 1400 million m^2. Together, they consume approximately 71 billion units of electricity, annually. The study estimates that there is a 25–28% energy-saving potential.

Therefore, as per Equation 1, the GHG emissions of the commercial buildings sector in 2017 were:

(Note: 71 billion units = 71 billion kWh = 71,000,000 MWh)

= 71,000,000 MWh × 0.82 tonnes CO_2e/MWh (Weighted average emissions factor of Indian grid) for FY 2017/18*

= 58,220,000 tonnes CO_2e

Further, the commercial sector floor area is expected to grow around 1.5–2 times in the next decade, and 2.5–3 times by 2037–38#

Hence, the total baseline GHG emissions in 2030 will be [as per Equation 2(ii)]:

= 71,000,000 MWh × 0.82 tCO_2e/MWh ×1.5

= 87,330,000 tCO_2e

Note: It can be observed that EPI has been considered constant at 2017 level in this case.

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* CO_2 baseline database for the Indian Power Sector, User Guide (version 14.0), December 2018, published by Central Electricity Authority, Ministry of Power, Government of India. Details available at http://cea.nic.in/reports/others/thermal/tpece/cdm_co2/user_guide_ver14.pdf

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5. Estimating GHG Emissions Impact (Ex-ante and Ex-post Scenarios)

This chapter describes the GHG impacts of the Energy Conservation Building Code (ECBC) as a policy till date (ex-post scenario) and its mitigation potential in the future (ex-ante). The impact of the policy can be estimated against the sectoral targets for emissions reduction or against the baseline emissions. The equations used for baseline emissions calculation (Equation 1 and Equation 2) can be used to calculate ex-post emissions as well as create ex-ante emissions scenarios.

The assessment of the ECBC will be collated on a national level but its implementation is carried out by states and the states are responsible for amending the code into state laws. Further, the urban development departments in the states are responsible for amending the Town and Country Planning (TCP) rules and regulations, and the building bylaws to incorporate the ECBC provisions. The implementation date of the code varies from state to state depending on the amendment of the bylaws and the year of notification by a state, which is independent of the year of release (2007) of the code.

The ECBC implementation will be carried out state wise, using the state-specific data assessment and calculations, which would be collated for carrying out a national-level assessment. The date of notification of the code in a state is treated as the 'base year' for the state and the data recorded from the base year onwards will be used for the ex-post assessment of that state. It should be noted that the GHG assessment for a state is contingent on the data reported by the designated authorities in the state, which is feasible only in the case of states that have made necessary bylaws and notified the ECBC code.

5.1 Estimating Ex-ante GHG Impact

The ex-ante GHG impact is the representation of probable course of emissions trends resulting from the ECBC implementation within the assessment boundary. The impact of the ECBC on commercial buildings can be obtained from research studies on sample buildings including through actual monitored building energy performance data of sample buildings within the assessment boundary (as described in the sample calculations). The samples are the buildings rated as green buildings in the country. The data on the required parameters (EPI and built-up area) can be collected from institutions such as GRIHA, IGBC for the rated commercial green buildings constructed in the country to carry out an ex-ante analysis. Though eventually, the analysis will need to be carried out at the state level, the availability of state-wise data can be a challenge.

As highlighted in Section 3, the relevant estimation parameters for estimating ex-ante GHG impacts of the ECBC are as follows:

- Total energy consumption of the subsector (MWh), which can be derived from:
  - i. Energy Performance Index (energy used per unit area, measured as kWh/m^2 in a given year) for the commercial buildings subsector
  - ii. Total built-up area in the base year and the area added each year (m^2)
- Weighted average emissions factor for Indian grid in a year as calculated by the Central Electricity Authority (tonnes CO_2e/MWh)

As per the ICAT Building Efficiency Guidance, the general approach is to first estimate the expected effect of the policy on each parameter, and then account for the barriers to obtain final parameter values, and finally convert this into the actual GHG impact of the policy.

The following step-wise approach may be adopted for assessing the GHG impacts in the ex-ante scenario:

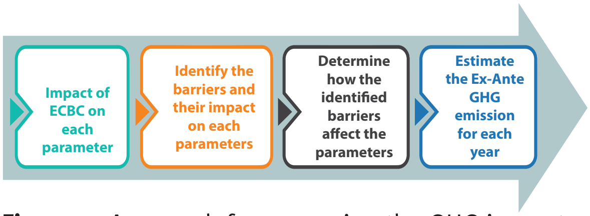

Figure 3: Approach for assessing the GHG impacts in ex-ante scenario

Step 1: Impact of ECBC on estimation parameters

Table 8 provides a summary of the likely impacts of the ECBC implementation on the GHG emissions assessment parameters along with the relative magnitude of the expected impacts.

Table 8 Impact of ECBC on identified estimation parameters

Estimation parameter	Impact likelihood	Impact magnitude
Energy Performance Index (EPI)	Very likely (code-compliant buildings will have less energy intensity)	Major
Grid emissions factor	Unlikely (not related to building code)	Minor
Built-up area complying with ECBC	Very likely (mandatory compliance for large commercial buildings). Institutions may not have adequate capacity	Major

It can be seen from Table 8 that two key parameters, i.e. EPI and the total built-up area are most likely to be impacted by the ECBC and will have the maximum effect on emissions mitigation.

Step 2: Identify the barriers and their impact on estimation parameters

There are several barriers such as financial barriers, institutional and administrative barriers, market barriers, lack of skilled personnel, technology barriers, etc., that may attenuate the potential for energy savings and corresponding GHG emissions reduction under the ECBC. Table 9 highlights some of these barriers, their likelihood, and relative magnitude of impact on estimation parameters.

Step 3: Determining how the identified barriers affect estimation parameters

Based on the likelihood and relative magnitude of each barrier, their effect on estimation parameters must be estimated. It can be difficult to quantify but estimates can indicate the impact of a barrier on an estimation parameter within a range. For example, the outcome after accounting for barriers may indicate that, under some assumptions, an identified barrier may have been responsible for reduction in the number of ECBC-compliant buildings by 3% to 6% for each year of the assessment period.

Step 4: Estimating ex-ante GHG emissions

The ex-ante GHG emissions can be calculated using the values of the estimation parameters obtained after barrier analysis. The ex-ante emissions for each year of the assessment period can be obtained using Equation 1 and Equation 2.

5.2 Ex-post GHG Impact

Ex-post assessment is useful to find the impact of any policy implementation during or after the completion of the implementation period. The assessment is usually aimed to find out whether the policy is able to achieve the intended outcomes or not, and can be used to decide if the policy should be continued or modified to achieve the policy targets. The impact of the policy is

Table 9 Examples of accounting the impact of barriers

Estimation parameter	Barrier	Likelihood	Relative magnitude	Overlap with other barriers and support policies
Additional ECBC-compliant commercial buildings (built-up area) constructed	Lack of skilled professionals for ECBC implementation	Likely	High	1. Capacity development trainings 2. Empanelment of expert professionals
Average energy performance index for ECBC-compliant buildings	High cost of new and energy- efficient equipment	Very likely	High	1. Promotion of new technologies 2. LED distribution programmes 3. Government bulk purchase programmes

usually assessed by comparing the observed data with the target set under the policy, or with the data from an ex-ante assessment.

Ex-post assessment in this case is a backward-looking analysis of policy implementation to assess the GHG impact of policy till date. In the case of ECBC implementation in India, enforcement is still very weak. Even in states where the ECBC has been incorporated in the state bylaws and code notified, the data is not reported yet so that its impact can be assessed. Therefore, an assessment of the impact of the ECBC implementation is difficult to carry out for such states.

However, to carry the ex-post impact assessment of the ECBC during its implementation, the following steps can be used:

Step 1: Defining the scope of assessment

The scope of assessment can be defined as per the requirement but since the purpose is to compare the ex-post emissions with a target, or baseline scenario, or an ex-ante assessment, the scope and boundary can be same for these assessments (refer to Table 5).

Step 2: Estimation of ex-post emissions from the policy

The ex-post assessment of GHG emissions from the policy (ECBC in this case) is obtained as follows:

(i) Collect the data on recorded values of the estimation parameters for the years for which ex-post assessment is to be done

(ii) Use Equation 2 to calculate the actual emissions for these years

The MRV framework includes provision for collection of data on estimation parameters on a continuous basis.

The availability of data in case of the ex-post assessment would be crucial to determine the impact of the policy implemented. The framework for the data collection, clearly defining the roles and responsibilities of the various stakeholders involved, would need to be brought out. The absence of the data does not allow a proper evaluation of the policy and its impact.

Step 3: Update baseline and impact calculation

Ex-post emissions can be compared with baseline emissions to find out the impact of the policy on emissions. This would give the actual impact of the policy on emissions. Baseline may, however, need to be updated every time an ex-post assessment is done to account for the impact of other policies that may have been introduced after the baseline was assessed. The difference between ex-post emissions and baseline emissions is indicative of the impact of the policy on emissions.

Step 4: Comparison of ex-post emissions with ex-ante emissions

The purpose is to determine if the impact of policy is in line with the expectations reflected in the ex-ante emissions. Similar to the reason of updating baseline, ex-ante assessment may also need to be updated to account for other policies introduced during the implementation of the policy (ECBC in this case). The difference between ex-post emissions and ex-ante emissions is indicative of the net GHG impact of the policy.

It is to be noted that baseline as well as ex-ante assessment need to be updated every time an ex-post assessment is done with adjustments to reflect the changes in any assumptions related to the policy scenario, or any development in equipment efficiency, which is not sufficiently captured in the baseline or ex-ante baseline.

6. Monitoring Plan for MRV System

There is a need to scale up the implementation of the Energy Conservation Building Code (ECBC) to benefit from the potential savings associated with the use of the code for commercial buildings and to calculate resultant GHG-emissions reduction. Collating all relevant data for evaluating the state-wise impact of the ECBC consistently is a major challenge. Due to insufficient data in the country, an effective MRV framework cannot be created. In order to make the framework robust, it is imperative that the various stakeholders involved in the implementation of the code are in close coordination with each other and have clarity on their roles and responsibilities. Considering the scope of MRV is mainly from the perspective of climate change mitigation actions, it is important that the institution responsible for this should have the necessary expertise and experience to enhance data collection. Based on stakeholder consultations, the reporting mechanism and institutional framework for the ECBC are proposed in the subsequent section.

6.1. Proposed Data Collection Mechanism for MRV

Table 10 highlights the proposed data collection mechanism for the key parameters required for assessing GHG impact. It also suggests roles and responsibilities of different entities at the state and national levels for supporting data collection. Notably, as data availability has been a challenge till now in the country, the table does not list out current sources of data presuming that documentation is yet to occur. The table only suggests likely sources for data collection in accordance with the Energy Conservation Building Code Rules, 2018.

Considering the Rules, 2018 and lessons drawn from the cases of Andhra Pradesh, Karnataka, and Maharashtra, which are amongst the first few states to adopt a mandatory implementation of the ECBC, an MRV framework is proposed to facilitate data collection. This framework was discussed in

Table 10 Proposed data collection mechanism and roles and responsibilities

S. No.	Data parameter	Reported to	Reported by	Responsibility of the reporter
1	Built-up area	Urban local bodies (ULBs)	Empanelled energy auditor (EEA)	The EEA will conduct on-site audits to calculate the EPI from the data gathered from building owners. The EEA would issue the ECBC Compliance Certificate on provision of relevant compliance documents by building owners.
2	Sub-sector-wise energy performance index (kWh/m^2 for the year) and built-up area	State designated agency (SDA)	Empanelled energy auditor (EEA)	Developers or building owners would submit compliance documents to EEA (empanelled by BEE) for verification of code compliance
3	Total energy consumption of the commercial building sector for year *t* (MWh)	Bureau of Energy Efficiency (BEE), Ministry of Power	State designated agency (SDA)	All SDAs will report state-specific data on total commercial building energy consumption (verified by EEAs)
4	Weighted average emissions factor for Indian grid in a year (tonnes CO_2e/MWh)	Ministry of Power (MoP)	Central Electricity Authority (CEA)	CEA will provide weighted average emissions factor as calculated and revised every year

a stakeholder consultation for validation and to gather feedback on the overall approach.

6.2. Proposed Institutional Structure for Data Collection and MRV

It is imperative that the national and sub-national agencies work in close coordination to eliminate policy implementation barriers. It is, therefore, suggested that implementation committees at both national and subnational levels be constituted, which shall serve the purpose of monitoring the process and verifying the reported data. These committees shall be constituted by the BEE at the national level, and by SDAs at the sub-national levels. The committees will comprise senior administrative officials from both the state and the central departments, and other relevant stakeholders such as the Bureau of Indian Standards, Public Works Departments, among others. The constitution of a formal accountability structure would ease the flow of data and strengthen synchronization between various agencies responsible for data collection and reporting. The state ECBC implementation committee would undertake the annual review of the EEAs in each state, and monitor and verify the submitted energy consumption data by the building owners. The suggested mechanism would require capacitating the agencies with skilled professionals who could assess, monitor, and verify the data at different levels.

However, in the stakeholder consultation, it was suggested that the empanelled energy auditors collect, maintain, and report the data on a centralized IT portal which can be further verified by SDAs or the BEE any time on either a sampling or through a grievance redressal basis. It was also informed that the BEE is working on a prototype of an online platform for ECBC implementation and compliance assessment, and a process for energy auditors (building) for certification and assessment of ECBC-compliant buildings. The stakeholders in a shared vision proposed that this can be leveraged from an integrated MRV mechanism in the states.

Based on suggestions from various stakeholders, an integrated institutional structure is proposed for data collection and MRV (Figure 4).

The Third Party Assessors (TPAs) can be appointed by the SDAs for verification and compliance assessment of the ECBC buildings. The TPA can record the building-level data as per the identified parameters for GHG assessment. The SDAs would manage the appointment of TPAs, ensure quality checks, and maintain transparency in the framework. The BEE would conduct the examination for accreditation of TPA [energy auditors (buildings)] and maintain a list of all the accredited energy auditors (buildings), similar to PAT scheme in the industry sector. The SDAs may also be able to assess the efforts of TPAs and report these to the BEE in case of an identified issue.

The proposed data collection mechanism and institutional framework for MRV are intended to overcome the barrier of data unavailability at the central level. The proposed MRV mechanism will run on transparent and verifiable framework for collecting and reporting data.

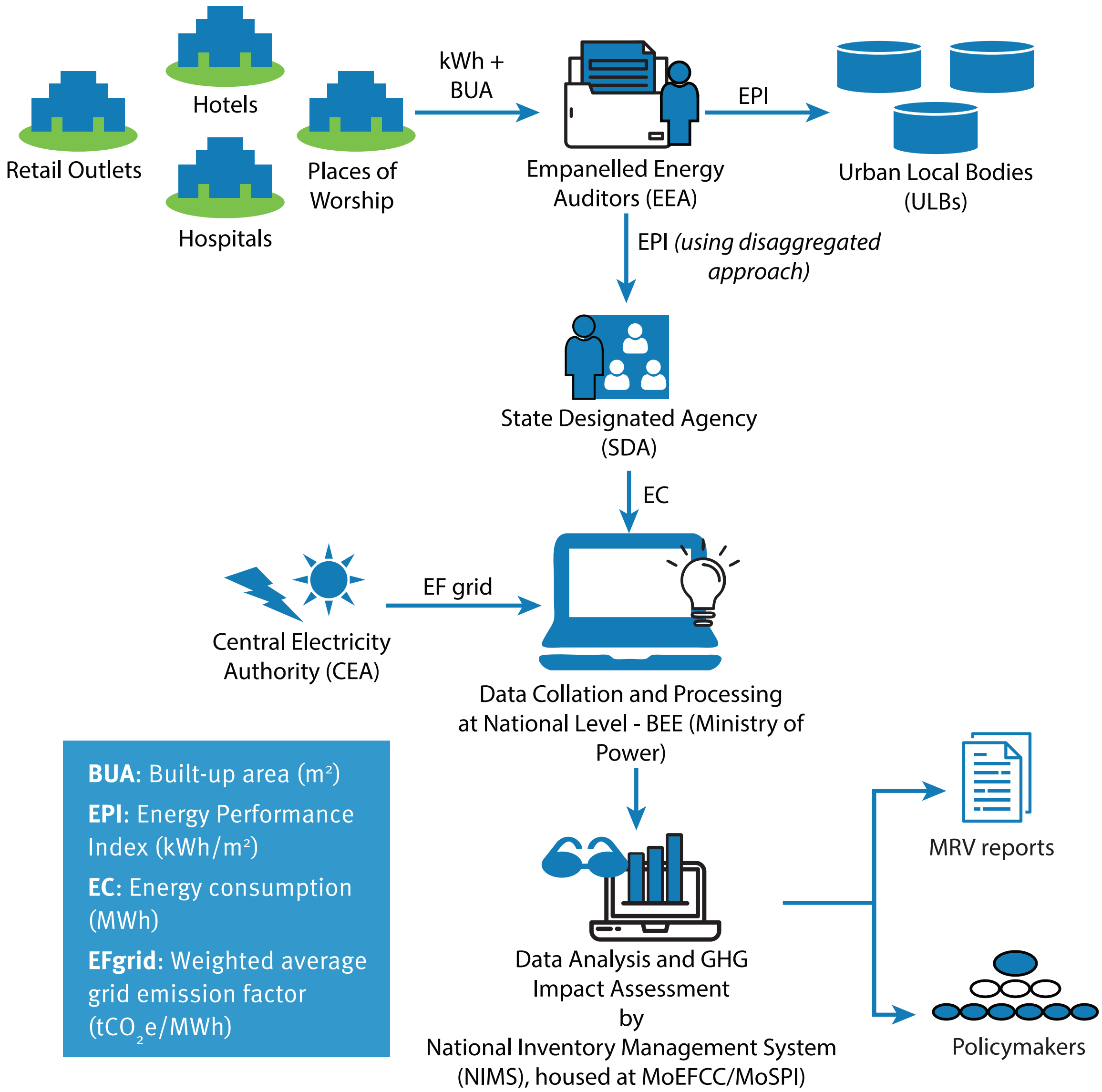

Figure 4: Proposed institutional structure for data collection and MRV

Annexure 1: List of Policies in the Building Sector

Programme/ policy	Stated objective	Impact or potential (Direct/indirect)	Applicability/Sectors covered	Starting year/ baseline	Implementation entity
Energy Conservation and Building Code (ECBC 2017)[3]	To promote energy efficiency in the buildings sector	Indirect as they are related to minimizing the energy consumption from the buildings through introduction of passive and energy-efficient measures	Applicable to only commercial buildings on voluntary basis. The minimum load requirement for a building to be ECBC compliant is 100 kW or 120 kVA. It is applicable to all new constructions and retrofitted buildings or parts of buildings having defined load with no difference in the compliance approach	2007	BEE responsible for developing the code, State Designated Agencies (SDAs) for regulating the code and Urban Local Bodies (ULBs) for checking the compliance to the code
Standards and Labelling Programme [4]	Promoting energy efficiency to provide the consumer an informed choice about the energy-saving and thereby the cost-saving potential of the marketed household and other equipment	Indirect as it is linked with appliance energy efficiency	The programme covers appliances such as room air conditioners, frost free and direct cool refrigerators, tubular fluorescent lamps, distribution transformers, colour televisions, and electric geysers on mandatory basis and induction motors, pump sets, ceiling fans, LPG-stoves, washing machines, laptops, office equipment on voluntary basis	2006	BEE for developing the policy, private industries for complying with the requirement of policy, Change it to Department for Promotion of Industry and Internal Trade (DPIIT) for checking the compliance to the policy framework
BEE star-rated buildings[5]	To create programmes that make commercial buildings energy-efficient	Indirect as it is related to energy consumption reduction from the building	The BEE has a star rating programme called the BEE Buildings Star Rating System based on the actual performance of a building in terms of its specific energy usage in kWh/m²/year. The programme rates existing buildings (office buildings, shopping malls, hotels, hospitals, and IT parks) on a one- to five-star scale, with five stars being the most efficient	2009	BEE developing and regulating the code. Third-party BEE certified auditor and evaluator are responsible for checking the compliance to the scheme.

[3] Details available at https://beeindia.gov.in/sites/default/files/tender_document/BEE_ECBC%202017.pdf
[4] Details available at https://beeindia.gov.in/content/standards-labeling
[5] Details available at https://beeindia.gov.in/content/existing-building

Programme/ policy	Stated objective	Impact or potential (Direct/indirect)	Applicability/Sectors covered	Starting year/ baseline	Implementation entity
Bachat Lamp Yojana (BLY)[6]	The programme aims at promoting energy-efficient artificial lighting system	Indirect as it is related to reducing the energy consumption from artificial lighting system by providing energy-efficient luminaires	Under the programme, a working incandescent bulb is exchanged with a CFL by the distribution company. The scheme is registered as Clean Development Mechanism Programme of Activities (CDM POA)	2009	BEE is responsible for regulatory framework
National Programme for LED-based Home and Street Lighting[7]	The programme aims at promoting energy-efficient artificial lighting system	Indirect as it is related to reducing the energy consumption from artificial lighting system by providing energy-efficient luminaires	Under the national programme, LED bulbs are being distributed in a phased manner from March 2015 onwards. The entire project of installing LED bulbs for domestic and street lighting in 100 cities was targeted for completion by March 2016. However, the high cost of LEDs and inadequate information of their comparative advantages have limited their demand	2015	BEE for regulating scheme
Green Rating for Integrated Habitat Assessment (GRIHA)[8]	The rating system aims at enhancing resource efficiency in the buildings sector	Indirect as it aims at bringing resource and energy efficiency in a building by minimizing its consumption and enhancing energy efficiency	GRIHA is the national rating system for green building design, developed and implemented by The Energy and Resources Institute (TERI) and the Ministry of New and Renewable Energy (MNRE). All new central government and public sector buildings are to comply with the requirements of at least three-star GRIHA ratings	2005	The GRIHA Council is responsible for developing, regulating and checking the compliance to the code
(LEED) India[9]	The rating system aims at enhancing resource efficiency in the buildings sector	Indirect as it aims at bringing resource and energy efficiency in a building by minimizing its consumption and enhancing energy efficiency	LEED India is the localized version of the international rating system and is administered by the Indian Green Building Council (IGBC)		IGBC is responsible for developing, regulating and checking the compliance to the code

6 Details available at https://beeindia.gov.in/content/bachat-lamp-yojana-bly-0
7 Details available at https://medium.com/@virilesarkariniti/prakash-path-way-to-light-the-national-led-program-ff50e4c400b4
8 Details available at http://grihaindia.org/
9 Details available at https://igbc.in/igbc/redirectHtml.htm?redVal=showLeednosign

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