Delineating the Implementation of Residential Building Energy Codes in India

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ABSTRACT

Climate change is impacting people's lives globally, and the rising energy demand and linked Green House Gas (GHG) emissions are critical concerns that pose significant risks to developing countries like India. The Government of India is taking various initiatives to reduce carbon emissions and its economy's energy intensity. As per the 2017 statistics, buildings consumed approximately 33% of the total electricity consumed in the country. India is expected to grow its residential floor area from 15.3 billion sq. m in 2017-18 to 21.9 billion sq. m by 2027 to accommodate the urbanization rate. The Bureau of Energy Efficiency (BEE) developed the building energy codes assessing the energy conservation potential in the building sector. Several initiatives have been taken to strategize, streamline and ease the implementation process, but bleak compliance is observed.

This paper will supplement the government's efforts by providing operational guidance to states for ENS implementation and highlight the need for a framework that would act as a guiding document for the code implementation by the urban local bodies. Focusing on the Eco-Niwas Samhita (ENS, Energy Conservation Code for residential buildings), the paper discusses the foreseen challenges in the ENS implementation. Based on literature studies and stakeholder consultations, the paper suggests feasible models for enforcement, applicability, compliance, and verification processes.

INTRODUCTION

Climate change poses a significant risk to developing countries like India, prone to irreversible impacts with frequent heatwaves, unpredictable rainfall events, and allied calamities (IPCC 2021). The escalating levels of GHG in the atmosphere causing rapid climate change has baffled the scientists and policymakers to think over remedial measures and associated mandates, policies and guidelines. Several countries had pledged to work collaboratively toward the common sustainability goals, which were strengthened in 2015 when 126 countries signed the Paris Agreement to limit global warming below 2˚C compared to pre-industrial levels by the end of the century (Huang and Zhai 2021).

The augmenting rate of urbanization reinforces the need for a proportional increase in demand for housing, infrastructure, and electricity, attributing to 71-76% of CO_2 emissions from the final energy use globally (UN Habitat n.d.), which is a significant contributor to climate change. With an urbanization rate of 31.14% (MoHUA 2019), India is excessively vulnerable due to high social and climate variability. The urbanization rate, improved access to energy supply, increasing heat stress, space cooling requirement, enhanced comfort aspirations and buying capacity of energy-intensive appliances act as a catalyst to the indirect emission caused by the building sector. It is established that amongst all sectors, the housing sector, including the household cooling appliances, is a significant GHG contributor to the atmosphere, warranting urgent measures to minimize its emission. The residential sector accounts for 24% of India's

electricity consumption (MoSPI 2019). The consumption has increased at a Compound Annual Growth Rate (CAGR) of 7.58% between 2008-09 to 2017-18 (Walia, et al. 2020), and this intensifying energy demand in the residential sector is a concern for India. It is imperative to enhance energy efficiency measures to minimize the emission of GHG from the booming building industry, predominantly the residential sector.

Conventionally, the vernacular architecture of the Indian subcontinent stands on the principles of climate-responsive design, incorporating features of passive cooling and ventilation strategies to enhance the indoor environment with little reliance on active cooling solutions (Satheesan 2017). In the current built stock, the construction practices are trending towards energy-intensive, active design strategies for heating and cooling buildings (Satheesan 2017). The knowledge of climate-appropriate design is diminishing from industry practice, with reduced sensitivity towards local climate and site features, poor design and material choices resulting in compromised occupant comfort. The focus on the construction of time and cost-effective mass housing has led to the use of alternative construction materials and technologies, compromising residents' comfort. India is predominantly tropical with enormous potential for natural and mixed-mode ventilation (Satheesan 2017). With a lock-in period of 50 to 60 years, the mushrooming growth of inefficient residential building stock will require more operational energy leading to higher power generation, which is capital and resource-intensive (Kneifel 2010). If the new generation residential buildings are not energy efficient, retrofitting them later may not be sustainable and economical. Adopting passive design and cooling measures can substantially enhance the thermal comfort of buildings in most of India's climate types and reduce or mitigate the dependency on mechanical cooling systems. Assiduous efforts are required to develop energy-efficiency strategies to limit energy consumption.

BACKGROUND

Taking cognizance to exploit the massive energy conservation potential in the new buildings, the Bureau of Energy Efficiency (BEE) developed building energy codes to mainstream energy efficiency in the building sector (commercial and residential) by setting minimum efficiency standards (BEE 2007, 2018). BEE is a statutory body under the Ministry of Power (MoP) that was constituted in 2002, under the Energy Conservation (EC) Act of 2001, with a mission to assist in strategizing and policy development to subside the energy intensity of the Indian economy. In 2018, BEE launched the Residential Energy Conservation Building Code, named Eco Niwas Samhita (ENS), to enhance thermal comfort and reduce the energy consumption of the residential sector. Prior to ENS, Energy Conservation Building Code (ECBC) was developed for the commercial buildings by BEE in 2007 and further updated in 2017. More than a decade's insight into the ECBC implementation process is critical learning that can benefit in strategizing an action plan for ENS implementation at the sub-national level. Feasible models, frameworks and mechanisms for code adoption, compliance and enforcement in the country are essential in operationalizing the code's implementation.

OBJECTIVE AND METHODOLOGY

The paper intends to submit suggestive ENS adoption, compliance, and enforcement models. These recommendations are built upon the findings from the literature review, study of the building approval process, industry expertise, and stakeholder consultations.

Consultations of experts working in different capacities at the National, sub-national, local government, and industry professionals helped identify on-ground challenges in ENS implementation. These consultations formed the basis for developing, checking feasibility and thoroughness, and verifying the proposed models' potential. The limitation of the paper lies in the fact that the suggestions and recommendations are at a high level. Ground-level feasibility is subjective to state and local level situation, administration, regulations and practicality of implementation.

ECO-NIWAS SAMHITA

The Residential Energy Conservation Building Code, or ENS, has been developed in two phases which apply to new "Residential buildings" and "Residential part of Mixed-land use building projects" with plot area $\geq 500m^2$ (BEE 2018a). Part 1 of the code sets minimum standards for building envelope design which can assist in achieving thermal comfort to occupants and a minimum energy saving of 20% compared to conventional. It suggests that the Residential Envelope Transmittance Value (RETV) for the building envelope (except the roof) for four climate zones, namely, Composite Climate, Hot-Dry Climate, Warm-Humid Climate, and Temperate Climate, shall comply with the maximum RETV of 12 W/m^2. ENS can potentially mitigate a mammoth 125 Billion Units of electricity per year by 2030 (BEE 2018b). Part 2 of the code sets minimum standards for electro-mechanical and renewable energy systems like lighting, elevators, comfort systems, solar water heating, and solar photovoltaic.

The India Cooling Action Plan recommend compliance to ENS to reduce the peak and annual cooling demand by enhancing thermal comfort in residential buildings and reducing the dependency on space cooling appliances and penetration of room air conditioners in the Indian household (MoEF&CC 2019). The energy-efficient homes can significantly reduce the overall energy demand and stress to the grid, indirectly targeting the carbon emitted for production and electricity supply.

To ensure uptake of the code, the BEE took a multipronged approach enabling the state administration and the construction market. Mitigating the administrative and technical gaps in the industry and market preparedness are essential to limiting the ENS timeline for practical implementation in the country. In comparison, it took more than a decade to see the first few remarkable milestones in the implementation of ECBC owing to a lack of industry awareness, capacity and expertise and a well-defined statutory and administrative framework which left the stakeholders in apprehension about the code's implementation. Taking learnings from ECBC implementation, BEE has taken a few initiatives to support and supplement the efforts in the country. Table 1 summarizes the recent initiatives by BEE to streamline ENS adoption by the states of India. All these initiatives have a common goal: to fast-track the implementation process of ENS. However, it is difficult to observe the success or effectiveness of these initiatives due to the lack of monitoring parameters.

Table 1: Initiative to support ENS implementation

Initiatives and Schemes	Status	Description

Exclusive website for ENS (BEE, 2017a)	Website running successfully	It aims to provide insightful information about the code and associated initiatives, publications, events and news. The website acts as a knowledge exchange platform and a comprehensive collection of all other initiatives.
ENS Online analytical and compliance Tools (BEE, 2017b)	Trial versions of the tools are launched on the ENS website	A desktop-based utility aimed at helping consumers and professionals of the industry examine the project's design energy performance based on the minimum standards set by both parts of ENS. The versions can be found here: https://www.econiwas.com/tools.php.
Buildings Cell in each State & Union Territory	Buildings cells are currently functioning in all the states and union territories.	BEE supported the state's capacity to understand, comprehend and disseminate the technical and administrative requirements of the building energy codes at the state and urban local body levels. These cells ensure coordination between relevant state departments (State Designated Agency (SDA), Urban Development Department (UDD), Public Works Department (PWD)) and support the amendment of the code as per the state's requirement, assist in the integration of code and it is compliance mechanism in the building approval process and enable authorities in the enforcement of the code.
Amendment in the Energy Conservation Act, 2001	Awaiting cabinet approval	The MoP has proposed amendments to the Energy Conservation Act, 2001 (EC Act) to provide statutory backing to the ENS. The amendment is proposed to be enacted to provide the much-needed legal framework and institutional arrangement for embarking on an energy efficiency drive for the residential buildings.
Star Label for Energy Efficiency Homes (BEE 2021)	The scheme has been launched; however, yet to be adopted by the states.	The scheme provides a benchmark to compare the Energy Performance Index (EPI), i.e. the annual energy consumption per square meter of the built-up area parameter of residential buildings in India. The objective is to make energy efficiency an essential parameter for users while deciding the home price in the future.
Energy Efficient Building Materials Directory and Material selection tool (BEE 2021)	The Beta version has been launched.	The tool is an online web-based utility that helps with digital data gathering and aims to eventually lead to the establishment of building material standards & labels. The directory consists of energy-efficient building materials with technical specifications, manufacturer details and applications. https://www.econiwas.com/materialdirectorypublicportal/public/index.php/tool

Handbook for Replicable Design for Energy Efficient Residential Buildings (BEE 2021)	The book is published and available on a public forum	A compendium launched by the Bureau to provide ready-to-use designs for constructing energy-efficient homes in India. The compendium intends to improve designers' and builders' knowledge by providing 35 type designs for urban areas representing all climate, housing sizes, and dwelling unit types.
Training and Capacity Building (BEE 2021)	Webinars are being conducted along with the provision of tutorial reports and presentations.	BEE targets to train over 7,500 architects, engineers and government officials. Further, BEE has also launched a Refresher Course for Master Trainers prepared by National Productivity Council, which covers topics like renewable energy, smart grid, smart cities, ISO 50001 (2018 version), measurement & verification, carbon footprint, and energy-efficient buildings.

BUILDING ENERGY CODE IMPLEMENTATION PROCESS IN INDIA

The section discusses the building code implementation process identified from the study of ECBC in the country. The different stages, hierarchies, and processes have been identified and mapped against the stakeholders involved in the implementation process's various stages. The implementation process requires code formulation, adoption, compliance, enforcement, monitoring and revision.

(a) The building energy code formulation is essentially the responsibility of the Bureau of Energy Efficiency at the National level. This involves a preliminary assessment of the present scenario, identification of the problem areas, solutions to mitigate or reduce the dependency on energy, and impact of the envisaged code. Code development is a multi-stakeholder process involving different line ministries, departments, organizations, academics, and institutes.

(b) The most vital phases in the implementation process are adoption, followed by enforcement. Adopting a building code is essentially the role of the state government as it is a state subject under the constitution of India (The Constitution of India 1950). The state government can amend the code without diluting its stringency to suit its climate type and administrative requirements. The notification process is after the code amendment, where the state government exercises the power of a legislative enactment. The code must be notified in the official gazette by the state government under the ambit of an existing act or law to exercise the power of a legislative enactment.

(c) Defining a compliance path is another crucial step to successfully implementing the code. The compliance rate of the code depends on factors like the applicability of the code, incentive or penalty framework, and the compliance mechanism, which is defined by the minimum requirements to be met by any building to be called code compliant. Once the code is notified, and it is legally binding for the applicable facilities to mandatorily comply with the code requirements, the building owner along with the design team incorporate the code requirements in the building design and construction, which is verified and certified by the person/department assigned as per the compliance mechanism. BEE devised ECBC Rules at

the national level to guide the states with a pre-defined compliance mechanism to amend and adopt as appropriate for the state's existing administrative structure (BEE 2018c).

(d) Verifying compliance is the next stage in the code implementation process. Compliance verification or enforcement is essential in achieving a better compliance rate. It also helps in monitoring the progress of code implementation. To enforce the code, the competent authority will ensure code compliance check, verification, and certification at different stages of construction.

(e) The compliant building in the ideal scenario should be monitored to verify the energy performance and impact of code compliance compared to conventional buildings. This can help set the benchmarking numbers for the code-compliant buildings and peer comparison. The implementing authority will establish benchmarks to gauge the implementation parameters for monitoring. Further, the administration must measure the performance indicators on all parameters to identify any deviation from the planned performance.

(f) Monitoring and periodic feedback from the industry stakeholders help identify issues and concerns that need attention and address in the code and may call for its revision, like amending the stringency of standards, specifications or conditions defined in the code. ECBC was recently amended in 2021 by BEE, post its launch in 2017, incorporating all the suggestions and recommendations from the states, industry partners and compliance difficulties highlighted by stakeholders.

For a policy to be streamlined, it is essential to designate the responsible authority for all the steps mentioned above. Bureau is yet to develop such a mechanism for ENS, which would act as a guiding document for the implementing authorities.

ADMINISTRATIVE AND INSTITUTIONAL FRAMEWORK FOR CODE IMPLEMENTATION

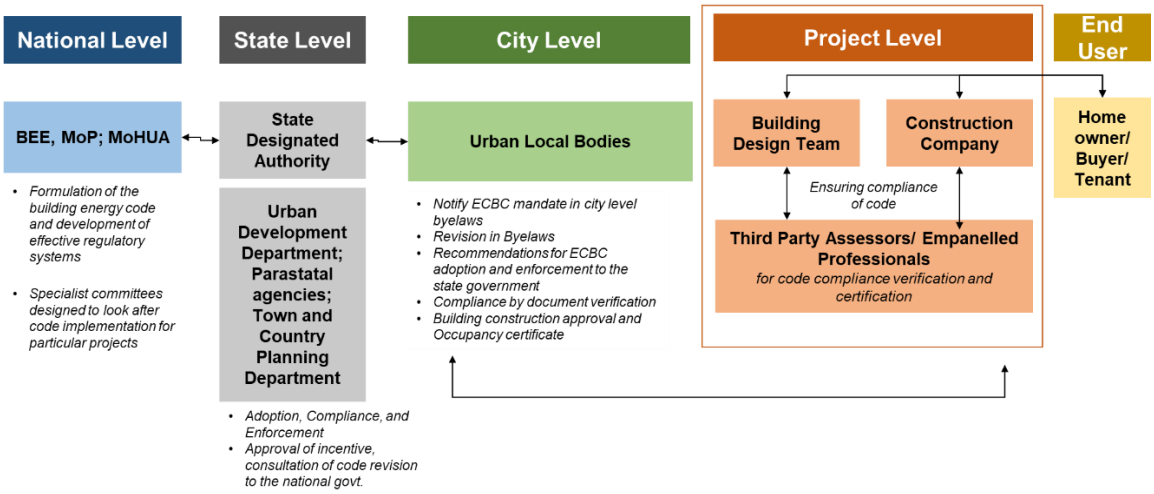

Figure 1: An overall code implementation strategy chart showcasing the different organizations/departments involved and their respective roles and responsibilities (Source: Author)

The Bureau of Energy Efficiency plays an integral part in developing, updating, and revising building energy codes. The Ministry of Housing and Urban Development (MoHUA) at the central level and Urban development (UDD), Town and Country Planning Departments

(TCPD) and Urban Local Bodies (ULB) in the states will have a significant role in the enforcement and implementation of the residential energy code. The ULB, in its jurisdiction, will ensure that all applicable buildings are identified and checked for code compliance. ULB will verify code requirements per the devised compliance mechanism before approving the commencement of construction and issuance of completion/occupancy certificate to applicable buildings. At the building level, the owner checks the applicability of the code before designing the building. The building under the code's scope must be designed per code requirements before applying for a construction permit. The code requirements should be followed through the construction of the building till ULB issues the occupancy certificate. Compliance with code requirements can be checked and verified by the ULB by developing internal capacity or through a third-party assessor or professional identified and empaneled by the state. The state has to define the roles and responsibilities of all these entities in the notified code compliance mechanism for the state.

FINDINGS OF THE STUDY: PATHWAYS FOR ENS IMPLEMENTATION

This section discusses the recommended and suggestive implementation models that the states and ULBs in India can adopt for code adoption, compliance and enforcement. These recommendations have been identified through various stakeholder consultations and their sectoral intelligence. The section highlights multiple options for each stage of implementation that can work in permutation & combinations based on the available legal tools to notify and enforce the building energy code in the state.

ADOPTION ROUTES OF ENS

The adoption process is inevitably time-consuming as significant deliberations, and consensus at the state level is required between the different ministries and departments. The consultations highlighted the imperative need to ensure minimum hindrance to ease of doing business through an easy and less intrusive code compliance mechanism. As the ENS code lacks a statutory and legal backing for its adoption, Table 2 below enlists the identified pathways for ENS adoption through the existing regulatory frameworks and the responsible bodies. The table is the list of regulatory decrees that can be used to provide statutory backing to the code. Subsequently, one or more of these decrees can be amended at the state/ local level to incorporate the code's procedural requirements. The feasibility of these recommended pathways depends on several factors like the person in charge, political willingness, and engagement of private players.

Table 2: Recommended adoption routes for ENS

Pathways	Description	Authority
Energy Conservation (EC) Act, 2001	The EC Act, 2001 provides a legal framework and institutional arrangement to embark on an energy efficiency drive in India. An amendment in the Act to include the residential buildings under its purview will ensure provision for notification, enforcement and compliance of ENS through the legal framework.	SDA; Building Energy Cells in State

Inclusion in Municipal Act (MoHUA 2019)	Municipal Acts are legislations by state governments to establish, administer, and provide a governance framework for cities within the state. ENS can be incorporated as a requirement in the Municipal Act. For example, Telangana state had included building energy codes compliance as a municipal body's responsibility.	Urban Local Bodies
A provision in Model Building Byelaws (MBBL) (TCPO 2016) and URDPFI (TCPO 2015)	Building Bye-Laws are legal tools to regulate buildings' design and construction aspects to achieve an area's orderly development. ENS implementation is not possible without its inclusion in the bye-laws. ECBC 2007 was already included in MBBL 2016, which recommended the applicants to take approval for the latest ECBC code. As the MBBL provides a guideline to develop the bye-laws, the states can use it to formulate their own. Similarly, Urban and Regional Development Plans Formulation and Implementation (URDPFI) Guidelines,1996 provided a framework for plan preparation and implementation and promoted efficient and innovative techniques for planned urban development.	UDDs of state, Town and Country Planning Departments (TCPD) of state, Urban Development Authorities (UDA).
Enforcement through Environmental Impact Assessment (EIA), 2006 (MoEF&CC 2022)	EIA, 2006, notified by the Ministry of Environment, Forest and Climate Change (MoEF&CC), is a streamlined process to evaluate a proposed project's likely environmental, social, cultural, and human health impacts. The Ministry made it mandatory to obtain Environmental Clearances for construction projects having covered built-up area (FSI + Non-FSI) greater than 20,000 sq. m. The act can be amended to ensure compliance with ECBC and ENS and enforced through the states	State Environment Impact Assessment Authority (SEIAA), State Energy Cell
Requirement in Real Estate Regulatory Authority (RERA) Act (MoHUA 2017)	The RERA Act was launched to protect buyers' interests through transparency in the real estate sector and establish an arbitrating mechanism for speedy dispute redressal. It applies to commercial buildings, residential apartments, and plots developed for sale. The registration applies for real estate projects exceeding 500 sq. meters or having more than eight apartments. Developers can ensure ENS compliance by introducing it as a mandatory requirement for RERA-registered projects.	State Real Estate Regulatory Authority
Thermal comfort and energy efficiency in Smart Cities Mission, PMAY	Lateral to the administrative adoption of the code, the concepts of thermal comfort and energy efficiency should be imbibed into the government housing schemes and made an integral part of the Smart cities and Pradhan Mantri Awas Yojana (PMAY) missions (MoHUA 2015). This will ensure that the government lead by example and has a powerful live demonstration of code compliance and its impact on energy conservation and occupant comfort.	State's and ULB's nodal agency for PMAY, Special Purpose Vehicle for Smart City

ENS COMPLIANCE

Even though the legislation adopts the code, its compliance requires industry professionals and administration awareness, training, and capacity building to eliminate the market's long-standing practices and knowledge. The stakeholder consultations determined that the compliance of ENS would require a strong buy-in from the builders, association, and other private players as they fear the added layers of the administrative and compliance processes. It is ideal for developing an elementary compliance mechanism in consultation with stakeholders to avoid chaos and market apprehension, negatively impacting code compliance in the state.

Compliance Approach.

The Bureau has defined a compliance approach in part 2 of the code launched in 2021(BEE 2021b). ENS specifies two approaches, i.e., prescriptive approach and point-based approach. The applicant can decide on one of the two compliance paths as convenient.

(a) ***Prescriptive approach:*** the building must meet all the mandatory and prescriptive requirements for compliance purposes. The prescribed approach has ease of application; designers and builders can quickly determine what they need to do to comply with prescriptive requirements and validate compliance. However, the limitation of prescriptive code is that they restrain the design flexibility.

(b) ***Point-based system:*** building design and construction meet all mandatory requirements and a minimum compliance score. The point-based system allows the applicant flexibility in compensating for the minimum energy requirements of the building components when prescriptive requirements cannot be met.

Compliance Mechanism.

The compliance mechanism can be formulated for the state by defining and detailing the roles and responsibilities of each entity involved in the compliance of ENS. The compliance mechanism can be framed as rules for ENS and notified by the state by publishing it in the official gazette, providing statutory backing to ENS implementation.

Applicability criteria of the code.

The housing sector is an enormous market, and the magnitude of applicable buildings will be humongous considering the present applicability criteria. ENS, as defined by BEE, will apply to "Residential buildings" with plot area $\geq 500m^2$ and "Residential part of Mixed-land use building projects with plot area $\geq 500m^2$. Considering this applicability criterion, ENS would hypothetically apply to 21% of number plots (Kumari, Suman and Garg, 2021). Though the applicability criteria significantly reduce the number of buildings seeking ENS certification, it would still burden the administration owing to the additional compliance check requirements. The states can amend the applicability criteria of ENS by assessing the situation of residential built stock and its administrative capacity. This section briefly lists the possible and feasible options for defining the applicability of the code in a jurisdiction based on different assessment parameters. The applicability criteria can be defined by determining the minimum (a) Built-up area or total floor space of the building, (b)The total area of the plot, and (c) the cost of the project/ construction. The states can further relook at the enforcement strategy by delineating a roadmap with, like:

(a) The states can adopt a phase-wise implementation of ENS, where specific building categories can be targeted initially, like Group housing can be focused on in the first phase as it will have a more significant impact considering the floorspace & no of units under a project and thus reducing stress on the administrative capacity (Kumari, Suman and Garg 2021).
(b) A cluster-wise adoption of ENS can be conceived where identified pockets in the cities and towns have to ensure mandatory compliance to the code with compliance check and verification in the first phase and self-declaration by others and gradually scaling up the model for compliance check and verification.
(c) The government can become the flagbearer of taking such initiative forward and induce acceptance in the market. As the market and the administrative frameworks prepare for the adoption, compliance and enforcement of ENS, the government can demonstrate the benefits of the code through lighthouse/ demonstration projects.
(d) ENS can be included in the affordable housing schemes and government-funded housing across India, especially those under the central government schemes as a first, with an intent of "Thermal Comfort for All".

ENFORCEMENT OF ENS

ENS encompasses the Envelope (Part 1) and Electro-mechanical components (Part 2) in the residential building segment. The stakeholder consultations identified that it is difficult for the Urban Local Bodies (ULBs) to verify compliance for the electro-mechanical components, considering their present administrative capacity, capabilities, and regulatory limitations. Verifying code compliance in the envelope will be reasonably effortless by the ULBs, considering their current administrative process for building approval. Upon issuing the occupancy certificate, the ULBs have a capacity deficit and lack administrative authority to overview and control the fit-outs installed in a building. The Indian market has a predominant share of residential units sold/leased or rented without any electro-mechanical fit-outs. As ULB might not be the ideal entity to verify and monitor the fit-outs in a residential building, implementing Part 2 of the code requires another route for compliance verification. This section lists the feasible and possible options for ensuring compliance with building envelope and electro-mechanical components. It also lists the incentives and penalties that could apply to support code compliance.

a. Compliance verification of Building Envelope.

Based on the understanding of the building approval process and ECBC implementation in India, this section highlights a proposed mechanism for compliance verification or enforcement considering the various aversions of stakeholders. Table 3 below showcases the compliance verification option for part 1 of the ENS, i.e., building envelope.

Table 3: Enforcement Models for ENS compliant Building Envelope

Enforcement Models	Description	Advantages/ Disadvantages

Self-Certification/ Declaration Model	The project architect self-declared and certified code compliance. The ULB may conduct random compliance checks and penalize non-compliance.	***Advantages:*** Minimum administrative capacity required Ease of Doing Business (EoDB) No additional expert apart from the project architect/ engineer is required for compliance declaration. ***Disadvantages:*** Diluted compliance stringency
Mandatory Compliance Check for ALL	All the applicable buildings have to go through a stringent compliance process at different construction stages: design, during construction and completion	***Advantages:*** Ensuring the ideal process from the beginning ***Disadvantages:*** Complicated process High administrative capacity required Compromise on EoDB
Mandatory compliance check for Large Projects	The state redefines the threshold for projects such that the more significant projects (group housing) go through a stringent compliance process (where the impact would be signification), and smaller projects can follow the self-declaration model (Kumari, Suman and Garg, 2021).	***Advantages:*** Medium administrative capacity required Self-paced and adaptable model Captures significant floor space with low administrative capacity ***Disadvantages:*** It needs strategic implementation; else, it might be challenging to move as per the defined timeline in a phase-wise manner.

(Source: Author)

b. Compliance verification of electro-mechanical components of the building.

The role of ULB for building permit approval is limited till the issuance of the occupancy certificate. It is difficult to verify and monitor building fit-outs that are not preinstalled but purchased and installed by the end-users on occupancy. As these appliances and equipment might be pre-owned or purchased by the owner later, it is challenging to verify the compliance as per the submitted design. Also, since appliances can be changed easily compared to the building envelope, there is a considerable possibility of fudging the results and corruption during the inspection. Thus, it was agreed in the consultations that it is logical and practical to steer the compliance check for the electro-mechanical components and systems by provisionally approving the compliance during the building approval process. Table 4 below suggests a few feasible approaches that can be adopted during the operational phase of the building to ensure the installation of efficient appliances and fit-outs indirectly.

Table 4: Compliance verification options for Electromechanical Component as per ENS

Compliance verification option	Description
Electrical Connection	The total connected load calculation can be checked for the compliant buildings. A city-wise benchmarking study can be conducted to determine the average load calculation for different categories of ENS-compliant residential units. The same method can be followed for any new connection rather than the conventional thumb rule.

Compliance verification option	Description
Energy Management and Information System (EMIS)	The ENS-compliant buildings can be connected through smart meters with an EMIS system that tracks real-time energy use patterns. This can further be integrated through an app that informs the end-users of their energy use pattern and how they fair in their neighborhoods.
Star Labelling of Homes	The ENS-compliant buildings can be deemed to comply with the Star Labeling of Homes, and monitoring of these buildings can be as per the guidelines of the Star Labeling Program.

(Source: Author)

c. Incentives and Penalty.

Incentives and penalties are the mechanisms to ensure the alignment of stakeholders' interests with the policy outcome. At present, both ENS parts 1 and 2 are voluntary. Under such circumstances, to encourage stakeholders to comply with the code or, when made mandatory, to motivate stakeholders to go beyond the minimum standards in code compliance, the states may explore the extent of incentives or penalties based on the existing market capacity and stakeholders' willingness. Below are some incentives and penalties options to improve the compliance rate. Incentives can be given both in the mandatory or voluntary phase of the code compliance, but penalties can only work when the code is made mandatory.

Few suggestive **Incentives:** (a) Awards and recognitions; (b) Subsidized loans, low taxes and surcharges; (c) Provision of additional Floor Area Ratio (FAR)/ Floor Space Index (FSI) or; (d) relaxation in other development control/ zoning regulations

Penalties: (a) Monitory fine for non-compliance by the competent authority; (b) Suspension of the license of compliance verifier/ architect for misrepresentation of facts; (c) Refusal of permit of construction/ occupancy in case of non-compliance; (d) Increased charges for per unit consumption of electricity.

CONCLUSION

The implementation of ENS is a challenging and considerable accomplishment, contrary to the outlined process. Derived from our learnings of ECBC implementation, the adoption, enforcement and compliance of the building energy codes in India is an exhaustive process. It requires profound planning and administrative capacity for efficient execution. BEE is working towards market preparedness by developing various schemes and strategies to support ENS implementation, like online tools for energy-efficient building design, ENS compliance Tool, Replicable design template, Online Building Materials Directory, and training programs. These initiatives would contribute toward ENS implementation but can only be actualized if the states initiate the implementation process.

The diagram below comprehensively highlights all the proposed options for ENS implementation pathways. The states can choose the most viable option based on their context. As a way forward to the study, the parameters to assess the feasibility of these pathways can be defined. A checklist in the form of a weighted average matrix can be prepared for ease of decision-making at the state and local levels, which can highlight the jurisdiction's strengths, weaknesses, opportunities, and constraints.

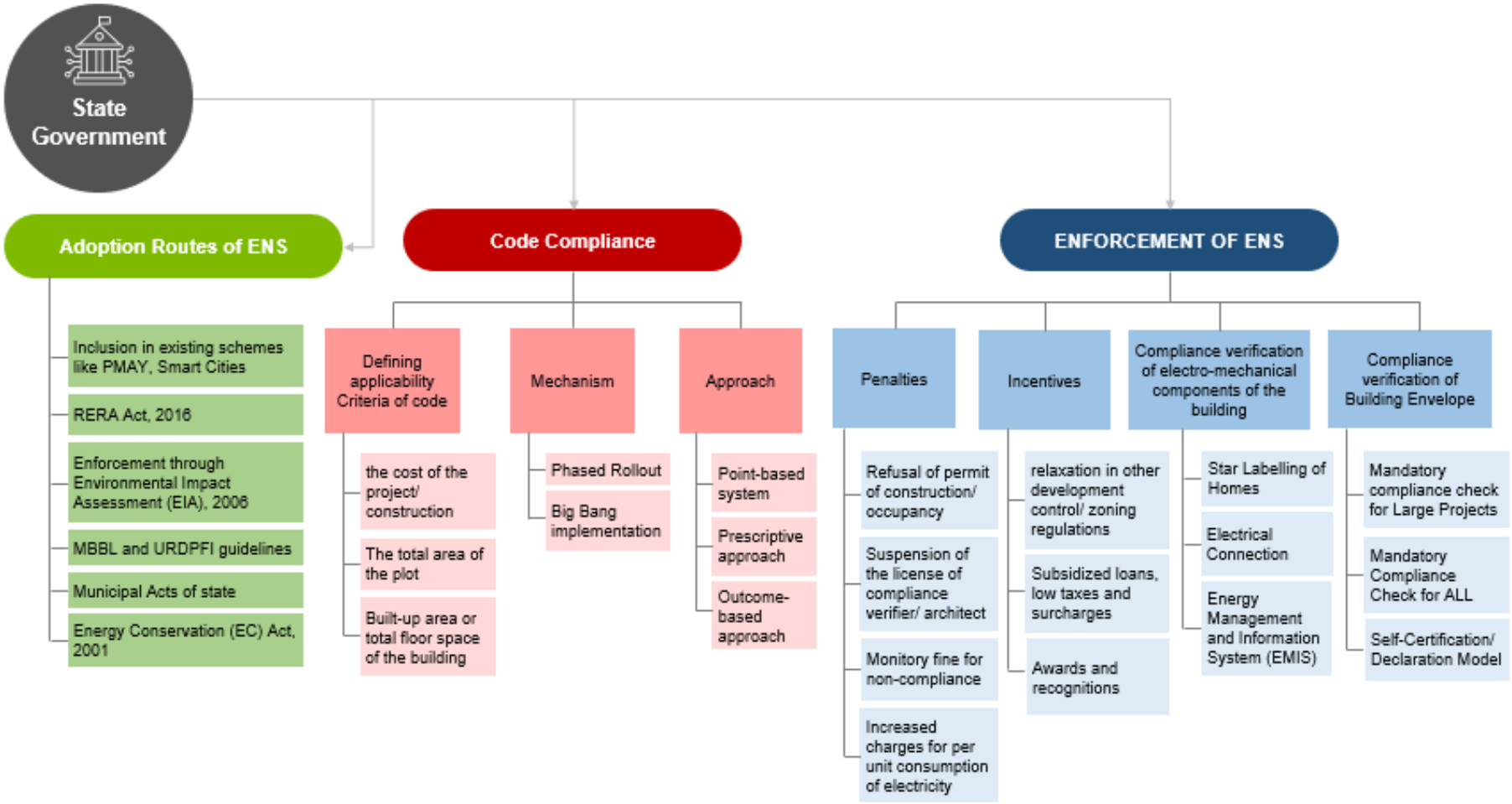

Figure 2: Proposed options for ENS implementation (Source: Author)

The following are the key takeaways from the study for effective ENS implementation:

a. There are various routes for adopting ENS, and the state can decide what works best for the state and the administrative setup.
b. For compliance, the state can decide the applicability criteria based on the situation assessment and the state's administrative capacity.
c. Compliance mechanisms should be simple, easy to follow and aligned with the existing building approval process in the state.
d. Enforcement of ENS in the housing sector is going to be a massive challenge considering the magnitude of development in the sector; hence the state has to very sensibly decide the model that would effectively work for the state, keeping into consideration its administrative structure, capacity and availability of professionals to effect code compliance.
e. The compliance of electro-mechanical components and systems has to be provisionally approved when construction completion, as limited housing in India has preinstalled fit-outs.
f. The ENS-compliant building can be linked to a monitoring scheme or the Star Labelling of Homes to monitor the energy performance of the building during the operational phase.
g. The Star Label for Energy Efficiency Homes program aims to constitute home pricing based on their comparative energy performance with buildings in a neighborhood. Part 2 of ENS can have effective compliance under this program, where the poorly performing buildings will be identified in the operational phase. Energy audits by utility providers can be undertaken for suggestive alterations to improve the energy performance of such homes.
h. Incentivization of code compliance is not recommended for mandatory compliance. However, exemplary performance can be awarded through such incentive schemes.
i. Imposing a penalty for non-compliance creates a sense of fear and boosts adherence to code compliance.

WAY FORWARD

The paper's findings and recommendations can guide the authorities at the sub-national level in adopting, complying, and enforcing ENS. The authorities and administration can wield the recommendations and map them against their existing legislation, policies and administrative processes to identify a feasible route for ENS implementation in their state. To realize the full potential of code compliance and affect the implementation of ENS, profuse and requisite advancements are essential in the states and ULBs. A few enlisted areas are:

- Extensive awareness and promotion campaigns are required to sensitize the homebuyers and end-users about the benefit of code compliance, creating a demand for code-compliant buildings.
- Central and State Public Works Department can adopt the code for construction compliance and revise their rate schedule to mobilize the market.
- Government and financial institutions can devise financial instruments to aid home buyers and builders and pursue code compliance.
- Development of operational manual and ENS Rules to guide the states/ULBs.

- Relevant courses like architecture, engineering diplomas and other professional courses.
- States should have a dedicated series of interactive and participative training modules that must be prepared and qualifying tests to enhance administrative and professional capacity.

The cross-sectorial nature and impact of the building energy code and its potential to contribute to the economy make it a vital developmental necessity for sustainable development. Robust policies prioritizing economic feasibility, technological interventions, financial and technical market drivers, and the ability for adoption, enforcement, and compliance are required. The different sectors need to interweavingly and cohesively work towards achieving our shared goals of enhancing sustainability, reducing the adverse impact of human activities on the climate and limiting our carbon emissions to ensure livability on Earth.

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