

Roadmap to implementation of thermal comfort policies in affordable housing.

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Abstract

The residential sector contributes to 24% of India's annual Green House Gas emissions within which 50% comes from heating and cooling needs. India's thermal comfort demands need to be energy-efficient and affordable to meet the 18 million low-income urban housing deficit. Here, we discuss the implementation of thermal comfort policies in affordable housing in India. We cross-examine the current implementation mechanism of thermal comfort and affordable housing policies and identify gaps in (a) clarity of roles and responsibilities of actors, (b) communication channels between actors, and (c) policy support instruments. We hypothesize that the gap between policies and their implementation comes from a lack of standardization and convergence between the two types of policies. We propose a roadmap to implementation via a 4-step approach: 1) outlining redefined roles and responsibilities of actors, 2) establishing a participatory planning process, 3) supplementing policies with implementation support, and 4) providing a framework for capacity building. The proposed roadmap can act as a guide to policy makers at the Union and State level, and implementation actors at the Urban Local Body level.

Keywords - Affordable Housing, Implementation Mechanism, Policy Implementation, Energy-efficient Construction, Thermal Comfort Policies

1. Introduction

The residential sector contributes 24% to India's annual GreenHouse Gas (GHG) emissions. 50% of this comes from heating and cooling needs for thermal comfort (Ozone Cell, 2019). The Intergovernmental Panel on Climate Change (IPCC, 2018) projects a global temperature rise of 1.5°C above pre-industrial levels over the next three decades, with the number already a reality for many regions (Masson-Delmotte et al., 2019). Indian cities are already at risk and inaction may lead to further heat waves similar to the one in 2015 that killed 2,300 people (National Weather Forecasting Centre, 2020).

An exponential rise in building footprint in the coming decades exacerbates this situation. As per the latest available information, the urban housing deficit in India was projected to be at 18.78 million homes for the period 2012-2017. 96% of this demand belongs to the low-income housing category (Roy & ML, 2020). The Pradhan Mantri Awas Yojna (PMAY) committed to construct 11.2 million affordable housing units across India, of which 7.6 million have been completed so far (Mission Dashboard, n.d.). This massive increase in building stock will result in 6-13 times increase in energy consumption, under a business-as-usual scenario (MoEFCC, 2021). The rise in energy demand, coupled with extreme heat events, will have widespread environmental, economic, and social implications, especially for the urban poor.

Heating, ventilation, and air conditioning (HVAC) systems are energy and carbon intensive, and unaffordable for low-income households (Dong et al., 2021). Studies show that poorly insulated affordable housing units pose a higher risk of exposing inhabitants to energy poverty (Chen & Feng, 2022). Higher indoor temperatures due to poor insulation and ventilation further lead to disproportionately higher mortality in the urban poor (Reducing Heat Stress in India's Informal Settlements, n.d.). Adaptive thermal comfort using low-cost, energy efficient means is thus the need of the hour.

There are efforts being made to address this in the policy sphere. The India Cooling Action Plan

(ICAP) was drafted by the Ministry of Environment, Forest, and Climate Change (MoEFCC) to address sectoral cooling requirements. It provides recommendations for thermal comfort in residential housing, but lacks tailored recommendations for affordable housing. Building codes such as the Eco Niwas Samhita (ENS) are similarly not integrated with affordable housing policies, and not mandated in all states (Bureau of Energy Efficiency, n.d.).

The consequences can be seen in Telangana’s affordable housing program, wherein 60% of the blocks in the state led affordable housing projects have compromised thermal comfort standards - being either too windy or in wind shadow areas compromising ventilation (Roychowdhury et al., 2021). An array of policy support instruments for thermal comfort such as the Bureau of Energy Efficiency (BEE) Design Guidelines for Energy-Efficient MultiStorey Residential Buildings, and the Building Materials and Technology Promotion Council (BMTPC) Compendium of Prospective Emerging Technologies for Mass Housing, which promotes innovative materials and construction techniques for thermal comfort in housing, exist. However, evidence on the adoption and implementation of these policies in the context of affordable housing is limited.

In this paper, we hypothesize that the gap between policies pertaining to thermal comfort in affordable housing and their implementation on ground stem from a lack of standardization and convergence between the two. We discuss the implementation framework of these policies to identify gaps through a threefold lens – (a) mapping roles and responsibilities of relevant actors, (b) mapping existing communication channels for implementation and monitoring, and (c) analysing the existing technical/ knowledge support instruments required for policy implementation. Finally, we recommend a roadmap to policy implementation based on the identified gaps.

2. Methods

This paper cross-examines policy implementation mechanisms across two paradigms – thermal comfort in the residential sector, and affordable housing. We conduct a literature review in the context of affordable housing in India to understand the implementation of existing policies on energy-efficiency and thermal comfort.

Table 1: Description of policy instruments reviewed

Instrument category	Description of instrument	Name of policy instrument
Regulatory instrument	Building codes and standards	Eco Niwas Samhita (Energy Conservation Building Code - Residential (ECBC-R)) part 1 and 2; National Building Code (NBC); American National Standards Institute/ American Society of Heating, Refrigerating and Air-Conditioning Engineers (ANSI/ASHRAE) Standard 55; Central Public Works Department (CPWD) Schedule of Rate for New and Innovative Technologies
Policy support	Design guidelines	Handbook of Climate Smart Cities: Thermal Comfort in Affordable Housing; BEE Design Guidelines For Energy-Efficient Multi-Storey Residential Buildings
Research, development, and deployment (RD&D)	Compendium of material and construction technologies	BMTPC Compendium of Prospective Emerging Technologies for Mass Housing
Climate Strategy	Perspective plans outlining climate targets and strategies	ICAP

In addition, we reviewed the individual implementation mechanisms of affordable housing policies under the PMAY mission, and state affordable housing policies of Karnataka, Rajasthan, and Tamil Nadu to create a comprehensive framework across both sectors.

Fig. 1 describes the framework for implementation of policies on thermal comfort and affordable housing. The framework comprises of five core actor groups – 1) Union level, 2) State level, 3) Urban Local Bodies (ULBs) 4) implementation experts – developers, contractors, designers, and 5) end users – Self-Help Groups (SHGs) and affordable housing consumers. The roles and responsibilities of each actor are outlined.

We then reviewed the implementation mechanism to identify gaps through two methods: 1) literature review on gaps in implementation, and 2) industry expertise on implementation process requisites for infrastructure-based policies.

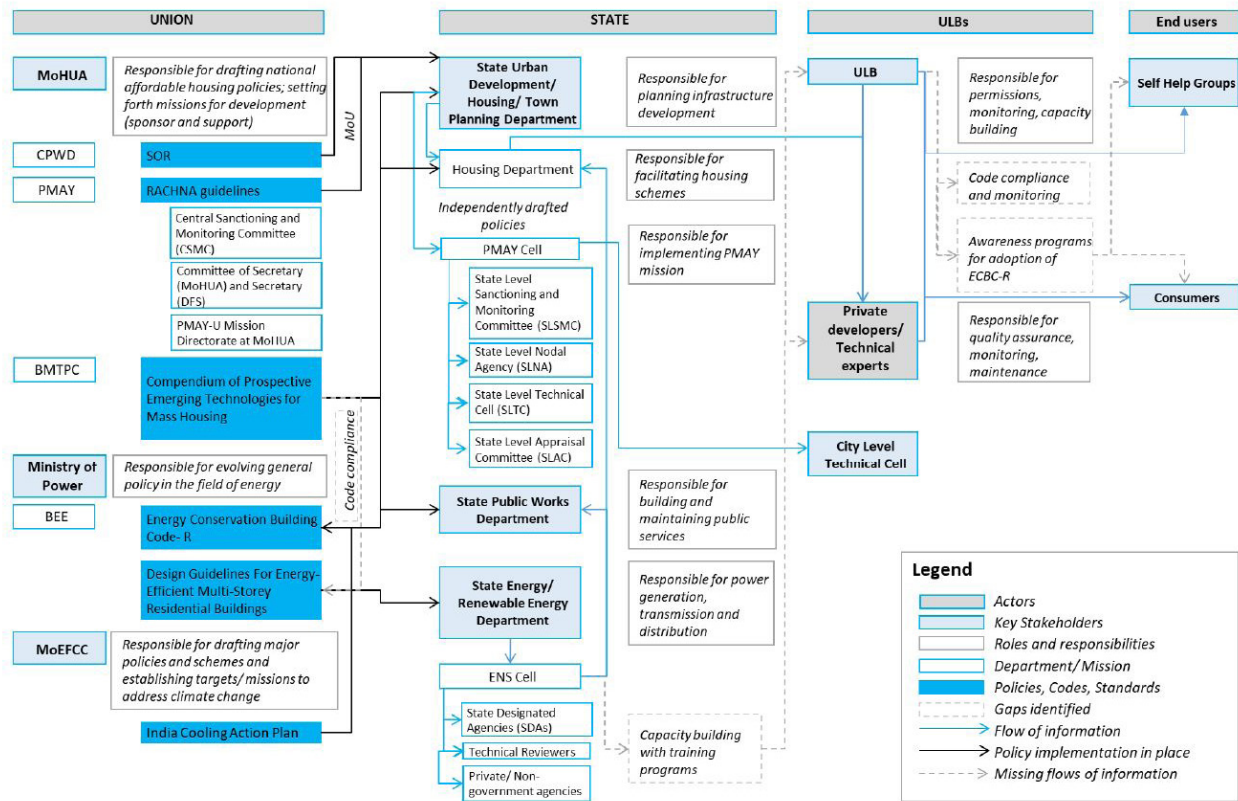


Figure 1: Implementation mechanism for thermal comfort and affordable housing policies

2.1 Implementation process requisites for infrastructure-based policies

Policies pertaining to infrastructure development require a comprehensive approach – from design to maintenance, including regular monitoring and evaluation to feed back into respective policies (see Fig. 2). We developed this process based on our expertise of implementing policy-based projects on ground, and through stakeholder consultations with municipal engineers, developers, and end users. Overlaying the findings from the literature review and the implementation process flow onto the existing implementation mechanism (Fig. 1) helped us identify the gaps in the current process. The next section presents the findings from the gap analysis, and provides recommendations to the current implementation mechanism to arrive at a comprehensive roadmap to implementing thermal comfort policies for affordable housing.

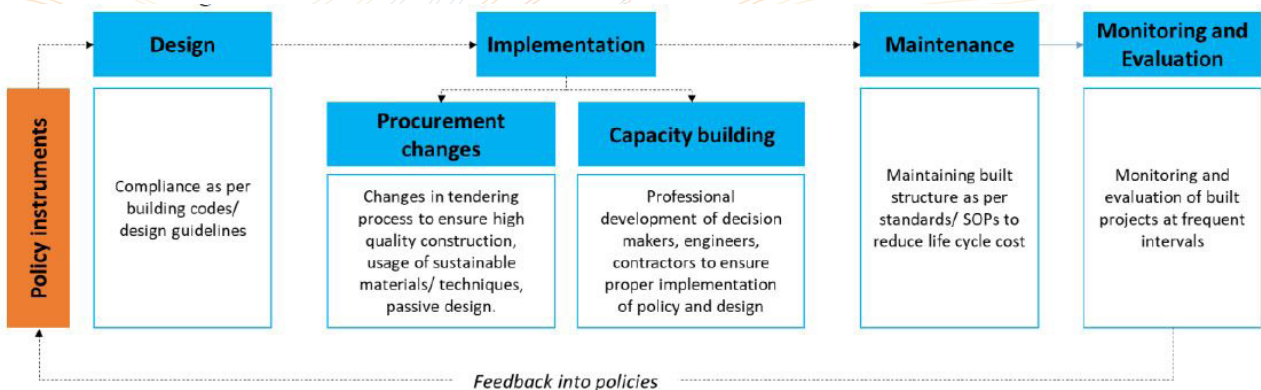


Figure 2: Implementation process for infrastructure-based policies

3. Results

3.1 Gaps in current implementation mechanism

3.1.1. Lack of a robust regulatory mechanism

Thermal comfort policies are not regulated across all affordable housing policies. The ENS policy is mandated in 10 states and amended and adopted for 10 more states (BEE & AEEE, 2022). However, its scope is not tailored to affordable housing policies. The PMAY has drafted the RACHNA guidelines through its technology sub-mission. However, there is limited evidence on its application, currently implemented in 6 lighthouse projects (Welcome To Global Housing Technology Challenge, n.d.) and demonstration projects across 14 cities (BMTPC, n.d.).

Fig. 1 demonstrates the regulatory framework of ENS, wherein dissemination from the Union is done through the State Energy Department, with the CPWD, State Public Works Department (PWD), and State Urban Development Authority as implementation partners. An ENS cell is sought in all states and Union Territories (UTs); however, there is limited evidence on their establishment (Bureau of Energy Efficiency, n.d.). The role of ULBs in the implementation scheme is currently not defined. Additionally, the State Energy Department engages with the Housing Department for ground implementation of thermal comfort standards, which has a limited role under the PMAY scheme. This demonstrates challenges in implementation stemming from a lack of inter-agency coordination and a robust regulatory mechanism.

3.1.2. Lack in participatory planning process

The BMTPC compendium on innovative materials is a comprehensive document comprising 24 materials and technologies identified for strength, stability, fire resistance, thermal comfort, water tightness, constructability and economic viability. Roychowdhury et al. (2021) finds that these materials and technologies have a higher cost implication and face market hurdles in mass housing schemes. This indicates a lack of feedback from consumers on the affordability of materials for thermal comfort.

Interviews with engineers conducted to measure the penetration of policies under the PMAY scheme show that there is considerable gap in the understanding of policies at the ULB level (WRI India Ross Center for Sustainable Cities, 2019). A lack of awareness of codes and policies at the end-user level leads to sale of affordable housing units that are not thermally comfortable (Suman & Kumari, 2022).

3.1.3. Lack in implementation support

Analysing the current implementation mechanism against the process for infrastructure-based policies (see Fig. 2) highlights the gap in implementation support. Existing policy support instruments such as design guidelines drafted by BEE and India Infoline Finance Limited (IIFL), and the BMTPC compendium proposes passive design techniques, innovative materials and construction techniques for thermal comfort. They are, however, not sufficiently supplemented by implementation manuals and capacity building programs for implementing actors at the ULB level such as engineers, contractors, developers, and self-help groups.

While PMAY has a dedicated capacity building program, this does not hold true for most state sponsored affordable housing programs (WRI India Ross Center for Sustainable Cities, 2019). Additionally, even for the PMAY program, the capacity building program has limited focus on thermal comfort.

3.2 Roadmap to implementation

In order to address the gaps identified, there needs to be a standardized approach integrating thermal comfort in affordable housing that ensure the following:

- (a) An integrated thermal comfort policy tailored to the Indian context and attuned to the 5 broad climatic zones, building codes addressing thermal comfort needs at the district/city level, notified design guidelines supplemented with implementation support toolkits, and a regulatory system enabling amendments of policy support instruments such as the Schedule of Rates at regular intervals.
- (b) Convergence of thermal comfort policies with affordable housing policies at the Union and State level, to ensure all affordable housing units are thermally comfortable and energy-efficient. This should be compounded with a mandate for all states to have an integrated affordable housing policy.

A roadmap to implement this approach is further outlined.

3.2.1. Outlining redefined roles and responsibilities

An analysis of the current implementation mechanism (see Fig. 1) highlights the need for redefined roles and responsibilities for all actors, to ensure stronger penetration of policies at/ beyond the ULB level.

Table 2: Redefined roles and responsibilities in the implementation mechanism

Actor	Current role	Additional roles and responsibilities
Union	Formulation of policies and standards; Specialist committees to ensure policy implementation; Monitoring policy implementation at the State/ ULB level; Development of effective regulatory systems	Enable inter-ministerial coordination for better integration of thermal comfort and affordable housing policies; mandate integrated thermal comfort and affordable housing policies for all states; develop database for housing deficit (data coordination with ULBs); convergence between existing guidelines and compendiums to consolidate into one guideline that is standardized/ notified into building codes; coordinating lab/ ground testing of materials to be incorporated into CPWD Schedule of Rates (SoR) and State SoR
State	Adoption, compliance and enforcement; Approval of incentives; Consultation of policy revisions to union government	Mandate thermal comfort standards in all affordable housing policies; develop database of district/ city level climate conditions;
ULB	Building construction approvals; Policy compliance through document verification; Monitoring of projects on ground; Capacity building for Self-Help Groups (SHGs) under PMAY mission	Collection of data on district/ city level climatic conditions; data collection on housing deficit and demand; feedback on contextual challenges in policy implementation; education and awareness of end users on thermal comfort standards; capacity building of engineers, contractors, developers, SHGs on thermal comfort, energy-efficient material and construction techniques; monitoring and compliance of thermal comfort standards
Developers/ contractors/ Designers	Design and building construction; quality assurance; ensuring code compliance	Ensuring compliance of thermal comfort standards; capacity building in energy-efficient materials/ construction techniques; collect and communicate feedback on administrative compliance process
End users	SHGs – housing construction; consumers – buying housing	Provide feedback on implementation challenges; comply with thermal comfort standard for buying affordable homes

3.2.2. Establishing a participatory planning process

Robust feedback mechanisms to understand implementation side challenges can only be enabled through a strong participatory planning process. Such a process enables a bottom-up approach in the policy implementation process, with dedicated communication channels across all actors, as outlined in Table 3.

Table 3: Participatory planning process

Communication Channel	Feedback parameters
Union - State	Revisions to code as per suggestions; Capacity building for decision makers to augment policy implementation; Suggested changes in SoR from BMTPC studies
State - Union	Communicating data on housing deficit; Providing policy feedback received from ULB and Developers; Communicating district/ city level climatic requirements for incorporation in national policies
State - ULB	Changes in policy compliances; Incentives for adoption of policies; Information on data collection for district/ city level climate requirements; Information on data collection for housing deficit; Implementation support through manuals/ job aids; Amendments in SoR
ULB - State	Data on housing deficit; Data on city/ district level climate requirements; Implementation challenges faced by developers/ contractors/ end users; Project monitoring and evaluation on thermal comfort evaluation of completed projects
State - Developers/ contractors/ designers	Incentives on adoption of policies; Training/ capacity building for alternate materials/ const. techniques
Developers/ contractors/designers - State	Feedback on ease of compliance of policies and codes; Feedback on incentives for policy implementation
ULB - Developers/ contractors/ designers	Code compliance and monitoring systems; Capacity building and training for alternate materials/ const. techniques
Developers/ contractors/ designers - ULB	Feedback on ease of compliance of policies and codes; Implementation and verification of code compliance; Design and planning documents; Code compliance verification
ULB - End user	Education and awareness regarding thermal comfort policies and standards
Developers/ contractors/ designers - End user	Stages of design development; Materials and construction techniques; Maintenance standards
End user - Developers/ contractors/ designers	Suggestions and feedback on design; Affordability of materials; Feedback on ease of maintenance post completion; Feedback on thermal comfort post completion

3.2.3. Supplementing policies with implementation support

In addition to building a robust feedback system between all actors in the ecosystem, it is imperative to augment policy implementation at/beyond the ULB level with additional policy support instruments, as outlined below.

1. Design guidelines – A design guideline provides unit, block, and site level spatial standards on the practical application of thermal comfort policies. This includes the usage specifications of passive design techniques, alternate materials and construction techniques pertaining to thermal comfort. A comprehensive design guideline should also account for housing affordability through the choice of materials, construction techniques, and design recommendations.

2. Implementation manuals – An implementation manual provides support to the design guideline by detailing out procurement changes in the form of contractor agreements/guidelines for contractor selection pertaining to thermal comfort design implementation. It also provides material specifications, templates of standard Good for Construction (GFC) drawings, Bill of Quantities (BoQ) and other relevant tender documents. A comprehensive implementation manual also incorporates project monitoring tools such as Job Aids including site visit checklists, documentation methodology, survey methodology to ensure standardization in measuring policy compliance on ground.

3. Maintenance manuals – This document provides a step-by-step detail on maintenance of all components of the affordable housing unit and community facility, for developers/contractors responsible for maintenance, and for housing occupants. This also includes specific maintenance for special materials and equipment, along with the frequency of maintenance.

4. Green Schedule of Rates (SoR) – BMTPC is currently the nodal agency for testing alternate materials/techniques pertaining to thermal comfort, and suggesting amendments to the CPWD SoR. We recommend a new Schedule of Rates manual called the Green SoR which comprehensively covers all materials/techniques pertaining to thermal comfort and energy efficiency. Such a document should incorporate local material/techniques vetted by the BMTPC. It should also contain construction manuals to ease knowledge transfer for contractors/ engineers/developers etc. The

BEE is developing an online database of alternate materials (BMDI, n.d.), which can be incorporated into the Green SoR.

3.2.4. Providing a framework for capacity building

A sound capacity building program that caters to all relevant stakeholders is crucial for successful policy implementation. We recommend the development of a Centre of Excellence in each district/city to deliver capacity building/ training on innovative construction. This can be incorporated within the ENS cell planned in each state. Multiple forms of training are recommended, as outlined.

- a) Training on thermal comfort, energy-efficient building codes and regulations compliance for all stakeholders responsible for and affected by policy implementation
- b) Knowledge/Awareness training for decision makers, junior to senior municipal engineers, energy officials responsible for policy implementation and recommendation on amendments.
- c) Knowledge training for engineers/developers/contractors on passive design, material innovation and construction techniques, by subject matter/industry experts such as Indian Green Building Council (IGBC), Leadership in Energy and Environmental Design (LEED) professionals, and Architects. This should incorporate sessions on preparation of BoQs, integrating the Green SoR with rates from various departments, methods on writing contract agreements for implementation, operation and maintenance, and efficient integration of Public-Private Partnership (PPP) models.
- d) Field training for actors responsible for project implementation on site monitoring, interagency coordination, sequencing of constructions, and post occupancy surveys and evaluation.
- e) Design workshops for decision makers and implementing actors on thermal comfort and energy-efficient buildings. This should incorporate sessions with all utility agencies, energy departments and technical cells. Accountability for the capacity building program should be maintained through skill certifications which can be integrated with existing courses under the National Skill Development Council (NSDC).

4. Discussion

4.1 Convergence of thermal comfort and affordable housing policies for efficient policy implementation

Thermal comfort policies in India are drafted for the residential sector in general, with no specific consideration to affordable housing requirements. The implementation mechanisms have limited convergence between actors (see Fig. 1). Two affordable housing policies (PMAY and state led programs) further complicate the roles and interactions of actors. Suggett, (2011) captures the requisites for successful implementation of program-based policies: (a) leadership and role clarity, (b) focus on skills: program design, administration etc., (c) governance and project management regimes, (d) risk management and audit, (e) communication: internal and external, and (f) monitoring, transparency and accountability. Aspects such as leadership and role clarity can only persist in the presence of a clear institutional framework with clearly defined roles. In this paper, we attempt to understand the ambiguity and potential duplication of roles between actors at the State and ULB level, and identify redefined roles and responsibilities that converge the implementation of thermal comfort and affordable housing policies.

4.2 Participatory planning in public policy

Participatory planning and stakeholder involvement is essential to policy implementation. The United Nations Industrial Development Organization, (2022) report on participatory policy making demonstrates how involving local actors in various stages of decision making lead to a higher willingness for policy adoption. Conversely, a failure to involve stakeholders in the policymaking can lead to difficulties during implementation. A study by the World Resources Institute (2019) captures

how a communication gap between Union, State, and ground-level implementation actors lead to reduced acceptance of the policy. In this paper, we address the need for robust communication that enables a mix of top-down and bottom-up approaches of policy implementation, and ensures a constant feedback of ground realities to further refine the policies or the implementation mechanism.

4.3 Program support at the implementation level

Successful implementation of policies is contingent to tactical support for implementing actors. Most regulatory instruments focus on a top-down policy implementation approach, relying on statutory language and administrative processes that ignore a supporting framework to translate policies on ground. In this paper, we discuss the need for supplementary policy instruments and capacity building at the implementation level.

4.4 Limitations of the study and future work

The scope of this paper is limited to understanding the roles, responsibilities of actors, feedback channels, and implementation support at the ULB level. However, this can be broadened to understand policy leverages and regulatory instruments such as mandating thermal comfort compliances in Environmental Impact Assessments, and amendment of building byelaws to incorporate thermal comfort guidelines and standards. Additionally, the research provided here is assimilated from secondary sources. Cross-examining the suggestions made here through stakeholder interviews on ground will lead to a more robust implementation framework.

5. Conclusion

In this paper, we discuss the implementation framework of thermal comfort policies in affordable housing. Through categorical exploration and thermal comfort and affordable housing policies and related instruments, it is evident that there exist sufficient resources for the implementation of thermally comfortable, energy-efficient affordable housing. However, the gap in implementation comes from a lack of standardization and convergence of the two policies, leading to duplication of roles, gaps in communication between implementing actors, and a lack of focus on strengthening implementation capacity on ground through relevant policy support instruments and a robust capacity building framework. To address this, we propose a new roadmap that builds onto an existing frame of resources, primarily advocating for a standardization and convergence of resources and information under the two types of policy in question. The roadmap outlines – (i) redefined roles and responsibilities for implementing actors, (ii) framework for a participatory planning process, (iii) policy support instruments such as implementation and maintenance manual, and a green SoR to ensure ease of construction, and (iv) a robust capacity building framework. The proposed roadmap has a two-fold intent – (i) ensuring affordable housing is thermally comfortable and energy-efficient, safeguarding consumers from extreme weather events and energy poverty, and (ii) developing a robust framework to ensure 100% penetration of infrastructure-based policies on ground.

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