GGGI

ASIA LOW CARBON BUILDINGS TRANSITION PROJECT

Life Cycle Assessment for Transitioning to a Low-Carbon Economy

Subnational Building Registry & Carbon Assessment in India

Approach & Key Recommendations

August 2025

ASEAN CENTRE FOR ENERGY ACE

EESL

HEAT

Supported by:

Federal Ministry for Economic Affairs and Climate Action

IKI INTERNATIONAL CLIMATE INITIATIVE

on the basis of a decision by the German Bundestag

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1. INTRODUCTION

The **Asia Low Carbon Buildings Transition (ALCBT) Project** seeks to address regulatory, capacity, and financing gaps that hinder large-scale adoption of low carbon buildings (LCBs) in Cambodia, India, Indonesia, Thailand, and Vietnam. Project interventions build technical and institutional capacity for city and state governments to contribute to national greenhouse gas (GHG) emission reduction targets from building materials and operations, particularly from cooling, complementing regional and global initiatives. Buildings are significant contributors to GHG emissions, making it imperative to reduce their energy demand and carbon footprints to meet Nationally Determined Contributions (NDC) targets. In Asia, high energy consumption and rising cooling demand from buildings are driving governments to shift toward bio-based materials, better design, and energy-efficient appliances.

In India, the project operates under the guidance of the **Ministry of Housing and Urban Affairs (MoHUA)**, actively engaging public and private sector stakeholders to develop technical, planning, and institutional tools that promote low-carbon adoption and measurable emissions reductions by 2028.

As part of the ALCBT project, a total of 1,200 new buildings across the five project countries are to be evaluated using a bottom-up approach, with 200 buildings assessed per pilot. Additionally, 5,000 existing buildings are being assessed using available data, with approximately 1,000 buildings analyzed in each country. In India, the project successfully achieved its Building Registry objectives, with a particular focus on the states of **Kerala**, **Uttar Pradesh**, and **Haryana**. The project assessed and registered a total of 1,600 (600 new buildings evaluated through the bottom-up approach and 1,000 existing buildings assessed using available data sources.

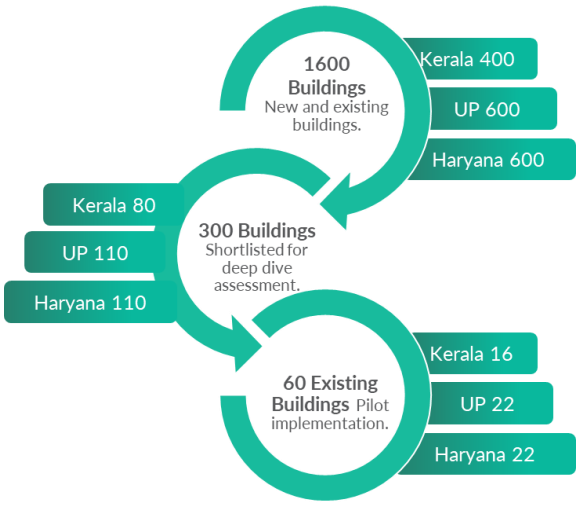

Figure 1: Building Registry Development in India.

The successful implementation of the building registry initiative in India underscores the project's commitment to advancing sustainable building practices and supporting climate action goals. This document presents the key outcomes and findings of the initiative for state partner review, highlighting the effective execution of the building registry framework, challenges encountered, and best practices identified.

This **approach paper aims to provide strategic recommendations for scaling similar initiatives to enhance energy efficiency across India's building sector.** The insights highlighted in the report will support state partners in fostering collaboration and make informed policy decisions that drive low-carbon growth across Kerala, Uttar Pradesh, and Haryana.

2. BUILDING ASSESSMENT APPROACH

2.1 Building Energy Code Implementation and Permitting Process Integration

A comprehensive assessment of Energy Conservation Building Code (ECBC) and Eco Niwas Samhita (ENS) implementation in Kerala, Uttar Pradesh and Haryana was conducted to evaluate the current status, identify gaps, and propose improvements. This analysis provided valuable insights into the effectiveness of existing policies and their impact on energy efficiency in the building sector.

The building permit and approval processes in major cities were mapped to understand regulatory workflows and identify opportunities to streamline compliance with energy codes. Based on these findings, the integration of energy and carbon assessment tools into municipal building regulations was proposed and facilitated, ensuring a more structured approach to sustainability in urban development. The 'Buildings Overview Report' for the three states is available on the ALCBT project website (www.alcbt.gggi.org).

Figure 2: Building Sector Overview Reports for the 3 Project States in India

2.2 Development of the Building Registry

A building registry database was successfully developed, encompassing over 1,600 buildings across Kerala, Uttar Pradesh, and Haryana. This extensive database serves as a centralized repository of critical building information, supporting data-driven decision-making in energy efficiency and carbon management. A comprehensive mapping exercise was conducted to categorize buildings by typology, ownership (public or private), operational energy use, and carbon footprint. This detailed classification provided valuable insights into energy consumption patterns and emission profiles across different building segments.

The objective of this registry exercise is to identify candidate buildings suitable for trial through Building Emission Assessment Tool (BEAT) and creating project pipelines for retrofits in cooling applications, thereby mobilizing necessary investments. GGGI engaged consultants for secondary data collection, stakeholder consultations and data analysis with support from state partners like Energy Management Centre (EMC), Government of Kerala, Haryana Energy Development Agency (HAREDA), Government of Haryana and Housing Development Board (UPHDB), Government of Uttar Pradesh. To ensure data

accuracy and relevance, government agencies, developers, and key stakeholders were actively engaged in the validation and refinement of the registry. Their inputs helped enhance data quality, align the registry with policy objectives, and strengthen its utility for future planning and regulatory enforcement.

Also, on the recommendation of the Technical Advisory Committee (TAC) of the ALCBT project, GGGI constituted a 4-member sub-committee to oversee and guide the building registry exercise. The sub-committee recommended the following broad criteria for selection of buildings under this registry exercise.

Table 1: Criteria for Buildings Registry Excercise

Preliminary Registry (1600 buildings)	For BEAT Assessment (for 300 buildings)	For Pilot Demonstration (60 buildings)
• Existing Building : constructed by 2024 • New Building : Constructed from 2025 • Connected Load >= 100 kW • Existing : New= 1000 :600 • Govt : Pvt= 70:30 • Commercial : Residential=80:20	▪ Existing Building (till 2017) ▪ New Buildings (from 2018) ▪ Connected Load >= 500 kW ▪ Typical Occupancy > 500 occupants ▪ Gross Floor Area > 1000 m2 ▪ EPI > 180 kWh/m2/year for Govt. and commercial buildings ▪ EPI > 50 kWh/m2/year for Residential buildings ▪ Air-Conditioning energy consumption > 50% of the total electricity consumption ▪ Annual Operating hours for cooling load > 3000 hours	▪ Investment Potential > $ 125,000 ▪ Willingness to invest ▪ Willingness to adopt ESCO business model ▪ Energy saving potential > 15% from baseline for active system ▪ Energy Saving Potential>25% with active and passive cooling design ▪ Qualified under ECSBC or ENS criteria ▪ Single ownership building

2.3 Stakeholder Engagement

A series of workshops and stakeholder consultations were conducted to raise awareness among building owners about the ALCBT project and the building registration process. These sessions also promoted low-carbon building strategies and encouraged collaboration among key decision-makers. Serving as platforms for knowledge exchange and capacity building, they facilitated the dissemination of best practices in energy efficiency and carbon reduction. Engagement with state agencies, urban local bodies, and regulatory authorities further supported critical policy discussions to strengthen regulatory frameworks for sustainable buildings. These interactions enhanced government capacity to implement energy and carbon assessments in the building sector, ensuring long-term policy alignment with sustainability objectives.

Figure 3: Stakeholder Consultation in Haryana with HAREDA, , January 31, 2025

Figure 4: Stakeholder Consultation in Kerala, with Energy Management Centre (EMC), March 19, 2025

Figure 5:Stakeholder Consultation and Technical Workshop in Uttar Pradesh with Faculty of Architecture & Planning, UPNEDA & UP Housing and development Board on July 14, 2025

2.4. Deep-Dive Assessment for 300 Buildings

A total of 300 buildings were selected from the registry of 1,600 buildings for a deep-dive assessment using a structured filtering approach to ensure a diverse and representative dataset. The following criteria were identified for the selection of the 300 buildings.

a. Buildings were classified based on typologies, including hotels, apartments, and healthcare facilities, with selections made from each category to ensure dataset inclusivity.
b. Within each typology, buildings were further shortlisted based on their area, ensuring equal representation from both the highest and lowest size categories (50:50).
c. Annual energy consumption was another key criterion, with buildings exhibiting both the highest and lowest energy usage selected to capture the full spectrum of consumption patterns.
d. Occupancy hours were prioritized, maintaining an even distribution of buildings operating for 24 hours and those with an 8-hour occupancy schedule.
e. Ownership structures were considered, segmenting buildings into single-owner and multiple-owner categories.
f. A balanced division between commercial and residential buildings was maintained, based on a ratio determined in consultation with GGGI.

For the selected buildings, a detailed evaluation was conducted to analyze energy performance and material utilization. The bill of quantities (BOQ) provides for the amount and type of construction materials in a building to determine embodied emission. However, when only architectural drawings were available, a detailed analysis was performed to extract essential details such as dimensions, material specifications, and construction elements. Material quantities were calculated by determining areas, volumes, and thicknesses, and the extracted data was systematically recorded in an Excel sheet for precise estimation. These estimates were then cross verified with standard construction norms to

ensure accuracy before finalization. In **cases where neither architectural drawings nor a BOQ were available the following approach was adopted -**

1. **Building Photography:** Building images taken from multiple angles were used to develop a comprehensive visual reference.
2. **Audit Findings:** A representative 2D model was created, incorporating key architectural and structural elements.
3. **Estimation:** Measurements and calculations were applied to estimate the materials used in construction. To enhance accuracy, field validation was conducted through on-site measurements, expert consultations, and comparisons with similar structures.

The sub-committee also recommended to adopt alternate methodology if there are data unavailability or deficiency to comply to the selection criteria for 300 buildings. The following table shows the alternate methodology for existing and new buildings.

Table 2: Alternate Methodologies for Selection of Buildings (Existing Buildings)

S.N.	Criteria	Deviation	Alternate Recommended Approach	Remark
1.	Age of Building > seven years	-	-	GPS location will be required
2.	Connected Load >= 500 kW	If more than 500kW is not available	Consider >100 kW Connected Load as per ECSBC criteria	To be finalized after full data analysis of 1600 buildings
3.	Typical Occupancy > 500 occupants	-	-	Subjective assessment based on floor area
4.	Gross Floor Area > 1000 m2	If floor area <1000 m2	Must be recommended building by the state Govt.	-
5.	Availability of detailed BoQ	Non-availability of BoQ	Refer Architectural Drawings and Basis of Design Document	-
6.	Architectural Drawing	Non-availability of architectural drawing	Refer tender document of any Govt./commercial buildings constructed/under construction in same state during 2024-25 Refer sale or lease document that contains the identification of the property, floor plans etc	The alternate criterial shall be used for the existing building having < 10 years of age. A site visit may be made compulsory for non-availability of any document
7.	Basis of Design Document	Non-availability of Design Document		
8.	Buildings with > 25 years of age	No-BoQs or any other data available	Refer Energy Assessment / Energy Audit Report for Assessment only for operational carbon (no embodied carbon)	To be finalized after full data analysis of 1600 buildings
9.	EPI > 180 kWh/m2/year for Govt. and commercial buildings	100 kWh/m2/year <EPI < 180 kWh/m2/year	Must be recommended buildings by the state Govt.	To be finalized after full data analysis of 1600 buildings
10.	EPI > 50 kWh/m2/year for Residential buildings	-	-	-

11.	Air-Conditioning energy consumption > 50% of the total electricity consumption	AC load energy consumption < 50%		To be finalized after full data analysis of 1600 buildings
11.1	Annual Operating hours for cooling load> 3000 hours		1. Cooling systems are More than 15 years old 2. Building authorities have plan for retrofit and budget availability	

Table 3: Alternate Methodologies for Selection of Buildings (New Buildings)

S.N.	Criteria	Deviation	Alternate Approach	Remark
1.	Age of Building < 7 years or under construction	-	-	GPS location will be required
2.	Connected Load >= 500 kW	-	-	Design data
3.	Typical Occupancy > 500	-	-	Design data
4.	Gross Floor Area > 1000 m2	-	-	Design data
5.	Availability of detailed BoQ	Non-availability of BoQ	Refer Architectural Drawing and Basis of Design Document Refer sale or lease document that contains the identification of the property, floor plans.	-
6.	EPI < 100 kWh/m2/year for Govt. and commercial buildings	-	-	-
7.	EPI < 50 kWh/m2/year for Residential buildings	-	-	-
8.	Air-Conditioning energy consumption > 50% of the total electricity consumption	-	-	To be assessed based on connected loads and average hours of operation

The final estimates were documented systematically for further analysis and reporting. In addition, walk-through energy audits were completed for all 300 buildings, delivering in-depth evaluations of energy performance and carbon intensity. Key energy efficiency interventions, particularly for cooling systems, were identified to minimize operational energy use. Baseline energy and carbon benchmarks were established at the state level and compared with national standards to evaluate performance gaps.

Finally, all 300 buildings were eventually being integrated into the BEAT platform, enabling a comprehensive assessment of both embodied and operational carbon. Developed by HEAT GmbH, a consortium partner of the ALCBT Project led by the Global Green Growth Institute (GGGI), BEAT represents a significant advancement in bringing sophisticated Life Cycle Assessment (LCA) methodologies to building practitioners in rapidly urbanising Asian countries. The tool is specifically designed for implementation in Cambodia, India, Indonesia, Thailand, and Vietnam—as Asia experiences unprecedented construction growth. This integration not only enhanced the project's data accuracy and visualization capabilities but also played a critical role in identifying high impact retrofit

opportunities. Based on the insights gained, 60 buildings were being finalized for targeted retrofitting interventions, ensuring alignment with low-carbon objectives and efficient resource deployment.

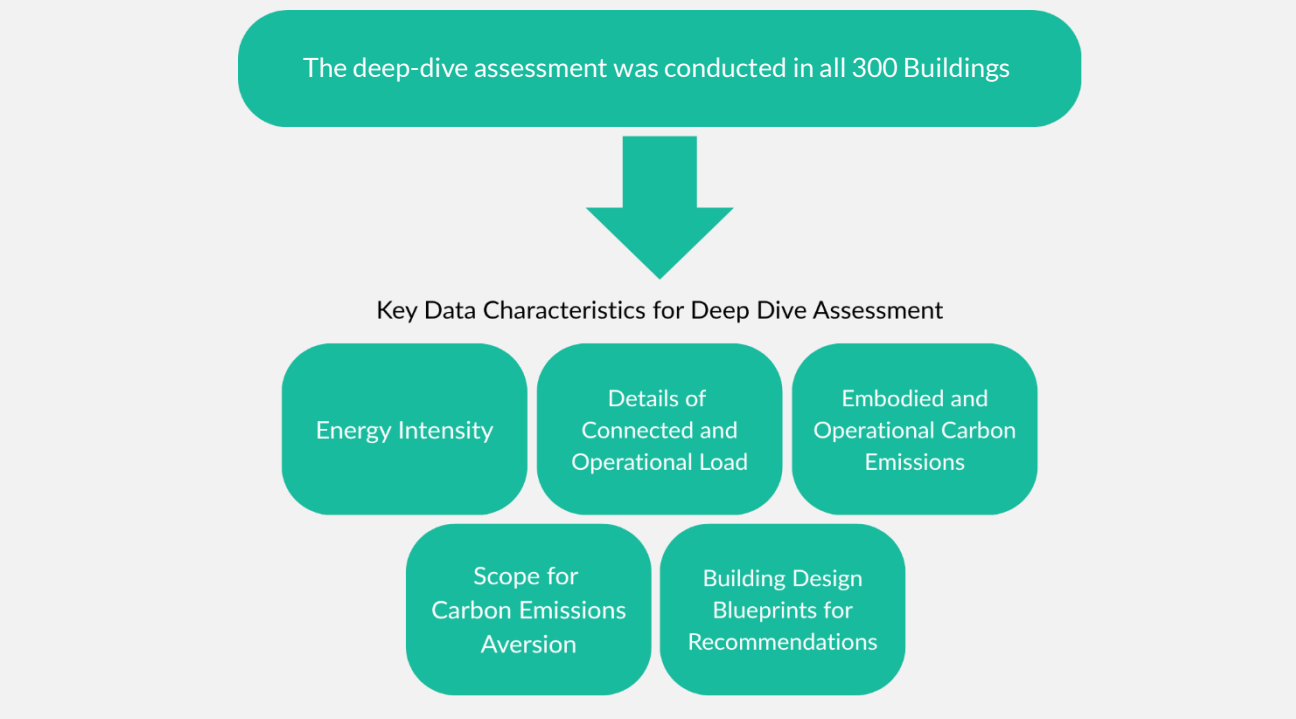

Figure 6: Deep-Dive Assessment: Key Data Characteristics

2.5. Building Registry Online Platform

In order to capture the expressions of interests from building owners, developers, and stakeholders, structured e-forms and guidance materials have been provided to ensure a user-friendly registration process in the buildings registry available on the ALCBT project website. These resources help participants navigate the platform easily and submit relevant project details with ease. It allows efficient building registration, ensuring broad accessibility and reach and streamlined data collection. A web-based dashboard will also being introduced for visualizations of building types, location, and embodied carbon & operation carbon performance in project countries and states.

2.6. Selection and Pilot Implementation of 60 Low-Carbon Buildings

As part of the initiative, 60 buildings will be selected for pilot implementation through a structured process focused on maximizing energy efficiency impact. The selection will be guided by key criteria such as energy and carbon savings potential, investment readiness, financial viability, compliance with Energy Conservation and Sustainable Building Code (ECSBC)/ENS standards, and owner consent for low-carbon interventions. From the deep-dive assessment of 300 buildings, the shortlist of 60 will be finalized based on the following;

a. Preference for buildings where owners actively expressed willingness to participate.
b. Buildings with allocated budgets for retrofits or owners with demonstrated willingness to fund or secure funding.
c. Priority for structures with inefficient cooling systems or significant energy-saving potential.
d. Eligibility limited to buildings compliant with ECSBC or ENS standards.

To support implementation, ESCO (Energy Service Companies)-based business models are being developed in collaboration with Energy Efficiency Services Limited (EESL), one of the project's implementation partners. Low-carbon retrofits were introduced in existing buildings, while sustainable

design strategies will be integrated into new constructions. These interventions aim to optimize energy performance, reduce operational costs, and minimize carbon footprints.

A comprehensive monitoring and evaluation framework will be established to track energy savings and carbon reductions, ensuring measurable impact and providing insights for scaling up future initiatives.

Also, a Green Finance Network (GFN) is being developed to bring all actors like developers, architects, ESCOs, Financial Institutions, building owners, energy auditors and the project pipelines in same platform. The following exhibit shows the summary of GGGI's approach from simple building registry to developing project pipelines and linking to GFN.

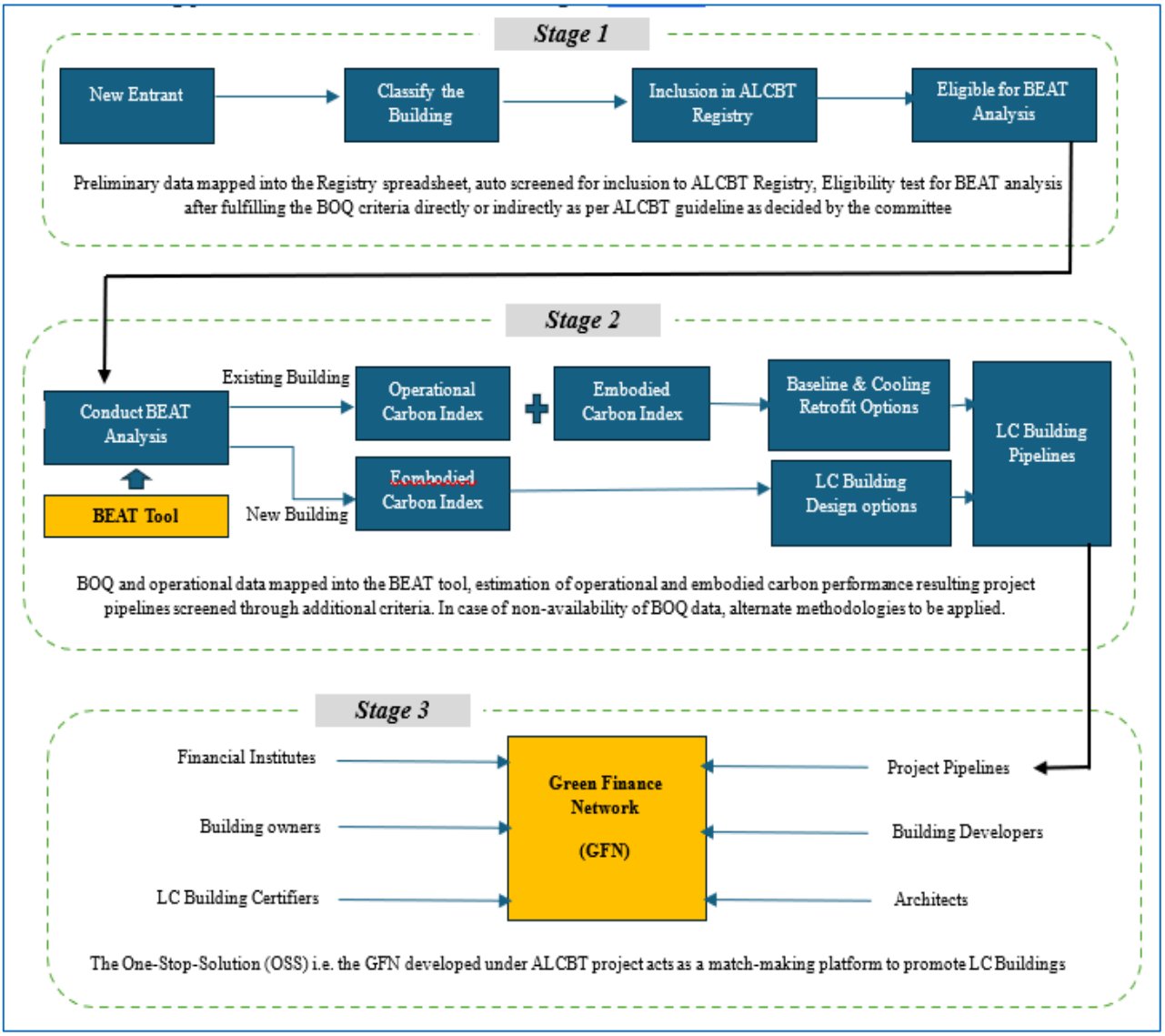

Figure 7: GGGI's Approach to Project Pipeline and linkage to GFN

3. KEY RECOMMENDATIONS FOR GOVERNMENT CONSIDERATION

3.1. Institutionalizing the Building Registry and Use of ALCBT BEAT

A digital platform established by state government partners to facilitate the continuous registration of buildings will be key for the establishment of building sector emission baseline, monitoring and reporting and aid in data-driven decision-making in the future. This platform will serve as a centralized system for tracking building performance, ensuring long-term data accessibility, transparency, and regulatory oversight.

To maintain accuracy and relevance, periodic updates of energy and carbon data should be mandated for all registered buildings. These updates will enable continuous monitoring of energy consumption and emissions from the building sector.

It is also recommended that the BEAT (Building Emission Assessment Tool) developed under the ALCBT project to be integrated into the building registry platform. BEAT offers a standardized, bottom-up methodology for assessing building-level emissions, enabling consistent evaluation across diverse building types. Its use supports informed decision-making by providing granular insights into energy use patterns and carbon hotspots, helping identify opportunities for emissions reduction. Furthermore, the building registry, together with BEAT-based assessments, should be embedded into urban planning and climate action policies to align with broader sustainability goals. Institutionalizing energy and carbon assessments within planning frameworks will strengthen regulatory enforcement, enhance transparency, and accelerate the development of low-carbon, energy-efficient urban infrastructure.

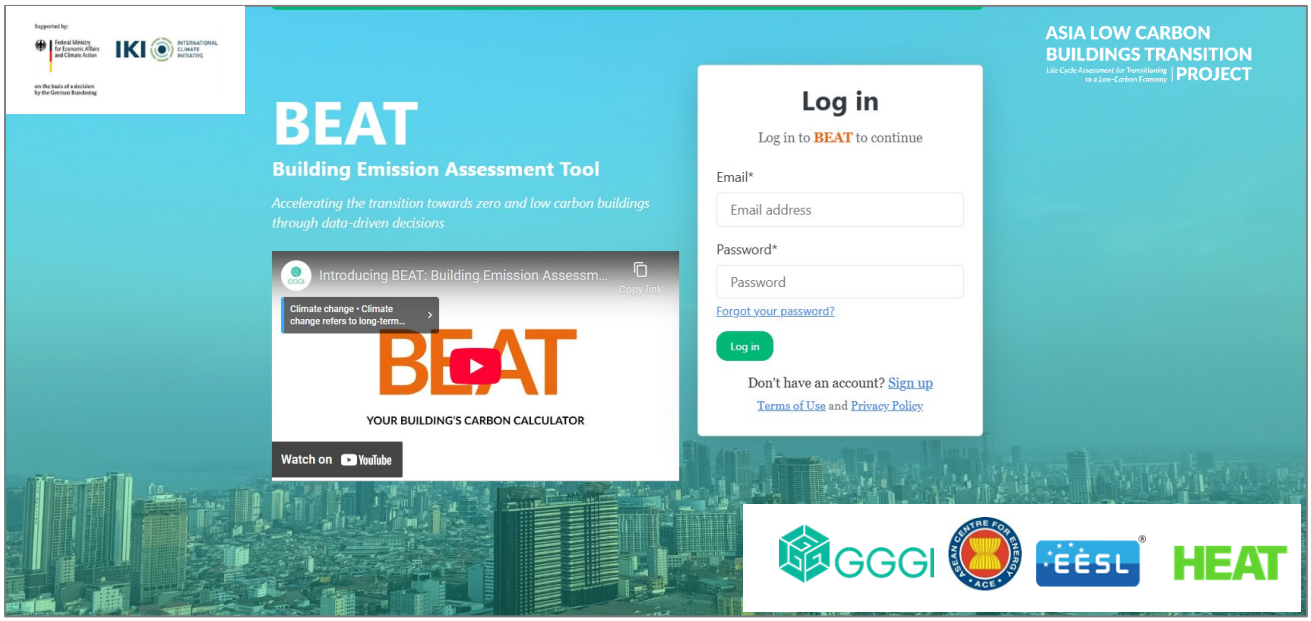

Figure 8: BEAT Developed under the ALCBT Project

3.2. Strengthening Energy Code Compliance

Mandatory compliance with ECSBC and ENS must be established for all new constructions and major retrofits to ensure that energy efficiency and sustainability standards are consistently upheld across the building sector. This regulatory measure strengthens the integration of low-carbon strategies into urban development.

To support effective implementation, training programs for municipal officials, architects, and building developers should be expanded. These capacity-building initiatives will equip stakeholders with the knowledge and skills required to enforce and adhere to energy efficiency standards, promoting widespread adoption of sustainable practices.

The building permit process should be streamlined by incorporating automated compliance verification tools, reducing procedural bottlenecks and ensuring efficient enforcement of ECSBC and ENS requirements. As part of this digital integration, the ALCBT BEAT should be utilized during the permit approval stage to assess projected energy consumption and carbon emissions for proposed constructions. This approach will enable early compliance verification in the design process, enabling data-driven approvals and improving regulatory efficiency. Embedding BEAT into the permitting workflow ensures that energy and carbon performance standards are upheld from the design phase, facilitating a smoother transition to low carbon construction while maintaining rigorous regulatory oversight.

3.3. Scaling Up Pilot Projects

The successful low-carbon pilot model must be expanded to include public and private buildings across Kerala, Uttar Pradesh, and Haryana, ensuring broader adoption of energy-efficient and sustainable construction practices. This scale-up should focus on replicating proven strategies, maximizing energy savings, and carbon emissions reduction across the built environment.

To support building owners in adopting low-carbon measures, financial incentive mechanisms must be developed, including subsidies, tax benefits, and concessional loans. These financial instruments can help reduce upfront costs, making energy efficiency upgrades more accessible and economically viable.

Strategic partnerships must also be established with ESCOs and green financing institutions to enable large-scale implementation. These collaborations provide technical expertise, financial support, and performance-based contracting models, ensuring the long-term sustainability of low-carbon initiatives in the building sector.

3.4. Policy and Regulatory Enhancements

A state-level Low-Carbon Building Task Force must be established to oversee the implementation and scaling of energy-efficient and sustainable building initiatives. This task force would play a crucial role in coordinating efforts, monitoring progress, and ensuring alignment with broader sustainability objectives.

State building policies must be better aligned with national climate goals and global best practices, reinforcing the state's commitment to reducing carbon emissions in the built environment. These policy enhancements will help embed international benchmarks and standards into state regulations, fostering a more resilient and energy-efficient construction sector. To accelerate investment in low-carbon buildings, public-private partnerships must be actively promoted. Leveraging private sector expertise and financing can drive widespread adoption of sustainable building practices, generating long-term economic and environmental benefits.

4. NEXT STEPS TOWARDS ALCBT GOAL: REPLICATION IN OTHER STATES

The successful completion of the Building Registry activities under the ALCBT Project in India will lay a strong foundation for the transition to energy-efficient, low-carbon buildings. The findings and recommendations to be presented along with this document provide a clear roadmap for institutionalizing energy efficiency, strengthening regulatory frameworks, and scaling up low-carbon interventions.

4.1 Proposed Next Steps for Government Action

1. Adopt the building registry as an official state-level initiative.
2. Integrate energy and carbon assessment tools into municipal building codes.
3. Expand pilot projects through state funding and private sector participation.
4. Establish a Low-Carbon Building Task Force to lead policy formulation and implementation.

By adopting these measures, state governments can position themselves as leaders in low-carbon urban development, ensuring sustainable growth and enhanced climate resilience in the building sector.

Figure 9: Sample Images of Selected Buildings from India

About ALCBT Project

The Asia Low Carbon Buildings Transition (ALCBT) Project seeks to significantly reduce GHG emissions by catalyzing nationwide transition towards low carbon buildings in Cambodia, India, Indonesia, Thailand, and Vietnam. In India, the project is being implemented across three states Kerala, Haryana and Uttar Pradesh under the guidance of the Ministry of Housing and Urban Affairs and with support of the state-designated agencies. The project addresses regulatory, capacity, and financing gaps that prevent large scale adoption of low carbon buildings and build technical GHG emission reduction targets from building materials and operations, particularly from cooling, complementing regional and global initiatives. The ALCBT project implementation is led by the Global Green Growth Institute (GGGI) in partnership with the ASEAN Centre for Energy (ACE), Energy Efficiency Services Limited (EESL), and HEAT International. It is supported by the German Federal Ministry for Economic Affairs and Climate Action under the International Climate Initiative.

About GGGI

The Global Green Growth Institute (GGGI), headquartered in Seoul, Republic of Korea is a treaty-based international, inter-governmental organization dedicated to supporting and promoting strong, inclusive and sustainable economic growth in developing countries and emerging economies.

About ACE

The ASEAN Centre for Energy (ACE) is an intergovernmental organization within the Association of Southeast Asian Nations' (ASEAN) structure that represents the 10 ASEAN Member States' (AMS) interests in the energy sector.

About EESL

Energy Efficiency Services Limited (EESL) is a super energy service company that seeks to unlock energy efficiency market in India, estimated to at Rs. 74,000 crore that can potentially result in energy savings of up to 20 percent of current consumption, by way of innovative business and implementation models.

About HEAT International

HEAT International is an independently acting consulting firm with 30 years of experience in the field of climate, heating & cooling, and transport. HEAT's goal is to support countries in their effort to mitigate emissions and to implement transformative pathways towards zero GHG emission solutions.

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ASIA LOW CARBON BUILDINGS TRANSITION PROJECT

Life Cycle Assessment for Transitioning to a Low-Carbon Economy | PROJECT

HQ Address:
The Global Green Growth Institute
19F Jeongdong Building 21-15, Jeongdong-gil Jung-gu, Seoul
Republic of Korea 04518

Office in India:
The Global Green Growth Institute
M-6 Haus Khas, Third Floor, Aurobindo Marg. New Delhi – 110068
Contact: india@gggi.org | +91 +91 1140501471

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