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Training Workshop
on
Lifecycle Carbon Assessment Using the
Building Emission Assessment Tool (BEAT)

Note: This training material was prepared specifically for use in the Cambodian country context.

Supported by:
Federal Ministry for Economic Affairs and Climate Action
INTERNATIONAL CLIMATE INITIATIVE
on the basis of a decision by the German Bundestag

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EESL HEAT

Introduction to Asia Low Carbon Buildings Transition (ALCBT) Project

HEAT

Content

1

- Introduction to ALCBT
- ALCBT video

2

- Introduction to HEAT
- Embodied Carbon: Rational and importance Its context in Cambodia

3

- BEAT walkthrough, methodology, data requirements,
- Understanding EPDs

4

- Demonstration of the use of the BEAT
- Case study – Part 1

5

- Case study – Part 2
- Interpreting results
- Next steps

8

- Conclusion
- Contact Info

ALCBT Project Overview

Impact: Nationwide transition towards low carbon buildings in Asian countries, substantially reducing GHG emissions from the sector.

Outcome: Technical, planning, and institutional tools for low carbon buildings have been successfully implemented by key public and private sector stakeholders in **Cambodia, India, Indonesia, Thailand, and Vietnam**.

Implementation period:
August 2023 – August 2028

Key Project Participants

- National & local government
- Building industry professionals
- Financial services institutions
- Universities & academia

Project Funding:
EUR 19.3 million

Target Outputs

- **Standardized tools and systems** for managing building carbon emissions
- **Enhanced capacity** of key stakeholders to deliver low carbon buildings
- **Financial pathways** established for low carbon buildings transition
- Knowledge products produced to facilitate **replication and scaling up**

Total **1.67** million tCO2eq
Direct and indirect emission reduced

Total **19,000+** people
Enhanced knowledge and capacity

EUR **140** million
Investment mobilized

Project Governance

Consortium Lead

GGGI

Government Counterpart

Funding Partner

Federal Ministry for Economic Affairs and Climate Action

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GGGI's Consortium Partners	Broad Role	Country (ies)
ASEAN CENTRE FOR ENERGY • ACE •	▪ **Develop Technical Learning Tools** to promote Low Carbon Buildings (LCBs) ▪ Facilitate development and use of Energy Performance Contract (EPC) and On-Bill Financing Model to promote LC Building by SME players in Building Sector ▪ **Knowledge sharing & capacity enhancement** on sustainable building across ASEAN member countries	**All 5 Countries**
HEAT	▪ **Develop methodology and Tool** for whole building Lifecycle GHG Assessment calculations, establish GHG baseline ▪ **Training** on building MRV Tools, LCBs & sustainable cooling, building taxonomy, and policy Integration (NDC, LEDS) ▪ **Training of Trainers** on LC Building Tools	**All 5 Countries**
EESL	▪ **Implementation LCBs** through **ESCO Model** ▪ **Capacity Building & Training** ▪ **Pilot demonstration** on sustainable AC system in **100 buildings** in **India (60)** and in **2 countries (40)** to demonstrate Demand Aggregation and Bulk Procurement	**India** 2 other Countries

Video: Introducing ALCBT Project

Click the play button or this link to watch the video.

HEAT

ASIA LOW CARBON BUILDINGS TRANSITION PROJECT

Life Cycle Assessment for Transitioning to a Low-Carbon Economy

Introduction to HEAT activities in ALCBT

ASEAN CENTRE FOR ENERGY · ACE

EESL

GGGI

Supported by:

Federal Ministry for Economic Affairs and Climate Action

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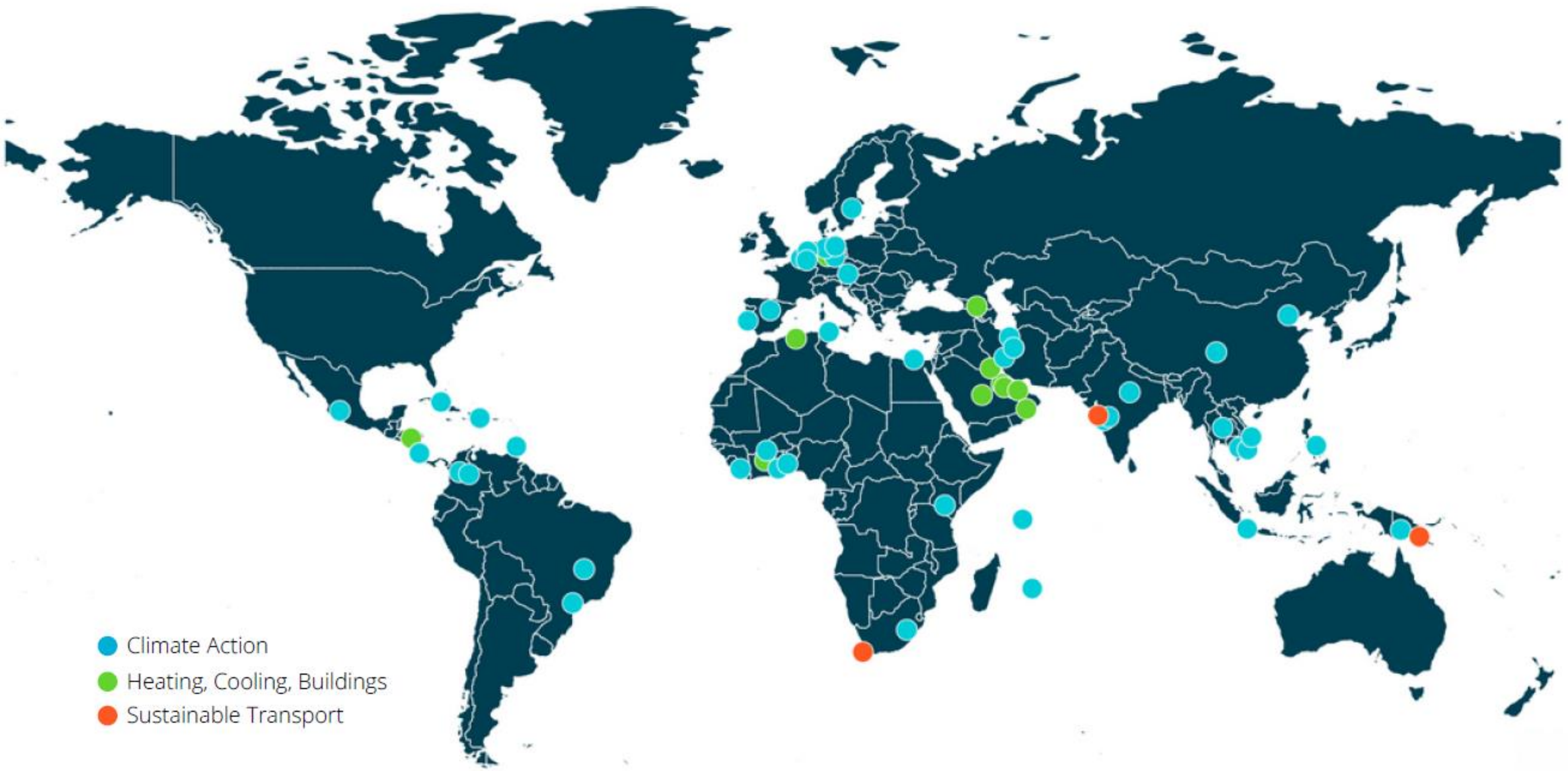
on the basis of a decision by the German Bundestag

Who we are and where we work?

GFA GROUP
Your purpose Our expertise | HEAT

HEAT GmbH has been committed to climate and environmental protection for over 30 years. Our extensive experience are in our three core areas: climate action; sustainable transport; climate-friendly heating, cooling of buildings, as well as in managing projects of international cooperation.

HEAT GmbH office is based in Frankfurt, Germany but maintains a global footprint, having worked in over 50 countries across Africa, Asia, Latin America, and Europe. We have local staff in Brazil, Colombia, India, US, Australia and Japan.



HEAT Activities for ALCBT

WP I: Country-specific institutional tools

Activity I-1.1:

BEAT and MRV Tool development

Activity I-1.3:

Policy Recommendations

WP II: Capacity development

Activity II-1:

Training and capacity building of BEAT and MRV tool

HEAT Activities for ALCBT

WP III: Finance tools and mechanisms

Activity III.2:

Building taxonomy development

WP IV: Replication and scaling up

HEAT

Embodied Carbon in Buildings

Relevance and importance

Image source:https://www.lek.com/insights/by/building-materials-supply-chain-disrupted-changes-consumer-behaviour

Which of the following best describes embodied carbon?

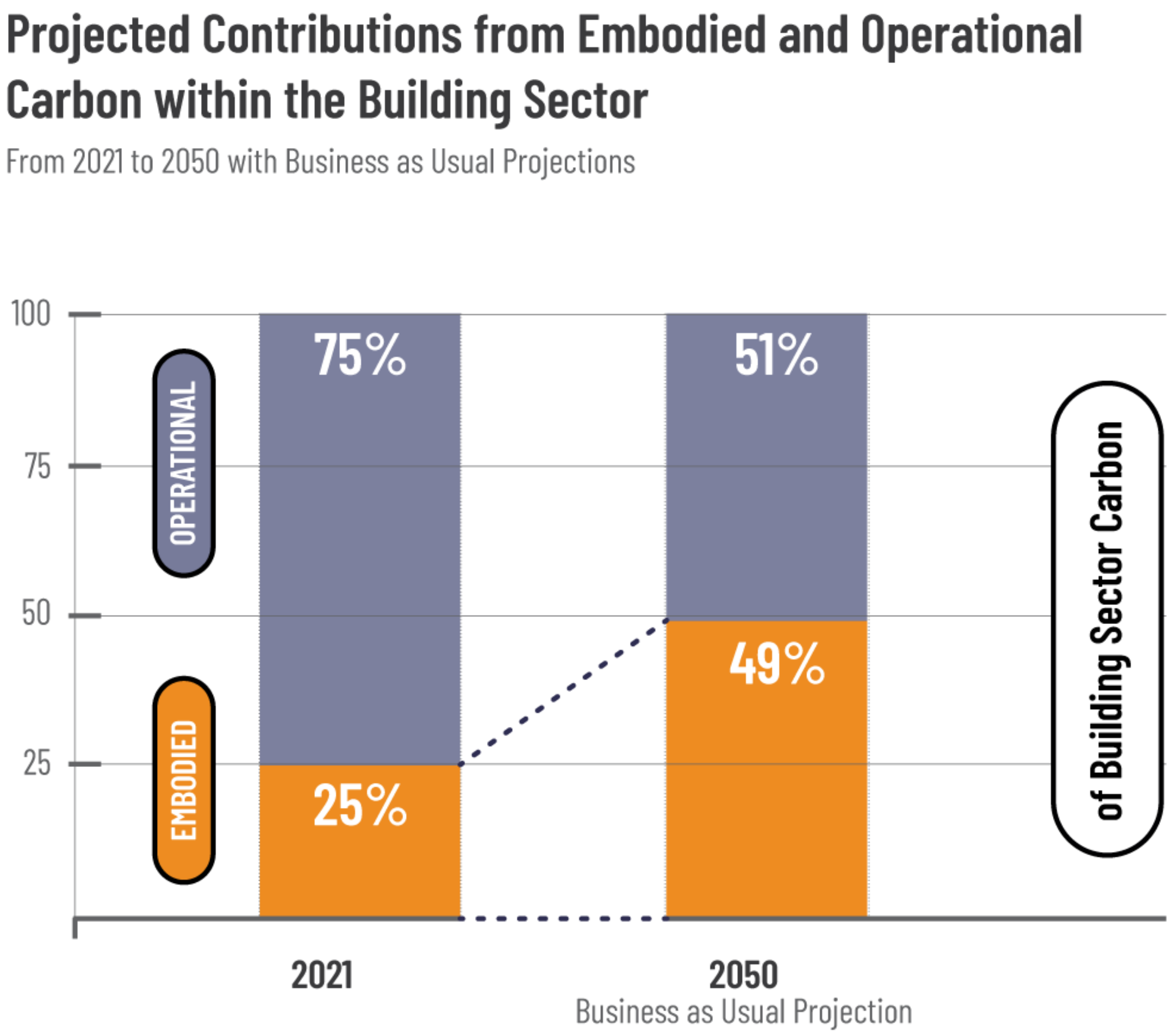
WHOLE LIFE CARBON

Embodied and Operational Carbon

- The **Whole Life** of a Building is the "entire life of a building from the material sourcing, manufacturing, construction, use over a given period, demolition and disposal or reuse"
- **Whole Life Carbon (WLC)** refers to the carbon impacts over the entire life cycle of a built asset, from its construction through to its end of life. It is composed of two main sources of emissions: **operational and embodied**
- The whole life carbon of a building broadly consists of **embodied carbon and operational carbon.**
- In addition, there are also user carbon impacts from the activities of the users of a built asset, outside of the use of energy and water used to operate the asset.

Source: RICS (2023). Whole life carbon assessment for the built environment. 2nd edition, Version 2

WHY EMBODIED CARBON?



"Operational carbon will continue to decrease with grid decarbonization, while embodied carbon is set to remain high without meaningful action".

(Building Materials and the Climate: Constructing a New Future, GABC, UNEP, 2023)

Source: global ABC website - https://globalabc.org/buildingmaterialsandclimate/chapte-2-life-cycle-thinking/2-1-embodied-versus-operational-carbon-emissions-in-buildings.html

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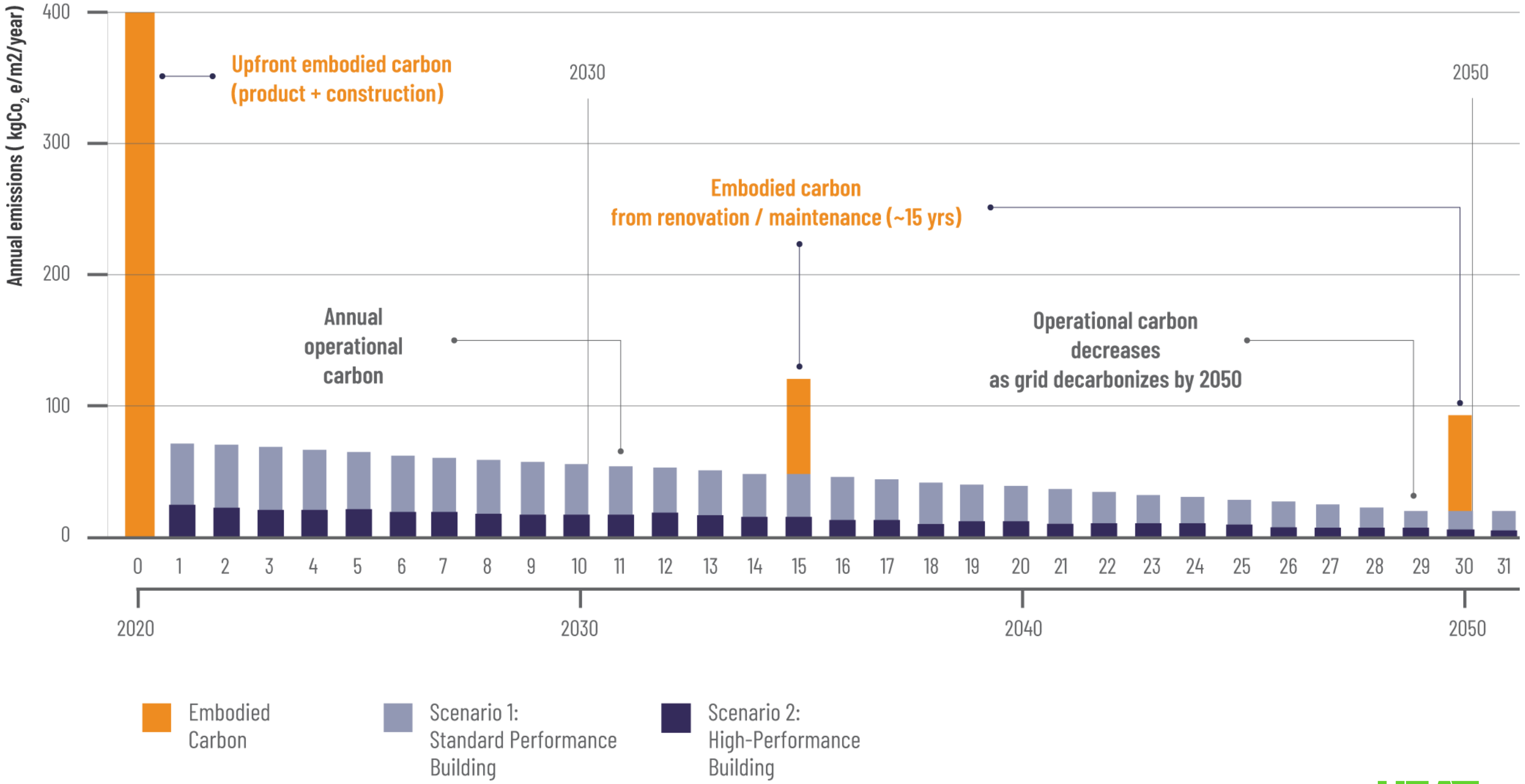
Projected Impact of Embodied Carbon Relative to Operational Carbon 2020-2050



Source: global ABC website - https://globalabc.org/buildingmaterialsandclimate/chapte-2-life-cycle-thinking/2-1-embodied-versus-operational-carbon-emissions-in-buildings.html

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Which stage emits the most embodied carbon?

BUILDING LIFE CYCLE

Various stages

Whole life carbon assessment information

Whole life carbon – System boundary

Embodied carbon/Life cycle embodied carbon

Production
- A0: Nonphysical process before construction, preliminary studies, test and design
- A1: Raw materials supply
- A2: Transport
- A3: Manufacturing

Upfront biogenic carbon

Construction
- A4: Transport
- A5: Construction and installation process

Biogenic carbon

Operation
- B1: Use
- B2: Maintenance
- B3: Repair
- B4: Replacement
- B5: Refurbishment

Biogenic carbon

End of life
- C1: Deconstruction/ Demolition
- C2: Transport
- C3: Waste processing
- C4: Disposal

Biogenic carbon

Operational Carbon
- B6: Operational Energy
- B7: Operational Water

User Carbon
- B8: User activities not covered in B1-B7

Circular Economy

Beyond Asset life
- Benefits and loads beyond system boundary
- D1: Net output flows from reuse, recycle, energy recover, other recovery
- D2: Exported utilities, e.g. electric energy, thermal energy, portable water

Biogenic carbon

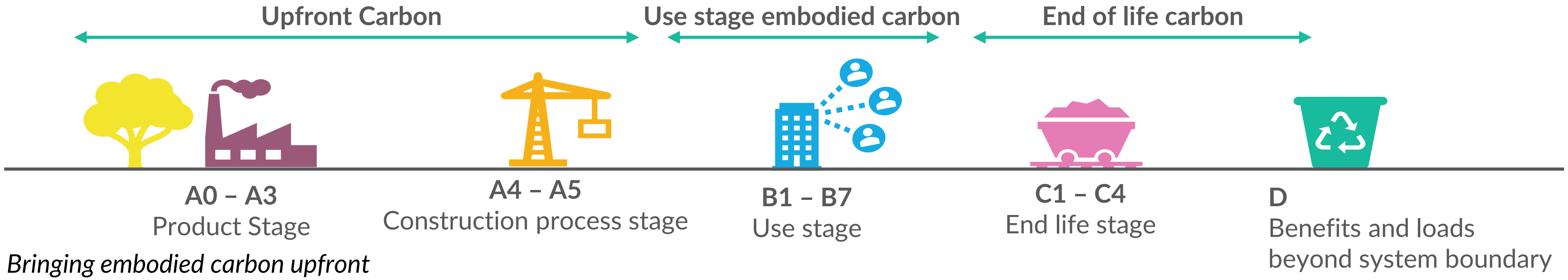
Source: RICS (2023). Whole life carbon assessment for the built environment. 2nd edition, Version 2

EMBODIED CARBON

Upfront, during Use and End of Life

Embodied carbon denotes carbon emissions associated with materials and construction processes throughout the whole lifecycle of a building. This includes:

- **Upfront carbon:** The emissions caused during the building material production and construction phases (A0-5) of the building's lifecycle before it is used. In contrast to other categories of emissions listed here, these emissions have already been released into the atmosphere before the building is occupied or the infrastructure begins operation.
- **Use stage embodied carbon:** Emissions associated with building materials and processes needed to maintain the building or infrastructure during use such as for refurbishments (B1-5). These are additional to operational carbon emitted due to heating, cooling and power etc.
- **End of life carbon:** The carbon emissions associated with deconstruction/demolition (C1), transportation from site (C2), waste processing (C3) and disposal (C4) phases of a building or infrastructure's lifecycle which occur after its use.



Source: WGBC (2019). Bringing embodied carbon upfront

Which of the following national documents or frameworks explicitly mention or relate to reducing embodied carbon in Cambodia?

EMBODIED CARBON

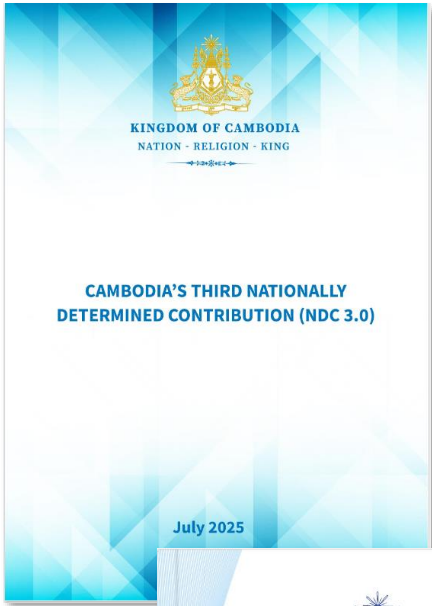
In Cambodian policies

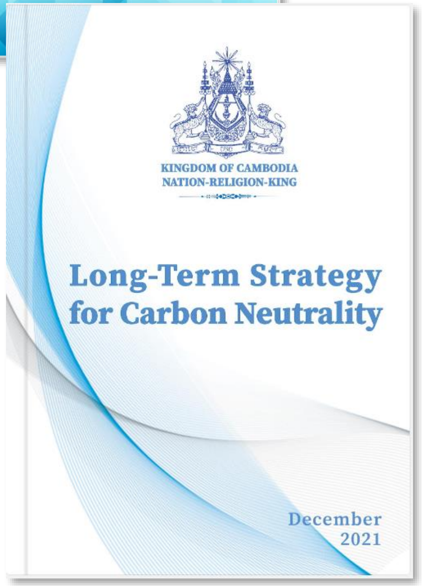
Cambodia NDC 3.0 by 2035:

- **Clinker reduction**: Transition to low-carbon materials by lowering the clinker-to-cement ratio from 90% to 75% by 2035, with emission reduction: 6.8 $MtCO_2e$ by 2035.
- Use of Supplementary Cementitious Materials (SCMs) like fly ash and blended cement
- Energy efficiency in cement sector: Emission reduction of 8.42 $MtCO_2e$ by 2035
- Timeline: These clinker and efficiency measures are explicitly set for 2026–2035

Cambodia LTS4CN by 2050:

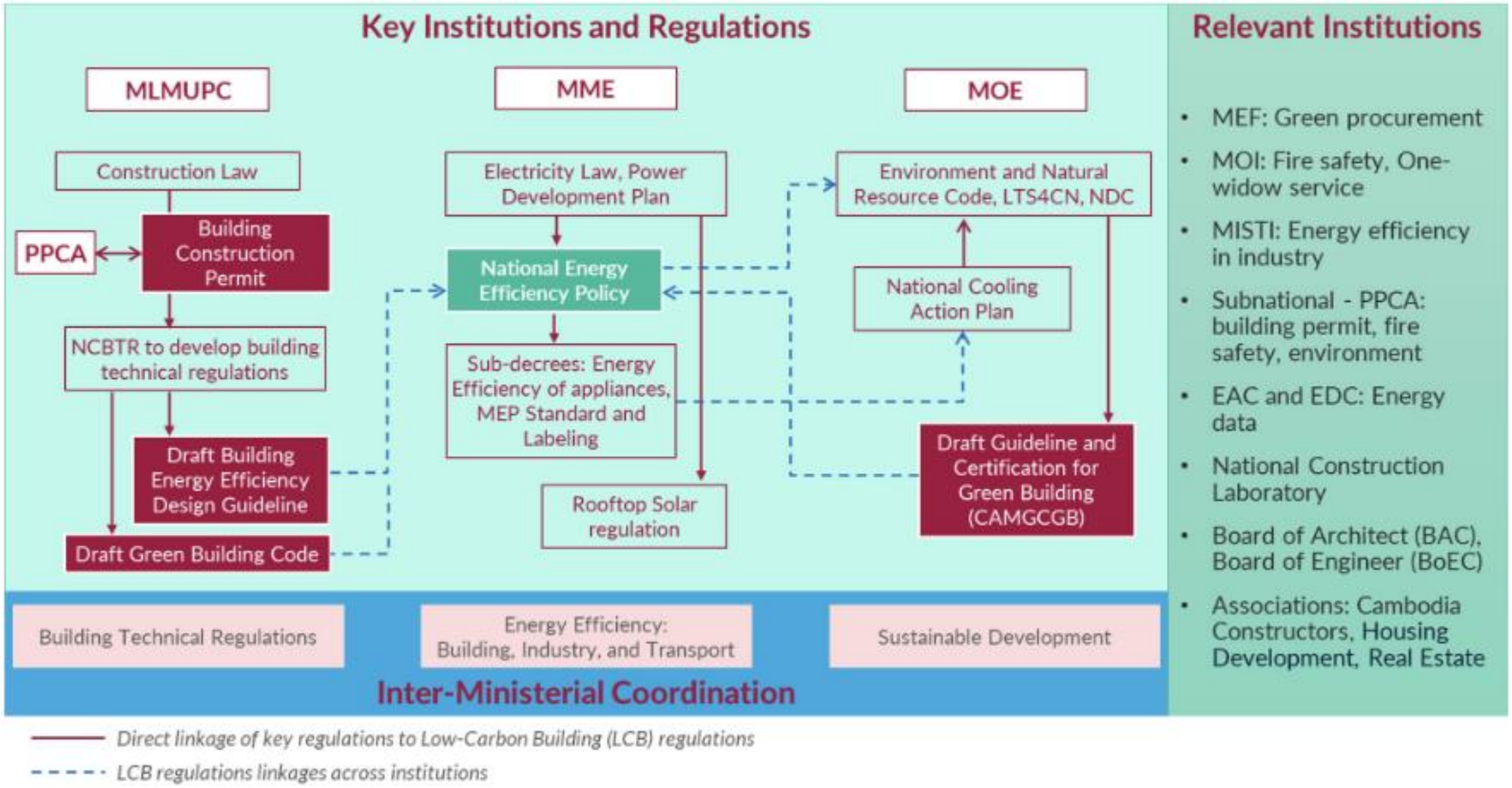
- **3 measures**: i) clinker substitution; ii) Carbon capture and storage (CCS) for cement kilns iii) Recycling of aggregate concrete
- **Industrial policy** changes mandating lower clinker composition; incentives (subsidized loans) for cement producers to adopt clinker substitution and CCS
- **Timeline**: Aligned with 2050 carbon neutrality, with progressive implementation throughout the 2020s–2040s.

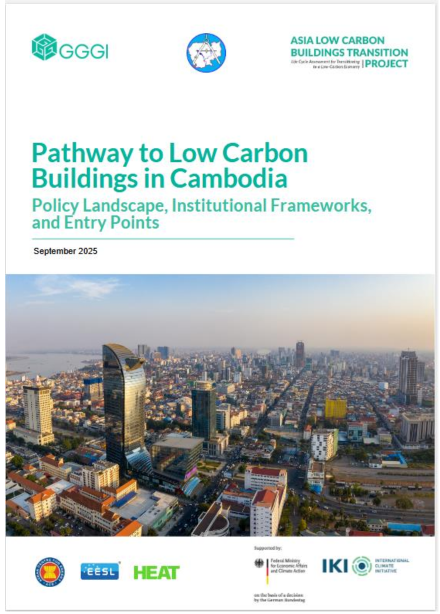




Institutional Framework for Low Carbon Buildings

In Cambodian context





Source: GGGI Cambodia, 2025

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EMBODIED CARBON

Its relevance and importance

- **Time value of carbon:** Unlike operational carbon emissions, which can be reduced over time with building energy efficiency renovations and the use of renewable energy, embodied carbon emissions are locked in place as soon as a building is built. It is therefore critical to reduce embodied carbon emissions as quickly as possible.
- **Lowering embodied carbon can drive value:**
  - ➢ Reducing cost by reducing the construction materials needed in a project.
  - ➢ Carbon-reduction strategies in the production of high-emitting materials like concrete can also reduce cost.
  - ➢ Unless their process is driven by carbon-intensive chemical reactions, low embodied-carbon products will, by nature, result in energy savings upstream of a material's end use, resulting in cost savings for material manufacturers.
  - ➢ Projects that reduce embodied carbon and/or include a whole-building life cycle assessment can help to meet green building certification requirements.
  - ➢ Low-embodied-carbon building design will be better prepared for future code or policy changes that incentivize or require low embodied carbon.
  - ➢ Reducing emissions in the extraction, manufacturing, and transportation of low-embodied carbon materials improves air quality and public health in communities located close to industrial centers.

Source: RMI (2021). Reducing Embodied Carbon in Buildings: Low-Cost, High-Value Opportunities.

CAMBODIA's CONSTRUCTION

Forecast of Residential and Commercial Building Stock

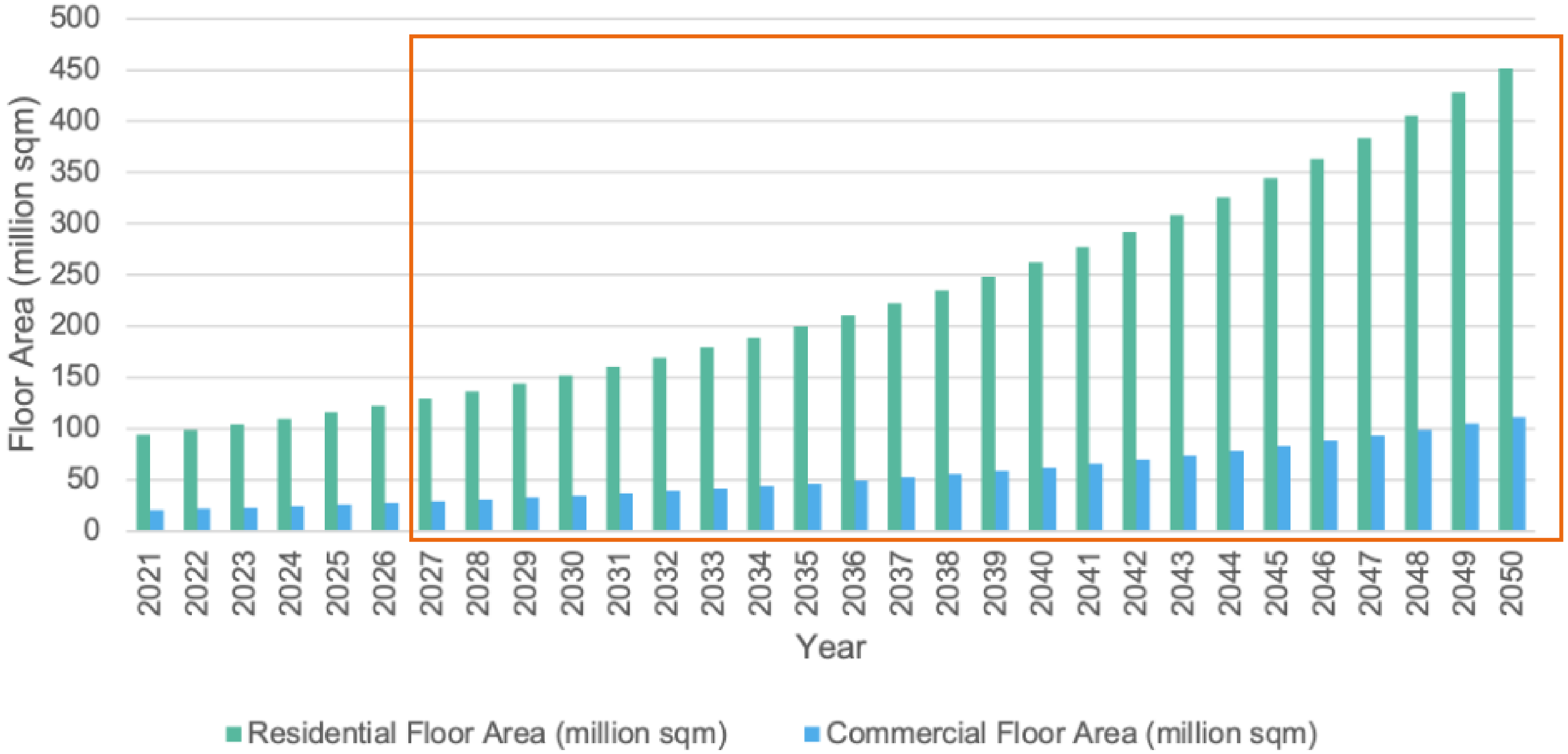


Figure 3: Forecast of Residential and Commercial Building Stock

- **400% Growth in Floor Area:** From 115 million m² (2021) → 563 million m² (2050)
- **Massive Energy Demand:** Building sector projected to consume ~35 GWh by 2050
- How about embodied carbon?

Source: GGGI Cambodia, 2025

Embodied Carbon in Buildings

Key driving materials

Image source:https://www.bricknbolt.com/blogs-and-articles/construction-guide/building-material-density-importance-construction

TO UNDERSTAND BUILDING EMISSIONS

HEAT

Lifecycle Stage Scope

Embodied Carbon

Product stage: A1 - A3

Construction stage: A4, A5

In-use stage: B1, B2, B3, B4, B5

End of life stage: C1, C2, C3, C4

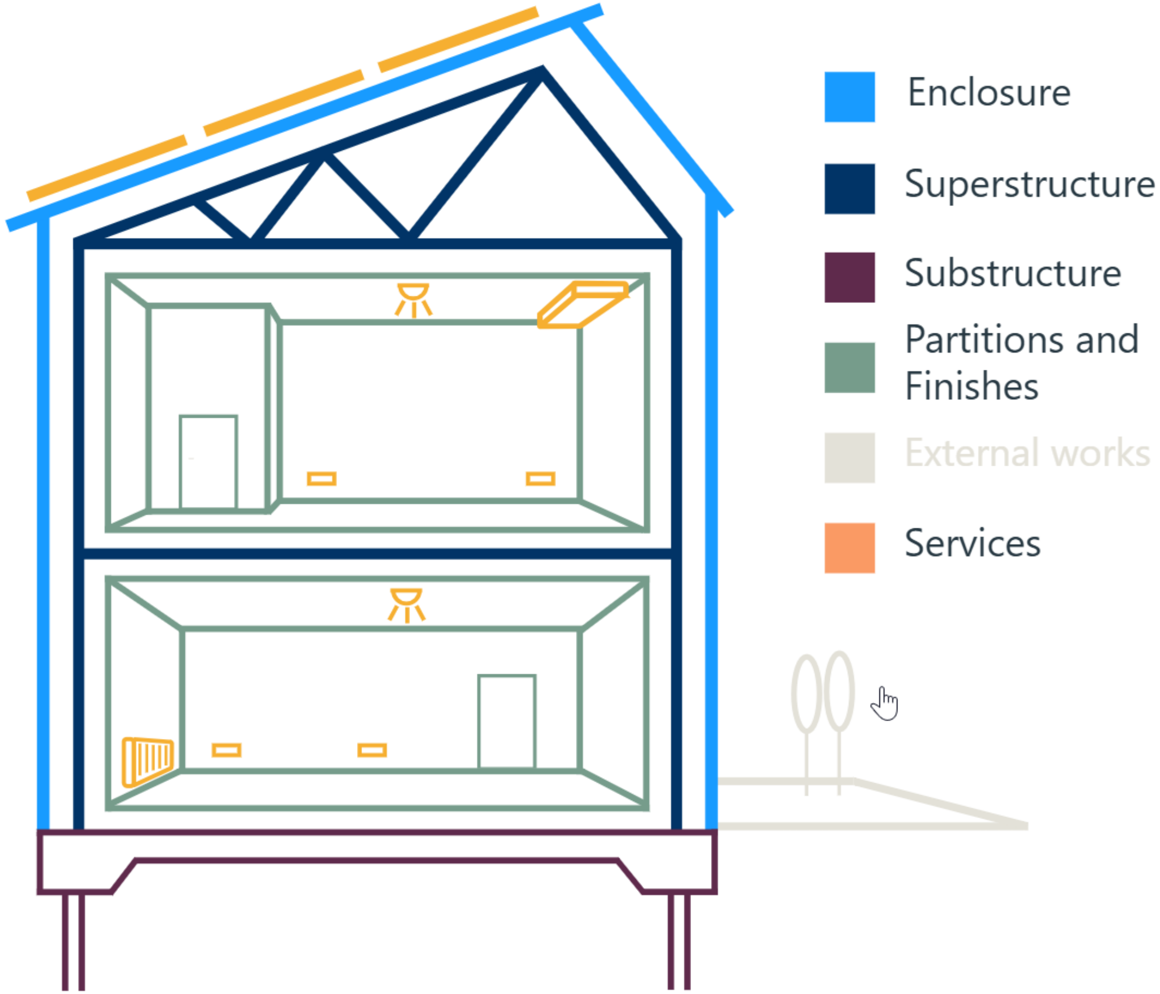
Biogenic

Operational Carbon

In-use stage: B6, B7, B8

Beyond System

D1, D2



Source: Ramboll

Which Material Has the Highest Embodied Carbon

HEAT

KEY DRIVING MATERIALS

Cement and Steel

A building's structure and substructure typically constitute the largest source of its up-front embodied carbon, up to 80% depending on building type. However, because of the relatively rapid renovation of building interiors associated with tenancy and turnover, the total embodied carbon from interiors can account for a similar order of emissions over the lifetime of a building.[1]

Globally, cement and steel are two of the most significant sources of material-related emissions in construction. Cement manufacture is responsible for 7% of global carbon emissions, with steel also contributing 7-9% of the global total (with half attributed to buildings).[2]

Both cement and steel are used in buildings in large quantities. These materials are carbon intensive as the manufacturing processes demand very high temperatures, achieved by firing of fossil fuels; carbon dioxide emissions occur due to combustion of fuels and also as part of chemical reactions during the manufacturing process.[2]

Cement/concrete and steel are the highest contributors to embodied carbon in typical construction in Cambodia. In Cambodia's industrial processes sector, cement production accounts for 74% of emissions, making it the dominant source of embodied carbon in construction materials. The energy sector analysis identifies cement and steel as requiring energy-intensive production processes that significantly contribute to the country's overall emissions profile[3]

[1]Source: Adapted from RMI (2021). Reducing Embodied Carbon in Buildings: Low-Cost, High-Value Opportunities.
[2]Source: Adapted from WGBC (2020). Asia Pacific Embodied Carbon Primer.
[3]Source: Royal Government of Cambodia. (2021). Cambodia's long-term strategy for carbon neutrality (LTS4CN). United Nations Framework Convention on Climate Change. https://unfccc.int/sites/default/files/resource/KHM_LTS_Dec2021.pdf

HEAT

KEY DRIVING MATERIALS

Other building materials

Walling materials are also significant contributors, as large number of buildings are RCC framed structures with masonry infill. Some of the walling materials like fired clay bricks and concrete blocks are carbon intensive.

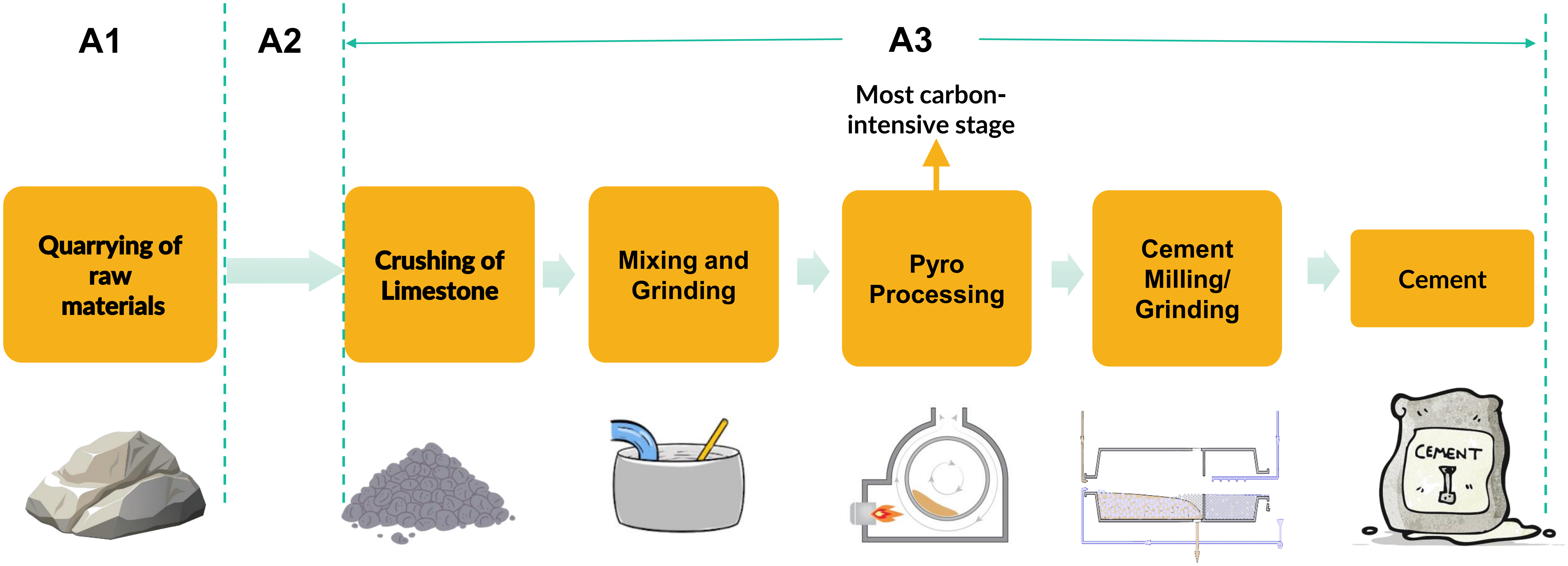
Similarly, glass and aluminum, which also have manufacturing processes at high temperatures, are carbon intensive, though their impact on buildings is smaller in comparison the cement and steel.

Depending on the type of buildings and the prevalent construction technology used in a region or country, the major materials driving embodied carbon may differ.

HEAT

CEMENT MANUFACTURING

Manufacturing process outline



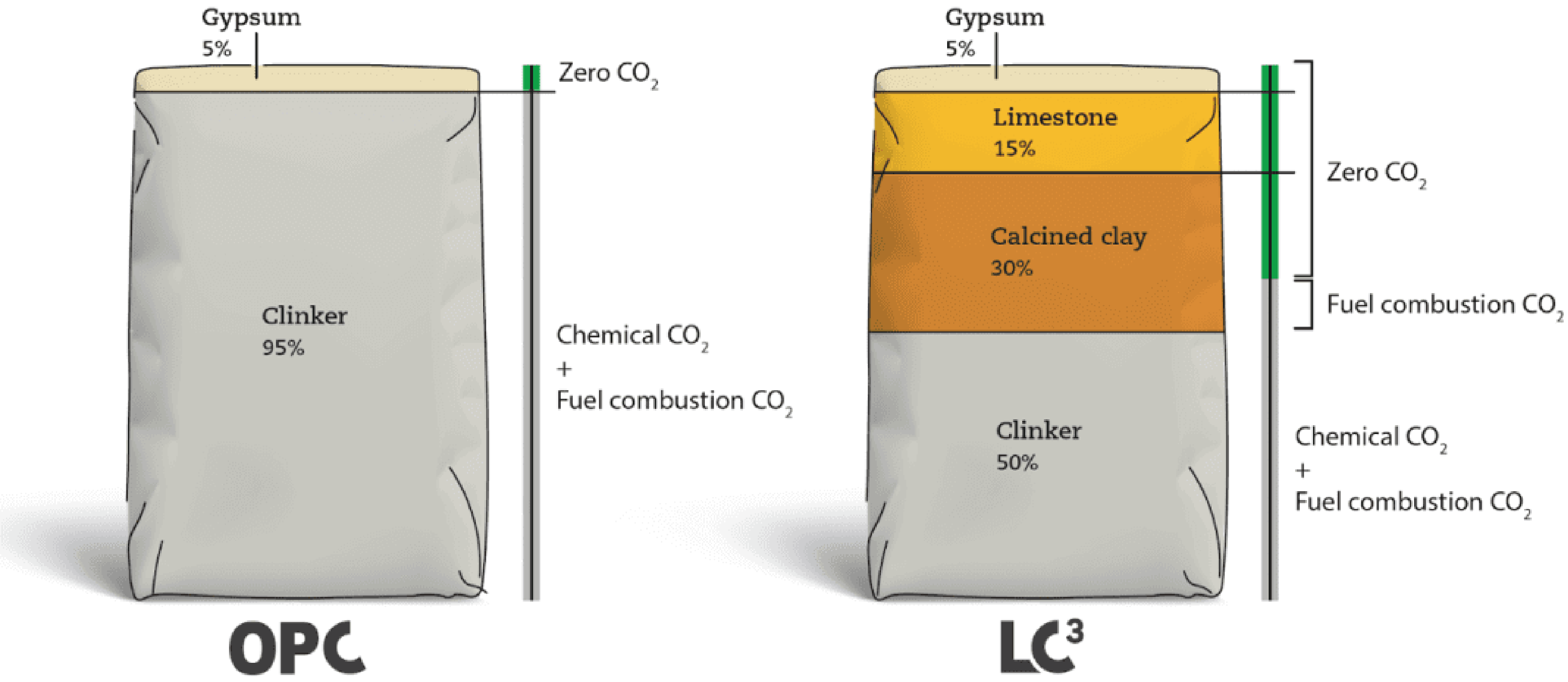
CEMENT MANUFACTURING

Options for reducing Carbon footprint

- **Use of alternative raw materials like fly ash, slag and other supplementary cementitious materials (SCMs)**
- **Use of alternative energy sources for reducing Carbon footprint**
    - Use of waste materials like tyres, fabrics, paper, municipal solid waste, hazardous waste, etc. as supplementary fuels in kilns for pyro processing.
    - Using sustainable fuels like biomass for partial substitution of fossil fuels in kilns.
    - Increasing pre-calciner stages to reduce exhaust gas temperature.
    - Electrical power generation from process waste heat.
    - Using renewable energy sources (biomass / solar) for the electricity power.
    - Green hydrogen as fuel in the pyro-processing / clinker-making process.
    - Explore possibility of electrification of kilns (technology is at a nascent stage).
- **Carbon emissions management through carbon capture, utilisation, and storage (CCUS) and carbon offsets**

LC3 CEMENT (Limestone Calcined Clay Cement)

Options for reducing Carbon footprint



Source: LC3.CH

LC3 CEMENT

Options for reducing Carbon footprint

Clinker substitution with alternative raw materials

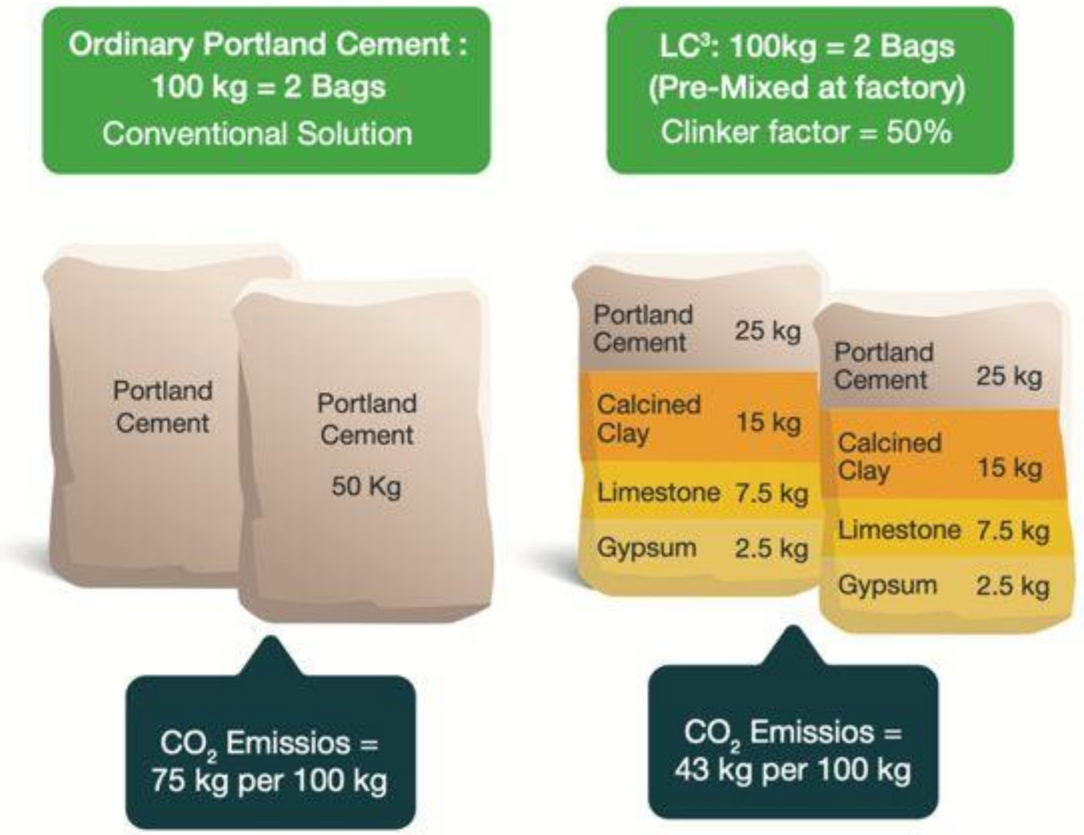
- Replaces 50% clinker with calcined clay (30%) and limestone (15%)
- Uses widely available low-grade kaolinitic clays
- Reduces CO2 emissions by 30-40% vs OPC

Energy optimization in production

- Clay calcination at 700-850°C uses 60% less energy than clinker production
- Limestone used uncalcined - no additional fuel needed
- Lower grinding energy requirements

Market readiness and performance

- Meets international standards (EN 197-1, ASTM C595)
- Comparable strength, improved durability



Source: LC3.CH

HEAT

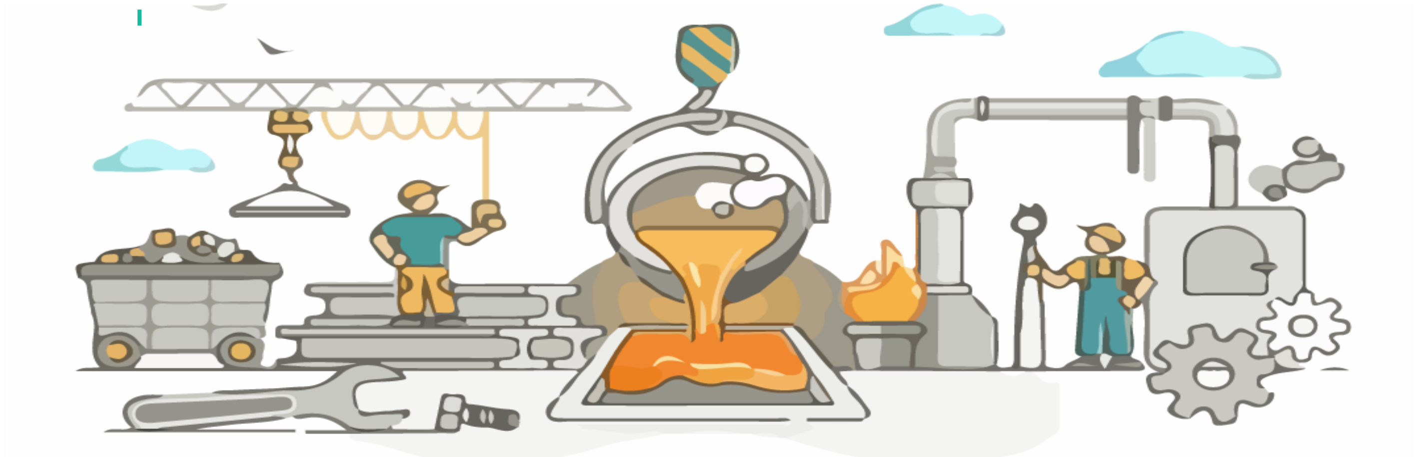
STEEL MANUFACTURING

Manufacturing process outline

A1 | A2 | A3

Most carbon-intensive stages

Mining → Iron Making → Steel Making → Crude Steel



STEEL MANUFACTURING

Options for reducing Carbon footprint

- **Energy efficiency measures**
  - Optimisation of raw material consumption.
  - Improvement in process and energy efficiencies.
  - Augmenting waste heat recovery.
  - Minimising re-heating of intermediate products.
- **Use of renewable energy for electricity power**
- **Alternative fuels for combustion and as reducing agents**
  - Explore possibilities for shifting from coal-based process to natural gas, biomass and green hydrogen; however, these options may be practically difficult to implement in existing plants.
- **Carbon management through carbon capture, utilisation, and storage (CCUS) and carbon offsets**

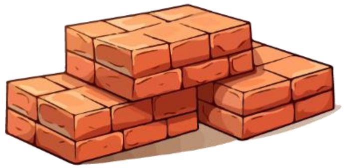
FIRED CLAY BRICK MANUFACTURING

Manufacturing process outline

A1 | A2 | A3

Most carbon-intensive stage

Excavation of soil → Preparation of clay mix → Moulding (Manual Process) → Sun drying → Firing in Kiln → Stacking



FIRED CLAY BRICK MANUFACTURING

Options for reducing Carbon footprint

- **Energy efficiency measures**
  - Efficient combustion of fuels
  - Manage and monitor use of raw materials and fuel as well as the emissions
- **Alternative fuels for combustion**
  - Explore possibility of fuel substitution from coal to natural gas, biomass, etc.
- **Use of renewable energy for electrical power**
- **Changing the fired walling product**
  - Manufacturing alternative fired walling blocks like hollow or perforated bricks etc., which require less raw material and fuel. This will also entail changes in the production process.

How Can I Estimate the Embodied Carbon of My Building?

WHY ENGINEERS & ARCHITECTS SHOULD LEARN ABOUT EMBODIED CARBON

HEAT

- **Regulatory & Market Shift –** Governments and clients are demanding carbon reporting and low-carbon designs, with future building codes enforcing embodied carbon limits.
- **Major Carbon Impact** – Embodied carbon can be 50-80% of a building's total emissions before use, making it a key factor in sustainable construction.
- **Competitive Advantage –** Mastering low-carbon materials and design provides an edge, leading to better projects, certifications, and market leadership.
- **Cost & Resource Efficiency** – Smart material choices reduce costs, minimize waste, and optimize energy use while aligning with circular economy principles.
- **Future-Proofing Careers & Projects** – The industry is moving towards carbon accountability, and professionals who adapt will stay relevant and lead innovation

Embodied Carbon in Buildings

Calculation methodology

HEAT

EMBODIED CARBON

Calculation methodology

Embodied carbon in buildings is commonly measured in **$kgCO_2e/m^2$ (kilograms of carbon dioxide equivalent per square meter of building)**. This allows comparison of embodied carbon of different buildings.

Simply put, the calculation is:

Inventory	×	Impacts	=	Total
Quantity of materials or products used in building		**Carbon factor or GWP of respective material or product**		**Total embodied carbon emissions**

The 'product stage' (A1-A3) emissions relating to the raw material extraction, shipping to factory and manufacturing is what is most commonly available in embodied carbon databases.

So, the calculation above, using figures from the carbon database, gives the carbon emissions of materials only for A1-A3 stages of the building life cycle.

Source: https://www.ribaj.com/intelligence/how-to-calculate-embodied-carbon-for-riba-2030-climate-challenge

GLOBAL WARMING POTENTIAL

Major building materials (India)

Material / Product	Unit	GWP ($kgCO_2$/unit) (A1-A3 stages)	Geography	Source
Ordinary Portland Cement (OPC)	kg	0.842	India	*CSE (2023). Decarbonizing India: Cement Sector.*
Portland Pozzolana Cement (PPC)	kg	0.582	India	
Portland Slag Cement (PSC)	kg	0.381	India	
Concrete	m^3	~450 to ~240 (Varies as per mix used)	Global	*Witte, A. and Garg, N. (2024). Case Studies in Construction Materials.*
Steel	kg	2.3 – 2.5	India	*Various, including Ministry of Steel (2020), CSE (2023), CEEW (2023)*
Solid Burnt Clay Brick	m^3	198.87	India	*Maithel, S. (2023). Book of Proceedings. CATE 2023.*
Solid Concrete Block	m^3	~200	India	*Calculated from India Construction Materials Database of Embodied Energy and Global Warming Potential (2017).*
Aluminium	kg	26	India	
Glass (6mm thick)	m^2	~19	India	*Manufacturer's EPD*

GLOBAL WARMING POTENTIAL

Major building materials (Indonesia)

Material / Product	Unit	GWP ($kgCO_2$/unit) (A1-A3 stages)	Geography	Source + Remarks
Ordinary Portland Cement (OPC)	kg	0.90-0.95	Indonesia	*Keintjem et al. (2024). Embodied Carbon in Concrete: Insights from Indonesia. ETASR, Suwondo et al. (2024). Comparative analysis of LCI. Journal of Material Cycles*
Portland Pozzolana Cement (PPC)	kg	0.65-0.7	Indonesia	
Portland Composite Cement (PCC)	kg	0.55-0.6	Indonesia	
Concrete	m^3	~350 to ~450	Indonesia	*Keintjem et al. (2024) - Higher than UK/US due to higher cement content*
Concrete with fly ash	m^3	~200 to ~260	Indonesia	*Same as above - 42% reduction vs standard concrete*
Steel (Rebar/Structural)	kg	2.2 – 2.5	SE Asia/Global	*UNSW (2024)*
Aluminium	kg	18-22	SE Asia/Global	*Same as above*
Solid Burnt Clay Brick	m^3	200-250	Indonesia	*Estimated from regional data*
Lightweight Concrete Block	m^3	150-180	Indonesia	*Agustiningtyas, R. S. et al. (2023)*
Glass (6mm float)	m^3	15-20	SE Asia	*Vitro Glass EPD (2024)*
Timber (Engineered)	m^3	-500 to -800	Indonesia	Carbon storing material (negative emissions)
Bamboo	m^3	-600 to -900	Indonesia	
Geopolymer Concrete	m^3	150-200	Indonesia	*Emerging alternative - 60% lower than OPC concrete*

EMBODIED CARBON

Calculations

Inventory	×	Impacts	=	Total
Quantity of materials or products used in building		Carbon factor or Global Warming Potential (GWP) of respective material or product		Total embodied carbon emissions

Material quantities: Data for material quantities used in a building are usually available with the project proponent in the form of a "Bill of Quantities" (BoQ).

Building Information Modeling (BIM) design tools can also provide material quantity estimates in the design phase.

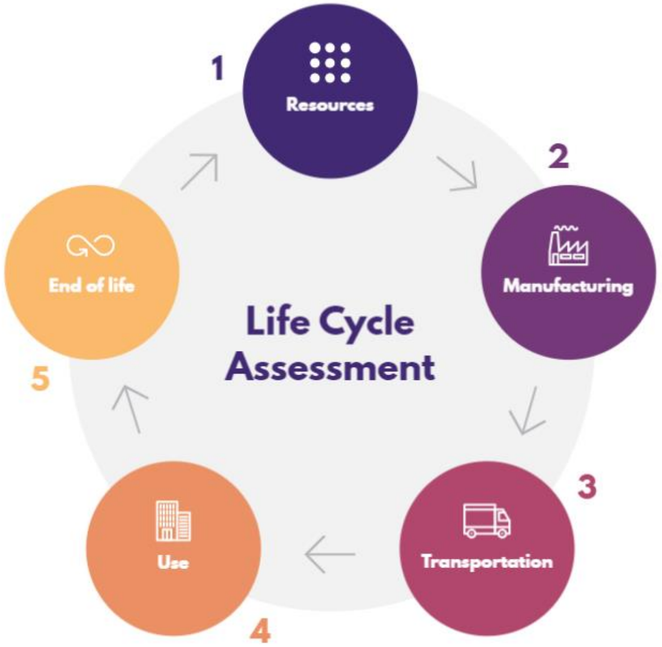
Carbon factor / GWP of building materials:

Sources in order of preference

- Manufacturer's specifications or product specific Environmental Product Declaration (EPD)
- Generic government or market-based or industry databases or Life Cycle Inventories (LCIs)
- Other databases like the Inventory of Carbon and Energy (ICE) database, etc.

Introduction to BEAT

Calculation methodology



HEAT

BEAT

YOUR BUILDING’S CARBON CALCULATOR

HEAT

BUILDING
EMISSION
ASSESSMENT
TOOL

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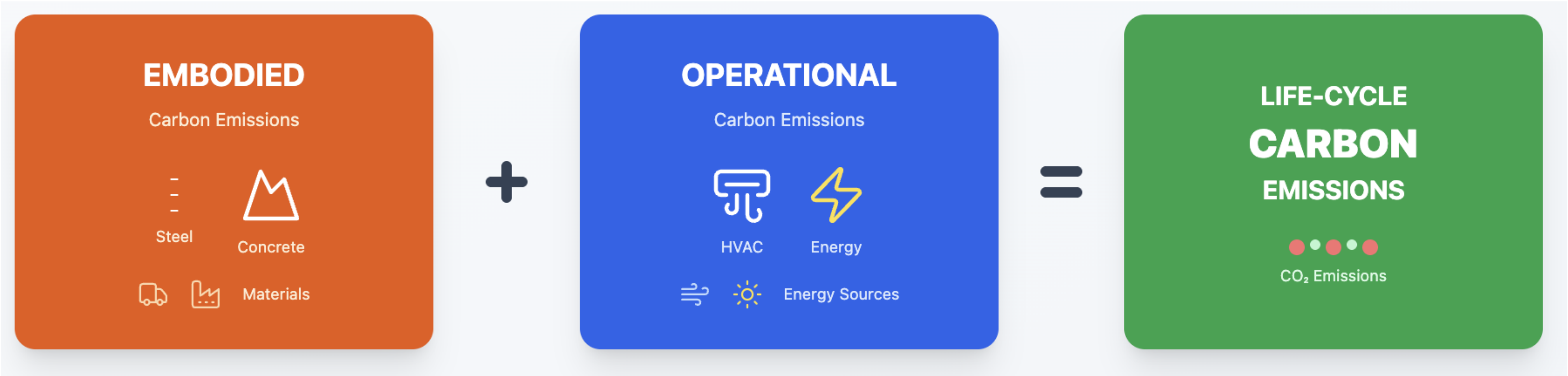
WHAT IS BEAT?

An easy-to-use **interactive tool** designed to help you **calculate your buildings carbon emissions** and make **informed decisions toward a low-carbon transition.**



Embodied Emissions: Assess emissions from manufacturing, transport and installation of building materials.

Operational Emissions: Operational Emissions: Calculate energy consumption during building operation.

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KEY BENEFITS OF THE BEAT

- Tailored to Asia's fast-growing building markets
- Supports national GHG inventories and climate targets
- Measures full building **emissions by quantifying both embodied and operational carbon**
- Enables **low-carbon investment decision-making**
- Fills data gaps with innovative **EPD-based methods**
- Promotes **transparency** in building-related emissions

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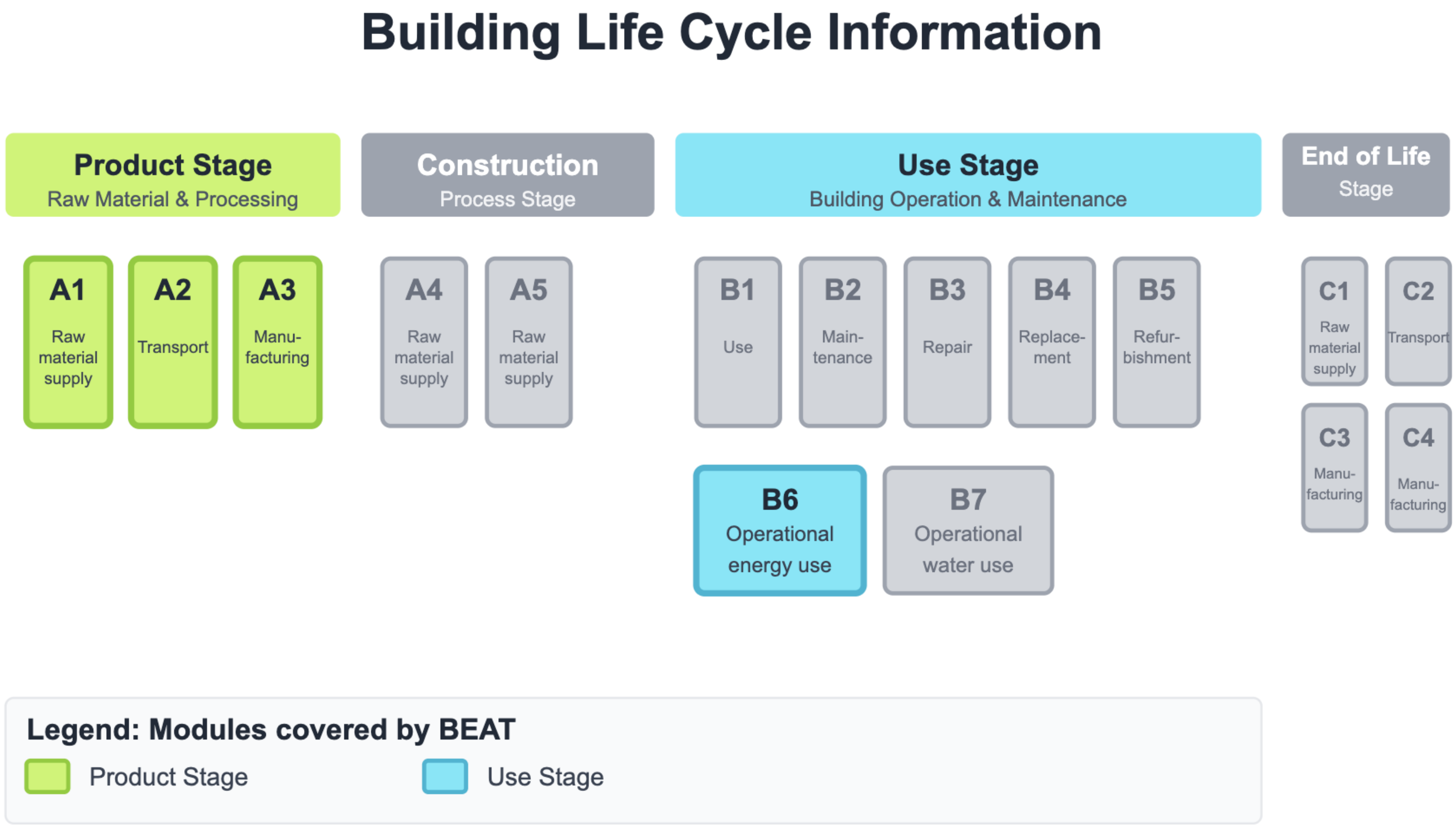
LCA SCOPE: BEAT



BEAT: VALUE ADDITION – FREE, ACCESSIBLE, OPEN SOURCE

Feature	BEAT ★	One Click LCA	SimaPro	EDGE v3
Cost & Access **Cost & Accessibility**	✓ Free & open access	✗ Paid license	✗ Paid license	✓ Free access
Carbon Assessment **Embodied Carbon Assessment**	✓ Full assessment	✓ Full assessment	✓ Full assessment	⚠ Partial coverage - structural elements limited
Data Sources **Environmental Product Declarations**	✓ Open EPD database with generic options	✓ Licensed global EPDs	✓ Licensed global EPDs	⚠ Limited transparency in data sources
Operations **Operational Carbon Assessment**	⚠ Current: electricity bills analysis. Future: appliance efficiency	✓ Full energy modeling	✓ LCA-based energy impact	✓ Energy savings estimation
Regional Data **Local Building Dataset & Benchmarks**	✓ 200-250 ALCBT buildings with local benchmarks	⚠ Limited ALCBT coverage	✗ Academic focus, no project dataset	⚠ Limited public project data
Transparency **Data Transparency**	✓ Full emission factor traceability	✗ Static, non-editable coefficients	⚠ Proprietary database	⚠ Proprietary methodology

METHODOLOGY

HOW BEAT CALCULATES EMBODIED CARBON

Building Components

Structure
- Foundations
- Columns & Beams
- Floor Slabs
- Load-bearing Walls

Envelope
- External Walls
- Windows
- Doors
- Roof System

Interior
- Partition Walls
- Ceiling Systems
- Floor Finishes
- Interior Doors

Material Composites

Composite Examples
- Concrete Wall System
- Brick-Veneer Wall
- Insulated Roof Assembly
- Layered Floor System

Properties
- Thickness
- Layer Configuration
- Density
- Material Ratios

Quantities
- Area (m^2)
- Volume (m^3)
- Weight (kg)
- Units (pcs)

Individual Materials

Material Types
- Concrete
- Steel
- Insulation
- Glass
- Timber

Material Properties
- Density
- Strength Class
- Thermal Properties
- Manufacturing Process

Environmental Data
- Global Warming Potential (GWP) ($kgCO_2e/kg$)
- Environmental Product Declarations (EPDs)
- Regional Factors

Embodied Carbon Calculation

$$\text{Embodied Carbon} = \sum \left(\text{Material Quantity} \times \text{Material GWP} \right)$$

Source: BEAT Hand book Part 1
https://alcbt.gggi.org/beat-handbook-part-1-core-concept-guide/

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METHODOLOGY

HOW BEAT CALCULATES OPERATIONAL CARBON

Building Energy Uses

Space Conditioning

- Heating
- Cooling
- Ventilation
- Air Conditioning

Lighting & Appliances

- Interior Lighting
- Exterior Lighting
- Office Equipment
- Appliances

Building Services

- Elevators & Escalators
- Pumps
- Security Systems
- Data Centers

Energy Carriers

Electricity | Natural Gas | Diesel | LPG | ...

Energy Consumption

- Annual Electricity (kWh)
- Annual Natural Gas (m^3)
- Annual Diesel (L)
- Annual LPG (kg)

Carbon Emission Factors

- Electricity ($kgCO_2e/kWh$)
- Natural Gas ($kgCO_2e/m^3$)
- Diesel ($kgCO_2e/L$)
- LPG ($kgCO_2e/kg$)

Operational Carbon Calculation

$$\text{Operational Carbon} = \sum \left(\text{Energy Consumption} \times \text{Emission Factor} \right) \text{ per Energy Carrier}$$

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A standardized document informing about a product's potential environmental and human health impact is called

ENVIRONMENTAL PRODUCT DECLARATION (EPD)

EXAMPLE: 1 m^3 CONSTRUCTION CONCRETE C20/25 (GERMANY)

EPD CERTIFICATE

Concrete C20/25
Germany

Environmental Impact
Global Warming Potential
Manufacturing Phase (A1-A3)

Resource Input
Primary Energy Renewable
Primary Energy Non-Renewable

Output Flows
Waste Categories
Material Disposal

Global Warming Potential (GWP)
Manufacturing Phase (A1-A3):
190.70 kgCO_2-Äqv.

Renewable Energy
PERT (A1-A3):
72.30 MJ

Non-Renewable Energy
PENRT (A1-A3):
846.00 MJ

https://epd-online.com/EmbeddedEpdList/Download/8773

Camel Strong Cement – Chip Mong INSEE: https://api.environdec.com/api/v1/EPDLibrary/Files/5c25afb5-f636-4ca7-5135-08dc2e3a662b/Data

DEEP DIVE EPD: CHIP MONG INSEE CAMEL STRONG

Based on the Environmental Product Declaration (EPD) for Camel Strong cement from Chip Mong INSEE Cement Corporation in Cambodia, the carbon footprint is: **0.7605 kg CO_2 eq. per kg of cement**

This is the Global Warming Potential (GHG) value, which represents the total greenhouse gas emissions per kilogram of cement produced.

Additional details from the EPD:

- This is the gross value that includes emissions from secondary fuels used in clinker production
- The cement contains 80% clinker and 17% recycled content (such as slag, fly ash, limestone)
- The data is based on 2022 production from their Touk Meas Plant in Kampot Province
- For context, this carbon footprint is relatively typical for Portland cement with some supplementary cementitious materials, reflecting the company's efforts to reduce clinker content through the use of alternative materials.

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ENVIRONMENTAL PRODUCT DECLARATION (EPD)

Food Nutrition Label

Nutrition Facts

Serving Size 1 cup (240g)
Servings Per Container 2

Calories	**250**
Total Fat 12g	18%
Cholesterol 30mg	10%
Sodium 470mg	20%
Total Carbohydrate 31g	10%
Protein 5g	10%

Building Material EPD

Environmental Facts

Product Concrete Block
Declared Unit 1 m^3

Carbon Footprint	**235 kg CO_2**
Water Use	145 L
Energy Used	850 MJ
Recycled Content	25%
Acidification	1.2 kg SO_2
Ozone Depletion	0.001 kg CFC

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BEAT BUILDS ON THREE TYPE OF EPDS

1 Official EPDs
(Highest Quality)

- Third-party verified and published in recognized databases
- Sources: ÖKOBAUDAT, ECO Platform, Asian National EPD Platforms

2 Generic EPDs
(Gap-Filling Solution)

- Industry-average data when official EPDs unavailable
- Maintains data quality standards for comprehensive coverage

3 Custom EPDs
(Future Feature)

- EPDs in process of national certification - complies with recognized standards but not yet officially certified at national levels
- Not available in national or international EPD databases - BEAT facilitates national certification process

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STATUS QUO OF AVAILABLE EPDS IN ALCBT COUNTRIES

Currently in BEAT we have these number of official EPDs

ALCBT Countries	
India	242
Indonesia	39
Vietnam	38
Thailand	27
Cambodia	1

Reference	
Germany	2,697

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SOLUTION: THREE TIER APPROACH

Use official EPDs when available

Leverage existing verified data

Apply generic EPDs as placeholders

Ensure comprehensive coverage

Enable custom EPDs for future locally certified EPDs

Support national database development

Goal: Complete coverage with increasing accuracy

As local data develops, transition from generic to official EPDs for improved regional accuracy

Encouragement

Local governments and industry to develop region-specific EPD datasets

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INTERIM STEP: GENERIC EPDS

1

Start with international (German) baseline data

Well-documented international emission factors for each energy carrier

2

Apply country-specific grid intensity

Multiply by each country's unique grid carbon intensity factor

3

Account for efficiency differences

Adjust for less efficient fuel delivery and heating systems in ALCBT countries

Result: Region-Specific Generic EPDs

Each material's baseline EPD is adjusted using country-specific factors to reflect local energy conditions and efficiency levels

GENERIC EPD ADJUSTMENT FACTORS

Building Materials Carbon Emission Factors Regional Comparison for Southeast Asia (tCO_2e per tonne)						
Material Category	Energy Profile	India	Indonesia	Vietnam	Cambodia	Thailand
Cement/Mortar	*55% Process, 15% Fuel, 30% Elec*	1.20	1.18	1.15	**1.10**	1.16
Clay Bricks	*0% Process, 85% Fuel, 15% Elec*	1.20	1.19	1.18	**1.17**	1.18
Ready-mix Concrete	*40% Process, 10% Fuel, 50% Elec*	1.35	1.32	1.25	**1.20**	1.28
AAC Blocks	*25% Process, 35% Fuel, 40% Elec*	1.35	1.33	1.27	**1.22**	1.29
Steel (EAF)	*5% Process, 20% Fuel, 75% Elec*	1.60	1.57	1.42	**1.35**	1.48
Natural Stone	*0% Process, 40% Fuel, 60% Elec*	1.50	1.47	1.35	**1.30**	1.40
Gypsum Boards	*5% Process, 55% Fuel, 40% Elec*	1.35	1.33	1.28	**1.23**	1.30
Mineral Wool	*0% Process, 65% Fuel, 35% Elec*	1.35	1.34	1.28	**1.25**	1.30
Timber Products	*0% Process, 40% Fuel, 60% Elec*	1.45	1.42	1.32	**1.27**	1.36

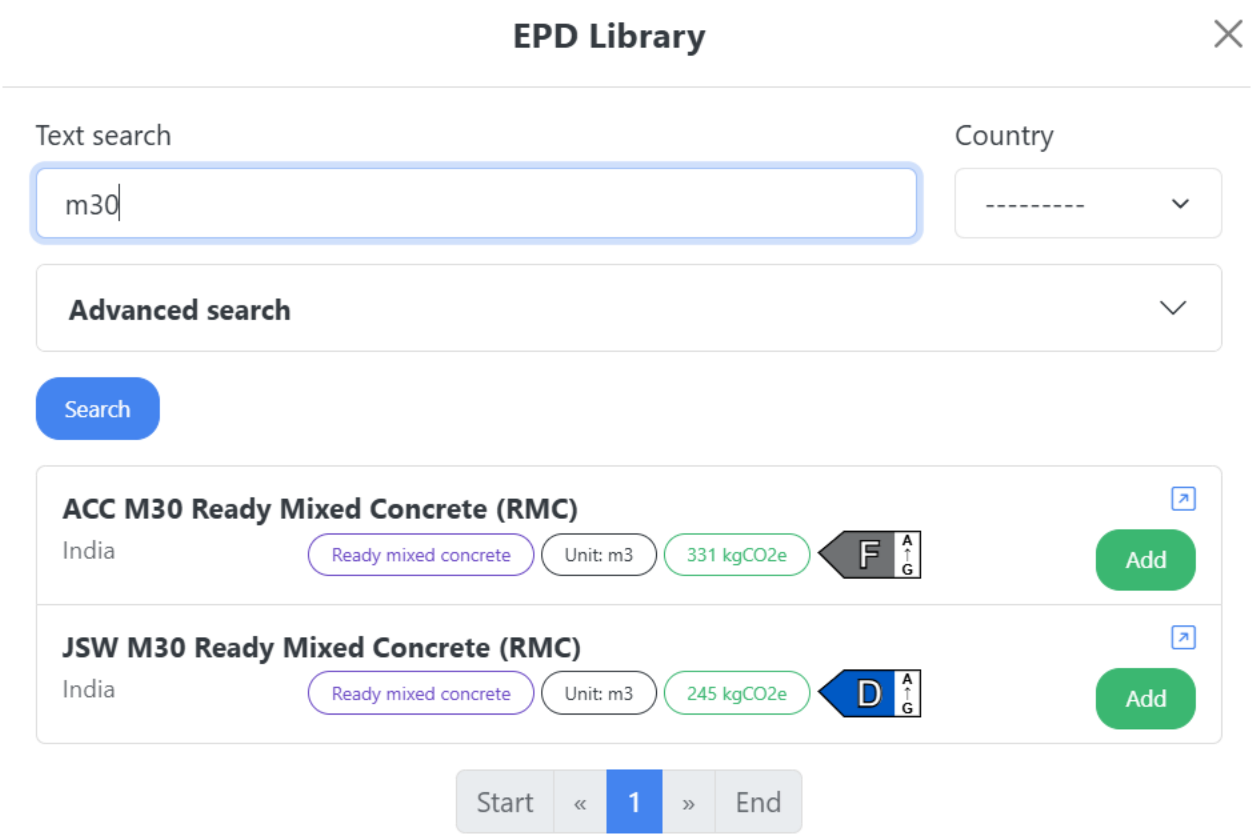
BEAT ADOPTS GCCA CONCRETE LABELS

GCCA EPD labels define performance benchmarks and provide verified data to assess embodied carbon in cement and concrete.

- **Every concrete EPD in BEAT** automatically receives GCCA band (A-G)
- Band A (excellent) to Band G (high carbon)
- **BEAT** plans to adopt similar labels to assist users in comparing EPDs for other building materials such as steel

BENEFITS

- **For Users**: Instant product comparison
- **For Industry**: Market differentiation & drive low-carbon products demand



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Building Operational Energy

The energy used for operating all equipment in a building

Operational Energy of buildings is the energy in the form of electricity and fuels for operating various equipment for providing comfortable room conditions for the occupants and operate various building equipment.

HVAC equipment: Heating, ventilation and air-conditioning equipment to maintain comfortable indoor temperature and air quality

Electric Lighting: Artificial lighting system to perform task when daylight is not sufficient/available

Hot water systems: Electric or fuel fired equipment providing hot water for bathing, cooking, laundries, cleaning, etc.

Appliances: Refrigerators, deep freezers, computers, printers, projectors, television sets, etc.

Other services: Elevators, escalators, water pumps, kitchen / pantry appliances, etc.

Building Operational Energy

End-use energy distribution in residential buildings

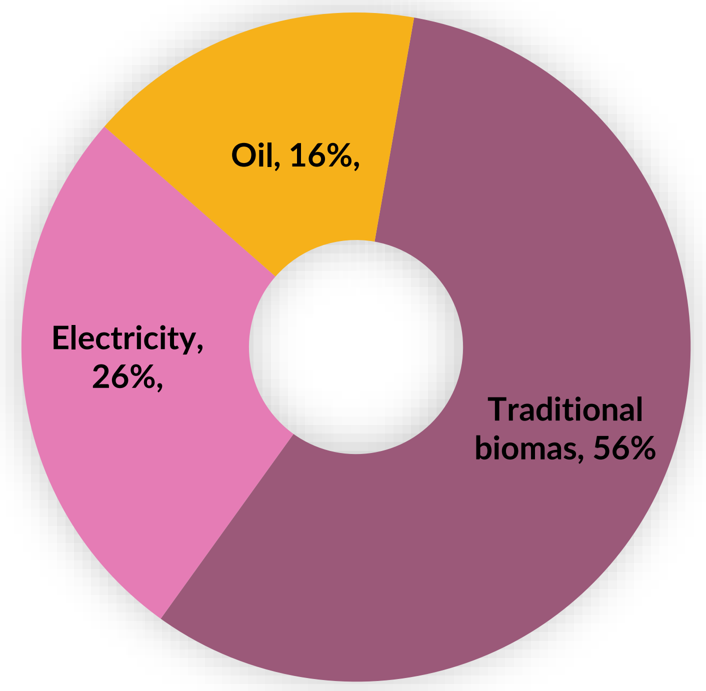
In Cambodia, According to the 7th ASEAN Energy Outlook (AEO7) by ACE, Cambodia's residential sector energy consumption in 2020 came from:

Traditional biomass: 0.72 Mtoe (approximately 56%)

Electricity: 0.33 Mtoe (approximately 26%)

Oil: 0.21 Mtoe (approximately 16%)

Cambodia's residential sector energy consumption



Source: AE07, 2020

Do not edit
How to change the design

Over 60 years of the life of the building, which of the following is the biggest contributor to Carbon emissions?

BEAT INPUT DATA

Essential Information for BEAT

Building Emission Assessment Tool Input Requirements

🏢 Building Information

Data Category	Required Information	Example
Basic Identification	Building name, ID, location, year of construction	Office Tower A, Jakarta, 2018
Building Type	Primary use/classification	Office (Grade B), Residential, Hospital
Building Size	Gross floor area, number of floors (above/below ground)	10,000 m^2, 15 floors above + 2 basement
Climate	Climate zone, location coordinates	Tropical wet, -6.2088° S, 106.8456° E
Occupancy	Typical occupancy patterns	9am-6pm weekdays, 20% weekends

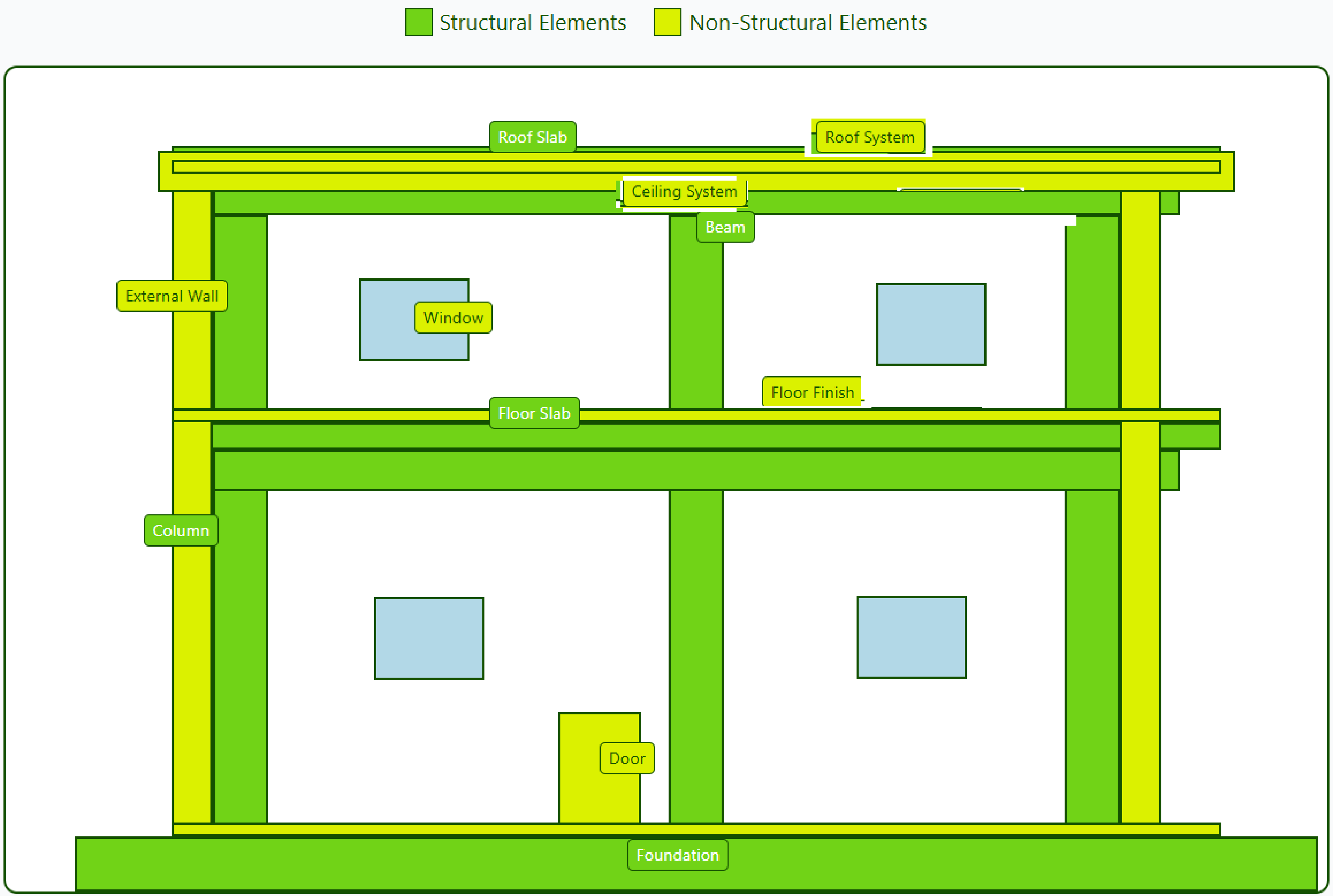
Note: Building information forms the foundation for all carbon calculations. Complete and accurate basic data ensures proper benchmarking against similar buildings.

Operational Information

Data Category	Required Information	Units
Electricity Consumption	Annual electricity usage	kWh/year
Fuel Consumption	Natural gas, diesel, LPG usage	m^3/year, L/year, kg/year
HVAC Systems	System type, capacity, efficiency	Type, kW, COP/EER
Lighting	Lighting system, lighting capacity	Type, kW
Comfort Parameters	Heating/cooling temperature setpoints	°C

Note: Operational data should ideally be based on actual measurements for existing buildings or detailed energy modeling for new buildings. Include at least 12 months of data when available.

Building Components Evaluated by BEAT



Material Quantities

Measurement Type	Material Type	Unit
Volume (m^3)	Concrete (foundations, columns, beams, slabs)	m^3
	Insulation materials	m^3
Mass (kg/tons)	Steel reinforcement	tons
	Structural steel	tons
	Aluminum (windows, facade)	kg
	Glass	kg
Area (m^2)	External walls, facades	m^2
	Windows, glazing	m^2
	Floor/wall/ceiling finishes	m^2
Length (m)	Railings	m

Note: Material quantities should be extracted from the Bill of Quantities (BoQ) or calculated from architectural and structural drawings. Include materials that contribute significantly to the building's carbon footprint.

BEAT Quality Data Requirements

For accurate embodied carbon assessment, all quantities must include:

Material Type	Quantity	Unit Measure	Building Component
JSW M30 Concrete	150	m^3	Foundation
Tata Steel Fe500 TMT	1	ton	Column
Penetron Seal Coat	5	kg	
Aluminium door	2	pieces	

All material quantities must be specified with precise measurement units and building component allocation for accurate carbon assessment

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ASIA LOW CARBON BUILDINGS TRANSITION PROJECT

Life Cycle Assessment for Transitioning to a Low-Carbon Economy

Demonstration of BEAT (Step to Step Guide)

Supported by:

Federal Ministry for Economic Affairs and Climate Action

IKI INTERNATIONAL CLIMATE INITIATIVE

on the basis of a decision by the German Bundestag

What are we going to do today?

Step 1: Read the BOQ and Extract all the material along with their quantities that have been used in the Building.

Step 2: Enter each extracted material into with exact quantity in the Building emissions assessment Tool (BEAT).

Step 3: Perform the analysis and learn how to interpret the results.

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Which of the following statement is ‘True’?

Located in Cambodia

Has 3 residential House in Total

Total Built up are of 157 Sqm

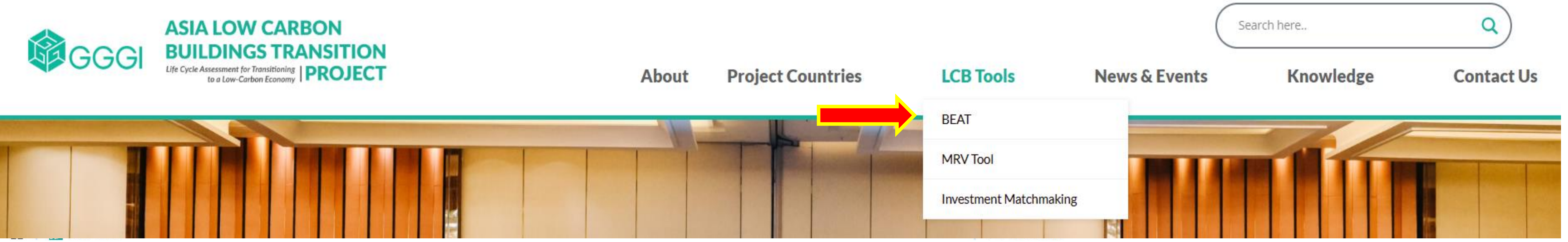
Source: Long, M., Han, V., Leclercq, P., & Reiter, S. (2025). Comparative life cycle carbon emission assessment of a residential building: A case study of Cambodia.

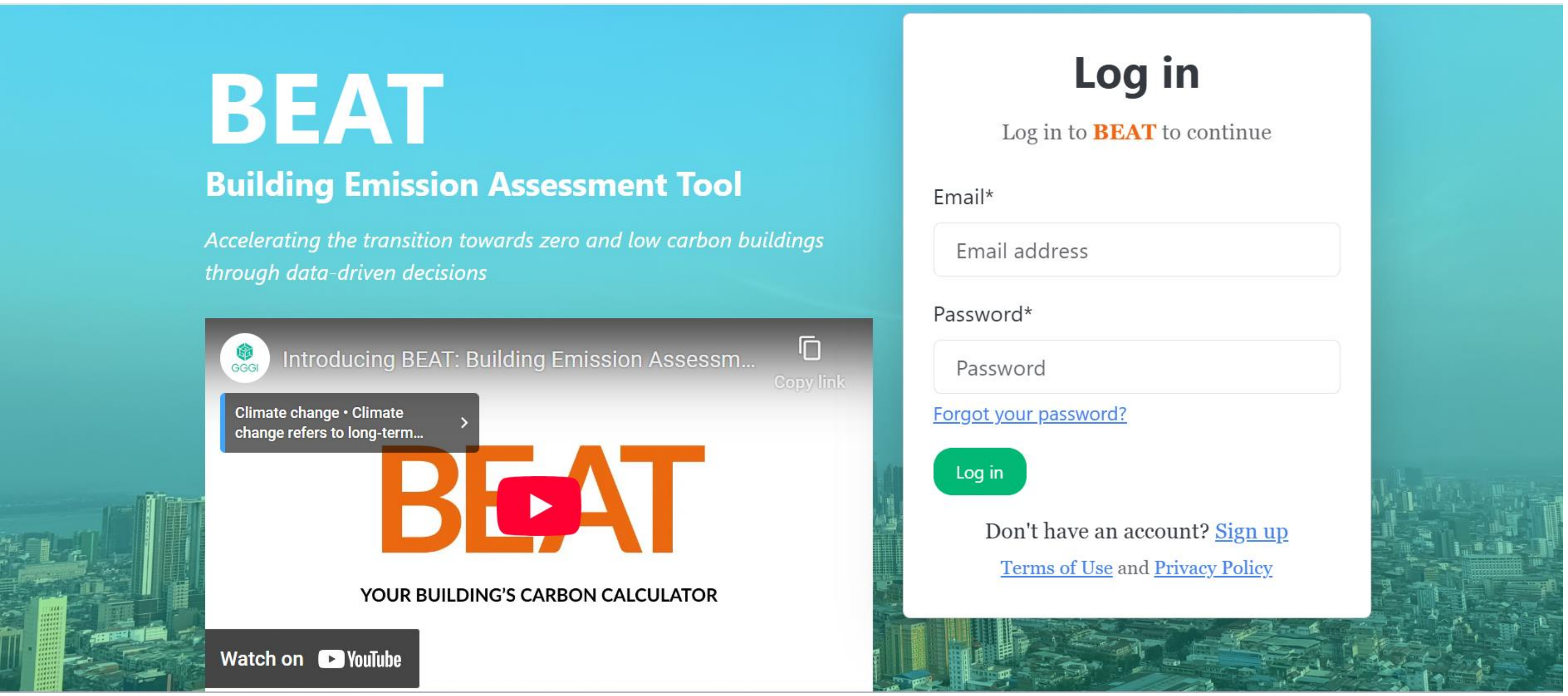
G+3 Structure

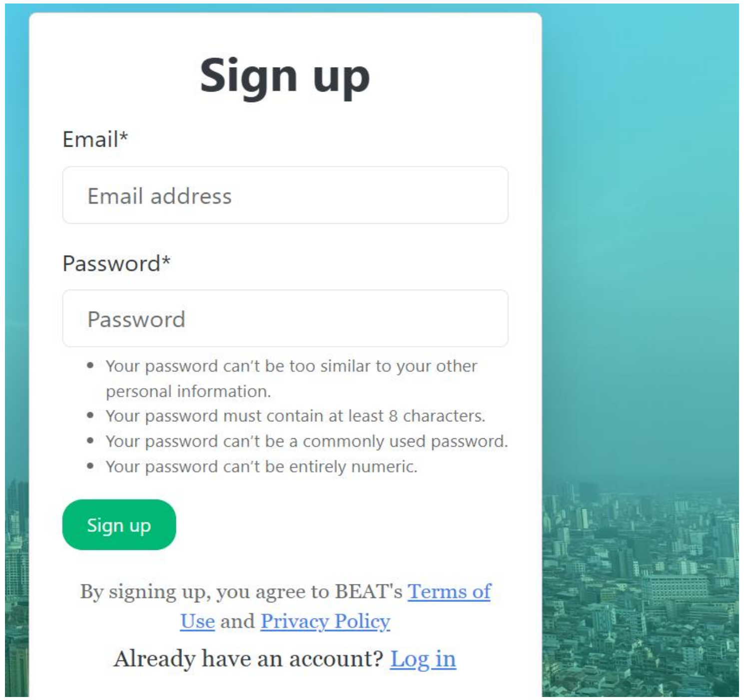
Designed for 8-12 people

Warm and Humid

Login to: https://alcbt.gggi.org/







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SCAN ME

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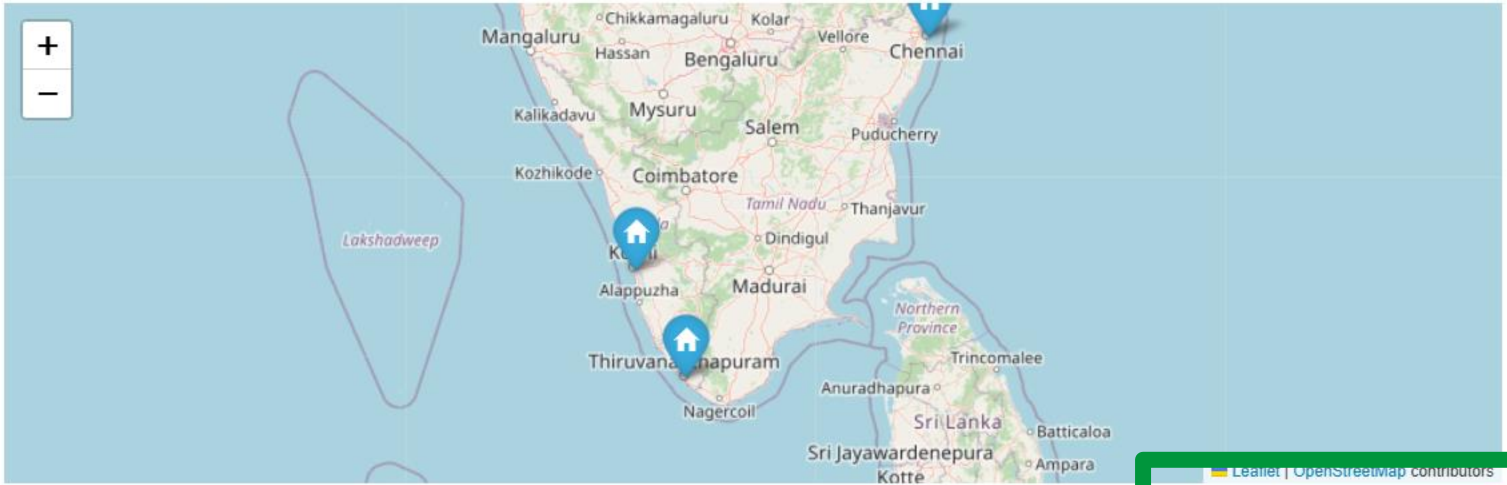
BEAT Overview Resources Settings

Welcome to BEAT

Begin assessing your building's whole life cycle emissions – from embodied to operational

Buildings overview

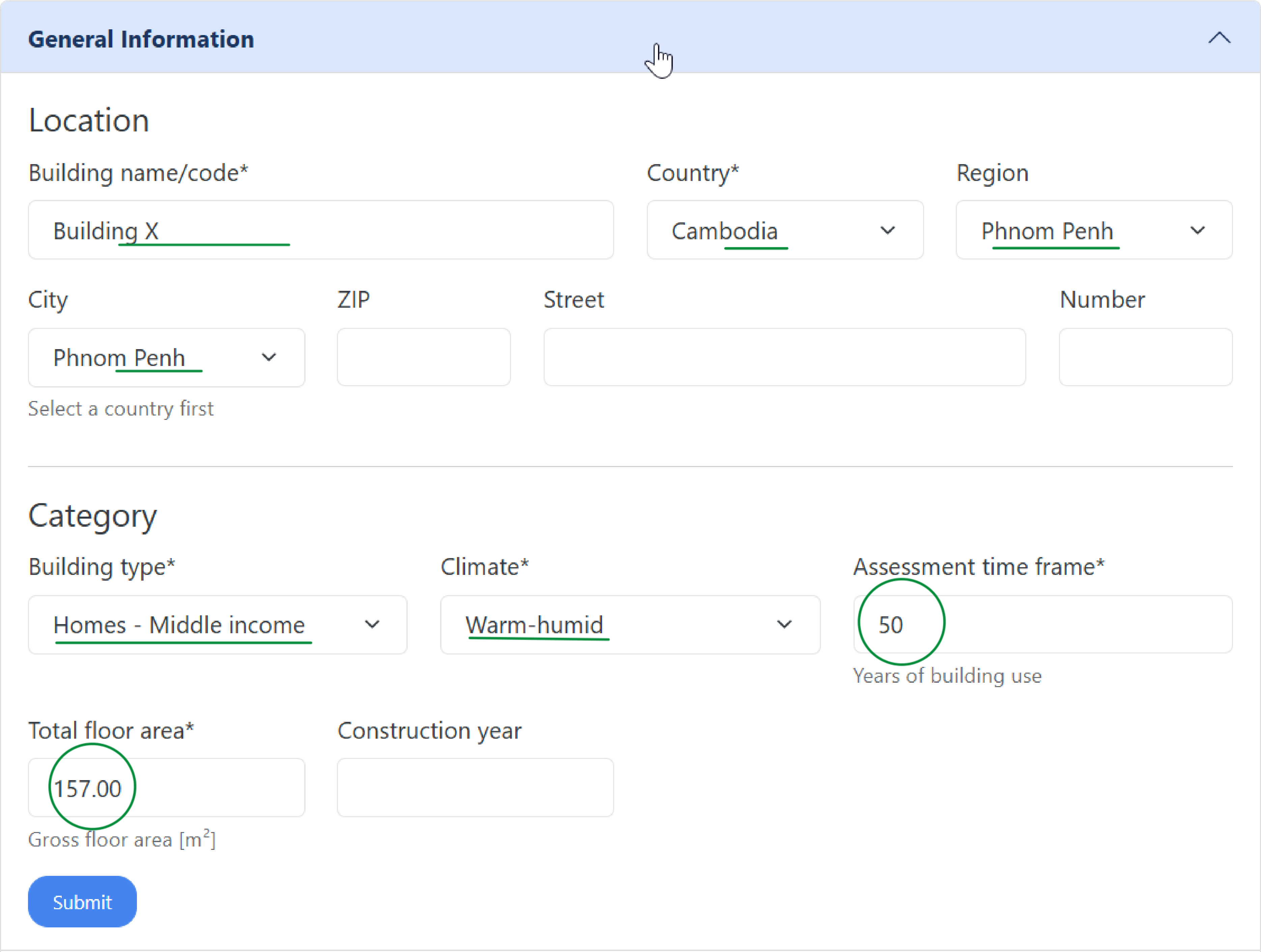


Your buildings

Add building

HEAT

Enter The Details

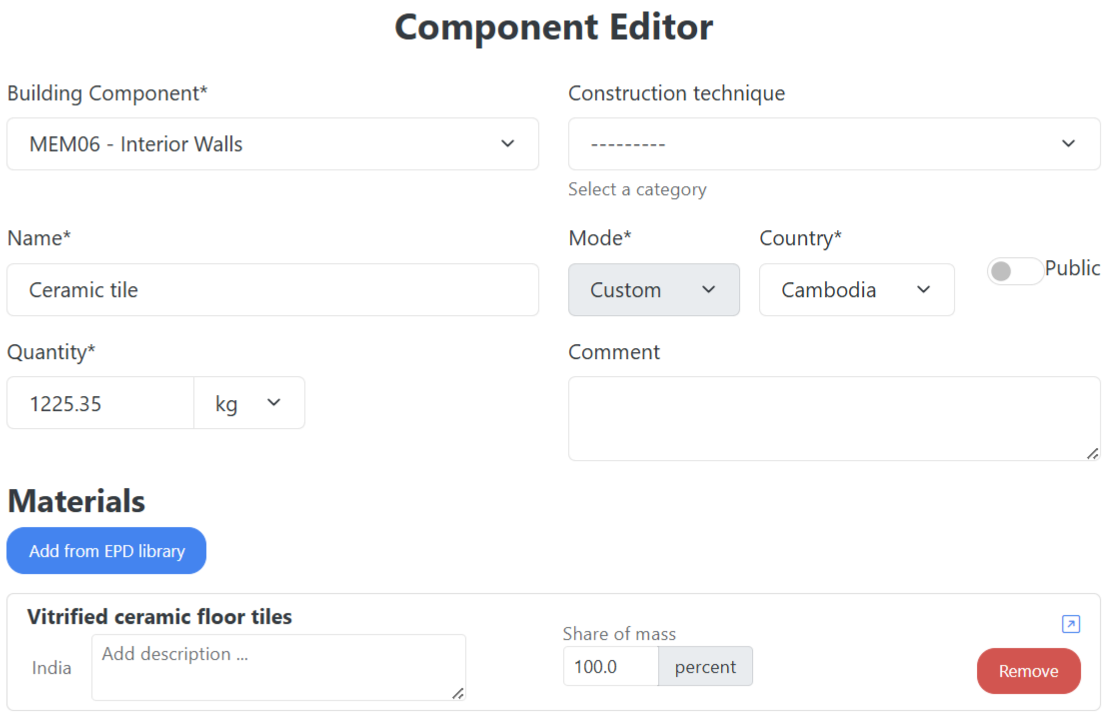


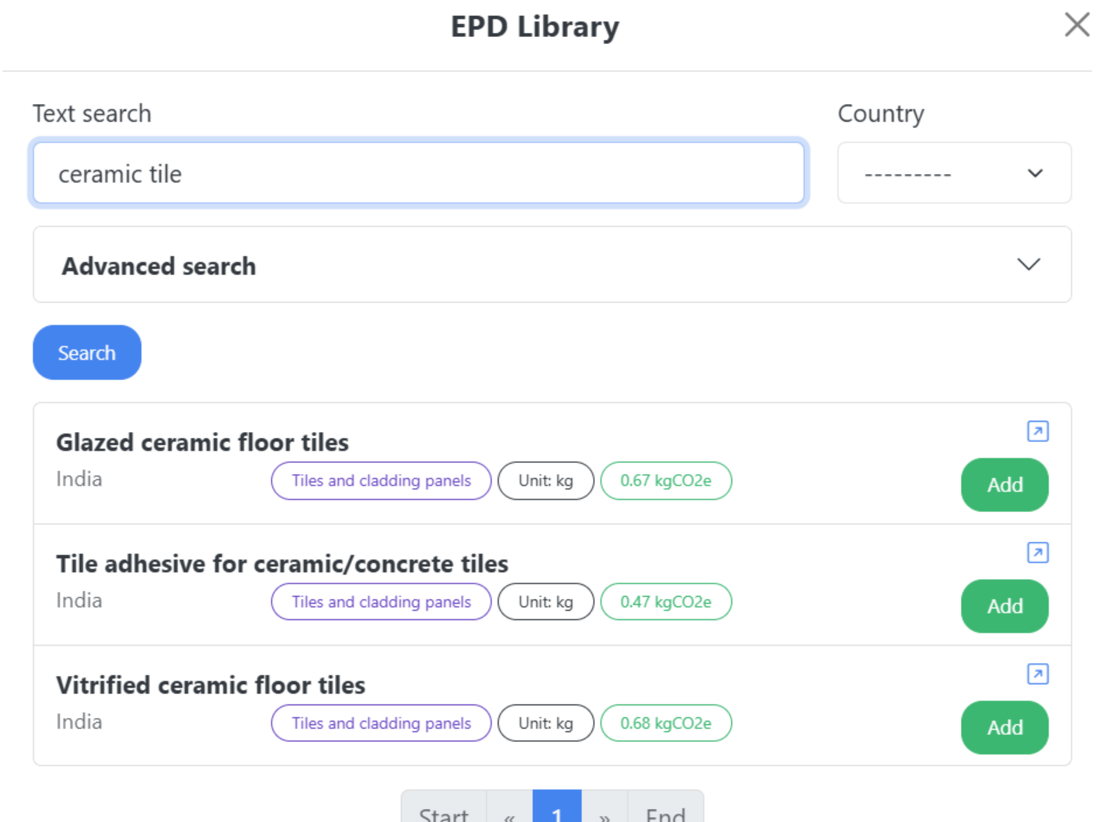
BUILDING PLAN

Source: Long, M., Han, V., Leclercq, P., & Reiter, S. (2025). Comparative life cycle carbon emission assessment of a residential building: A case study of Cambodia.

Let us look at the BOQ

Item of work	Unit	Quantity
a) Internal Walls		
Ceramic tile	kg	1225.35
Clay Brick	kg	2839.2
Cement Mortar	kg	2028
Base Plaster	Kg	930

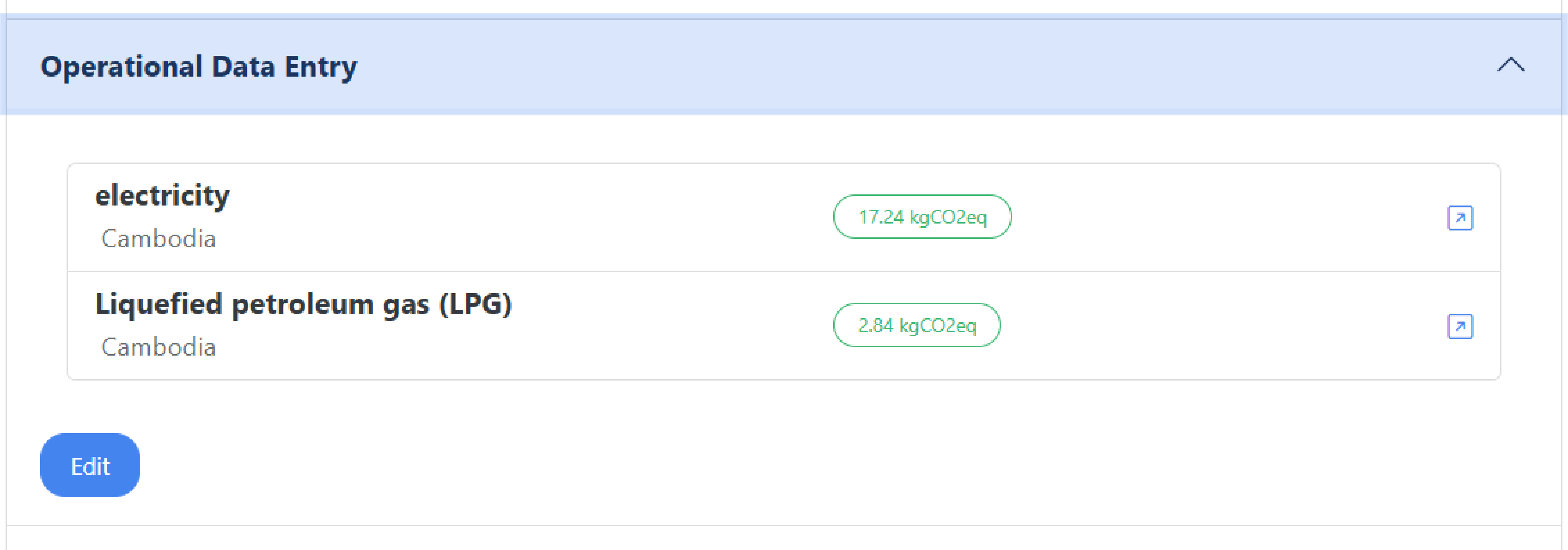




Operational Carbon Calculation in BEAT

Example of 157 sqm residential building in Cambodia

- Annual Energy Consumption per sqm (kWh) – 6480 kWh
- Annual energy Consumption – 208 X 12= 2500 kWh
- LPG: 12 kg per month exclusively for cooking needs



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While performing LCA why is it important to engage stakeholders in the early design process

UNDERSTANDING BEAT RESULTS

From 1 sample building in Indonesia

1. Material Carbon Hotspots: BEAT identifies biggest carbon contributors: (e.g. Masonry – 28.0 %, Ready-mix concrete & cement: 20.2%, Steel: 9.5%, Rebar: 16.4%...)

Value: Target high-impact materials first

2. Building Element Breakdown: BEAT shows carbon by elements: (e.g. Exterior walls: 35.5%, Foundations: 19.4%,...)

Value: Optimize design where it matters most

3. Complete Carbon Picture: BEAT provides full lifecycle view: Total: 3026 kg CO_2eq/m^2 (Embodied: 370.4 kg CO_2eq/m^2 (12%) & Operational: 2656 kg CO_2eq/m^2 (88%)),

Value: See both material and energy impacts

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UNDERSTANDING BEAT RESULTS

4. Regional Benchmarking: BEAT enables performance comparison: Country-specific benchmarks and Clear performance indicators with Visual comparison tools

Value: Know where you stand vs. regional standards

5. Optimization Potential: BEAT quantifies possible savings: (Current: 3025 kg CO_2eq/m^2, Optimized: .... kg CO_2eq/m^2) Total reduction: 20.9%

Value: See exactly what's achievable

6. Strategic Insights: BEAT transforms decision-making: Data-driven material choices, Science-based targets, Investment justification, Progress tracking

Value: Turn carbon data into competitive advantage

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BEAT UPDATES

SNEAK PREVIEW

Ready:

- User Management
- Embodied Carbon Assessment
- EPD Database
- Custom Structural Elements
- Generic EPDs
- Operational Carbon

In Progress:

- Reuse of Customised Materials
- Excel Import & Reports
- Benchmarking View
- Language Translation

Planned:

- **Carbon Optimisation & Potential Savings**
  Advanced analytics for carbon reduction recommendations

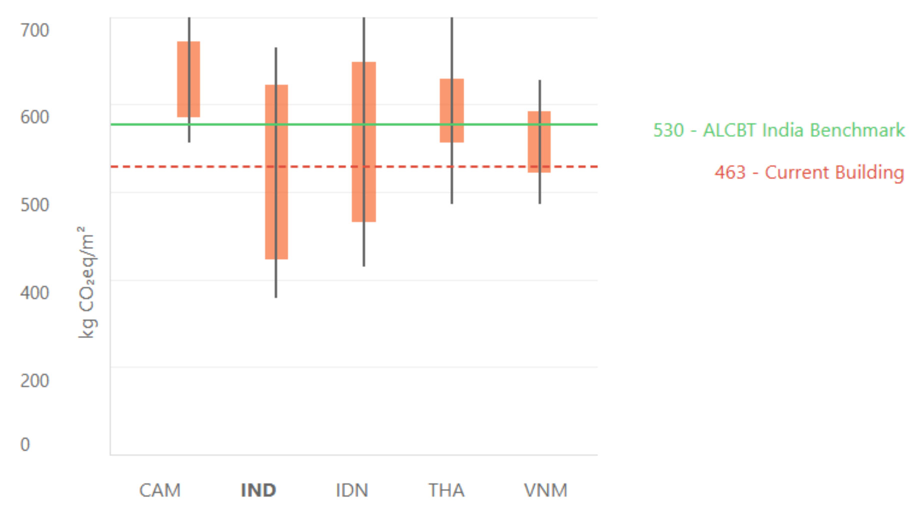
PLANNED UPDATES (V2)

Assembly | Material | Benchmarking | Improvements

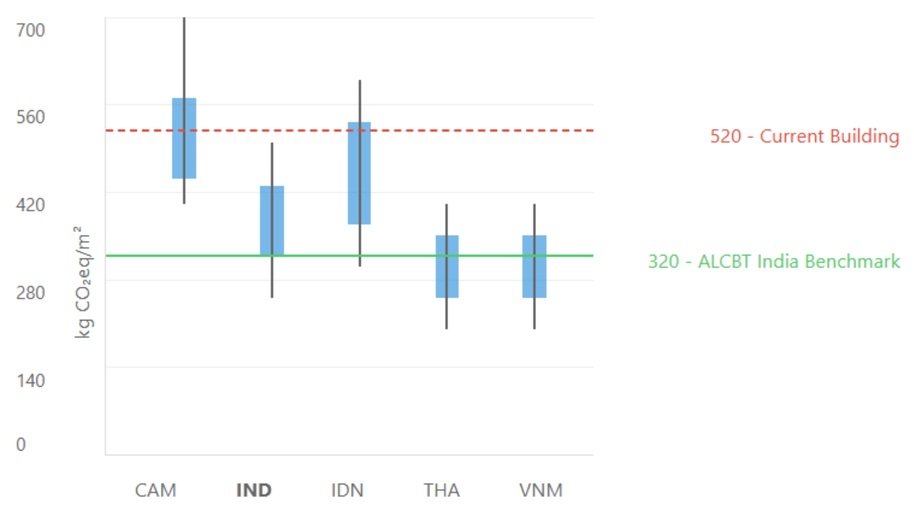
Benchmarking Analysis

Building Carbon Footprint	Total Embodied Carbon	Operational Carbon
983 kg CO_2eq/m^2	463 kg CO_2eq/m^2	520 kg CO_2eq/m^2

Embodied Carbon - Commercial Office Buildings



Operational Carbon - Commercial Office Buildings



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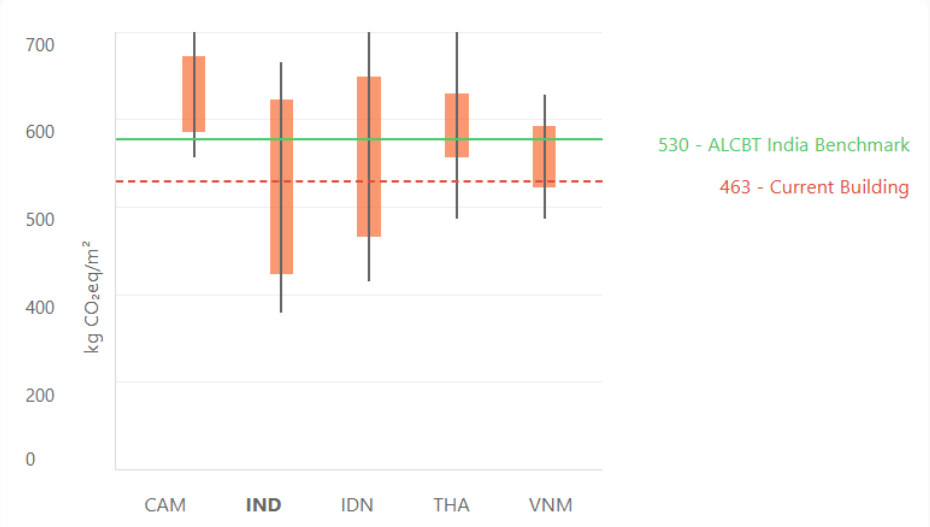

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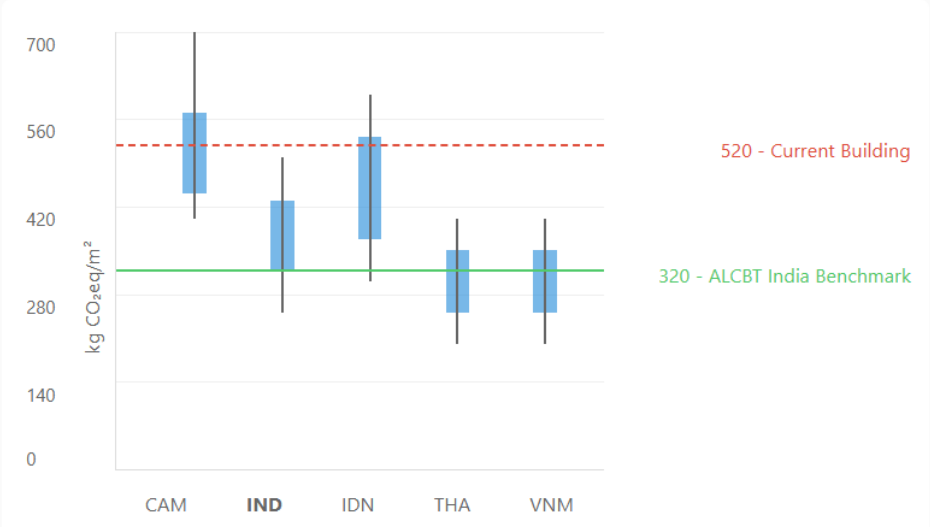

PLANNED UPDATES (V2)

Current Total	Embodied Reduction	Operational Reduction	Optimized Total	Total Savings
983 kg CO_2eq/m^2	-85 kg CO_2eq/m^2	-120 kg CO_2eq/m^2	778 kg CO_2eq/m^2	20.9% reduction

Embodied Carbon Optimization

Ready-mix concrete & cement — 30.0% of total

-25% with GGBS/Fly Ash

139 kg CO_2eq/m^2 → 104 kg CO_2eq/m^2 (-35 kg)

Steel — 15.0% of total

-20% with recycled content

69 kg CO_2eq/m^2 → 55 kg CO_2eq/m^2 (-14 kg)

Rebar — 10.0% of total

-30% with high recycled content

46 kg CO_2eq/m^2 → 32 kg CO_2eq/m^2 (-14 kg)

Pre-cast concrete — 7.0% of total

-22% with blended cement

32 kg CO_2eq/m^2 → 25 kg CO_2eq/m^2 (-7 kg)

Masonry — 8.0% of total

-18% with AAC blocks

37 kg CO_2eq/m^2 → 30 kg CO_2eq/m^2 (-7 kg)

Finishing materials — 6.0% of total

-15% with low-carbon options

28 kg CO_2eq/m^2 → 24 kg CO_2eq/m^2 (-4 kg)

Operational Carbon Optimization

Cooling System — 35.0% of operational

-30% with VRF & 5-star efficiency

162 kg CO_2eq/m^2 → 113 kg CO_2eq/m^2 (-49 kg)

Ventilation System — 20.0% of operational

-25% with heat recovery & EC fans

93 kg CO_2eq/m^2 → 70 kg CO_2eq/m^2 (-23 kg)

Lighting System — 18.0% of operational

-40% with LED & daylight sensors

83 kg CO_2eq/m^2 → 50 kg CO_2eq/m^2 (-33 kg)

Lift & Escalator System — 15.0% of operational

-20% with regenerative drives

69 kg CO_2eq/m^2 → 55 kg CO_2eq/m^2 (-14 kg)

Hot Water System — 12.0% of operational

-15% with heat pumps & solar

56 kg CO_2eq/m^2 → 48 kg CO_2eq/m^2 (-8 kg)

Total Operational Reduction — -120 kg CO_2eq/m^2

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Planned updates in BEAT (v2)

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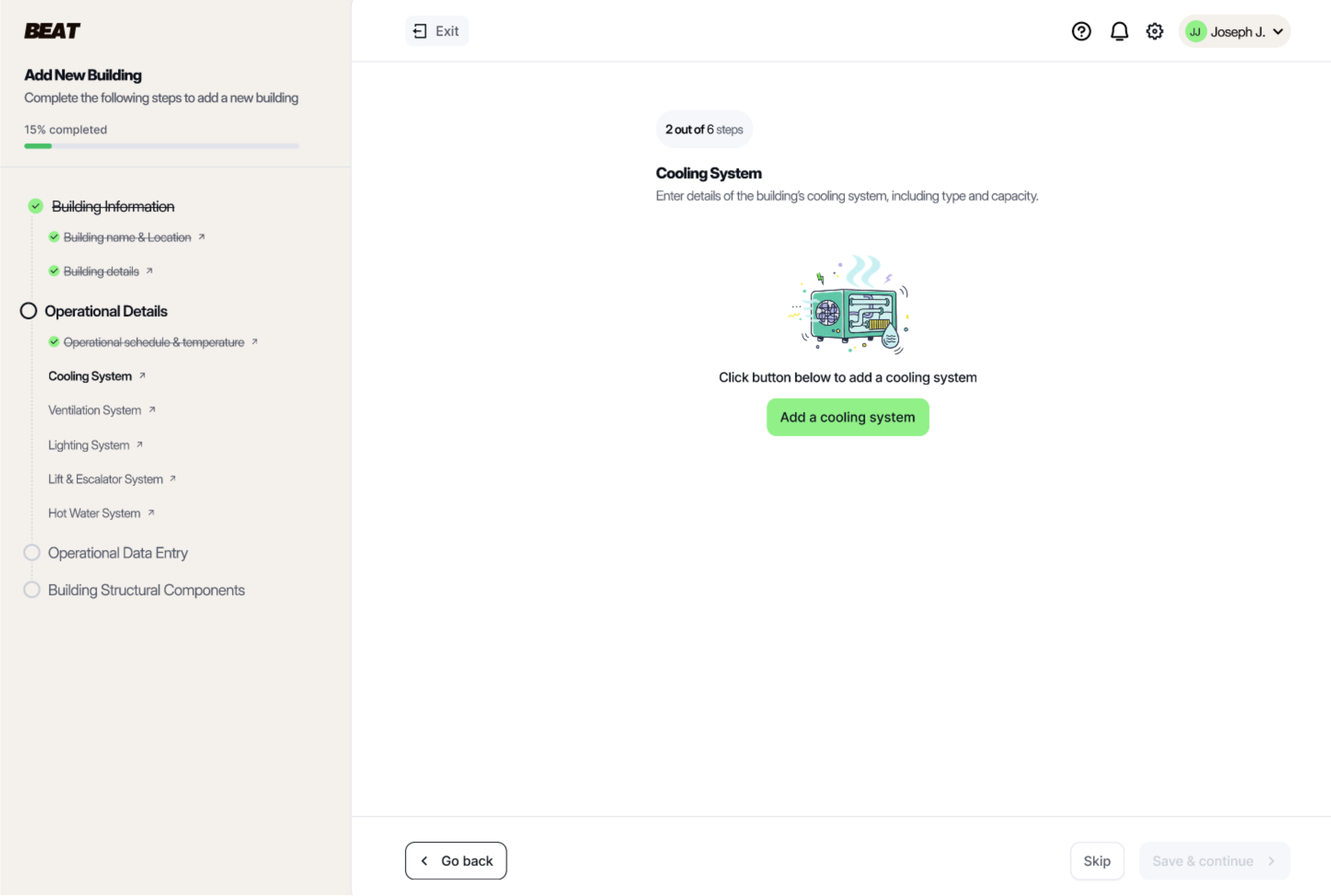
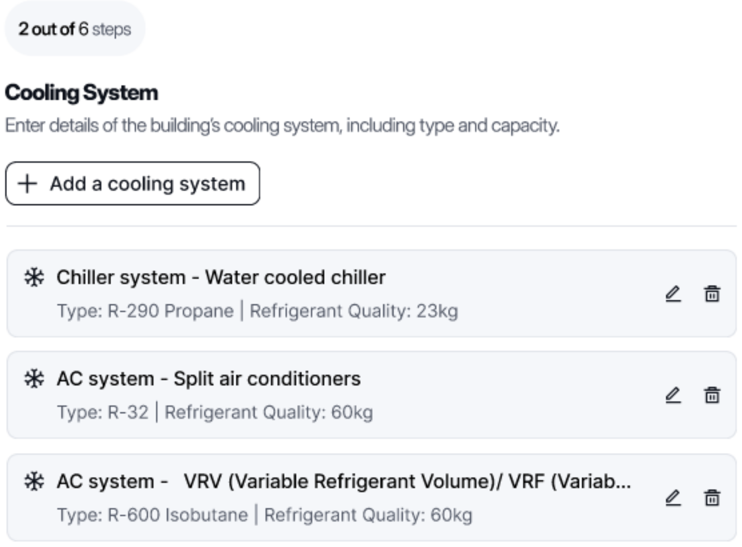
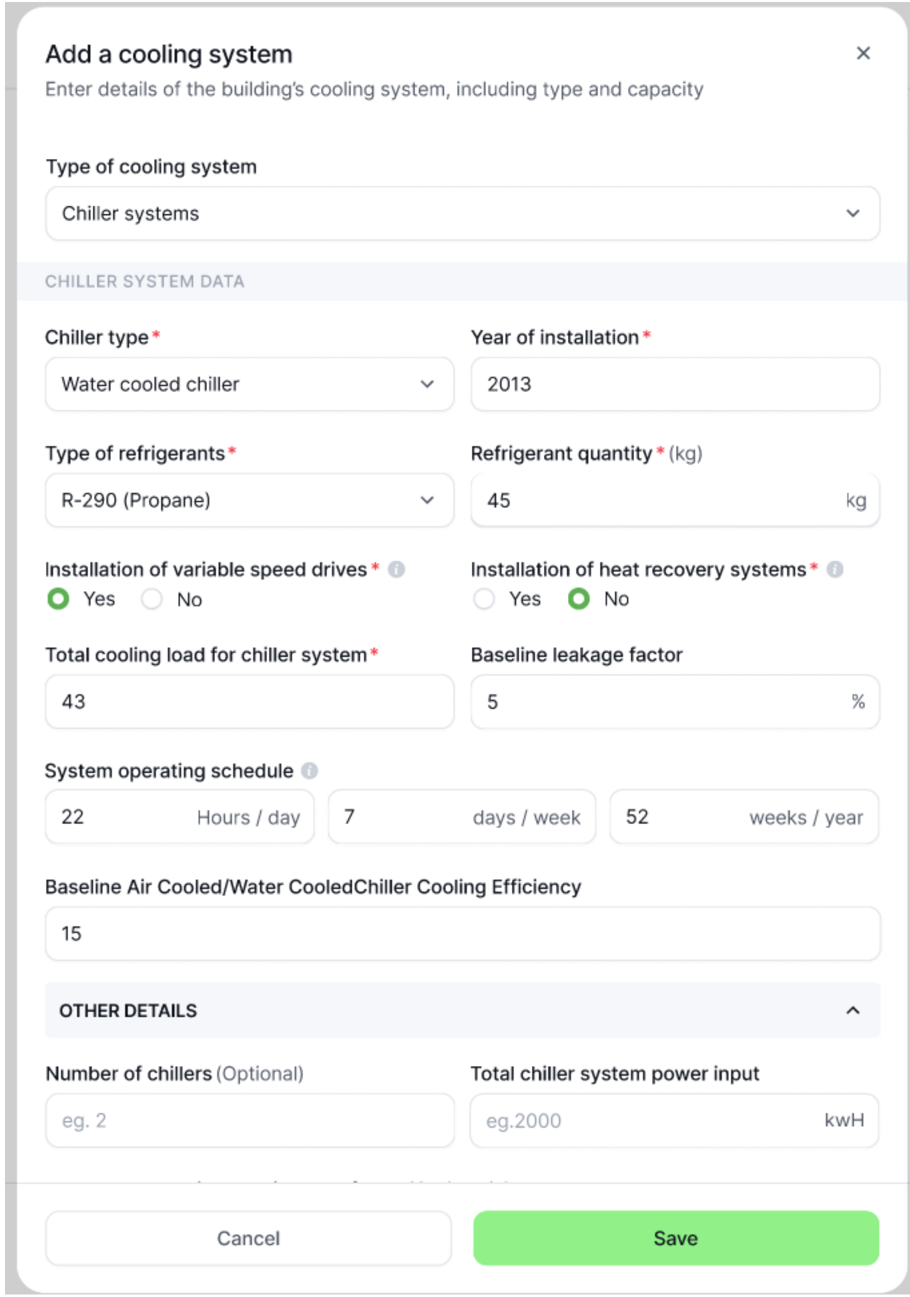


Planned updates in BEAT (v2)

- Breakdown of operational carbon by HVAC and appliance level.
- Multiple cooling and ventilation system modeling.
- Capture type and quantity of refrigerants in cooling equipment to track direct emissions and GWP impact.
- Comprehensive system coverage: Monitor emissions across cooling, ventilation, lighting, lifts/escalators, and hot water systems





Planned updates in BEAT (v2)

3 out of 6 steps

Ventilation System

Provide details on the building's ventilation type, capacity, and coverage to assess airflow and indoor air quality.

Click button below to add a ventilation system

Add ventilation system

3 out of 6 steps

Ventilation System

Provide details on the building's ventilation type, capacity, and coverage to assess airflow and indoor air quality.

+ Add a ventilation system

Air handling units (AHUs)
Airflow rate : 45CMH | Capacity units : m³/hr

Fan coil units (FCUs)
Airflow rate : 55CMH | Capacity units : ft³/min

Ceiling or wall mounted cassette ACs
Airflow rate : 10CMH | Capacity units : m³/hr

Add a ventilation system

Enter details of the building's ventilation system, including type and capacity

Ventilation type *: Ceiling/Exhaust/Wall fan

Ventilation capacity *: m³/hr

Baseline ventilation system efficiency *: 45 W/CMH

System operating schedule: 10 Hours / day; 4 days / week; 32 weeks / year

total ventilation system power Input *: 150 Watts

Air flow rate *: 45 CMH

Installation of Demand Controlled Ventilation *: Yes / No

Installation of Variable Speed Drives *: Yes

Total number of ventilation type installed: 450

total energy consumption of ventilation system annually: 250 kWh/year

Energy efficiency label: Select efficiency label

Number of stars: Select efficiency label

Cancel | Save

Planned updates in BEAT (v2)

4 out of 6 steps

Lighting System

Provide details on lighting types, power use, and controls to assess efficiency.

Click button below to add a lighting system

Add lighting system

4 out of 6 steps

Lighting System

Provide details on lighting types, power use, and controls to assess efficiency.

+ Add a lighting system

Office: Conference Room,Lobby, office
Area of room: 445m² | Bulb type : LED (Light emitting diode) lights

Add a lighting system

Provide details on lighting types, power use, and controls to assess efficiency.

Room type*
Office: Conference Room, Lobby, Ofiice

Area of room*
540 m²

Light bulb type*
CFL (Compact flourescent lamp) lig...

Number of Lighting bulbs*
10

Light Bulb Power Rating*
50 W

System operating schedule*
8 Hours / day
5 days / week
50 weeks / year

Installation of Sensors*
Yes

Baseline Lighting Power Density (LPD)*
1,3433 W/m²

Total energy consumption of lighting system annually
234 kWh/year

Energy efficiency label
Select efficiency label
- BEE Star Rating
- EGAT

Number of stars
Select efficiency label

Do not edit
How to change the design

What is the basic, but most important input for a LCA study in BEAT?

Potential savings in operational carbon

HEAT

1 Three Pathways to Save Energy

Starting Point
Inefficient Chiller: 1.5 kW/RT

MEASURE 1

Replace with Efficient Chiller

New efficiency: 0.85 kW/RT

130,000
kWh/year saved

MEASURE 2A

Add Variable Speed Drive

20% energy reduction

60,000
kWh/year saved

MEASURE 2B

Add Heat Recovery System

30% energy reduction

90,000
kWh/year saved

Potential savings in operational carbon

HEAT

2 Conversion to Operational Carbon Savings

S2 — Scope 2 Emissions

Electricity consumption

kWh × Grid Emission Factor

= tCO_2 from electricity

+

S1 — Scope 1 Emissions

Refrigerant leakage

Quantity × Leakage × GWP

= tCO_2 from refrigerants

Total Operational Carbon Savings

Scope 1 + Scope 2 = Total tCO_2/year

Potential savings in operational carbon

HEAT

Energy Use Calculation

Energy = Cooling Load (RT) × Efficiency (kW/RT) × Operating Hours

Energy Savings

Savings = Energy Use (Baseline) - Energy Use (Improved)

Carbon Emissions Avoided

Carbon Savings = (Energy Saved × Grid Factor) + Refrigerant Savings

GWP of Refrigerants used in AC

HEAT

Common Synthetic Refrigerants

Refrigerant Type	Application	GWP Value	Status
R-32	Modern AC systems	675	Replacement for R-410A TRANSITION
R-22	Older AC systems	1,810	Being phased out PHASE-OUT
R-410A	Current AC systems	2,088	Being replaced by R-32 PHASE-OUT

Natural Refrigerants (Low GWP)

Refrigerant Type	Chemical Name	GWP Value	Status
R-290	Propane	3	Natural
R-600a	Isobutane	3	Natural

Key Insights

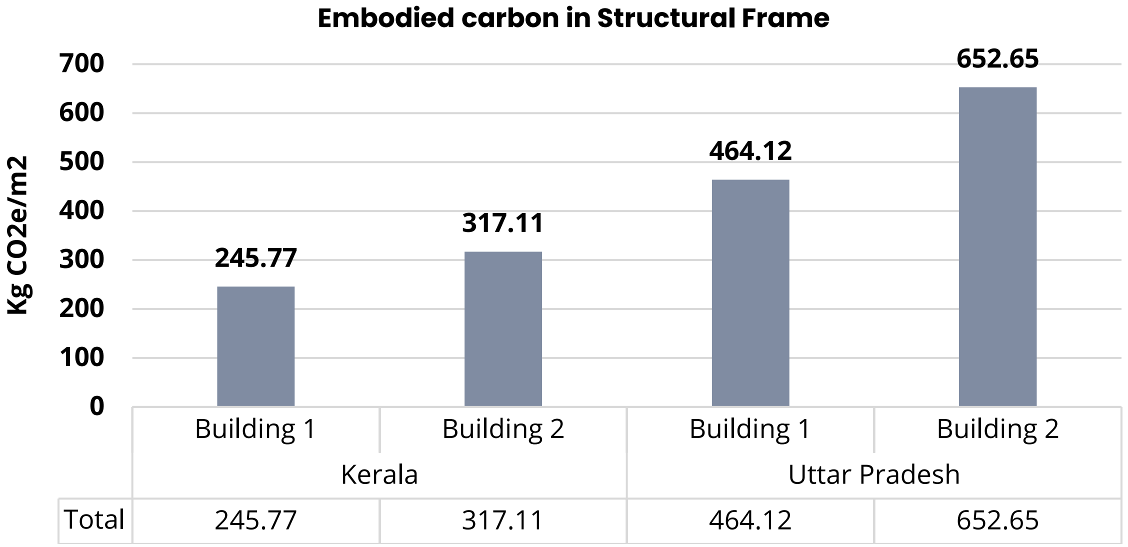
696×
R-410A higher than R-290

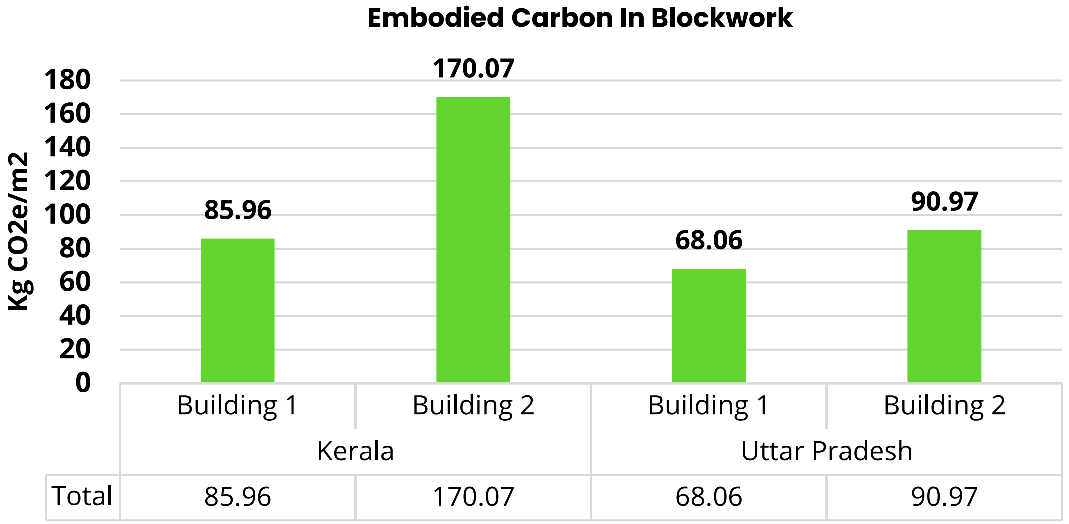
0-3
Natural refrigerant GWP

68%
GWP reduction R-410A to R-32

99.9%
GWP reduction to naturals

Structural Element Embodied Carbon Trends (Indian dataset)





Structural Frame
Largest single contributor (≈68% of total emissions).
High values are justified since RCC structural frames (columns, beams, slabs) dominate material intensity with cement and reinforcement steel as key inputs.

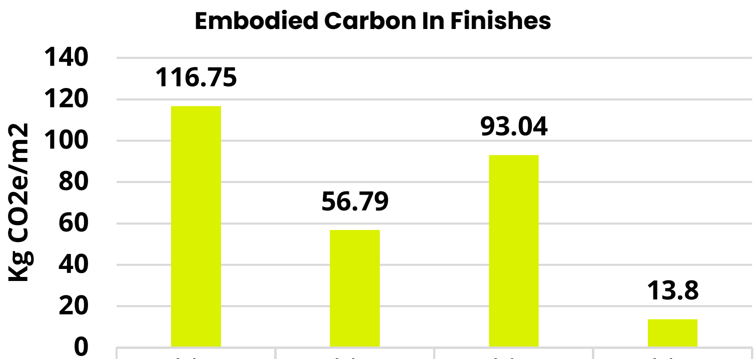
•**UP buildings show higher frame emissions** (652.65 in Building 2) compared to Kerala (317.11 max), likely due to Climatic and seismic demand.

Blockwork
Significant share after structural frame (≈17%).

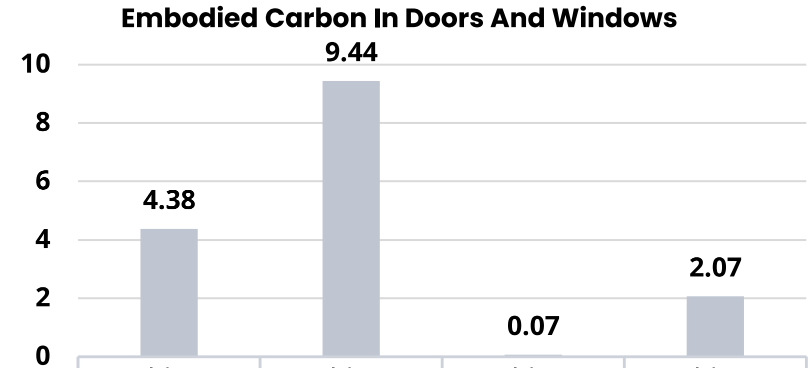
Kerala's higher values (170.07 in Building 2) suggest heavier reliance on conventional masonry infill walls, possibly brick or denser blocks.

UP's lower figures (≈91 in Building 2) indicated by use of lighter block systems (AAC/CMU), reducing embodied carbon in wall assemblies.

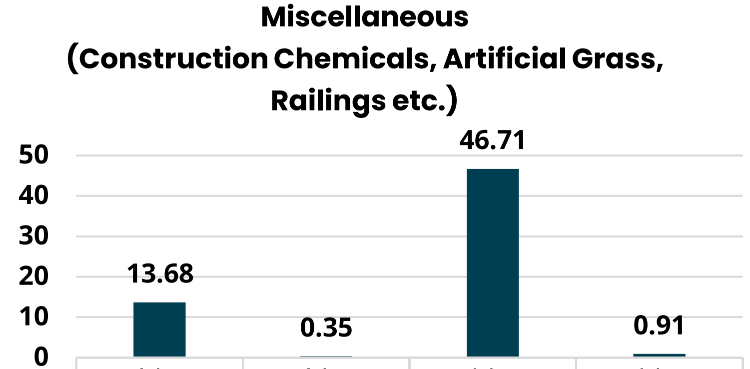
Structural Element Embodied Carbon Trends (Indian dataset)



	Kerala		Uttar Pradesh	
	Building 1	Building 2	Building 1	Building 2
Total	116.75	56.79	93.04	13.8



	Kerala		Uttar Pradesh	
	Building 1	Building 2	Building 1	Building 2
Total	4.38	9.44	0.07	2.07



	Kerala		Uttar Pradesh	
	Building 1	Building 2	Building 1	Building 2
Total	13.68	0.35	46.71	0.91

Finishes –Substantial contribution (≈11%).

High finish-related emissions in Kerala (116.75 in Building 1) suggest extensive use of tiles, putty, and plaster layers demanded due to coastal weather and heavy rains.

Uttar Pradesh (93.04 in Building 1) shows slightly efficient finishes per area, possibly due to simpler exterior treatment, reducing finishing materials scope.

Doors and Windows –Lowest overall contributor (<1%).

Kerala’s Building 2 (9.44) has relatively higher emissions, likely due façade glazing design with a composition of aluminium PVC and glass

UP values are very small (≤2), indicating either minimal openings or more efficient choice of Door window materials such as timber

Miscellaneous –Smaller share (≈2.5%)

UP’s Building 1 (46.71) disproportionately drives due to Galvanized Profiled Decking Sheet and Cementitious Fireproofing used at terrace.

Kerala remains negligible here (≤14), possibly due to Limited materials from BOQ present for captured in miscellaneous category.

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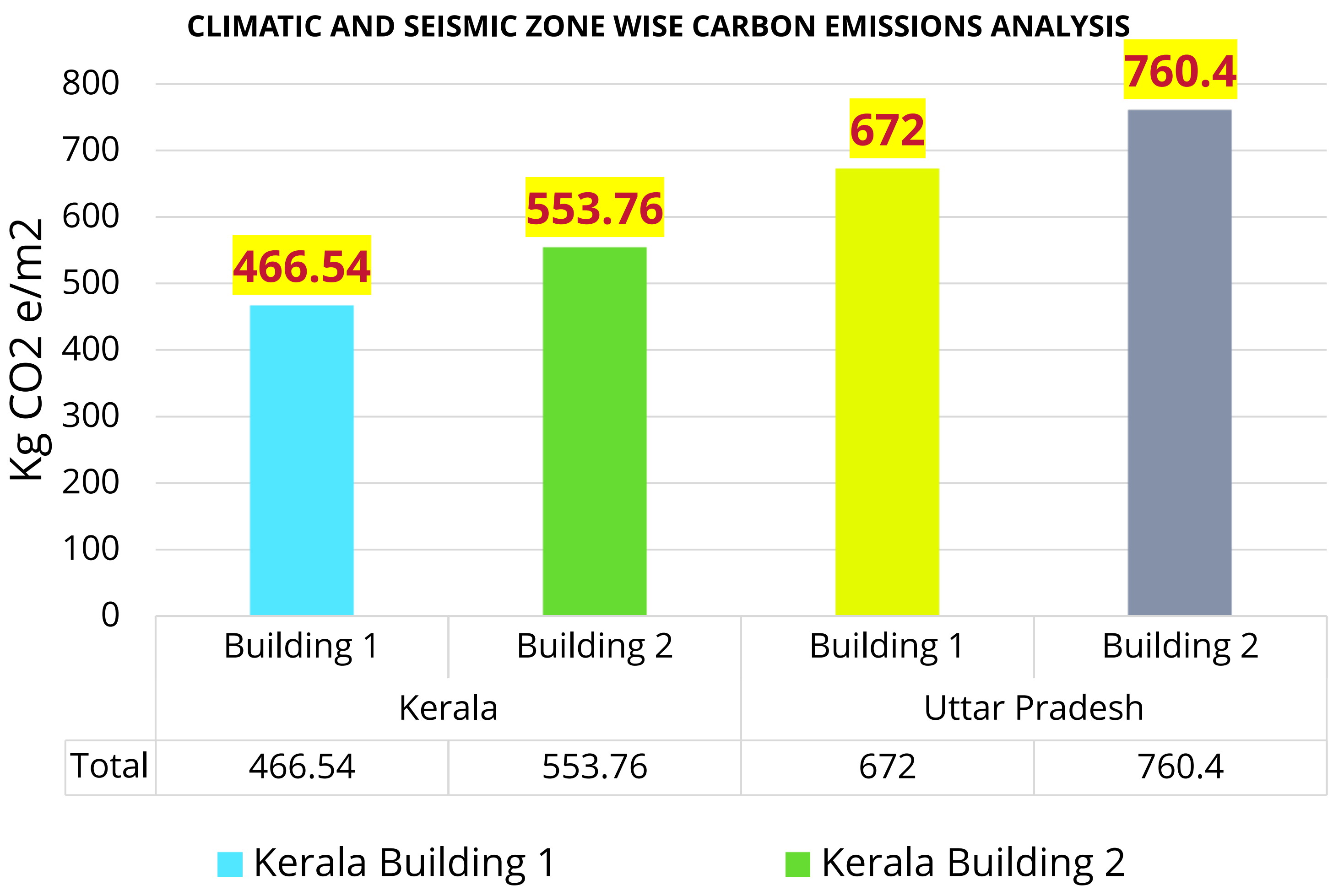
Observe the numbers based on Climatic and Seismic Zone Analysis



Observations

- Embodied carbon is higher in composite climate buildings (Uttar Pradesh) than warm-humid buildings (Kerala).
- Composite climate buildings record up to 760 kg CO_2e/m^2 vs. 466–554 kg CO_2e/m^2 in warm-humid zones.
- Higher seismic zones (III & IV, Uttar Pradesh) requirement for additional reinforcement spikes the embodied carbon number as well.

Understanding

- Composite climate + seismic demands = more material-intensive, carbon-heavy construction.
- Warm-humid climate (Kerala, Zone III) allows lighter construction and low embodied carbon design.

Conclusions

Why do we need to understand these embodied carbon numbers?

- Set industry benchmarks and drive the shift towards low-carbon construction.
- Understand the link between embodied carbon, operational performance, and overall lifecycle emissions.
- Optimize design and material choices early, reducing embodied carbon by up to 25% without structural changes.
- Enable designers and engineers to think in a low-carbon way at every stage of decision-making.
- Provide measurable data to influence policies, standards, and green building certifications.
- Support clients and stakeholders in making informed, future-ready investment choices.
- Build awareness across the value chain, encouraging material efficiency and innovation.

Reducing greenhouse gas emissions today is more beneficial than reducing the same number of emissions in the future!

@LCB_COMMUNITY

HEAT

- Interested in low-carbon community in Cambodia for future events/trainings?
- *Consider joining the Telegram group!*

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