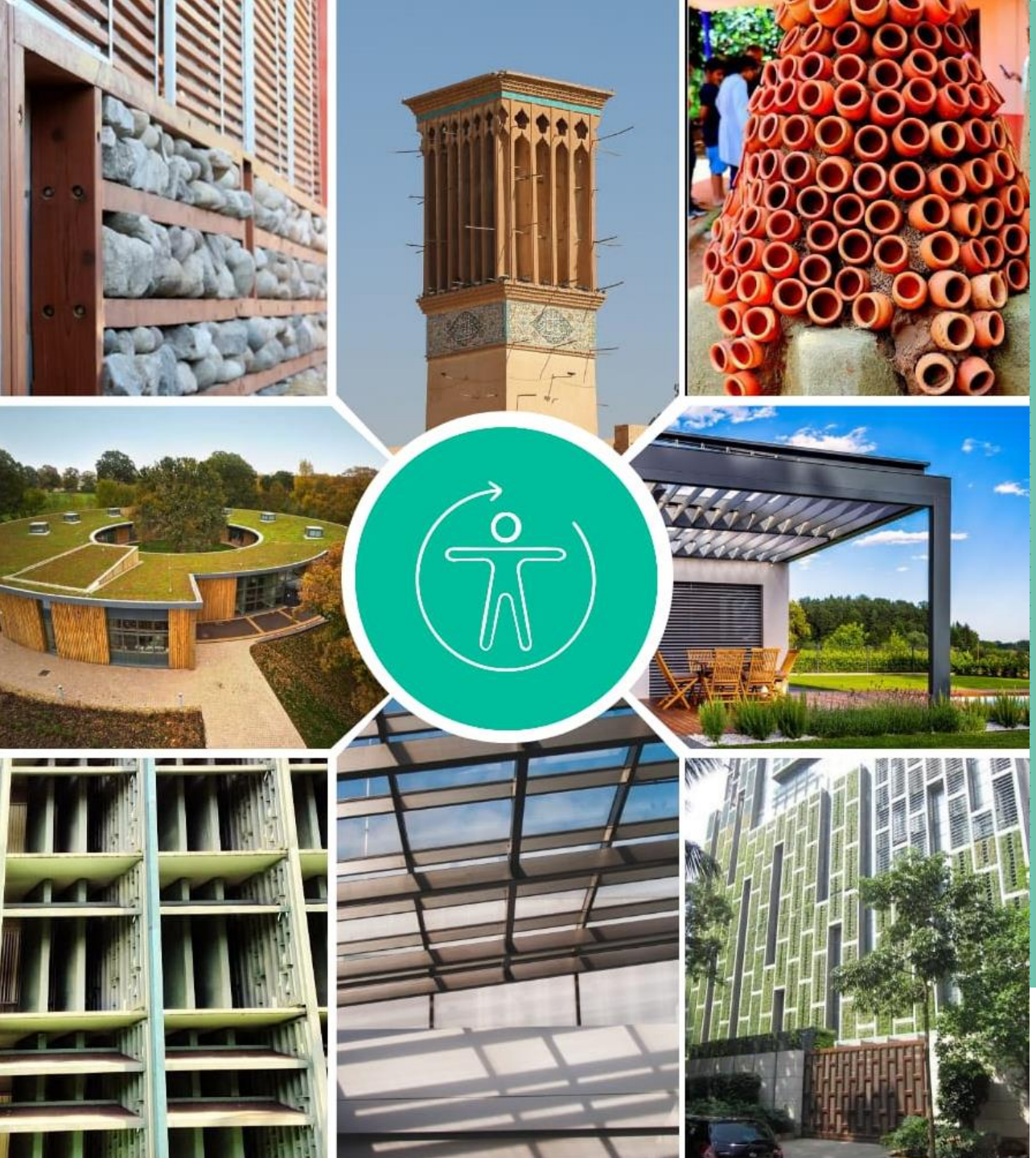


GGGI

ASIA LOW CARBON BUILDINGS TRANSITION PROJECT

Life Cycle Assessment for Transitioning to a Low-Carbon Economy

3.5 Low Carbon Building Assessment Tools

November 2024

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

WHAT WILL YOU LEARN?

01 **Carbon Assessment Tools for Buildings**

02 **Typical Internationally-used Carbon Assessment Tools: How it Works and Case Examples**

03 **ALCBT Carbon Tool: How it Works, Scope and Benefits**

CARBON ASSESSMENT TOOLS

Analytics for sustainable buildings

Carbon assessment tool provides analytics for:

CARBON ASSESSMENT TOOLS

Design-integrated tool

- Web-based tool
- Whole life carbon analysis
- Environmental product declaration (EPD) generation
- Licensed access
- Tailored for the construction sector

Source: Carbon Leadership Forum

CARBON ASSESSMENT TOOLS

Calculators

- Web-based tool
- Whole life carbon analysis
- Pre-fed cases
- Comparative energy and material efficiency measures
- Free access

- Embodied Carbon in Construction Calculator
- Access to building material EPDs
- Useful for selection and procurement
- More like a comparison tool
- Focuses on A1–A3 emissions
- Free access

Source: Carbon Leadership Forum

CARBON ASSESSMENT TOOLS

Other life cycle assessment (LCA) tools in construction sector

- Software application for LCA and green building certification
- Free access

HEAT

- Software tool for assessing embodied and operational carbon (under development) in building sector

CARBON ASSESSMENT TOOLS

Other life cycle assessment tools targeting a range of industries: automotive, electronics, agriculture…

thinkstep
GaBi

- Whole life carbon analysis
- Licensed access
- Used mainly by industry professionals

SimaPro

- Paid service
- Whole life carbon analysis
- Used mainly by industry professionals

openLca

- EPD generation
- Free + paid datasets, popular in academia

Source: Carbon Leadership Forum

EC3 TOOL: EMBODIED CARBON CALCULATOR

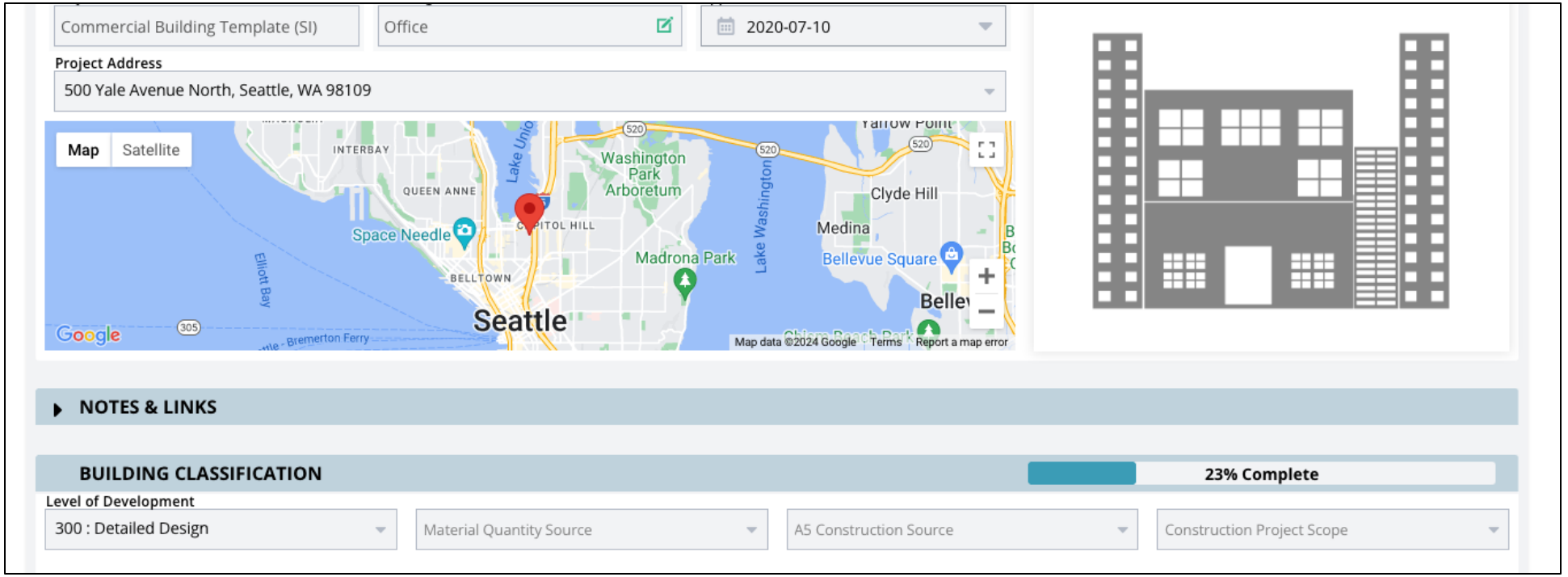
Life cycle assessment tool

- The Embodied Carbon Calculator EC3 is a free, open-access tool developed by Carbon Leadership Forum and Building Transparency. It covers LCA scope A1 to A3, and has a straightforward, easy-to-use interface for global application
- How:
  - Uses building material quantities from construction estimates (and/or information from BIM/REVIT)
  - Uses transparent, free-to-access database for EC of each material used consisting of **digital, third-party-verified EPDs**
  - This allows the user to directly specify which low carbon material should be procured for construction
- EC3 tool does not have a certification scheme, but helps certification programs, owners and policy-makers assess supply chain data (data granularity)
- EC3 tool is highly specific **to embodied carbon in materials** and this tool is ideal for architects and engineers focused on material choices

Source: Building Transparency

EC3 APPLICATION

Data entry screen

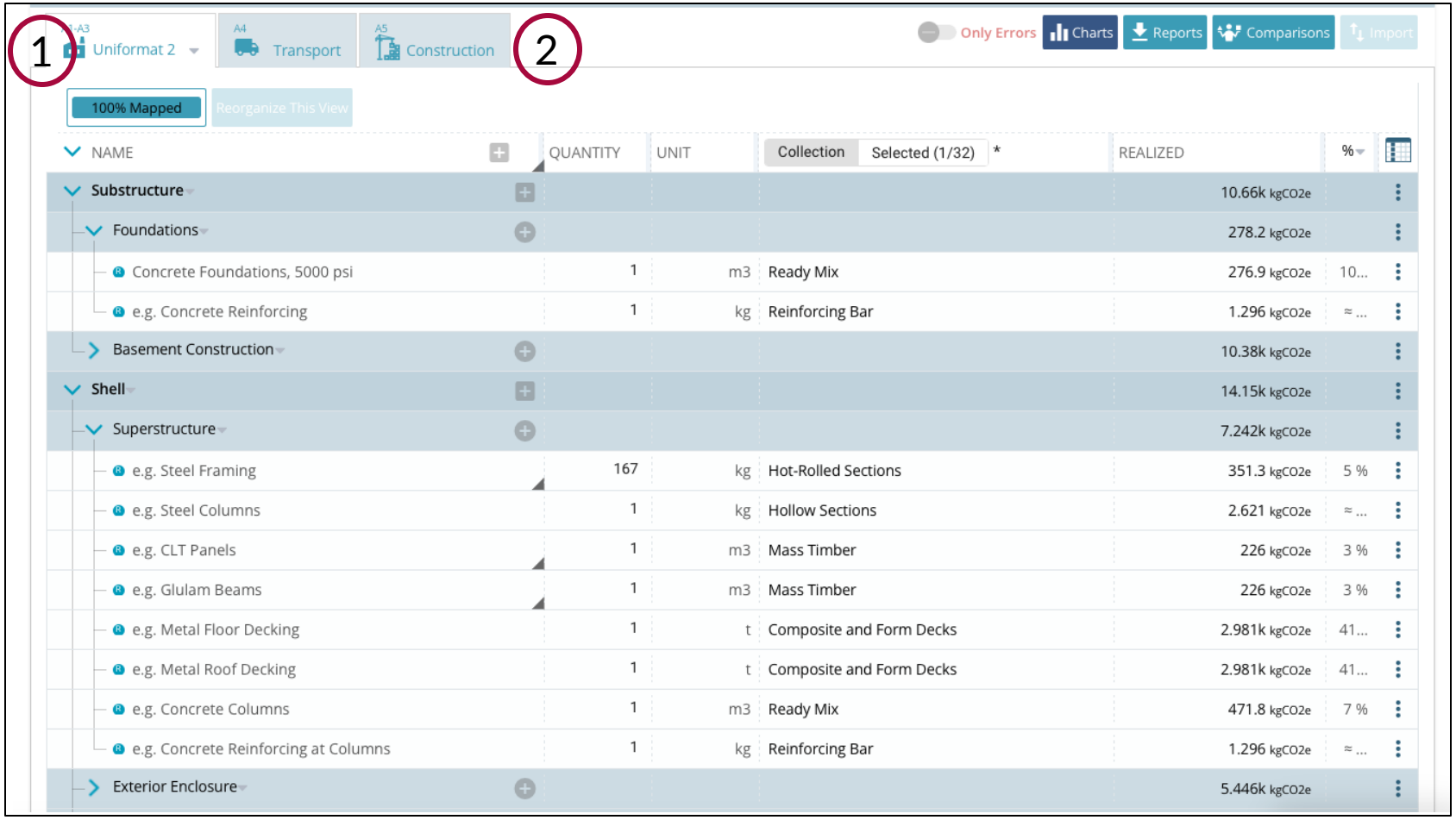


Choose the specific building type and location → Add additional data (floor area, natural gas/electricity consumption, etc.) → Start work in materials in the building

Source: EC3

EC3 APPLICATION

Substructure, shell and interior



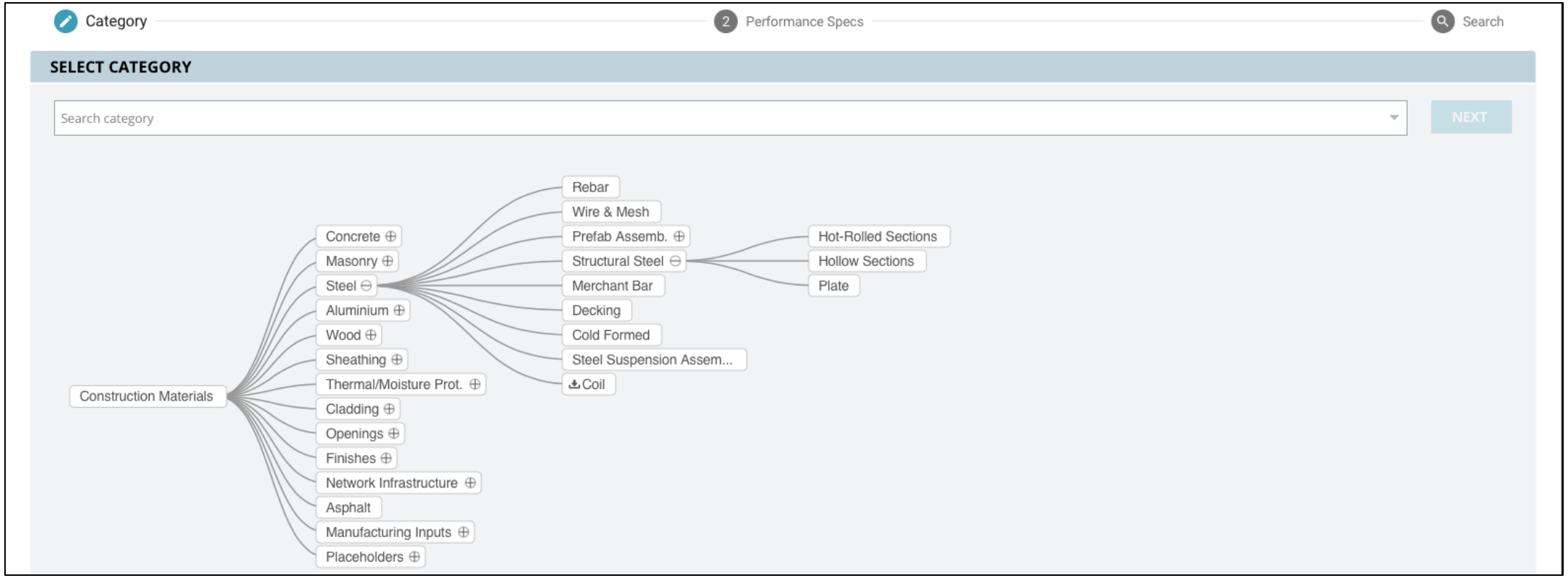
1. Subdivide into: e.g., substructure (foundations), shell (superstructure, exterior enclosure, roofing), and interior (insulation, ceiling tiles, carpet), …

2. Additional emissions for transport and construction can be added (see tabs at the top). The importance is to know: the quantity of each material and the distance/how materials are transported

Source: EC3

EC3 APPLICATION

Material workflow



Choose the specific construction material → Choose the specific requirements (e.g., compressive strength), distance from location → **Search and compare for relevant EPDs**

Source: EC3

EC3 APPLICATION

Find and compare materials

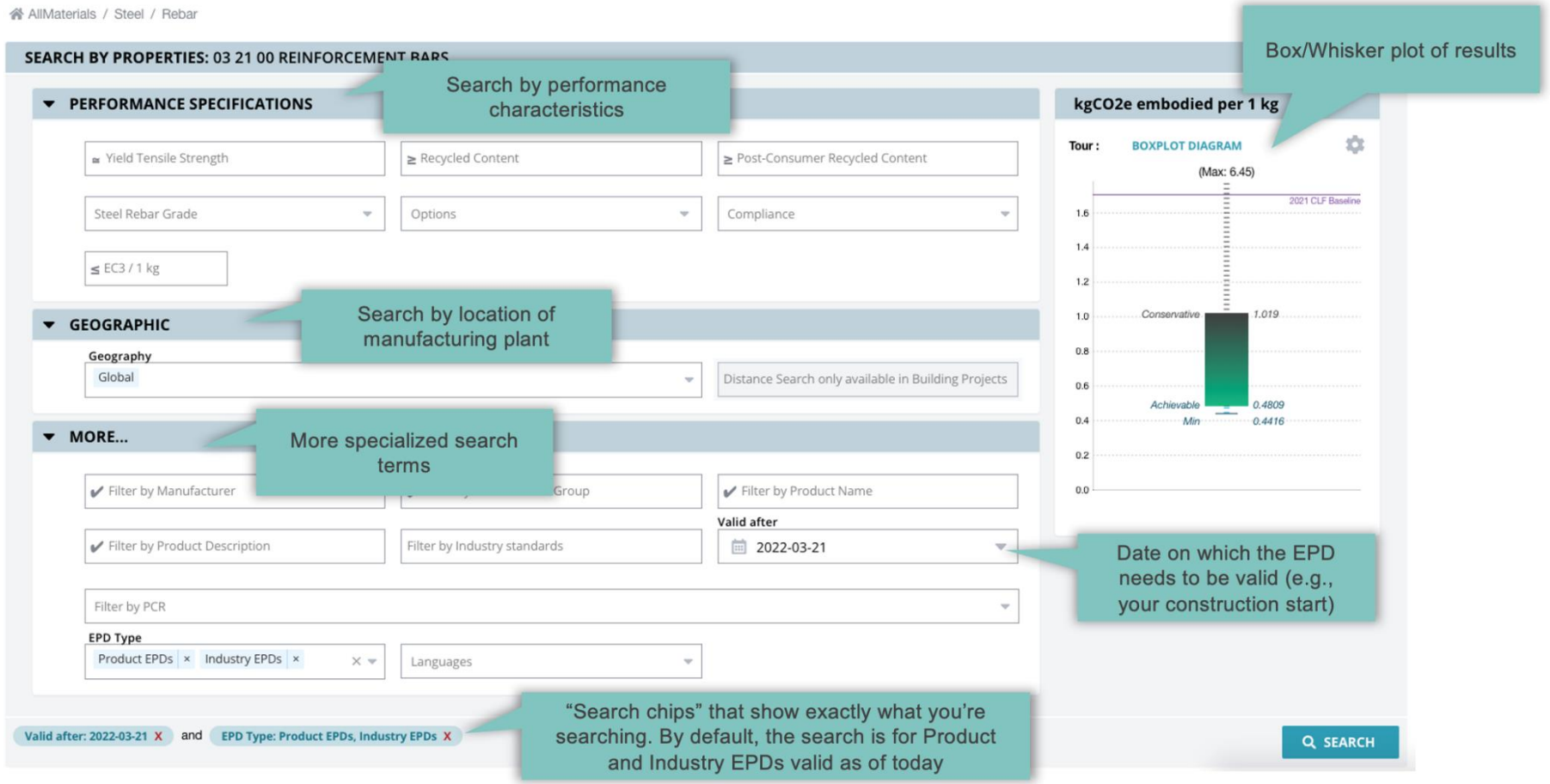


Image source: https://docs.buildingtransparency.org/ec3/main-features

EC3 APPLICATION

Plan and compare buildings

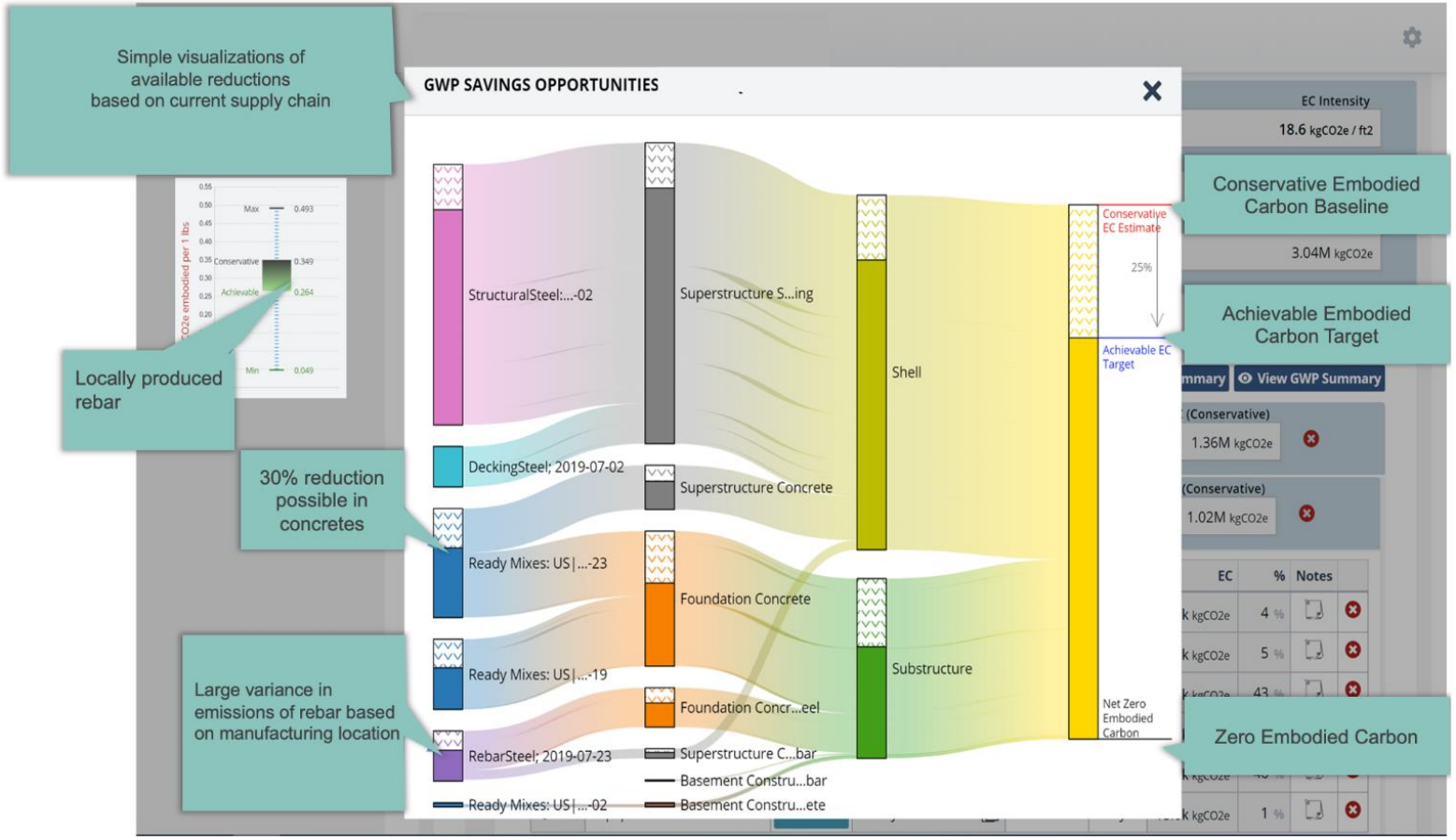


Image source: https://docs.buildingtransparency.org/ec3/main-features

EC3 APPLICATION

Results

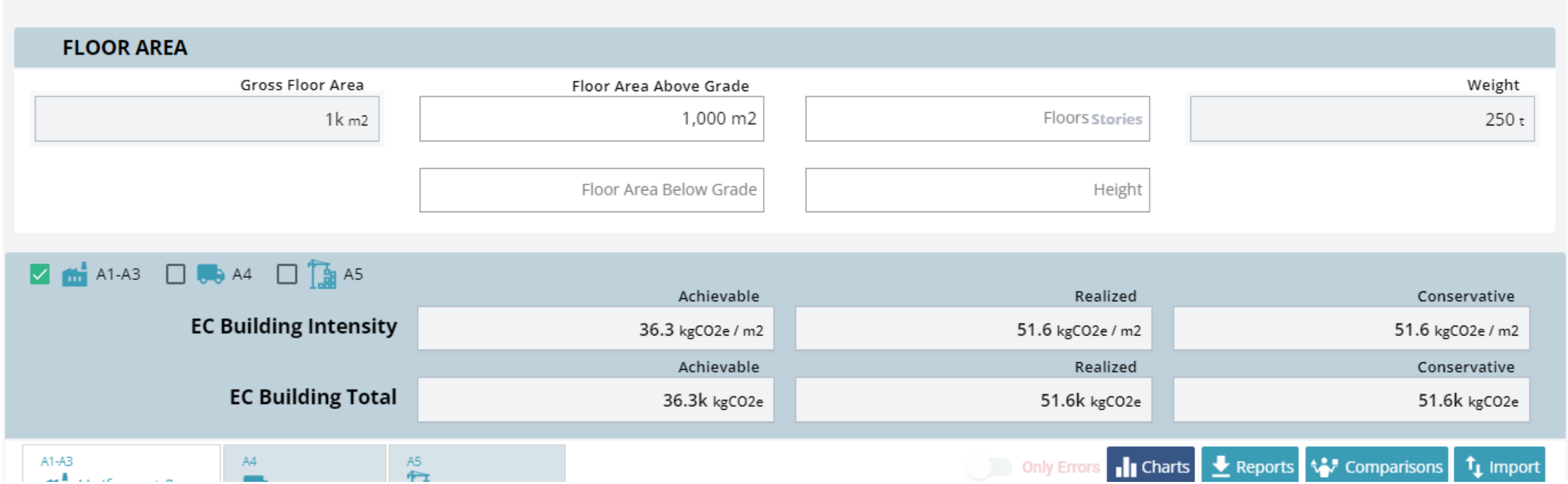


Image source: https://docs.buildingtransparency.org/ec3/main-features

EDGE APPLICATION

Life cycle assessment and certification tool

- EDGE is a green building certification system focused on making buildings more resource efficient. An innovation of IFC, a member of the World Bank Group, EDGE empowers emerging markets to scale up resource-efficient buildings in a fast, easy and affordable way
- EDGE enables developers and builders to quickly identify the most cost-effective strategies to reduce energy use, water use and embodied energy in materials. The strategies that are integrated into the project design are verified by an EDGE Auditor and certified by Green Business Certification Inc. (GBCI)
- EDGE is comprised of:
  - EDGE Software – The web-based EDGE App, available for free at edgebuildings.com, allows you to quickly determine the optimum combination of building design strategies for the best return on investment
  - Global Standard – EDGE requires a minimum projected reduction of 20% in energy use, water use and embodied energy in materials as benchmarked against a standard local building
  - Certification System – Certification by GBCI validates your achievements at a modest cost for nearly all building types, both new and existing

Source: US Green Building Council

EDGE APPLICATION

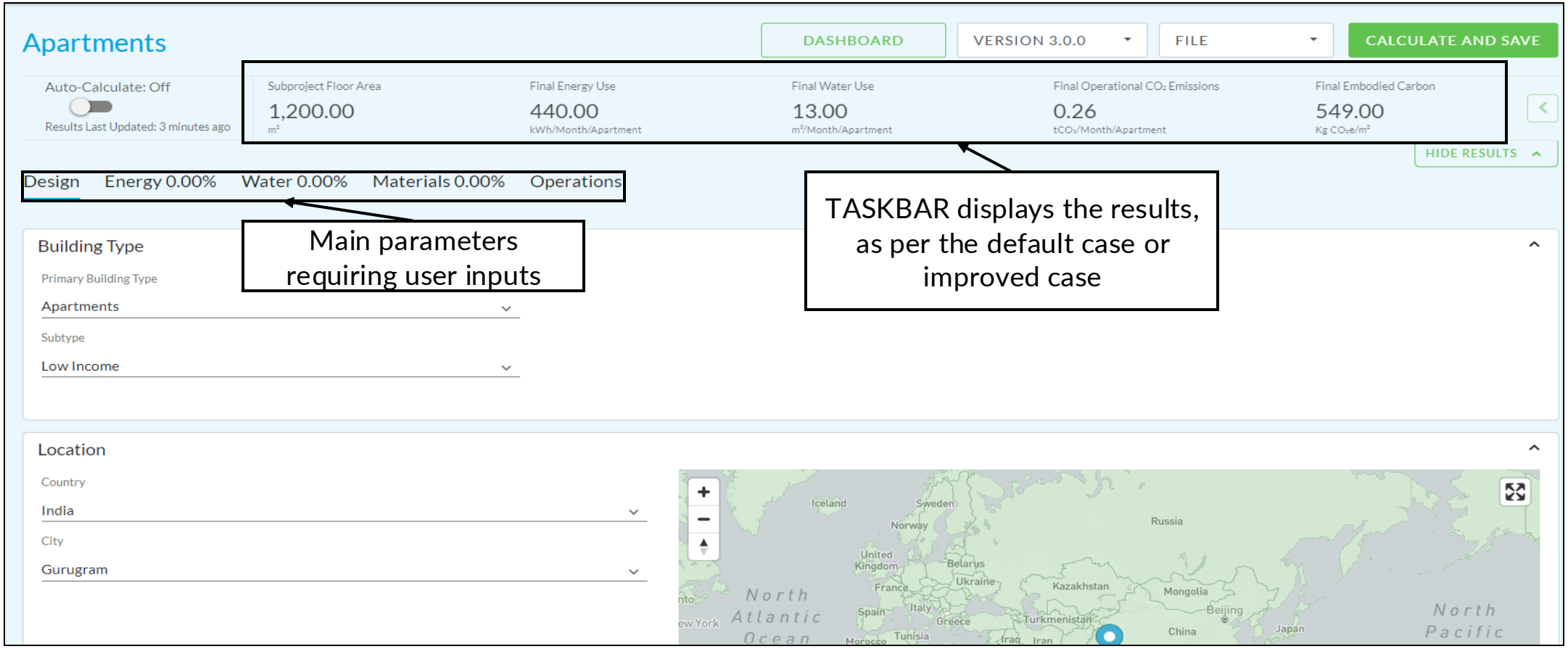
Life cycle assessment tool

- It is a comparative assessment tool, usually used for green building certification
- Based on location, typology and income group, pre-fed base case results are displayed:
  - Final energy usage
  - Final water use
  - Operational carbon
  - Embodied carbon
- The basic sections of the tool are:
  - Building design parameters
  - Energy efficiency measures
  - Water efficiency measures
  - Material efficiency measures
  - Operational energy

Source: EDGE

EDGE APPLICATION

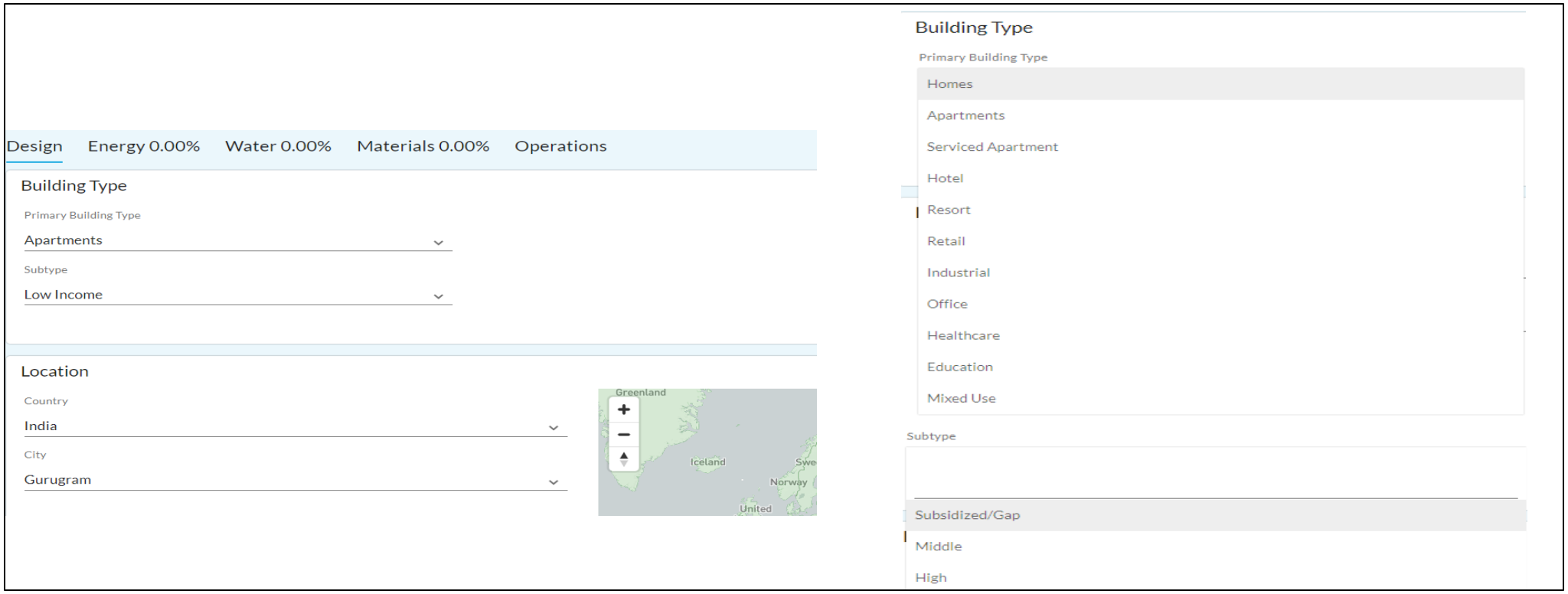
Data entry screen



Source: EDGE

EDGE APPLICATION

Data entry screen



Base case values are governed by choosing building type, income group and location

Source: EDGE

BUILDING DESIGN PARAMETERS

User data entry

- User needs to input basic project details – name, organization, address, etc.
- Building data – number of apartments, floors above and below the grade, floor-to-floor height, etc.
- User can modify the typology according to project-specific details
- Building dimensions – building length in different directions
- HVAC system details
- Area and loads breakdown
- Fuel usage details (emissions factors of fuels can be customized)
- Climate data – elevation, annual rainfall, monthly average temperatures

Source: EDGE

ENERGY EFFICIENCY MEASURES

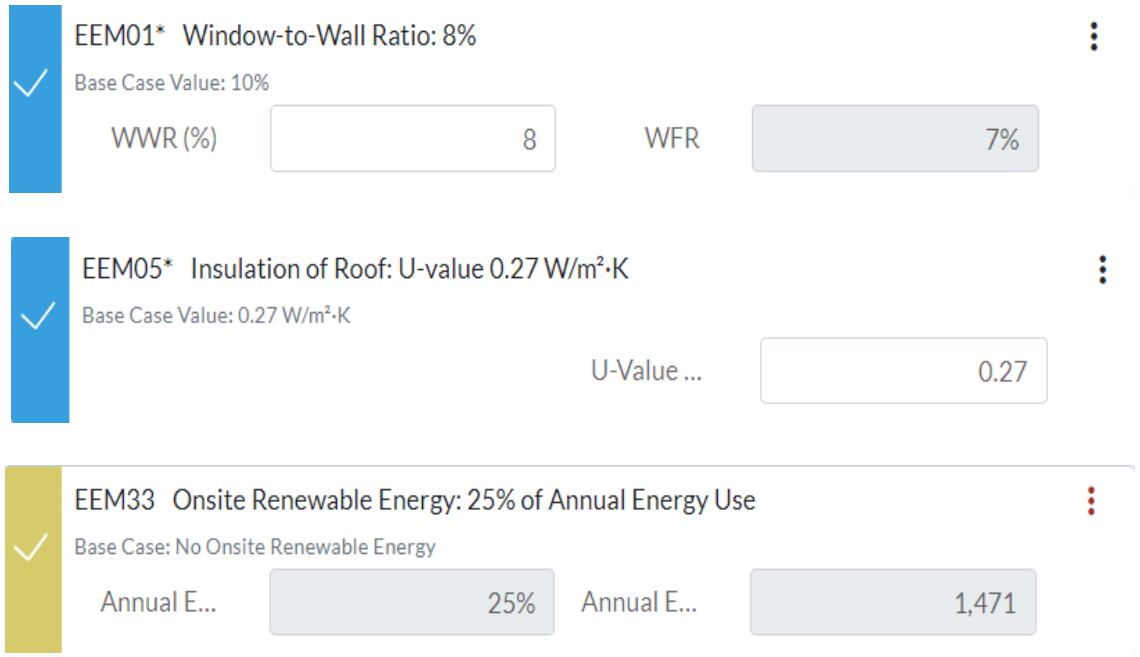
EDGE: List of measures available

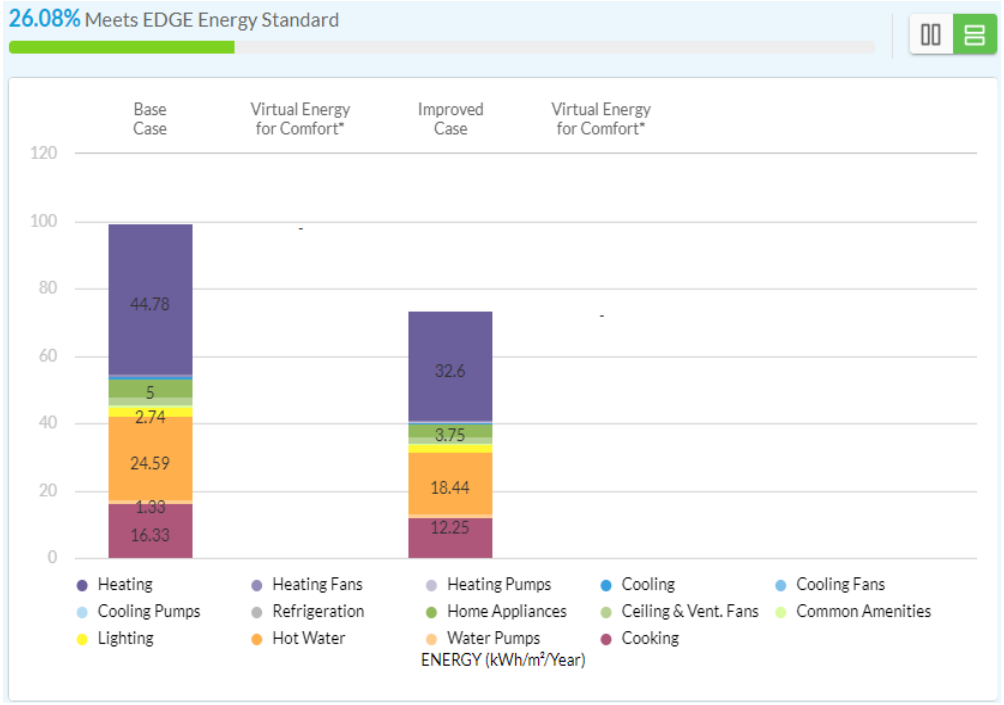
- Air infiltration of envelope
- Natural ventilation
- Ceiling fans
- Cooling system efficiency: COP
- Variable speed drives
- Fresh-air pre-conditioning system
- Space heating system efficiency
- Room heating controls with thermostatic valves
- Domestic hot water system
- Window-to-wall ratio
- Reflective roof: solar reflective index
- Reflective exterior walls: solar reflective index
- Insulation of roof: U-value
- Insulation of ground/raised floor slab: U-value
- Green roof
- Insulation of exterior walls: U-value
- Efficiency of glass: U-value, SHGC, VT
- Domestic hot water pre-heating system
- Economizers
- Demand control ventilation using CO_2 sensors
- Efficient lighting for internal areas
- Efficient lighting for external areas
- Lighting controls
- Efficient appliances
- Efficient smart meters and submeters
- Power factor corrections
- Onsite renewable generation
- Low impact refrigerants
- External shading devices: annual average shading factor

Source: EDGE

ENERGY EFFICIENCY MEASURES

Comparative analysis





After choosing some measures, improved case shows the respective changes in the energy numbers

Source: EDGE

MATERIAL EFFICIENCY MEASURES

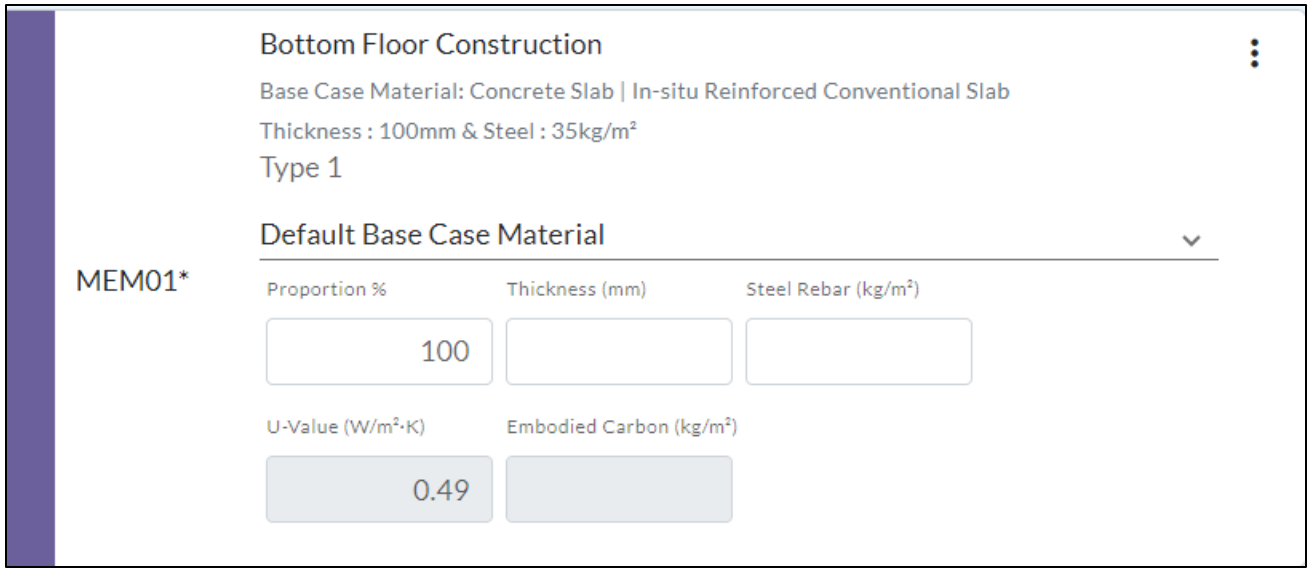
EDGE: List of measures available

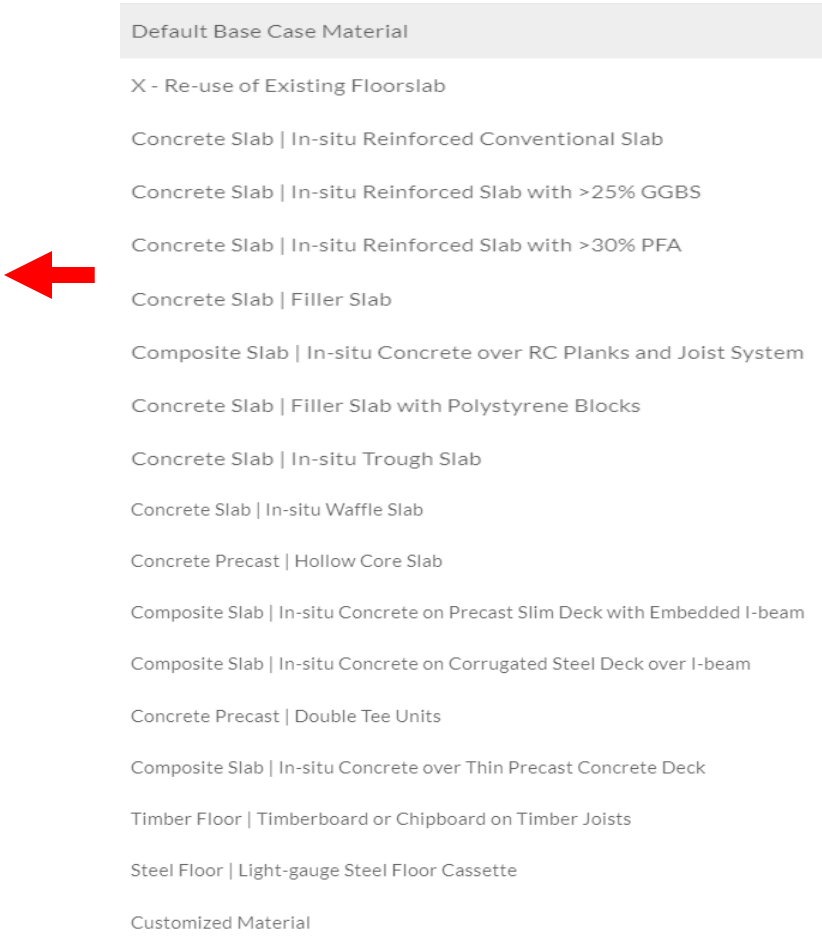
- Bottom floor construction
- Intermediate floor construction
- Floor finish
- Roof construction
- Exterior walls
- Interior walls
- Window frames
- Window glazing
- Roof insulation
- Wall insulation
- Floor insulation

Source: EDGE

MATERIAL EFFICIENCY MEASURES

EDGE: List of measures available



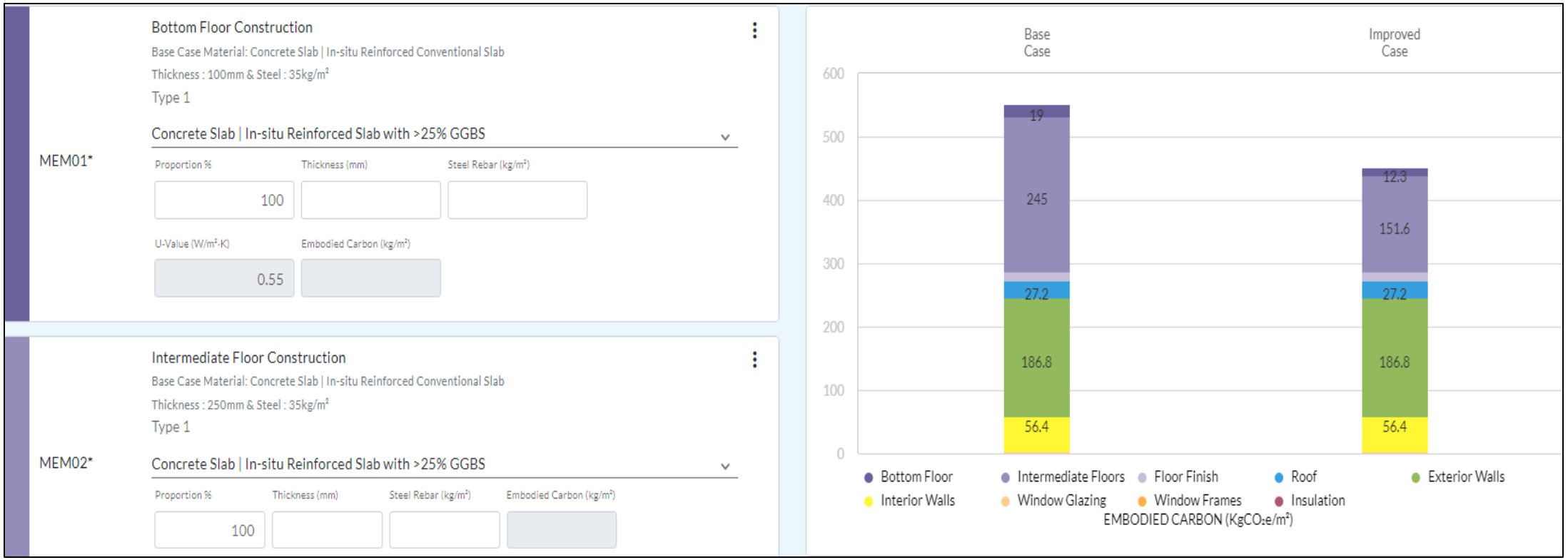


For every measure, there is a default case available. The user can change it to other available variants, as shown in the drop down menu on the right

Source: EDGE

MATERIAL EFFICIENCY MEASURES

Comparative analysis



After choosing the measures, improved case shows the respective changes in the embodied carbon numbers

Source: EDGE

OPERATIONAL ENERGY

User data entry

- User needs to input energy consumption data for all the months, the energy sources being:
  - Conventional electricity
  - Onsite renewable electricity
  - Offsite renewable electricity
  - Carbon offsets purchased
- For onsite non-renewable energy generation (if applicable), user can input fuel type and fuel consumption values for different months
- Outputs from the tool:
  - Total energy consumption
  - Onsite carbon emissions
  - Carbon mitigation from exported renewable energy
  - Net carbon emissions onsite
  - Total GHG offset
  - Net carbon emissions balance

Source: EDGE

EDGE

Case example: Residential home in Philippines

- Location: Philippines
- Energy measures: Window-to-wall ratio, LED lighting, solar photovoltaics
- Material measures: Corrugated zinc sheets for roof, in-situ reinforced wall for external walls, ferrocement wall panel for internal walls

GHG reductions: 0.4 tCO_2/year/home

SOLUTIONS		SAVINGS
Energy	► Reduced Window to Wall Ratio ► LED Lighting ► Solar Photovoltaics	42%
Water	► Low-Flow Showerheads ► Low-Flow Faucets for Kitchen Sinks ► Low-Flow Faucets for Washbasins	20%
Materials	► Corrugated Zinc Sheets for Roof ► In-Situ Reinforced Wall for External Walls ► Ferrocement Wall Panel for Internal Walls	26%
RESULTS		
Savings		
	Utility Bills ($/month/home)	11
	Energy (kWh/month/home)	135
	Water (kL/month/home)	2.4
	Embodied Energy (MJ/home)	1,320
Environmental Benefits		
	GHG Reductions (tCO_2/year/home)	0.4

Source: EDGE

EDGE

Case example: Commercial building in Mexico

- Location: Mexico
- Energy measures: Window-to-wall ratio, external shading, AC with water-cooled chiller, low E-coated glass, energy efficient lighting system, insulation of roof and wall
- Material measures: Concrete filler slab for floors and roof, medium-weight hollow concrete blocks, finished concrete flooring, uPVC window frames

GHG reductions: 497 tCO_2/year

SOLUTIONS	SAVINGS
Energy	**51%**
▸ Reduced Window to Wall Ratio ▸ External Shading ▸ Air Conditioning with Water-Cooled Chiller ▸ Low-E Coated Glass ▸ Energy-efficient Lighting System ▸ Insulation of Roof and Wall	
Water	**32%**
▸ Low-Flow Showerheads ▸ Dual Flush Water Closets ▸ Water-efficient Urinals	
Materials	**44%**
▸ Concrete Filler Slab for Floors and Roof ▸ Medium-weight Hollow Concrete Blocks ▸ Finished Concrete Flooring ▸ uPVC Window Frames	
RESULTS	
Extra Costs & Payback Time	
Green Solutions ($)	56,000
Payback (Yrs.)	0.6
Savings	
Utility Bills ($/month)	7,634
Energy (kWh/month)	90,028
Water (lt./room/night)	121
Embodied Energy (MJ/m²)	744
Environmental Benefits	
GHG Savings (tCO_2/year)	497

Source: EDGE

EDGE

Case example: Unlocking green buildings market for banks

- ProCredit is an international group of development-oriented commercial banks mainly active in South-Eastern and Eastern Europe
- ProCredit has been interested and engaged in financing green buildings for years but has had to develop an individual assessment approach for each country. This approach has posed a serious challenge due to the substantial additional workload involved, coupled with the difficulty of obtaining relevant information
- The group launched its first green loans in 2006 and gradually developed a green lending methodology and a green bonds framework to standardize its lending process and ensure specific environmental impacts are achieved. As of the end of 2020, the group's green loan portfolio amounted to almost EUR1 billion, representing 19% of its total loan portfolio
- Initially, the group has assessed green buildings against country baselines and according to country building codes. The process is intensive and often difficult to implement, owing to a lack of data or proper regulation in its countries of operation
- The situation changed when ProCredit integrated EDGE into the environmental impact assessments carried out for the head offices of its banks, where the benefits of EDGE were apparent: user-friendly application, availability of data, the possibility of preliminary assessment and recognized certification

Source: Polychroniadou, 2021

EDGE

Case example: Unlocking green buildings market for banks (continued)

- ProCredit decided to promote this certification further in its markets by using it as a tool in the assessment process for green buildings. The banks can now use EDGE instead of conducting individual analyses for the purpose of assessing a building's eligibility for a green loan
- ProCredit proposes conducting a preliminary assessment using the EDGE app to make an initial determination whether the project has potential for improved performance of 20% compared to the local baseline. This is done in partnership with Sintali-SGS, who offers EDGE Expert support through its partner network. EDGE Experts provide support in using the application and conducting initial analyses of ProCredit clients' projects
- This assessment is then submitted to the business committee of the bank for review and if approved, the client can benefit from preferential loan rates for the development of the green building project. A further requirement to be eligible for these loan rates is the actual completion of the EDGE certification process
- The use of EDGE data to define eligibility criteria enables the ProCredit banks to have a standardized and comparable approach across its markets, thus unlocking significant potential for building improvement and green finance. It also reduces the time required to conduct an initial eligibility analysis, as local baselines have already been calculated in the EDGE app
- By implementing green lending programs and leading by example through the certification of its own buildings, ProCredit is putting sustainability into action

Source: Polychroniadou, 2021

EC3 AND EDGE TOOLS

Comparison: Easy-to-use tools with different visions

EC3

Not a Certification Scheme

- Focuses on construction materials
- Uses EPDs
- Compares individual materials to be procured
- Ideal for architects and engineers focused on material choices

Perspectives: Granular Value Chain of Products (EC3) vs Financing/Policy (EDGE)

Current Focus: Developed Countries (EC3) vs Developing Countries (EDGE)

Edge

Certification Scheme

- Financial calculator
- Simplified compliance
- Reduced processing
- Cost effective
- Better suited for broader assessments and policy-making

ALCBT CARBON TOOL

Development of a low carbon assessment tool for the ALCBT project

The Tool

- The ALCBT Carbon Tool is a pivotal component of the Asia Low Carbon Buildings Transition (ALCBT) project
- It aims to address embodied and operational carbon in buildings in key Asian countries (Cambodia, India, Indonesia, Thailand, Vietnam)

The Objective

- Provide a scalable, user-friendly platform for assessing whole life carbon emissions in buildings
- Empower stakeholders to quantify and reduce carbon footprints
- Inform the development of a robust taxonomy and thresholds for green public procurement (GPP)

ALCBT CARBON TOOL

Overview

Comprehensive Carbon Assessment

Detailed Embodied Carbon for Structural and Non-structural Elements

Operational Carbon over Building Lifespan

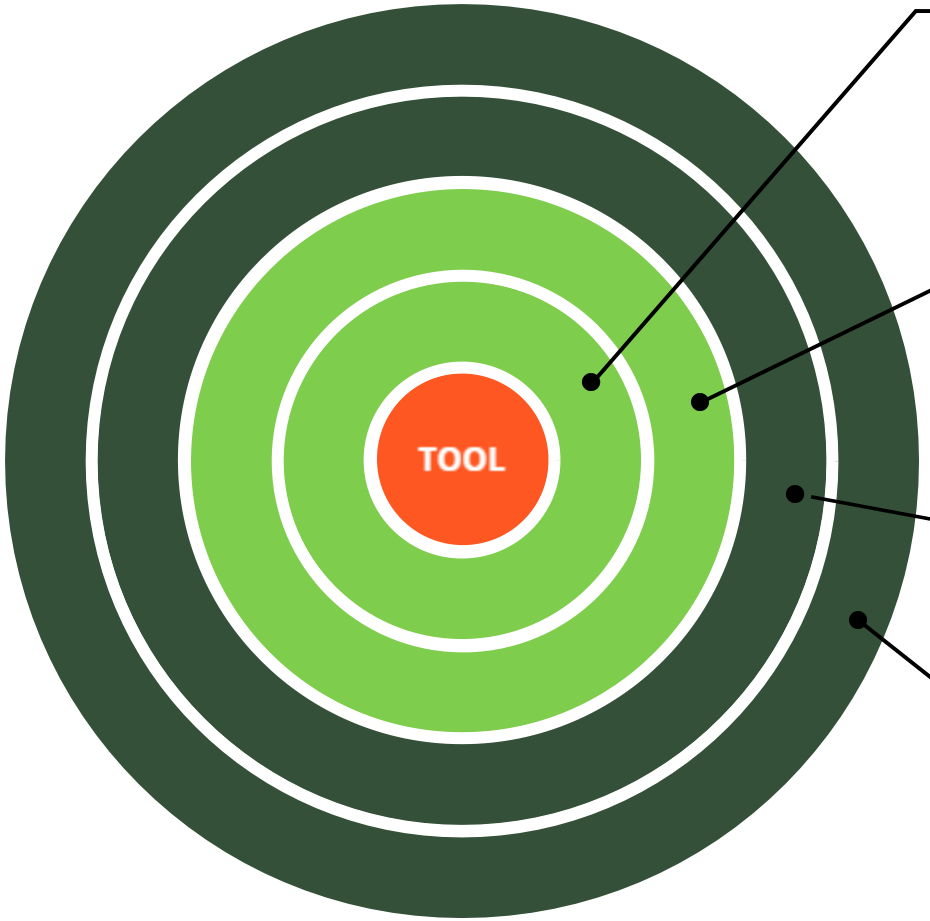
Data Capture from BIM Tools like REVIT for Accurate Material Quantification

Hierarchical EPD System: Site-specific>National>Regional>Global> Calculated LCA

Sensitivity Analysis for Material Choices and Design Alternatives

ALCBT CARBON TOOL

Design principles



Modular structure

Allows for updates and expansion

Comprehensive built-in material and EPD database and interface

Initially for India, later expandable to all ALCBT countries

Adaptive functionality

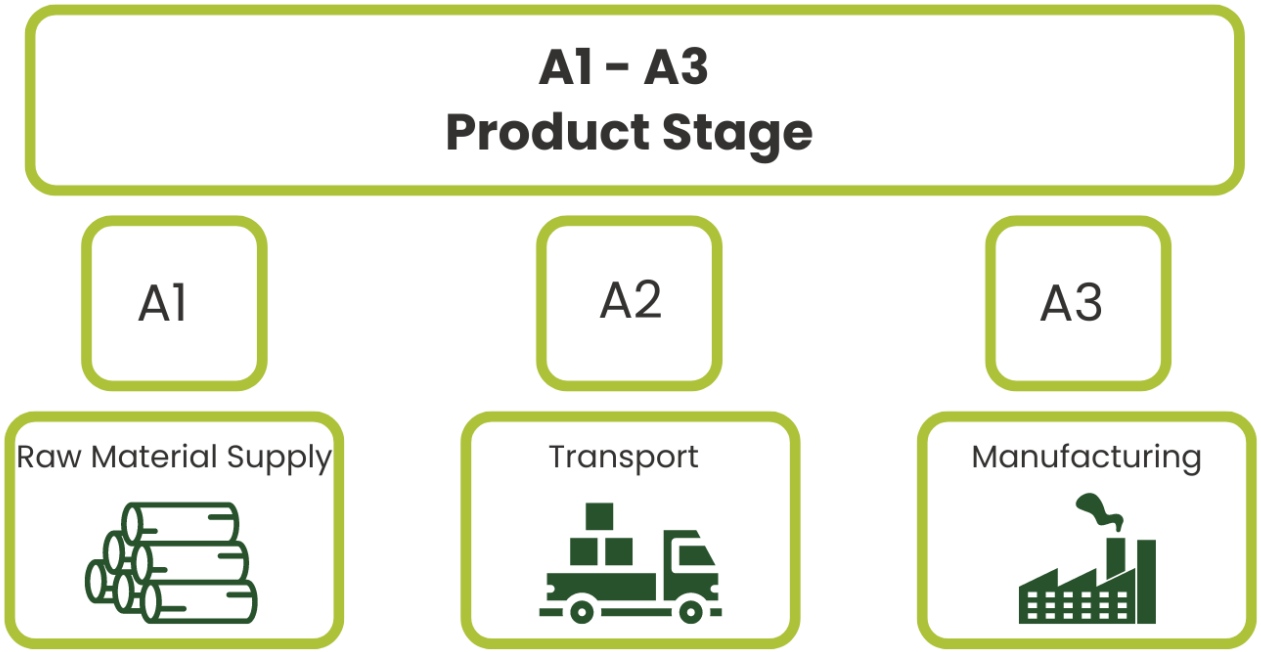
Accommodates limited data availability in certain regions

Full transparency

In calculations and data sources to ensure credibility and trust

ALCBT CARBON TOOL

Current LCA scope



ALCBT CARBON TOOL

Specific features

QUANTIFICATION

- Measure carbon emissions
- Track construction activities
- Monitor material impact

CARBON HOTSPOTS

- Identify high-impact areas
- Analyze intensity levels
- Target improvements

DESIGN ALTERNATIVES

- Compare options
- Evaluate impacts
- Optimize choices

COMPLIANCE

- Meet standards
- Drive benchmarks
- Facilitate certification

ALCBT CARBON TOOL

Overview of user interactions

TAB 1: Data Entry: Building Information

TAB 2: Modeling Elements

TAB 3: Modeling Items

TAB 4: Results + Analysis

ALCBT CARBON TOOL

Data entry requirements

Building characteristics and information – type, location, climate zone, gross floor area, year of construction, etc.

Building elements – structural and non-structural, e.g., exterior walls, floors, thickness of each layer, etc.

Material categories and groups, e.g., components of windows and curtain walls, declared units

Material-specific data – EPDs, PCRs, embodied carbon factors, etc.

Operational energy use – annual electricity consumption, energy audit report, heating, cooling usage

Life cycle considerations – scope of LCA (A1–A3), end of life use, etc.

ALCBT CARBON TOOL

Modeling elements

Element Definition

Name: Exterior Walls

Type: Residential Wall Assembly

Layers Breakdown

Layer 1: Outside Cladding
Material: Laminated Timber
Thickness: 5 cm

Layer 2: Insulation
Material: Perlite 0–3
Thickness: 10 cm

Layer 3: Structural Layer
Material: Softwood Lumber
Thickness: 10 cm

Calculation

Volume = Thickness × Area

Mass = Volume × Density

Environmental Impact = Mass × GWP/PENRT Factors

ALCBT CARBON TOOL

Calculation example

Table 1: Outer Wall Structure LCA Data

Layer	Material	Thickness (mm)	Bulk Density (kg/m³)	GWP A1-A3 (kg CO2-eq)	PENRT A1-A3 (MJ)
1	Material A	250	800	12.5	50
2	Material B	100	600	7.0	30

Table 2: Roof Structure LCA Data

Layer	Material	Thickness (mm)	Bulk Density (kg/m³)	GWP A1-A3 (kg CO2-eq)	PENRT A1-A3 (MJ)
1	Material C	300	900	15.0	60
2	Material D	150	700	8.0	35

Table 3: Summary of LCA Results

Structural Element	Total GWP (kg CO2-eq)	Total PENRT (MJ)
Outer Wall	19.5	80
Roof	23.0	95

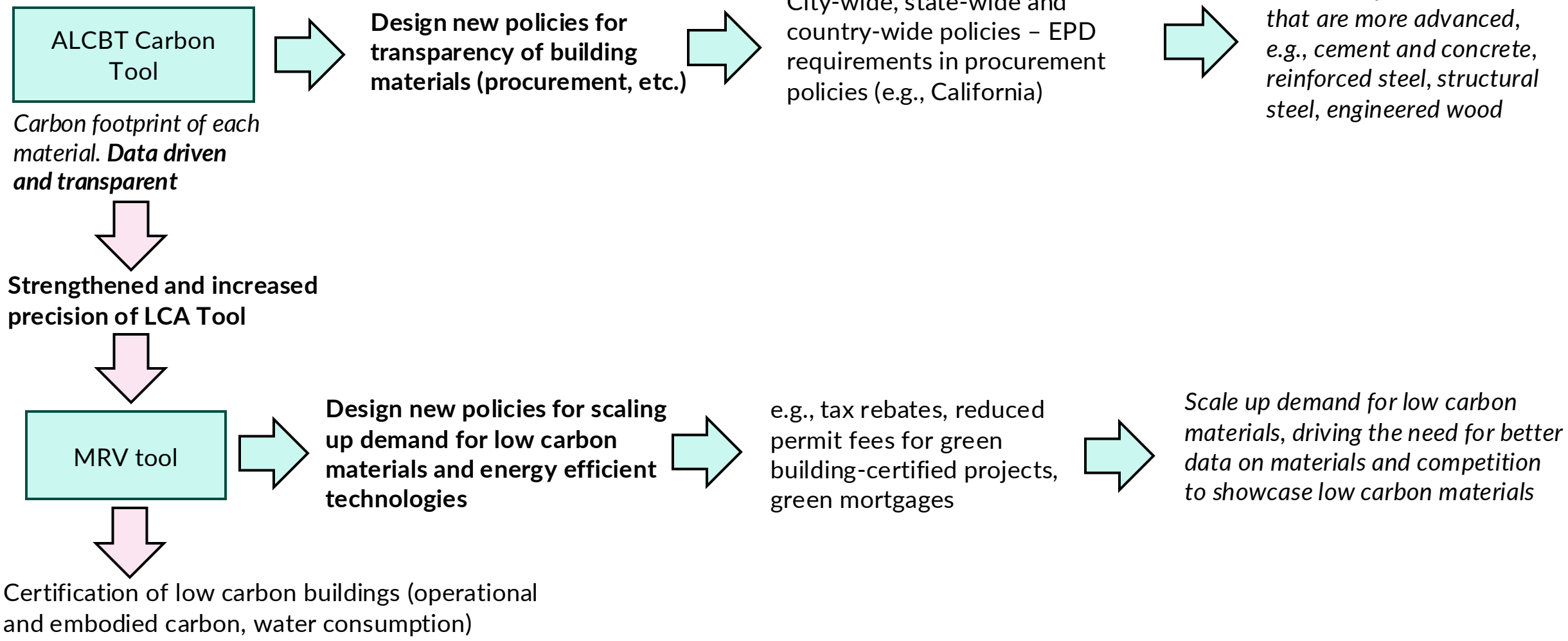
MRV CONCEPTS

Distinction between MRV and ALCBT tool

- The ALCBT Carbon Tool helps to **create a baseline for a building stock** from ALCBT countries. This will help to feed in entry data for the monitoring, reporting and verification (MRV) tool
- The MRV tool **calculates or estimates emissions under different future scenarios** by allowing users to change selected factors that impact projected emissions from the building sector at given time periods, including any significant actions such as regulations and policies, or introduction of efficient and low carbon solutions at specific periods, alone or in combination
- The MRV tool supports large-scale modeling of buildings, building populations, and future pathways, scenarios and baselines. **This tool enables policy-makers to set national targets in NDCs and LT-LEDS**
- The ALCBT Carbon Tool can provide both quick and detailed modeling of whole life carbon of a building. This tool helps to define baselines for city- and country-specific buildings, and design new policies for scaling up the demand for low carbon materials and energy efficient technologies

SCALING UP BUILDING LCA

Potential pathway



Thank you!

For more information, visit us at https://ALCBT.GGGI.ORG or scan the QR code below

IKI Independent Complaint Mechanism

Any person who believes they may be harmed by an IKI project or who wish to report corruption or the misuse of funds, can lodge a complaint to the IKI Independent Complaint Mechanism at IKI-complaints@z-u-g.org. The IKI complaint mechanism has a panel of independent experts who will investigate the complaint. In the course of the investigation, we will consult with the complainant so as to avoid unnecessary risks for the complainant. More information can be found at https://www.international-climate-initiative.com/en/about-iki/values-responsibility/independent-complaint-mechanism/.

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