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Sustainable Building and Construction Practical Mainstreaming Guidance

Development Alternatives

UN HABITAT
FOR A BETTER URBAN FUTURE

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UNOPS

Acronyms

BAU - Business As Usual

CBA - Cost Benefit Analysis

CBM - Circular Business Models

CC - Climate Change

DfD - Designing for Disassembly

DoW - Designing out Waste

LCA - Life Cycle Assessment

MPTF - Multi-Partner Trust Fund

MRV - Monitoring, Reporting and Verification

RBC - Real estate, Building, and Construction

SBC - Sustainable Building and Construction

SME - Subject Matter Experts

UNCT - United Nations Country Team

Glossary

Carbon footprint
The amount of carbon dioxide emissions associated with all the activities of a person or other entity.

Circular Economy
A circular economy is an industrial system that is restorative or regenerative by intention and design. It replaces the end-of-life concept with restoration, shifts towards the use of renewable energy, eliminates the use of toxic chemicals, which impair reuse and return to the biosphere, and aims for the elimination of waste through the superior design of materials, products, systems, and business models (World Economic Forum).

Climate Change
Refers to long-term shifts in temperatures and weather patterns (United Nations).

Embodied Carbon
Refers to all the CO2 emitted in producing materials. It's estimated from the energy used to extract and transport raw materials as well as emissions from manufacturing processes. The embodied carbon of a building can include all the emissions from the construction materials, the building process, all the fixtures and fittings inside as well as from deconstructing and disposing of it at the end of its lifetime (University College of London).

Material and Resource Efficiency
Improving resource efficiency is among the top priorities in today's world, as governments, businesses and civil society are increasingly concerned about natural resource use, environmental impacts, material prices and supply security (OECD).

Life Cycle Analysis -
A method used to evaluate the environmental impact of a product through its life cycle encompassing extraction and processing of the raw materials, manufacturing, distribution, use, recycling, and final disposal.

1. Introduction

Construction is one of the most vital sectors contributing to the growing demands of rapid urbanisation. While the sector is a significant driver of economic and social development, especially in developing countries, it also consumes huge quantities of non-renewable resources and energy, coupled with generation of huge amounts of waste and emissions. In 2020, the built environment accounted for 36 percent of the energy demand and 37 percent of energy-related CO2 emissions globally (GABC, 2021). Though statistics show a reduction in the value of energy related emissions in 2020 compared to previous years, this reduction is primarily due to a decrease in general economic activity and construction work due to the COVID-19 pandemic and an overall change in the usage and operation patterns of the existing building stock during this period (GABC, 2021). As cities across the world grow and try to cope with increasing demands for resources and services, there is a need for application of new models and systems at different scales to tackle issues of resource circularity and material efficiency in the construction sector.

In its report on Resource Efficiency and Climate Change - Material Efficiency Strategies for a Low-Carbon Future (IRP, 2020), the International Resource Panel describes the vast potential of material efficiency strategies towards climate change mitigation, especially with respect to developing countries where majority of the urban growth is predicted to take place in the coming decades. In the built environment, the report uses the example of India and China where it projects that material efficiency strategies can help reduce up to 60-70% of life cycle emissions from homes by 2050, compared to a potential reduction of 35-40% in G7 countries. While most current material-related policies are built around end-of-life landfill

diversion as their major focus, it is imperative for innovative policies to evolve from a multi-stakeholder perspective covering the complete value chain of the construction industry. Material resource efficiency in the building sector can be achieved by designing out waste and re-examining material options throughout the project's lifecycle. Integrating circularity into the construction industry involves reorganising the supply chain to address resource scarcity and environmental impacts through principles such as Designing out Waste (DoW), prefabricated construction, sustainable procurement practises, standardisation of practises and components, and Design for Disassembly (DfD) (Mohandas and Wilts, 2019). It is thus crucial to both mainstream the concept of circularity for all resource flows within human settlements as well as encourage a more scientific, data-based approach to decision making and incorporating resource efficiency concerns into policy processes (Niazi et al, 2020).

The primary objective of resource efficiency is to minimise the environmental impact of production and consumption of materials through prioritisation of responsible practices and sustainable development. In this context, the housing and construction sector plays an important role due to its huge environmental footprint with continuously increasing demand due to rapid urbanisation. Consequently, the sector also holds tremendous potential for bringing transformative changes in terms of minimising the environmental damage of resource extraction and consumption while maximising socio-economic benefits (Seto et al, 2014). Resource-efficient construction considers not only zero-energy, zero-carbon, and zero-emissions construction, but also parameters that aid in the better operation of existing buildings, resource and material efficient future built-environment with less and environmentally responsible materials, technologies, and design approaches (Brien, 2011) .

The MPTF initiative aims to provide UN country teams with essential tools and information to support the One Planet SBC Programme goals. This toolkit seeks to facilitate the reforming of the **building and construction sectors to become more resource efficient and climate resilient**, catering to processes and actors across the sector's value chain including the decision-making around design and selection of materials as well as the implementation phase where resources are extracted and used. The initiative also aims to raise awareness around material efficiency for sustainable buildings and construction-related benefits and possibilities among national stakeholders along the construction value chain.

2. What is this Guide?

This **Practical Mainstreaming Guidance** is Part II of the SBC resource efficiency toolkit which puts forward a curated set of tools that allow governments and other stakeholders to gain access to, understand, and use improved assessment processes in order to make better decisions regarding the building and construction sector. In addition, the tools can assist decision-makers in prioritising resource efficiency concerns in country policies and plans, as well as capacity building and partnerships for putting these strategies into action.

With the overall objective of putting forth a set of tools that countries would be able to apply in their planning strategies for effective delivery of policies and interventions, this mainstreaming guidance sought to learn from current practices in the sector and improve on them. The guidance is based on analysis of current gaps in the application of tools for resource efficiency in the building and construction sector to develop an understanding of which tools are already in use and by which stakeholders, and why certain tools or types of tools are used or not used. The factors explaining the current patterns of application have been used for shortlisting tools for the practical mainstreaming guidance.

To do this, an assessment framework was developed for analysing tools and methodologies through detailed research on existing approaches and frameworks used to improve resource efficiency and climate resilience in the building and planning sectors. This assessment of tools was further strengthened through primary consultations with experts on gaps in existing tools and methodologies and understanding the requirements as well as constraints in the construction sector in developing countries. The toolkit takes all these factors into account to present a

curated set of tools that comprehensively serve the unique requirements of a variety of stakeholders across the sectoral value chain.

The tools put forth in this guide covers all stages of the construction value chain, and various categories of construction related tools such as LCA tools and methodology, buildings and construction roadmaps, country assessments, data and MRV, procurement, policies, project design, evaluation, and certification, finance, and implementation. The curated set of tools span various functions such as cost benefit analyses, planning and decision making, modelling, implementation, monitoring and evaluation, certification, and financing making it an invaluable resource for stakeholders across the housing, building, and construction sector.

The tools in this toolkit were chosen after thorough background research including literature review and expert consultations. A rigorous 3-step methodology of filtering, scoring, and mapping was used to narrow down a large set of tools identified as beneficial to the construction sector to a practically useful set of 16 tools that stakeholders can use to transform their ways of operations, and adopting innovative methodologies for making informed decisions.

The detailed methodology adopted to shortlist the tools can be read in Annexure 4. The entire list of tools that have been evaluated for this toolkit can be found in Annexure 5. For users seeking more information, a larger database with over 50 additional tools is available on the webpage.

3. Who is this Guide for?

This guide is intended for stakeholders in the housing, building, and construction sector at different phases of the value chain, including financing, planning, design, and commissioning, construction materials, logistics, construction, property markets, operation/maintenance/renovation, and end-of-life. The objective of the toolkit is to present a bouquet of options of state of the art tools and methodologies to actors involved throughout the many dimensions of the buildings and construction sector for facilitating the mainstreaming of resource efficiency in their decision making through a scientific data-based approach.

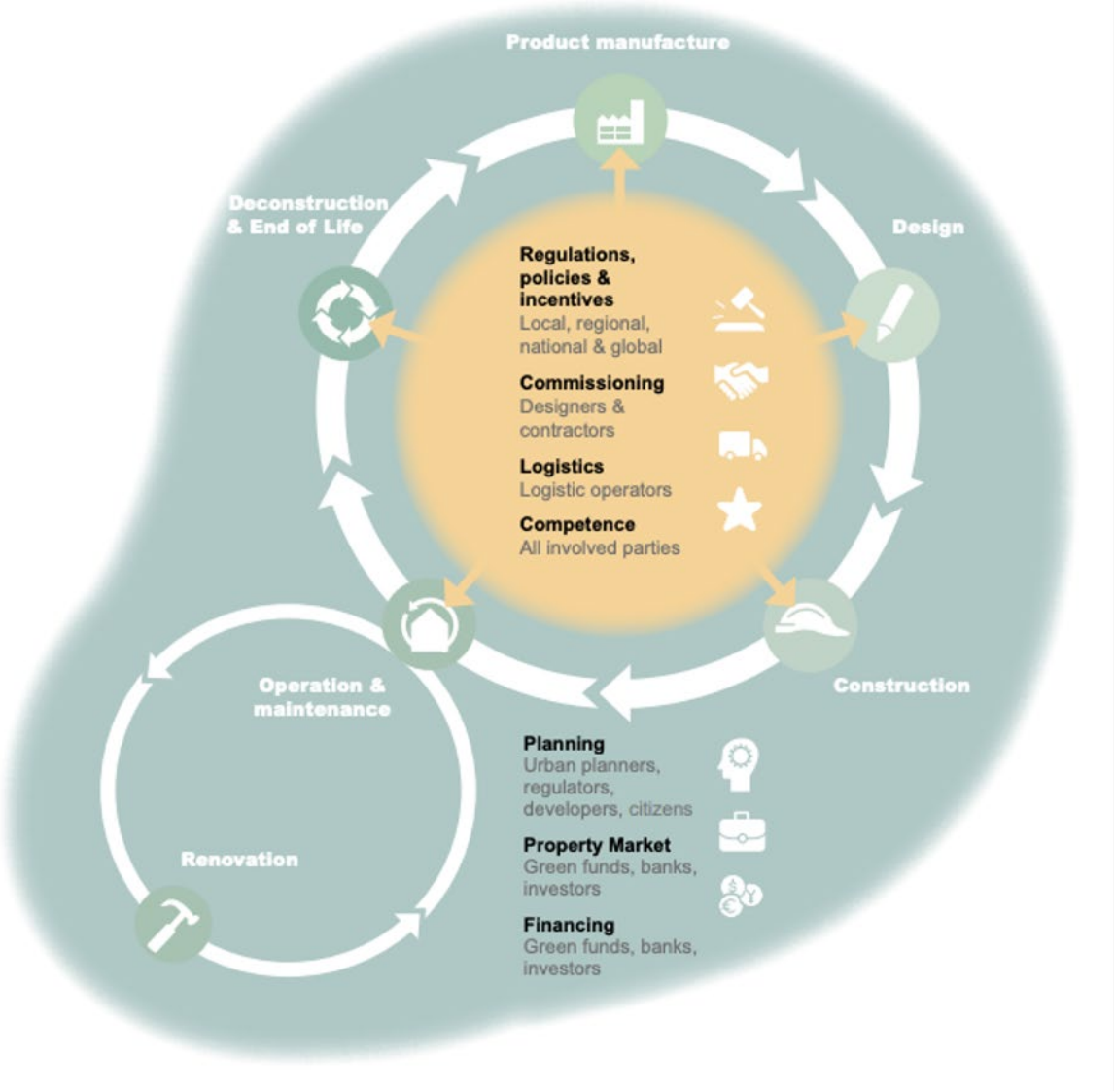

Fig 1: Buildings and Construction sector value chain

The toolkit is designed such that stakeholders from different global contexts and wide ranging geo-climatic conditions and socio-economic backgrounds across the globe can benefit from it. A variety of tools serving different functions have been included to widen the scope of applicability of the toolkit and address needs of different kinds of users. Each tool mentions the type of actors who are most likely to

find the tool useful though the potential list of users may include other actors beyond the ones mentioned as well.

The toolkit has been consciously designed to address differences in capacities among users with respect to data availability and technical skills needed for effective usage of the tools. To this end, the toolkit comprises both passive[1] and interactive[2] tools, which require varying degrees of inputs from the user and provide information outputs of varying levels of complexity. This range of tools includes specialised tools such as life cycle analysis and carbon assessment tools which provide detailed information on material usage and would be most used by technically trained personnel, while possibly requiring special software and higher amount of specific data inputs. On the other hand, to simplify decision-making in contexts where available data may be scarce and technical capacities may be lacking, guidelines and policy assistance documents have also been included which are easy to follow and provide directly usable information which may especially help in planning and implementation activities at larger scales.

The reader can thus assess their requirements and available resources to decide on the tools that fit their needs. Figure xyz maps out the applicability of different tools for different actors and may be used as a guide for navigating the toolkit.

Fig xyz: Tools and their respective users (to be added)

[1] Passive tools are such instruments that the user does not have to actively interact with it to apply it into the analysis. These can be in the form of step-by-step guidelines, data and information dissemination platforms, etc.

[2] Interactive tools are such instruments that the user actively interacts with the tool to attain an analysis or certain results according to the inputs provided by the user, e.g., LCA tools.

4. How to use this Guide

This toolkit is designed to facilitate the mainstreaming of concepts of resource efficiency in the buildings and construction sector. Correspondingly, the toolkit is structured around three broad phases of the mainstreaming process: making the case, prioritisation, and implementation. While the previous section describes how stakeholders may select tools that are generally most applicable to their nature of work, these three phases help users decide the applicability of tools as per the current phase of interventions in the target areas. The three phases may be understood as follows:

i. **Making the case -** The first phase of the process looks at the development of a strong argument for the need for and potential benefits from integrating resource efficiency concerns into policy and planning processes. This phase requires detailed mapping and preliminary assessments of resource and material flows in the buildings and construction sector along with their associated impacts to build robust country-specific evidence while also mapping potential alignments between the practical guidelines and achievement of SDGs. This requires application of tools for resource flow analysis, life cycle assessment, carbon assessments, etc along with methodologies incorporating additional socio-environmental impacts based on localised, contextualised indicators.

ii. **Prioritizing -** This next phase looks at the incorporation of resource efficiency concerns into country strategies, plans, policies and regulation, and processes using the rich data assimilated in the previous phase for further integration into mainstream policy guidelines and initiatives. This requires tools for informing policy formulation processes such as decision-making, modelling, simulations, planning and road-mapping, etc.

iii. **Implementation** - This phase focuses on tools that help in facilitating implementation of resources and material efficiency strategies through effective capacity building and partnership-building, requiring stakeholder engagement tools, monitoring and reporting tools, templates, step-by-step guides, etc. This phase looks at providing practical support to local stakeholders in an easy to understand manner for carrying out policy initiatives and projects on ground.

Tools have been selected to address all three phases and many of the tools address two or more of the mainstreaming phases with variations in terms of the impacts measured and their applicability. The set of tools presented in this toolkit include both passive and interactive tools all measuring different kinds of socio-cultural and economic impacts in addition to environmental impacts. The identified tools span across different categories, functions, and different stages of the construction value chain. The toolkit has thus been designed to maximise coverage across the various parameters that influence the adoption of tools by different users and address their needs effectively.

Figure 2 shows how the 16 selected tools are distributed across the three phases of the mainstreaming process. These tools are explained in detail in the next section with examples of practical application of some tools to give users an idea of how such tools may aid in decision making and potential sustainability benefits from the same.

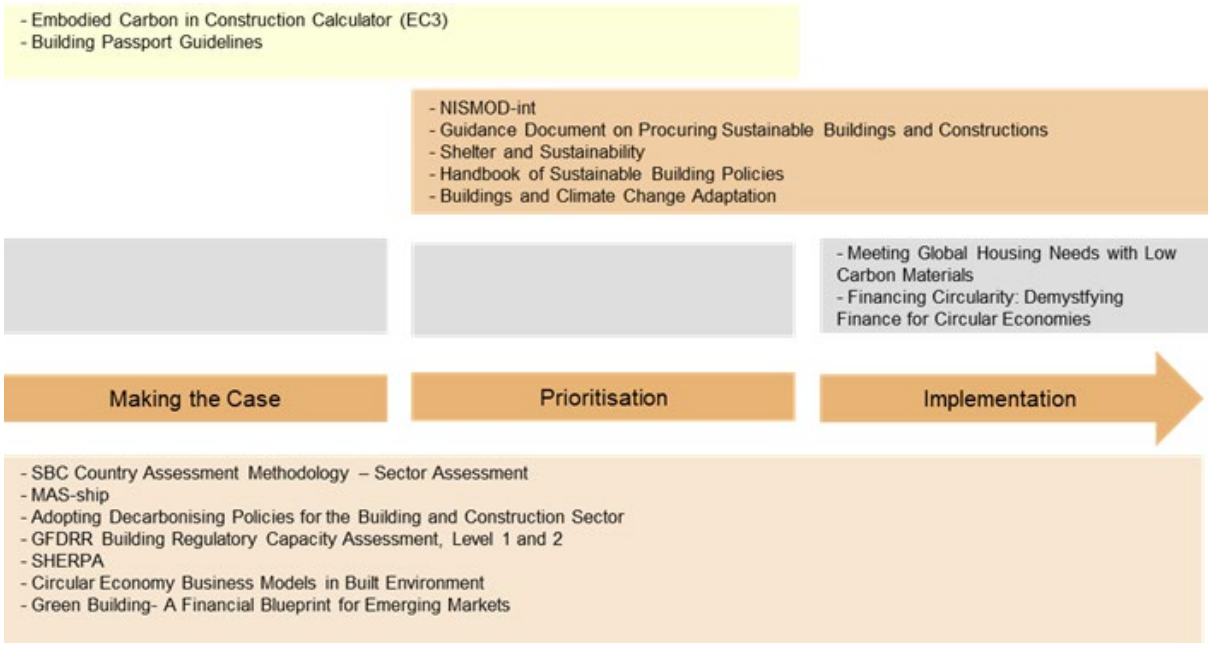

Fig: 2 Tools categorised according to the phases of mainstreaming

In Figure 3, the shortlisted tools are arranged according to the category and the types of impacts it measures. The impacts mentioned in the infographic are in addition to the environmental impacts, making it easier for the reader to identify a specific tool that addresses specific requirements.

S. No.	Tool	Category	Additional impacts measured
1	Embodied Carbon in Construction Calculator (EC3)		
2	NISMOD-int		E
3	SBC Country Assessment Methodology – Sector Assessment		S E O
4	Building Passport Guidelines		S E
5	Guidance Document On Procuring Sustainable Buildings and Constructions		S E
6	MAS-ship		S E
7	Adopting Decarbonising Policies for the Building And Construction Sector		S E O
8	Shelter and Sustainability		S E O
9	Handbook of Sustainable Building Policies		S O
10	GFDRR Building Regulatory Capacity Assessment Level 1 and 2		S E O
11	SHERPA		S E O
12	Buildings and Climate Change Adaptation		S E O
13	Meeting Global Housing Needs with Low-carbon Materials		S E
14	Circular Economy Business Models in Built Environment		S E
15	Green Building- A Financial Blueprint for Emerging Markets		S O
16	Financing Circularity: Demystfying Finance for Circular Economies		E

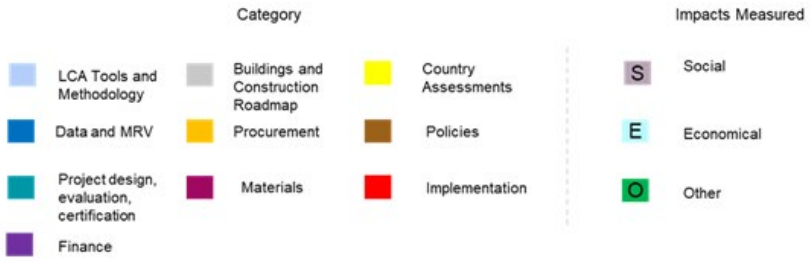

Fig 3 : Tools categorised according to the category it comes under and the impacts measured

Note: 'Other' impacts include tools that are measuring cultural impacts, conducting material comparison, suggesting nature-based solutions, etc.

5. Mainstreaming Toolkit

Making the case | Prioritising | Implementation

Embodied Carbon in Construction Calculator (EC3)

EC3 is a free and simple-to-use ***life-cycle analysis tool*** that assists users in planning and decision-making processes through embodied carbon benchmarking, assessment, and reductions in construction materials' supply chain emissions.

Type of tool - Interactive

Who can use this tool?

- AEC Professionals
- Policymakers
- Material Manufacturers and Suppliers
- Construction Project Owners

Strengths:

- An open source database for construction materials EPDs in one location.

Creator - Carbon Leadership Forum (CLF), SKANSKA, and C-Change Labs

The EC3 tool uses building material quantities from construction estimates and/or BIM models, as well as a large database of digital, third-party verified Environmental Product Declarations (EPDs). The EC3 tool can be used in both the design and procurement phases of a construction project to assess the project's overall embodied carbon emissions, allowing for the specification and procurement of low-carbon alternatives.

The tool can be used by AEC Professionals, service providers & contractors, project owners, developers, & managers, policymakers & government agencies, material manufacturers and suppliers, and certification bodies, and auditors in comparing the embodied carbon in

alternative materials and compare between building plans which will help in choosing materials and construction plan which has lesser embodied carbon. Owners, green building certification programmes, and policymakers can use the EC3 tool to evaluate supply chain data in order to generate EPD criteria and set embodied carbon limitations and reductions at the construction material and project scale.

To know more about EC3, visit here.

Practical Applications

Adaptive Reuse in L.A. : The former westside pavilion shopping mall was redeveloped as a state-of-the-art innovation campus using existing structural steel. The original mall's structural steel was repurposed in EC3, which showed a 33% reduction in carbon. Hence, the steel was reused in construction, resulting in significant embodied carbon savings.

Skanska- Headquarters in Redmond, Washington—a 17-building redevelopment : EC3 was used in the early stages of structural engineering in this project. The engineers were able to compare various approaches and choose a structural system that used less material and had a lower carbon footprint.

Microsoft 500-acre headquarters in Redmond, WA: By discovering alternate materials through EC3 to substitute products with higher embodied energy, the company was able to cut embodied carbon by as much as 30% without significant cost increases in this project.

Vancouver Regional Office: EC3 was utilised in this project to find material options that lowered embodied carbon while having a low cost effect. Overall, embodied carbon was reduced by 23% compared to the industry average baseline scenario.

References:

https://www.buildingtransparency.org/resources/case-studies/
https://www.fastcompany.com/90608415/microsoft-and-skanska-are-using-this-free-tool-to-dramatically-cut-their-carbon
https://query.prod.cms.rt.microsoft.com/cms/api/am/binary/RWGtgl

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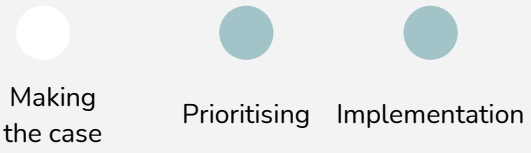
The National Infrastructure Systems Model (NISMOD-Int)

*NISMOD is a strategic planning **modelling tool** that generates interdependent infrastructure system models to integrate development demands across six sectors: energy, water, transportation, wastewater, solid waste, and digital communications.*



Type of Tool - Interactive

Who can use this tool?

- Policymakers
- Financial Institutions, Insurers, Investors

Strengths: Open-access libraries, frameworks, and databases for easy analysis

Creator - ITRC, UNOPS, University of Oxford, EPSRC

NISMOD-Int is a set of open-source analysis tools designed to help developing countries apply evidence-based decision making. These tools will enable recipient nations to develop and evaluate different infrastructure transition strategies in order to accomplish their long-term development objectives. The tool enables long-term strategic infrastructure planning, infrastructure for sustainable development, and risk and resilience assessment. It comprises infrastructure simulation models, analysis frameworks and libraries, and databases and systems for managing datasets, model configuration, inputs, and outputs.

The tool can be used by government and decision makers to understand the performance of the existing infrastructure and analyse the need for additional infrastructure. This evidence-based analysis helps in designing sustainable transition strategies.

Practical Applications

The Oxford-Cambridge Arc's energy systems were studied using NISMOD- Int to develop a strategy for reducing carbon emissions in a cost-effective manner. For the Arc Scenarios, energy demand and transportation models were used to calculate heating and non-heating energy requirements, as well as transportation demand, using population, additional dwellings, and GVA growth assumptions.

This tool was also used to design a climate-smart transportation policy in Vietnam, which would help the country to be more resilient in the face of future disasters.

References:

https://sustainable-infrastructure-tools.org/tools/the-national-infrastructure-systems-model-nismod-int/

https://www.itrc.org.uk/casestudies/low-carbon-energy-supply-strategies-for-the-oxford-cambridge-arc-region/

https://www.itrc.org.uk/casestudies/analysis-and-development-of-model-for-addressing-climate-change-disaster-risks-in-multi-modal-transport-networks-in-vietnam/

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Making the case

Prioritising

Implementation

Type of tool - Passive

Who can use this tool

Policymakers
Government Agencies
NGOs

Strengths: Enables self-assessment of SBC context in respective countries environment but only buildings and construction

Creator - UNEP, One Planet Network

SBC Country Assessment Methodology – Sector Assessment

*SBC country assessment methodology is a **country assessment guideline** that proposes an approach and methodology to conduct Sustainable Buildings and Construction country assessments for developing and emerging economies.*

The SBC country assessment methodology provides an approach to analyse a country's building and construction sector, taking into account the four pillars of sustainability: environment, society, economy, and culture. The tool gives guidance on a variety of topics and subjects that affect sustainability in the building and construction life cycle, as well as the rules and regulations that govern it. The tool's goal is to provide a solid overall baseline on the construction sector's current situation in a specific context, as well as an analysis of the country's SBC needs, challenges and opportunities, in order to demonstrate the benefits of introducing sustainable building practises and related enabling policies.

Government agencies and policymakers can use the tool to assess and analyse existing building and construction policies, strategies, institutions, and specific contexts from a

sustainability viewpoint, using an evidence-based approach. This benchmark can aid countries in assessing their progress.

Global Alliance for Buildings and Construction

RICS

Building Passport Guidelines

The Building Passport Guidelines is a **country assessment tool** that guides the stakeholder at all the stages of the building value chain in developing a Building Passport for an ongoing or upcoming project.

Type of Tool - Passive

Who can use this tool?
All construction stakeholders

Strengths: Acts as a single point of input, access and visualization of all the information associated with a building

Creator - GABC, RICS

A Building Passport is a repository of data regarding a building's administrative documentation as well as data regarding its plot location, its technical and functional characteristics, and its environmental, social and financial performance. The building passport guideline tool that explains the Building Passport concept in the context of existing informality and data-related challenges in the construction and building industry. The tool offers practical recommendations and examples of best practises for improving data capture and management, ensuring adequate standardisation, and fostering sector transformation through progressive digitization of building-related data and information, creating sector transparency and opportunities for the development of new business models and tools.

Resource:

https://globalabc.org/news/new-report-building-passport-practical-guidelines

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Guidance Document on Procuring Sustainable Buildings and Construction

*This document is a set of **procurement guidelines** that provides procurement officers and other members of the public and private sector with a variety of sustainable building and construction procurement methods and processes.*

Making the case | Prioritising | Implementation

Type of tool - Passive

Who can use this tool?
Procurement Officers

Strengths - Cover newer methods of integrated project delivery (IPD) and public-private procurement

Creator - UNEP

The goal of the guideline is to enable Sustainable Public Procurement (SPP), which contributes considerably to long-term sustainable development. Governments may make evidence-based decisions and meet critical policy objectives by implementing SPP. SPP assists governments in lowering greenhouse gas emissions, increasing resource efficiency, and facilitating the recycling of C&D waste.

Practical Application

Energy- Efficient office in Kenya: In this example, procurement followed the typical design-bid-build contract, wherein the contractor was selected using an in-house designed scorecard that included 15 to 30 points out of 100 for sustainability. With the help of

daylight, natural ventilation, green office equipment, centralised cafeteria, dedicated elevator for products, and server room cooling solution, the energy consumption was decreased from 147 kWh/m2/a to 42,5 kWh/m2/a. The reduction was explored right after design, before construction began.

Sustainable low-cost housing for indigenous communities in Australia : The contractor and professional services were chosen with the help of a sustainability expert. Bidding for building modules that the homeowners may use in their designs was part of the procurement. Building companies were asked to tender costs for each of a number of house modules with varied sleeping and living space arrangements, as well as modules with different floors, decks, and roofs, as part of the bidding process for the dwellings. This was done to allow potential homeowners to put together their own design. The dwellings were built using low-cost housing approaches such as a simpler modular design that reduced waste and allowed pieces to be set in multiple layouts according to the homeowners' preferences.

Reference:https://www.efcanet.org/sites/default/files/2019-06/Guidance%20Document%20on%20Procuring%20Sustainable%20Buildings%20and%20Construction_Final.pdf

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Making the case | Prioritising | Implementation

Type of Tool - Interactive

Who can use this tool?

- Policymakers and government agencies
- Social Housing Developers
- AEC Professional

Strengths: Focuses on housing assessments for marginalised communities

Creator - Development Alternatives, UN-HABITAT, TERI, UNEP

MaS-SHIP
(Mainstreaming Sustainable Social Housing in India Project)

*MaS-SHIP is a **Policy and decision support tool** that enables social housing developers to integrate environmental performance, affordability, and social inclusion.*

The tool was developed under the 10 YFP (Ten Year Framework of Programmes) on Sustainable Consumption and Production Patterns managed by the United Nations Environment Programme (UNEP). Under this framework, primary and secondary data is collected (through secondary research and primary sources like manufacturers, building practitioners, and households) across 18 attributes: Embodied energy, Critical Resource Use, Recycled Content, Future Reusability, Water Consumption, Familiarity with the material/technology, Modification ability, Construction Cost, Skill Requirement, Supply chain, Time of construction, Job creation, Durability, Ease and Frequency of Maintenance, Impact on cooling loads, Noise transmission, Thermal Mass and Thermal Performance.

Decision Support Toolkit, a component of MAS-ship, is an interactive and online toolkit that includes a variety of outputs, information, tools, and insights to aid stakeholders in selecting sustainable building materials, implementing sustainable design interventions, and

implementing sustainable construction methods in social housing projects. The Sustainability Assessment Tool (SAT), a key component of the DST, aids in the retrieval of missing data and information required to evaluate building performance by mapping the availability of sustainable building system options via the Material mapping application.

The tool enables construction professionals, housing developers, and policymakers to make well-informed and evidence-based decisions on the materials, systems, and design strategies to use in social housing projects.

Practical Applications

Resettlement of Kiron ki Dhani Slum in Jaipur, India - This project was taken up under Rajiv Awas Yojna, a total of 920 EWS and 184 Rental Housing dwelling units were constructed, the cost for which was shared amongst Govt. of India (50%), Govt. of Rajasthan (20%), JDA (20%), and beneficiaries (10%). *Alternative building materials/ technology adopted included fly ash bricks, solar panels for street lights.*

Jakkampudi colony on the outskirts of Vijayawada, India - This project was taken up under the Valmiki Ambedkar Awas Yojana scheme. A total of 8608 EWS dwelling units were constructed, the cost for which was borne by Bruhat Bengaluru Mahanagara Palike Central Share (50%), Karnataka slum development board (40%), and beneficiaries (10%). *Alternative building materials/ technology adopted included a shear wall construction system, fly ash brick wall, rainwater harvesting.*

References: Mainstreaming Sustainable Social Housing.pdf (poornima.edu.in), CASE STUDIES | mas-ship (mainstreamingsustainablehousing.org)

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Adopting Decarbonization Policies for the Buildings and Construction Sector

Type of tool - Passive

Who can use this tool?

- Policymakers and government agencies

Strengths: Addresses all three aspects of carbon footprint of buildings including: 1) direct emissions from building energy use which includes (2) indirect emissions from the power sector, (3) and emissions from energy used in the building materials and construction supply chain (embodied emissions).

Creator - UNEP, GABC

*A set of **policy drivers for decarbonisation** in the building & construction sector, and analyzing costs, benefits and risks associated with policy implementation.*

The tool includes policies to reduce direct emissions from building energy use, which includes indirect emissions from the power sector, and emissions from energy used in the building materials and construction supply chain (embodied emissions). The tool examines the evidence of the effects of implementing cost-effective policy initiatives to lower the building and construction sector's carbon footprint. The report examines the most critical factors that policymakers at all levels of government should consider when developing climate initiatives that will have a long-term economic impact and reduce emissions.

This report is designed for national, state and local governments and relevant ministries in charge of developing and implementing buildings and construction policies. It provides a review of the evidence on cost effective public policies for reducing building energy consumption and associated greenhouse gas emissions to achieve greater social benefits.

Access the tool here.

Shelter and Sustainability

*A comparative overview of different **shelter typologies**, which were recently implemented in various field locations and in different stages of a humanitarian response to forced displacement.*

Making the case | Prioritising | Implementation

Type of tool - Passive

Who can use this tool?
- Policy makers
- Government Agencies
- Humanitarian Workers

Strengths - Focuses on the sustainability of humanitarian response for the marginalised

Creator - UNHCR

The tool seeks to examine shelter designs, the life-cycle of the materials used and analyze possible strategies to increase the sustainability of humanitarian responses and reduce their carbon footprint, while at the same time ensuring shelter adequacy and suitability. It illustrates the real costs of shelter solutions, taking into account the specificities of each site and material, using established criteria to measure technical performance, habitability, affordability, and environmental impact of each shelter design.

Evaluation of sustainability is done by measuring shelter lifespan, set up time, workforce required for setup and suggested temperature range. A rating framework is used to assess shelters for environmental (embodied and usage energy) , technical (structural resistance- based on context wind resistance, seismic resistance or flood mitigation, suitability- natural ventilation, fire and flammability, thermal comfort, personal security and accessibility) , habitability (covered living area, natural and artificial lighting, facilities, etc.) and affordability (cost).

Practical Applications

Emergency Shelter in Ituri settlements:

The shelter was built in response to internal displacement crises in Ituri province, Eastern Congo, during a period of increased violence. More than 14 settlements received emergency shelter from the UNHCR. Through a cash-for-work model, the PoCs and the host community were involved in the initiative. Simple one-room constructions were used as life-saving emergency shelters. The locations were outfitted with improved water supplies, communal bathrooms and showers, and kitchen spaces in addition to emergency shelters.

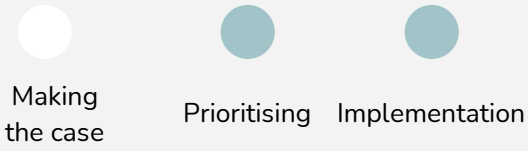
Transitional shelter, Kutapalong settlement:

Following the 2017 crisis, which resulted in a significant inflow of Rohingya refugees into Bangladesh, Kutapalong became one of the world's most congested and largest refugee settlements. The cyclone-prone location, with continuous deforestation, became overcrowded and hazard-prone. UNHCR has worked to improve the site's design, infrastructure, and facilities, as well as prepare the land for future arrivals, by aiding refugees with either completed shelters or shelter kits, since the beginning. The transitional shelters were designed as a bamboo building that was raised off the ground to prevent flooding and had concrete pad foundations to prevent landslides. The settlement also had common bathrooms and showers, as well as access to water sources.

Reference:
https://sheltercluster.org/resources/documents/unhcr-shelter-and-sustainability

UN environment programme

Handbook of Sustainable Building Policies



Type Of Tool - Passive

Who can use this tool?

Policymakers
Government agencies

Strengths - Can be used as training tool for experts (architects, engineers, planners) to build capacity in sustainability practices

Creator - UNEP

*It is a **policy-making support tool** to improve the long-term sustainability of energy consumption in buildings.*

The tool aids decision-makers in examining existing or proposed policies, assessing their applicability to the local context, and obtaining advice on the relevance of including them in a policy package aimed at increasing the long-term sustainability of energy consumption in the construction sector. The Handbook can also be used as a reference manual by policymakers and professionals for policy instruments and to understand how they interact with one another. The Handbook of Sustainable Building Policies allows users to review and design coherent policy packages made up of individual instruments referred to as policy building blocks. These policy building blocks are then combined with others to create a strong and efficient policy package. The tool proposes the idea of a policy package, which is advised since a single policy instrument has limited ability to produce long-term change, particularly when dealing with complicated policy goals and impediments. The Handbook presents 25 different policy instruments in the following categories:

- Regulatory-normative (e.g. building codes and standards)
- Regulatory-informative (e.g. certification and labelling programs)
- Economic and market-based (e.g. preferential mortgages or carbon market

mechanisms)

- Fiscal instruments and incentives (e.g. taxes, subsidies or loans)
- Support, information and voluntary action (e.g. public leadership programs, awareness-raising)

References: unep-handbook-of-sustainable-building-policies.pdf (unepdtu.org)

GFDRR
Global Facility for Disaster Reduction and Recovery

GFDRR Building regulatory capacity assessment Level 1 & 2

Making the case | Prioritising | Implementation

Type of tool - Passive

Who can use this tool?

Project Managers
Government Officials
Contractors/technical expert

Strengths: Applicable to a wide range of project types and can be used at different phases of the evaluation and planning process.

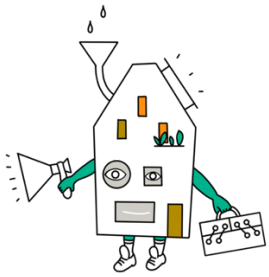
Creator - GFDRR

A building **regulatory capacity assessment tool** that helps in the assessment of building and land use regulatory systems, as well as the collection of vital information regarding a city's or country's building regulatory framework.

The tool defines building regulatory framework as "complex set of laws, regulatory documents, compliance mechanisms, education and training requirements, product testing and certification, professional qualifications and licensing schemes that support a safe, sustainable and resilient built environment". It focuses on three critical components of building regulatory frameworks: legal and administrative, development and maintenance, and implementation.

It comprises two parts - Level 1 and Level 2. Level 1 is to assist city officials and project managers to conduct a preliminary assessment that helps in initiating strategies required to achieve the developmental objectives of the target city. Level 2 provides guidelines to stakeholders who are collecting and analyzing the data related to the building regulatory capacity for a city, region, or a country. The Assessment identifies important gaps, provides the information needed to build a baseline for technical support and draws conclusions that can be utilised to identify areas requiring intervention and investment.

https://openknowledge.worldbank.org/bitstream/handle/10986/27656/117745-WP-PUBLIC-building-regulatory-capacity-assessment-level-2-2017.pdf;sequence=1



Housing Value Assessment Methodology (VAM)

Making the case | Prioritising | Implementation

Type of tool - Interactive

Who can use this tool?
Stakeholders at all stages of the construction value chain

Strengths: Act as a personal guide to support all actions in implementing a sustainable housing

Creator - UN-Habitat

The Housing VAM is a **self-evaluation tool** for stakeholders involved in the planning, design, construction, and assessment of housing projects.

It is an easy-to-use tool designed to guide users in implementing sustainable construction structured in 4 sections: Context, governance and regulations. Housing design and emissions, Resources and circularity, Environment impact and resiliency. It aids in the evaluation of housing programmes and large projects from conception to completion, including site selection and design. It considers the life cycle and recyclability of building materials utilised while providing recommendations in the local context. The tool can also be used at the construction stage to keep track of the project.

The tool makes recommendations based on the project details provided by users, such as the stage of the project, the number of units, the climate, and the location. The tool then provides a score on the sustainability of the project and also makes recommendations based on the information provided in a questionnaire about the household, neighbourhood, territory, and construction procedures.

It is part of the RE-Think Buildings toolkit and you can find it at the SDG12 HUB.

Global Alliance for Buildings and Construction

OID
Penser l'immobilier responsable

Making the case | Prioritising | Implementation

Type of the tool - Passive

Who can use this tool?
- Stakeholders at all stages of the value chain of building sector

Strengths: An all-in-one tool that guides through the issues that each construction value chain stakeholder faces in adapting buildings to the CC issue.

Creator - Global Alliance for Buildings and Construction

Buildings and Climate Change Adaptation - A Call for Action

It is a **guiding tool** for raising awareness and recommending actions for the Real Estate, Building, and Construction sector to adapt to Climate Change (CC) issues.

The goal of this report is to create a shared strategic vision for climate change adaptation and its objectives. It is one of the first to address the issues of climate change adaptation as well as the advantages of RBC sector activities. With the support of the French Ministry of Ecological Transition, the report was coordinated by the Green Building Observatory (OID, Paris).

The report is divided into three parts. The first section talks about the need for adapting buildings to climate change issues. The second section focuses on the necessary changes and required interventions in the RBC sector to better integrate adaptation challenges. The last and the third section presents a framework for suggested action for challenges identified for each of the key actors in the RBC sector. The frameworks were informed by surveys and interviews held with relevant stakeholders which were then reviewed by sectoral organisations to provide five recommendations to the five key challenges identified.

https://globalabc.org/sites/default/files/2021-02/Buildings%20and%20Climate%20Change%20Adaptation%20-%20FULL.pdf

Practical applications:

Promoting resilient urban development in the Ramallah Resilience Strategy, Palestine

Prioritizing urban and economic development that fosters resilience is one of the goals of the Ramallah Resilience Strategy. To implement it, an action focuses on developing and promoting resilient urban design guidelines. Recommendations from the guiding tool will aid in the strategic development of residential and mixed-use schemes by addressing issues including public space, seismic risk, onsite water capture and reuse, and passive design solutions. The Ramallah Municipality is leading this effort in collaboration with the Association of Engineers, the development and social sectors, universities, developers, and other local governments.

A data-sharing initiative on climate risks

The Federation of Finnish Financial Services (Finanssialan Keskusliitto) and the Finnish Environment Institute collaborated on a flood insurance data-sharing programme. This is an example of a data-sharing collaboration that other insurers throughout the world may implement in their own country.

Nanaimo regional general hospital –climate change vulnerability assessment, Canada

The Vancouver Island Health Authority used the PIEVC (Public infrastructure engineering vulnerability committee) protocol to undertake a climate change vulnerability assessment for Nanaimo Regional General Hospital (NRGH). Identifying potentially vulnerable infrastructure systems, evaluating possible climate change-induced effects on pertinent climatic parameters, and creating a risk rating for each such interaction were all part of the project.

Global Green Growth Institute

Making the case | Prioritising | Implementation

Type of tool - Passive

Who can use this tool?

- Contractors and Developers
- Project Owners
- Policymakers and government agencies
- Material manufactures and suppliers
- Researchers, National and International Organisations
- Financial institutions,Investors, and Insures

Strengths: Provides low-impact material recommendations in local context

Creator - Global Green Growth Institute

Meeting Global Housing Needs with Low Carbon Materials (GGGI)

It's a **guiding framework** for **low-carbon material selection** during the design stages of low-cost housing.

The pressure on the material supply chain can be relieved by shifting from traditional building materials like cement and steel to locally sourced resources for housing. It contributes to lowering material costs while also lowering transportation-related GHG emissions. Prioritizing local resources also promotes economic growth in the area.

This report has taken a life cycle approach to identify the materials that can facilitate the transition to low-carbon, affordable housing at scale. While the tool's prime objective is to provide adequate housing with low environmental impact, it also acknowledges that such initiatives in developing countries must also provide local jobs, skills, and economic opportunities.

Practical applications

Use of Hollow Compressed Stabilized Earth Brick (CSEB), Nepal: Build Up Nepal, a local non-governmental organisation (NGO), strongly supported the use of CSEB in the restoration of rural homes and schools following the devastating earthquake in 2015. Since, seismic protection is of high importance in earthquake prone Nepal, hollow CSEB proves to be an ideal material as the raw materials are inexpensive and the interlocking properties of the blocks, together with the steel reinforcement attached to the blocks, provide good earthquake resistance.

When 50,000 CSEB houses are built using their design, Build Up Nepal projects that 495,000 tonnes of Carbon reduction can be achieved as compared to building using clay bricks.

Cement Bamboo Frame in Housing projects: In 2011, the HILTI Foundation created the Cement Bamboo Frame technology, and the Base Bahay Foundation was formed to use the CBF technology to build typhoon and earthquake-resistant homes for vulnerable people in disaster-prone locations.

CBF buildings are built to withstand moisture, rot, pest infestation, fire, typhoons, and earthquakes. Base Bahay, using a life cycle analysis approach, shows that each dwelling unit saves roughly 7 tonnes of carbon equivalent in emissions when compared to typical reinforced concrete houses. Till date, around 3,000 tonnes of Carbon have been saved as a result of this. In addition, local labour is used on all projects, resulting in employment creation and project ownership. Overall, CBF homes are cheaper, less harmful to the environment, and better for local economies.

https://www.oneplanetnetwork.org/sites/default/files/report_-_green_building_materials_for_low-cost_housing_final2.1.pdf

https://gggi.org/site/assets/uploads/2020/10/Meeting-Global-Housing-Needs-with-Low-

Carbon-Materials.pdf

bam ARUP

Circular Economy Business Models in Built Environment

This is a **guiding tool** for achieving a circular economy for businesses in a built environment.

This report investigates how Circular Business Models (CBM) add value throughout the construction value chain. It is anticipated that by emphasising the value proposition among the construction value chain stakeholders, more businesses will realise the benefits of contributing to a circular economy-based built environment.

Making the case | Prioritising | Implementation

Type of tool - Passive

Who can use this tool?

- Stakeholders across the value chain of the construction sector

Strengths: Act as an introduction guide to CBM to stakeholders in the building sector

Creator - BAM Construct and ARUP

Through the adoption of CBMs the focus will transition to sustainable material sourcing, sustaining material productivity over the lifecycle of projects, and reducing non-renewable material losses. The report emphasizes that adopting CBMs can contribute to long-term financial, social, and environmental gains.

Practical Applications

Abn Amro Pavilion: This circular pavilion is designed so that all of the materials can be (re)used in the future. The structure is almost entirely remountable. Materials which cause minimum environmental impact are chosen for Inner walls, doors, cables and fire hose reels. Old jeans collected from Abn Amro employees have been used to create acoustic ceilings.

Armstrong tiles: By developing an end-of-life take-back programme for their own mineral ceiling tiles, Armstrong Ceilings made the initial steps toward circular design concepts. Armstrong has collected over 500,000 square metres of old ceilings in Europe, including those from competitors, and has recycled over fifteen million square metres internationally. Besides, they also made sure that their goods were made with materials that are safe, healthy, and infinitely reusable, and production procedures used less energy and water.

Reference:

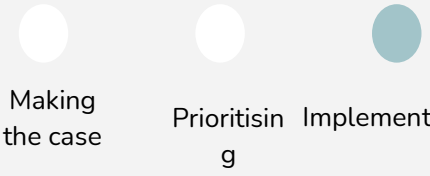
https://www.arup.com/perspectives/publications/research/section/circular-business-models-for-the-built-environment

IFC
International Finance Corporation
WORLD BANK GROUP

Green Building: A Financial Blueprint for Emerging Markets

A ***practical guide*** for financial institutions and investors in developing nations on how to transform their real estate portfolios to finance green buildings.

The research examines the roles of green building developers and owners, as well as governments, who play major roles in establishing a market for green construction financing. It is also advised for governments in developing economies, especially at the subnational and municipal levels, to encourage green construction in order to achieve green economic growth and satisfy climate obligations. The tool focuses on the design and use of green buildings, as well as the economic and environmental benefits of energy efficiency, water conservation, and waste reduction strategies.



Type of tool - Passive

Who can use this tool?

- Financial Institutions, Investors, Insurers
- Policymakers and Government Agencies
- Project owners, Developers, and

Strengths: A comprehensive guide to shift the investment of finance institutions into green buildings

Creator - International Finance Corporation

Practical applications:

Fiscal and non-fiscal incentives

Governments are employing fiscal policies including property tax incentives, technical assistance, grant provisions, and loan programmes to encourage developers to build green, in addition to incentives and restrictions aimed directly at the financial sector. In Argentina, for example, residential structures with Class B insulation, solar hot water collectors, and LED lighting up to 140,000 UVA obtain a 10% VAT exemption. This tax break is only available for the first 60,000 units produced by August 2022.

In Colombia, project design services qualify for a 19 percent VAT exemption and a 25% income tax deduction for both residential and commercial structures.

Labeling and energy performance certification

Buildings now have an energy performance label ranging from "A" to "G" under the European Energy Performance of Buildings Directive, with "A" being the most energy efficient. The Dutch government passed legislation in 2018 mandating that office buildings have an energy performance label of "C" or better by 2023, and an "A" badge by 2030.

Market-based mechanisms

South Korea applied an emissions trading system at the point of electricity consumption to expand the mechanism's scope to include entities such as large buildings that would have otherwise been exempted.

Financial sector regulations and incentives

For the additional cost of green measures applied to light industry building, the Bank of Bangladesh has mandated that all commercial banks provide a discounted financing rate of 9%.

References:

https://www.ifc.org/wps/wcm/connect/a6e06449-0819-4814-8e75-903d4f564731/59988-IFC-GreenBuildings-report_FINAL_1-30-20.pdf?MOD=AJPERES&CVID=m.TZbMU

FINANCE
UNEP INITIATIVE

Making the case | Prioritising | Implementation

Financing Circularity: Demystifying Finance for Circular Economies - UNEP 2020

Type of tool - Passive

Who can use this tool?

- Financial Institutions, Insurers, Investor

Strengths: Focuses on post-pandemic context

Creator - UNEP Finance

A ***guiding tool*** on how to finance circularity in different sectors including building and construction. The tool examines the strategies and measures that financial institutions can take to expedite financing of the transition to a CE, as well as how they can minimize associated risks, and expand innovation and potential in products, services, and financial instruments/investments.

Practical Applications

Some EU member countries are speeding up their transitions to a circular economy on a national level. The Dutch government, for example, has set a goal of having a circular economy in place by 2050. Another example is France, which enacted a law in early 2020 called "Fight against Waste for the Circular Economy (lutte contre le gaspillage et à l'économie circulaire)" to match environmental law with circular economy ideas. Its overall goal is to produce a net-zero ecological footprint while remaining mindful of planetary constraints. By doing so, France has adopted a legal position within the EU-27 on rules requiring circular economy practises ahead of schedule.

Financing Circularity: Demystifying Finance for the Circular Economy – United Nations Environment – Finance Initiative (unepfi.org), https://www.unepfi.org/wordpress/wp-content/uploads/2021/03/UNEPFI_DemystfyingFinanceCircularity-2020-2.pdf

Other important tools

Life Cycle Assessment tools

Life Cycle Assessment (LCA) tools are used to evaluate environmental impacts of materials and systems in all life cycle stages of a product or building including both production and consumption cycles as well as end-of-life. Such tools provide rich detail on material footprint for specific resources and allow for robust-choice making based on life cycle impacts from adoption of different materials and technologies.

A key limitation of LCA tools is that these tools often require higher technical skills for deployment and may also require the purchase of specialised software and databases which may not always be feasible for many stakeholders. For these reasons, while the tools were not included in the primary list of curated tools, they present significant opportunities towards rationalising resource usage and must be considered a valuable part of the resource efficiency tools arsenal. Some commonly used LCA and associated tools are:

- One Click
- Standard for Sustainable & Resilient Infrastructure (SuRe)
- Tally
- Woodworks Carbon Calculator
- Athena Impact Estimator for Buildings (IE4B)

References:

https://www.phrc.psu.edu/assets/docs/Publications/RB0511.pdf

Certification Tools

Certification of buildings as well as materials and technologies are an essential component in encouraging and formalising building practices through standardisation and benchmarking processes. Clearly defined quality standards, guidelines and metrics help in leveraging policy pushes as well as financial support towards encouraging adoption of sustainable building practices.

These tools are highly contextualised as they respond to specific regional concerns and are mostly developed by national or regional institutions. National Certification standards and codes are thus often inapplicable to other country contexts. Usage of certification tools require basic technical capacities for assessment and assimilation of interventions and are also often accompanied by fees and charges. These tools help in presenting comprehensive roadmaps and guidelines for systemic adoption by local stakeholders and integrating sustainable building practices into prevalent market trends and capturing the public's attention.

Some examples of certifications tools are:

- Green Housing Assessment System (SISEVIVE-EcoCasa), Mexico
- GREENSL (Green Rating System), Sri Lanka
- Casa Colombia (Green certification), Colombia
- Nationwide House Energy Rating Scheme (NaTHERS), Australia
- National Australian Built Environment Rating System (NABERS)

CLF- Embodied Carbon Policy Toolkit, Embodied Carbon Toolkit for Building Owners

Carbon Leadership Forum (CLF) released the Embodied Carbon Policy Toolkit to offer decision-makers, industry professionals and sustainability enthusiasts a guidance package for development of decarbonization policies at all verticals- municipal, state and national. It lays down various policies such as:

- Procurement Policies (like Buy Clean and material-specific variations)
- Climate Action Plans
- Building codes
- City Zoning, Land use, and building regulations and incentives, including building and material reuse policies
- Executive orders addressing embodied carbon of building and industrial sector emissions

In addition, CLF has also launched an Embodied Carbon Toolkit for Building Owners (investors, developers, users) to encourage them towards reducing carbon footprint by carefully deciding their project requirements.

https://carbonleadershipforum.org/clf-launches-ec-policy-toolkit/,
https://carbonleadershipforum.org/clf-owner-toolkit/

Real estate impact assessment tools

The Real Estate Impact Analysis Tool was developed by UNEP-FI to help financial institutions identify and analyse the impacts of their real estate investments and portfolios holistically. The Real Estate Impact Analysis Tool is an Excel 2013 iterative input-output workflow. It asks users to enter information about their real estate asset to generate a number of outputs, including a set of impact profiles by asset or fund/profile, and to guide the user in identifying the asset's or fund's/most portfolio's significant impact areas using a set of built-in impact mappings. The output helps the user in efficient decision-making, strategy development, and target-setting.

The Real Estate Impact Analysis Tool can be utilised at two levels of analysis:

- **Individual real estate assets** (existing assets, renovations and new developments) : This level of analysis is intended to support investment decision-making and the monitoring of impacts over time.
- **Funds or Portfolios** containing or uniquely made up of real estate assets : This level of analysis is intended to support investors and financial institutions seeking to gain a cross-portfolio or fund-level view of the impacts of their real estate and to manage those funds/ portfolios accordingly.

https://www.unepfi.org/wordpress/wp-content/uploads/2021/06/Real-Estate-Impact-Analysis-Tool-User-Guide.pdf
(https://www.unepfi.org/positive-impact/unep-fi-impact-analysis-tools/real-estate-impact-analysis-tool/)

EDGE (Excellence in Design for Greater Efficiencies) Materials

EDGE is a green buildings platform which comprises a building standard, a software application, and a certification program for 150+ nations. EDGE MATERIALS measure embodied energy of all building materials used in a project. Together with other EDGE calculations which are based on site specifications, occupant use, operational energy consumption and water use, it creates a comprehensive, responsive and dynamic repository which allows to reduce the overall carbon footprint and optimize for efficiency. While EDGE Materials is an open access tool, some parts of software applications are paid.

EDGE is designed to address the demand for an economical online tool for planning and assessing resource efficient design in order to scale up green building growth. The application's simple interface allows industry experts to quickly assess resource efficiency and corresponding cost reductions simultaneously on the same platform. With improved accessibility of new data, standards become more demanding and EDGE continues to evolve.

Resource:

https://app.edgebuildings.com/project/allBuildings

6. Challenges & Way forward

There is now increasing awareness around the significant potential that can be derived from the use of tools and frameworks for generating and utilising data for scientific decision-making and integrating resource efficiency concerns into the buildings and construction sector. However, there are certain barriers that impact the adoption of such tools by various stakeholders and restrict the penetration of such approaches. Some of these barriers were identified through literature research and consultation with the Subject Matter Experts from different contexts and have been presented below.

Challenges

- **Time and resources** required for proper usage of the tool including technical personnel training costs, software version use costs, hardware configuration costs, team management costs.

- **Technical Capacity** of users for application of tools for decision making as well as of MSMEs and local supply chain actors to transition from BAU without external (technical and financial) support.

- **Lack of demand from clients** which reduces reliance on these systems thus also leading to lack of awareness and motivation for professional and service providers to acquire relevant skills and build a market towards the same.

- **Informality** in the construction sector is a stark reality in most developing countries and poses challenges towards accurate measurement and estimation of impacts.

- **Data availability and data sharing** is insufficient due to insufficient capacities for data collection along with the lack of integrated systems for data management and analysis.

This raises concerns when being applied in technical tools and frameworks where the advantages of information integration and model information sharing are often weakened due to technical defects and imperfect application patterns.

- Some **operational concerns** include lack of unification of application standards across regions and lack of access to quality assurance/certification of materials resulting in insufficient depth of application patterns & lack of institutional capacity to enforce regulation.

Way Forward

In light of the aforementioned concerns, it is essential that different countries are able to assess their local conditions along with available skills, capacities, and resources to adopt the right kind of tools for effective application and generating results. It is also crucial that these tools are made readily available to them for swift implementation. Some key enablers that need to be put into place for comprehensive strategization of sustainable building practices and encouraging this tool-based approach include:

- **Capacity Building**: There is an urgent need to provide resource materials to various stakeholders in easy to use formats while imparting requisite training and capacity building programmes to ensure that users understand the various tools and methodologies and their applications.

- **Financial support & Incentives**: The financial costs associated with the usage of tools can be significant and prohibitory for users as discussed above. This necessitates easing of this financial burden through innovative policy as well as market measures to support the use of these tools while also providing incentives and financial support to address the paucity of resources towards usage.

- **Integration of standards**: There is a need for refinement in standards, laws and regulations on existing technical tools at the national level as well as further monitoring, evaluation and verification of the operability and guidance of the issued standards and technical application cases. Strategic policy interventions can help in mainstreaming the use of standards and also generate demand for skilled professionals to support these processes.

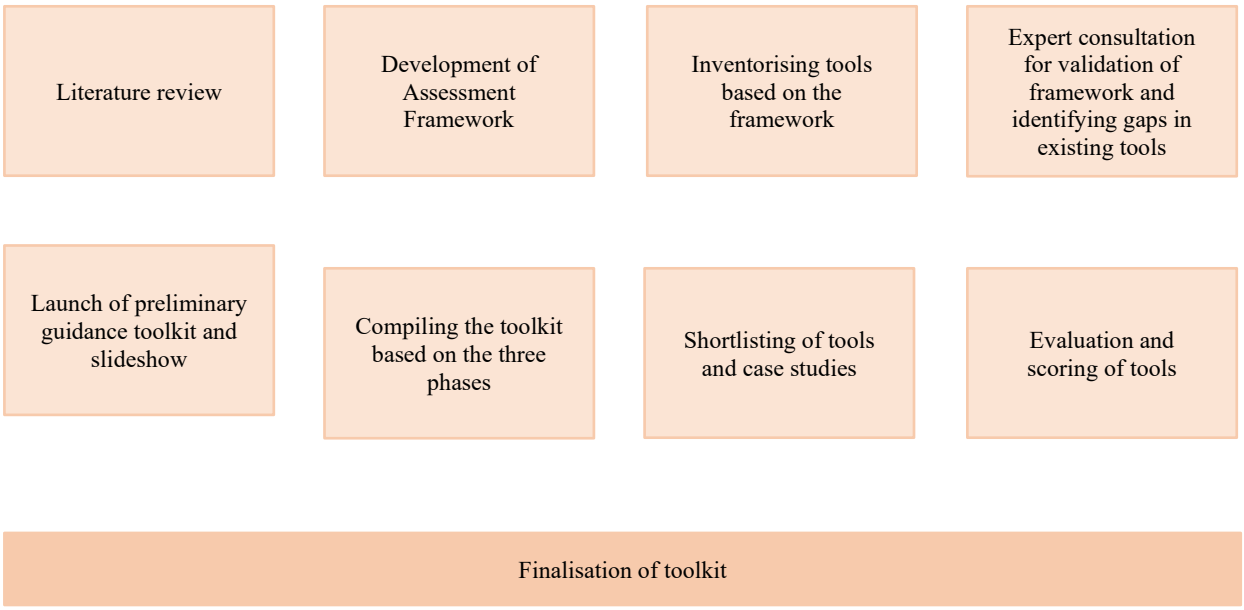
- **Data platforms**: Integrated data collection and management systems can help regional institutions benefit from easy availability and access to high-quality data for use in the relevant frameworks.

7. Annexures

Annexure 1: Project Methodology

DETAILED METHODOLOGY

The detailed methodology for the research follows the following steps *(see figure xx)* and has been described further in this section.



i. Literature Review: The research began with a literature review to understand the status-quo of the construction sector and to identify various tools and methodologies used in the construction sector value chain for understanding the numerous types and features of existing tools in use at various phases of the process, while also studying the methodologies and frameworks used to evaluate them. To identify relevant literature, keywords such as “resource efficiency in construction, material

efficiency in housing sector, tools used in construction sector, climate resilience in building and housing sector, tools used in construction sector for resource efficiency, tools used for sustainable construction" were used.

ii. Development of Assessment Framework: An assessment framework was created based on the literature review, with three key categorising heads: **coverage; usefulness; and usability**. The framework was built with the concept that the tools being examined might be used in one or more phases and focus on different areas of socioeconomic and environmental implications. The framework has been described in detail further in this section.

iii. Inventorisation of tools based on the framework: Following the three phases around which the toolkit is designed, existing tools were inventoried based on the criteria defined under the assessment framework. The inventory consists of tools as provided in the project brief as well as other tools identified in the construction and planning sector. Priorities for selecting tools have been defined as per the assessment framework and scoring methodologies.

iv. Validation of assessment framework and identifying gaps in existing tools: Expert consultations were carried out to validate the assessment framework and establish priorities for improving the practical applicability of the toolkit in the target countries. The consultation was used to seek advice on identifying gaps in the resource efficiency tools used in the construction sector, particularly from subject matter experts from developing nations such as Sri Lanka and Burkina Faso. The expert consultation was conducted using written correspondence to establish a clear understanding of the project scope while allowing experts to provide detailed inputs and examples from their own country contexts.

v. Evaluation and scoring of tools: Based on the inputs received from the subject matter experts the assessment framework was reviewed and scoring metrics were assigned to the criteria to proceed with the evaluation.

vi. Shortlisting of tools and case studies: A 3 step methodology of filtering, Scoring, and mapping was developed to shortlist the tools. The shortlisted tools are the tools that earned the highest scores based on the assessment criteria. Case studies relevant to each of the phases are shortlisted and presented.

vii. Compiling the toolkit based on three phases: the preliminary toolkit is compiled according to the three phases; **making the cases, prioritisation, and implementation.** The toolkit lays down clear guidelines for using appropriate tools based on stakeholders' requirements as per the country context. Each of these phases are also illustrated with case studies to provide practical guidance on the application of the methodologies. Other key tools that were not shortlisted but are essential for creating a resource efficient construction sector are discussed in a separate section after the curated set of tools.

viii. Launch of preliminary guidelines toolkit, presentation and finalisation of toolkit: The preliminary version of the mainstreaming guidance is compiled and readied for piloting in Sri Lanka and Burkina Faso by UN country teams. The lessons from the country operations will be incorporated into the toolkit at a later stage.

Annexure 2: Assessment Framework

The proposed framework for evaluating and shortlisting tools for the guidance was derived from a combination of priorities as defined in the project brief along with inputs from the literature review and expert consultations.

The framework takes into account that the tools evaluated may be applicable to one or more phases of the value chain, may serve multiple functions, and may focus on measuring various overlapping socio-economic and environmental impacts. These overlapping characteristics have been built into the framework to help in classifying tools for different purposes. To enable the toolkit to better respond to local conditions across regions and geographies, the criteria prioritises tools that facilitate participatory planning while also assessing the scope of tools' applicability in various contexts, such as international, national, state, and local levels, geo-climatic conditions, socio-economic conditions, and risk factors, among others.

Based on the research on trends in the construction sector, the assessment framework is created with three categorising heads - **coverage, usefulness, and usability**. These categories have been described further along with details of the respective set of criteria and the priorities established for the toolkit.

COVERAGE: This category of criteria have been proposed to ensure that the toolkit is able to respond to needs of different stakeholders in varying contexts, while ensuring the inclusion of a diverse set of tools across the value chain. Data has also been recorded on the relevant actors who can make use of the tool and may be able to contribute data to be fed into the tool, thereby taking into consideration if value chains in developing nations are evolved enough to supply data and enable tool

adoption. This head categorises the tools according to their type, function, phase of usage, value chain phases, and key stakeholders.

Coverage				
Criteria	**Description**	**Values**		**Priority for Toolkit**
Category	Categorisation of tools as per type of tool	*-LCA tools and Methodology* *-Buildings and construction roadmaps* *-Country assessments* *-Data and MRV* *-Procurement*	*-Policies* *-Project design, evaluation, certification* *-Materials* *-Implementation* *-Finance*	Ensuring coverage of all types of tools
Phase	Applicability of tool across defined phases of the mainstreaming process	***Making the case*** *- mapping and assessments of resource and material flows to build country specific evidence.* ***Prioritising phase*** *- incorporation of SBC resource efficiency into country strategies, plans, policies and regulation, and processes.* ***Implementation*** *- facilitating implementation of resources and material efficiency strategies through effective capacity building and partnership-building.*		Selection of tools that can help meet the requirements of each phase
Function	Broad function(s) of the tool	*-Cost Benefit Analysis* *-Planning and Decision-making* *-Modelling*	*-Implementation* *-Monitoring and Evaluation* *-Certification*	Ensuring inclusion of different types of tools
Stage(s) of Value Chain	Applicability of tool across multiple stages of the buildings and construction sector value chain	*-Financing* *-Planning, design and Commissioning* *-Construction Materials (extraction, processing, manufacture)* *-Logistics*	*-Construction* *-Property markets* *-Operation/Maintenance/ Renovation* *-End-of-life*	Adequate coverage across value chain
Relevant Actors	Actors involved in the different stages of the value chain (and from whom data might be needed) Actors that could potentially use this tool	*-Govt. bodies at local, regional, state and national level* *-Architects, technical consultant, urban planners* *-Industries, Material Manufacturing companies, Equipment manufacturers*	*-Suppliers, wholesalers* *-Contractors, developers* *- Real estate brokers, buyers* *-banks and other financial institutions*	Assessing whether value chains are evolved enough in developing countries to provide data and enable uptake of tool

USEFULNESS: This head helps in assessing the practical utility of each tool for inclusion in the toolkit in terms of identifying the outputs generated or the impacts measured by the tool and gauging the applicability of the tool with respect to wide

scale applicability and replicability in the developing country context. As an important priority for the toolkit, 'scope for participatory planning' has been included as a criterion to encourage tools and methodologies that allow for stakeholder engagement in the planning processes.

Usefulness				
Criteria	**Description**	**Values**		**Priority for Toolkit**
Impacts Measured	Types and details of impacts measured by tool	- *Environmental* - *Social*	- *Economic* - *Cultural*	Wide coverage of most relevant impacts
Applicability to Context	Gauging applicability to various contexts with respect to geo-climatic conditions, socio-economic parameters, risk factors, etc.	- *strong* - *moderate* - *weak*		Scope for wide-scaled applicability & replicability in context of developing countries
Scope for Participatory Planning	Assessing the level of engagement with various stakeholder & target groups, transparency of processes	- *Yes/No* - *not applicable*		Preference to tools that have scope for participatory planning

USABILITY - This criterion determines how usable the tools are with respect to the input requirements and general features and characteristics of the tools which may encourage or prohibit the uptake of the tool in practical working conditions. This includes criteria such as data needs, ease of use, terms of use, languages in which the tools are available, and compliances to which the tool adheres.

Usability				
Criteria	**Description**	**Values**		**Priority for Toolkit**
Type of Data needed	Data required for assessment by the selected tools to address concerns of uneven availability & access to data	- *Project details* - *Building Information* - *Material Information* - *Energy consumption and cost details*	- *Equipment and material transportation details* - *Pattern of Use* - *Service Life*	Tools with simple data requirements or assist in collecting data

	- mapping of passive and interactive tools	*passive/interactive*	
Ease of Usage	-skill requirement for tool usage -platform (software, app or web based, etc) -availability of support, tutorials, demos		Prioritisation to ease of use
Terms of Usage	paid or free of use (creative commons, open education, public)		Only free to use tools to be considered
Language	The languages in which the tool is available for use	- English, French, Spanish, etc.	Preference for availability in multiple languages, especially UN official languages
Compliances	Compliance with different regulatory frameworks	*Yes/No with description*	Relevant compliances may be prioritised

Annexure 3: Questionnaire

Questionnaire for Expert Inputs

Practical Mainstreaming Guidance for Sustainable Building & and

Construction

Name:

Organisation:

Country:

1. Which tools are you aware of that are used by the buildings and construction sector stakeholders in your country? (based on any type of stakeholders or type of tools)

2. What do you perceive to be the major challenges stakeholders face in adopting existing tools? (such as data availability, stakeholder capacity, cost, ease of usage, language, compliances, etc)

3. What stages of the value chain need immediate attention in terms of tool inadequacy? Please help us identify stages of the value chain where urgent challenges
are seen which can be addressed through the use of appropriate tools.

4. Please suggest other tools that you feel may be relevant and should be considered for this toolkit.

5. Please suggest if there are successful examples or case studies of the application

of tool-based approaches in the building and construction sector that you are aware of. (from your own country or others)

6. Please share your comments on the adequacy and effectiveness of the proposed assessment framework for selecting tools.

Annexure 4: Shortlisting Methodology

The methodology used for shortlisting the tools follows a three-step process; *filtering, scoring, and mapping for coverage*.

The list was narrowed down from a total of 73 tools that were initially inventoried to a curated set of powerful tools that can assist stakeholders at different stages of the construction value chain in accessing and applying advanced methodologies, adopting efficient construction technology, materials, and construction practices, and making informed decisions. A set of 16 tools were shortlisted at the end of the review applying the three-step methodology, spanning the construction value chain and the three mainstreaming processes. The three-step process is further elaborated in this section.

Step 1 : Filtering

As a first step tools were assessed according to the following criteria and tools not meeting the criteria were filtered out;

1. **Universally applicable to developing countries' context** - Only tools that were universally relevant to a variety of geo-climatic settings and socio-economic backgrounds were chosen. The tools that were not available in English were also filtered out during this process.

2. **Terms of usage** - Only those tools that were both free to use and open source were considered. All paid tools were filtered out in the process.

3. **Impacts measured** - The tools for measuring environmental impacts were given a higher priority. The tools that did not measure environmental impacts were eliminated from consideration.

4. **Usage Independent of other tools** - Tools that can be used independently were chosen, while those that can be used as a plug-in to larger tools such as BIM and Revit were filtered out.

5. **Fully functional** - Only tools that were fully operational in relevance to the construction sector were shortlisted.

At the end of this step the number of tools were narrowed down to 27 as shown in table --.

1	Embodied Carbon in Construction Calculator (EC3)
2	GlobalABC Guide for Incorporating Buildings Actions in NDCs
3	World GBC - Bringing embodied carbon upfront
4	NISMOD-Int
5	CAT-I (UNOPS)
6	SBC country assessment methodology – sector assessment (UNEP)
7	Common Carbon Metric (CCM 2.0) - UNEP
8	Building Passport guidelines
9	Guidance Document on Procuring Sustainable Buildings and Construction
10	MAS-ship
11	Adopting Decarbonization Policies for the Buildings and Construction Sector
12	Shelter and Sustainability
13	Handbook of Sustainable Building Policies
14	GFDRR Building regulatory capacity assessment Level 1 & 2
15	SHERPA
16	GlobalABC Call for action buildings adaptation
17	Meeting Global Housing Needs with Low Carbon Materials (GGGI)
18	Edge Materials – Embodied energy methodology (IFC)
19	The Pathfinder
20	Weathershift
21	The Building System Carbon Framework
22	Eco-i Building Materials
23	Available technologies for local building materials (UNIDO)
24	Circular Economy Business Models in Built Environment
25	SEfficiency
26	Green Building: A Financial blueprint for Emerging Markets
27	Financing Circularity: Demystfying Finance for Circular Economies - UNEP 2020

Step 2: Scoring

The next step to identifying the most relevant tools for the construction sector was to score them using three criteria head including language, impacts measured, and the ease of usage as shown in the table --

Criteria Head	Criteria	Score	Maximum score for the criteria
Language	English + UN/any regional Languages	+1	1
Impacts measured	Environmental + social	+1	2.5
	Environmental + economical	+1	
	Environmental + others	+0.5	
Ease of usage	Passive/guidelines	+1	1
	Non-technical	+0.5	
	Highly technical	+0.25	
Maximum Possible score			4.5

1. **Language**: While the filtering mechanism ensures that tools not available in English are filtered out, preference was given to tools that are available in additional regional languages with a score of +1 with maximum possible score for the criteria head being 1.

2. **Impacts measured**: With the priority of the toolkit being resource efficiency from an environmental lens, tools measuring additional socio-economic

impacts were scored with an additional score of +1 each for tools measuring economic and social impacts and +0.5 score for tools measuring other kinds of impact, the maximum possible score for this criteria stands at 2.5.

3. **Ease of Usage**: Under this criteria, the tools were classified into three types: passive or/and step-by-step guidelines, Non-technical tools, and highly technical tools. The maximum score a tool can get under this criteria is 1.

    a. Passive tools are such tools that can easily be adopted to a system like step-by-step guidelines, frameworks, catalogues and so on which can be applied to the system without the need for intensive training and additional resource requirements which were given a higher weightage with the score of +1.

    b. Non-technical tools may be both passive or interactive which again can be applied without prior training on the tool and additional tools which were given a score of +0.5.

    c. Highly technical tools are mostly interactive tools which may require large amounts of data to be input into the tool which often comes with the need for intensive prior training and additional resources such as time, cost, and personnel. In many of the cases, these are the tools that a local level administrative body would have to hire an external agency to apply into the system or which may require capacity development modules for the personnel which will cause additional cost. Hence, these tools while still very important were given a lower priority with a score of +0.25.

After the scoring the tools that scored 50% or above of the maximum possible score of 4.5, i.e, 2.25 were identified. Table -- shows the scoring for the 22 shortlisted tools and the high-scoring tools have been highlighted.

S. No.	Tool	Language	Measured			Ease of Usage	Total Score	Phase		
			Environmental + Social	Environmental + Economic	Environmental + Others			Making the Case	Prioritising	Implementing
1	Embodied Carbon in Construction Calculator (EC3)	1		1		0.25	2.25	•		•
2	GlobalABC Guide for Incorporating Buildings Actions in NDCs	1				1	2			•
3	World GBC - Bringing embodied carbon upfront					1	1	•	•	•
4	NISMOD-Int	1	1	1	0.5	0.25	3.75		•	•
5	CAT-I (UNOPS)			1	0.5	0.25	1.75	•	•	
6	SBC country assessment methodology – sector assessment (UNEP)		1	1	0.5	1	3.5	•	•	•
7	Common Carbon Metric (CCM 2.0) - UNEP			1		0.5	1.5	•	•	
8	Building Passport guidelines		1	1		1	3	•	•	
9	Guidance Document on Procuring Sustainable Buildings and Construction		1	1		1	3		•	•
10	MAS-ship		1	1		0.5	2.5	•	•	•
11	Adopting Decarbonization Policies for the Buildings and Construction Sector		1	1	0.5	1	3.5	•	•	•
12	Shelter and Sustainability		1	1	0.5	1	3.5		•	•
13	Handbook of Sustainable Building Policies		1		0.5	1	2.5		•	•
14	GFDRR Building regulatory capacity assessment Level 1 & 2		1	1	0.5	1	3.5		•	•
15	SHERPA	1	1	1	0.5	0.5	4	•	•	•
16	GlobalABC Call for action buildings adaptation		1	1	0.5	1	3.5		•	•
17	Meeting Global Housing Needs with Low Carbon Materials (GGGI)		1	1		1	3			•
18	Edge Materials – Embodied energy methodology (IFC)			1		1	2	•		•
19	The Pathfinder					0.5	0.5	•		
20	Weathershift					0.5	0.5	•		
21	The Building System Carbon Framework					1	1	•		
22	Eco-i Building Materials		1			1	2			
23	Available technologies for local building materials (UNIDO)					1	1	•		
24	Circular Economy Business Models in Built Environment		1	1		1	3			•
25	SEfficiency				0.5	1	1.5			
26	Green Building: A Financial blueprint for Emerging Markets		1		0.5	1	2.5			
27	Financing Circularity: Demystifying Finance for Circular Economies - UNEP 2020			1		1	2			•
								6	11	13

Table --

Step 3: Mapping for Coverage

After the highest scored tools were identified, the list of shortlisted tools was mapped for coverage on the criteria such as; Phases of mainstreaming process, Category, Function, Stages of Value Chain, and Mix of passive and interactive tools. Some tools which scored less than the cut off of 2.25 were added to ensure coverage across the various parameters. This mapping is presented in Table --.

S. No.	Tool	Language	Measured				Total Score	Phase			Category	Function								Stage of Value Chain							
			Environmental + Social	Environmental + Economic	Environmental + Others	Ease of Usage		Making the Case	Planning	Implementing		Cost Benefit Analysis	Planning and Decision-making	Modeling	Implementation	Monitoring and Evaluation	Certification	Financing	Passive	Financing	Planning, Design, Contracting	Construction materials	Property Markets	Logistics	Construction	Operation/Maintenance/renal/renovation	End of life
1	Embodied Carbon in Construction Calculator (EC3)	1		1		0.25	2.25	•		•	LCA Tools (1)		•								•	•		•	•		
2	GlobalABC Guide for Incorporating Buildings Actions in NDCs	1				1	2			•	Buildings and construction roadmaps (1)		•		•	•			•		•						
3	World GBC - Bringing embodied carbon upfront					1	1	•	•	•			•				•	•	•	•	•	•	•	•	•	•	•
4	NISMOD-Int	1	1	1	0.5	0.25	3.75		•	•			•	•							•						
5	CAT-I (UNOPS)			1	0.5	0.25	1.75	•	•		Country assessments (1)		•								•	•			•		
6	SBC country assessment methodology – sector assessment (UNEP)		1	1	0.5	1	3.5	•	•	•			•			•			•		•				•	•	•
7	Common Carbon Metric (CCM 2.0) - UNEP			1		0.5	1.5	•	•		Data and MRV (1)					•					•					•	•
8	Building Passport guidelines		1	1		1	3	•	•			•	•		•	•		•	•	•	•	•	•	•	•	•	•
9	Guidance Document on Procuring Sustainable Buildings and Construction		1	1		1	3		•	•	Procurement (1)		•		•	•	•		•		•	•			•	•	
10	MAS-ship		1	1		0.5	2.5	•	•	•	Policies (5)		•		•	•					•	•		•	•		
11	Adopting Decarbonization Policies for the Buildings and Construction Sector		1	1	0.5	1	3.5	•	•	•		•	•		•	•			•		•	•			•		
12	Shelter and Sustainability		1	1	0.5	1	3.5		•	•									•		•						
13	Handbook of Sustainable Building Policies		1		0.5	1	2.5		•	•									•		•						
14	GFDRR Building regulatory capacity assessment Level 1 & 2		1	1	0.5	1	3.5		•	•			•						•		•						
15	SHERPA	1	1	1	0.5	0.5	4	•	•	•	Project Design, Evaluation, and certification (2)										•				•		•
16	GlobalABC Call for action buildings adaptation			1	0.5	1	3.5		•	•			•		•			•	•	•	•	•			•	•	•
17	Meeting Global Housing Needs with Low Carbon Materials (GGGI)		1	1		1	3			•	Materials (1)	•	•		•				•			•		•	•	•	•
18	Edge Materials – Embodied energy methodology (IFC)			1		1	2	•		•		•	•				•				•	•			•		
19	The Pathfinder					0.5	0.5	•					•								•					•	
20	Weathershift					0.5	0.5	•					•								•	•					
21	The Building System Carbon Framework					1	1	•					•		•						•	•		•	•		•
22	Eco-i Building Materials		1			1	2						•								•	•		•			•
23	Available technologies for local building materials (UNIDO)					1	1	•					•								•	•					
24	Circular Economy Business Models in Built Environment		1	1		1	3			•	Implementation (1)		•		•				•	•	•	•		•	•	•	•
25	SEfficiency				0.5	1	1.5						•							•		•			•	•	
26	Green Building: A Financial blueprint for Emerging Markets		1		0.5	1	2.5				Policy, Finance (1)		•		•				•	•	•				•		
27	Financing Circularity: Demystifying Finance for Circular Economies - UNEP 2020			1		1	2			•	Finance (1)	•	•						•	•	•						
	No. of selected tools - 16							6	11	14		4	15	1	8	5	1	4	12	5	15	8	1	5	11	6	6

Table --

At the end of the 3-step shortlisting process, a set of 16 tools were finalised to be presented in this toolkit.

Annexure 5: Inventory

<To be added>

References

<To be added>