TRANSFORMING THE BUILT-ENVIRONMENT THROUGH SUSTAINABLE MATERIALS

GlobalABC Accelerator Session | 01 June 2023

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Development Alternatives

People | Planet | Prosperity

OUR VISION

A world where every citizen can live a secure, healthy, and fulfilling life, in harmony with nature

OUR MISSION

Our mission is to deliver and promote scalable solutions that enable resilient economies for everyone, especially the vulnerable communities, women, farmers, and young people in India

Our Goal - Build Resilient Futures Together




40 YEARS Development Alternatives
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STRATEGIC IMPACT AREAS

RESOURCE EFFICIENCY AND CIRCULAR ECONOMY

Accelerating the transition to inclusive and circular modes of production and consumption will

- reduce carbon and material footprints across the lifecycle of economic activity
- promote local value and wealth creation

CLIMATE RESILIENCE AND ECOSYSTEM RESTORATION

Regenerating degraded ecosystems to

- build resilience to climate change and extreme events
- enhance institutional and community capabilities & generating prosperity

LIVELIHOOD SECURITY AND INCLUSIVE ENTREPRENEURSHIP

Innovative business models and institutional ecosystems that

- empower local entrepreneurs for creating businesses
- generate jobs and deliver basic needs

Key Sectors and Work Areas

- Innovate and package green technology solutions
- Create and support entrepreneurship
- Catalyse and service markets for alternatives
- Build community and institutional capacities for resilience
- Design and catalyze social change processes
- Influence and service policy and industry shifts

CIRCULARITY IN THE BUILT ENVIRONMENT

ISSUES THAT CONCERN US

Use of Virgin Raw Materials

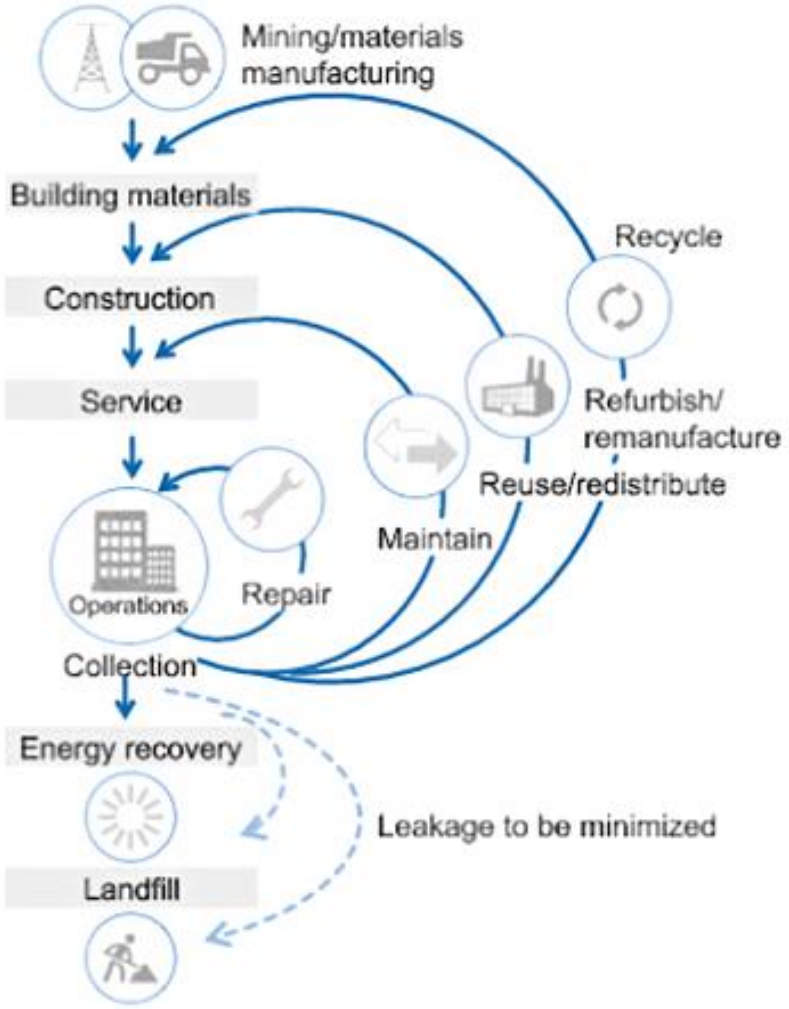
- **Minimising the non-renewable virgin material footprint** of construction activities – soil, sand, stone (including limestone for cement), aggregates, metals
- Ensuring sustainable sourcing of the renewable material used in construction – timber, water

Energy & Environment

- Minimising building energy requirement – **embodied energy in materials** and operation and use of buildings
- **Closing the material-energy loops** though post life management of the building

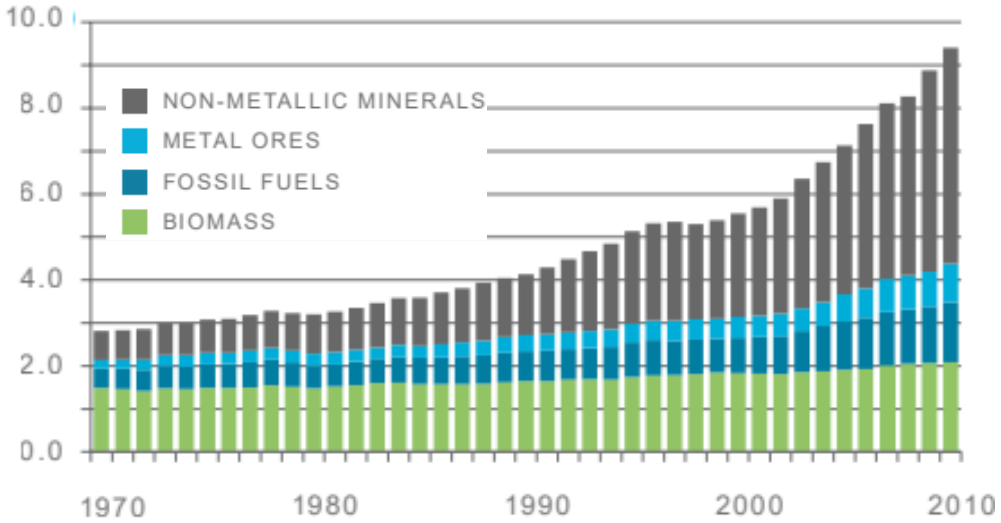
Employment & Enterprise

- **Maximising the job creation potential** of construction activities, and the **local economy benefits** from the production and servicing of local infrastructure



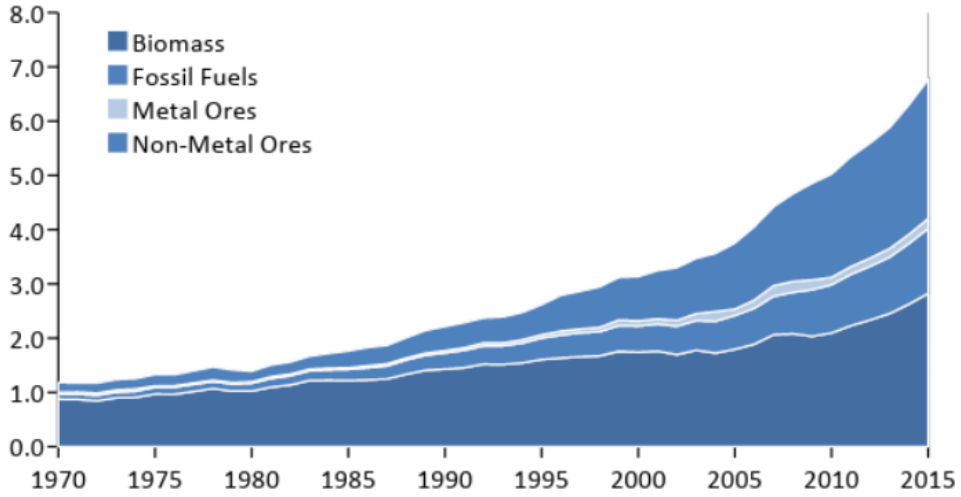
Circular economy principles in the construction value chain
Source: Ellen McArthur Foundation, 2013

MATERIAL CONSUMPTION :: INDIA



Material consumption per capita – Asia and Pacific
(Source: UNEP, 2016)

- **Urbanisation, population growth,** and **industrialisation** pressures driving high material use in Asia.
- **Domestic extraction in India increased by 317%** between 1970 & 2019.
- India's **resource extraction per unit area is one of the highest in the world** at 1579 tonnes/acre compared to the global average of 454 tonnes/acre
- India's per capita extraction in 2007 was 5.67 tonnes – **less than half of the global average** of 12.44 tonnes.
- Material productivity has improved but still far behind other nations



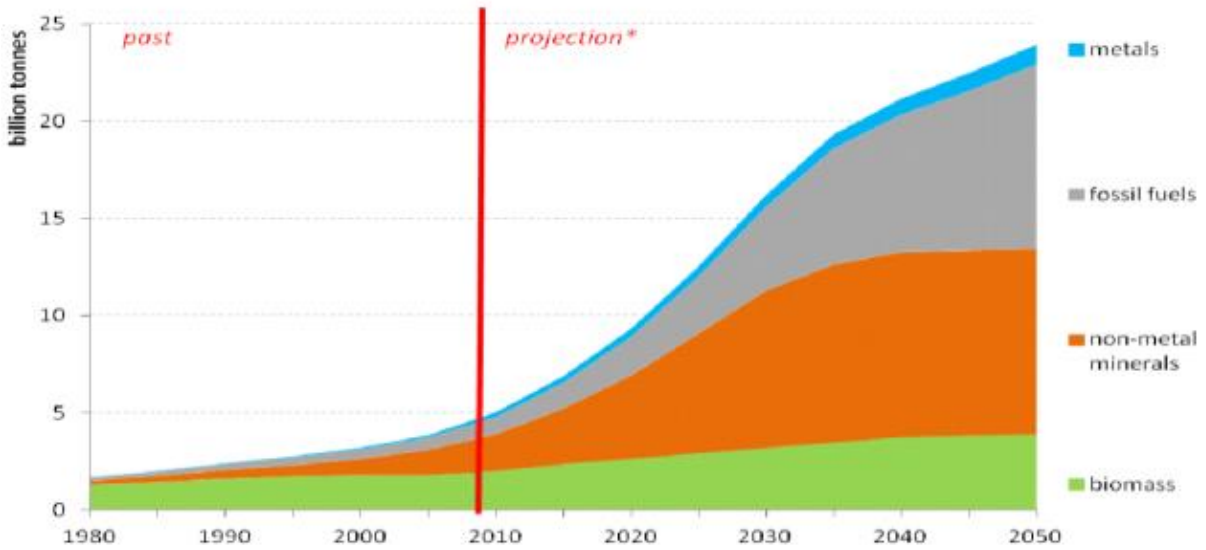
India's trend in material consumption (billion tonnes)
(Source: www.materialflows.net/visualisation-centre/, last accessed May 2023)

	China	Germany	India	Japan	United States of America	World
Total material consumption (billion tonnes)	35.19	1.21	7.42	1.14	6.58	91.88
Per capita consumption (tonnes/capita)	25.19	14.75	5.67	8.92	20.58	12.44
Material productivity (percentage improvement between 1970 and 2015)	311	287	256	301	276	115

Material Consumption and Productivity in selected countries
(Source: www.materialflows.net/visualisation-centre/, last accessed May 2023)

MATERIAL CONSUMPTION TRENDS :: INDIA

- **Non-metallic minerals had the largest share** in 2019 (45.6%), with 98.2% of this for use in construction.
- Material consumption for non-metallic minerals in India is likely to rise rapidly till 2035, before plateauing.



Projections of future material consumption patterns in India
(Source: GIZ-TERI-DA-IFEU, 2015)

Domestic Extraction of India in 2019, by material group *(Source: www.materialflows.net/visualisation-centre/, last accessed May 2023)*

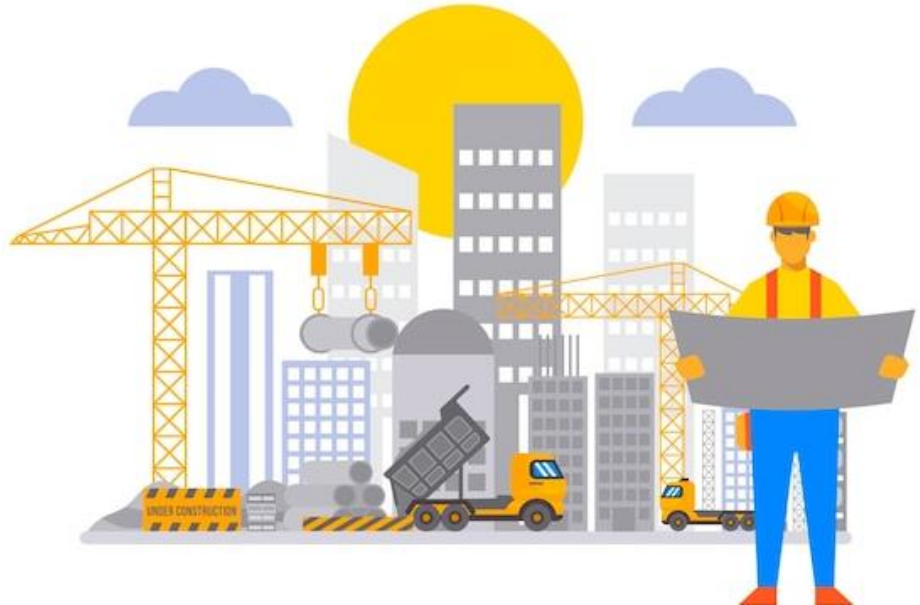
CONSTRUCTION INDUSTRY OVERVIEW :: INDIA

- The construction industry is the **second-largest industry in India** after agriculture, accounting for 7.54% of the GDP in 2019.
- Expected to record a CAGR of 15.7% to reach **USD 738.5 billion by 2022** (InvestIndia, 2020).
- According to the Indian Green Building Council, the green built-up area in the country was about **1,850 sqm in 2003,** increased to about **0.7 billion sqm in 2020**, and is targeted to reach **2.37 billion sqm by 2030**.
- The estimated market opportunity of the green building sector is estimated at **USD 1.04 trillion**.

Taking a circular pathway for the Indian economy can bring India annual benefits of USD $624 billion in 2050, compared to BAU - equivalent to 30% of India's GDP in 2050 and 11% of GDP in 2030.

Projected savings from circularity	By 2030	By 2050
Greenhouse gas emissions	**23%**	**44%**
Water usage in construction industry	**19%**	**24%**
Use of virgin materials in cities and construction, food and agriculture, mobility and vehicle manufacture	**19%**	**24%**

(Source: McKinsey Global Institute 2010, 2009)



TRANSFORMING THE BUILT-ENVIRONMENT THROUGH SUSTAINABLE MATERIALS

PROJECT OBJECTIVE

- To reduce embodied carbon in the built environment.
- To address the gaps in the construction sector value chain to assist transforming the supply and demand-side bottlenecks and transition to low carbon pathways for the sector in target geographies.
- To develop a sustainable building material market for the building and construction sector in India (focus on Odisha and Maharashtra and eventually provide lessons and approaches for further replication and scaling up in other states).

Project Implementation Period:	2022 - 2025
Implementation Partner:	United Nations Environment Programme
Technical Partner (India):	Development Alternatives

BMZ Federal Ministry for Economic Cooperation and Development
UN environment programme
One planet handle with care
Development Alternatives
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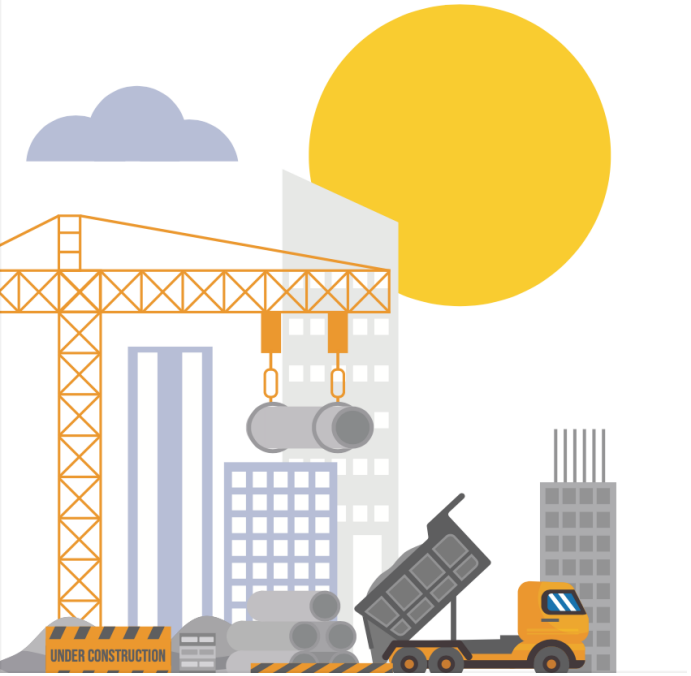


PROJECT APPROACH

To facilitate a systemic transformation of the built environment through sustainable building materials, focusing on affordable housing.

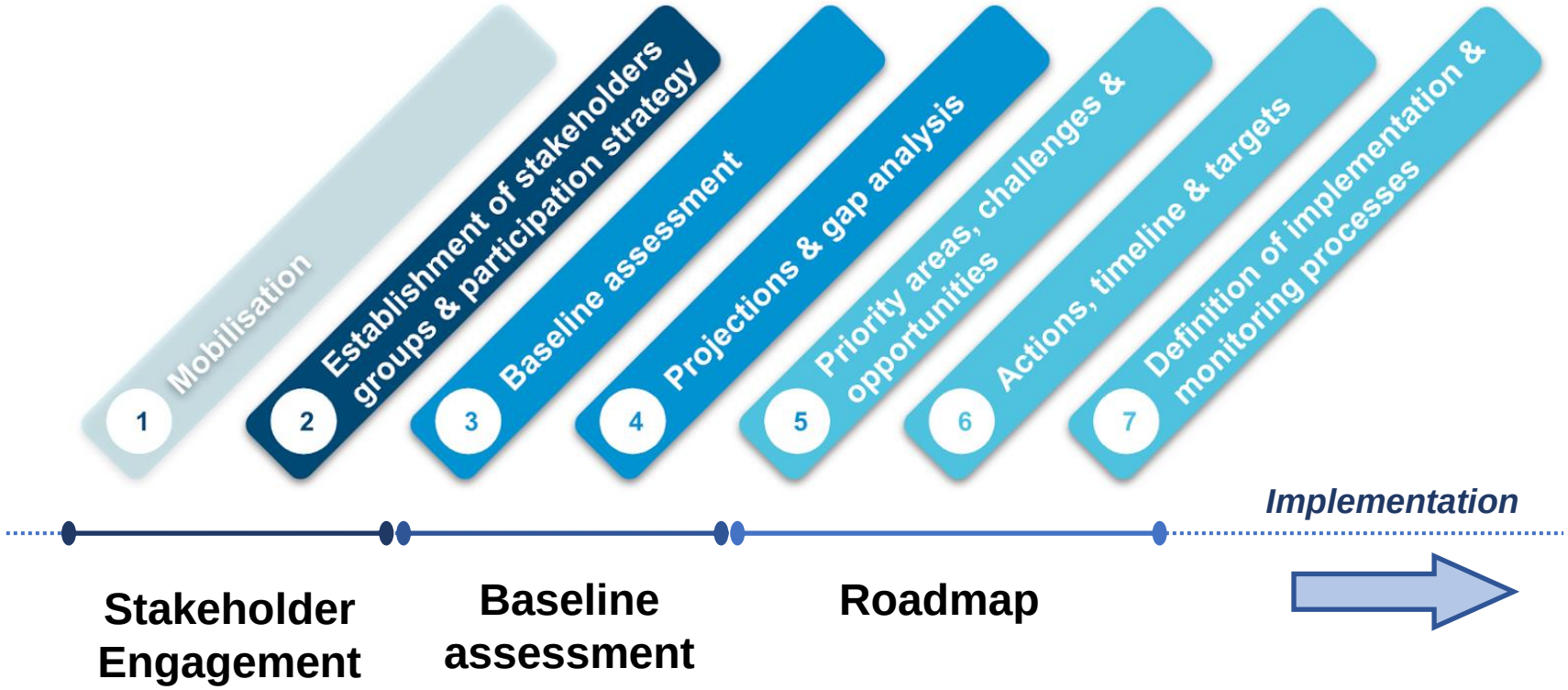
Policy Frameworks - Current policy frameworks guiding and supporting the sustainable building and construction sector; effectiveness of current policy initiatives; prominent gaps and barriers in regulatory frameworks, codes, standards, certification systems; India's NDC and SDG commitments and ambitions.

Material and Carbon Footprint - Resource efficiency and circularity concerns in material consumption; carbon footprint of buildings including embodied and operational energy; life-cycle assessment and material flow analyses approach; context-appropriate technologies and innovations in masonry, concretes, and bio- based materials.

Market and Finance - Demand and supply trends in the affordable housing sector; challenges in implementation and practice; barriers to market acceleration; project finance challenges and innovative/green finance mechanisms; green building certification - challenges and opportunities

METHODOLOGY

*Based on the **GlobalABC Methodology** for Roadmap Development*

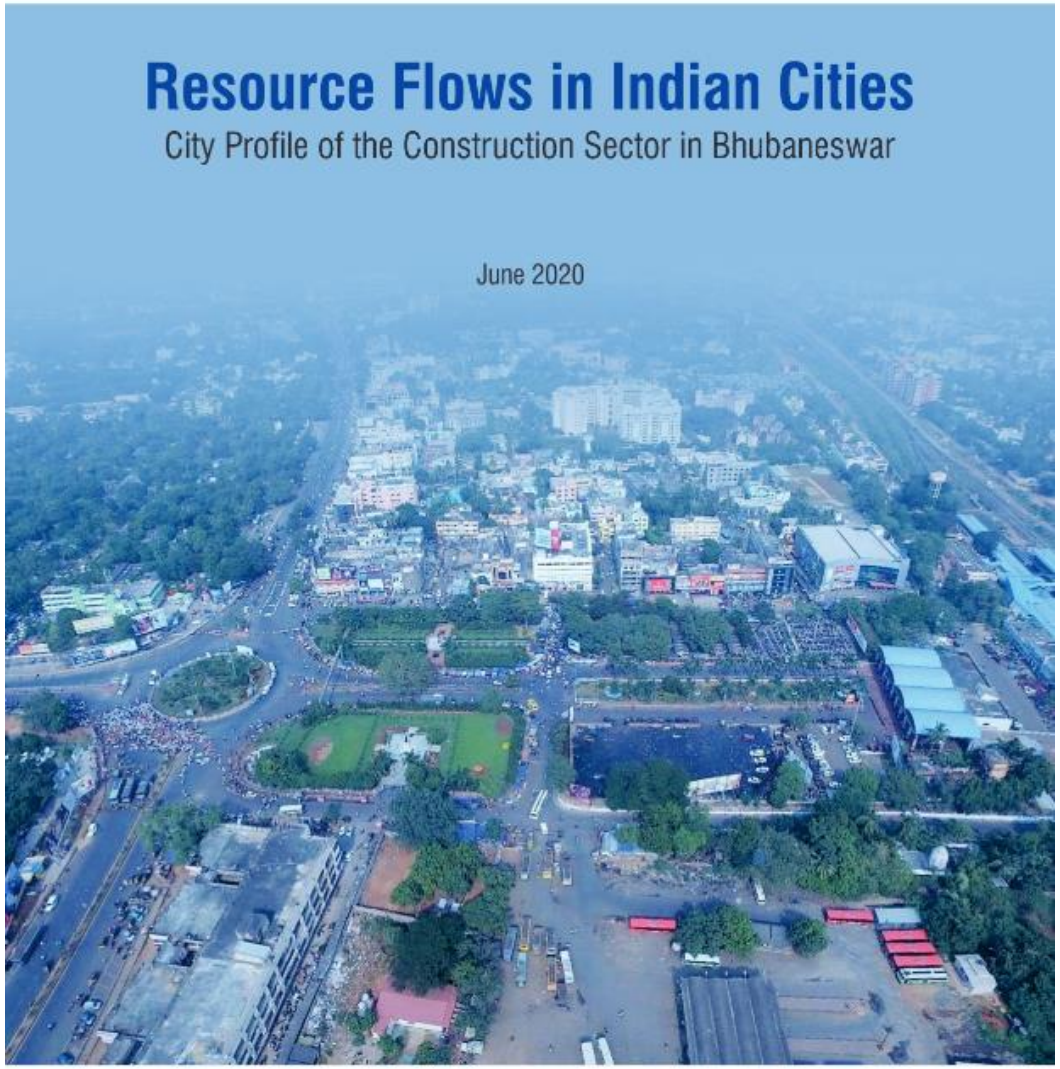


- **State level enabling frameworks** (updating construction polices, regulations, standards, planning & procurement practices)
- **Pilot demonstration**
- **Tools & Business Models**
- **Capacity Building**
- **Learning & Dissemmination**

CONSTRUCTION SECTOR RESOURCE FLOWS IN BHUBANESWAR, ODISHA

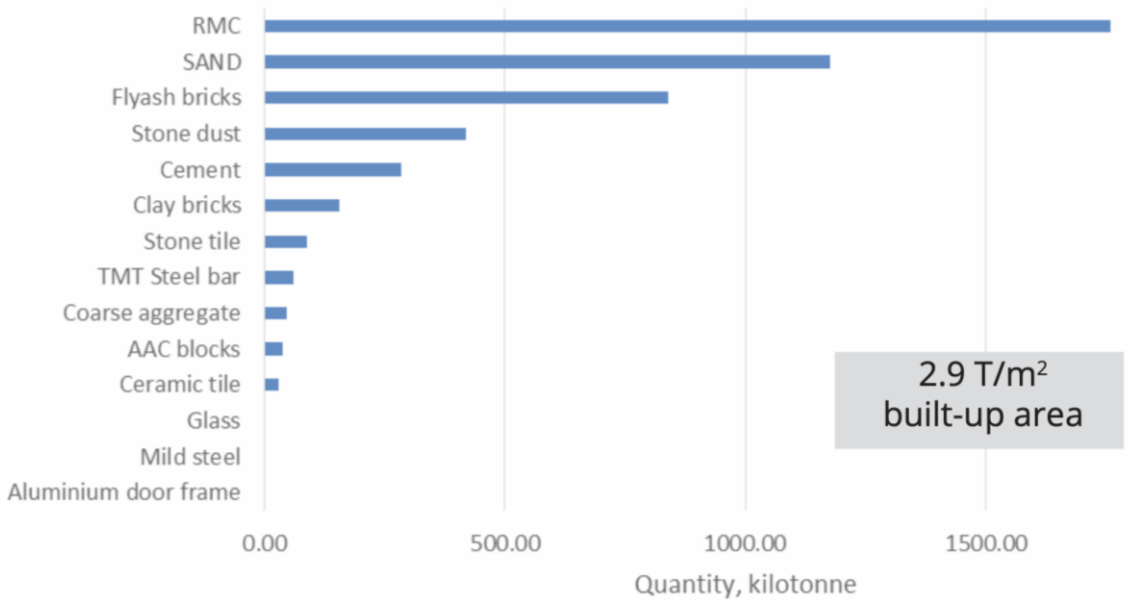
- **Detailed analysis of material flows** into the city and environmental footprint in terms of CO_2 equivalent emissions.

- Assessment of consumption patterns and availability of resources and alternatives to identify potential intervention points.



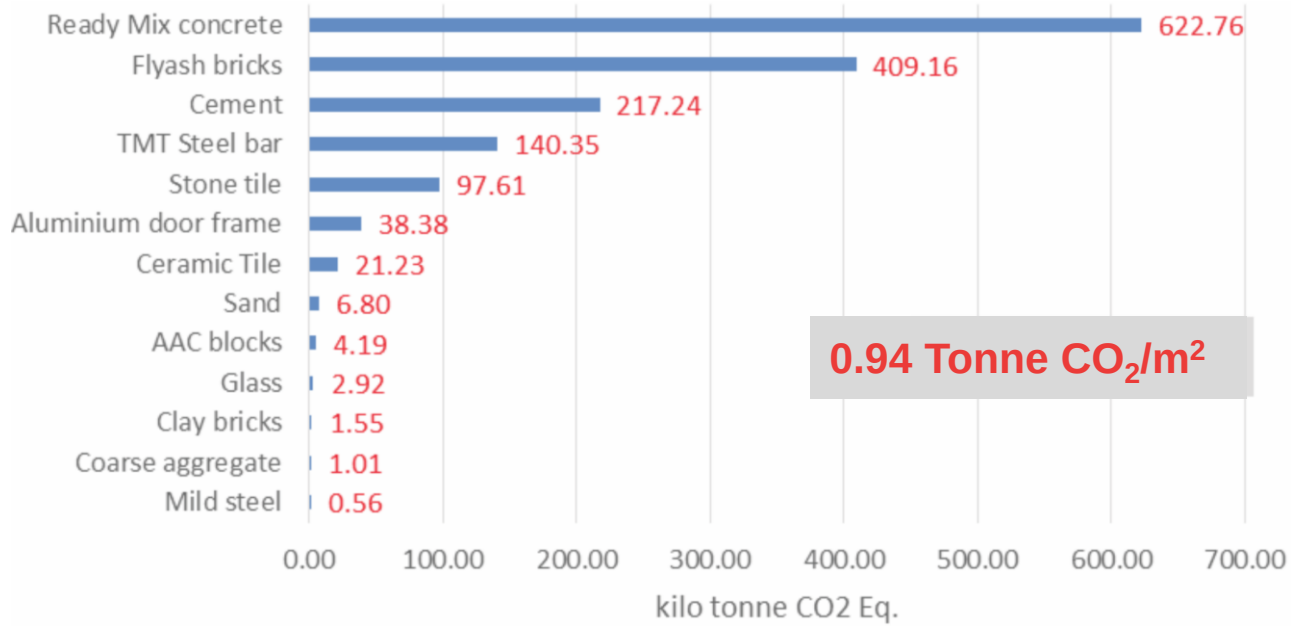
MATERIAL & CARBON FOOTPRINT

for 2179 residential buildings in Bhubaneswar with 1.6 million sqm built-up area

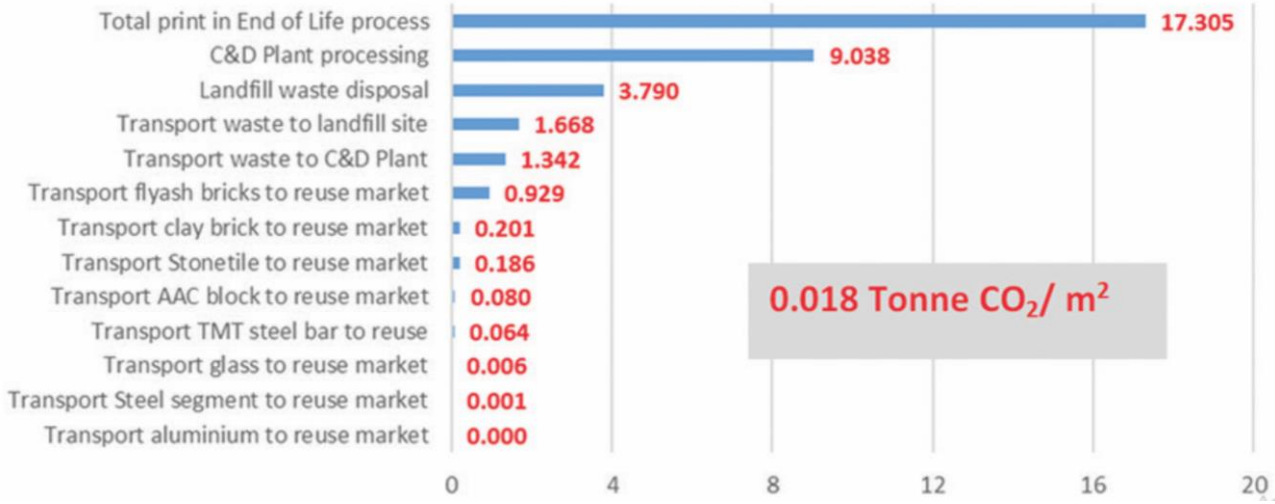


Material Footprint (kilotonne per sqm)

- Highest material footprint is for **RMC, sand**
- **Emissions are dominated by the use of concrete in construction (40%), followed by fly ash bricks (26%)**
- On a raw material level, **cement alone accounts for 42% of the total emissions**
- Sand, which constitutes 33% of the flow of primary materials, accounts for less than 2% of the total emissions

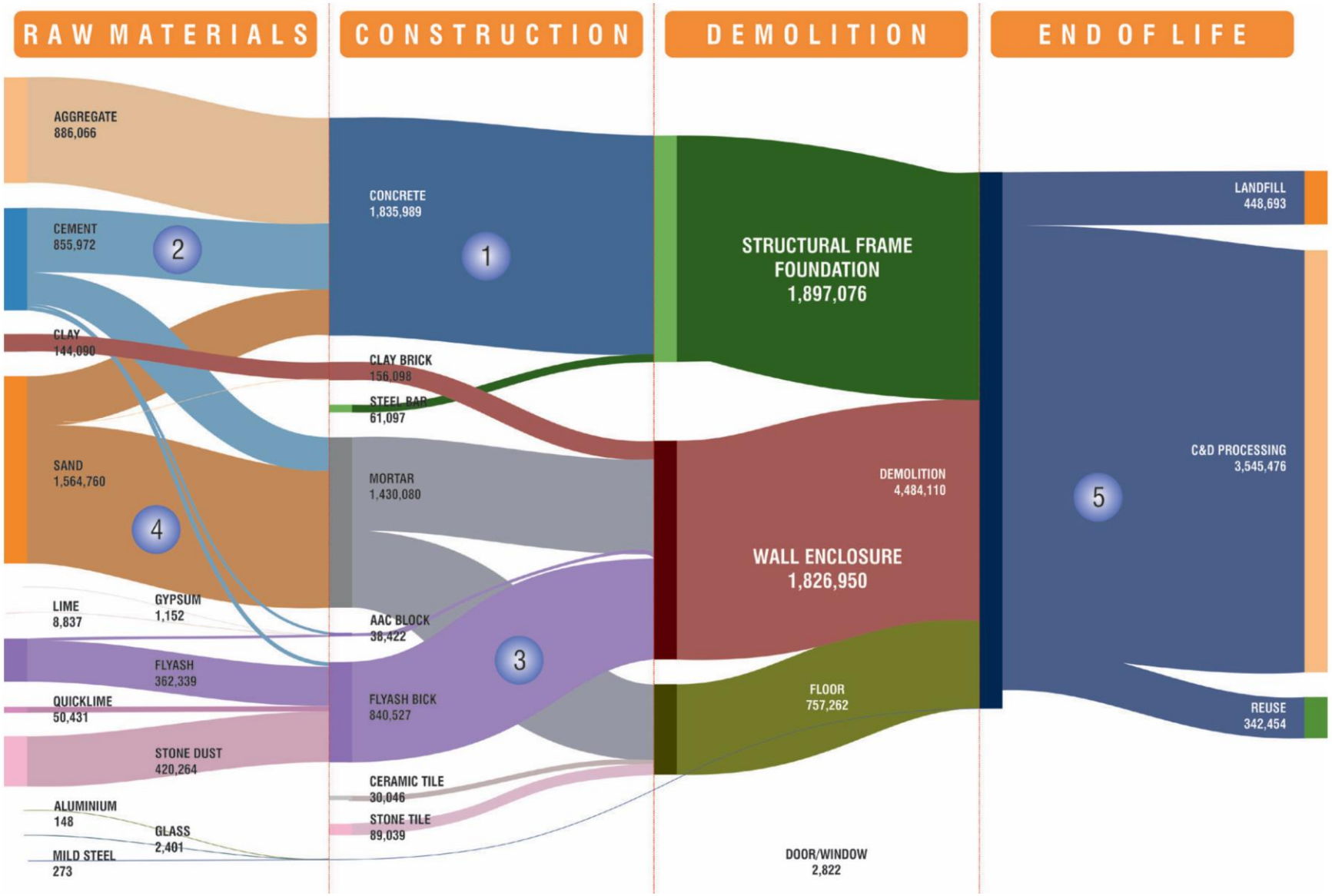


Carbon Footprint of Materials (kilotonne Co2 eq per sqm)



Carbon Footprint of Materials in end-of-life phase (kilotonne CO2 per sqm)

MATERIAL FLOWS FOR HOUSING

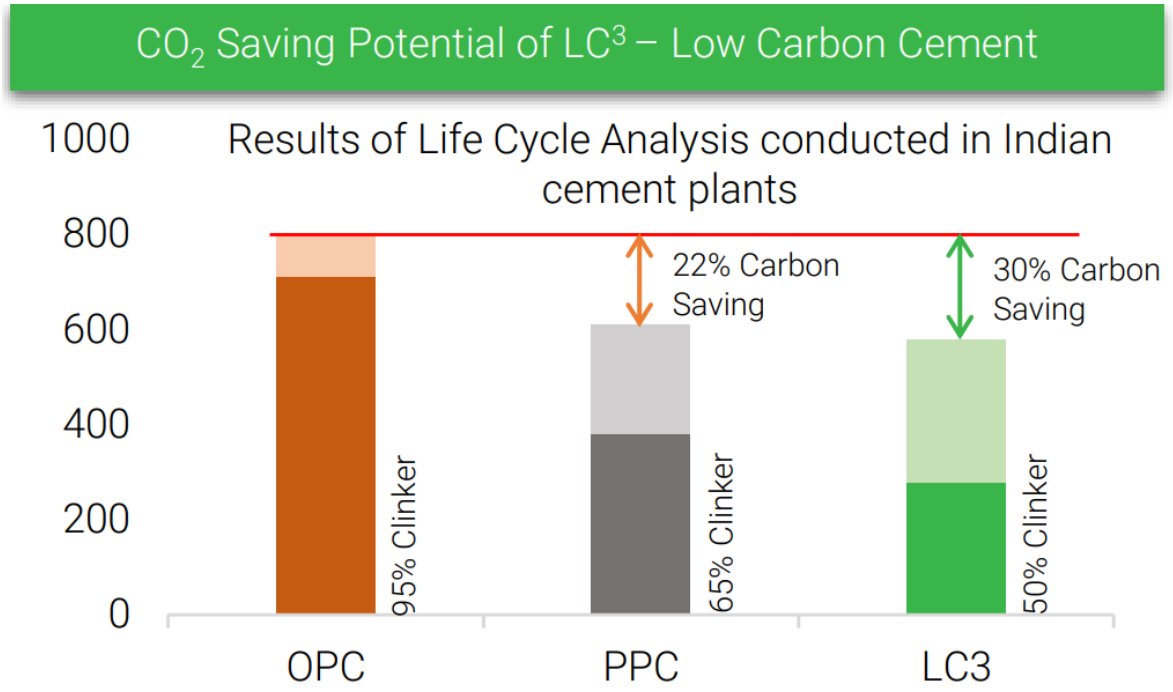


PRIORITY MATERIAL GROUPS

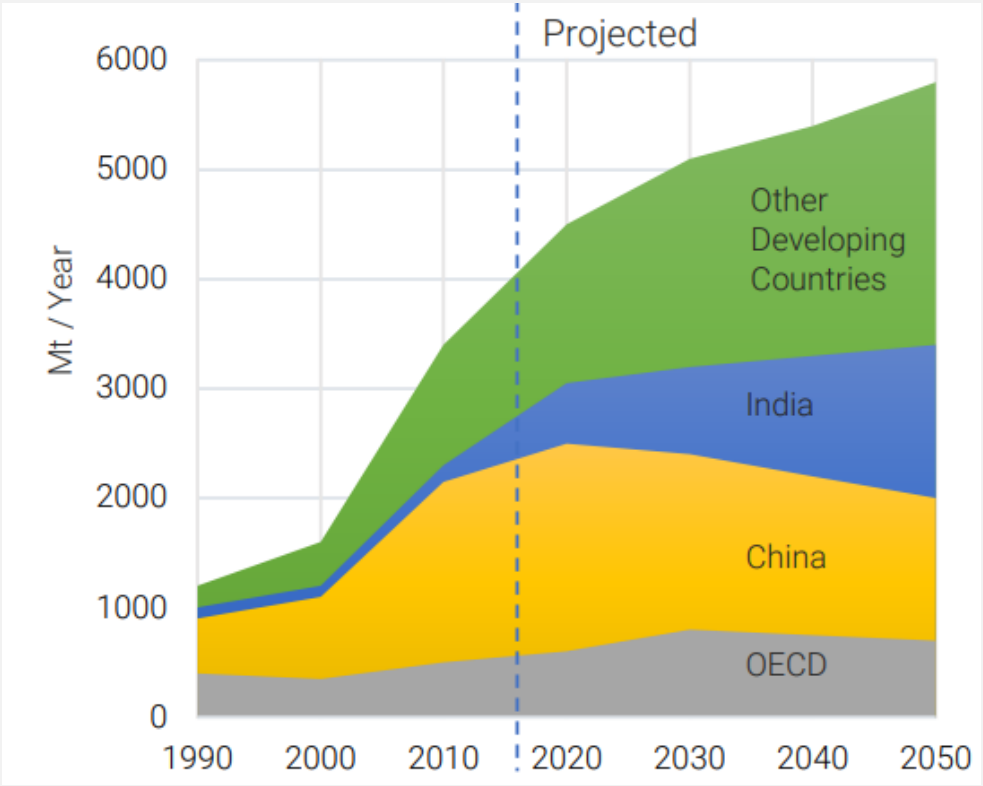
1. Concrete
2. Cement
3. Masonry (wall enclosure)
4. Sand
5. Construction & Demolition Waste Processing

Material Alternatives :: CEMENT

- **Potential savings of up to 40% of CO_2** compared to Ordinary Portland Cement
- **Resource savings**: Need for up to 60% less clinker, replacement with limestone and available low-grade clays
- **Cost-effective**; does not require capital-intensive modifications to existing cement plants



Limestone Calcined Clay Cement **LC^3**



Projections of World Cement Production

(Adapted from CEMBUREAU)

Material Alternatives :: AGGREGATES FOR CONCRETE

SECONDARY RESOURCES AVAILABLE

- **Industrial Waste –** Fly ash, ground granulated blast furnace slag, red mud
- **Construction and Demolition Waste**
- **Agricultural waste and biomass-based materials (timber/bamboo) ??**

APPLICATIONS

- Manufactured Sand
- Recycled Aggregates
- Sintered Fly ash aggregates
- Geo-polymers
- 3D Printed Concrete/Alternates
- Part Replacement for cement

Available Secondary Materials and Potential Applications

Fly ash bricks

Sintered Aggregates

Ground Granulated Blast Furnace Slag (GGBS)

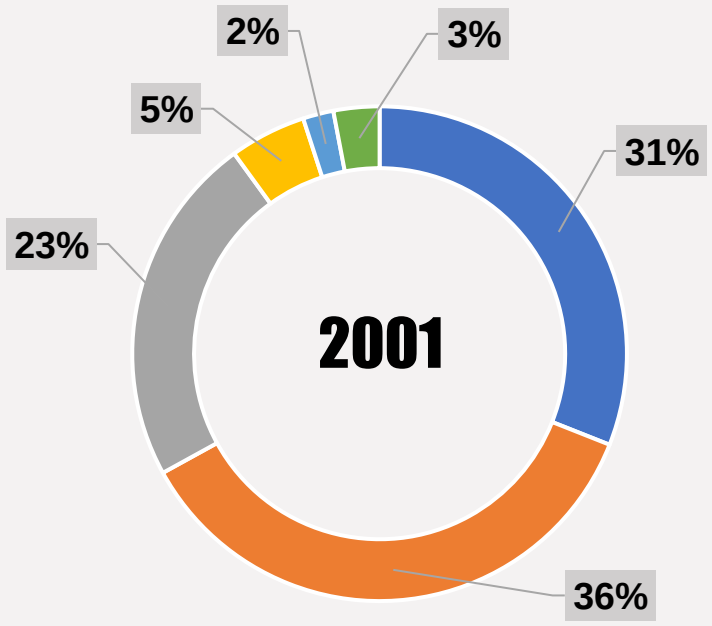
Red mud

Material Alternatives :: CONSTRUCTION & DEMOLITION WASTE

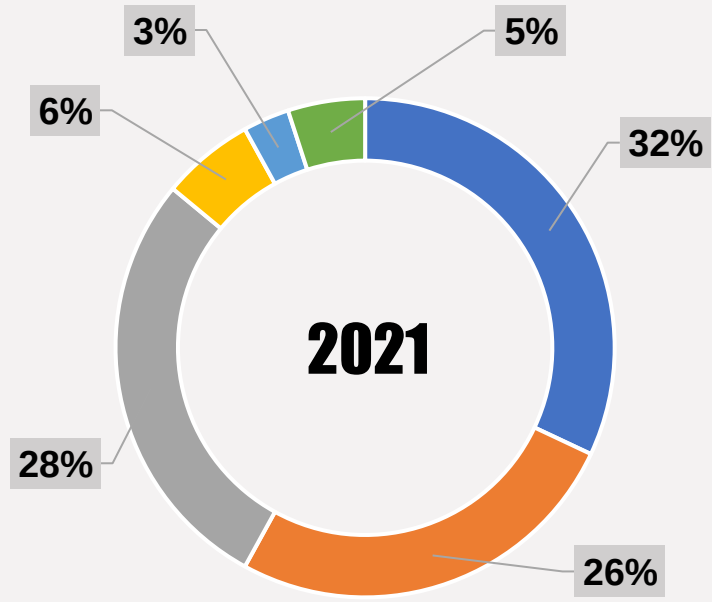
- **Waste management challenge for ULBs** – annual generation estimates range from 165 to 750 million tonnes
- **Projected increase in quantity** over time as more buildings from the past 50-100 years reach their end of life
- **Changing materiality**: reducing bricks and masonry; increasing soil, sand, gravel, and concrete
- Recycled C&D waste **officially recognised as a legal substitute for natural sand** in the concrete mix in 2016 by BIS

Typical Material Profile of C&D Waste in India

- Bricks and Masonry
- Soil, sand and gravel
- Concrete
- Metals
- Wood
- Others



Recreated from TIFAC (2001)



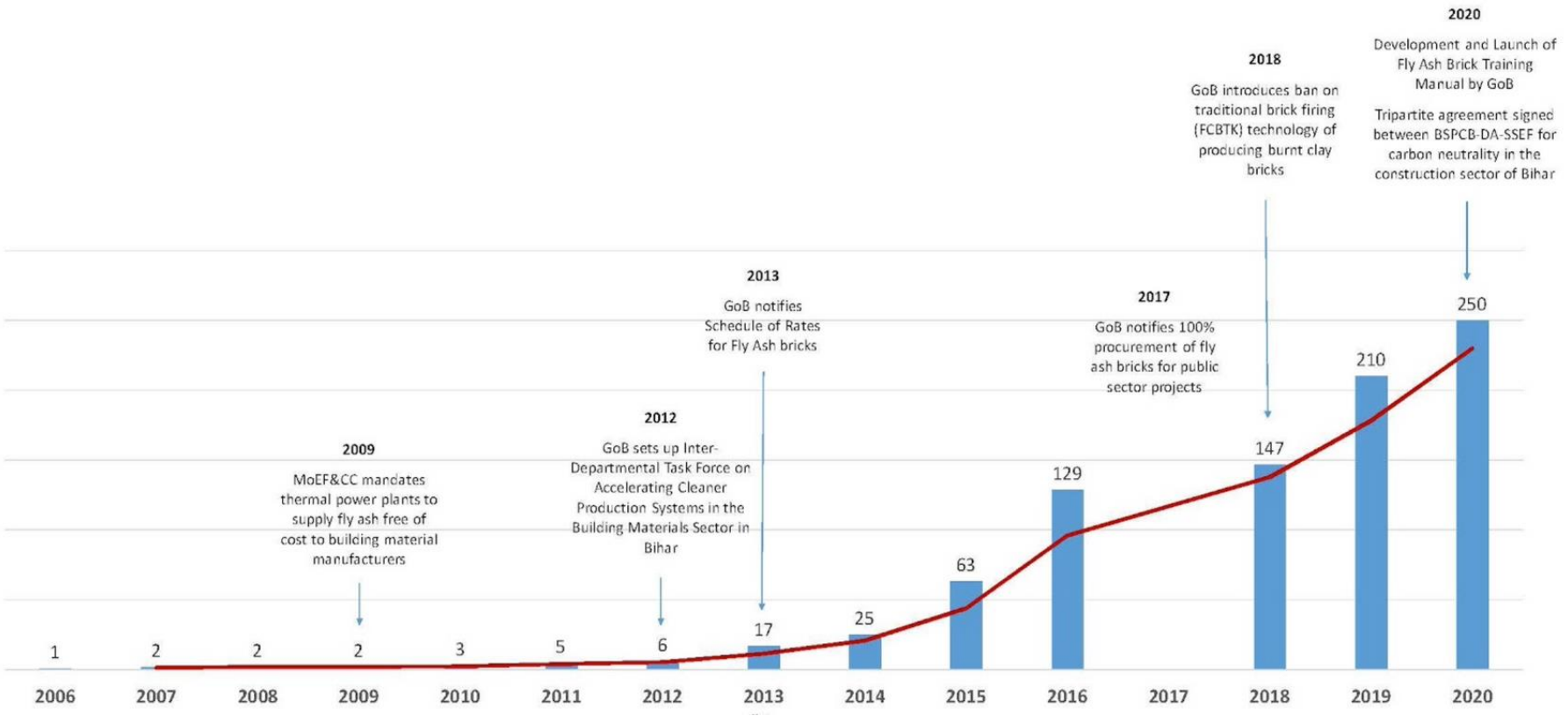
Recreated from Report of the Sub-Committee on Circularity in C&D Waste Management in India, (2021)

Material Alternatives :: MASONRY

Greening the Brick Sector in Bihar :: FLY ASH BRICK-MAKING TECHNOLOGY

Steps towards making Bihar a Carbon Neutral State
(2005 – ongoing)

- Bihar has declared net zero targets for the construction sector; promoting shift to resource-efficient, circular and cleaner production
- Transitioning **from burnt clay bricks to fly ash bricks** (FAB) *(made up of fly ash, industrial waste from thermal power plants, sand, and cement)*

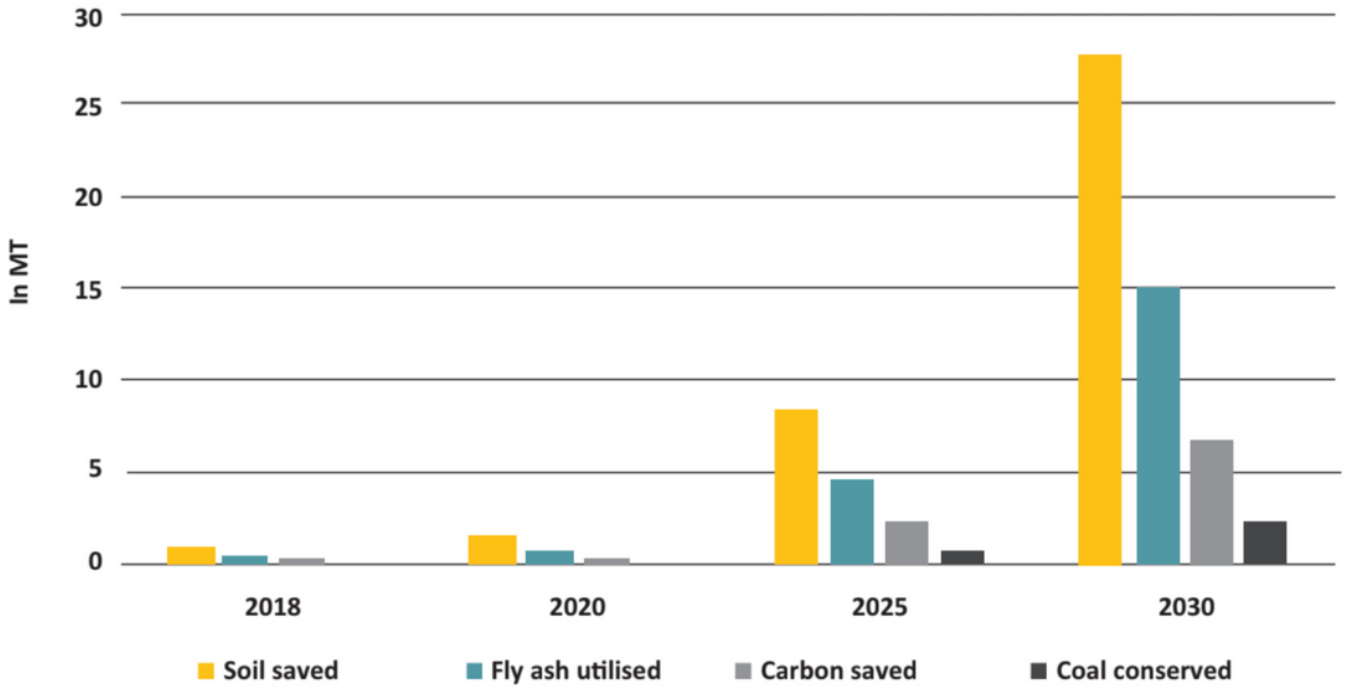


INTERVENTIONS

- **Enterprise development** - increase in FAB from 25 to 600+ since 2005
- Continuous **capacity-building** on entrepreneurship, financial literacy, and improvement in production quality
- **Policy measures:** setting up of Fly Ash Brick Quality Rating System (FABQRS) & Resource Centre, reduced taxation
- **Multi-stakeholder engagement**
  - *Bihar State Pollution Control Board*
  - *TARA (DA Group)*
  - *Fly-Ash Association of India, and Bihar*
  - *Shakti Sustainable Energy Finance, Green Economy Coalition, Department of Science &Technology*

CO-BENEFITS

- **Circular Economy -** environmental waste reutilization, reduced coal extraction
- **Climate Dimensions –** carbon mitigation, enhanced resilience of the agriculture sector
- **Local Economy Benefits -** promotion of entrepreneurship, local employment generation with improved skills



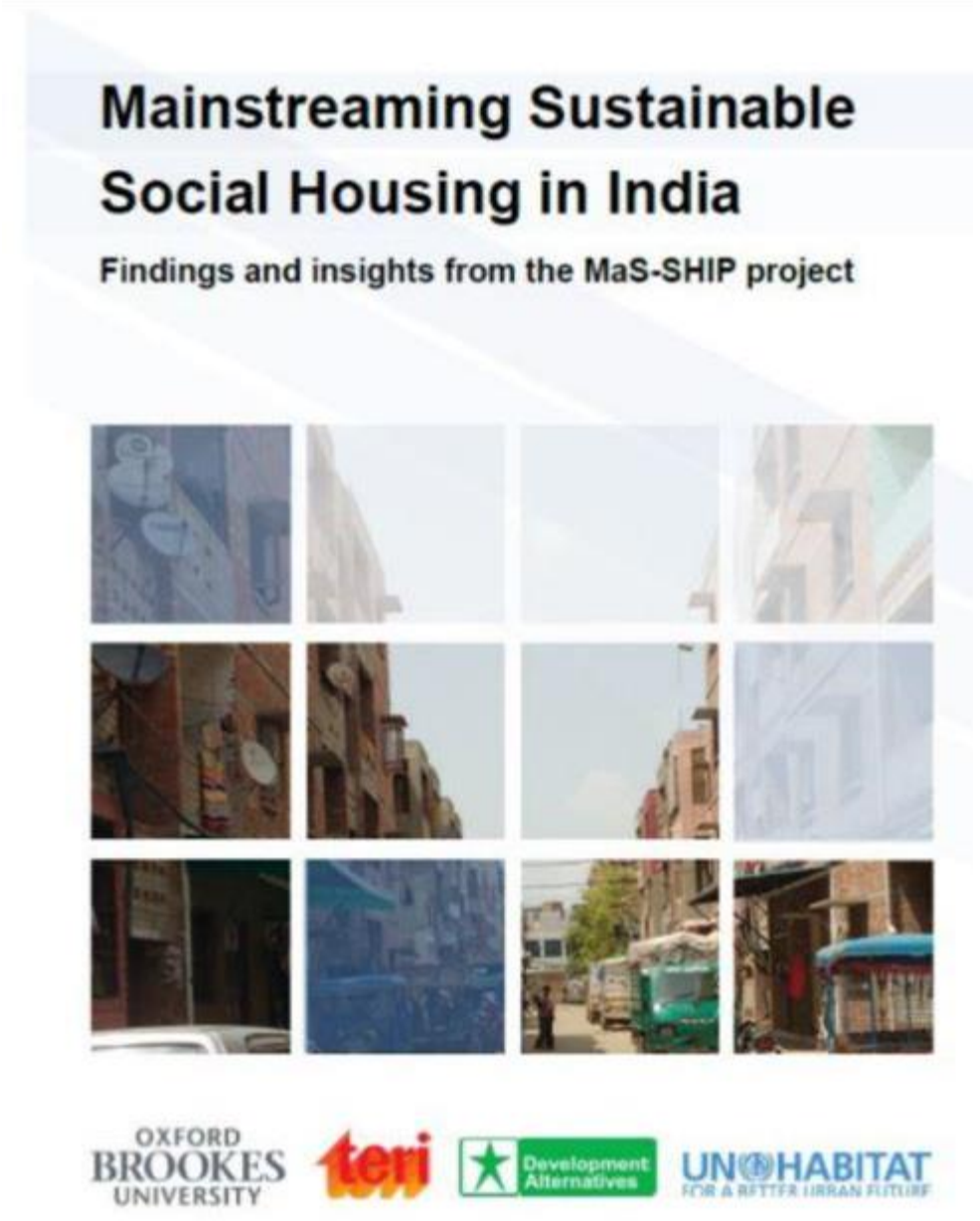
Projected impact of flyash brick industry

Source: Development Alternatives (2020)

Capacity Building & Enterprise Development

MaS-SHIP

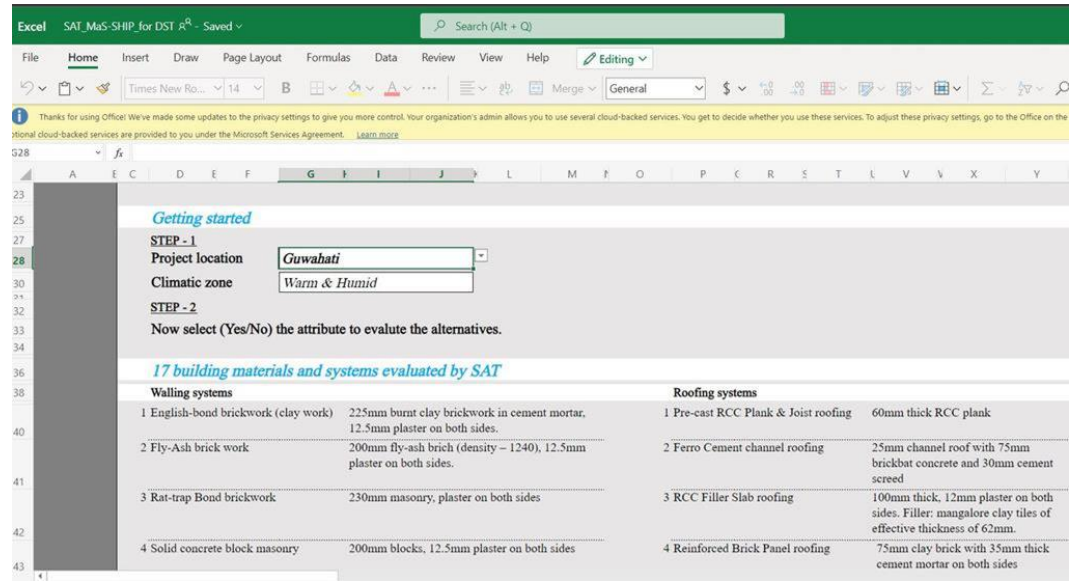
- An updatable **data-based Sustainability Assessment Method and Tool** for selecting the most optimal building materials and construction systems in a given context.
- **18 attributes of sustainability** that measure the performance of established and emerging building systems from **ecological, economic, and social perspectives**
- A **dynamically updatable mapping** of availability and supply of identified building materials
- A **catalog of 17 assessed technologies** with information regarding the sustainability attributes
- **Design guidelines for housing development** in different geo-climatic zones for India
- **Policy recommendations** for mainstreaming sustainability in social housing



Integrating sustainability in social housing in India

WHY	HOW	WHAT	WHERE	FOR WHOM
Why should sustainability be integrated in social housing projects? Why does this matter?	*How should sustainability be integrated into the design of social housing across different climatic zones in India?*	*What sustainable building materials and technologies are appropriate for social housing projects? What criteria should be used to evaluate their performance?*	*Where are these sustainable building materials available?*	*Who are the residents of social housing and what are their experiences of living in such developments?*

Strategies to mainstream sustainable social Housing | Using the DST to assist in mainstreaming sustainability into social housing | Pathways to adopt the DST to mainstream sustainability into social housing



Getting started

STEP - 1

Project location: *Guwahati*

Climatic zone: *Warm & Humid*

STEP - 2

Now select (Yes/No) the attribute to evalute the alternatives.

17 building materials and systems evaluated by SAT

Walling systems		Roofing systems	
1 English-bond brickwork (clay work)	225mm burnt clay brickwork in cement mortar, 12.5mm plaster on both sides.	1 Pre-cast RCC Plank & Joist roofing	60mm thick RCC plank
2 Fly-Ash brick work	200mm fly-ash brich (density – 1240), 12.5mm plaster on both sides.	2 Ferro Cement channel roofing	25mm channel roof with 75mm brickbat concrete and 30mm cement screed
3 Rat-trap Bond brickwork	230mm masonry, plaster on both sides	3 RCC Filler Slab roofing	100mm thick, 12mm plaster on both sides. Filler: mangalore clay tiles of effective thickness of 62mm.
4 Solid concrete block masonry	200mm blocks, 12.5mm plaster on both sides	4 Reinforced Brick Panel roofing	75mm clay brick with 35mm thick cement mortar on both sides

MaS-SHIP- Decision Support Toolkit

Integrating sustainability in social housing in India

WHY	HOW	WHAT	WHERE	FOR WHOM
	Design guidelines Composite climate			
	Design guidelines Warm-Humid climate			
	Design Guidelines Cold climate			
	Design guidelines Hot-dry climate			
	Design guidelines Temperate climate			

MaS-SHIP- Decision Support Toolkit

Integrating sustainability in social housing in India

Full Name *

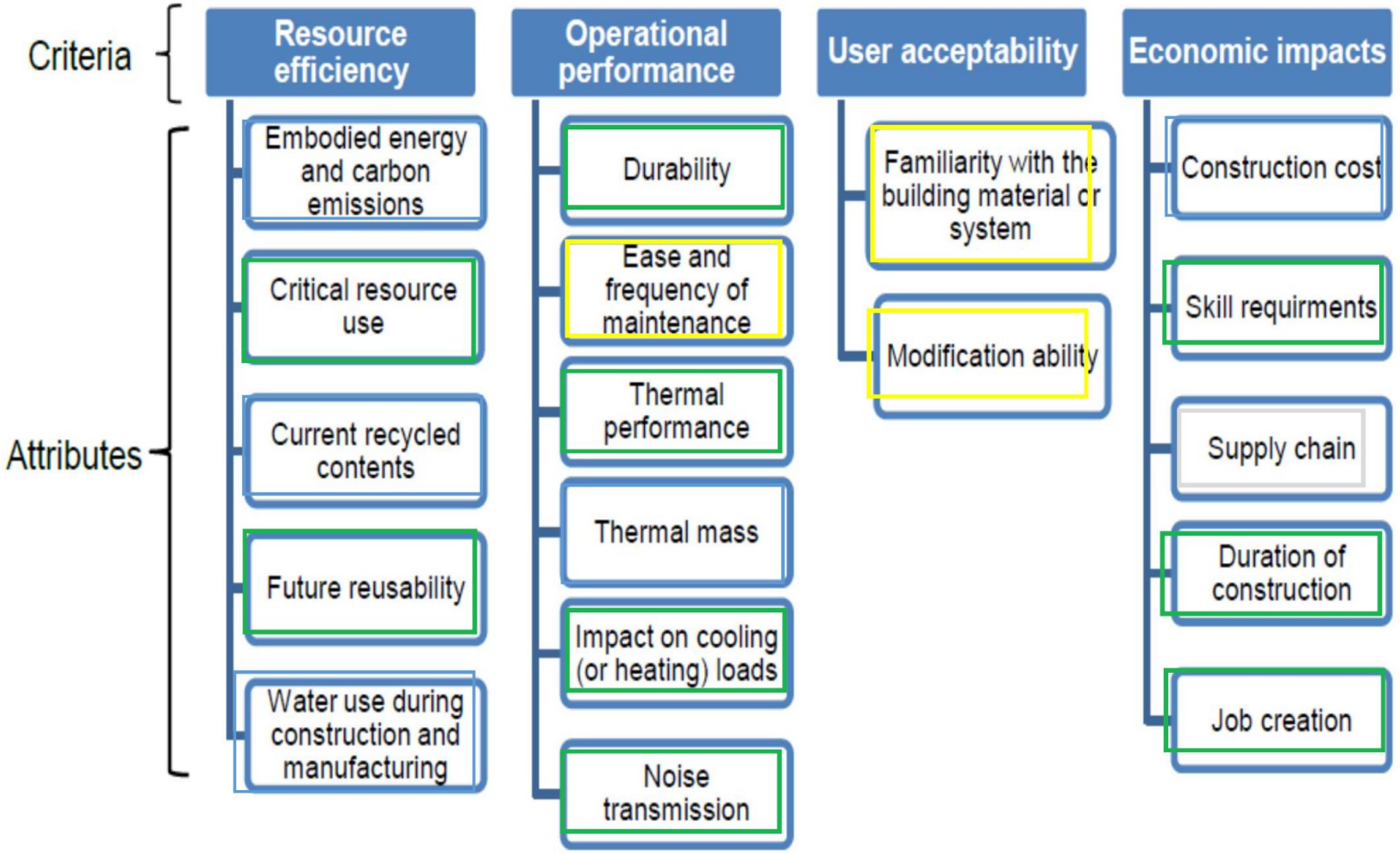
Email Address *

Organisation *

Project location

Submit

MAS-Ship: attributes / indicators of sustainability

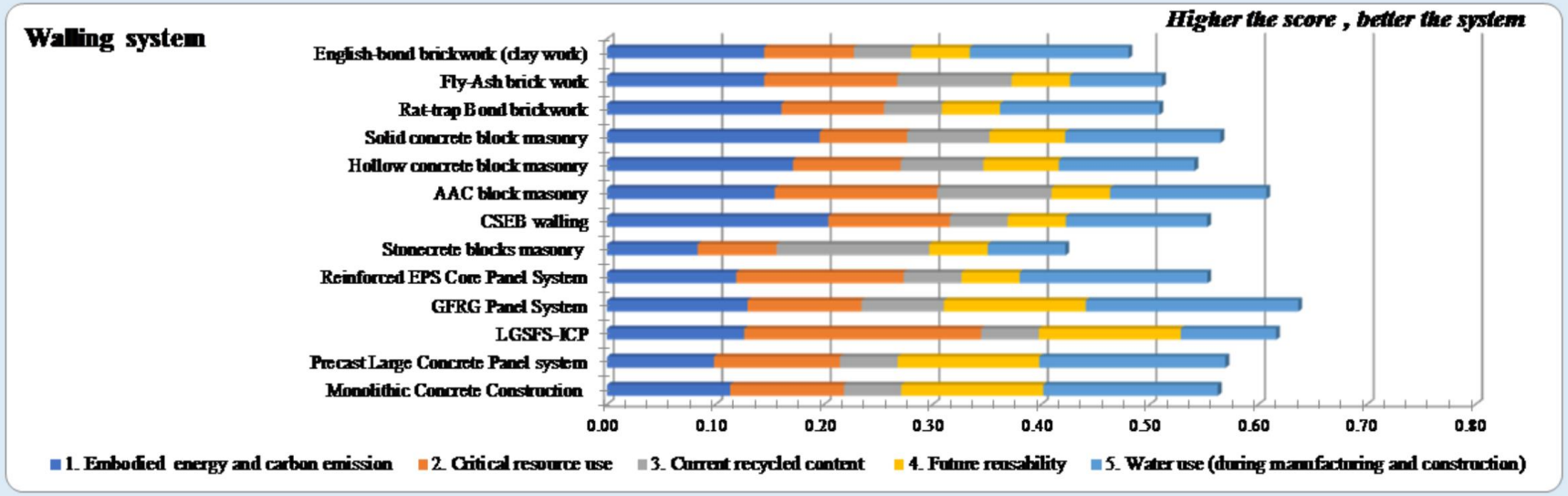


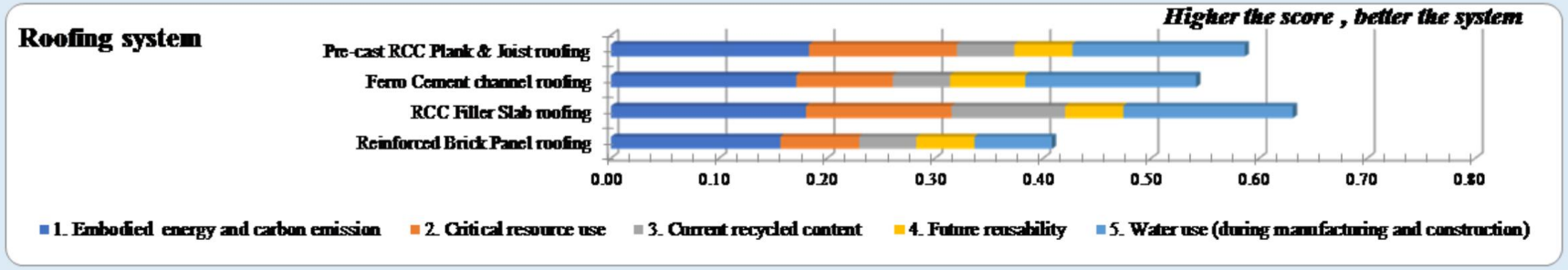
Sustainability Assessment - Resource Efficiency

Sustainability Assessment Tool - Criteria wise

Resource Efficiency

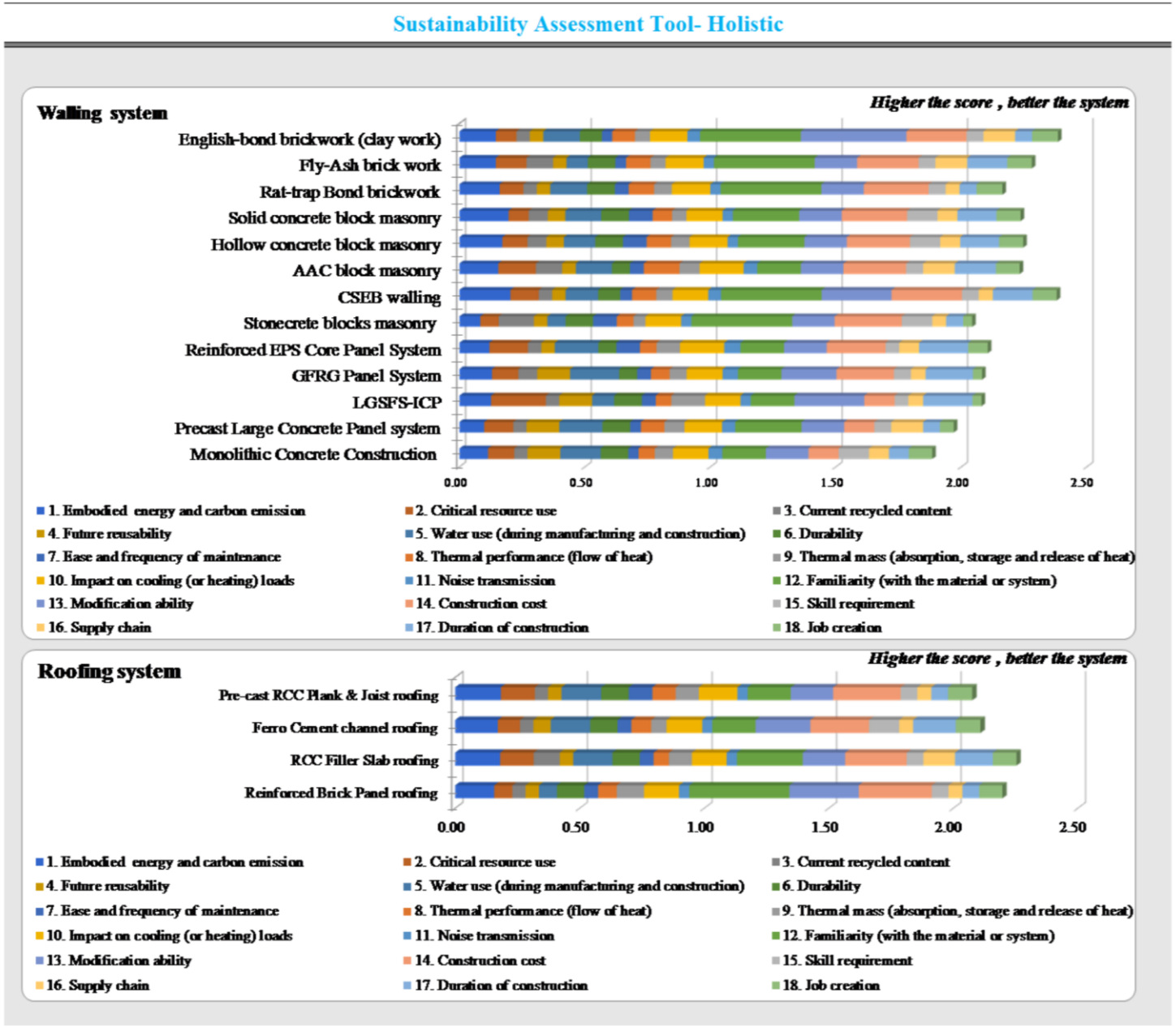
Attributes	1. Embodied energy and carbon emission	2. Critical resource use	3. Current recycled content	4. Future reusability	5. Water use (during manufacturing and construction)
Evaluation scale	MJ/ Sq. M	Index	High-Medium-Low	High-Medium-Low	Litre/ Sq. M
Evaluate - Yes/No	Yes	Yes	Yes	Yes	Yes





Sustainability Assessment - Holistic

- Enables choice-making based on a weighted attribute / indicator
- Potential for setting benchmarks for indicators
- Can be used to establish boundary conditions for key indicators
- Indicator value range can be connected with incentives, regulations, with tender conditions
- Product information disclosures possible



Sustainability Assessment Criteria

for application in the Himalayan region

Hazard resistance

Earthquakes, floods - Structural integrity of buildings

Embodied Energy

Energy consumed during production and transportation of raw materials and during construction process

Criticality of resource use

Based on Criticality Index of natural resources against three criteria – Scarcity, Environmental Degradation, and Conflict of use

Local Economy Component

Measuring the relative contribution of the building process to village economy

Job Creation

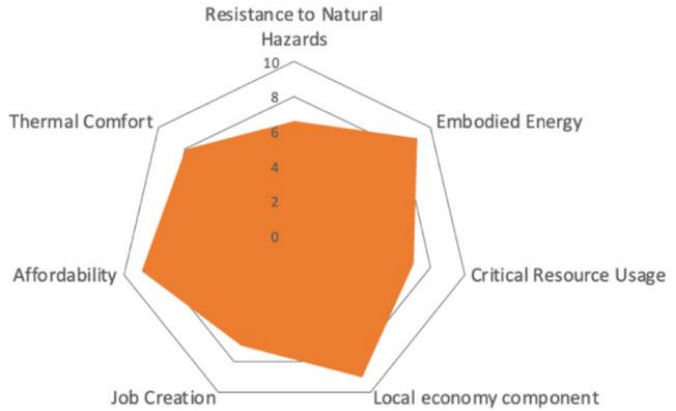
Assessing the local jobs created

Affordability

Cost of construction of building element and maintenance

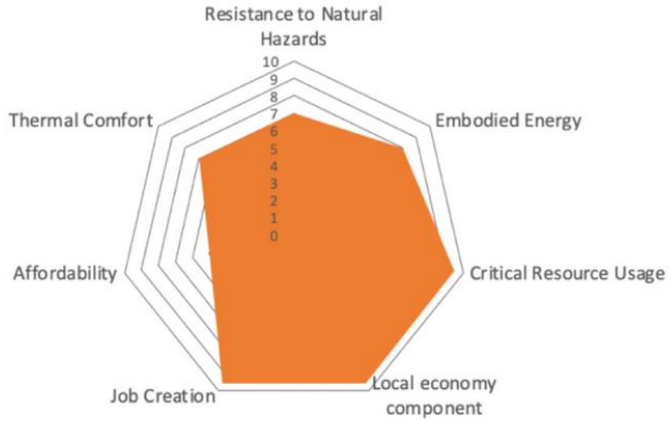
Thermal Comfort

To measure climate responsiveness and resistance to transfer of heat and cold

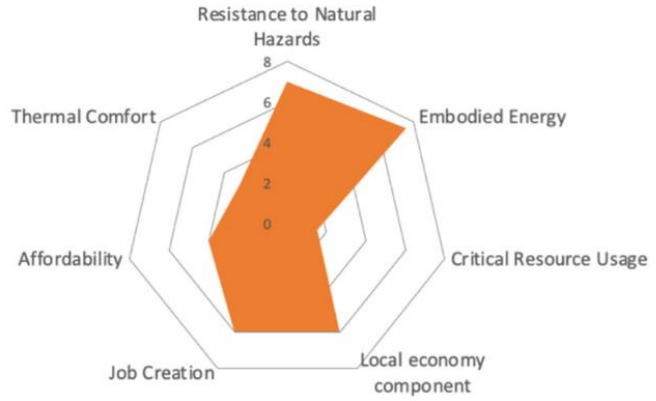


Random Rubble Masonry

Fired Red Brick Masonry



Stabilized Compressed Earth Blocks



Concrete Blocks

Comparative Sustainability Assessment for Walling Options

The bigger the plot area and the more balanced its shape, the more sustainable the building technology.

ACTION AREAS :: Policy Frameworks

Policy Frameworks and Regulatory Landscape

- **Siloed approach - lack of integrated vision, coordination and action** across national, subnational, and local levels, and across government departments (housing, urban development, energy, environment, industry, MSMEs, health, others)

- Potential alignment with affordable housing development (PM Awaas Yojana) and slum redevelopment projects to supplement social benefits with high environmental performance in public projects.

Codes, Standards, Regulations

- **Lack of integration in codes** – no uniform material benchmarking systems or standardised methodologies based on LCA, MFA approaches, **high incubation time** in the standards development process

- **Lack of data & missing baselines** for comparative analysis – for city-level consumption patterns, material performance

- **Need for disclosures** across the value chain, EPDs; integration of performance standards in tender evaluations

- India Roadmap for Mainstreaming Energy Efficiency in Residential Buildings *- Eco Niwas Samhita (ENS) - non-mandatory national residential building energy conservation code*

BMTPC
PACS
PERFORMANCE APPRAISAL CERTIFICATION

Performance Appraisal Certification Scheme (PACS) - *voluntary disclosures for energy efficiency in manufacture and use >> embodied energy or resource efficiency parameters not adequately captured yet*

ACTION AREAS :: Skills and Innovation

Technology

- **Need push for innovation** - **Weak R&D ecosystem** for circular building materials, products and services, and innovative business models
- **Need for piloting and demonstration of new technologies** to generate performance validation case studies

Skills and Capacities

- **Limited knowledge and capacities** of policymakers, public officers, builders and developers, AEC industry, and others; Lack of integration in **technical education curricula**

Global housing Technology Challenge (MoHUA)

- ***54 Innovative Construction Technologies*** *in six broad categories*
  - *Precast Concrete Construction System - 3D Precast volumetric*
  - *Precast Concrete Construction System – Precast components assembled at site*
  - *Light Gauge Steel Structural System & Pre-engineered Steel Structural System*
  - *Prefabricated Sandwich Panel System*
  - *Monolithic Concrete Construction,*
  - *Stay in Place Formwork System*
- ***6 Lighthouse Demonstration projects*** *across India, all for high-rise construction*

Brigade – Real Estate Accelerator Programme (REAP) for Proptech

ACTION AREAS :: Market Development

- **Lack of adequate incentives, green financial instruments, and market mechanisms** to make the transition to sustainable materials attractive for consumers
- **Demand and supply-side bottlenecks** - Limited availability and uptake of existing alternative materials, lack of information & trust among consumers.

SUNREF India Programme by National Housing Bank: Financing for green affordable housing projects - *credit facility of €100 mn, investment grant of €9 mn, including €1 mn dedicated to green label certification;* ***Technical assistance and capacity building*** *for NHB and private and public stakeholders*

सत्यमेव जयते

GeM
Government
e Marketplace
Efficient • Transparent • Inclusive

Sustainable public procurement *– integrating environmental labelling systems on Government e-Marketplace*

Sustainable Design and handholding support to project developers *by IIFL Home Loans*

कुटुम्ब

IIFL HOME LOAN

Green Value Partner Initiative

OTHER KEY PRIORITIES

- **Aligning the mandates** of circularity and resource efficiency with larger narratives, including climate change, decarbonisation, biodiversity conservation, inclusive development, SDGs, to simplify the narrative

- Enabling collaboration and coordination between actors based on a shared vision and realistic goals – need for **enhanced advocacy and diplomacy** for top-down priority setting with bottom-up action

- Fostering **technological AND social innovation** through **systemic intermediation** for nudging policy and market shifts

- Building the case for the **economic opportunity** from circularity to drive **finance and investments**

Thank you!

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