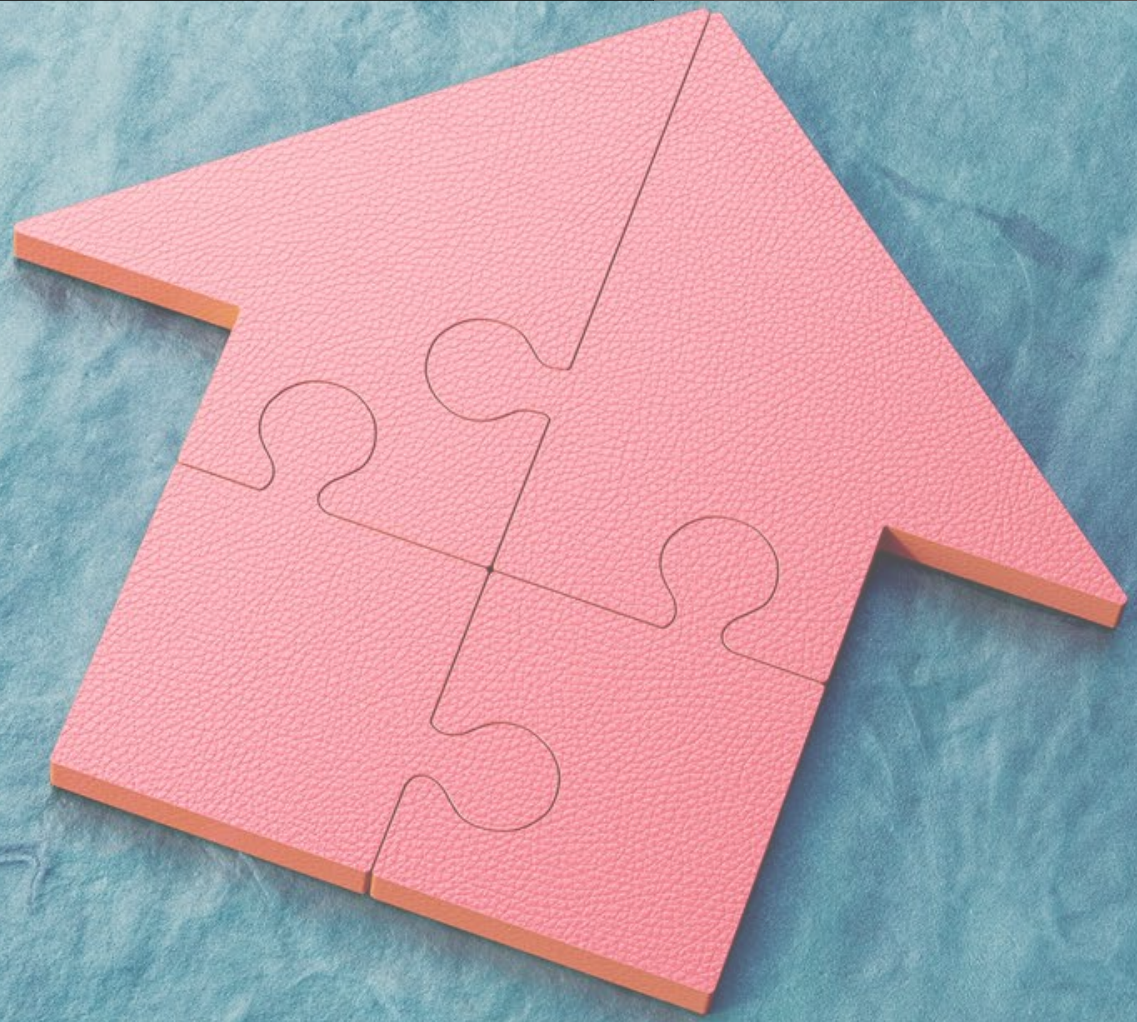
greenthumb Kenya
ABMT HANDBOOK

A platform for Green Alternative, Appropriate & Emerging Building Materials & Technologies

KENYA GREEN BUILDING SOCIETY
BUILD GREEN, SAVE KENYA

ANALYSIS OF ABMT'S FOR AFFORDABLE HOUSING IN KENYA.

Enhancing Sustainable Construction



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INTRODUCTION:

In the pursuit of a rapidly evolving and sustainable world, the role of Alternative Building Materials & Technologies (ABMT) is pivotal. Exploring the transformative potential in shaping a more sustainable built environment, ABMT not only addresses contemporary urban development challenges but also sets the stage for resource-efficient and community-centric solutions. In an era defined by urbanization, environmental consciousness, and resource scarcity, ABMT emerges as a beacon of hope and ingenuity. It's a concept that transcends conventional construction methods, offering a spectrum of options that align with our collective aspiration for a greener, more resilient future. The built environment is undergoing a profound transformation, and our ABMT handbook is our guide to navigating the terrain of innovative materials and technologies that will shape our cities and communities for the better.

Key findings and innovations:

Innovative Building Solutions:

ABMT opens doors to a wealth of creative solutions that refine construction norms.

Enhanced Energy Efficiency:

A significant stride towards resource-conscious construction that echoes across project lifecycles.

Resource Conservation:

An ABMT Impact cornerstone that lies in its resource-saving capabilities, with a potential 40% reduction in resource consumption, redefining constructions ecological footprint.

ABMT REPORT


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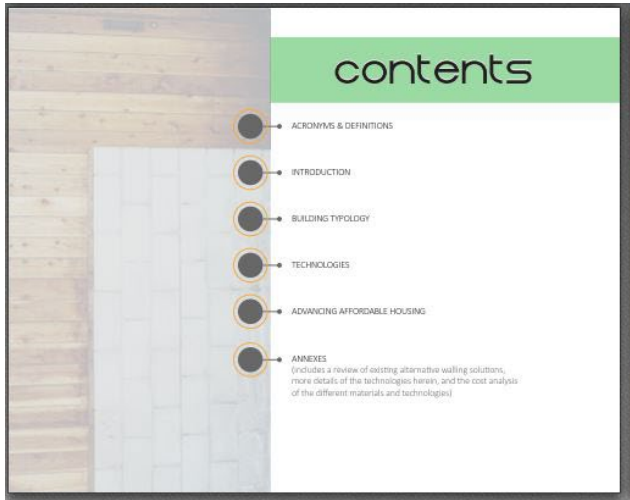
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(includes a review of existing alternative walling solutions, more details of the technologies herein, and the cost analysis of the different materials and technologies)


acronyms & definitions
Appropriate/Alternative Building Materials and Technologies (ABMTs):
ABMT refers to processes, materials, elements, and tools that are compatible with the local socio-cultural, economic as well as physical and ecological environment of an area.
Affordable Housing:
Housing that is adequate and costs not more than 30% of the household income per month to rent or acquire. In the context of this report, the various building materials both conventional and ABMTs are analysed based on their level of affordability.
Affordable Housing Programme (AHP):
The Affordable Housing Programme (AHP) is an initiative by the Kenyan Government as one of the pillars under the 'Big 4 Agenda' which ensures that low- and middle-income households have access to decent and affordable housing units.
State Department for Housing and Urban Development (SDHUD):
This is a unit in the national government mandated with facilitation of access to adequate and decent housing and preparation of urban plans for sustainable development.
Kenya Green Building Society (KGBS):
This is an organization that champions integration of green / sustainable building and construction practices in Kenya. It is a member of the World Green Building Council (WGBC).
Kenya Building Research Centre (KBRC):
Kenya Building Research Centre (KBRC) is one of the institutions domiciled under the State Department for Housing and Urban Development that reinforces the institutions mandate to spearhead the Building Research Services in Kenya.
FSD Kenya:
Financial Sector Deepening Kenya (FSD Kenya) is an independent trust dedicated to the achievement of a financial system that delivers value for a green and inclusive digital economy while improving financial health and capability for women and micro and small enterprises (MSEs).
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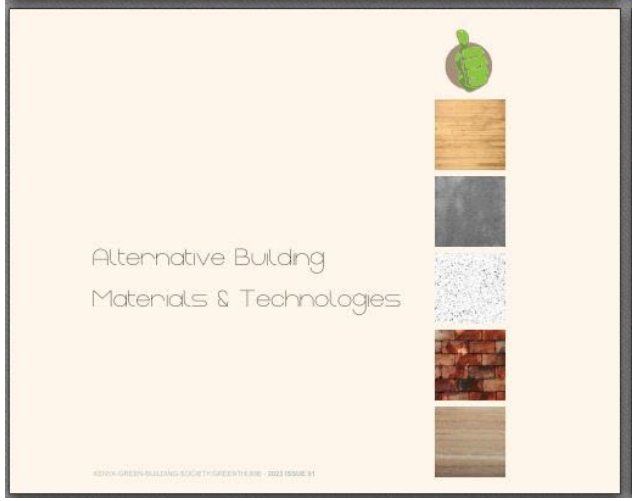
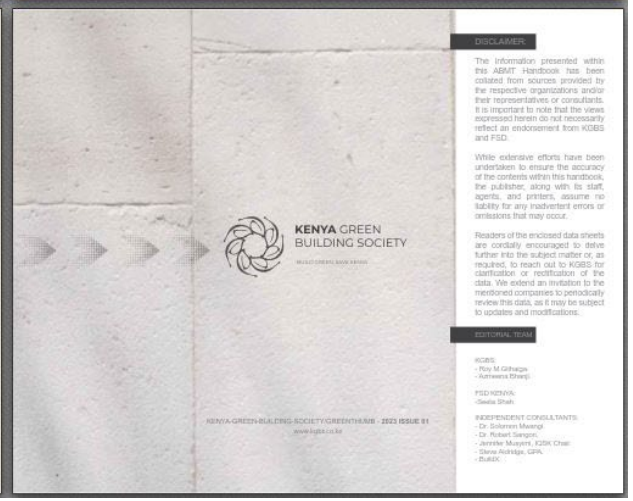

Alternative Building Materials & Technologies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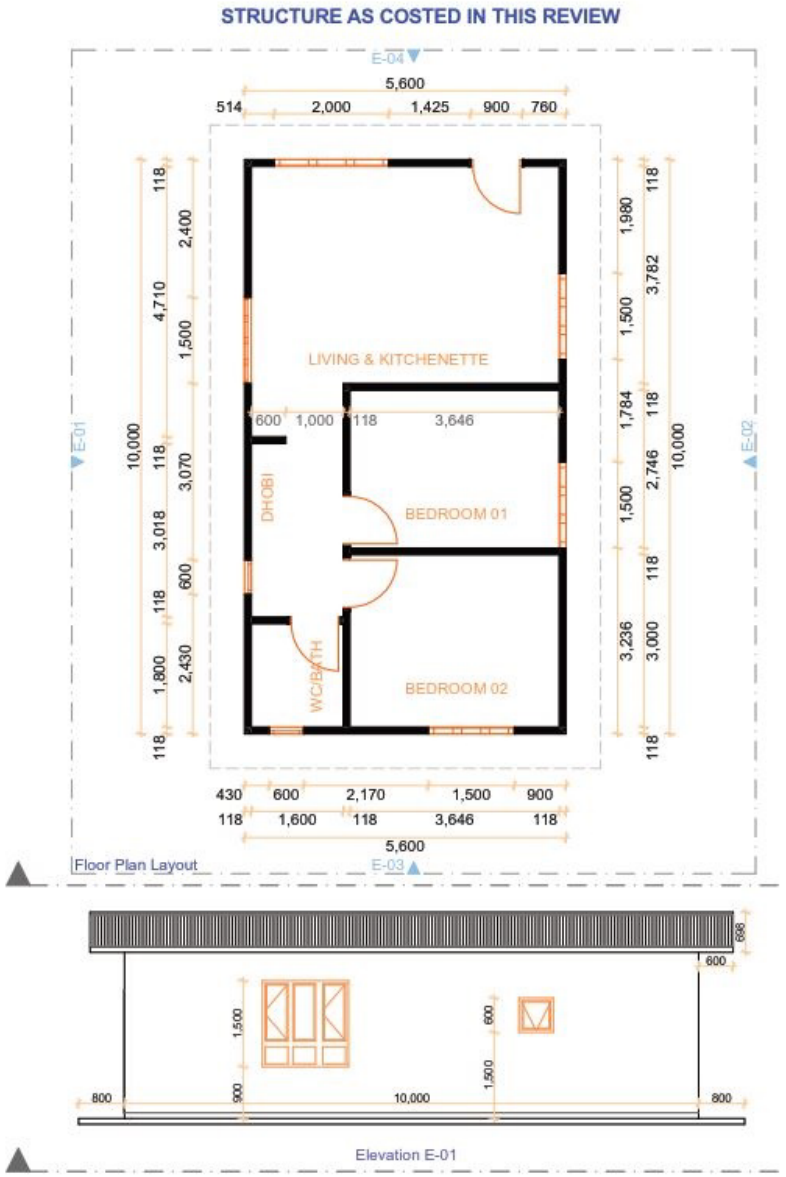
"Alternative Building Materials and Technologies (ABMTs) can provide significant climatic benefits by reducing greenhouse gas emissions, minimizing energy consumption, and promoting sustainable resource use.
By using these materials and technologies, we can help create a more sustainable built environment."

ABMT REPORT



introduction

The growing global population presents significant challenges to the efforts being championed by various governments in facilitating access to affordable and adequate housing for their citizens. According to the UN-HABITAT, 2020, half of the world's population now lives in cities, and this is projected to increase to two-thirds by 2050. Urban areas drive innovation, consumption, and investment worldwide, making them a positive and potent force for addressing sustainable economic growth, urban development, and prosperity. However, the rapid urban growth rate of towns and cities has led to dramatic problems, including huge shelter needs, the emergence of squatter settlements and slums, and deficient infrastructure in many low-income settlements.

The Universal Declaration of Human Rights (UN, 1948) declared housing a basic human right, stipulating under Article 25(1) that everyone has the right to a standard of living adequate for their health and well-being, including food, clothing, housing, medical care, and the necessary social amenities. The Habitat Agenda challenges governments to use shelter development as a tool to break the vicious cycle of poverty, homelessness, and unemployment. Agenda 2063; The Africa We Want emphasizes the need to provide opportunities for all Africans to have access to decent and affordable housing in clean, secure, and well-planned environments in sustainable human settlements. The Sustainable Development Goal 11 seeks to make cities and human settlements inclusive, safe, resilient, and sustainable, while target 11.1 specifically envisages ensuring access for all to adequate, safe, and affordable housing and basic services and upgrading slums by 2030.

Kenya has also been experiencing rapid population growth as a result of increased fertility rates. The population increase has been tremendous over the years, with the 2019 Housing and Population Census results estimated at 47.5 million people and 12.2 million households (KNBS, 2019). The continued increase in population size has led to increased housing demand for the low, middle, and high-income groups in society. Over time, the number of urban households has increased mainly due to rural-urban migration and natural population growth, which has led to an upsurge in demand for affordable housing in urban areas. For this reason, there has been a need for cheap and appropriate technology to assist in alleviating the problem of inadequate housing and affordable construction costs.

"The Africa We Want emphasizes the need to provide opportunities for all Africans to have access to decent and affordable housing in clean, secure, and well-planned environments in sustainable human settlements."

building typology

The typology used in this analysis is a single storey, 56 sqm, 2 Bedroom house, with a gable roof. Its space efficient and sufficient for a family and is complete with windows and doors, however, no other services (water, power, sanitation connections) or finishes (tiles or floor finishes, kitchen fittings, toilet and shower fittings etc) are accounted for.

The single storey unit is selected as:

i. It is a simpler technology than multi-storey, which needs a lot more structural strength, space within the building for circulation etc. For this reason, single storey buildings should be much more cost efficient in terms of construction cost.
ii. This is how an estimated 80% of housing in Kenya is currently built.
iii. There is room to make the delivery of such housing better in terms of cost, time of delivery and green targets. Green targets encapsulate longer term resilience and quality.

PRODUCT DATA SHEET

technologies studied

The appropriate technology for building materials was introduced in the year 2003 with the formal launch of the Appropriate Building Technology (ABT) Programme undertaken in 2006, an initiative that has since spread to most parts of the country.

This study reviews the financial and environmental implications of 14 different walling technologies and 2 different roofing technologies, commonly available in Kenya.

- Burnt Bricks
- Stabilized Soil Blocks (SSB)
- Interlocking Stabilized Soil Blocks (ISSB)
- Hollow Concrete Blocks
- Interlocking Hollow Concrete Blocks
- Machine-cut Natural Stone
- Kwangu Kwako Pre-cast Concrete Panels
- Expanded Polystyrene (EPS)
- Rammed Earth
- Cross Laminated Timber (CLT)
- Light Gauge Steel(LGS)
- Aluminium Formwork Poured Concrete
- Recycled Plastic Blocks
- 3D Printing
- Mabati Roofing Sheets.
- Recycled Plastic Roofing Sheet

PRODUCT DATA SHEET

BURNT BRICKS

GENERAL DESCRIPTION

Burnt bricks are a viable option in very low-income settings as local people already have existing knowledge in this type of construction and it's easy to manufacture. It's also very low cost for a durable product.

From an environmental perspective it lacks sustainable qualities related to carbon impacts and deforestation.

Given this material is a known and well-used technique in East Africa, it is important to refer to it but should not be advocated for due to its environmental footprint.

MATERIAL SPECIFICATIONS

Burnt bricks is a prevalent technology particularly in rural areas. Bricks can be made manually or mechanically moulded and then fired. Various fuels are used for firing including firewood, coffee and rice husks, saw dust and coal. Soils with high clay content work best for permanent construction (70% clay : 30% sand).

Standard Dimensions - L190xW90xH90mm

EMBODIED CARBON

The need to burn bricks in kilns where wood or charcoal is burned as fuel increases the embodied carbon impact of burnt bricks. The raw material, in this case, earth or soil, is likely to be local, so minimal transport is needed and extraction impacts are not severe.

The use of cement mortar when bricks are laid and likely need for plaster further impacts the carbon footprint of burnt bricks.

APPLICATION - WALLING, FLOORING & CLADDING

- Load bearing for single story buildings.
- As an infill for multi-story buildings.
- Used both in urban and rural areas.

PRODUCT DATA SHEET

ABMT:

These materials, born from the fusion of sustainable practices and cutting-edge technologies, hold the power to revolutionize not only how we build but also the profound ways in which our communities thrive. By embracing ABM, local communities are no longer confined by the limitations of conventional construction; they become architects of change, designing resilient structures that not only shelter but also uplift. In this narrative of transformation, the environment stands as the ultimate beneficiary. ABM, with their reduced carbon footprints, minimized resource consumption, and unparalleled efficiency, weave a narrative of environmental stewardship that resonates across borders.

Key examples:

Interlocking soil blocks:

These are blocks made from a mixture of soil and cement and sometimes lime and sand is added. The mixture is fed into a manual or mechanical block press, where it is subjected to high compressive pressures. Resultant block has a very high compressive strength and resistance to water erosion due to cement added.

Rammed Earth:

Rammed Earth is a vernacular building technology that comprises of monolithic rammed earth, compacted between formwork, resulting in a wall thickness of between 150-300mm. The rammed earth needs to be stabilized with 10% cement to be water resistant. Soils can be found on-site or within proximity, which lowers the carbon footprint.

Cross laminated timber:

Sustainably sourced timber is a very good option environmentally, as it is a natural and carbon-negative material with low production impacts. A CLT panel consists of several layers of kiln-dried timber boards stacked in alternating directions, bonded with structural adhesives, and pressed to form a solid, straight, rectangular panel.

Burnt Brick:

Burnt bricks is a prevalent technology particularly in rural areas. Bricks can be made manually or mechanically molded and then fired. Various fuels are used for firing including firewood, coffee and rice husks, saw dust and coal. Burnt bricks are a viable option in very low-income settings as local people already have existing knowledge in this type of construction and it's easy to manufacture.

INNOVATIONS:

Together, these innovations rewrite the narrative of construction, proving that sustainability isn't just a lofty goal – it's a tangible reality within reach. By embracing these alternative building materials and technologies, we can construct homes, communities, and cities that stand as living testaments to our commitment to future generations and the well-being of our planet.

BURNT BRICKS

MATERIAL SPECIFICATIONS

Burnt bricks is a prevalent technology particularly in rural areas. Bricks can be made manually or mechanically moulded and then fired. Various fuels are used for firing including firewood, coffee and rice husks, saw dust and coal. Soils with high clay content work best for permanent construction (70% clay : 30% sand).

TIMBER: CROSS LAMINATED

MATERIAL SPECIFICATIONS

A CLT panel consists of several layers of kiln-dried timber boards stacked in alternating directions, bonded with structural adhesives, and pressed to form a solid, straight, rectangular panel. CLT panels are sanded and do not require any additional plastering or finishing.

SSBs & ISSBs

Stabilised Soil Blocks & Interlocking SSBs

MATERIAL SPECIFICATIONS

These are blocks made from a mixture of soil and cement and sometimes lime and sand is added. The mixture is fed into a manual or mechanical block press, where it is subjected to high compressive pressures. Resultant block has a very high compressive strength and resistance to water erosion due to cement added. The soil used must have a high sand content of 60-70% - an exception is areas with black cotton soil are not suitable. In laying the SSB you also require mortar, but not with the ISSB.

RAMMED EARTH

MATERIAL SPECIFICATIONS

Rammed Earth is a vernacular building technology that comprises of monolithic rammed earth, compacted between formwork, resulting in a wall thickness of between 150-300mm. The rammed earth needs to be stabilised with 10% cement to be water resistant.

MABATI ROOFING SHEETS

MATERIAL SPECIFICATIONS

These roofing sheets are available in various profiles such as corrugated, box or tile-shaped profiles. They are also available in different colours and thicknesses referred to as gauge. Commonly used gauges are 26-32. G26 for instance refers to a sheet thickness of 0.26mm. Some factories do supply custom cut lengths as per Client's requirements.

From reducing carbon footprints to redefining the affordability of housing, the journey that unfolds promises to showcase how these materials and technologies can reshape not only the physical structures we inhabit but also the socio-economic fabric of our communities

Impact on communities:

Alternative Building Materials and Technologies (ABMT) wield a transformative power that extends far beyond bricks and mortar. They hold the potential to reshape communities, fostering sustainable development that goes hand in hand with social progress and environmental responsibility.

Affordable housing enhancements:

ABMT stands as a beacon of hope for addressing one of the most pressing challenges communities face – affordable housing. By adopting these innovative materials and technologies, construction costs are lowered significantly. This translates into housing that is not only structurally sound but also financially attainable for a broader spectrum of residents. It opens doors for individual families to secure homes without compromising on quality, promoting inclusivity and reducing socio-economic disparities that often plague urban landscapes.

Empowering urban planning:

In the tapestry of community development, urban planning plays a pivotal role. ABMT paints a new canvas for urban planners, enabling the creation of smarter, more resilient cities. By embracing resource-efficient materials, communities can mitigate their environmental impact, reduce energy consumption, and curtail waste production. This translates into infrastructures that enhance the quality of life, reduce strain on resources, and promote healthier living environments. ABMT's ripple effect extends to green spaces, transportation systems, and public amenities, creating sustainable communities.

Job creation and local empowerment:

Sustainable development doesn't solely concern the environment; it encompasses economic growth and societal well-being. ABMT ushers in a wave of job opportunities, particularly within the local context. As communities adopt these technologies, skilled labor is required for their implementation, maintenance, and innovation. This not only generates employment but also empowers local communities. This creates new skill avenues, strengthening local entrepreneurship

Environmental stewardship and social cohesion:

ABMT isn't just about buildings; it's about building a sense of shared responsibility for the environment. Communities that integrate these solutions become stewards of their surroundings. The act of utilizing sustainable materials becomes a collective effort that fosters social cohesion, as residents rally around a common goal of preserving nature for current and future generations. This shared commitment creates a culture of environmental consciousness.

Efficient resource management is essential for introducing Appropriate Building Materials and Technologies (ABMTs) (like Interlocking Stabilized Soil Blocks) to local communities.

By optimizing resources—financial, labor, and local materials—we can accelerate ABMT implementation across Kenya.

The Kenya Green Building Society (KGBS) plays a vital part in this endeavor. Through advocacy and partnerships, KGBS can raise awareness about ABMT benefits among stakeholders, securing funds and incentives for projects.
Additionally, through our knowledge sharing exercises, KGBS will begin training initiatives to empower local builders with ABMT skills, ensuring successful integration into housing projects.

Resource management fuels ABMT adoption, with the Kenya Green Building Society driving progress by promoting awareness and providing essential training for sustainable community development.

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TACKLING EMBODIED CARBON IN THE BUILT ENVIRONMENT

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CARBON & THE BUILT ENVIRONMENT

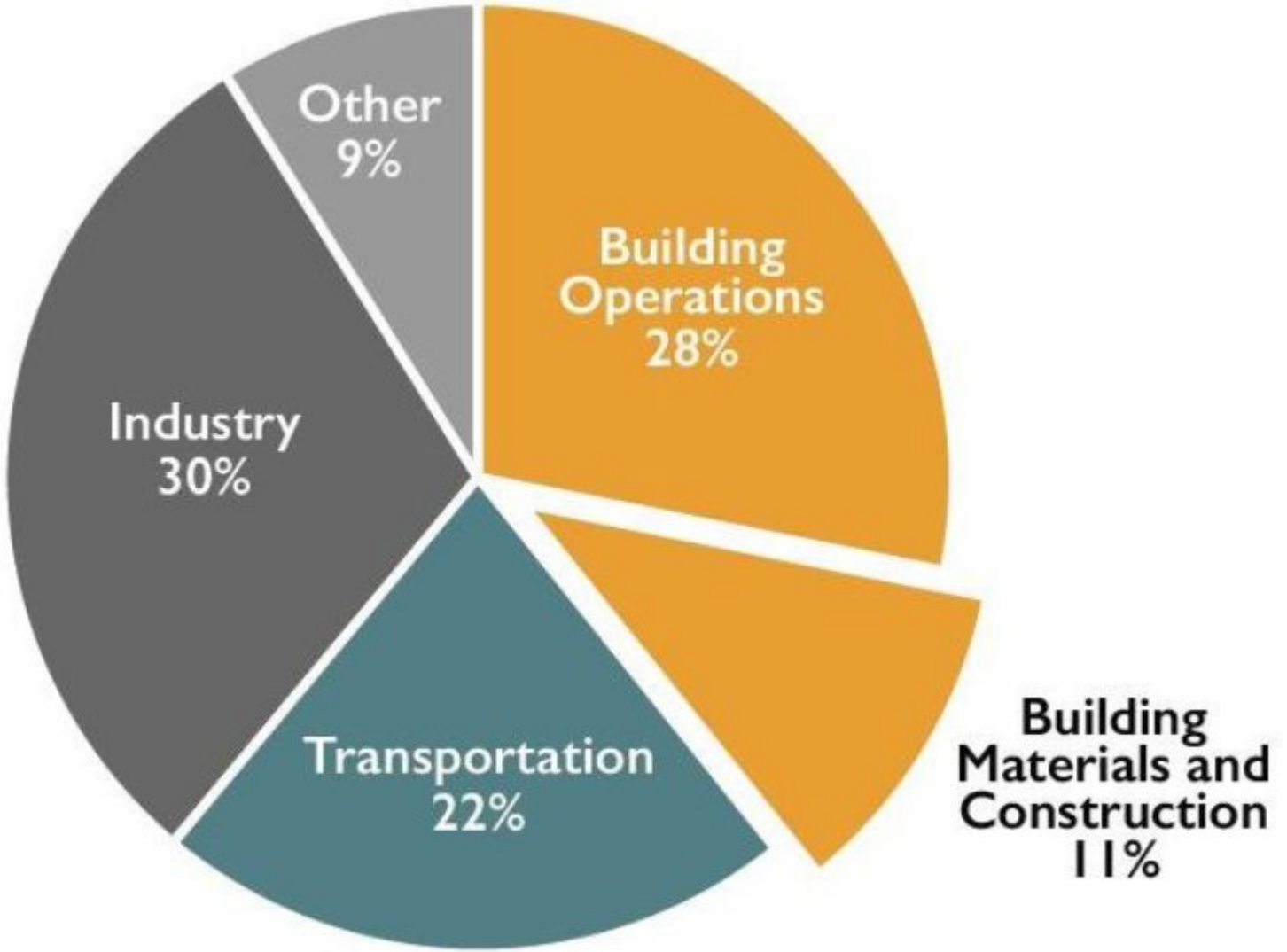

Figure 3 - Global GHG Emissions by Sector (Cortese, 2020)

- The built environment is the single highest contributor to GHG emissions
- Responsible for 39% of global GHG emissions
- Major reductions in built environment carbon emissions are VITAL to achieve Paris Agreement goals
- There is an urgent need to recognize the importance of decarbonizing the built environment

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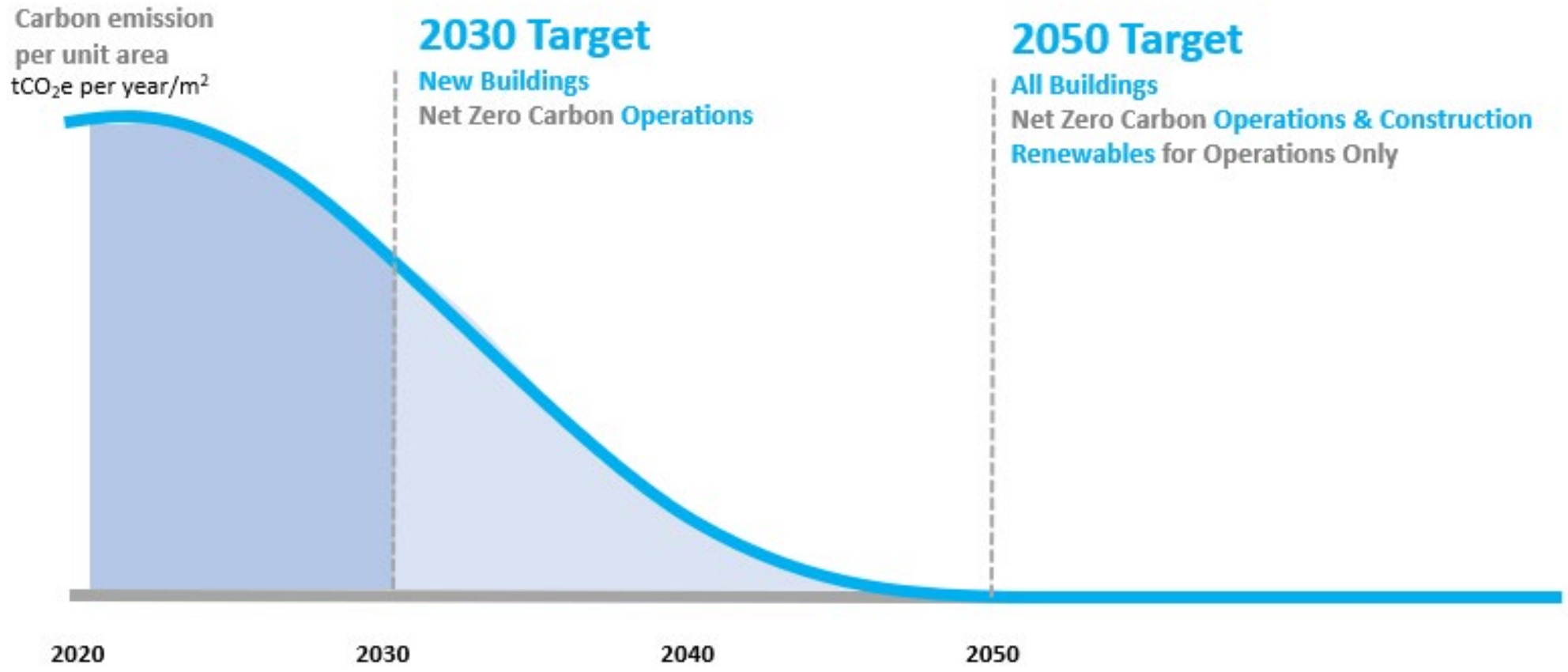
MAPPING A ZERO CARBON PATHWAY FOR BUILDINGS

Paris Agreement Goals (COP26)



Edge

IFC International Finance Corporation WORLD BANK GROUP
Creating Markets, Creating Opportunities

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CARBON FOOTPRINT OF A BUILDING

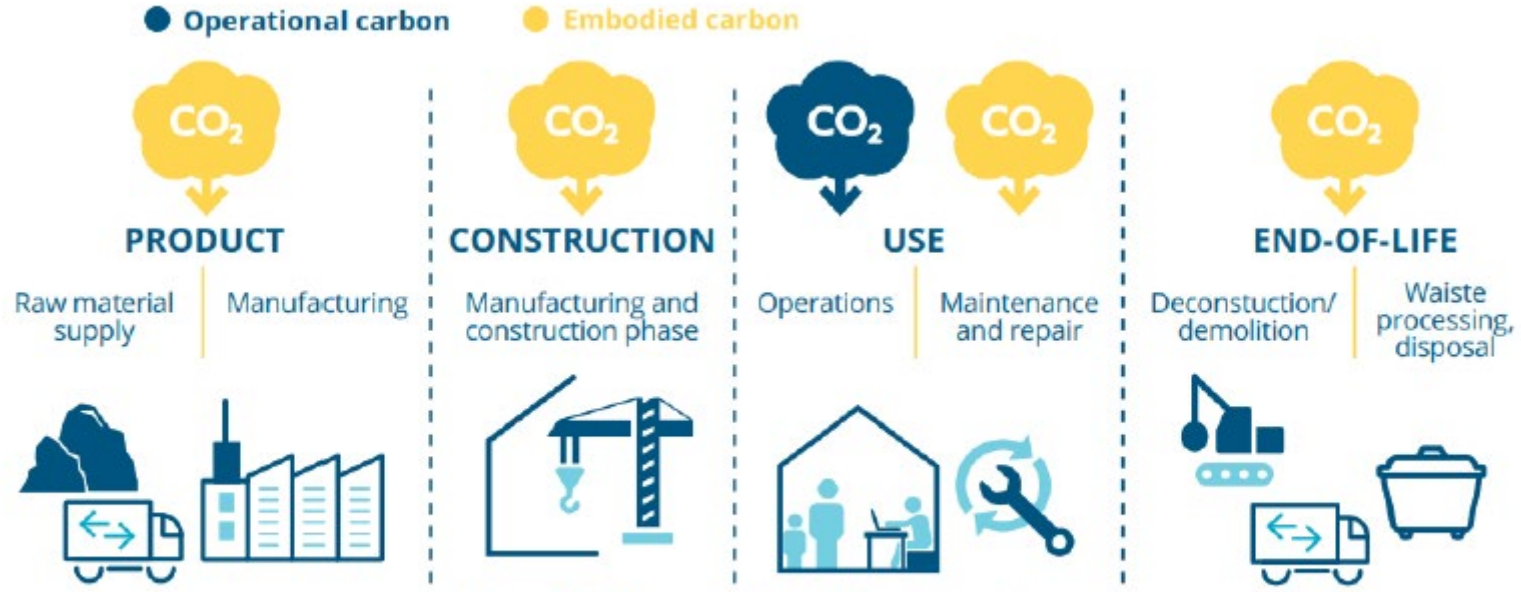

Figure 17 - Stages of the Building Lifecycle

OPERATIONAL CARBON

- ✓ Lighting
- ✓ Heating & cooling
- ✓ Ventilation
- ✓ General power consumption

EMBODIED CARBON

- ✓ Extraction, production and transportation of materials
- ✓ Manufacturing & construction
- ✓ Ventilation
- ✓ Retrofit, demolition, end-of-life deconstruction, re-use, recycle, waste

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IF ONLY 11% OF BUILDING EMISSIONS COME FROM EMBODIED CARBON, WHY WORRY?

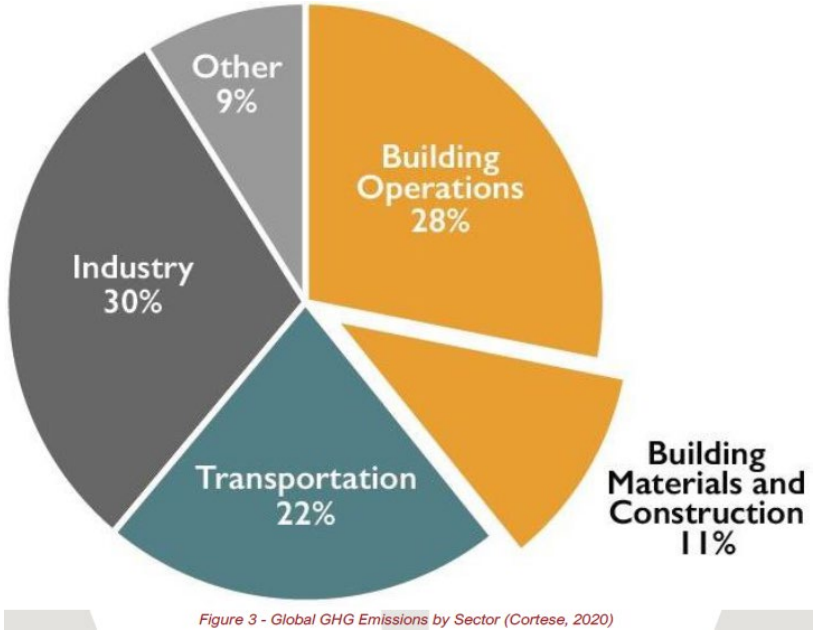
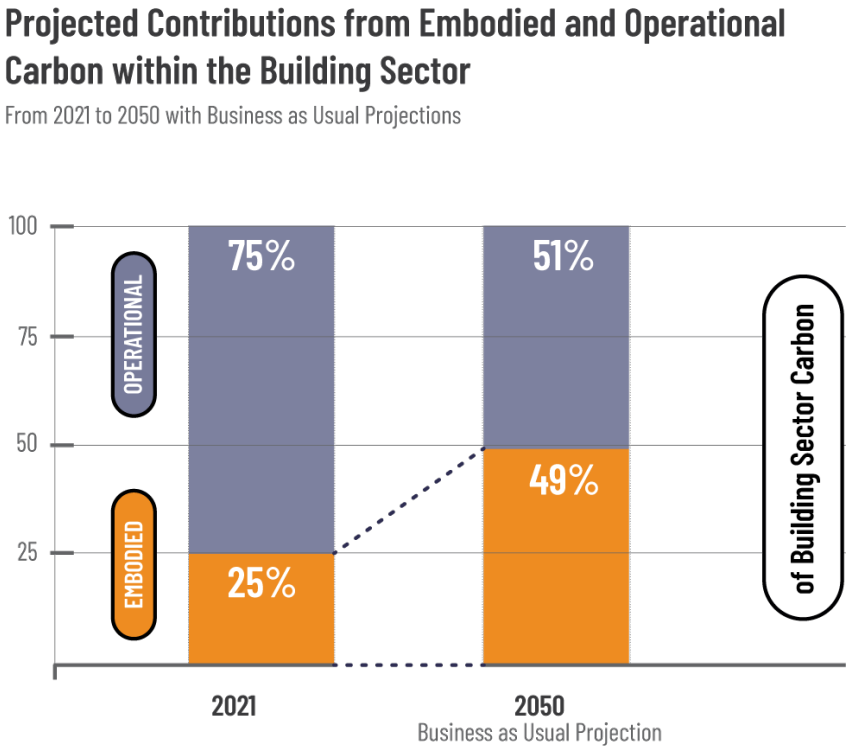


Figure 3 - Global GHG Emissions by Sector (Cortese, 2020)



- ✓ Over the last 50 years, the building industry has focused on making buildings more energy efficient
- ✓ Buildings are using lesser and cleaner energy
- ✓ As operational carbon goes down, embodied carbon will account for a larger percent of total carbon
- ✓ Under business as usual, embodied emissions will contribute nearly half of all building emissions by mid-century

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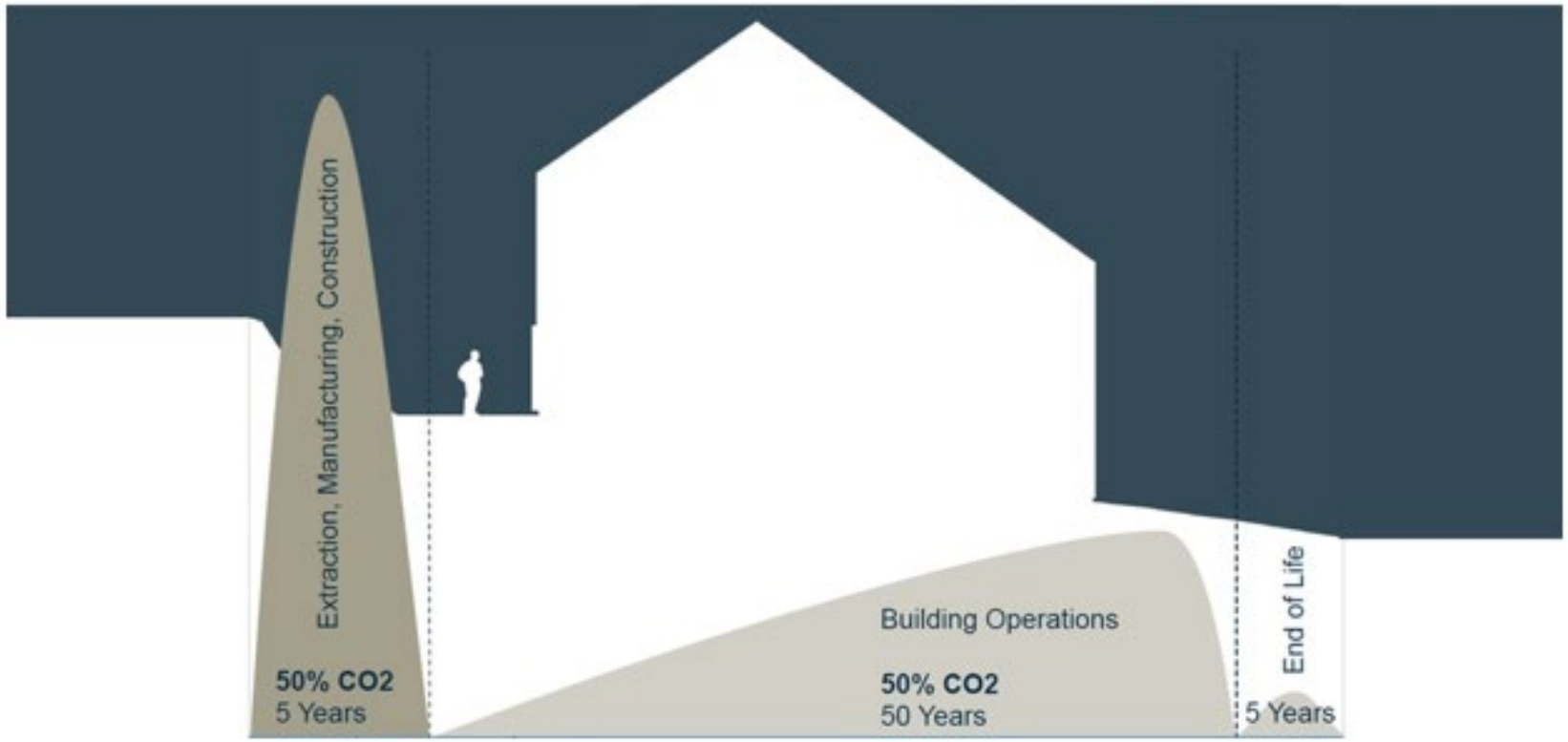
THE TRUE COST OF EMBODIED CARBON

Embodied Carbon is Happening Now



- Embodied carbon is spent before a building is even used – it is a sunk cost and cannot be reduced after building completion
- Surprisingly, less than 1% of buildings have their carbon footprints assessed, and even fewer have a detailed analysis of the two different types of carbon: embodied and operational.

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OUR CARBON BUDGET

- Our carbon "budget" between now and 2050 is 420 GT
- That is the amount of carbon we can emit over the next 26 years and still achieve the goals of the Paris Agreement
- Right now, we are drastically overspending that budget
- At the current rate of 53 GT/year, we are on track to hit 1325 GT by 2050
- To reduce this spending spree, we must tackle the carbon that is being emitted NOW
- THIS IS WHERE EMBODIED CARBON IN BUILDINGS COMES INTO PLAY

EMBODIED CARBON

- ✓ Emissions from materials used constructing, maintaining and disposing buildings
- ✓ Also referred to as "Capital Carbon"
- ✓ Includes emissions associated with raw materials extraction, manufacturing, transportation, construction, use, maintenance, refurbishment, demolition and disposal
- ✓ Found in building structure, envelope, interiors, equipment and site

https://oneclicklca.com/en/resources/articles/revised-construction-products-regulation-to-include-epd-data-0#:~:text=The%20operational%20carbon%20footprint%20of,emitted%20during%20the%20construction%20process.

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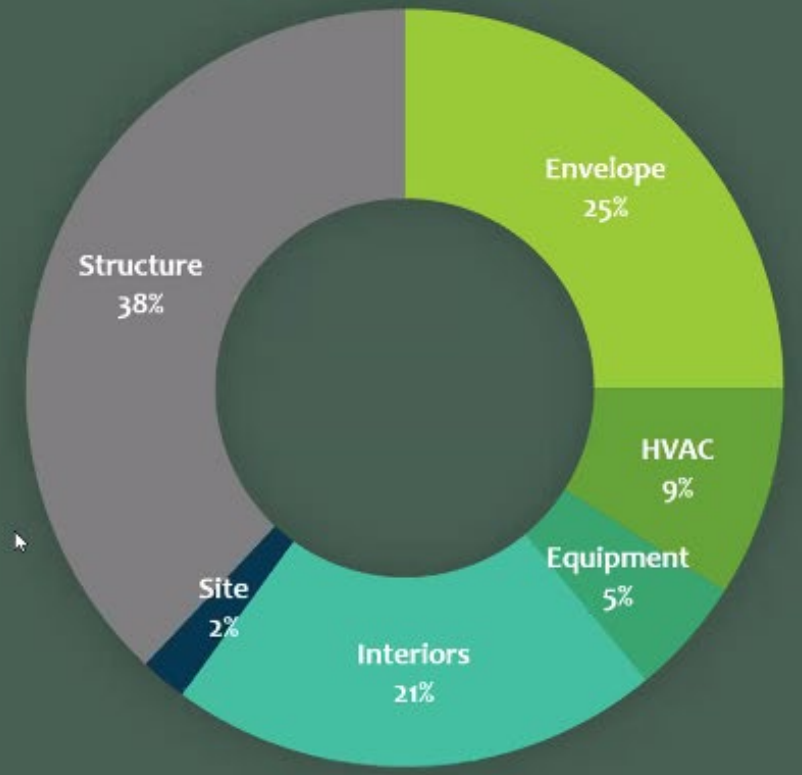
PRIORITIZING DECARBONIZATION

Embodied Carbon in an Office Building

- Structure accounts for ≈40%
- Next 2 major contributors are Envelope & Interiors
- ≈40% linked to operational carbon
- Reduction potential in structural elements & façade design
- Consider linkages between façade design & operational emissions



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CARBON MANAGEMENT STRATEGIES

Carbon Management Strategies

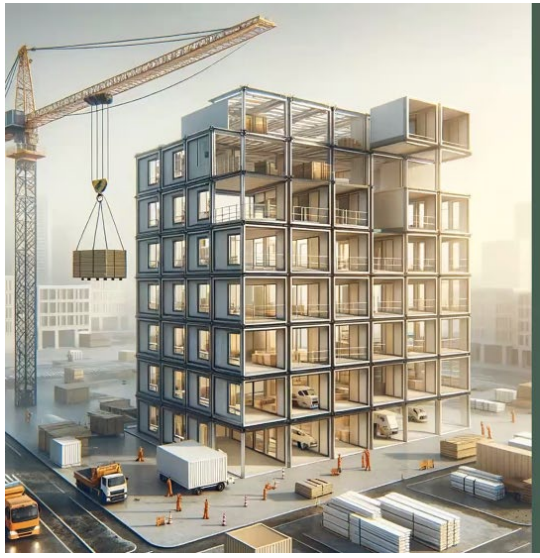
Low Carbon Materials

Low-carbon, long-lived materials such as bricks in conjunction with modern, sustainable technologies like solar panels and green roofs can reduce carbon footprints over a building's lifespan.

Carbon Management Strategies

Regenerative Design

Leaving concrete surfaces exposed and integrating living greenery for CO2 absorption or incorporating biogenic materials, like sustainably sourced wood, to sequester CO2



Carbon Management Strategies

Efficient Construction

Modular systems and other efficient processes can reduce carbon emissions by streamlining the building process & enhancing build quality, cutting down on construction waste and decreasing repair frequency after completion

Carbon Management Strategies

Lightweight Construction

Lightweight construction techniques reduce a building's carbon footprint by minimizing materials needed to construct it

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CARBON MANAGEMENT STRATEGIES

Reuse & Retrofit

Repurposed or recycled materials

Compact Shape or Form

Compact shapes have smaller surface areas relative to volume, reducing material use and energy use, while minimizing external surface areas

Durability & Flexibility

Durable materials & components reduce frequency of repairs & replacements, while flexible ensure buildings can be adapted to other uses, thus lasting longer

Waste Minimization

Carbon emissions from material and product wastage requires a multifaceted approach and meticulous planning & design to optimize material efficiency through the building lifecycle

Local Sourcing

Specifying locally-sourced materials, e.g., local stone or timber, reduces transport-related emissions, while making it easier to procure replacements for repairs & maintenance

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CARBON MANAGEMENT STRATEGIES

Carbon Management Strategies

Reduced Energy Use

Installing energy-efficient building electrical and mechanical systems, and substituting grid supplied electricity with onsite energy generated from renewables or clean energy sources, is a crucial strategy for reducing a building's operational carbon emissions

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MAPPING A ZERO CARBON PATHWAY FOR BUILDINGS

Built environment

As African cities grow, so do emissions. Greenhouse gas emissions in Africa are projected to increase by over 2.5 times to 10% of global emissions by 2050, driven by large transformations in urbanization, industrialization and electrification. Abating these emissions is possible through the promotion of low-carbon infrastructure.

African cities are growing at an average annual rate of 4% - **twice the global average**

Manufacturing is growing rapidly, with some countries' **output growing >10% per year**

1.6 TW of power generation is needed by 2030, with **~600 m people needing electricity**

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