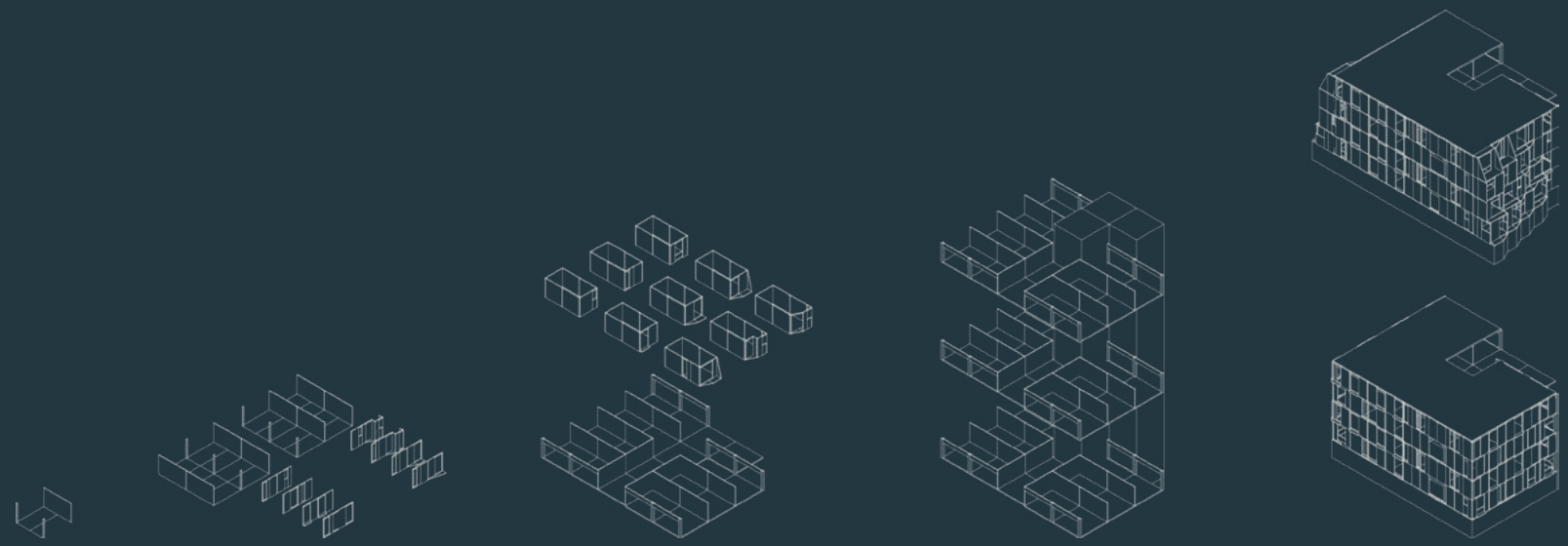
BUILDX LT

MASS TIMBER

Pioneering a mass timber processing and building market in East Africa, the most promising opportunity for eliminating the embodied carbon of buildings on a global scale.



GATSBY AFRICA

STICHTING DOEN

AUTODESK FOUNDATION

MULAGO

Climate Smart Forest Economy Program

Cross Laminated Timber

BUILDX

L T

Produced by BuildX Studio and Gatsby Africa

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XLAM

Cross Laminated Timber

BUILDX

L

T

We see a world where all buildings are **radically better**: buildings that are net zero carbon, more equitably designed, and enhance quality of life and wellbeing.

Certified B Corporation

BuildX Studio is B CORP™ Certified

BuildX Studio, the first architecture, engineering or construction company in Africa to become B Corp™ certified, has been renowned for its commitment to social and environmental impact. B Corps inspire all businesses to not only be the best in the world, but to be the best for the world. There are just over 3,000 Certified B Corporations in the world with 1 unifying goal – to redefine success in business.

As a B Corp™ certified company, we believe in using business as a force for good.

GATSBY AFRICA

Gatsby Africa exists to create jobs, raise incomes, and reduce poverty in East Africa.

Gatsby Africa is a private foundation set up by Lord David Sainsbury with a mission to create jobs, raise incomes, reduce poverty and build opportunities for people in East Africa.

We believe this can most effectively be achieved at scale through the economic transformation of high potential sectors: those where large numbers of people could benefit through growth of a sector, if the competitive potential of firms and the sector at large can be realised.

To achieve this, we use our own funds to set up sector focused programme teams in the region to:

- Work in partnership with a range of actors, whether governments, the private sector, social ventures, research institutions, and development partners;
- Test, learn and scale aspects of innovation covering technology adoption, skills development, policy and regulatory reform, business model design, and financing and more; in line with a long-term vision for the sector's development.

We take a long-term view as to how sectors can be transformed; are pragmatic in how we work; and place a premium on learning what works and what does not in order that lessons can be transferred.

SUMMARY

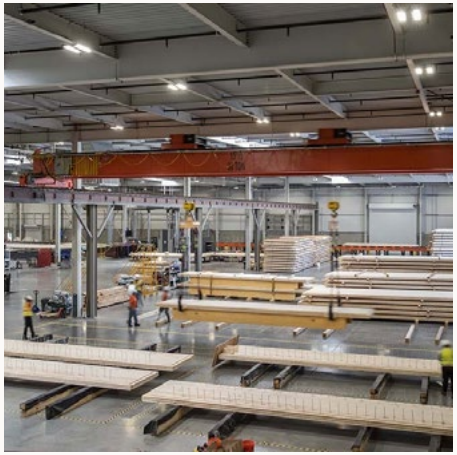
BuildX and partners are pioneering mass timber processing and building, the most promising opportunity for eliminating carbon in buildings on a global scale.

Our mass timber initiative is based on a coordinated partnership with organisations operating in the forestry sector, establishing processing facilities for cross-laminated timber (CLT) as a high value market for sustainable timber, creating the early demand for urban wood buildings, and fostering an enabling environment within which a sustainable and impactful value chain - from forest to building (or from farmer to homeowner) - can thrive.

Develop CLT Buildings

Enable Public Environment

Coordinate Forestry



Establish CLT Factory

GUIDE

PROBLEM

Rising GHG emissions and depleting natural carbon sinks are changing our climate, risking human life and our planet. We must make urgent changes, globally.

A Warming Planet

Current trends globally indicate we are nowhere close to the levels of GHG emissions reduction required to meet the Paris Climate Agreement targets.

39% CO_2 by Buildings

Buildings and construction are among the greatest GHG emitters, responsible for 39% of global carbon emissions (incl. embodied and operating emissions). We're also expected to add the equivalent of an entire Paris, or New York City, in new construction to the planet every single week for the next forty years.

Rapid Deforestation

Meanwhile, Africa suffers from one of the fastest deforestation rates globally, losing an estimated 4M Ha per year (~5.6M football fields), and depleting the amount of carbon being naturally removed from the atmosphere.

1.25B Population Rise

More than half of the population growth this century will occur in Africa, where the urban population is expected to triple. This will drive demand for new buildings, with 35% of all global construction by 2060 expected to occur in Africa, and if left unchecked will worsen deforestation.

Sources:
FAO
United Nations
World Bank
World Green Building Council

SOLUTION

Mass timber processing and building in East Africa offers the most promising opportunity for eliminating the embodied carbon of buildings on a global scale.

Sink

Trees naturally sequester carbon dioxide from the atmosphere, which is stored when used in durable products.

Store

By using wood products to construct buildings we guarantee that carbon is locked away long-term.

Substitute

By building with wood we are avoiding the high carbon emissions from using concrete or steel.

MASS TIMBER

Mass timber is a recent innovation in wood products comprised of multiple solid wood pieces bonded together to create larger panels of exceptional strength.

What is Mass Timber?

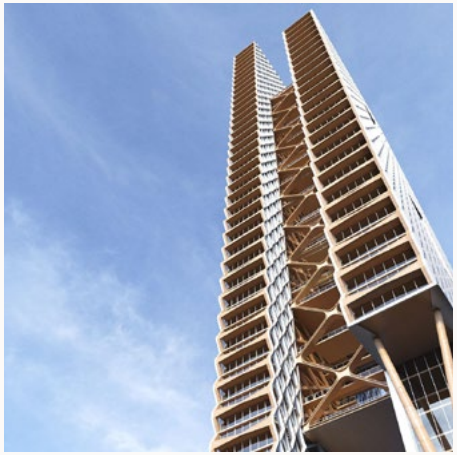
"Mass timber" is a collective term for a relatively new group of wood building products that are factory-produced and structural in nature, usually panels or beams made from multiple solid wood pieces bonded together. Mass timber construction was first developed in the 1990s in Austria and Germany, and is intended for structural applications as an alternative to concrete and steel, particularly in larger and taller buildings.

Types of Mass Timber

The most common type of mass timber is Cross-Laminated Timber (CLT) panels, made by gluing together multiple solid wood pieces ("lamellas") in counter-directional layers to create large loadbearing panels for walls or floors. Glue-laminated (glulam) timber, which glue the lamellas together in the same direction across each layer, are also popular for frame structures.

Global Growth

Mass timber buildings are popping up all over the world with increasing demand and interest due to their significant environmental and human wellbeing benefits, faster construction and cost competitiveness. There are now over 600 built or planned mass timber commercial buildings in the US, with many other countries following suit.



Future Outlook

Mass timber buildings are widely being touted as the future of sustainable cities worldwide. Challenges remain, especially in ensuring sustainable supply and updating national policies. However, the opportunities and benefits are substantial at all scales, illustratrated by a planned 80-storey timber building in Chicago.

RATIONALE

Mass timber building is quick, clean, and easy, making it the basis for safe and healthy cities made of exceptionally designed and responsibly constructed buildings.

Global emerging evidence indicates that making 90% of all new buildings from wood, rather than concrete and steel, could cut global CO_2 emissions by 4% - more than the carbon footprint of flying. Existing evidence for different building types shows that by replacing traditional building materials with mass timber we can achieve GHG emission reductions between 20% and 80% depending on where, how much and what type of timber is used.

With a rapidly growing population, East Africa faces a significant challenge to provide dignified and affordable housing, and other buildings and infrastructure, to meet the needs of its society. Kenya alone has a residential housing deficit of around 2 million homes which is predicted to grow to 9 million homes over the next 20 years based on a business-as-usual approach to the development of new housing supply.

Mass timber construction (namely using CLT and glulam) offers an unparalleled opportunity to build fast enough to meet this growing demand, to reduce the carbon footprint of buildings and construction in East Africa, and to build safer and healthier cities for the future. In addition, the creation of a new, high-volume, high-value market demand pull for mass timber could unlock significant new investment, job creation and livelihoods in the forestry and wood processing sector.

With widespread industry buy-in, a mass timber building market realised at scale can also deliver lower overall building development costs.

BENEFITS

Mass timber is superior to concrete and steel, offering better structural performance and benefits for both people and planet.

Lower Carbon Footprint

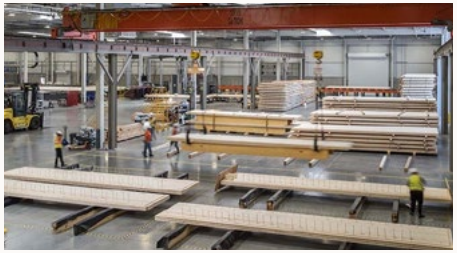
Concrete and steel alone account for around 14.7% of total global carbon emissions. Mass timber is not only net carbon negative but also a direct structural substitute.

Greater Strength

A Portland experiment found that engineered timber is 14.5% stronger than steel. Pound-for-pound, mass timber is stronger than both reinforced concrete and steel, making it an ideal building material.

80% Lighter

Timber is 80% lighter in volume which means smaller structural members, reduced transport costs and overall cost efficiencies. In Kenya, production must be established before full cost benefits.



20% -70% Faster

Due to prefabrication, mass timber building projects can be between 20% - 70% faster to build, making this type of construction more attractive for investors and developers alike.

Thermal Efficiency

Concrete is 15 times less efficient at thermal insulation than wood, and steel is 400 times less efficient. This results in a better indoor environment without the need of further insulation.

Better Fire Resistance

Charring of the surface during a fire protects mass timber enabling it to maintain its structural integrity. Contrary to assumptions, it performs better in fire - especially for human safety - than concrete or steel!

Health Benefits

Wood improves indoor air quality by moderating humidity. Studies also show that interiors with wood reduce users' blood pressure and stress levels and improve their optimism and ability to concentrate.

INDUSTRY INITIATIVES

BuildX and Gatsby Africa are leading a mass timber Breakthrough Initiative (BI) for East Africa as part of the **Climate Smart Forest Economy Program** (CSFEP).

The CSFEP is a program from Climate-KIC, The Nature Conservancy, World Economic Forum, and the World Resources Institute, with seed funding from Good Energies Foundation and support from Dalberg.

The program aims to increase the use of climate smart forest products by catalysing market demand from sectors that need rapid decarbonisation, while meeting social and ecological safeguards.

BuildX (East Africa BI Lead), and Gatsby Africa, recognise that the development of a sustainable mass timber market in East Africa needs to be a broad industry movement with multiple stakeholders across the entire '3S Model' value chain (forests - processing - buildings) working together. **Through this Breakthrough Initiative, our goal is to grow a consortium of partners across this value chain.**

Climate Smart Forest Economy Program

INDUSTRY INITIATIVES

Gatsby Africa Kenya Commercial Forestry Programme:

The KCFP is a multidisciplinary Kenya based team of 15+ staff and pool of international advisors covering: forestry, wood processing, policy, business strategy and analytics.

GA takes a long term outlook with a programme strategy focused on pathways to sector transformation:

1. Unlocking investments in commercial forestry, including through group schemes and PPP arrangements;
2. Demonstrating high-value processing and value-addition linked to Kenyan farm forestry;
3. Unlocking win-win trade links between Uganda and Kenya.

The programme has multiple partnerships and engagements with public and private sectors actors across different timber value chains.

Working with a high-tech commercial nursery to produce high-quality eucalyptus seedlings from imported improved seed for a range of Kenyan growers.

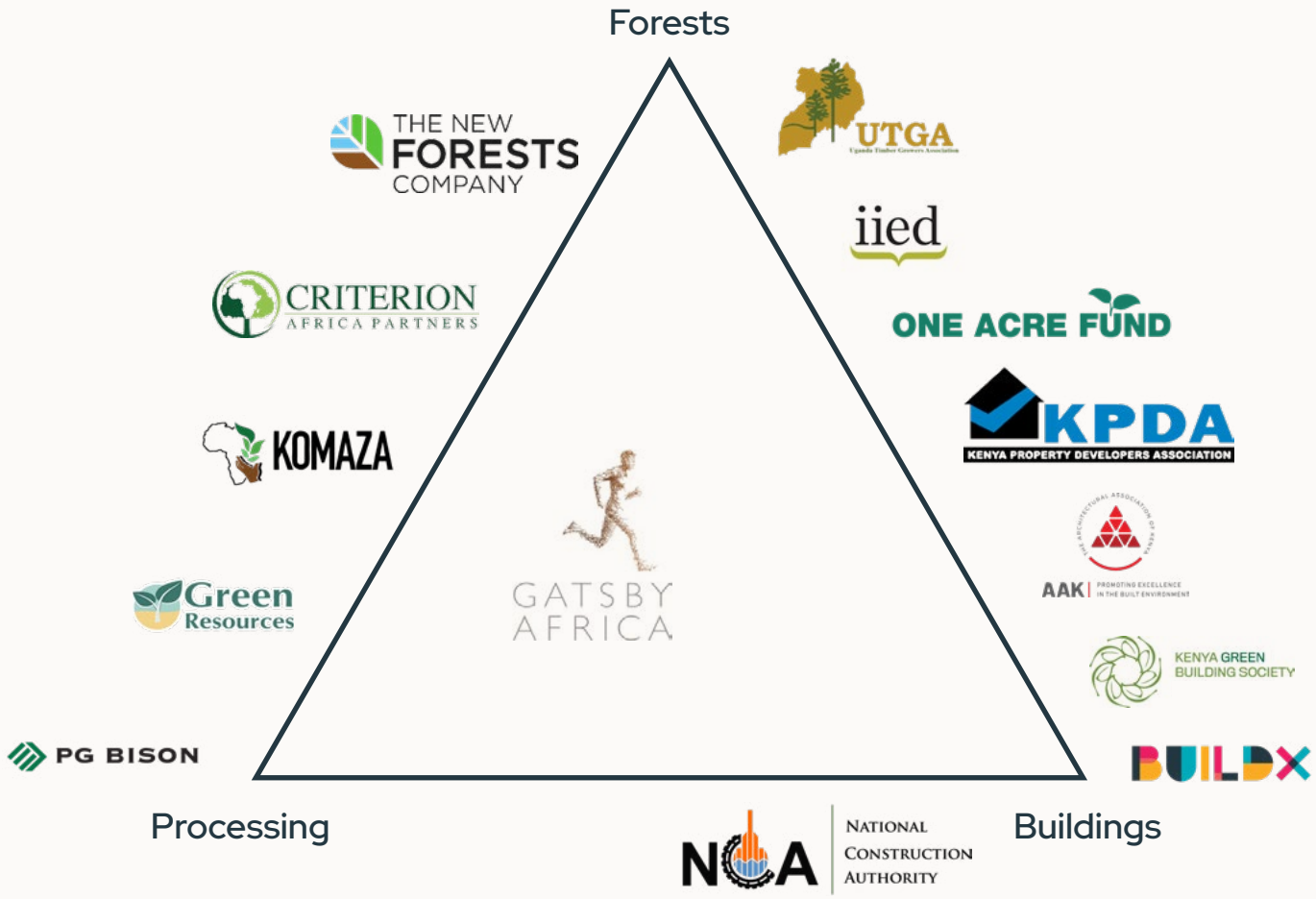
Testing innovations in remote sensing to cost-effectively monitor commercial tree species in Kenyan farm forestry systems.

Working with industrial processors in Kenya and Uganda to test the quality of sawntimber from different forest resources and its potential end product value from innovations in secondary processing.

Facilitating investments in forestry, wood processing and value addition – including organising exposure visits for key decision makers to see examples of new technologies in action.

NETWORK

We are building strategic partnerships and alliances. The following maps current and potential stakeholders whom we believe can play a key role in growing a CLT industry.



ROLES

Developing a mass timber market in East Africa is bigger than any single organisation. To lead an industry movement, BuildX and GA are taking the following roles:

BuildX: Develop CLT Buildings
As a leading and innovative design-build-developer, BuildX's main role is to develop the first mass timber buildings in Kenya. As the CSFEP Breakthrough Initiative leader for East Africa, in partnership with Gatsby Africa, BuildX will also play a coordinating role with the wider industry network, consolidation of research and key climate data, and as a local hub for knowledge in CLT construction.

Gatsby Africa: Support the development of a competitive, inclusive and resilient forestry and wood processing sector
The Kenya Commercial Forestry Programme is working with public and private sector actors to transform Kenya's commercial forestry sector. The programme works across the whole value chain with the goal to enhance the sector's competitiveness and unlock inclusive and resilient growth, in turn creating thousands of jobs, improved livelihoods and environmental benefits. The development of a mass timber market in EA forms an important part of KCFP's market development strategy.

The programme is working with forestry and wood processing stakeholders:

- **To drive new investments** in higher quality sawmilling to unlock higher value secondary processing, including CLT;
- **To stimulate new, high-quality commercial tree planting** using quality inputs and technical knowledge;
- **To engage government** to ensure the necessary enabling environment is in place to allow the sector to develop.

X MARKET ANALYSIS

GLOBAL GROWTH

The T3 in Minneapolis, the largest CLT building in the USA (20,530 sqm).

The Mjøstårnet Tower in Brumunddal, Norway the world's tallest Mass Timber Building standing at 85.4 meters (18 stories).

Sources:
IMARC Group,
Tallwood Design Institute
Thinkwood

Global CLT market reached a value of US$ 1.07 Billion in 2020. Looking forward, the market is expected to exhibit strong growth at 13-16% yearly for the 2021 – 2026 period.

The market for CLT first took off in Europe in the early 2000s, then in the United States and Canada from 2011 onwards. With a demand for CLT of 1 million m3 per year, the European market remains by far the largest globally, followed by the North American market with 340,000 m3 per year. Lessons can be drawn from the growth of both these markets.

Initial Growth in Europe

19-20%: year-on-year growth in the initial 15 years (2000 - 2015).

Having reached maturity, the European market has been growing by 12% yearly since 2016.

Initial Growth in North America

75%: year-on-year growth in the first 4 years (2011-2014), followed by a 38% growth in 2015 – 2019.

North America has shown significantly faster growth than Europe benefitting from knowledge transfer, technology and manufacturing developments in the past decade.

Future Prospects

11% per year for the European market from 2020 onwards.

25% per year for North America until 2027, then 15% until 2034.

CLT Use

69% Residential,
31% Others (commercial, civic etc.)

36% Pure CLT,
64% Hybrid model (CLT + concrete and steel.)

Nb. Based on European market data.

MARKET VALIDATION

Opportunities in East Africa

At a regional scale, East Africa offers a strong sustainable mass timber market proposition, with high reforestation potential and a rapidly growing construction industry.

A recent London School of Economics study identified the World's most promising sustainable mass timber markets by 2030. The study ranked countries against three categories:

1. **The Urban Score** - level of demand for new construction;
2. **The Forestry Score** - availability of timber, extent of forest industry and level of sustainable forest management;
3. **The Infrastructure Score** - ability to handle a mass timber market, in particularly in terms of transportation and logistics.

Promisingly, Uganda is ranked 5th overall in the world, and 2nd when assessed for export potential only due to its high Forestry Score. Kenya ranks 12th on an import-only model due to its high Urban Score. Together, with Uganda exporting wood to Kenya's markets, CLT has the opportunity to scale.

Rank	Standard Model	Import Model	Export Model
1	Sweden	Hong Kong	Zambia
2	Finland	Taiwan	Uganda
3	Zambia	UAE	Sweden
4	Austria	Oman	Hong Kong
5	Uganda	Kuwait	Finland
6	Norway	Egypt	Austria
7	Germany	Qatar	Burkina Faso
8	Hong Kong	Saudi Arabia	UAE
9	Burkina Faso	Cote d'Ivoire	Taiwan
...12		Kenya	

Notes:

The Standard Model gives equal weight to all scores, showing the countries with the highest overall score.

The Import Model gives greater weight to the Forestry Score, identifying countries with the best environment for CLT building where the material is imported rather and manufacturing in-country.

The Export Model shown here is based on limiting the weight given to current sustainability of forest management practices in each country on the basis that sustainability improvements could be made in countries which otherwise score highly on other metrics.

MARKET SIZE

Kenya

Notes:

With global attention on addressing climate change rising, there is a potential for CLT - as a major climate positive solution - to grow exponentially alongside a rapidly increasing demand for green buildings and key enabling shifts in policy.

In a conservative scenario, the potential addressable market for CLT starts at 9,000 sqm in 2025 up to 28,000 sqm in 2035 (12% average growth rate).

In an optimistic scenario with an especially conducive market environment, the size grows by 30% yearly, from 12,000 in 2025 to 159,000 sqm in 2035.

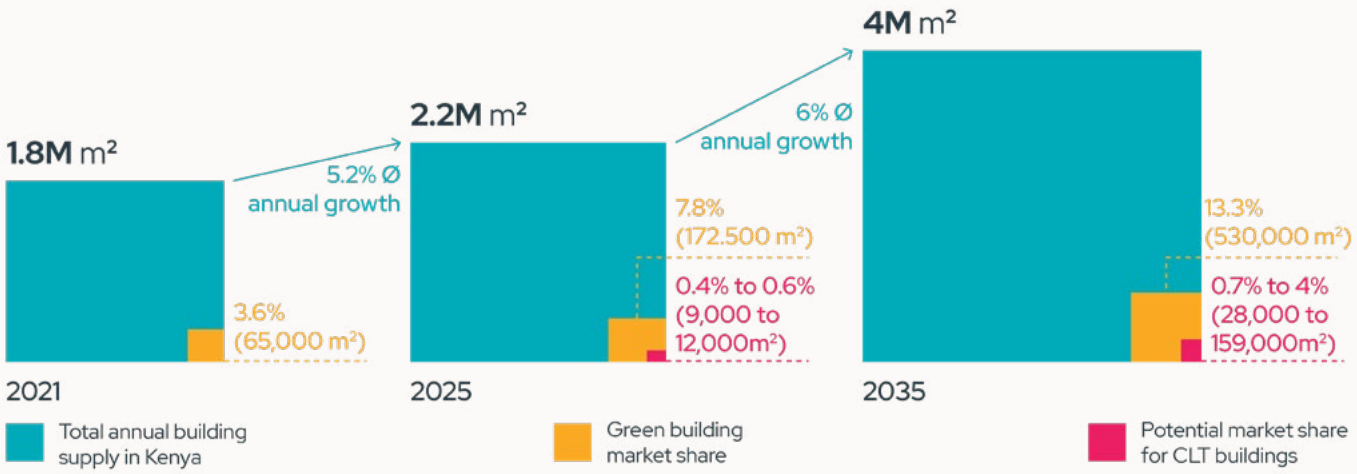
Sources:
BuildX Research
Gbig.org
IFC EDGE (high-level estimates)

With a supply of nearly 2 million sqm per year, Kenya has a dynamic real estate market, which is conducive for the development of CLT, especially in and around Nairobi.

The construction industry in Kenya is estimated to grow 5% to 6% per year until 2035, supported by strong fundamentals, including steady economic and population growth, quick urbanisation, as well as a proactive affordable housing policy.

As the economic hub of the region, Nairobi concentrates most of the quality residential and commercial real estate in the country. It is also one of the cities in Sub-Saharan Africa which sees the strongest demand for certified Green Buildings. Since 2012, over 30 buildings have been either certified or registered, representing over 500,000 sqm. Green buildings now account for 3.6% of the total supply in Kenya, with strong prospects for growth.

Demand for CLT is likely to be driven by environmentally-conscious developments. The potential market size for CLT is therefore calculated as a share of the green building market, and remains small relative to the total real estate market.



INDUSTRY PROFILE

Kenya

A Market Sounding Analysis was conducted by BuildX from April to August 2021, to assess the interest of market stakeholders for new construction materials in general, and for CLT in particular.

Eleven developers, six banks and seven insurance companies responded. A first general interview was followed by a visit of the CLT prototype and a second interview onsite for half of the participants.

The following pages present the conclusions of this research.

Sources:
BuildX Research

Kenyan developers will be the first target clients for CLT in the region. They are aware of Alternative Building Materials, although they do not use them much yet.

A Fragmented Industry

Real estate developers have not yet been able to build at scale in Kenya. Only a few large players can build more than a few hundred residential units per year.

There are many real estate developers, principally in Nairobi. Almost all of them only undertake one project at a time, two at the most. Given the focus on affordable housing, this is expected to change quickly, with larger players emerging.

Alternative Building Materials and Technologies

Developers are aware of ABMs available on the market including Expanded Polystyrene (EPS) panels, Aluminum Formwork, Light Gauge Steel and Pre-Cast concrete.

However, general opinion is that they are more expensive than traditional techniques (concrete & steel structure, stones or brick & mortar infills). They also require larger upfront costs. Given this, their use remains quite marginal.

ABMs are mostly used when specific needs arise, especially for fast delivery. Lightness and thermal properties have also been mentioned.

Key Challenges

Construction costs remain expensive in Kenya, and the market is very price sensitive.

Interviews reveal that developers have been fine with slow construction times in the past given low offtake. However, speed of construction is becoming a key concern when scaling up operations. Cost of finance, and the relative wariness of banks when providing construction loans, is another key concern.

End User Perceptions

A key challenge for the adoption of ABMs is expectations of end users, especially homeowners. Being attentive to the strength and safety of their homes, they consider that “a house must be made of stone” and are reported to disregard ABMs as weak and not durable.

Consequently, developers are hesitant to use ABMs and often consider these products haven’t yet “proven themselves”.

FEEDBACK

Real Estate Developers

This page summarises key takeaways of interviews with developers. Most of the 11 who visited the prototype may be willing to consider CLT seriously, though only if cost competitive. Speeding up construction was the main appeal.

They thought reluctance from end-users is a key barrier, but it can be lifted through the first successful deliveries.

Developers are keen on understanding better their interest in adopting CLT in the future, including the financial viability. Most would welcome a detailed commercial proposition once the material can be produced locally.

Developers were also instrumental in making recommendations on the way forward.

Sources:
BuildX Research

Professionals showed genuine interest for the prototype and for CLT and trusted the properties of the material. Concerns exist, especially regarding cost.

Key Motivators

1. **Quick delivery**, which also means accelerated offtake, cheaper finance and savings.

2. **Product differentiation** on high-end markets + beauty.

3. **Keenness** to look at new products and concepts.

4. **Reliability and ease of use** (pre-fabricated).

5. **Access to green finance** (should it become available) and to green certifications.

Key Barriers

1. **Cost** is by far the main barrier. Must be comparable to usual techniques.

2. **Lack of familiarity**, as the industry is conservative. Strong confidence would be required.

3. **Lack of trust from end users** for ABMs in general.

4. **Wariness from insurers** regarding wood.

5. **Environmental friendliness** is not a priority.

6. **Unfit regulatory environment** and difficulty to get approvals.

7. **Not left visible:** how can I sell an innovation if the buyer doesn't see it?

8. **Limited changes during construction** (prefabricated).

Way Forward

Highlight all direct and indirect costs benefits of CLT in the business plan.

Define the most affordable hybrid model, in case 'pure CLT' is too expensive.

Provide full evidence to explain the technique, prove benefits and alleviate concerns.

Focus on high-end and make CLT aspirational for it to appeal to all.

Show concrete realisations: the prototype, and also one/several CLT development(s).

Allow for all applications: high-density, but also standalone houses.

Create predicable environment and set incentives, engaging with regulators, banks, insurers and professional associations.

Ensure quality through a clear process, including training and controls onsite.

FEEDBACK

Banks and Insurers

As for most Alternative Building Materials, there is no objection to finance and insure CLT developments.

Banks

Banks all show willingness to finance CLT developments. Interest rates would not be made higher based on the sole use of an alternative material, as this is not a parameter that impacts the proposed loan conditions. Rather, banks look at the overall feasibility of the project to ensure its viability. Overall, they are cautious when providing construction loans given the high default risk.

Banks are interested in the ability of CLT to speed up construction, thereby accelerating traction on sales and limiting the risk of stalled developments. In other words, they see protecting themselves against default as a priority over incurring higher interests due to delays in completion.

Prospects for financial incentives on CLT are limited as green finance for construction remains underdeveloped in Kenya and at rare exception banks do not have green mandates. However, this is expected to change quickly given international pressure. The Green Climate Fund is a good example.

Insurance Companies

Insurance companies in Kenya are wary of wood, first because of its association with low-quality, informal construction, and second because fire is the main risk when insuring a building.

However, there is willingness to insure CLT but potentially with a high premium initially. ABMs systematically incur premiums, while traditional construction using concrete and steel is deemed the safest. High premium on new materials are also due the insurer not being able to spread the risk across many comparable buildings. Cost will decrease with time as comparable insured stock grows and as more evidence on risks is collected internally.

To determine premiums, insurers are interested in evidence from other parts of the world, especially when provided by their re-insurer partners, which can play in favour of CLT. All evidence is reviewed objectively.

Sources:
BuildX Research

STRATEGY

STRATEGY

Overview

A coordinated full value chain approach - from forest to building - will be required in order to transform the market and create an enabling environment for wood buildings.

Our strategy follows the following sequence, and recognises the process is not linear but requires a multi-faceted approach.

Develop CLT Buildings

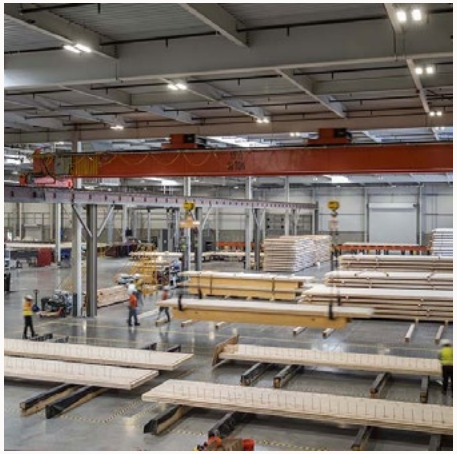
BuildX is pioneering the first mass CLT buildings in Kenya, as the design-build firm and real estate developer.

Enable Public Environment

To truly scale a wood building market will require public and private sector support in both the forestry and construction sectors. Policy changes and improvements, political buy-in, and the traditional building materials sector will all need to be addressed.

Coordinate Forestry

In order to sustain growing demand for sustainable timber the forestry sector needs to be engaged to plan for the future. Further, coordinating supply and demand can help drive investment in sustainable forestry growth and reforestation.



Establish CLT Factory

Currently there is no CLT processing in East Africa (the nearest facility is in South Africa). In order to achieve competitive pricing, and meet environmental goals, local CLT processing needs to be established.

Short Term	Prototype & BuildX Projects	Political Buy-In	Ugandan Plantations	Imported CLT (South Africa)
Mid-Long Term	Green Building Market Demand	Major Policy Changes	Kenyan Plantations	In-Country CLT Processing
Opportunity	Affordable Housing Program	Align to Kenya Climate Goals	Smallholder Farm Forestry	Export Markets

STRATEGY

Short-Term

In the short term, we have developed an industry development strategy across 3 broad phases of work over the next 5 years, underpinned by ongoing research.

1. Create Public Sector Buy-In

Key Outcome:
Government buys-in to a CLT vision and creates the necessary enabling environment to enable raising investment for, and implementation of, pilot buildings.

Activities/Outputs:
- Production of high-quality white paper showing opportunity of CLT
- Formation of CLT industry coalition – construction players; forestry sector etc.
- Engagement with Govt on white paper and need for developing a CLT industry development strategy
- Co-development of industry strategy with Govt & private sector coalition
- Convening of Govt & development partners on industry strategy

Timeframe:
1 – 1.5 years, assuming building code

2. Develop a Ready Market

Key Outcome:
A number of pilot CLT buildings are built using imported CLT, demonstrating the value of such construction and creating demand from other developers.

Activities/Outputs:
- Securing an experienced industry resource to be based in EA to support industry coalition on market development
- Fundraising by construction players secures capital for CLT pipeline buildings
- Building designs completed and planning permission granted
- CLT pilot buildings constructed
- Behaviour change campaigns highlighting benefits of CLT
- Development of built environment financing

Timeframe:
2 - 4 years.

3. Establishing Local CLT Processing

Key Outcome:
In response to market demand, East Africa's first CLT factory is established, producing cost-effective CLT for new buildings and creating a new forestry demand pull.

Activities/Outputs:
- Development of CLT business plan
- Identification of CLT operator
- Investment raised for CLT factory
- Factory set-up and HR recruitment
- Commissioning

Timeframe:
2 - 5 years.

These phases could switch or overlap, to establish local CLT processing to supply the first CLT buildings in East Africa.

STRATEGY

Long-Term

Our goal is to scale a mass timber processing and building movement in East Africa, and beyond, to transform the carbon footprint of buildings globally.

Growing a sustainable mass timber industry in Kenya, East Africa, or beyond, is bigger than just BuildX or Gatsby Africa. It requires a full industry movement, with clear doers and payers driving the market demand:

Doer-at-scale

Real-estate developers replicating a simple model:

1. Design sustainable CLT buildings
2. Get them financed (through green finance instruments if available)
3. Target the appropriate clientele of investors and occupiers
4. Build them profitably

Payer-at-scale

Building owners and occupiers demand CLT buildings for reasons including:

- Health and wellbeing benefits
- Lower operating costs
- Low environmental impact
- Corporate commitments
- Added building value

SCALE

In order to scale up significantly, building with CLT must also be cheap and simple enough to do and replicate, with a big enough market to absorb a high demand.

Big Enough?

As shown in the Market section of this report, East Africa ranks strongly for CLT market potential based on growing demand, sustainable forestry, and supporting infrastructure.

Cheap Enough?

To begin with, CLT will retail at a premium compared with traditional building materials, however, at scale and alongside the vast gains in build time, CLT panels should match or surpass the cost of traditional building materials. To get there faster, incentives or subsidy may be required to stimulate growth.

Simple Enough?

CLT construction is far easier and less wasteful than traditional construction. As a "dry" process with panels made-to-spec in the factory, CLT buildings go together like a giant jigsaw puzzle using a crane and with only very basic tools (power drills and props) required on site. In Kenya, contractors and labourers would require training, however, the level of skill required to build is easily achieved.

BEHAVIOUR CHANGE

Wood buildings spark many socio-cultural biases and myths, meaning we need to fundamentally shift the systems, mindsets and beliefs that prevent progress.

Engage with the public & key stakeholders to build **awareness**.

Source: Sharon Davis Design

Create landmark buildings that inspire and foster public **desire**.

Source: Sidewalk Labs

Provide visitors to these buildings with **knowledge**.

Source: Bjarke Ingels Group & Carlo Ratti Associati

Create high volume market solutions **actioning** the same ideas.

Source: Lacol Arquitectura Cooperativa

Reinforce people's changing perceptions via demos & workshops.

PROJECTS

PROTOTYPE

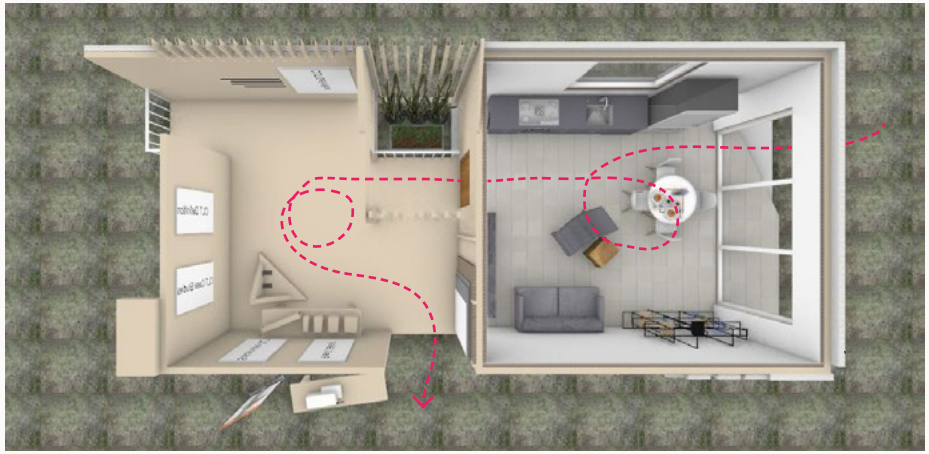
We have constructed a CLT prototype structure - the first ever CLT in Kenya - at Tatu City, Nairobi, as an exhibition for visitors to experience and learn about wood buildings.

Production

The CLT panels for the prototype were manufactured by XLAM in South Africa and shipped to Kenya in a single container.

Prototype Objectives

The objective of the prototype is to assess market interest from key stakeholders: developers, financiers, insurers, key Government officials, and the general public.



Visitor Experience

It's not always easy to visually spot many CLT buildings from the outside, since some kind of exterior-quality material (like brick or stone) is required to clad the CLT structure. As such, visitors to our prototype have no initial indication that it is made from wood. Inside, the first room is fully finished and furnished as a mock apartment, with gypsum hiding the CLT panels. Visitors provide feedback in this first space - Do they like it? What do they think of the quality? Can they guess what it's made from? - before discovering the CLT construction in the second space alongside exhibition information and other sample materials.

The 50m² prototype structure took a mere 20 hours to construct

Part of the interior is fitted out like a real apartment

The rest of the prototype reveals the fully exposed CLT

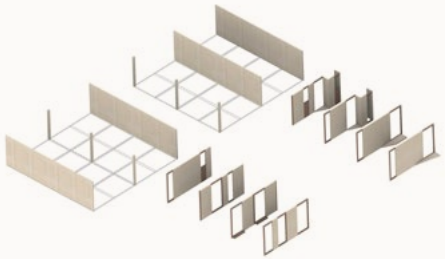
From the outside, the CLT can be seen alongside a thin stone exterior cladding

MODUL

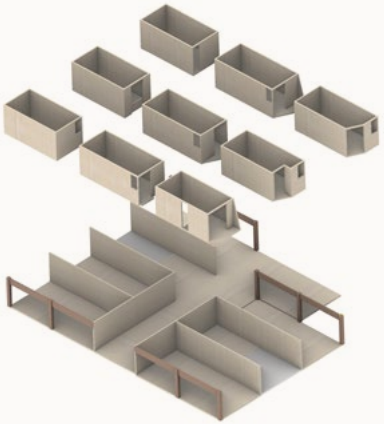
Residential Project

We are developing a flat-pack CLT urban housing concept with options for both affordable and middle-income developments as a high volume market solution.

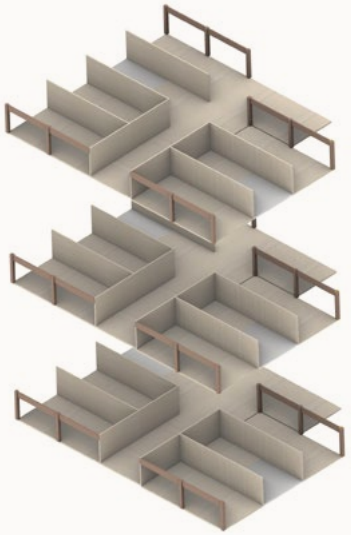
CLT Panel



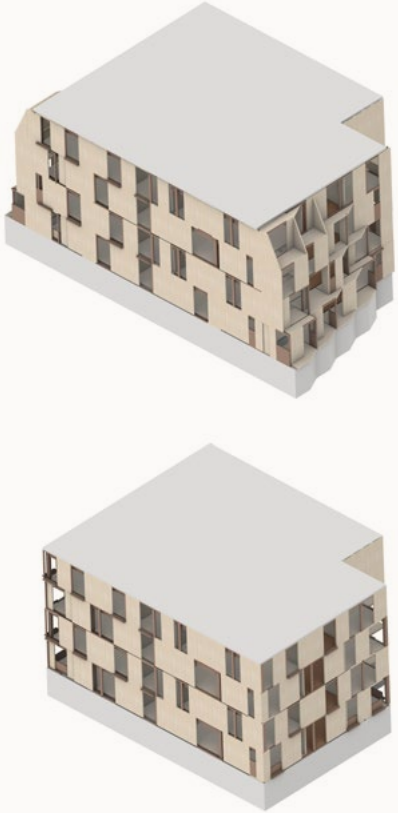
Assembly



Modules



Apartments



Buildings

MODUL means **MO**del for **D**ecarbonised **U**rban **L**iving

× IMPACT

APPROACH

Our core impact estimates span the first decade of local manufacturing (2025-2035). We also modelled impacts for potential long term scale (2050+).

Market growth assumptions:

	Phase 1 2025-2030	Phase 2 2030-2035	Phase 3 2050+
% share of total building market	0.4%	0.9%	10%
Average annual growth rate CLT market	15%	15%	3%

CLT manufacturing phases and expected outputs:

Phase 1: 2025-2030

- 1 small CLT facility
- Majority of raw material supplied from Uganda
- 20% of required sawmill raw materials supplied by smallholder tree growers
- 28,760 m3 CLT produced to meet market demand for 2025 to 2029

Phase 2: 2030-2035

- 1 small + 1 medium CLT facility
- Diversification of supply base: Uganda + Kenya
- 50% production increase supplied by farm forestry tree growers
- 73,203 m3 CLT produced to meet market demand for 2030 to 2035

Phase 3: 2050+

- 17 large CLT facilities
- 3% CLT annual production increase
- 2,149,400 m3 CLT produced to meet market demand for 2050 - 2060

IMPACT

Summary

A local CLT sector can unlock significant positive impacts related to investment, job creation and carbon benefits along the whole supply chain.

	Plantation investment required	Roundwood production	Job creation in plantations and manufacturing *	CLT and sawmill processing CAPEX investment	Value creation in wood production and processing sales	Total carbon benefit through sequestration, storage and substitution
PHASE 1 and 2 Total Benefits Year 1 - 10 (2025 - 2035)	+ USD 9.5M	+ 321 k m³	7,861	+ USD 13M	+ USD 136.7M	1.7 MtCO2e
PHASE 3 Total 10-year benefits at scale (10% total market share)	+ USD 200M	6,772 k m³	161,966	USD 134M	+ USD 2,882M	35.7 MtCO2e

*Direct jobs in forestry have been categorized into 3 groups: (1) planting jobs for plantation establishment and management, (2) support activities jobs i.e. nursery jobs and (3) the harvest & haulage jobs. All have been converted to FTEs by taking into account the total number of days worked in a year.

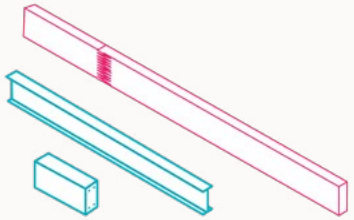
CARBON

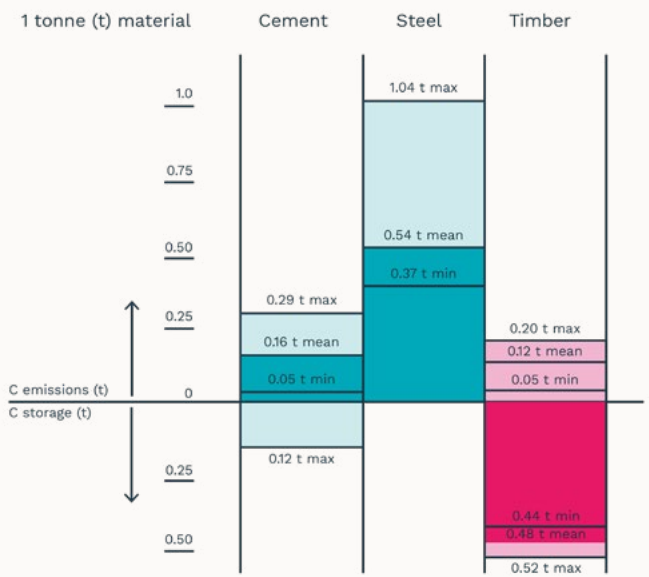
Potential

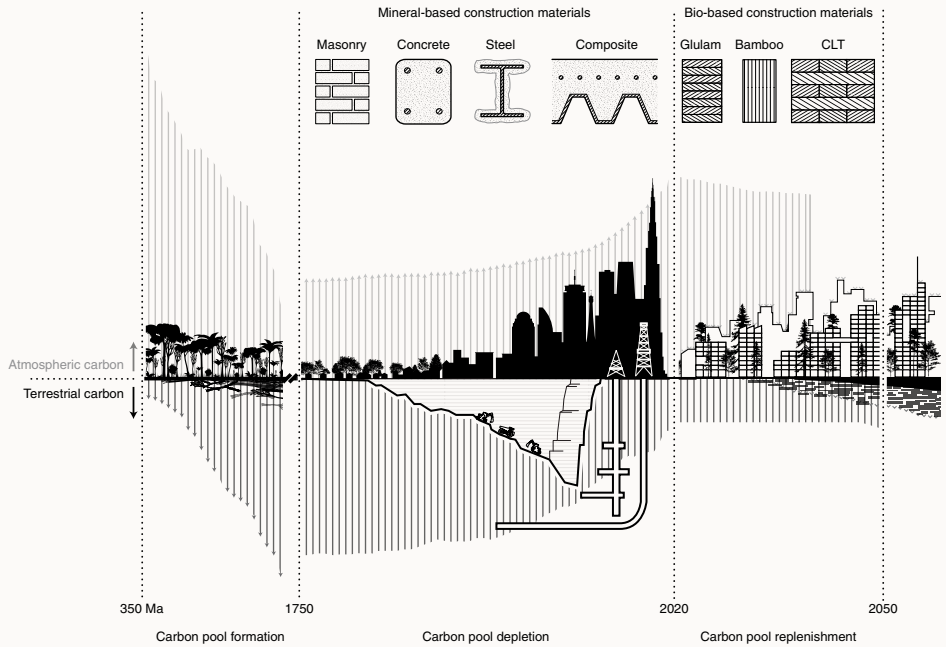
Unlike mineral-based finite materials (concrete and steel), wood is the only big structural material that is renewable, enabling us to grow our buildings like we grow our food.

1 cubic metre of wood will store approximately 0.75 - 1 tonne of carbon.

Provided the wood is sourced from sustainably managed forests, building with wood provides a long-term carbon store and, combined with substitution of concrete and steel, can ultimately absorb more carbon than it releases throughout its full life cycle.







Sources:
Churkina et al 2020, Nature Sustainability

CARBON

Impacts

We have modeled carbon benefits from plantation to building level assessing opportunities for carbon sequestration + storage + substitution to estimate possible total carbon benefits.

	Carbon sequestred in plantations [t/CO2]	Carbon stored in CLT [t/CO2]	Carbon substituted by CLT [t/CO2]	Total carbon benefit [t/CO2]	Equivalent of cars taken off the road for one year
PHASE 1 and 2 Total Benefits Year 1 - 10 (2025 - 2035)	1,594,789	84,119	15,294	1,694,202	368,455
PHASE 3 Total 10-year benefits at scale (2050 - 2060)	33,618,679	322,410	1,773,254	35,714,343	7,767,152

Carbon impacts are modeled based on predicted construction sector growth and CLT market share once a local CLT factory is operational. Carbon sequestration benefits have been modelled using the long term average carbon stock that is stored by an area of productive forests managed on a sustainable basis. The long term average is calculated over a 50 year period to ensure that the long tree growing and harvesting cycles are accounted for. It has been assumed that once the trees are harvested, all of the forest carbon is released into the atmosphere and thus carbon stocks return to zero. This means there is no double counting of carbon benefits between the forest carbon sink step and subsequent storage and substitution steps. Carbon storage and substitution have been modelled on the assumption that every m3 of timber used in structure locks 825kg of CO2 into the structure and concrete expresses 300kg of CO2 per m3.

Sources:
New Forests' Sustainability Report 2020 Webinar (underlying assumptions for carbon estimates), EPA GHG equivalents calculator

CIRCULAR

CLT is a leading circular economy resource, optimised by effective forest management with graded logs going to CLT rather than lower quality, short life products.

Forests absorb CO_2 from the atmosphere through photosynthesis

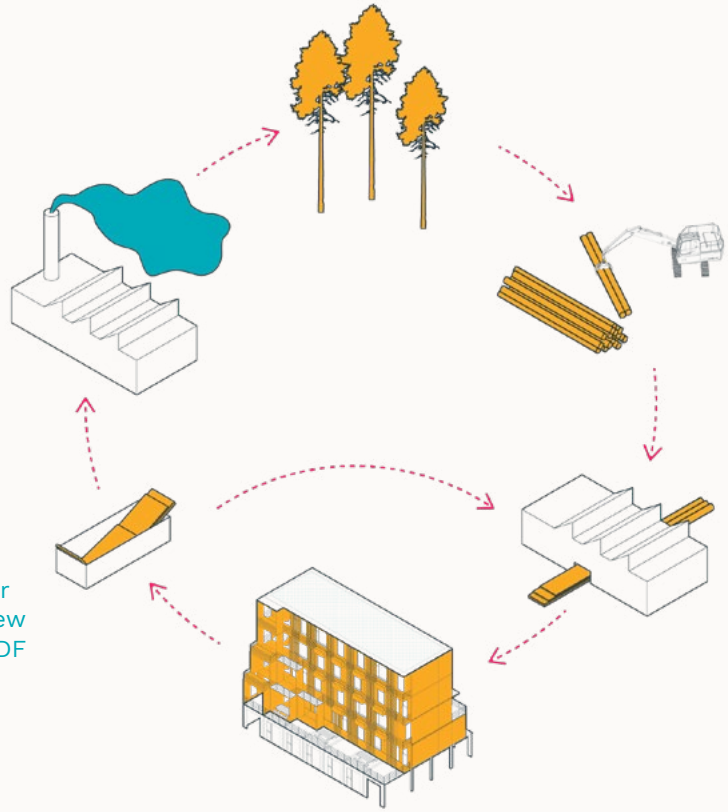
Trees are a renewable resource and store carbon, even when harvested.

CLT manufacturing produces very little pollution and uses almost all of the log, with any waste usable in other wood products.

Timber buildings store carbon in their structures for their entire lifecycle.

Wood products, like CLT, can be reused or recycled to create new products, such as MDF or OSB.

Wood can be burned for clean energy



FORESTRY BENEFITS

Sustainability

The development of an EA CLT market will provide a high-value market pull to drive new investments in tree growing, wood processing & sector support services.

Timber demand for the first phases of local CLT production in Kenya can be met with sustainable supply from Uganda. We predict demand will increase to an estimated 50,000 m3/ year of roundwood equivalent by 2035. Such a volume of wood could be supplied by an area equivalent to 2,500 - 3,000 ha of high-quality, sustainably managed commercial forests. Uganda's sector has developed close to 100,000 ha of high-quality plantations over the last two decades of which a significant proportion is, or will be, certified to ensure sustainable forest management.

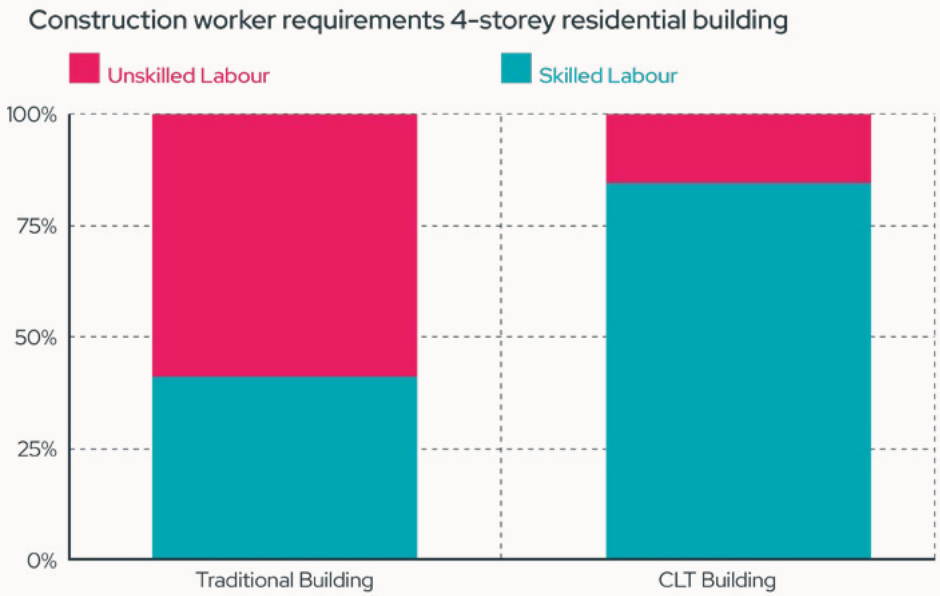
CLT demand from Kenya presents a market opportunity for Uganda. Uganda's forestry sector will see an oversupply of wood in the short term due to its success in developing its forest resource coupled with its relatively small domestic markets. The wood surplus (estimated at least 400,000 m3/ yr) can easily meet CLT market demand in Kenya.

A developed CLT market at scale will increase the value proposition of commercial forestry in the long term, in turn leading to increased investments in tree planting, processing and sector support services such as tree nurseries and silvicultural contractors, as well as indirect benefits through improved livelihoods and incomes.

BUILDING JOBS

Mass timber construction increases the demand for skilled labour with higher incomes.

Compared with traditional building, demand for skilled labour is greater compared to traditional construction. Skilled labourers for CLT construction generally undergo a more intense training and receive higher wages compared to concrete construction. CLT construction slightly reduces the overall number of required people per project (compared with traditional construction). However, our assumption is that the increased demand for jobs at forest and manufacturing level leads to a net benefit in terms of job creation. Research to be conducted as part of the CSFEP Breakthrough Initiative will test this hypothesis.



Source: BuildX

HEALTH & WELLBEING

We spend over 90% of our lives indoors, meaning buildings shape our quality of life and wellbeing more than any other physical environment.

Emerging evidence points to various benefits related to wood building:

Worker benefits

Mass timber buildings benefit workers involved in the construction process because of safer, cleaner building sites.

Health benefits

Wood improves indoor air quality by moderating humidity. Interiors with wood reduce users' blood pressure and stress levels and improve their optimism and ability to concentrate.

Wood in healthcare settings has restorative properties, resulting in improved patient recovery.

Organisational benefits

Organizational benefits of wood buildings include reduced employer costs and increased productivity based on the following employee outcomes: reduced illness, absenteeism and presenteeism; increased retention; increased job performance; and reduced stress and fatigue.

In school classrooms with wood interiors, students experience less stress and better learning outcomes.

Notes:

BuildX - in collaboration with one of our investors - is piloting a tool for the assessment of quality of life and wellbeing of our building users.

This can easily be adapted and applied to our BuildX LT projects.

Sources:
Lowe 2020, Forestry Innovation Investment

BUILDX LT THEORY OF CHANGE

Desired Change

Mass timber processing and building is established in East Africa contributing significantly to reductions in carbon emissions.

Long Term Outcomes

- Growing market demand, investment and conducive enabling environment
- Increase in quality of life & wellbeing of CLT building users

Short Term Outcomes

- Government buy-in and support
- Increased awareness and positive feedback from relevant market staekholders including funders/ investors
- (Pilot) developments used/ occupied
- Local timber supply incentivised
- Increase in smallholder-led commercial forestry
- Growth in sustainable commercial forestry
- High value timber market created locally

Outputs

- Prototype set up, market engagement through tours and interviews
- Residential development(s) for middle income audience designed and built
- CLT landmark building designed/ built and used for market engagement
- Factory operational
- Residential development(s) for low income audience designed and built
- Growing manufacturing capacity and demand through diverse client based

CLT Supply

- CLT Import from SA
- Timber supply from Uganda, local CLT manufacturing
- Timber supply from Uganda & Kenya, local CLT manufacturing

Phase

- Prototype & market sensitisation
- Pilot CLT projects (housing & landmark)
- Local CLT factory pilot phase
- Local CLT factory scale up phase

Impact Management Focus/ KPIs

- Stakeholder feedback from market engagement
- Outcomes of market awareness creation
- Funding secured
- Partnerships formed

+

- Carbon savings of CLT used
- Embodied carbon emissions per unit/development
- Comparison of carbon emissions with traditional buildings
- Emerging impacts on quality of life & wellbeing of building users

+

- Manufacturing capacity, sales, client demand
- Reduction of CLT costs compared to import
- Job creation and skill development related to timber supply, CLT manufacturing & construction projects
- Carbon impacts for CLT produced

+

- % of supply coming from smallholders
- Increase in income for smallholders

CLT & FORESTS

OVERVIEW

There are many advantages for sustainable, commercial tree growing in East Africa:

- Climate change impacts;
- Protect and enhance high conservation values;
- Livelihood and job creation in rural areas, due to several factors:
  - A resilient crop, most commercial tree species are hardy enough after one year to survive even extreme weather changes;
  - Farmers can earn more than 3x the amount per acre of forest than maize-crop, although it takes much longer before revenue is received due to the time it takes for the trees to grow;
  - Caring for trees generally requires less labour and maintenance costs compared with livestock or food crops.

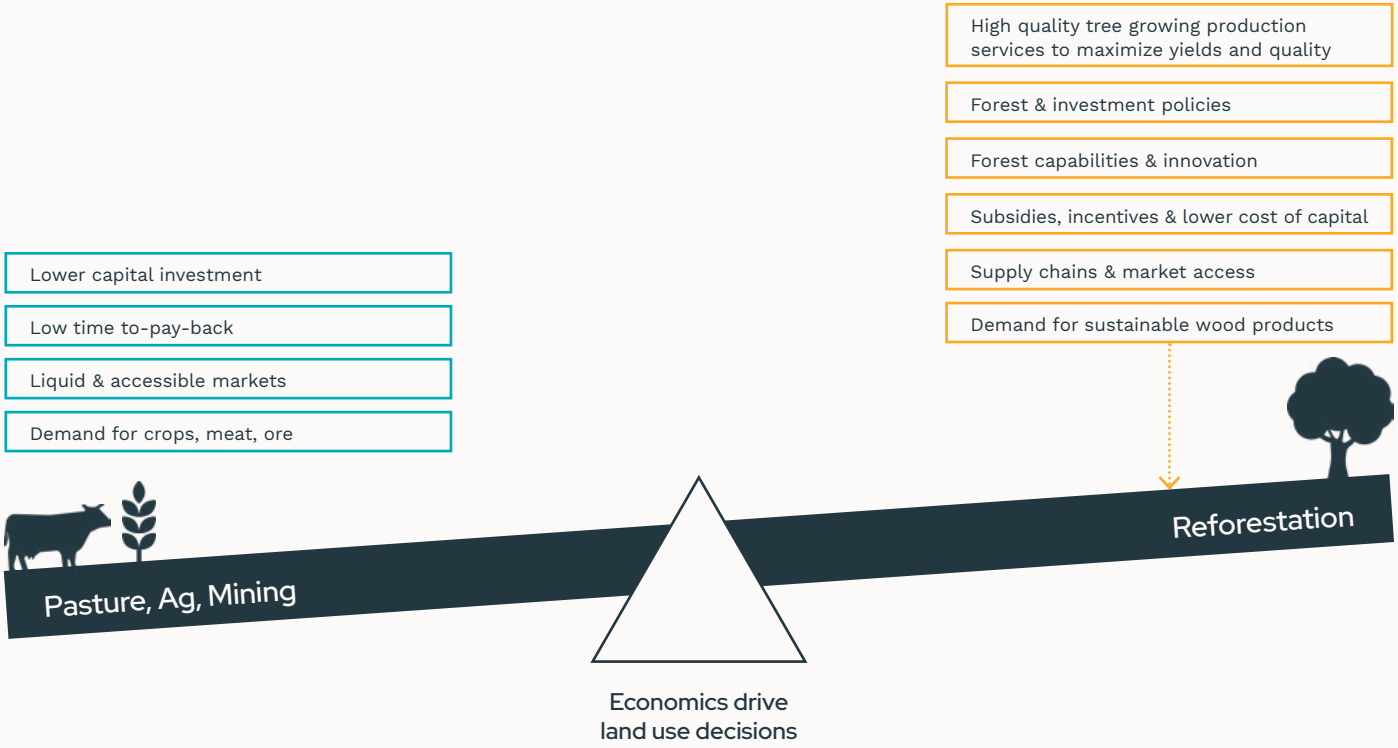
Sources:
The Nature Conservancy
WWF's New Generation Plantations

Natural climate solutions can deliver up to 37% of the global emission reductions needed by 2030, of which reforestation is by far the most impactful solution.

However, to drive reforestation at scale we need to make forests a more attractive and competitive land use for commercial tree growers of all scales.

Alternative land uses that drive deforestation are currently attractive to landholders

A number of levers can make forests a more competitive land use for landholders



SUPPLY & DEMAND

Raw material supply must be planned at a regional level, with forest stocks and primary processing capabilities variable across East Africa.

Within East Africa, Uganda currently has the most promising forestry sector, whilst recent investment in Komaza and other private sector growers can drive increasing long-term supply volumes in Kenya.

Country Summaries:

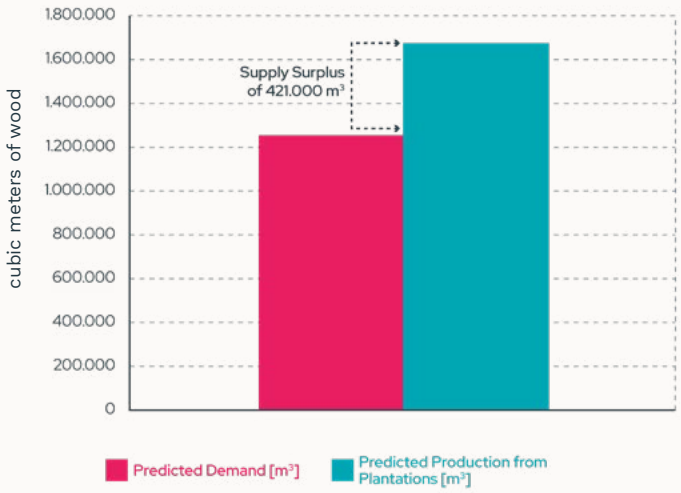
Uganda offers the most promising supply option in the short-mid term, with a high-quality resource base of industrial and small-scale commercial growers and a woodflow that is expected to increase from 200,000m³/yr in 2020 to 1.3 million m³/yr by 2027, primarily consisting of pine (~86%) and eucalyptus (~13%). A significant area of the Uganda resource base - vertically integrated and smallholder tree growers - is certified by the Forest Stewardship Council (FSC) ensuring sustainable forest management.

Kenya's commercial forestry value chains currently have supply deficits due to increasing demand and limited new investment in plantation development. However, there is a vast area of farm forestry resources (est. > 300,000 ha) which could reduce this deficit if it can be proven that raw material from such systems can be brought into more formal markets.

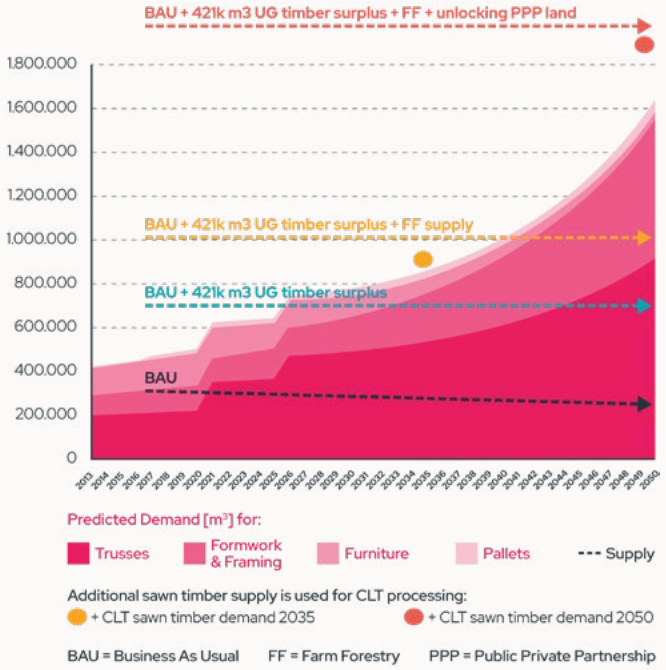
Sources:
Gatsby Africa
Kenya Forest Service
SPGS 2010

Supply & Demand of Sustainable Timber

Uganda Surplus by 2030



Kenya + Uganda Supply vs. Kenya Demand (excl. CLT)



SOURCING

Our working hypothesis is that wood supply will primarily come from Uganda in the short-term; however, alongside key forestry partners we can also help catalyse a growing sustainable forestry sector in Kenya and Tanzania.

Based on supply forecasts, Uganda is the most viable resource base, whilst Tanzania also offers good supply potential alongside Kenya:

Strong / Average / Poor	Private Forestry Sector Strength	Quality of Resource Base	Sustainable Certification (e.g. FSC)	Short Term Viability
Uganda				Yes, short & long term
Tanzania				Yes, short & long term
Kenya				Limited, long term

We plan to use Eucalyptus and Pine, two of the most popular forestry species in East Africa, with both highly suited to mass timber construction.

Species Summaries:

Eucalyptus is less commonly used for mass timber products, although tests have shown it to be potentially more promising. It is around 25% cheaper than pine and faster growing. Additionally, it has a natural protection to insects and termites, and, as a hardwood, it offers better physical durability.

Pine is widely used and tested in mass timber products globally. It is easier to process and season, being less liable to split or warp than Eucalyptus.

SAFE-GUARDS

Commercial forestry needs to be implemented responsibly to ensure it is sustainable and delivers environmental, social and economic benefits:

Environmental
- No clearing of natural forests
- Ensure high-conservation value areas are conserved
- Buffer zones implemented around water resources – particularly important if exotic species are used
- No invasive species used

Social
- Free prior informed consent to ensure local communities rights are upheld with regards to forestry land-use
- Prioritisation of jobs for local communities
- Improved smallholder tree grower livelihoods

Economic
- Job creation in rural areas and downstream industrial processing
- Tax contribution

SAFE-GUARDS

It is crucial that any new wood product market, such as CLT, is managed sustainably with appropriate safeguards in place to ensure a healthy supply chain.

CLT production in East Africa will use sawntimber from commercial species such as pine and eucalyptus. Native species will not be used and as such the growth of the industry will not directly increase pressure on natural forest.

Indirect pressure is possible if demand for sawntimber for CLT production leads to a reduced supply of firewood which is then met through wood or charcoal from natural forests. However, the creation of a high-value mass timber market would increase the value proposition of investments in commercial forestry, in turn leading to an expanded resource base and potential for increased biomass as a by product.

FARM FORESTRY

Although large forest plantations are likely to serve most early demand, we believe there is a huge opportunity to unlock a higher value market for smallholder farmers.

Collectively, smallholder farmers possess vast land and labour resources to plant billions of trees. Forestry is an ideal tool to help farmers grow long-term wealth, as they can earn more than 3x the amount per acre of forest than the equivalent area of maize or other food crop.

Other organisations in East Africa with smallholder farm forestry programs or integrating smallholders into their overall supply chains include:

- Green Resources
- International Institute for Environment & Development (IIED)
- New Forests Company

Key Stakeholders

Komaza

Based in Kenya, Komaza are revolutionizing African forestry by building a “virtual plantation" across tens of thousands of small-holder farms. Mostly Eucalyptus, Komaza are currently investing in Kenya's Central Region as well as in primary and secondary processing facilities.

One Acre Fund

In 2012, OAF began supporting their farmers in Kenya with tree-planting kits. By 2019, over 2.8M trees had been planted and they forecast 70M trees planted by 2024. Currently OAF do not track their farmers' tree stocks for volume or quality, but hope to implement this in future.

Uganda Tree Growers Assoc

UTGA is a member's organisation that brings together 670 tree growers & 80,000 ha of commercial plantations across Uganda, with both large & small/ medium scale growers. The organisation has achieved the region's first Group Scheme FSC certification and is looking to support its members to access high-value markets.

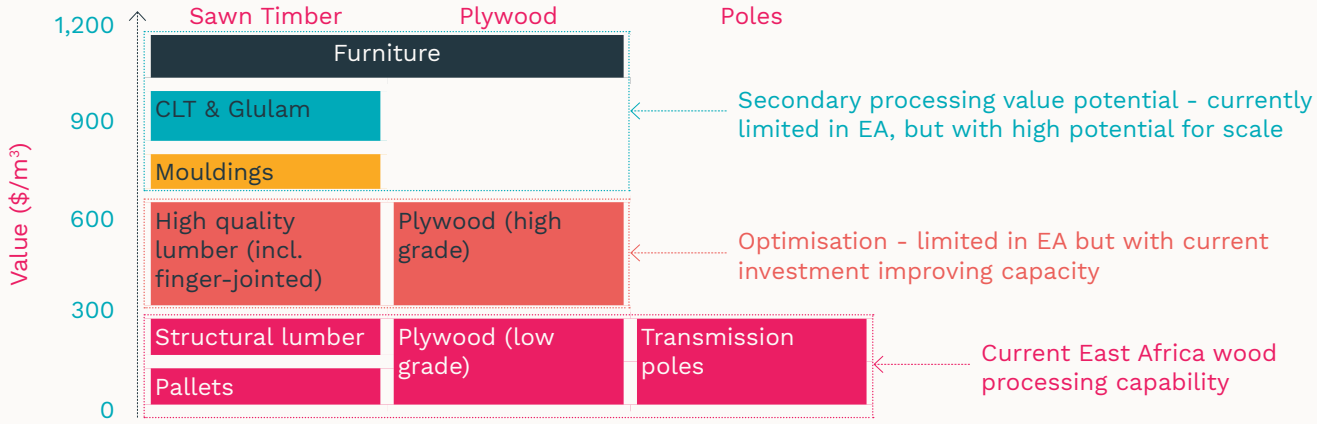
CLT PROCESSING

OVERVIEW

Processing

Optimised primary product is required to enable high value secondary processing operations, such as CLT, in turn creating green jobs at scale.

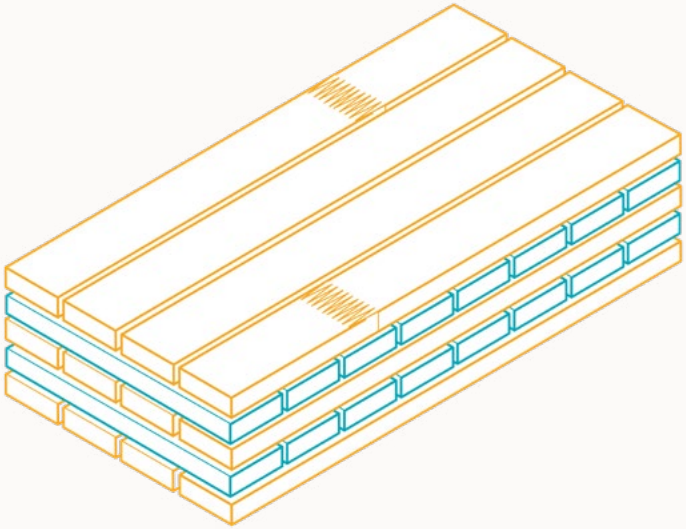
Innovation in wood processing can drive the greatest immediate market value to forestry actors considering the East African context where growth of a competitive and inclusive commercial forestry sector is central to realising Kenya's environmental, social and economic development agenda.



Alongside this, activation of a timber building market at scale is necessary to drive higher opportunities for the forestry sector and related climate benefits. Higher quality wood products can also enable built environment professionals to deliver timber buildings which transform market perception and position wood as an aspirational material.

PRODUCT

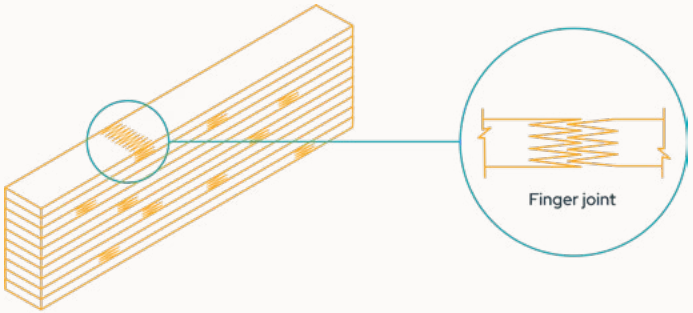
We propose two mass timber products for the East African building market: Cross-Laminated Timber (CLT) and Glue-Laminated Beams (Glulam).



CLT and glulam are two of the most popular and widely used mass timber building products globally. They combine well together, and can be used to create almost any type or size of structure. Moreover, the manufacturing process for each is highly compatible.

Cross-Laminated Timber
CLT panels are made by gluing together multiple solid wood pieces ("lamellas") in counter-directional layers to create large loadbearing panels for walls or floors. Each panel consists of an odd number of layers (typically 3, 5, or 7) according to strength and thickness requirements. Glue is applied between the layers and pressed under large hydraulic (proposed for East Africa), pneumatic, or vacuum presses. Panel sizes range up to 3m x 8m and 360mm thickness. Post-production enhancements can then be made using a CNC router to make the necessary cuts (e.g. for utility conduits, joints, or openings) according to the specific building design.

Panels can be finished to different quality levels:
1. **Exposed CLT:** panels with the highest visual quality sawn timber grading classes.
2. **Industrial:** panels with a moderate finish quality, achieved by mixing visual and strength-based grading classes of the sawn timber used.
3. **Non-exposed CLT:** panels with a low finish quality using only strength-based grading classes.



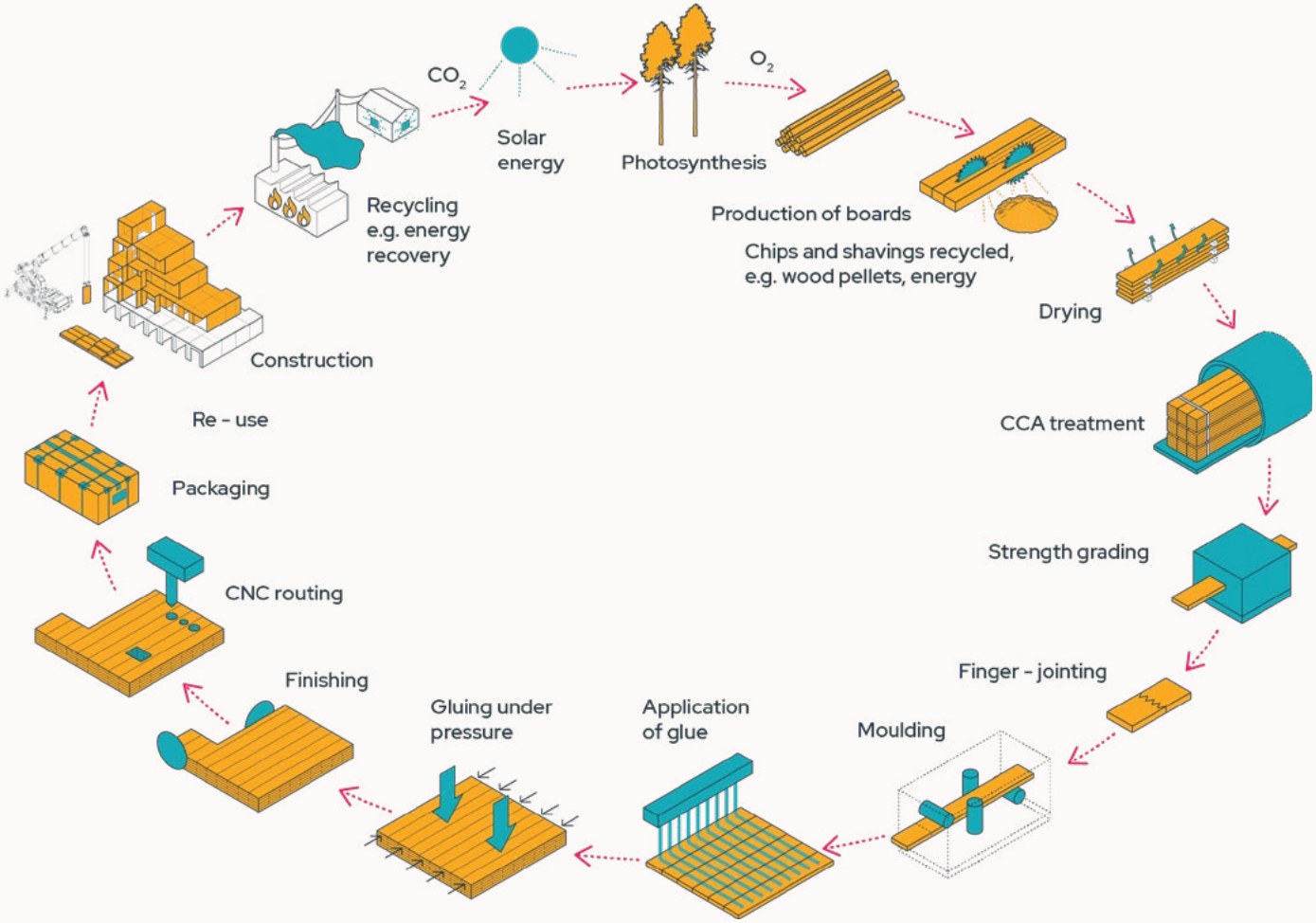
Glue-Laminated Timber
Glulam beams (or columns) are made by gluing the lamellas together in the same direction across each layer, and can be used to create frame structures or as beams together with CLT panels to span wider distances.

PROCESSING

CLT processing is a circular system which produces minimal unusable waste. The methods and equipment used are typically the same worldwide.

Steps:

Photosynthesis - Trees absorb CO_2 and water from the air and soil, transforming it into glucose and oxygen respectively. The CO_2 is stored in the wood, even when harvested.
Production of Boards - Harvested logs are sawn into planks, known as "lamellas".
Drying - The wood must be dried, using kilns, to reduce the moisture content to ~12% (+/- 2%).
CCA Treatment - The lamellas are treated with a preservative (Chromated Copper Arsenate) protecting the wood from microbes and insects.
Strength Grading - Each lamella is individually graded and sorted to ensure controlled quality according to strength, aesthetics, and defects.
Finger-Jointing - Lamellas can be joined together to form longer pieces using an interlocking joint with glue.
Moulding - Lamellas are honed to fine dimensions by shaving off small amounts of wood.
Application of Glue - The lamellas are laid side-by-side with glue applied between each layer.
Gluing under Pressure - CLT panels are created by compressing the pre-glued layers together.
Finishing - The panels are trimmed and sanded to achieve the finish quality desired.
CNC Routing - Openings (e.g. windows/ doors) or channels (e.g. for electricty conduits) can be cut into the panels.
Packaging - Panels safely packed for transport to site.
Construction - The panels are lifted into place using a crane. In future, re-used panels can offset new ones.
Recycling - Any waste wood can be used as bioenergy.



PROCESSING

East Africa Status

Recent investment in high quality primary processing facilities in East Africa means the introduction of CLT processing facilities is a viable next step.

Supply Location (Forest) ⟷ Demand Location (Urban Area)

Primary processing is likely to be more efficient if handled at or near to the forest resource, except where technical capability is lacking in which case these processes can be moved to the demand location (the CLT factory).

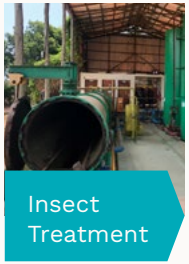
Product optimisation of this type is limited in East Africa. Pioneer firms in Uganda and Kenya are exploring FJ capabilities. Otherwise, this would need to be handled at the CLT factory.

Secondary processing for CLT is entirely new to the region and requires a bespoke technical setup. Since CLT panels are large, the factory should be as close to the demand as possible.

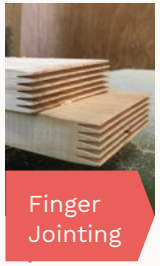

Logs

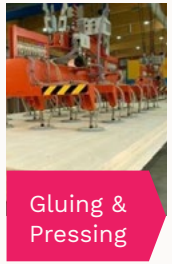

Sawmilling


Kiln Drying


Insect Treatment


Grading


Finger Jointing


Gluing & Pressing


CNC Cutting


Packaging for Shipping to Site

- Briquettes
- Wood Chips
- OSB, etc.
- Sawn Timber

Combustible

Waste

External Input/Output

- Plywood, LVL, LSL
- Transmission Poles

- Furniture
- Roof Trusses

- CLT Panels to Buildings

FACTORY

CLT Processing

XLAM

Import Partner:

Based in South Africa, **XLAM** is Africa's first CLT manufacturer. They also use the same species of Eucalyptus and Pine commonly found in East Africa, meaning their product is comparable to that which we would produce locally.

Notes:

- Capex assumes design and construction of bespoke factory building due to extra clear operating height required which is unlikely to be found in current industrial rental facilities in Nairobi. To avoid high cost of down-time or moving of heavy equipment (within space or to another location), the model assumes factory floor area required for Large Module for all modules.
- Cost prices will reduce (excl. inflation) with economies of scale over time as production capacity increases.

Setting up a local CLT factory is critical to meet cost targets, minimise carbon emissions, and foster a healthy and prosperous forest economy in East Africa.

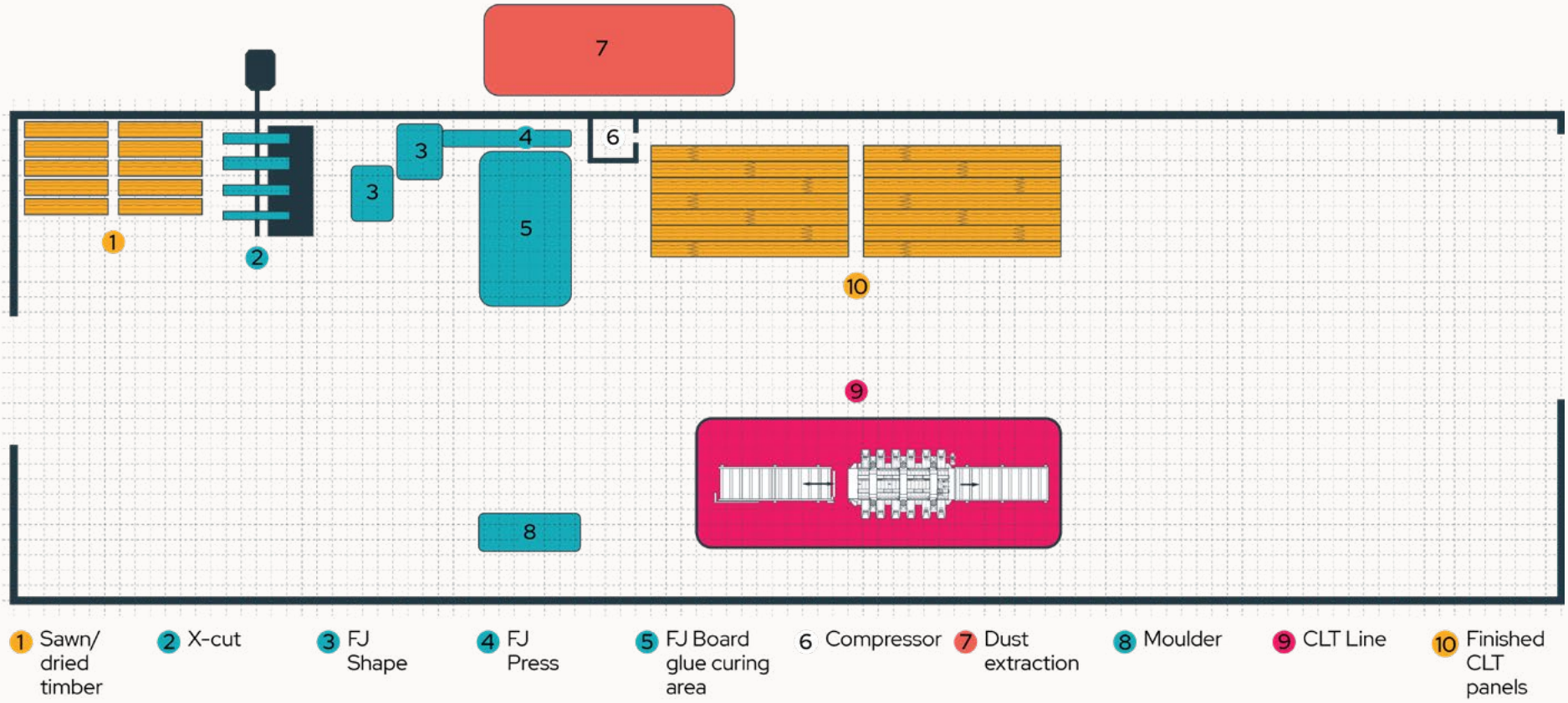
We have designed a simple CLT processing setup which balances leading technology with manual labour requirements to ensure job creation (rather than replacement) in Kenya's high unemployment rate markets. Designed to be modular, these small, medium and large setups can be further replicated and scaled up as demand grows.

Equipment	Small Module	Medium Module	Large Module
Finger Jointer	1	1	2
X-Cut	4	2	2
Moulder	1	2	3
Hydraulic Press	1	1	1
Opticut	0	1	2
CNC Machine	0	1	1
Milling	0	0	1
Power Required (kW)	329	458	715
Capex (USD)	3,087,005	4,643,547	6,776,075
Factory Floor Area (m^2)	3,250	3,250	3,250
Rate of Production (m^3/year)	4,984	8,818	18,403
Cost Price (KES/m^3 in Year 1)	63,659	60,077	58,017
Cost Price (USD/m^3 in Year 1)	589	556	537

FACTORY

Stage 1

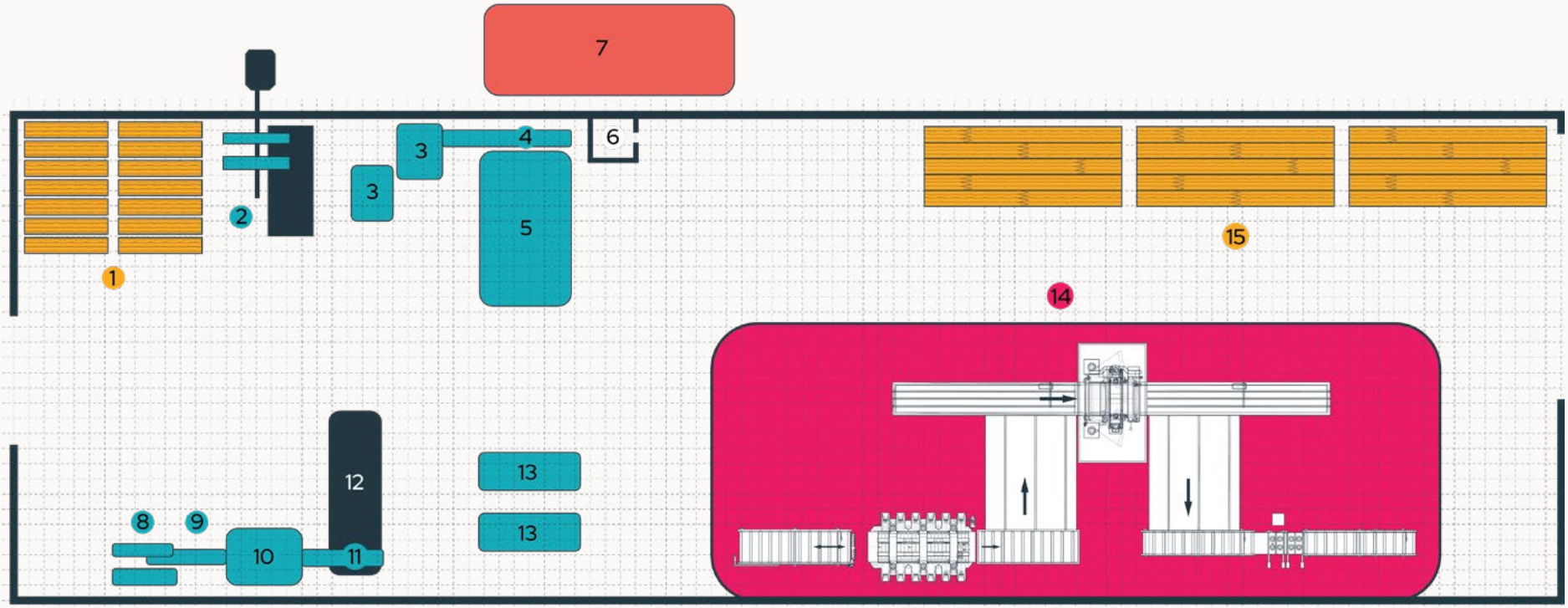
The Small Module is designed for market entry, laid out within a larger industrial space to allow for future expansion without costly relocation.



FACTORY

Stage 2

The Medium Module is designed for increased capacity and product refinement.

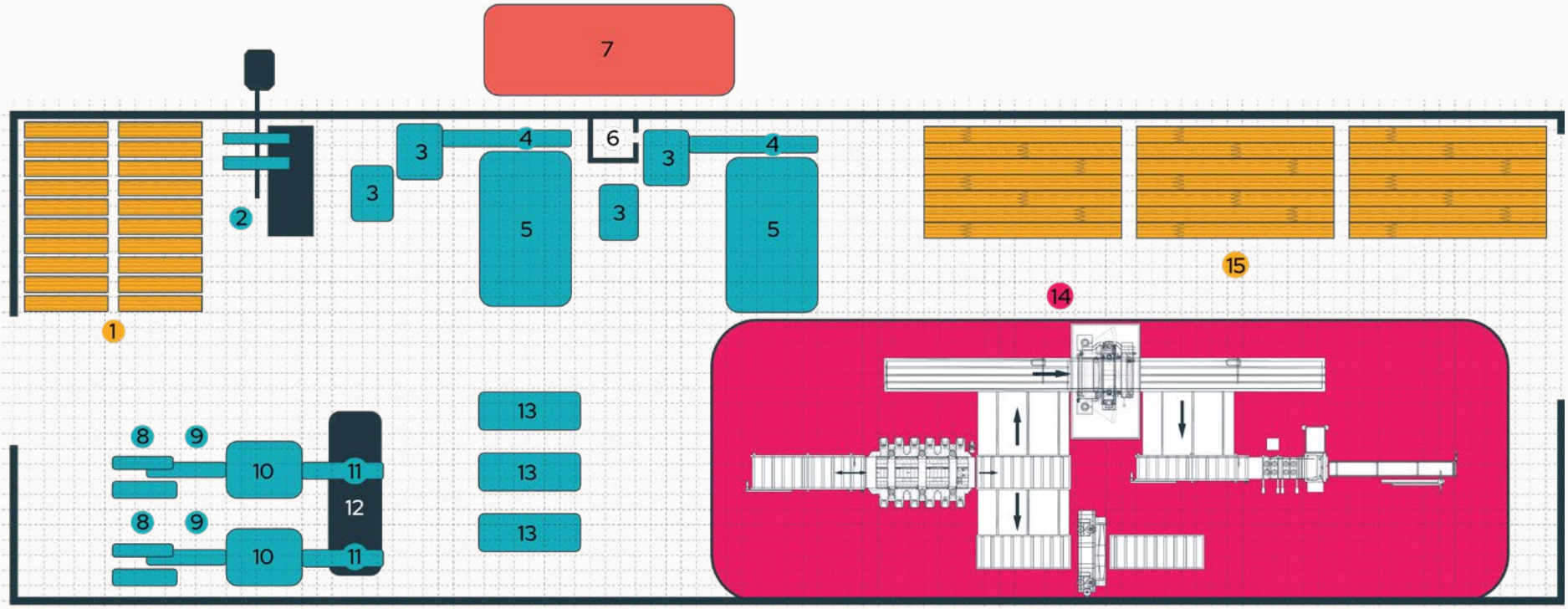


1 Sawn/ dried timber
2 X-cut
3 FJ Shape
4 FJ Press
5 FJ Board glue curing area
6 Compressor
7 Dust extraction
8 Marking
9 Infeed
10 Optiicut
11 Outfeed
12 Product conveyor
13 Moulder
14 CLT Line
15 Finished CLT panels

FACTORY

Stage 3

The Large Module maximises the use of the industrial warehouse space, with further expansion requiring additional floor space.



1 Sawn/ dried timber
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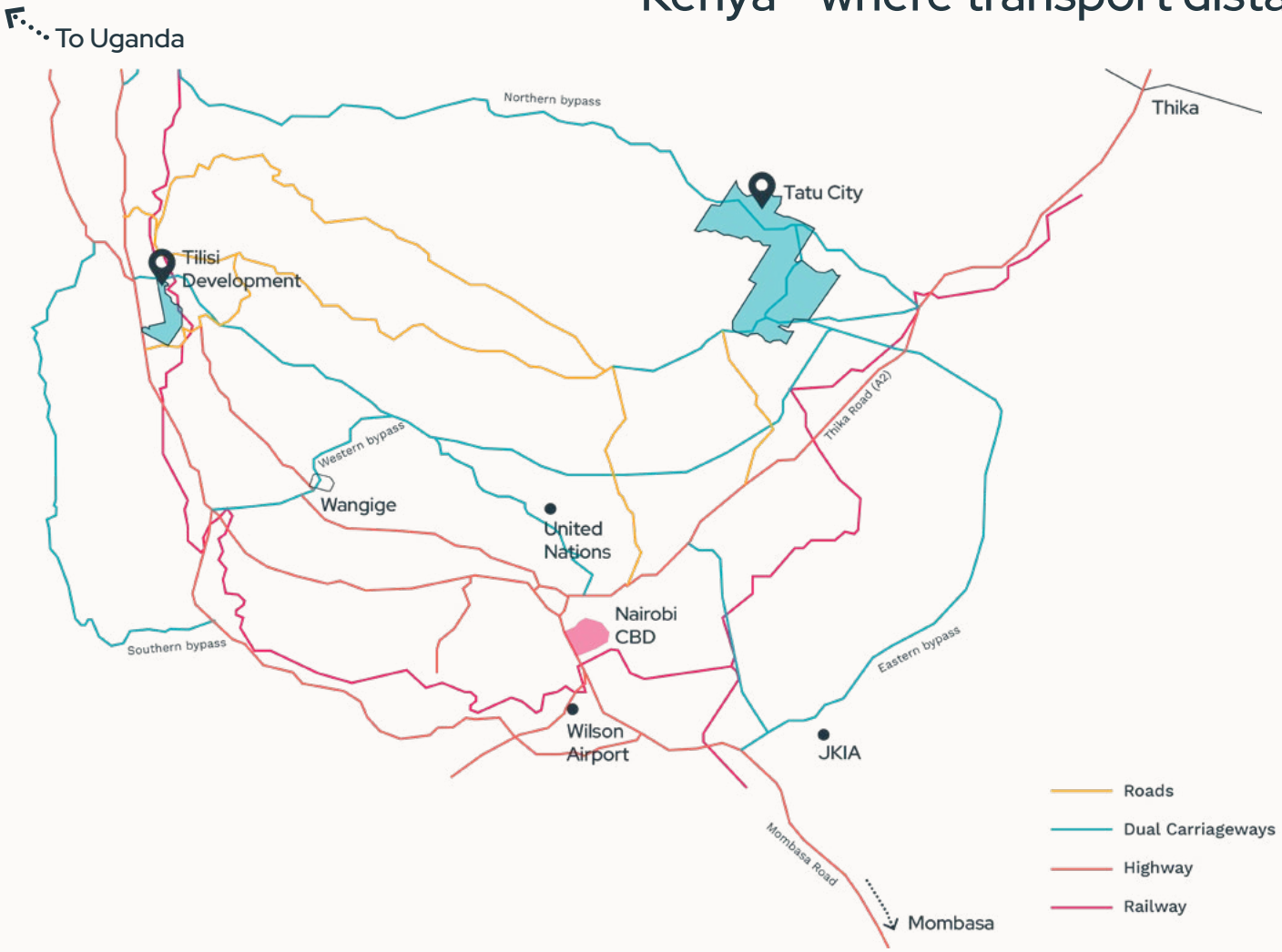
5 FJ Board glue curing area
6 Compressor
7 Dust extraction
8 Marking
9 Infeed
10 Optiicut
11 Outfeed
12 Product conveyor
13 Moulder
14 CLT Line
15 Finished CLT panels

LOCATION

CLT panels are large, meaning the best location for a factory is close to the major source of demand - Nairobi, Kenya - where transport distance can be minimised.



With forecast wood resource coming primarily from Uganda it makes sense to locate the factory to the north west or north of Nairobi. A CLT factory also requires stable power, with backup, and good transport infrastructure and linkages. For these reasons, serviced developments such as Tatu City and Tilisi offer the most competitive setup locations.

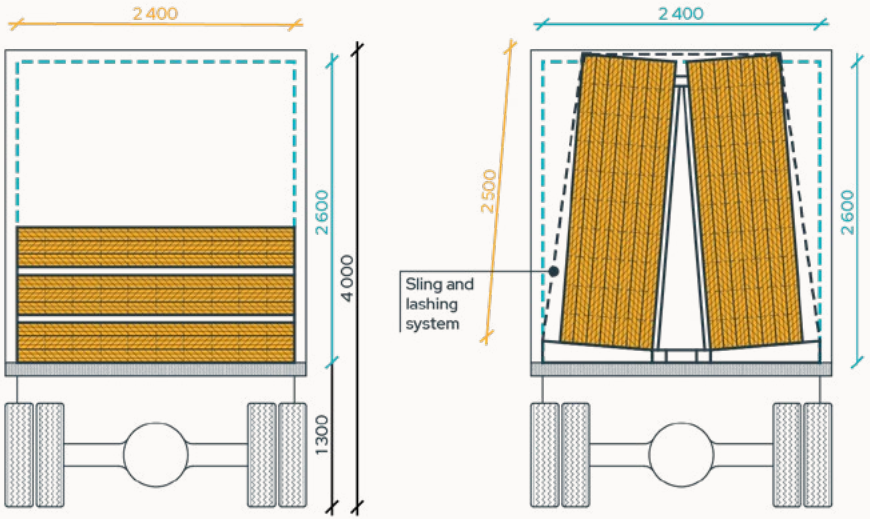
LOGISTICS

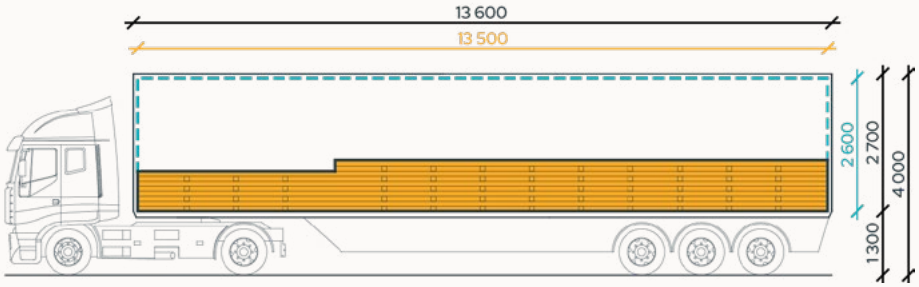
Transporting CLT

CLT panels can be produced in different sizes, variations in which will determine different loading arrangements for transport, either on an open-bed truck or in a container.

HORIZONTAL
Maximum size of transportable panel
2 400 x 13 500 mm

VERTICAL
Maximum size of transportable panel
2 500 x 13 500 mm





Trucks transporting CLT panels are rarely fully-loaded since the payload (weight limit) is usually exceeded before the loading volume capacity is reached.

For example, assuming 1m³ of CLT = ~450kg, then a 16t truck with a volume of around 80m³ will already reach its payload with 35.6m³ of CLT.

28t trucks are the most commonly available larger vehicles in Nairobi, and can carry around 62.2m³ of CLT.

PER 28T PAYLOAD/ 80m³ TRUCK	CLT Panels	Quarry Stone	Ready-Mix Concrete	EPS Panels
Max. Volume (m³)	62.2	17.5	11.7	80 (truck limit)
No. of trucks per 100m² building	1	4	6	0.65

CLT is considerably lighter per volume than stone or concrete, meaning that to construct the same area of building works it requires 4x fewer trucks than for stone construction and 6x fewer trucks than for concrete construction. EPS panels are lighter than CLT, however, only marginally more efficient due to the volumetric limits of the truck.

BUSINESS

Business Model for a CLT Factory

We propose a CLT processing business model based on providing a simple and efficient end-to-end process for customers' mass timber building projects.

Stages

Project
A Customer places an order based on a CLT building project. Customers may be developers or other building project clients.

Order Confirmed
CLT is made "to order", given the different panel sizes and specs required per each building project. An initial design appraisal is required.

CLT Processing
Once all technical details and final pricing are confirmed, the CLT panels will be manufactured and stored until ready for site (if required).

Construction
The CLT is delivered and assembled on the Customer's building site by a licensed contractor. Many finishes/fittings can already be installed off-site.

Added Services

Technical Support
In-house architects and engineers, experienced with CLT, will develop the technical information required for processing and construction.

Transport & Assembly
The panels are carefully packaged and transported to site, whilst a network of licensed contractors handle on-site assembly with supervision from the in-house experts.

Revenues

Fees for Service
Technical support fees will be built into the unit cost of the CLT product. Customers must have their own design team.

CLT Panel Sales
Our core revenue source will come from the sale of CLT panels, priced by cubic metre.

Payment Plans
As developers sell off-plan they can pay by instalment plus interest.

Optional Pricing
Customers can arrange their own transport and assembly, or opt to pay an additional lump sum fee for our team to fully deliver and assemble the panels on site.

Notes:

There are various options for the CLT processing business' role in transport and assembly on-site:

- **Delivery Only** - CLT panels delivered to site or picked up from the factory, and assembled by the Customer's own contractor. This limits liability but risks product mis-use;
- **Direct Full Service** - The factory company takes full responsibility for assembling the CLT panels on site, as a sub-contractor. This is maximum liability but ensures proper use of the product;
- **Licensed Assembly (Recommended)** - The factory trains and certifies selected building contractors to assemble the CLT panels on the Customer's site and who take on the liability for doing so.

ECONOMICS

CLT Processing

Setting up a local CLT factory is critical to meet cost targets, minimise carbon emissions, and foster a healthy and prosperous forest economy in East Africa.

We estimate that a CLT (and glulam) processing facility in Nairobi can achieve an IRR of between 13% (large module) and 17% (small module) over 11 years, based on an equity financed approach.

The larger the initial capital outlay for a local CLT factory, the lower the IRR in comparison to smaller module sizes given the same period.

In order to ensure full annual production capacity is achieved, the following demand would be required:

	Small Module	Medium Module	Large Module
Rate of Production (m^3/year)	4,984	8,818	18,403
Selling Price (KES/m^3 in Year 1)	76,391	72,092	69,620
Selling Price (USD/m^3 in Year 1)	707	668	645
New Building Demand Required (m^2)	9,968 - 16,613	17,636 - 29,393	36,806 - 61,343
Equivalent No. 2-bed affordable homes	199 - 332	353 - 588	736 - 1,227

Notes:

- The Selling Prices shown assume a fixed net profit margin of 20%;
- New building demand required is calculated on the assumption that between 0.3m^3 and 0.5m^3 of CLT is used per square metre of building area constructed;
- The equivalent number of 2-bed affordable homes have been calculated assuming a gross floor area of 50m^2 per home.

OPERATORS

An operator with experience in timber processing and the East African market will be required to establish the region's first CLT processing facility.

We plan to identify and collaborate with an operating partner who will be selected competitively, based on the following draft criteria:

Financial Strength
An operator with a strong balance sheet to lead the development of a nascent CLT processing market.

Relevant Experience
Experience doing business in East Africa or other developing markets, alongside expertise in relevant operations including timber processing (CLT or otherwise) or other manufacturing.

Track Record
Demonstrated track record and safeguards as a socially and environmentally responsible company.

Vertically Integrated
Operators who can establish a vertically integrated model, with reliable and sustainably managed own wood supply.

Inclusion
Operators with a policy of inclusion and demonstrated integration of smallholder farm forestry, and of other low income or vulnerable groups, into their supply chains.

CLT & BUILDINGS

MATERIALS

CLT compares favourably against traditional and alternative building materials, making it a compelling choice for building projects in the near future.

Material	Affordability	Embodied Energy	Ecological Impact	Circularity	Lifespan	Build Speed	Regulatory Acceptance	Social-Cultural Acceptance	Suitable for Tall Buildings	Market Availability
CLT	Moderately Desirable	Desirable	Desirable	Desirable	Desirable	Desirable	Moderately Desirable	Undesirable	Desirable	Undesirable
Concrete	Desirable	Undesirable	Undesirable	Undesirable	Desirable	Undesirable	Desirable	Desirable	Desirable	Desirable
Steel	Moderately Desirable	Undesirable	Undesirable	Moderately Desirable	Desirable	Moderately Desirable	Desirable	Moderately Desirable	Desirable	Desirable
Quarry Stone	Desirable	Moderately Desirable	Undesirable	Undesirable	Desirable	Undesirable	Desirable	Desirable	Moderately Desirable	Desirable
CSEB/ SSBs	Desirable	Desirable	Desirable	Moderately Desirable	Desirable	Moderately Desirable	Moderately Desirable	Moderately Desirable	Moderately Desirable	Desirable
Timber Frame	Moderately Desirable	Desirable	Desirable	Moderately Desirable	Moderately Desirable	Moderately Desirable	Moderately Desirable	Undesirable	Undesirable	Moderately Desirable
EPS	Desirable	Undesirable	Undesirable	Undesirable	Moderately Desirable	Desirable	Desirable	Moderately Desirable	Desirable	Desirable

	Desirable
	Moderately Desirable
	Undesirable

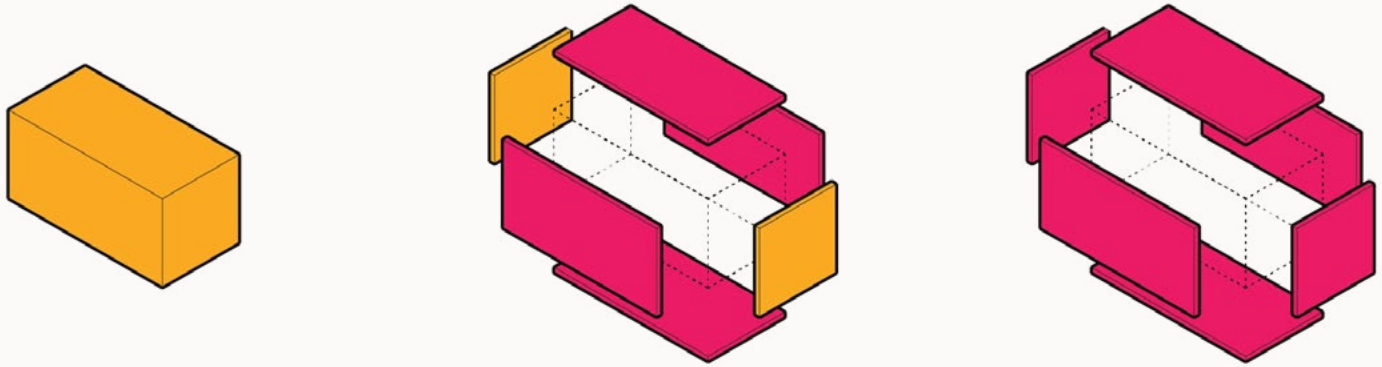
Currently the most prevalent building materials in the Kenyan market are (steel-reinforced) concrete and quarry stone, with some limited heavy-gauge steel construction for taller commercial buildings. All of these materials have heavy environmental consquences - both in emissions and ecological damage - yet remain hard to beat on cost and are thus still strongly favoured by local consumers and developers.

Compared to other alternative building materials, CLT offers the most promising opportunity to offset demand for these traditional materials, however, local production at scale is required to sufficiently match or surpass on cost.

FORMAT

CLT can be delivered to site in various formats, from a flat-pack system to a fully constructed volumetric unit, depending on project needs and priorities.

STANDARDISATION ⟷ FLEXIBILITY



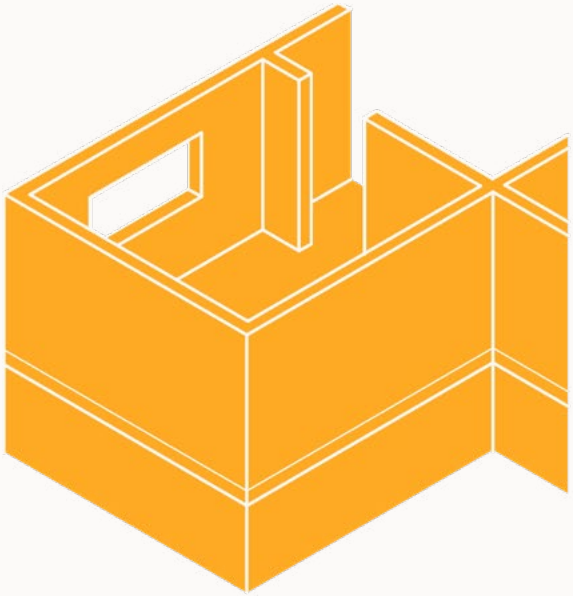
VOLUMETRIC POD CONSTRUCTION FLAT PACK

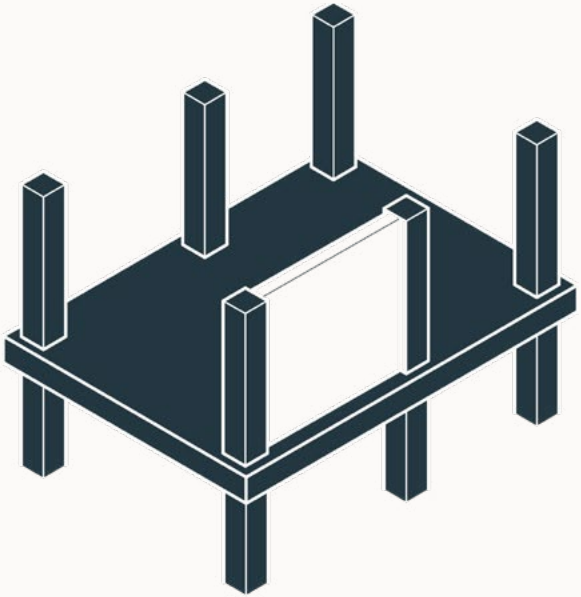
In the East African market, we believe that flat pack or pod construction (meaning volumetric pods, typically for bathrooms or kitchens, alongside flat pack panels for all other spaces) are the most feasible options since they allow for more efficient transportation and therefore reduced overall project cost.

Source:
Waugh Thistleton Architects

METHOD

CLT panels are used for all structural elements (walls and floors) as a single comprehensive construction method which doesn't require separate structure and infill.



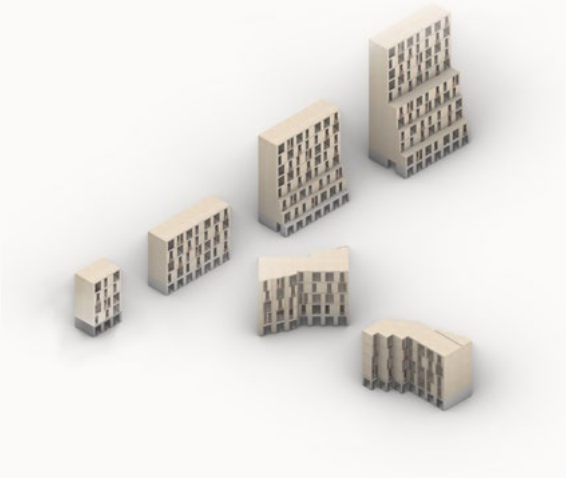


A CLT structure already includes all internal and external walls, compared to a reinforced concrete (or steel) frame which still requires infill to create the walls. In Kenya, this infill is usually quarry stone. This makes construction quicker, cleaner, and easier.

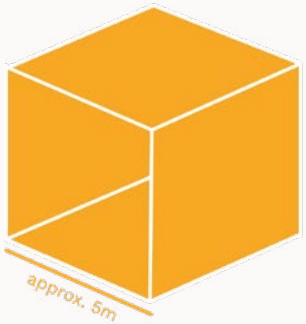
Image Source:
Waugh Thistleton Architects

TYPOLOGY

CLT can be delivered to site in various formats, from a flat-pack system to a fully constructed volumetric unit, depending on project needs and priorities.

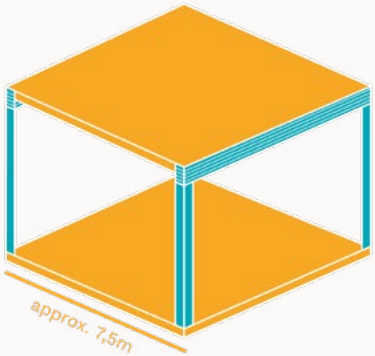


CLT is best suited for urban buildings around four storeys or higher.



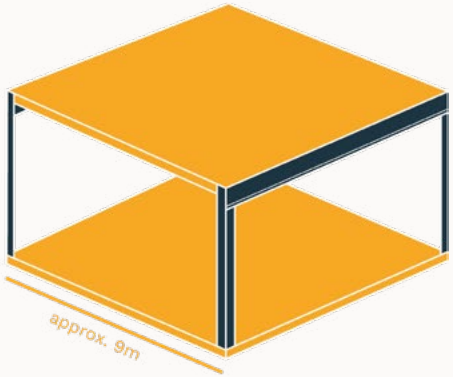
Pure CLT

CLT forms all principal structural elements.



Timber hybrid

Utilizing CLT slabs with glulam columns and beams.



Hybrid

CLT slabs supported by a concrete or steel frame.

Due to its considerable structural strength, CLT is generally best suited for urban buildings around four storeys or higher. Depending on the building design, CLT can be used in combination with other materials, including both timber and non-timber systems, to achieve different spans and structural forms.

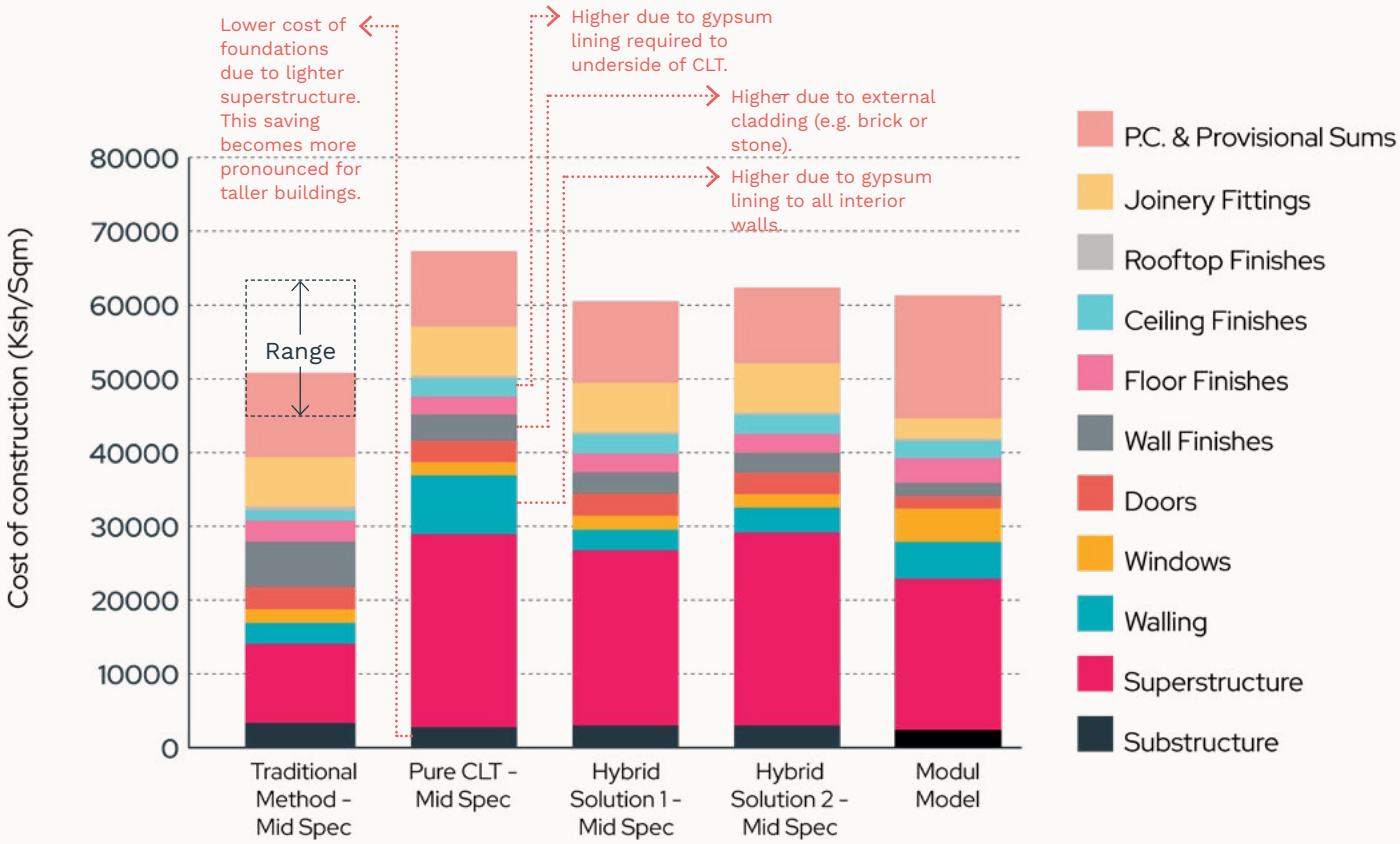
Image Source:
(right) Waugh Thistleton Architects

BUILD COST

Mid Spec

As a new product on the market, full CLT construction will cost a premium compared with traditional methods. With growth this superstructure cost will decrease significantly.

Hybrid solutions, which merge CLT elements with traditional methods can lower initial costs whilst gradually introducing the product to market.



Notes:

Pricing is based on a case study of a 13-storey medium spec residential apartment building in Nairobi.

- 'Traditional Method' assumes a steel-reinforced concrete (RC) frame, RC floor slabs, and local quarry stone infill walling.
- 'Pure CLT' assumes a full CLT superstructure (e.g. for all walls, floors, etc).
- 'Hybrid Solution 1' assumes a RC and masonry ground floor, RC stair core, and CLT walls and floors for upper storeys.
- 'Hybrid Solution 2' assumes a RC frame with masonry infill, and CLT floors.
- 'MODUL' is BuildX's full CLT urban housing system and shows the potential to reduce a pure CLT structure with effective value engineering.

BUILD COST

Low Spec

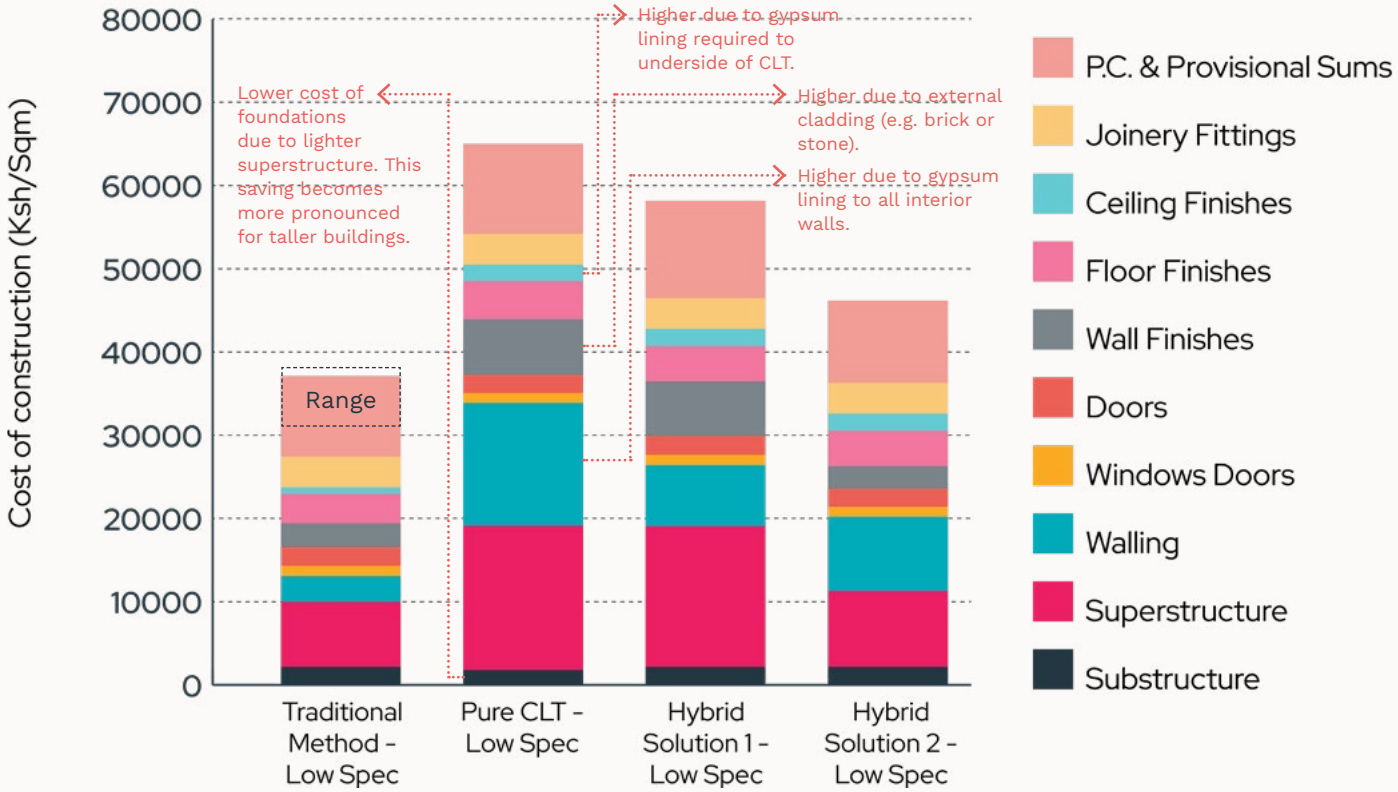
Building using locally-made CLT panels can be competitive with the mid and upper market early-on, whilst serving the affordable market will require scale.

There are a number of cost savings which can be realised over time to help reduce the cost of CLT to compete in the lower-end affordable market.

Notes:

Pricing is based on a case study of a 4-storey low spec residential apartment building in Nairobi.

- 'Traditional Method' assumes a steel-reinforced concrete (RC) frame, RC floor slabs, and local quarry stone infill walling.
- 'Pure CLT' assumes a full CLT superstructure (e.g. for all walls, floors, etc).
- 'Hybrid Solution 1' assumes a RC and masonry ground floor, RC stair core, and CLT walls and floors for upper storeys.
- 'Hybrid Solution 2' assumes a RC frame with masonry infill, and CLT floors.



SAVINGS

As a new product, CLT will initially retail at a premium compared with traditional construction. In order to close the gap, the following savings can be achieved with time:

Economies of Scale
Our cost forecasts to produce and build with CLT assume early production capacity ranges. If CLT demand scales up and claims an increasing share of the market, these costs can reduce significantly due to better efficiencies.

Vertical Integration
A CLT operator which is vertically integrated with forestry and primary processing facilities will likely be able to deliver a lower cost end product.

By Design
Design and engineering of CLT buildings is an emerging area of expertise, and there still exists many opportunities to reduce costs through design.

Panel Size
Smaller (2x2m) panels that connect together on site are an emerging trend globally and can reduce processing and transportation costs significantly.

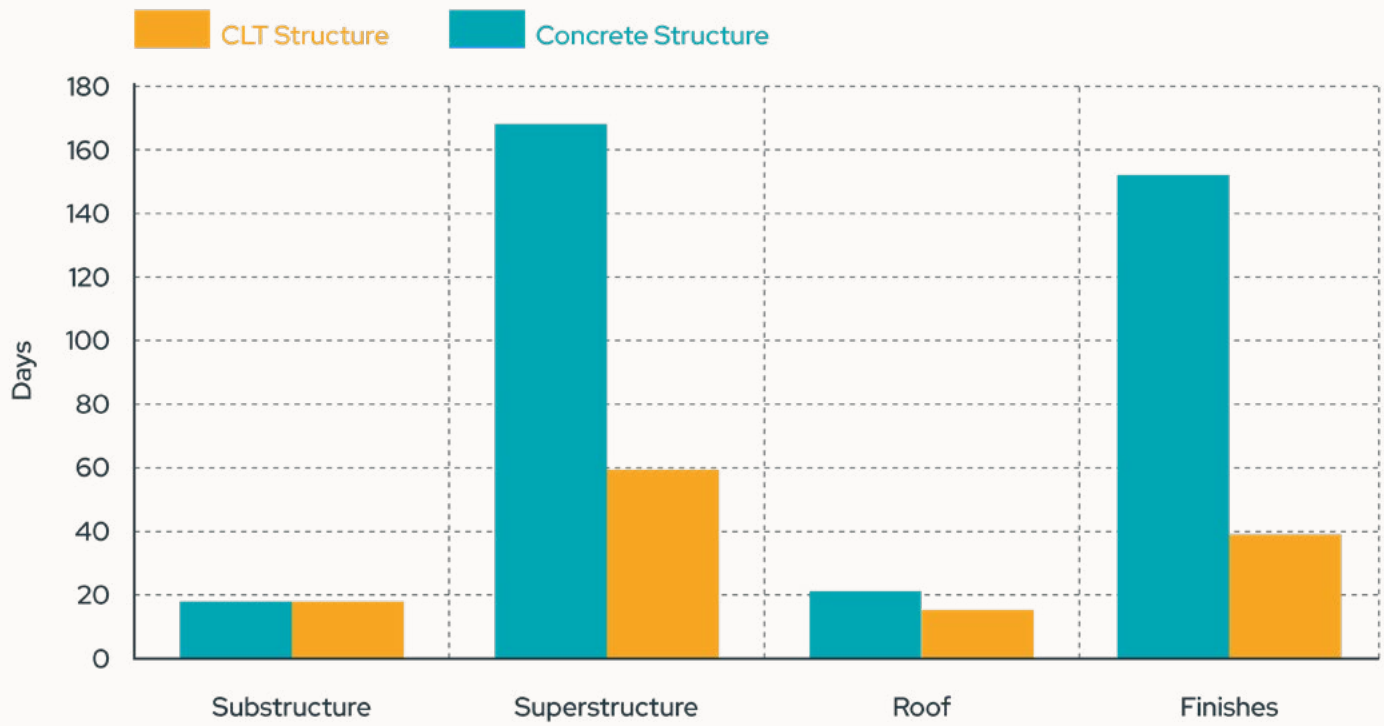
Cost of Capital
Building with CLT panels can be up to 70% faster than traditional construction, thereby reducing developers' cost of capital and offsetting a cost which would have otherwise been incurred with traditional methods.

Carbon Credits
Due to the substantial carbon offset potential of CLT, developers may be able to offset their costs by selling carbon credits in future.

BUILD TIME

CLT construction can be between 40-75% faster than traditional methods, whilst construction quality and finish is greatly enhanced through prefabrication in the factory.

In the example, below, based on an 8-storey, 750m² housing development in Nairobi, CLT assembly would be approximately 65% faster than concrete frame construction.



Notes:

- 'Traditional Method' assumes a steel-reinforced concrete (RC) frame, floors and local quarry stone infill.
- 'CLT Construction' assumes a full CLT superstructure (e.g. for all walls, floors, etc).

END OF LIFE

Few buildings are designed with end-of-life in mind, thus creating significant GHG emissions and waste. If planned well, CLT buildings can be recycled or reused.

Disposal in Landfill

CLT panels could be sent to landfills, where they will decompose and emit landfill gas, which includes methane and CO_2. In Kenya some waste-to-energy projects have been launched to convert landfill gas to usable energy, however, this is not yet a widespread practice.

\+ Some carbon stored indefinitely and landfill gas can be used to produce energy

− Landfill gas contains methane, which has greater global warming potential than an equivalent quantity of CO_2

Biomass Incineration

CLT panels could be incinerated in a biomass power plant to produce electricity. As a biomass fuel, panels could also be used to power CLT or other factories.

\+ Power produced from biomass (burning wood like CLT) potentially avoids fossil fuel use

− Carbon from CLT is released as CO_2 and the biomass power plant might not result in actual reduction in fossil fuel use

Recycling & Reuse

The best end-of-life option for CLT panels is their full reuse as structural panels in other buildings. Since the end-of-life of the overall building may occur before the end of the CLT's usable life, this may be possible. Where reuse isn't possible, the panels can be recycled to create other wood products such as wood chips or sheet wood products.

\+ Reuse or recycling of material potentially reduces or avoids the harvest of virgin wood for CLT and other wood products

− Poor planning of building projects or end-of-life management may mean intended end-of-life scenario is fulfilled

Source:
Tallwood Institute

X AN ENABLING ENVIRONMENT

OVERVIEW

There are many opportunities for CLT in Kenya, but also changes and improvements to policy and mindset shifts among key stakeholders needed to ensure success.

There are no laws, policies or regulations in Kenya which directly prohibit the construction of CLT buildings, however, as it is an entirely new technology political and institutional buy-in remains key, especially in the following areas:

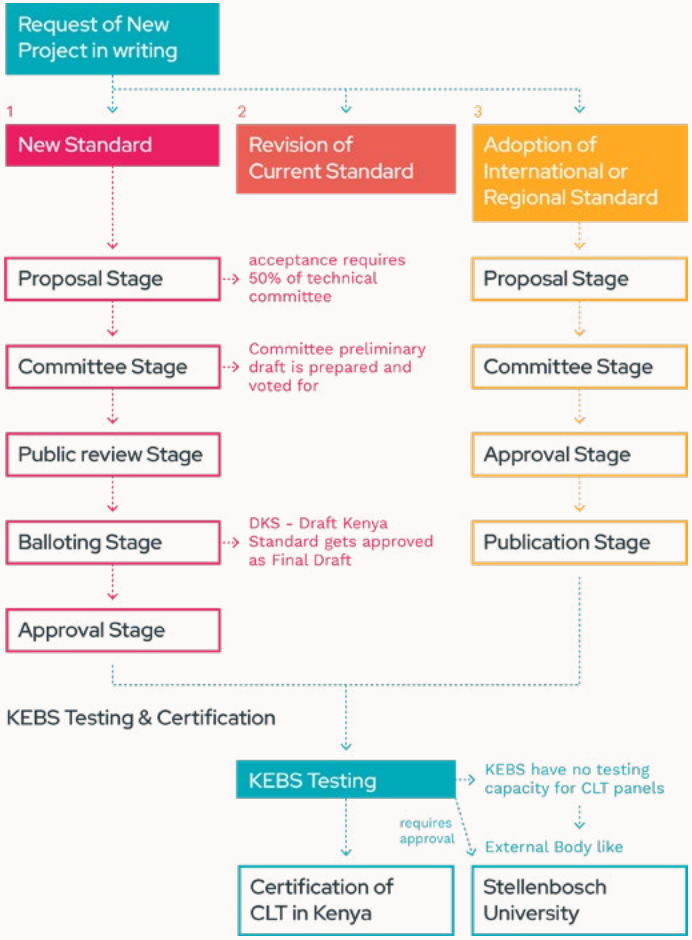
The Regulatory Environment
- Product Standards & Certification
- Building Code
- Logging Restrictions
- Importation of Sawntimber

A full value chain initiative in CLT is also very timely, aligning with Kenya's Vision 2030, Big Four Agenda, and National Climate Change Policy targets, including:

Supporting Mandates
- The Big Four Agenda - Affordable Housing
- The Big Four Agenda - Manufacturing
- Climate Targets - Kenya's Nationally Determined Contribution (NDC)
- Forestry Targets - Constutional & Vision 2030

STANDARDS

As a new product, CLT will require approval from KEBS to certify that it meets criteria for structural timber as outlined in the building code.



The Kenya Bureau of Standards (KEBS) approval process is well defined, however, testing is likely to have to be undertaken in South Africa (or otherwise outside of Kenya) due to a lack of appropriate equipment for structural timber testing.

BUILDING CODE

The Regulatory Environment

Kenya gazetted the British Standards and the Eurocodes as the official Codes of Practice for engineering as a local building code and national annexes are being developed.

The Kenya Building Regulations 2009 permits the structural use of timber in accordance with Eurocode 5 with Kenya National Annex KS EN 1995.

KEBS gazetted the Eurocodes which are gradually replacing the British Standards which have been the reference codes used in Kenya since 1969. Any design that conforms to the Eurocodes is acceptable in Nairobi County and Kiambu County. The shift to Eurocodes favours CLT construction in Kenya because the next revision of Eurocode 5 (KS EN 1995) will include the design guidance and specification of CLT panels as a structural material.

Despite the gazettement of the Eurocodes, approval in many counties is currently done using both Eurocodes and British Standards. British Standards are gradually being phased out. Although different counties have different approval procedures, structural approval follows the same engineering procedures and the approvers are expected to be Registered with the Engineers Board of Kenya.

LOGGING BAN

The Regulatory Environment

Govt extends logging freeze by six months

WEDNESDAY MAY 23 2018

A man fells a tree inside Mt Kenya Forest on January 16, 2018. The government has extended the ban on logging by six months. FILE PHOTO | NATION MEDIA GROUP

A current logging ban in Kenya continues to limit supply of sustainable timber in the country, further supporting a regional supply strategy focused primarily on Uganda.

In 2018, the GoK imposed a ban on logging in public and community forests aimed at slowing deforestation and which has also led to supply shortages and rising timber costs. Ultimately, Kenya needs to invest in better forest management, sector policy, and market regulation, aligned with wood products market demand.

IMPORT

The Regulatory Environment

Inefficiencies in the importation process for sawntimber between Uganda and Kenya must be addressed in order to ensure a reliable supply chain.

As a first step of KCFP's sector transformation strategy on unlocking win-win trade linkages between Uganda and Kenya, an importation pilot is being planned with a vertically integrated Ugandan forestry and wood processing operator. The pilot will test the current importation process by working with an appropriate logistics service provider to bring kiln dried sawntimber (suitable for CLT processing) into Kenya.

The pilot will address the following key questions: What is the cost to import? Are there opportunities to leverage backhauling opportunities to drive down the cost? How long does importation take? It will also identify constraints in the current system and potential intervention opportunities to overcome these to enable efficient trade between the two countries.

In the short term, whilst a CLT industry is being developed, importation of wood products from Uganda will go into more ready markets (e.g. furniture and general construction), and become a ready supply chain for Kenyan production of CLT when a processing facility is set-up.

The pilot has been delayed due to Covid-19 restrictions in Uganda. Processing of sawntimber with the Ugandan operator is expected to take place in September 2021 with importation of lumber into Kenya happening in early November 2021 once the sawntimber has been properly kiln dried.

BIG FOUR AGENDA

Developing a CLT market in Kenya will support two of the four pillars of the Big Four Agenda, namely Affordable Housing and Manufacturing.

Affordable Housing

Kenya's current housing shortage is estimated at 2 million units and is predicted to grow to 9 million units over the next 20 years, meaning we need to build faster and smarter. The affordable Housing Program of the Government aims at delivering 500,000 affordable homes by 2022. With only 1,000 units completed and another c. 15,000 in the pipeline, the Government is still exploring new ways to unlock the production of housing at scale in Kenya.

CLT can revolutionize affordable housing by drastically increasing the speed of construction. Provided adequate offtake is secured, CLT offers the possibility to complete large scale, replicable projects in record times, in line with political objectives.

A coordinated effort will be necessary to make the cost of CLT competitive in the affordable housing space. Alongside savings measures outlined earlier, climate financing subsidies and other incentives could be deployed to accelerate market growth and achieve the economies of scale required to drive down costs quickly.

Singapore: subsidizing CLT to unlock affordable housing supply

Singapore's CLT industry is an example of where a subsidy has been used to catalyse the industry's development through creating greater incentives for the industry to take off. Singapore saw CLT as a strategic innovation, however, in the short-term many CLT products were not cost-competitive. The government offered a subsidy equal to the additional cost of CLT which in turn unlocked demand.

Manufacturing

The GoK is working to stimulate manufacturing capabilities in Kenya toward creating one million jobs and raising the sector's contribution to GDP from 8.5% to 15%. The creation of Special Economic Zones is helping reduce costs for manufacturing companies, especially for export products. The mandate to create jobs in manufacturing is further enhanced by a wider focus by the impact-driven ecosystem on green jobs and sustainable livelihoods.

Sources:
Housing Finance Africa

CLIMATE & FORESTS

Supporting Mandates

A sustainable CLT market can help Kenya catch up on both its constitutional and national commitments to restoring forest cover and reducing its carbon emissions.

The Government of Kenya National Constitution and Vision 2030 set an ambitious target of achieving 10% forest cover. With current forest land at 7%, this represents an added 1.6 million ha.

Tree planting at such scale, and sustaining it, will rely heavily on commercial forestry with market forces incentivising growers to keep planting. CLT could unlock a high value, high volume market creating a new market demand pull to stimulate such planting.

This is supported by Kenya's recently updated Nationally Determined Contribution (NDC) to the United Nations Framework on Climate Change, which includes scaling of nature based solutions for mitigation and enhancement of REDD+ activities.

In order to meet or exceed its targets, Kenya needs to find ways of significantly reducing its annual emissions, with the forestry and construction sectors presenting leading opportunities to do so.

× TEAM

ABOUT

BuildX creates **radically better buildings**. We design, build & develop green buildings which meet market demand & have the potential to change how others build in future.

We are a design-build-develop B Corporation incorporated in Nairobi, Kenya, in 2016. We leverage our capabilities in architecture, engineering and construction to identify and create real estate projects which set radically better examples for social and environmental impact.

Following a Theory of Change approach, we build partnerships to package these innovations for replication at scale, transforming the way we build and its impact on people and our planet.

× We Design

× We Build

× We Develop

LEADERS

BuildX's committed, experienced and visionary leadership team is >70% women, whilst BuildX is 50% women-owned.

Elizabeth Wangechi Chege
Board Member

Vice Chair at World Green Building. Council Africa Regional Network.
Chair of Kenya Green Building Society.
CEO & Co-Founder at WEB Ltd.
Government of Kenya Advisor for Climate Action Summit.

Charlene Chen
Board Member

COO at Lantum.
Co-Founder & Board Director at AZA Finance (Bit Pesa).
Founder at COOhort.

Tom Kabuga
Board Member

Director at Pangea Capital.
Former COO, Centum Capital Partners.
Trustee at The Kays Foundation.

Carolina Larrazábal
Co-Founder & Design Director

5+ years design leadership.
MArch University of Navarra.
Amani Institute Leader for Impact.
Miller Center GSBI/AMP Alumni.

James Mitchell
Co-Founder & CEO

13+ years design build leadership.
MArch Cardiff University.
Co-Founder/ Board Chair of Buildher.
Mulago Henry Arnhold Fellow (2021).

Ciru Okobi
Board Member

Commercial Director at Actis (Garden City).
MBA Bentley University.
Masters in Finance Bentley University.

Lilian Oyando
Finance Director

13+ years in finance/ investment sector.
MSc Oxford University.
BCom University of South Africa.
Founder, Side Africa (Pty) Ltd.

Maryanne Tana
Operations Director

13+ years operations leadership in construction.
BEng (Architectural) Cardiff University.
Institution of Civil Engineers (ICE).
IStructE Graduate.

TEAM

We have built a committed, experienced and visionary XLT project team consisting of BuildX staff and other key experts and advisors.

Wesam Al Asali
Innovation Fellow

8+ years design experience
Phd, Centre for Natural Material Innovation, University of Cambridge.
Founder, CERCAA (training centre)

Nick Milestone
Global Mass Timber Executive

Senior Vice President Strategy & Partnerships, Softwood Lumber Board.
Chairman, TRADA.

George Wekesa
Designer

BORAQS Qualified Architect
BArch University of Nairobi
Autodesk University Fellow

We are also working with:

AKT II is a London-based structural engineering firm with experience on many of the world's leading mass timber projects.
They are supporting the structural design of our CLT flat-pack housing system.

Axel Decavele
Special Projects Lead

12+ years in real estate development & advisory
Master in Urban Planning & Project Management

Kimani Muiru
Quantity Surveyor

BORAQS Qualified QS
Bachelor of Quantity Surveying, University of Nairobi

Nathan King
Automation & Industrialised Constr.

Technology Centers Senior Strategic Relationships Manager, Autodesk
Co-Director, Center for Design Research, Virginia Tech

Carolin Schramm
Impact Lead

MSc Development Management
BA Business Administration & Management
15+ experience in MERL

X NEXT STEPS

GAPS

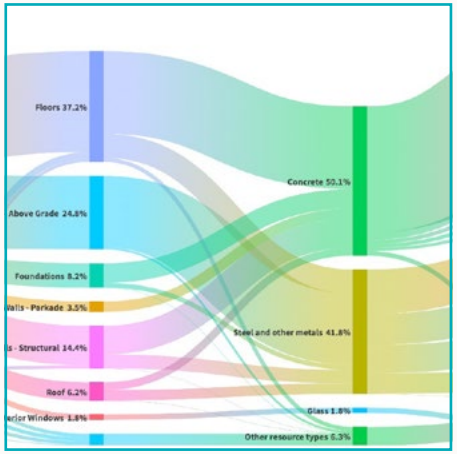
Looking ahead, we have identified some key gaps, other than capital, where added support and focus can significantly boost the project and our chances of success.

CLT Testing

We will need to run product tests, including for structural and fire resistance, on a trial CLT product in order to meet Kenya Bureau of Standards requirements.

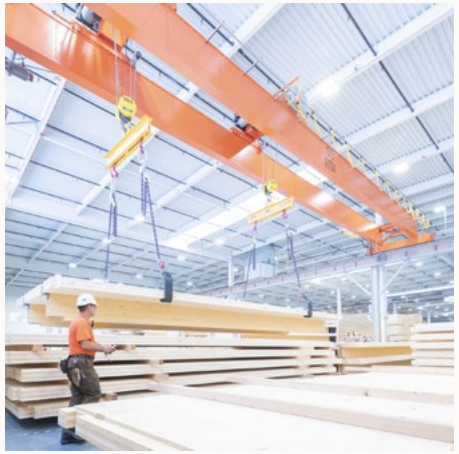
Behaviour Change

We are already following a behaviour change approach, listening to key stakeholders and undertstanding the barriers and motivators which affect current behaviour and which can change behaviours in the ways we need them to. However, we need to bring on board behaviour change experts to carry out deeper research and implement this area of our strategy.



Carbon & LCA Analyses

Calculating the carbon life cycle of CLT is a complex exercise which varies by geographic location and is greatly impacted by the biogeophysical energy, material, and information of the specific forest source. It is critical that we gather intelligent data to ensure our initiative does no harm and is optimised for maximum climate-positive impact. Exploration of verified emission reductions (carbon offsets) associated with CLT could open up future financing options, in addition to climate finance in general.



CLT Factory Operator

Although BuildX is leading the development of the CLT Factory planning at this early stage, an experienced CLT (or other engineered timber) manufacturing operator will be required to manage the factory.

Additionally, capacity building and technical assistance may be required around processing and related skills training (for manufacturing, design and building with CLT).

Public Sector & Policy

Ensuring Government and institutional support and buy-in is the major barrier we need to unlock in order to implement and scale this initiative. Support from skilled public sector and policy advocacy partners, as well as globally-renowned experts on our team, will be required to garner this critical support and help foster an enabling environment going forward. Additional advocacy at a regional and international level will also be valuable in scaling up CLT beyond Kenya and even in opening up export markets for CLT.

THANK YOU

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Companies To Inspire Africa
2019

Design for Health & Wellness
2019

Aspen Spotlight Health Awardee
2018

Shortlisted
2018

Curry Stone Honoree
2017

GSBI & AMP Alumni
2016 & 2020

Our sister-organisation:

buildher.org

buildxstudio.com