East Africa sustainable timber construction
Supply and demand study

Long report

Contents

Decarbonising the construction boom

By 2050 one billion additional people will live in African cities, all of whom need decent housing, schools and places to work. If the Paris Agreement to limit the world's temperature increase to 1.5°C above pre-industrial levels is to be met, a range of solutions are urgently required to decarbonise the coming construction boom.

As a natural low carbon material, the role that timber can play in place of carbon intensive materials such as steel and concrete is gaining increased attention. A recent study[1] suggested that housing 90% of the world's growing urban population in mid-rise wooden buildings could prevent 106bn tons of carbon emissions by 2100. This is equivalent to the last 20 years of USA carbon emissions.

Material switching on this scale would create unprecedented new demand for timber which in turn leads to concern over whether it can be supplied sustainably from managed plantations without adverse impact on natural forest.

This research presents the findings from a supply and demand study for sustainable timber in construction, and mass engineered timber (MET) in particular. It includes 20-year projections of how this may change under three scenarios: 'business as usual', a realistic 'timber transition', and optimistic 'timber renaissance'.

Given the scale of the challenge we face to balance the needs of the environment and of society our optimistic scenario or 'timber renaissance' is purposefully ambitious, requiring systemic change in the enabling environment, supply chain and the construction industry.

Method

Our research focused on three overarching factors, the enabling environment, supply, and demand. Research into the enabling environment and demand focused on Kenya. While supply, looked at Kenya, Tanzania and Uganda.

Data gathering was based on stakeholder mapping, documentation review and interviews. Subsequently we developed qualitative descriptions of the three scenarios as a way of illustrating change required to realise each.

We also developed a supply and demand model, for greater understanding of and insight into the supply chain. The supply side traces volumes from plantations through to kilns, separating the pre-requisite steps required for engineered timber. The demand side focuses on the residential sector, specifically the use of engineered timber for mid rise residential buildings, and sawn timber for single family dwellings.

In order to inform the indicative model, we carried out a concept design of a mid-rise residential timber building. This enabled us to explore cost, carbon, fire engineering and buildings insurance, specific to the Nairobi. Whilst the typology chosen is relatively typical it does not necessarily equate to an average design and so the numbers generated by scaling up this typology in the demand model should be treated with caution.

Methodology

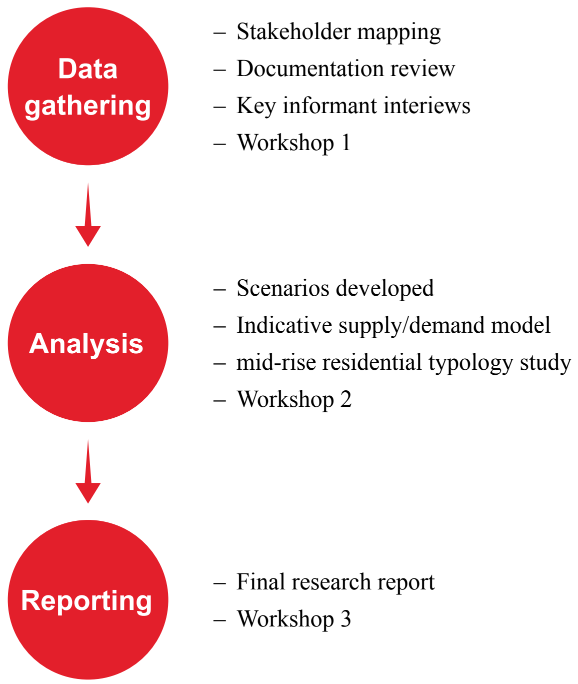
Overview and Research Framework

The study was split into three main stages: data gathering, analysis and reporting with key activities at each stage.

The research framework provides a holistic approach to the study, it was reviewed during inception via a workshop. It is divided into three sections: enabling environment, supply and demand.

The supply theme looked across the region (Kenya, Tanzania and Uganda) whilst demand and enabling environment were focussed on the Kenyan market.

Governance and carbon research factors were added to the framework as the study progressed in order to ensure they received adequate emphasis.



Themes	Factors	
Enabling Environment (Kenya)	– Goverance – Policy – Incentives	– Carbon – Regulations and standards – Insurance
Supply (Kenya, Uganda, Tanzania)	– Timber supply	– Manufacturing capability/capacity
Demand (Kenya)	– Need/quantum – Structural typologies – Design capability	– Construction capability – Cost – Acceptance

Key Assumptions and Limitations

Supply and demand modelling

Additional research is needed to understand timber flows outside of construction and within informal construction sector. The basis for sawn timber demand is outdated.

Sawmill capacity was only gathered for Kenya.

It is assumed that 35% of round log volume is 'recovered' during sawmilling, 65% of the round log volume is lost to offcuts and sawdust.

The study focuses on the use of timber in construction and on the commercial and residential sectors. The residential sector in particular is expected to drive demand. The residential market is assumed to be split equally between multi-unit residential and single family dwellings.

The construction industry can be conservative in adopting new technology and we have arbitrarily estimated that the hybrid construction typology would capture twice the market share, compared to the mass timber option.

Our demand model is based primarily on the mid-rise residential typology study. Whilst the typology study represents a reasonable example of mid-rise residential development, there are many other variations and alternative solutions which could alter the results of the model.

Cost models

Inflation was not considered in cost assessment.

Incentives such as tax relief and carbon markets are not accounted for, which could further favour the use of timber.

Fire protection costs capture sprinklers only and does not allow for additional fire protection such as additional fire boarding/protection.

Scenarios

2040 Scenarios Introduction

We developed three 2040 scenarios: 'business as usual', 'timber transition' and 'timber renaissance'. Factors affecting the use of timber in construction are qualitatively described for each scenario. These scenarios help to generate a series of actions for various stakeholders and also serve to provide context to the indicative supply and demand model, which was likewise developed for the 2040 scenarios.

	Business as usual (BAU)	Timber transition (TT)	Timber renaissance (TR)
Research factor	Qualitative description of a 'business as usual' scenario for a given research factor, based upon the current baseline situation.	Qualitative description of our realistic/conservative scenario for a given research factor.	Qualitative description of our optimistic scenario for a given research factor. This would require systemic change in the enabling environment, the supply chain and the construction industry.
Enabling environment			
Governance	On the supply side the Kenya Forestry Service represents the interests of plantations with the Kenya Association of Manufacturers representing the value chain. Both the National Construction Authority and Kenya Green Building Society are working to promote the sustainable use of timber within their broader activities around green construction. At present there is no dedicated body for advancing the use of sustainable timber in construction.	The Kenya Association for Sustainable Timber (KAST) is established with a remit to promote and advance the use of sustainable timber in design and construction. With limited funding it focusses its efforts on awareness and developing a National Timber Framework that sets out a roadmap to growth of the sustainable timber sector in Kenya.	The new body: – Has strong links to national government and the construction industry. – Is engaged with universities for establishing dedicated timber design modules and developed CPD training for local professionals. – Establishes a strong network with regional and international counterparts.

	Business as usual (BAU)	Timber transition (TT)	Timber renaissance (TR)
Policy	The Kenya logging moratorium remains in place with a lack of clarity over when it may be lifted. This continues to have a negative impact on the domestic sawmilling sector. The government has decreed that that all affordable housing developments under the nation's 'Big 4' agenda are required to meet EDGE Certified green building standard (Level 1). As a result, developers become more familiar with EDGE standards and the requirements to design and build resource-efficient structures.	The moratorium gets lifted in 2022. The sawmilling sector begins to recover as a result. Government of Kenya requires all new build housing to achieve EDGE Certified (Level 1) and sets targets for EDGE Advanced (Level 2). As a result, more developers consider timber KAST authors a National Timber Sector Development Framework but investment required to implement is lacking.	The National Timber Sector Development Framework has been implemented – it is well received and gains engagement from relevant ministries. Sawmilling sector sees significant investment from government and private sector. EDGE certification becomes the norm within the construction industry, with 70% of all building projects achieving EDGE certification and all government projects required to meet EDGE Advanced (Level 2) certification.
Incentives	A small number of real estate and financial institutions provide loans and bonds to support green construction projects tied to IFC EDGE certification targets. National incentives such as tax relief on the importation of raw timber are applied inconsistently.	Financial incentives tied to EDGE certification have increased, targeting the housing sector in particular. In order to meet these targets more projects look to incorporate sawn timber and in limited cases engineered mass timber to meet the EDGE certification requirements.	EU funded Uganda Sawlog Production Grant Scheme has been replicated across the region and has resulted in the re-establishment and certification of a proportion of the KFS plantations. A wide range of supply and demand incentives have promoted the use of timber in construction and served to reduce costs with use accelerating accordingly.
Carbon	Kenya remains without an industry/manufacturing carbon tax or CO_2 emissions trading system. Existing energy tax instruments create little incentive for material switching in the built environment and demand for engineered timber products. Embodied carbon is not a regulated consideration at point of design and construction. Building codes are silent on the issue. Planning and environmental consenting mechanisms for development set no requirements.	A carbon taxation mechanism is created, focused on industry, manufacturing and land use, land use change and forestry activities (LULUCF). A forward pricing corridor is established but it falls short of Paris aligned goals. Industrial sectors establish basic decarbonisation plans. Whilst promotion and advocacy for carbon measurement and management becomes common practice within design community and clients.	Kenya implements industry, manufacturing and LULUCF carbon taxation mechanism with Paris aligned pricing corridor. This is reinforced with a built environment focused instrument applied at the design/construction stage, that drives low carbon material choices. Building codes stipulate objectives for embodied emissions abatement. That results in development of expertise in carbon measurement, management and design. Country benefits from considerable investment flow from mandatory and voluntary offset mechanisms for nature-based solutions including forestry.

	Business as usual (BAU)	Timber transition (TT)	Timber renaissance (TR)
Regulations and Standards	The National Building Code 2020 remains in draft form. Designers continue to refer to NBC 1968 which refers to outdated British standards which in turn do not cover engineered timber and preclude use of structural timber above two storeys for fire.	The National Building Code 2020 gets approved which in turn refers to the suite of timber Eurocodes, including MET and fire. Whilst their use remains rare, designers and authorities start to have awareness of timber Eurocodes.	Kenya develops national annexes for Eurocode timber design setting out context specific requirements. KEBS (Kenya Bureau of Standards) develops a new Kenya MET testing standard to meet demand from a number of testing facilities which have been set up.
Insurance	The local insurance market remains largely untested for multi-storey MET buildings. A small number of local branches with international connections are open to providing insurance for buildings of hybrid or MET construction. Provided that they are supported by additional documentation e.g. a fire life safety report, fire strategy report and fire rating certification.	Two local insurers with international connections have insured MET mid-rise towers. Due to limited precedence in the region, higher risk and premiums are put in place by insurers.	All the major players in the buildings insurance market now offer insurance for both hybrid and full MET construction. With a high number of hybrid and mass timber projects being built each year the cost premium has reduced significantly.
Supply (Kenya, Uganda, Tanzania)			
Plantations	Forests in the region are not replanted/sustainably managed. The increasing supply of sawn wood in Uganda and Tanzania results in an over-supply of low-grade, wet-off-saw sawn wood and ultimately a reduction in prices and consequent conversion of plantations to other land uses.	Existing forests in Uganda and Tanzania are sustainably managed and reestablishment within KFS plantations proceeds. Small holdings in Kenya are unable to produce logs of adequate quality for structural sawn wood.	Existing forests are sustainably managed with additional forests planted. Forestry plantation areas are expanded by 77% in Uganda, Kenya and Tanzania, compared to BAU, through a suite of mechanisms that include public-private partnerships, outgrower schemes and local grower groups.
Species, size, grade	There are extensive areas (some 668,000 ha) of eucalyptus, pine and cypress plantations within the region. Only a small proportion of the plantations within the region are FSC certified (7%), a very limited portion of which can be graded due to the limited kiln drying capacity. This results in a very limited volume of sawn wood being suitable for engineered timber products.	FSC certification increases to 14% across the region as KFS, UTGA and Tanzania's small to medium growers start to achieve certification in a small proportion of their plantations, through group schemes and via market incentives. As a result, a greater portion of the sawn timber stock is suitable for engineered timber products, but grading is still limited by capacity and limited investment in the value chain.	Quality has increased through improved forest management practices and wider-scale membership of FSC-certification group schemes. This results in ~40% of plantations within the East Africa region achieving FSC certification. Greater investment in the value chain has resulted in a greater proportion of the certified sawn wood stock being graded and therefore suitable for engineered timber products.

	Business as usual (BAU)	Timber transition (TT)	Timber renaissance (TR)
Manufacturing	The moratorium has led to several sawmills and other manufacturing facilities closing in Kenya and no new investment. Kiln capacity remains the key bottleneck in the value chain with total kiln capacity limited to 63,000 m^3/year across Kenya, Uganda and Tanzania. The limited manufacturing capacity of MET remains solely for bespoke purposes only.	The value chain is strengthened through investment in sawmills and kilns. Kiln capacity increases by 40% to 88,000 m^3/year. Investment begins for scaling up MET manufacturing, with two large factories established in the region with a combined yearly capacity of approximately 40,000 m^3/year. Where demand exceeds manufacturing capacity CLT products are imported from South Africa or further afield.	The value chain receives substantial investment to keep increasing the volume of suitable structural grade timber, with kiln capacities increasing to 946,000 m^3/year. MET factories of varying sizes are established in Kenya, Uganda and Tanzania, with a combined capacity reaching 470,000 m^3/year. The region is known for MET on the continent.
Demand			
Need/ Quantum	The growth of the construction sector remains high (6.8% growth rate) but the green construction market remains at 3%. There is a huge demand for new affordable housing to meet the population growth within Nairobi. Lack of awareness and continued restrictions on the supply chain mean that use of timber remains limited.	Demand continues to be met predominantly by traditional construction materials and the green construction market expands to 15%. As a result, a small portion of the market 1.2% and 2.4% starts to be met by full MET and hybrid projects respectively, as developers and contractors utilise green incentives.	The green construction market grows to 70% and a higher percentage of the demand 14% and 28% starts to be met by full MET and hybrid construction projects respectively, as developers and contractors utilise green mandates and incentives for using sustainable MET within projects. Demand also increases due to reduced costs for MET as production is scaled up, and as a result of greater public interest to inhabit "green" sustainable developments.
Structual typologies	Use of timber on construction projects remains limited to doors and windows frames. In rural areas 'green' sawn timber is used for house building, primarily for roof trusses.	Construction of hybrid construction typologies become more frequent. CLT panels start being used for floors for multi-storey residential and commercial office projects. Kiln dried sawn timber becomes more widely used within high rise developments for non- structural partition walls. A small minority of rural house building projects start to use kiln dried sawn timber as opposed to 'green' sawn timber.	Full CLT and glulam structures start to be constructed for multi-storey residential and commercial office projects. Some MET is still imported, but due to significant investment within the region most MET products are sourced locally. Kiln dried sawn timber has supplanted 'green' timber for single storey roof trusses.
Design capacity	There is insufficient demand from designers to justify training courses being introduced at educational institutions. Design of MET and structural timber generally remains the preserve of international firms.	With awareness of timber gradually increasing KAST has developed a CPD module for Design to Timber Eurocode. Local firms are developing structural timber design capacity. Fire engineering for timber mid/ high rise is still delivered by international firms.	Timber design is now being taught at two major universities. Structural and fire engineering capability has developed to the point where it is exported across the region.

Scenarios

	Business as usual (BAU)	Timber transition (TT)	Timber renaissance (TR)
Construction capability	Insufficient demand means that contractors remain wary of MET and structural timber generally. The significant number of carpenters in Kenya continue to focus primarily on non- structural uses such as furniture, window frames, doors etc.	With a handful of projects under construction they are built either by international firms or by a single local firm which is investing in the dedicated skills and specialist tools required for MET construction. Initial projects suffer time and cost overruns due to mistakes during installation. As a niche technology with limited practitioners, it commands a premium.	There is a larger demand for building out of MET. Five local contractors develop the required skills for handling and installing MET elements. The local timber trade body (KAST) collates all lessons learnt from early MET projects. Site management and QA/QC procedures become more robust due to knowledge sharing implemented by KAST. Future projects are able to hold more competitive tenders, due to the number of suitable contractors available.
Cost	MET remains commercially uncompetitive within the Kenyan construction sector. A limited number of projects are able to tap into the loans and grants provided by real estate and financial institutions, where IFC EDGE certification must be achieved. In these instances overall costs are reduced and sawn timber is commonly utilised for non-structural purposes to meet the embodied energy material saving requirements.	MET use remains accessible only to high end and niche markets and there remains high dependence on climate finance and grants to construct full MET buildings. Costs reach a point where it is commercially viable to build hybrid structures for a comparable base cost to traditional methods. However, there are still items, such as fire protection measures (sprinkler systems) and building insurance which will cost a premium.	Due to significant investment across the whole value chain, the production of MET is scaled up significantly enough that the base build cost for hybrid construction becomes comparable to traditional construction and mass timber construction becomes more cost competitive. A premium is still required for additional items such as fire protection, which keeps overall building costs above traditional methods. Increased availability of financial support in the form of bonds and loans from financial institutions for green construction and carbon taxation mechanisms, are key to ensuring that MET becomes competitive.
Acceptance	The use of MET remains rare and awareness remains low among the public, developers, authorities and design professionals. As a new technology the industry remains wary of getting it wrong. End users lack familiarity and therefore trust in timber buildings.	Demonstration projects start to break down barriers and raise awareness. Costs start to come down helping to drive more frequent consideration of MET in projects.	Frequent use of timber for both high end and affordable housing, coupled with KAST awareness campaigns have driven acceptance among the public. Designers, developers and insurers have addressed fire safety and associated buildings insurance.

Typologies

Typologies Material Study

This section details a material typology study consisting of the concept design of a hypothetical mid-rise residential tower, made of timber. The concept design relied upon data specific to the context of Nairobi. It was carried out to inform the demand side of the indicative model and further research and discussion of:

– Cost

– Carbon

– Fire engineering

– Buildings insurance

The selection of the typology was informed by an initial review of the timber processing chain and how this feeds into different structural elements and forms of construction. Timber species in the region were assessed for suitability for selected construction products.

A mid-rise residential tower was chosen as this is seen as a key typology in addressing urbanisation and associated need for housing. At the same time this is also a potential application for engineered timber. A high-level scheme design of the substructure and superstructure has been carried out, to determine element sizes and material volumes.

The mid-rise timber tower was then compared against two other designs, one of which utilised traditional reinforced concrete and masonry and a third hybrid design which used a mixture of engineered timber and reinforced concrete.

– Traditional

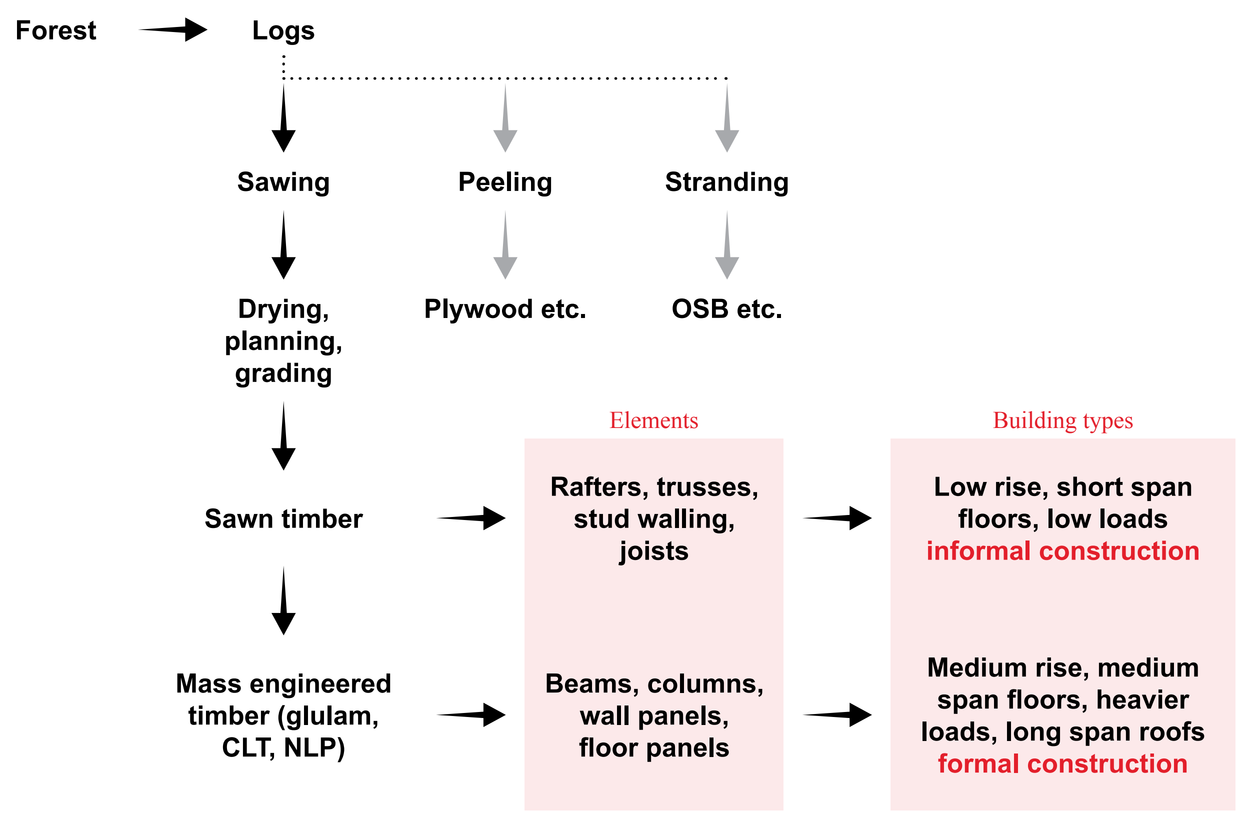
– Hybrid timber

– Fully timber

Timber Processing Chain[5]

Timber construction products originate via sawing, peeling or stranding, with sawing the focus of this study. In turn sawn timber should be dried and ideally treated before being used for products such as rafters, trusses and walling. Single family dwellings represent a key typology for the use of sawn timber.

MET represents an additional step in the supply chain. The key advantage over sawn timber is that sections of wood are glued and finger jointed together, removing knots and other weaknesses, to create an engineered material. For the purposes of this study a key typology for MET could be residential developments in urban areas.



Mass Engineered Timber Products[6]

Glue-Laminated Timber (Glulam)

To form a glulam element, wood laminations are jointed end to end, allowing for long spans, and are bonded with a durable, moisture-resistant adhesive. The laminations' grains run parallel with the member's length.

Uses: Typically used to fabricate long span beams or columns.

Cross Laminated Timber (CLT)

CLT panels consist of layered timber boards (usually three, five, or seven) stacked crosswise at 90-degree angles. Glue is applied between layers and then pressed hydraulically, pneumatically or by vacuum. Finger joints and structural adhesive connect the boards length ways.

Uses: Typical applications for CLT include floors, walls and roofing.

Mechanical Laminated Timber (e.g. Nail-Laminated Timber (NLT), Dowel-Laminated Timber (DLT))

Mechanically laminated timber is created by placing dimensioned timber on its short edge and mechanically fastening together with nails / screws or friction-fit together with dowels. Similar to glulam because grains run in one direction.

Uses: Typically used for beams within flooring and roofing applications.

International perspective

Glulam makes up 80% of the world's supply of MET and the remaining 20% is predominantly CLT.

Mass Engineered Timber Construction

Fabrication

Traditional carpentry is fabricated from relatively small members (8'x4' plywood, 10"x2" joist etc.). These members are delivered to site and assembled by hand. Machining of the members can be undertaken using handheld or electric circular saws.

MET is predominately machined in a factory setting using computer controlled machines and large table saws. Members must be handled by hoists or cranes due to their weight (>>100kg). Openings and dimensions of members must be known well in advance of construction as fabrication drawings must be created months before fabrication takes place.

Equipment

Traditional carpentry tools are low-tech, relatively low cost and ubiquitous. Hammer, handheld drills, nail gun, small self-tapping wood screws (<100mm) etc.

MET tools are similar to traditional tools but often much larger and more specialised. Drills required to insert very large screws are specialised and not readily available. Specialist tools are also required to position the large CLT panel7 or insert screws at specific angles. MET often utilises proprietary connectors that require the installer to be familiar with the manufacturer's installation procedure.

Assembly

Unlike traditional carpentry, assembly of an MET structure requires operatives competent with the handling of large heavy members at height. This requires significant skill and experience when compared to construction of light frame timber using scaffolding.

Temporary stability of large members is also a consideration that does not exist in traditional carpentry where progress is more gradual.

Storage of MET materials on site is more critical as damage (water damage or physical damage) can have significant implication to program as replacement members are not readily available.

QA/QC

As MET structures tend to have fewer components, the connections between these components becomes more critical to the building's integrity. Poor quality control can have significant implications versus a traditional timber frame which has a lot of redundancy (dozens of timber joists replaced by one CLT panel).

Key finding

MET construction requires specialist skills, training and equipment.

Species Suitability for Construction

There are two primary species of timber within the East Africa region. The below table describes the suitability of both eucalyptus and pine for sawn timber and engineered timber.

	Sawn timber	Engineered timber (mechanical)	Engineered timber (glued)
Eucalyptus	Yes	Feasible	Feasible
	Density means it is hard to drill/cut on site making it less suitable	Fabrication in workshop makes cutting easier despite density, but panels will be heavy and expensive to transport	Harder to dry, glue and machine
Pine and other softwoods	Yes	Yes	Yes
	Low density so easy to work on site	Low density so easy to join and transport pieces	Easy to kiln dry, glue and machine

International perspective

Globally, softwood species such as pine have been found to be most appropriate for construction – sawn or engineered, as a result of being easier to work with. They and are believed to represent over 99% of timber used for construction. Europe has invested in kilning and MET manufacturing to increase the value and potential of its timber.

Product Costs

This table is a summary of the costs that we have gathered through the desk study, consultation and analysis stages of this research study. Note that all costs stated are subject to change and will vary depending on market conditions.

Importation costs

If timber is being sourced from outside Kenya then there are additional costs that need to be accounted for. This includes such items as transportation, VAT, boarder verification fees, customs clearing, loading and offloading costs, import permits and KFS fees. Consultations suggest that tax relief for timber has intermittently been in place which will impact importation costs.

Approximate importation cost from Uganda to Nairobi: ~ KES 13,500 ($120) per cubic meter.

The Kenya Revenue Authority (KRA) also have their own evaluation rates for imported Ugandan timber which can add to importation costs. This is done to protect local Kenyan suppliers.

Key finding

Cost will be a key factor in demand for sustainable timber. Since the introduction of the logging moratorium the cost of sawn timber in Kenya has doubled, far exceeding costs in Uganda. Importing sawn timber from Uganda brings significant added costs. With very limited MET manufacturing capacity in the region locally sourced engineered timber is currently prohibitively expensive. South Africa manufacturers for glulam and CLT are globally competitive and are typically cheaper than European manufacturers. Importing MET into Kenya from South Africa is likely to add at least 20% to the cost.

Cost /m³ (local currency)	Cost /m³ (USD)	Comments	Source
Sawn Timber			
~ KES 58,000	$480*	Pine (2019) – sawn cost is highly dependant on government policy in Kenya and is higher than normal due logging moratorium. *Before moratorium cost for pine in 2017 was ~$240	Gatsby – Sawn Timber KCFP value chain assessment
~ KES 26,000	$220	Eucalyptus (2019)	Gatsby – Sawn Timber KCFP value chain assessment
UGX 300,000 – 450,000 UGX 150,000 – 260,000	$75 – $120 $40 – $70	Pine (2021) – costs are based on 150mm wide plank widths of varying lengths. Eucalyptus (2021) – costs are based on 150mm wide plank widths of varying lengths.	UTGA – Timber Prices in Uganda (20/09/21)
R 3,600 – 5,800	$220 – $350	Pine (2022) variation in cost depends on grade of pine used. Note there is an approx. 30-50% decrease for non kiln dried timber.	Various sawmills located in South Africa

Cost /m³ (local currency)	Cost /m³ (USD)	Comments	Source
CLT			
KES 72,000	$600	Based on BuildX Studio's factory study for local manufacturing in Kenya.	BuildX Studio
KES 140,000	$1,200	Importation rate from South Africa.	BuildX Studio
R 17,000	$1,000	Pine (2022) – South Africa.	XLAM
–	$680 – $800	Pine (2022) variation in cost depends on grade of pine used. Southern Africa region.	Confidential source
€750 – €1,300	$750 – $1,300	Costs are based on a range of manufacturers and projects based in the European region.	Arup
CAD $2,100	$1,650	Cost based on bespoke small scale order for a project in Canada.	Arup
Glulam			
KES 550,000	$4,600	Rate for locally (Kenya) manufactured Glulam from h-tes. This rate is high due to small scale manufacturing and the bespoke nature of their existing work (e.g. not mass produced)	BuildX Studio
R 16,000	$950	Pine (2022) – South Africa.	XLAM
–	$625	Pine (2022) Southern Africa region.	Confidential source
–	$1,000	Eucalyptus (2022) Southern Africa region.	Confidential source
€1,100 – €1,900	$1,100 – $1,900	Costs (inc. connections) are based on a range of manufacturers and projects based in the European region.	Arup

Mid-rise Residential Scheme Design

A typical six storey tower was selected as the building typology to carry out a schematic design of three different material options, to inform the demand aspect of the indicative model.

Across all three options a matching grid and central core arrangement was followed, which allowed for a high-level cost and carbon comparison assessment to be undertaken.

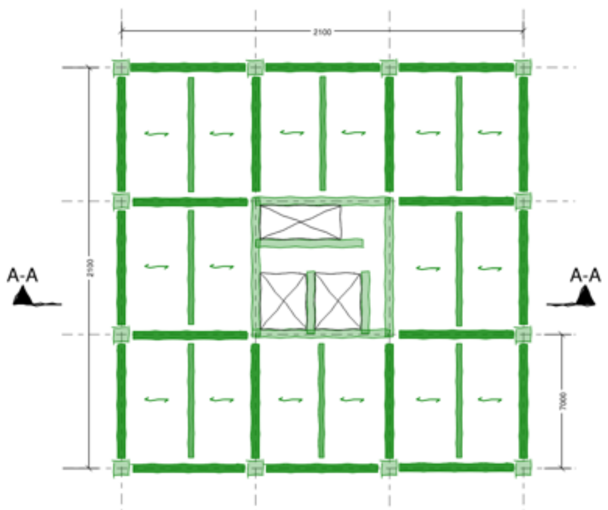
The substructure has been schemed as shallow reinforced concrete pads or strip footings, with the sizes and volume of concrete adjusted to suit the varying loading of the superstructure across the options.

The superstructure for all three options has a consistent central reinforced concrete core so the stability system is the same across all three schemes. The vertical and horizontal structure has then been changed across the hybrid and mass timber options to incorporate CLT and glulam elements.

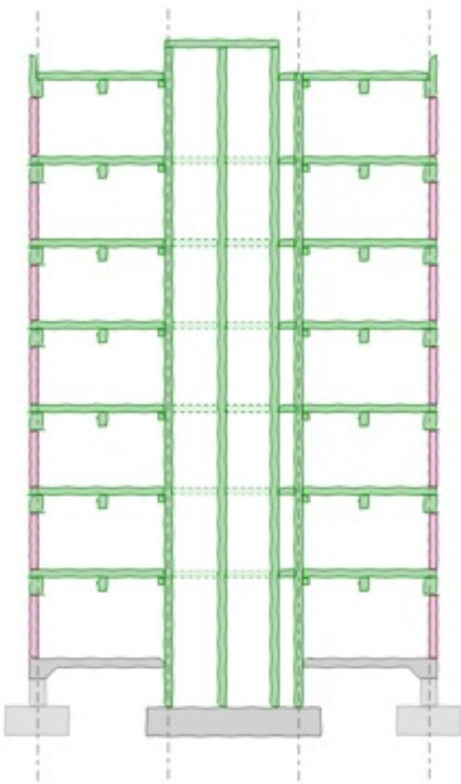
The building footprint has been sized at twenty-one metres square, with an equal grid spacing of seven metres in both directions which was a suitable span which worked economically for both traditional reinforced concrete and mass timber. Downstand beams support the chosen floor construction for each option, spanning between the central core walls and the perimeter vertical structure.

Within this scheme, seismic design was not considered. This was not a priority because the building becomes lighter across the three options which is advantageous from a seismic design perspective.

Thermal performance has also not been considered. It is worth highlighting that lightweight buildings may require additional cooling in hot climates, for example through air-conditioning.



Typical Plan View



Typical Section A-A

Materials

This page details which materials were used for specific elements (foundations, columns, etc) within each building typology.

It also provides an overall summary of the amount of concrete and of the overall amount of MET used in each of the concept designs.

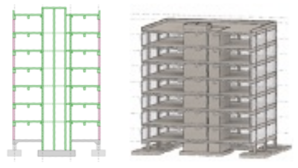
The red text signifies where changes have been made away from the baseline traditional reinforced concrete frame (option one).

*A floor screed has been assumed and allowed for in all three options.

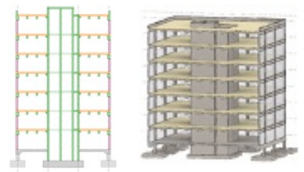
Key

- Concrete superstructure
- Mass timber
- Concrete substructure
- Perimeter infill walls

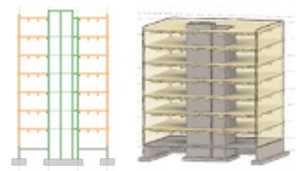
Option One – Traditional



Option Two – Hybrid



Option Three – Mass timber



	Option One – Traditional	Option Two – Hybrid	Option Three – Mass timber
Foundations	Reinforced concrete pads	Reinforced concrete pads	Reinforced concrete strip footings
Columns	Reinforced concrete	Reinforced concrete	None
Beams	Reinforced concrete	Reinforced concrete	Glulam
Floor slab	RC or beam and pot/block*	CLT*	CLT*
Core construction	Reinforced concrete	Reinforced concrete	Reinforced concrete
Perimeter walls	Masonry/stone infill	Masonry/stone infill	CLT
External cladding	Cement and sand render	Cement and sand render	Brick cladding
Internal partitions	Masonry/stone	Lightweight timber partitions	Lightweight timber partitions
Material volumes	~ 1,300m^3 0m^3	~ 800m^3 ~ 400m^3	~ 500m^3 ~ 1000m^3

Key finding

By replacing heavy materials such as stone and reinforced concrete with timber you reduce the weight of the building, which has additional savings in the design of the supporting beams, columns and foundations. This serves to further reduce the amount of concrete required.

Cost

Business as usual

Pricing is based on:

– Material volumes are from material typology study.

– Otherwise unit rates for materials have been provided by BuildX Studio, assuming a mid-range level of fit out and finish.

Key finding

For BAU the overall building costs for options two and three remain significantly more expensive due to current imported MET rates and fire protection with sprinkler systems accounting for 18% and 15% of the overall building cost for options two and three respectively.

	Option One – Traditional (USD/m²)	Option Two – Hybrid (USD/m²)	% diff'	Option Three – Mass Timber (USD/m²)	% diff'
Substructure	76	61	▼ 20%	62	▼ 19%
Superstructure	180	267	▲ 48%	426	▲ 139%
Everything else* (exc. sprinklers)	307	312	▲ 2%	312	▲ 2%
Sprinklers	N/A	139	N/A	139	N/A
Total cost **	564	779	▲ 38%	939	▲ 66%

*Everything else captures the following: non-structural walls; windows and doors; wall, floor and ceiling finishes; joinery; provisional sums for MEP works and lift installation etc.

**Omissions:

– Fire protection costs capture sprinklers only and does not allow for additional fire protection such as additional fire boarding/protection.

– Costing does not consider inflation

– Incentives such as tax relief and carbon markets are not accounted for, which could further favour the use of timber.

– BAU Scenario Specific Notes

– CLT and Glulam costing is based on current South Africa importation rates of $1,200 USD/m³

Timber transition

– CLT and glulam costing reduced to intermediate rate of $900 USD/m³ (average between theoretical local factory rate from BuildX Studio's study[8] and imported rate from South Africa).

– Cost of lightweight internal partitions have been reduced by 25% to account for reduced cost of sawn timber due to increased market availability.

– Sprinkler costs have been reduced by the same factor as the mass timber to account for an increased level of local manufacturing and less reliance on importation of materials and products.

Key finding

For TT the overall building costs remain more expensive for mass timber construction (41%) and hybrid construction (22%). Fire protection in the form of sprinkler systems could account for 15% and 13% of the overall building cost respectively.

	Option One – Traditional (USD/m²)	Option Two – Hybrid (USD/m²)	% diff'	Option Three – Mass Timber (USD/m²)	% diff'
Substructure	76	61	▼ 20%	62	▼ 19%
Superstructure	180	225	▲ 25%	329	▲ 83%
Everything else* (exc. sprinklers)	307	301	▼ 2%	301	▼ 2%
Sprinklers	N/A	104	N/A	104	N/A
Total cost **	564	692	▲ 22%	796	▲ 41%

Cost

Timber renaissance

– CLT and glulam costing assumes a rate of $600 USD/m³ (based on theoretical local factory rate from BuildX Studio's study[8]).

– Cost of lightweight internal partitions have been reduced by 50% to a rate where they are equivalent to traditional masonry partitions.

– Sprinkler costs have been reduced by the same factor as the mass timber to account for an increased level of local manufacturing and less reliance on importation of materials and products.

Key finding

For TR the overall building costs for hybrid construction becomes comparable to traditional construction methods and mass timber construction becomes more cost competitive. Fire protection in the form of sprinkler systems could account for 10-11% of the overall building cost for options two and three within the TR scenario.

	Option One – Traditional (USD/m²)	Option Two – Hybrid (USD/m²)	% diff'	Option Three – Mass Timber (USD/m²)	% diff'
Substructure	76	61	▼ 20%	62	▼ 19%
Superstructure	180	186	▲ 3%	238	▲ 32%
Everything else* (exc. sprinklers)	307	290	▼ 6%	289	▼ 6%
Sprinklers	N/A	69	N/A	69	N/A
Total cost **	564	607	▲ 7%	659	▲ 17%

Embodied Carbon

Business as usual and timber transition

A high-level embodied carbon assessment has been carried out on the structural scheme design material volumes for the three construction options.

– The carbon assessment is exclusively based on the substructure and superstructure material volumes.

– Embodied carbon values are based on global average material specifications.[9]

For a full building carbon assessment other considerations would include:

– Internal and external finishes

– MEP fit out

– Differing levels of fire protection

– Non-structural elements e.g. partition walls

– Operational carbon, maintenance, repair (Stage B)

Key finding

Switching to mass timber could save up to 40% embodied carbon compared to traditional construction materials.

Note that lightweight buildings may require additional cooling in hot climates, for example through air-conditioning, which requires significant additional operational energy.

Refer to BS EN 15978 and BS EN 15804 for further details.

	Traditional	Hybrid	Mass Timber
A1-A5 Product stage to construction and practical completion (handover)	1,110 tCO_2e	786 tCO_2e	660 tCO_2e
Biogenic Carbon Carbon that is stored in biological materials	0 tCO_2e	-321 tCO_2e	-748 tCO_2e
C End of life stage, including deconstruction/demolition, waste processing and disposal	71 tCO_2e	372 tCO_2e ▼ 30%	793 tCO_2e ▼ 40%
A-C Full project life cycle including demolition and waste processing etc.	1,181 tCO_2e (398 $kgCO_2e/m^2$)	837 tCO_2e (282 $kgCO_2e/m^2$)	705 tCO_2e (237 $kgCO_2e/m^2$)
Flights from London to New York saved	N/A	380	530

Embodied Carbon

Timber renaissance

Recent research[10] has shown that industry average carbon factors from European MET manufacturers are significantly less than those within the Inventory of Carbon and Energy (ICE), a commonly used database.

CLT: 0.437 $kgCO_2e/kg$ to 0.25 $kgCO_2e/kg$

Glulam: 0.512 $kgCO_2e/kg$ to 0.28 $kgCO_2e/kg$

The reduction in embodied carbon is associated with efficiency of production and therefore less energy being required, the increased use of renewable energy, and reduction in material waste.

In case a hypothetical East Africa MET Industry were able to replicate these savings this reduction in embodied carbon has been factored into the 'timber renaissance' scenario for the life cycle modules A1 to A3 (product stage).

Key finding

Switching to mass timber could save up to 50% of the embodied carbon compared to traditional construction materials in case best practice environmental approaches can be adopted from European manufacturers.

	Traditional	Hybrid	Mass Timber
A1-A5 Product stage to construction and practical completion (handover)	1,110 tCO_2e	749 tCO_2e	571 tCO_2e
Biogenic Carbon Carbon that is stored in biological materials	0 tCO_2e	-321 tCO_2e	-748 tCO_2e
C End of life stage, including deconstruction/demolition, waste processing and disposal	71 tCO_2e	372 tCO_2e ▼ 32%	793 tCO_2e ▼ 48%
A-C Full project life cycle including demolition and waste processing etc.	1,181 tCO_2e (398 $kgCO_2e/m^2$)	800 tCO_2e (270 $kgCO_2e/m^2$)	616 tCO_2e (208 $kgCO_2e/m^2$)
Flights from London to New York saved	N/A	425	635

Carbon Trading

Timber renaissance

Currently there is no global standard for carbon trading in relation to material substitution in the construction and building industry. However, the voluntary carbon market is an avenue that can be explored to generate additional finance when substituting MET for traditional building materials.

By utilising the results from the cost and carbon analysis, we have investigated what the required revenue from voluntary carbon trading would need to be, to balance the cost difference for the hybrid and mass timber typologies within the 'timber renaissance' scenario.

Key finding

In order to fully finance the cost difference for the hybrid and mass timber typologies in this study compared to traditional construction, the required carbon price would be 338 USD/tCO_2e and 504 USD/tCO_2e respectively. This far exceeds the current voluntary market average which stands at 5-15 USD/tCO_2e.[11] However there are instances in carbon removal methods such as direct air capture where carbon credits will be sold for 250-600 USD/tCO_2e.[12] Further work is required to fully understand the finance potential for material substitution in the construction industry on the voluntary carbon market.

	Traditional	Hybrid	Mass Timber
tCO_2e saved	N/A	381 tCO_2e	660 tCO_2e
USD/m²	564 USD/m²	607 USD/m²	-748 tCO_2e
Total Building Cost* (USD)	1,692,000 USD	1,821,000 USD	1,977,000 USD
Building Cost Difference	N/A	129,000 USD	285,000 USD
Carbon Price per tonne to eliminate cost difference	N/A	338 USD	504 USD

*Assuming a 3,000m² building footprint.

Fire Engineering

Kenya is in the process of updating the National Building Code, with a recent draft[13] setting out the adoption of Eurocodes.

Eurocodes allow countries to set their own requirements regarding construction type and fire protection through National Annexes. For example, loadbearing CLT is not allowed to be used for perimeter walls in England and Wales for buildings taller than 18m. This is not the case for other European countries.

It is likely that for a six-storey building the Kenyan National Building Code will require floors to be non-combustible. To allow the timber and the hybrid options to be constructed would likely require a performance-based approach (alternative engineered solution).

This section explores the potential implications of such an approach.

Fire protection

- Dividing walls between all individual units will require 60 or 90 minutes fire protection.

Fire resistance

- Fire resistance ratings of 60 or 90 mins to the structure – walls, floors, beams and columns. Ratings to be proven through a combination of calculations and fire testing.

Other solutions

Other fire protection may include:

- Two fire exit stairs
- Smoke detection and automatic occupant warning systems
- Emergency lighting and signage
- Water supplies for fire fighting
- Corridor/stairwell smoke ventilation (natural or mechanical)

Connections between timber elements to use market available fire tested products.

In a new market like Kenya, it would be expected that sprinkler protection would be included as part of a performance-based solution.

The MET could be exposed and this would be the basis of a submitted performance based solution. Precedence exists in North America and Europe.

Fire protection measures are imported but are available through local suppliers. Issues likely to exist around certification of installers, third party inspection reviews, commissioning and maintenance.

Best practice to use CLT that retains glue line integrity in fire and does not delaminate.

Approval processes and negotiations required with regulatory bodies for use of MET as an alternative building material.

It is expected that a hybrid solution will be easier to gain approval than a full MET solution.

Key finding

For a building of this height to be constructed from timber it is likely that a performance-based approach will be required, which in turn has a number of implications for the design process and the design itself. A key requirement being the inclusion of sprinklers.

Buildings Insurance

This section discusses the implications on buildings insurance for buildings utilising engineered timber.

Consultation with local insurers confirmed that timber buildings have previously been insured in Kenya. Typically these have been single storey hotels of mixed construction in tourist areas such as Maasai Mara.

The typology explored in this study is notably different and was utilised to frame discussions with insurers. The annotated diagram illustrates key considerations. The outline design information was also used to form the basis of an indicative insurance quotation provided by Britam.

Buildings insurance premium (expressed as a % of the total sum insured)

1	Traditional	0.20%
2	Hybrid	0.65%
3	Mass Timber	0.775%

Key finding

Industry is open to new technologies and construction materials, but will require additional evidence, documentation (e.g. fire life safety and fire strategy reports) and guidance from international insurance partners. Premium uplift will be in the region of 3-4x higher when using MET as a structural material.

Insurance is based on economies of scale. Therefore as structural timber is not commonly used in Kenya – the insurance cost will be considerably higher.

The industry is open to new technologies and will consider an evidence-based approach in regard to fire ratings and protection.

Currently there is limited data or precedence for MET construction in Kenya – therefore local insurance companies would look to get guidance and data from European insurance partners.

Documentation and evidence needed for risk assessments and to help lower risk ratings. Such evidence includes:

– Fire life safety report

– Fire strategy report

– Fire rating certification

Sprinklered buildings typically have a 15-30% reduced insurance cost compared to a non-sprinklered buildings. This applies for all building types and typologies. The level of automation and sophistication also has an impact on this.

Based on the information provided from the local insurance provided Britam. The annual premium are 3.25x higher for hybrid buildings and 4x higher for mass timber buildings, compared to traditionally constructed buildings.

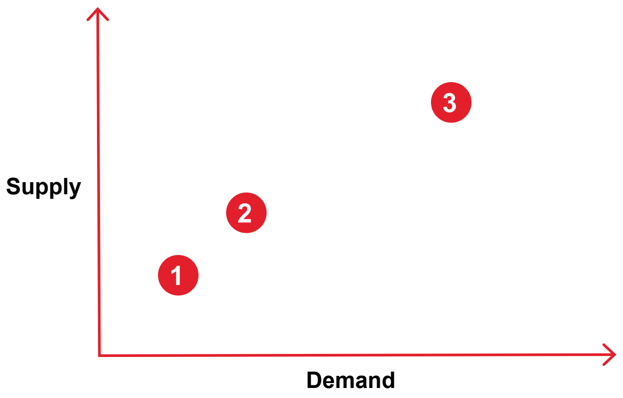
Indicative supply/ demand model

The following section sets out an indicative supply and demand model. Input data has been gathered through desk study and consultation. In places where data is incomplete or else uncertain the limitations and assumptions are noted. Given the scarcity of data it is to be treated as indicative only, to be used for identifying key issues and areas for further work.

The demand side of the model looks primarily at engineered timber, and at structural grade sawn timber, which is a pre-requisite step in the supply chain. For engineered timber, the demand side of the model has drawn upon the material volumes and the construction costs from the mid-rise residential typology study. Sawn timber demand within construction has been captured from existing research studies.

The model has focussed on multi-unit residential and commercial markets as these are assessed to be key markets for the use of engineered timber. The model extrapolates data through to 2040 on the estimated building demand and market sizes of these sectors.

The model focusses on the construction industry and it has not been possible to explore the myriad of other uses for sustainable timber which will inherently impact on the supply model. Nor has it been possible within this scope of this study to account for export of timber.



1 **Business as usual**	Supply and demand is extrapolated from existing baseline with minimal to no changes.
2 **Timber transition**	Moderate increase in supply and demand.
3 **Timber renaissance**	Significant increase in supply and demand. Systemic change required.

Regional Supply Definitions

Definitions, key assumptions and limitations for the steps which have been used to define the supply chain are provided here, to be read in conjunction with diagram overleaf:

1 – Annual sustainable cut of round logs
The volume of round logs that a given plantation can produce annually in perpetuity. It is directly related to the average growth rate of the trees and the harvesting cycle. It further assumes that all areas harvested are re-planted and that diligent stewardship is practiced. The volume is calculated by multiplying the area of plantation by species by the annual estimated growth rate for each species by country specific rates (alternatively known as the mean annual increment expressed as m^3/ha/year). Annual growth rates for each species by country has been estimated following consultation and interpreting data shared by regional forestry companies. It is assumed that there is an even spread of age classes.

2 – Sawmill capacity
The capacity of sawmills to process round logs into sawn wood measured in cubic meters of sawn wood. This is determined by the equipment available to saw the logs into planks. Data on regional sawmill capacity has only been identified within Kenya.

3 – Annual sustainable production of sawn wood
The annual sustainable production of sawn wood is derived from the annual sustainable volume of round logs and the proportion of sawn wood (planks) that is extracted from the round logs, this also known as the percentage recovery. In East Africa, the percentage recovery ranges from ca. 25% to 45% of the round log volume depending on log size, sawing technology and the sawn wood assortment. A percentage recovery average of 35% has been used in this report.

4 – Sawn wood of suitable size and quality not considering FSC certification
Sawn wood should be at least 100mm to 150mm wide by 25 to 50mm thick to be considered for engineered timber. This is translated into a minimum small end log diameter of 200mm. Considering the age at which non FSC certified trees might be harvested it is estimated that ~50% of logs would satisfy this.

5 – FSC certified sawn wood
The volume in cubic meters of sawn timber which originates from plantations which have achieved FSC certification. The FSC certification confirms that the forest is being managed in a way that preserves biological diversity and benefits the lives of local people and workers, while ensuring it sustains economic viability. The volume of FSC sawn wood is calculated by multiplying the area of FSC certified plantations by the weighted average annual growth rate (alternatively known as the mean annual increment expressed as m^3/ha/year).

Historically, the primary drivers of FSC certification in East Africa have been the plantation development funders, particularly development finance institutions and the EU. In the developed world market access has been the primary driver. Access to developed markets is likely to be a further driver of FSC certification in East Africa.

6 – Sawn wood of suitable size and quality that is FSC certified
Considering the improved forestry practices and longer rotations for harvesting within FSC certified plantations, it is assumed 85% of FSC certified sawn wood volume will be of a suitable quality, size and dimension for MET.

7 – Kiln capacity
The volume in cubic meters of sawn timber that can be kiln dried each year in a given country.

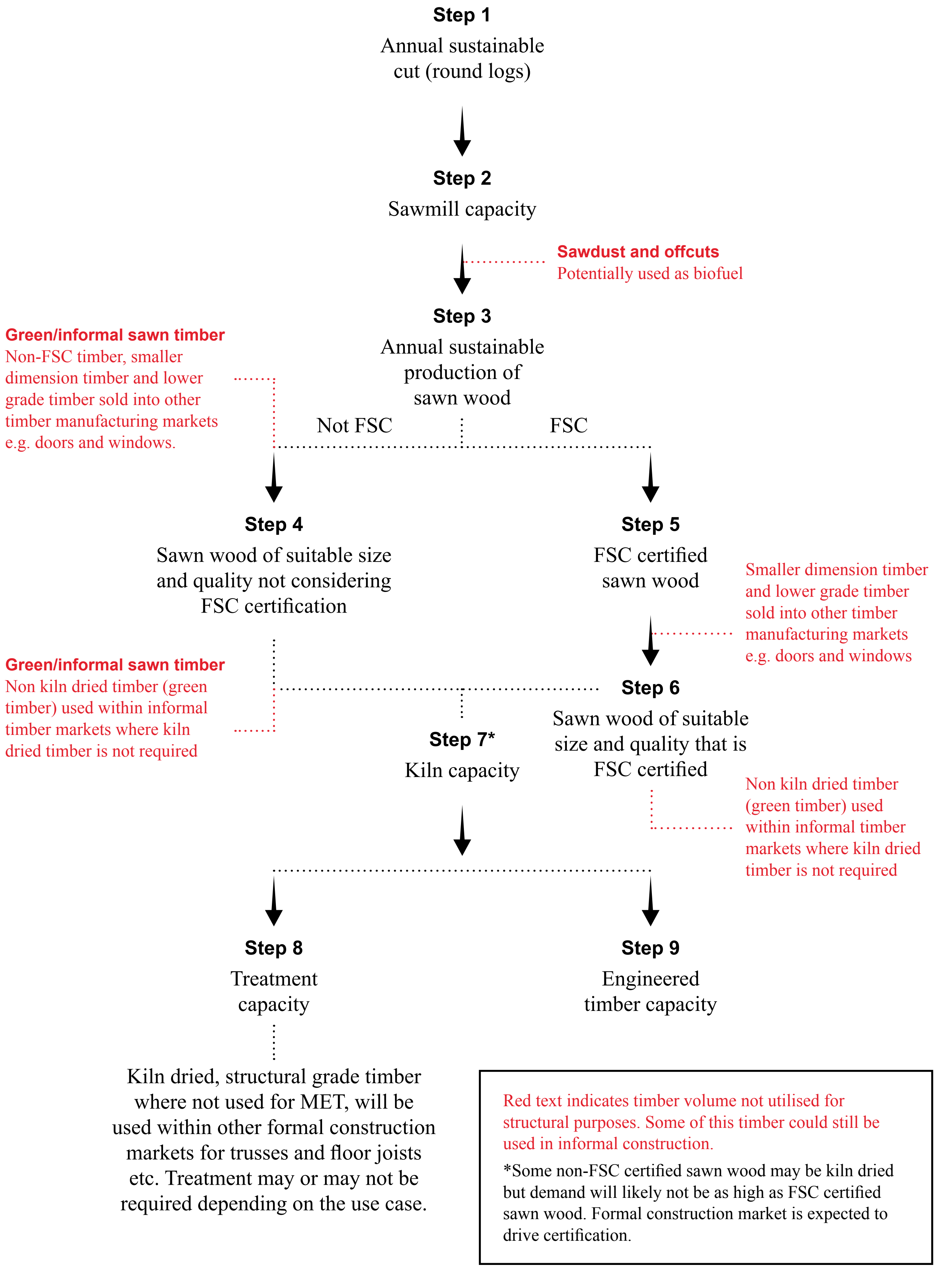
8 – Treatment capacity
The capacity of timber treatment facilities to process sawn wood measured in cubic meters of sawn wood. Sawn wood is pressure treated with wood preserving chemicals in a high-pressure cylinders.

9 – Engineered timber capacity
The capacity of engineered timber facilities to process sawn wood and expressed in cubic meters of timber products produced.

Existing data on finger jointing capacity has not been gathered or estimated in the future scenarios. Finger Jointing machinery has low capital cost compared to kilns and MET and is not expected to be a constraint in case of investment in the supply chain.

Indicative supply/demand model

Supply Chain diagram



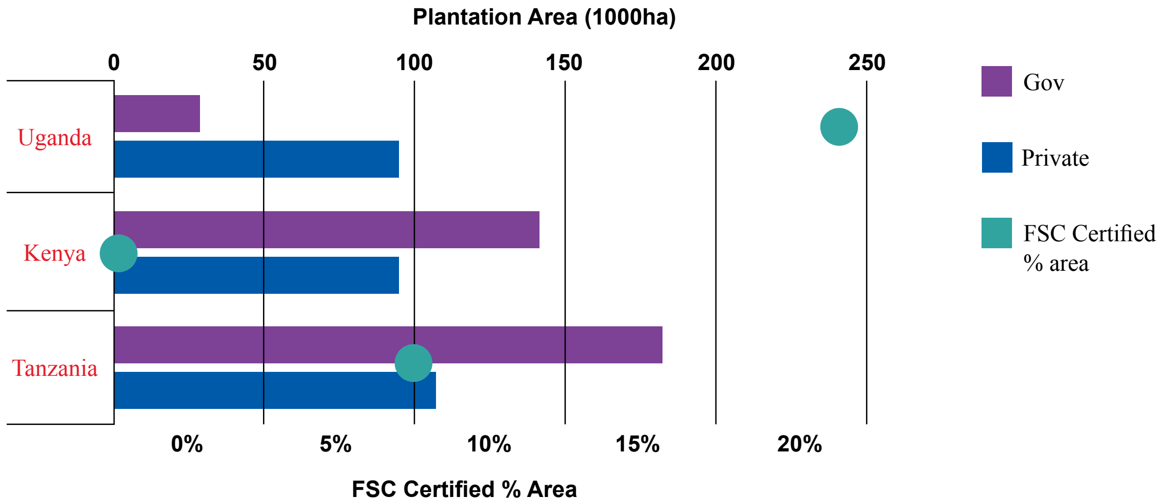
Regional Supply Plantations

The existing area of plantations both government and private totals 668,000 ha across the East Africa region of Kenya, Uganda and Tanzania.

Tanzania has the greatest area of 335,000 ha with a proportion of 33% being government owned and 77% being private. Conversely Kenya has a total of 228,000 ha but 60% are KFS government owned, with the private sector in Kenya being for the most part made up of trees on small holder farms rather than commercially managed plantations. This brings a number of challenges regarding the quality, quantity, uniformity and utilisation of the available timber.

Uganda has the smallest area of plantations of 105,000 ha, but as a consequence of the very successful SPGS (Sawlog Production Grant Scheme) intervention, a large volume of high quality pine sawlogs is expected to come onto the market in the next 10 years. The wood flow volumes will far exceed the capacity of the domestic market to either process or utilise the timber and the export of timber will be required to avoid a drastic reduction of domestic wood prices. A reduction in wood prices would likely to lead to the conversion of timber plantation areas to other land uses such as agriculture.

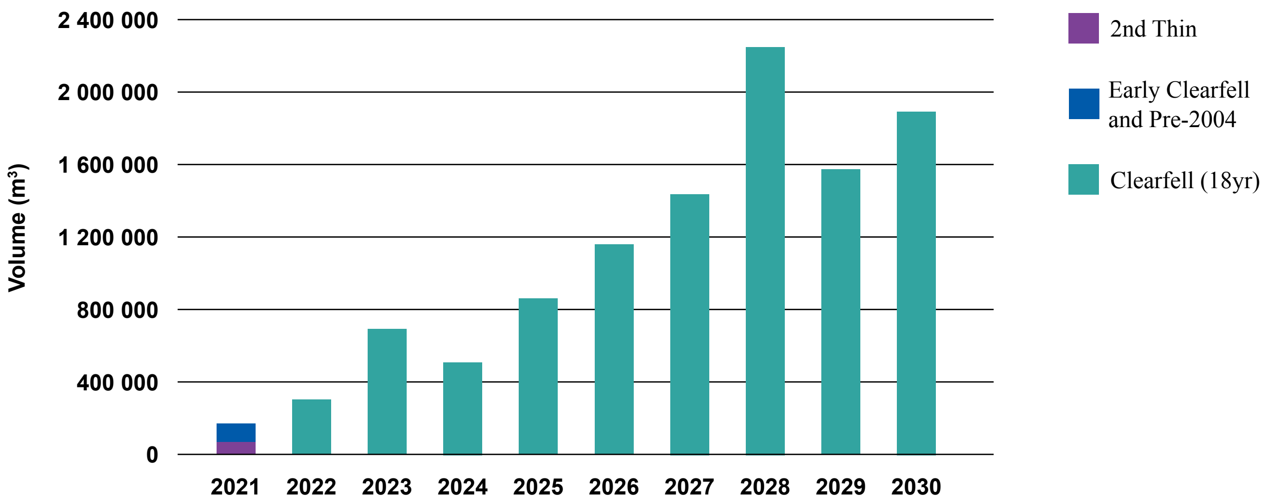
Commercial Plantation Area



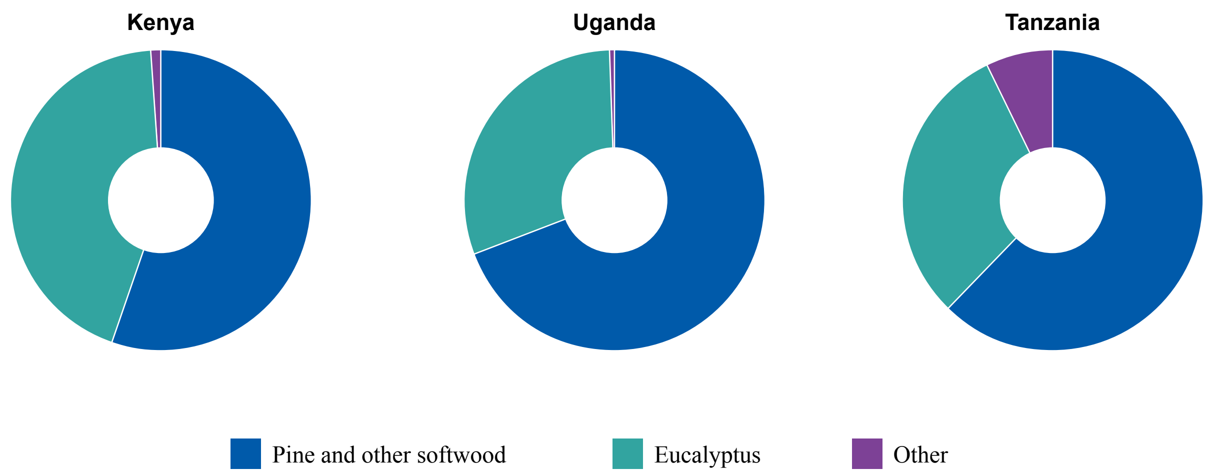
Pine and other softwoods are the most commonly available timber species within the region with a percentage of 55%, 70% and 62%, in Kenya, Uganda and Tanzania respectively. Eucalyptus is the other commonly grown species across the three countries.

In regard to FSC certification, although Uganda has the smallest total plantation area, it has the largest resource of well-managed FSC certified plantations. Kenya has no FSC-certified plantations. The current total area of FSC-certified plantations is 47,000 ha.

Uganda – Projected Volumes of Pine



Species proportion overview by region



Regional Supply

Business as usual

Within the 'business as usual' scenario it is assumed that the logging moratorium has remained in place. As a result KFS plantations are not included within Step 1 (annual sustainable cut).

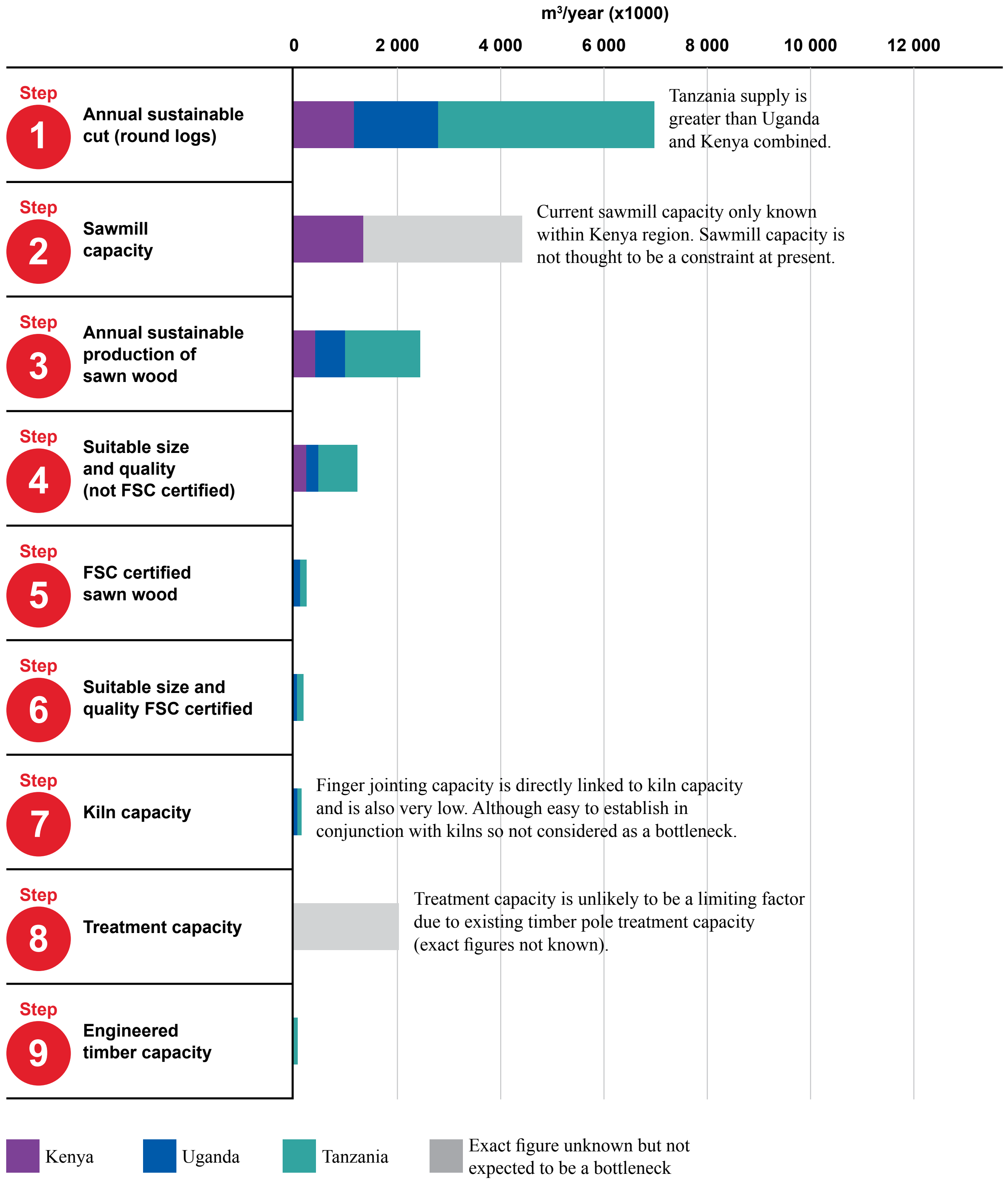
Only a small proportion of the plantations within the region are FSC certified (9%), making it one of the primary bottlenecks within the value chain.

The other key bottleneck in the value chain is kiln capacity with the total kiln capacity limited to 63,000 m^3/year across Kenya, Uganda and Tanzania combined. This results in a very limited volume of sawn wood being suitable for engineered timber products.

Manufacturing capacity of MET in the region remains solely for bespoke purposes only. Two small scale and bespoke manufactures exist with capacity of approximately ~100 m^3/year.

Overall the volume of timber arising from plantations within the East Africa region, far exceeds the capacity of the following steps in the supply chain.

> **International perspective**
>
> All of the forested European countries have established MET industries. Germany, Austria, Switzerland dominate glulam, and Austria has the majority of CLT capacity. France, Spain, Italy, Sweden, Finland also have MET capacity. Attempts to establish MET capability in UK were unsuccessful due to lack of high-quality local timber and the small size of the market.



Regional Supply

Timber transition

Within the 'timber transition' scenario, the moratorium is lifted and KFS plantations contribute to an increase in supply. Conservative increases have also been applied to the total plantation areas within Uganda and Tanzania. Annual production of sawn wood would now exceed the UK.

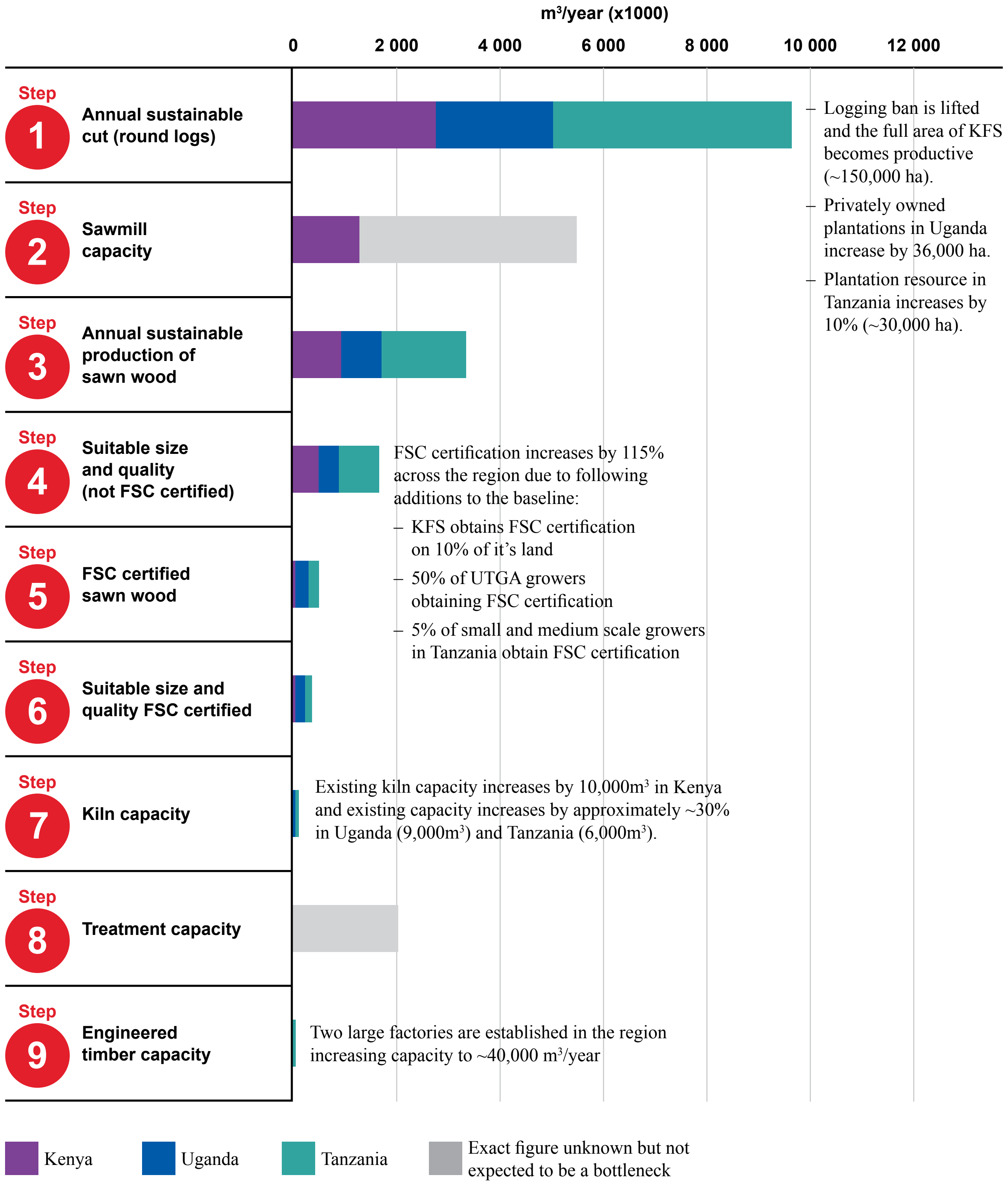
FSC certification increases to 14% across the region as KFS, UTGA and Tanzania's small to medium growers start to achieve certification in a small proportion of their plantations. It is assumed that there is an economic incentive for growers to obtain certification.

As a result, a greater portion of the sawn timber stock is suitable for MET products.

The value chain is conservatively strengthened through investment in sawmills and kilns in particular. With kiln capacity increasing by 40% to 88,000 m³/year. Similar to the FSC certification it is assumed that there is an economic incentive for processors to kiln-dry and grade sawn wood, where higher prices are paid for the end products.

International perspective

The UK produces about 3 million m³ of sawn softwood per year (for construction and other uses from managed forests). Austria produces approximately 9 million m³ and Germany produces 20 million m³. The USA produces about 80 million m³, with demand driven almost entirely by single family dwellings.



Regional Supply

Timber renaissance

The ‘timber renaissance’ is the optimistic scenario within the supply model and assumes systemic change takes place within the enabling environment and supply chain. As a result, plantations within the region are increased to a total of ~900,000 ha (77% increase from BAU).

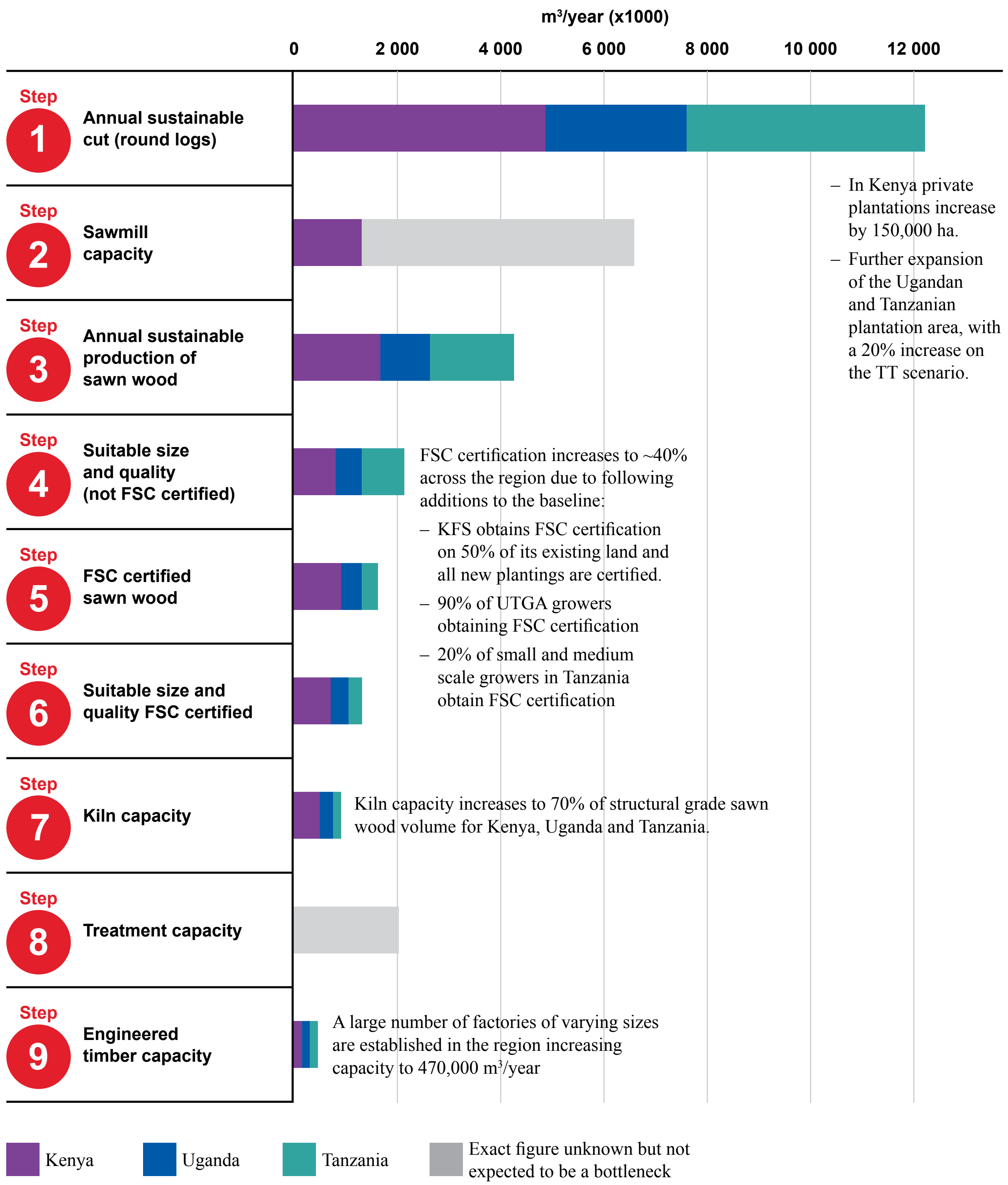
FSC certification increases to ~40% of the total plantation area within the East Africa region, due to improved forest management practices and economic incentives for growers.

It is assumed the demand for MET and other sawn wood products increases substantially through wide-scale appreciation of the benefits of using wood as a construction material.

To meet the increasing demand, significant investment is required in the value chain to ensure a greater proportion of the certified sawn wood stock is graded and suitable for engineered timber products. Therefore, kiln capacity across the region is increased to 70% of the certified structural grade sawn wood volume. Resulting in a kiln capacity of 946,000 m^3/year across the region.

International perspective

Global supply of MET is currently estimated at 1 million m^3 in the United States and 4 million m^3 in the EU.



Regional Supply

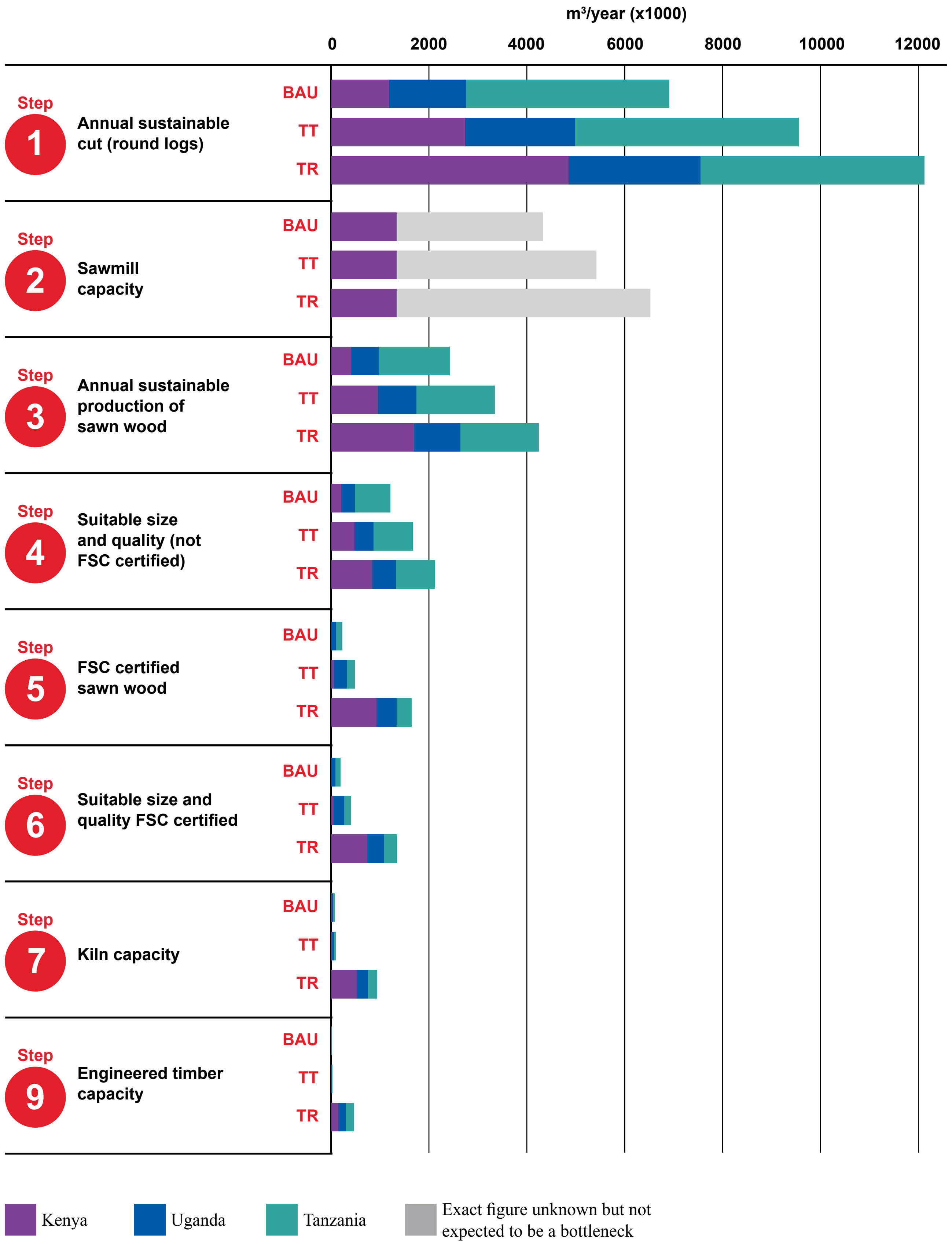
Scenario comparison

Under ‘business as usual’ there is effectively no MET capacity and there are significant drops in capacity at each step illustrating the need for investment along the supply chain. FSC certification and kiln capacity are key constraints where capacity should be increased if MET factories are to be established. Sawmill capacity may also need to increase, depending upon the total regional capacity (which is currently unknown).

Whilst the annual sustainable cut far exceeds the capacity of subsequent step it is assumed it would also need to increase. This acknowledges the fact that timber flows outside of the construction industry are not accounted for in this study.

	BAU	TT		TR	
Regional plantation area (ha x1000)	519	739	42%	917	77%
(m³/year (x1000))	BAU	TT		TR	
1 Annual sustainable cut (round logs)	7,000	9,600	37%	12,200	74%
3 Annual sustainable production of sawn wood	2,450	3,375	37%	4,275	74%
4 Suitable size and quality (not FSC certified)	1,225	1,675	37%	2,150	74%
5 FSC certified sawn wood	225	485	115%	1,660	640%
6 Suitable size and quality FSC certified	190	410	115%	1,350	640%
7 Kiln capacity	63	88	40%	950	1400%
9 MET capacity	0.2	40	N/A	470	N/A

Indicative supply/demand model



Kenya Demand

The estimated demand by 2040 has been investigated using two different models. The first model is based on the estimated annual building demand (e.g. floor area) and the second is based on the market size (e.g. construction value).

Extrapolations to 2040 are based upon 6% annual growth based on current annual building supply (1.8 Million m²/year) and market size estimates.[14, 15]

The mid-rise typology study has been used to inform an estimate of the number of buildings being completed per year, the volume of MET required.

Factory sizes are based on BuildX Studio's Strategy Report[8] (small = 4,984m³/yr., medium = 8,818m³/yr., large = 18,403m³/yr.).

Limitations and assumptions

We recommend these numbers are treated with caution. Due to the limited data available the model is indicative only and is to be used for identifying key issues and areas for further work.

Only multi-unit residential and commercial sectors have been considered as they are seen as the primary sectors where Mass Engineered Timber could penetrate the existing market.

The residential market is assumed to be split equally between multi-unit residential and single family dwellings. This was based upon an average from research sources which suggest 75:25[16] and 25:75[14] respectively.

The construction industry can be conservative in adopting new technology and we have arbitrarily estimated that the hybrid construction typology would capture twice the market share, compared to the mass timber option. Compared to international benchmarks this currently represents an optimistic ratio for engineered timber.

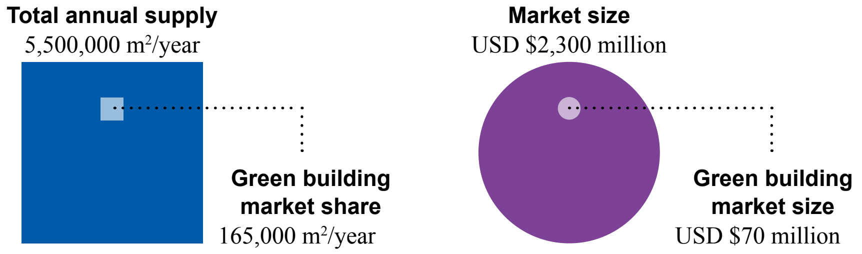
We have used both the material volumes and construction costs from the mid-rise typology study to inform the model. Whilst the typology study represents a reasonable example of mid-rise residential development, there are many other variations and alternative solutions which depending on the solution would alter the results of the demand model.

Business as usual

Within the 'business as usual' scenario, the green building market has not changed from the current level of 3%15, where traditional construction practices and materials have remained and MET has not entered the Kenyan construction market at any significant scale. Manufacturing capacity of MET in the region remains solely for bespoke purposes only. Resulting in no buildings or factories being developed within this scenario.

International perspective

The % of market share for MET for international contexts is not specifically known but is thought to be very small.



Potential market share for mass timber	Potential market share for mass timber
0 m²/year	**USD $0**

	Building Demand Model	Market Size Model
Green building market share % in 2040 (on all new residential and commercial developments)	**3%**	
MET Market Share % in 2040 (on all new residential and commercial developments)	**0%**	
No. of buildings constructed in the year 2040 based on typology study (e.g. 6 storey mid-rise towers)	**0 buildings**	**0 buildings**
Volume demand of mass timber per year (m³/year) in 2040 • Hybrid only (option two) • Mass timber only (option three)	 0 m³/year 0 m³/year	 0 m³/year 0 m³/year
Size and no. of factories required to meet demand*	**N/A**	**N/A**

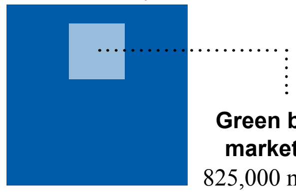
* Factory sizes are based on BuildX Studio's Strategy Report[8] (small = 4,984m³/yr., medium = 8,818m³/yr., large = 18,403m³/yr.).

Kenya Demand

Timber transition

Within the conservative 'timber transition' scenario, demand continues to be met predominantly by traditional construction materials. However, the green construction market expands to 15%, with MET construction accounting for 1.2% of the market and hybrid construction accounting for 2.4%. As a result, the number of hybrid buildings and mass timber buildings being constructed per year ranges between 28-44 and 12-22 respectively depending on which model is being used. Based on this demand this results in one to two large factories being needed to meet the required volume of MET locally.

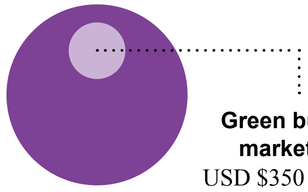
Total annual supply
5,500,000 m^2/year



Green building market share
825,000 m^2/year

Potential market share for mass timber
200,000 m^2/year

Market size
USD $2,300 million



Green building market size
USD $350 million

Potential market share for mass timber
USD $84 million

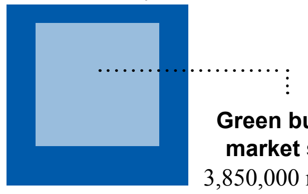
	Building Demand Model	Market Size Model
Green building market share % in 2040 (on all new residential and commercial developments)	**15%**	
MET Market Share % in 2040 (on all new residential and commercial developments)	**1.2% mass timber and 2.4% hybrid** (8% and 16% of green building market)	
No. of buildings constructed in the year 2040 based on typology study (e.g. 6 storey mid-rise towers)	**44** hybrid buildings **22** mass timber buildings	**28** hybrid buildings **12** mass timber buildings
Volume demand of mass timber per year (m^3/year) in 2040 • Hybrid only (option two) • Mass timber only (option three)	**Total = ~40,000 m^3/year** ~18,000 m^3/year ~22,000 m^3/year	**Total = ~23,500 m^3/year** ~11,500 m^3/year ~12,000 m^3/year
Size and no. of factories required to meet demand*	**Two large factories** (110% capacity)	**One large factory** (125% capacity)

Timber renaissance

Within the optimistic 'timber renaissance' scenario, the green building market has grown significantly, where the construction sector has shifted away from traditional practices in order to adapt to the climate crisis and contribute to the race to net zero. In this scenario green construction market has grown to 70%. As a result, MET construction has increased to 14% of the market and hybrid construction has increased to 28%. The number of hybrid buildings and mass timber buildings being constructed per year ranges between 360-500 and 170-250 respectively depending on which model is being used. Based on this demand it results in 17 to 25 large factories being needed to meet the required volume of MET locally.

> **International perspective**
> Europe has invested in kilning and MET manufacturing to increase the value and potential of its timber.

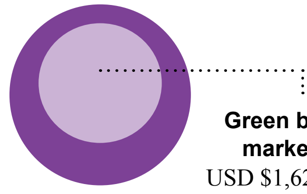
Total annual supply
5,500,000 m^2/year



Green building market share
3,850,000 m^2/year

Potential market share for mass timber
2,300,000 m^2/year

Market size
USD $2,300 million



Green building market size
USD $1,620 million

Potential market share for mass timber
USD $970 million

	Building Demand Model	Market Size Model
Green building market share % in 2040 (on all new residential and commercial developments)	**70%**	
MET Market Share % in 2040 (on all new residential and commercial developments)	**14% mass timber and 28% hybrid** (20% and 40% of green building market)	
No. of buildings constructed in the year 2040 based on typology study (e.g. 6 storey mid-rise towers)	**500** hybrid buildings **250** mass timber buildings	**360** hybrid buildings **170** mass timber buildings
Volume demand of mass timber per year (m^3/year) in 2040 • Hybrid only (option two) • Mass timber only (option three)	**Total = ~470,000 m^3/year** ~215,000 m^3/year ~254,000 m^3/year	**Total = ~310,000 m^3/year** ~150,000 m^3/year ~160,000 m^3/year
Size and no. of factories required to meet demand*	**25 large factories** (102% capacity)	**17 large factories** (100% capacity)

* Factory sizes are based on BuildX Studio's Strategy Report[8] (small = 4,984m^3/yr., medium = 8,818m^3/yr., large = 18,403m^3/yr.).

Findings

Enabling Environment

The enabling environment for the use of sustainable timber in construction is currently undeveloped with gaps across governance, policy, incentives and regulation.

Whilst the Kenya Forestry Service and Kenya Timber Manufacturers Association represent growers and manufacturers respectively there is no industry body dedicated to use of sustainable timber in construction. Establishing such a body will provide a focal point for driving initiatives across this area. The Tanzania National Timber Sector Development Framework is a key reference and developing a similar framework for Kenya could be a priority action for such a body.

Policy both within Kenya and as relates to imports from Uganda has not been conducive to supply. The logging moratorium in Kenya has served to stifle the domestic manufacturing supply chain. By contrast the EU funded SPGS has been effective in increasing projected pine volumes in Uganda. The import costs from Uganda and Tanzania will have a significant effect on future demand and regional coordination and cooperation will be key.

To date national incentives such as tax relief on the importation of raw timber have been applied inconsistently. Demand policy within Kenya does not explicitly promote timber in construction, although steps are being taken to promote green technology, for example through EDGE certification. Financial institutions are providing loans and bonds to support green construction, often tied to the use of IFC EDGE as a framework/target, presenting an opportunity to influence material choice. Ideally this would be backed up through a national carbon taxation mechanism and integration of emissions targets into Government strategies. At present there is an active voluntary carbon trading market in Kenya, primarily for international buyers but with an increasing local market. The majority of these projects are in the forestry sector indicating such opportunities are already being pursued.

At time of writing, the Kenya National Building Code 2020 remains in draft. If approved it would support timber design via the Eurocode suite, until then however there is no code for engineered timber. The draft does not include targets for carbon emissions. Once approved the next step will be the authoring of a Eurocode National Annexe for Kenya, for the design and construction of timber and MET, including local empirical timber design values.

Buildings insurance and fire risk are often cited as barriers to uptake. For MET to be used as a structural building material (especially at height), there will be a requirement to adopt a fire engineered performance-based approach. Insurers are open to new technology but are likely to require additional design documentation in the form of fire life safety and strategy reports. A key impact on building design is a requirement for sprinklers. According to our typology study this could add as much as 18% to the overall building cost compared to traditional construction which does not require this measure.

Initial consultations suggest building insurance premiums will be in the region of three to four times higher when using MET as a structural material. Building insurance premiums are based on economies of scale and this premium would likely reduce in case the technology became more common.

18%

Annual growth in construction, Nairobi's fastest growing sector, between 2016-2020

2.3bn m^3

Predicted global demand for sawn timber in 2020

Supply

Pine, a softwood, is the most commonly available timber in the region followed by eucalyptus which is a hardwood. Pine is well suited to use in construction as sawn wood or else as engineered timber. Tanzania has the largest area of timber plantation in the region and associated volume of timber supply, this is anticipated to remain the case under all three scenarios.

Uganda has the smallest area of plantations of 105,000ha, but as a consequence of the successful SPGS a large volume of pine sawlogs is expected to come onto the market in the next ten years. This will far exceed the capacity of the Ugandan market to either process or utilise the timber and the export of timber will be required to avoid a drastic reduction of domestic wood prices.

It is important that any further increase in demand is met by sufficient supply to prevent disruption to material flows. This study suggests that under 'business as usual' there would be sufficient supply of timber from these plantations to support increased use in construction, but that 'business as usual' manufacturing capacity would prevent this. The 'timber transition' scenario sees a modest increase in annual sustainable cut, associated primarily with the Kenya logging ban being lifted and KFS plantations (150,000ha) becoming productive. The 'timber renaissance' scenario assumes expansion of private plantations (180,000ha) across the region. Further work is required to understand the viability of KFS replanting, private Kenyan small holdings as well as regional land availability and biodiversity impact of such an increase in plantation area.

In regards to FSC certification, although Uganda has the smallest total plantation area, it has the largest resource of well-managed FSC certified plantations. Kenya has no FSC certified plantations. The current total of FSC certified plantations in the region is 47,000ha or 7%.

Engineered timber must first be kiln dried and of suitable size and quality before it can be glued together. FSC certification is highly likely to be another prerequisite, as clients, developers and consumers looking to utilise MET, will require assurances that the timber being used is sustainably sourced.

Although Uganda has the smallest total plantation area, it has the largest resource of well-managed FSC certified plantations.

Kiln capacity, FSC certification and forest management practices (and therefore quality and suitability for construction) all require strengthening. Finger jointing capacity is also very low, although considered easy to establish and so should not be a bottleneck in case of investment in MET. In comparison there is greater sawmill and treatment capacity, noting absence of data for sawmills outside of Kenya.

Under the 'business as usual' scenario the region is estimated to generate just over 2million m^3 of sawn timber. Once consideration is made for FSC certification, quality and kiln capacity the volume drops to just 63,000m^3. By comparison the UK produces three million m^3.

Investment is needed along the supply chain, not just in the establishment of MET factories of which there is effectively no capacity at present. MET requires stringent quality control during the gluing process and specialist testing to ensure quality. A number of larger companies, namely Green Resources and The New Forests Company have installed kilns to dry timber from their sawmills which would allow this timber to be used to manufacture engineered wood products.

Under the 'timber renaissance' scenario, annual production of sawn wood increases to just over four million m^3 with sufficient kiln capacity to dry nearly one million m^3 and MET capacity of ~0.5million m^3. Kiln capacity should exceed MET capacity in order to ensure a supply of structural grade sawn timber for other uses such as trusses. By comparison the USA currently produces ~1million m^3 of MET. This scenario assumes that over 40% of multi storey residential and commercial market demand is met by engineered timber buildings (either hybrid or fully timber).

Demand

Demand for both MET and structural grade sawn timber are currently low, as evidenced by the lack of the kilns and MET factories. Where sawn timber is used in construction it is typically 'green' (timber that has not been kiln dried), with demand currently estimated at 0.5million m^3.

The population of Nairobi is growing at a rate of 4.7%, among the highest growth rates in Africa. Construction was the fastest growing sector between 2016-2020 with 18% annual growth.

Kenya needs to build about 200,000 new housing units every year in its cities just to keep pace with population growth and rocketing demand, according to a World Bank study.

An embryonic green building market exists and this is likewise forecast to grow, with Manufacturing Africa assessing that low-cost housing and apartment blocks present the two largest markets for sawn timber.

Global demand for sawn timber was predicted to reach 2.3billion m^3 in 2020[2], with much of that demand driven by construction. Engineered timber supply is a small fraction of this, with USA and Europe combined accounting for ~5million m^3 or 0.2%. Housing and particularly single-family dwellings are a key driver in the global and regional demand for sawn timber where it is used to form trusses and rafters for roofs in particular.

MET can be well suited to the demand for mid-rise residential construction in urban areas due to potential savings associated with prefabrication and being a lightweight material. Glulam is well suited to longer span beams or columns whilst prefabricated CLT panels are typically used for floors and walls, allowing columns to be omitted and saving time on site.
By replacing heavy materials such as stone and reinforced concrete with timber you reduce the weight of the building, which has additional savings in the design of the supporting beams, columns and foundations, further reducing the amount of concrete required.

Awareness of MET in Kenya is low among the public, developers, authorities and the construction industry.

Universities and other educational institutions are not thought to teach timber design. Materials are studied in general but not specifically timber or MET. Known structural timber projects have relied on international expertise for both structural and fire design. In contrast carpentry is one of the primary trades in Kenya with nearly 15,000 registered carpenters, albeit primarily focussed on furniture, doors, windows. This provides a significant base from which to upskill recognising that additional training would be required for structural use of sawn timber and certainly for engineered timber which requires specialist skills and tools for fabrication and assembly.

Cost will be key in overcoming distrust of a new technology such as MET and in driving demand for timber in construction generally.

Since the introduction of the logging moratorium the cost of sawn timber in Kenya has doubled, far exceeding costs in Uganda. Importing sawn timber from Uganda brings significant added and sometimes uncertain costs. With very limited MET manufacturing capacity in the region locally sourced engineered timber is currently prohibitively expensive. South Africa manufacturers for glulam and CLT are globally competitive and are typically cheaper than European manufacturers. Importing MET into Kenya from South Africa is likely to add at least 20% to the cost.

Buildings are made of various components with different materials bringing different qualities which are not necessarily directly comparable at component level and so it is important to assess overall building cost. Our mid-rise residential typology suggests that under the 'business as usual' scenario both hybrid and fully MET options are significantly more expensive (+38% and +66%) than traditional construction. Notably fire protection in the form of sprinkler systems accounts for 15-18% of the overall building cost. For comparison, CPS, a developer in Tanzania reports CLT as currently being 15% to 25% more expensive than standard construction, but fully tax exempt.

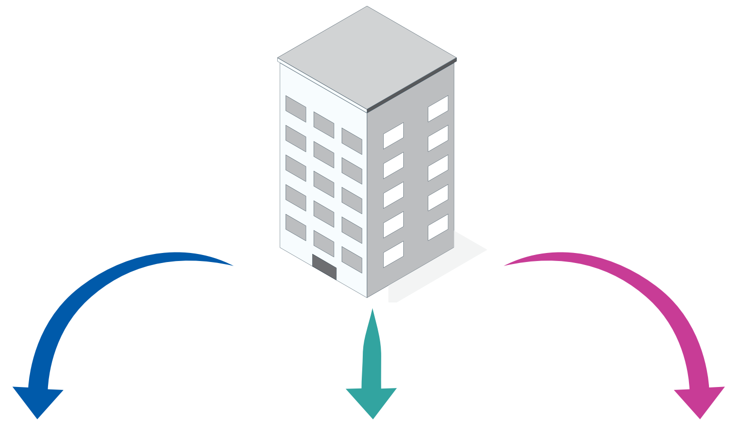
For the 'timber renaissance' scenario the overall building costs for hybrid construction becomes comparable (+7%) to traditional construction methods and mass timber construction becomes more cost competitive (+17%). Fire protection in the form of sprinkler systems could account for ~10% of the overall building costs.

Whilst utilising lightweight timber for mid rise buildings enables savings in other parts of the structure it brings additional requirements such as fire protection which serve to counteract that saving. The 'timber renaissance' scenario assumes a rate of 600USD/m^3 for engineered timber, which is at the low end of rates from South Africa which in turn are lower than average globally, further illustrating the challenge of competing on cost.

Timber is being increasingly put forward as part of efforts to decarbonise construction. Our mid-rise residential typology study suggests that up to 40% of the embodied carbon could be saved compared to traditional construction materials utilised in Nairobi. Uptake of best practice environmental approaches in the manufacturing supply chain could increase this saving to ~50%.

This would represent a total saving of embodied carbon by 2040 within the multi storey residential sector of 234,000 tCO$_2$e and 2,970,000 tCO$_2$e under our 'timber transition' and 'timber renaissance' scenarios respectively.

Utilisation of the voluntary carbon market presents a possible opportunity to improve cost competitiveness of timber buildings. Our study determined a carbon price of 330-500 USD/tCO$_2$e to bridge the difference in construction cost, far exceeding the current market average.



		Traditional			Hybrid			Mass timber		
Material volumes (m³)	Concrete	~1,300			~800			~500		
	Timber	0			~400			~1,000		
		BAU	TT	TR	BAU	TT	TR	BAU	TT	TR
Cost (USD/m²)		564	564	564	779	692	607	939	796	659
Embodied carbon (tCO$_2$e)		1,181	1,181	1,181	837	837	800	705	705	616
Carbon price to eliminate cost difference compared to traditional (USD/tCO$_2$e)		n/a	n/a	n/a	1,875	1,116	338	2,363	1,462	504
Buildings insurance premium (% of the total sum insured)		0.2%	0.2%	0.2%	0.65%			0.775%		

Residential Typology Study

A hypothetical mid rise tower was designed to concept stage in timber and compared against a traditional reinforced concrete tower and a third hybrid design.

The table summarises material volumes, cost, embodied carbon, carbon price required to eliminate any cost difference and buildings insurance for each of the three designs.

The study shows the cost of construction for timber and hybrid reducing in each scenario as a result of economies of scale. These reductions are insufficient to match traditional construction and they remain +17% and +7% more expensive respectively in the 'timber renaissance' scenario.

Embodied carbon savings from timber are significant, and could be improved further by emulating European MET manufacturer standards of efficiency and renewable energy, with a reduction of 40% for a fully timber building under the 'timber renaissance' scenario.

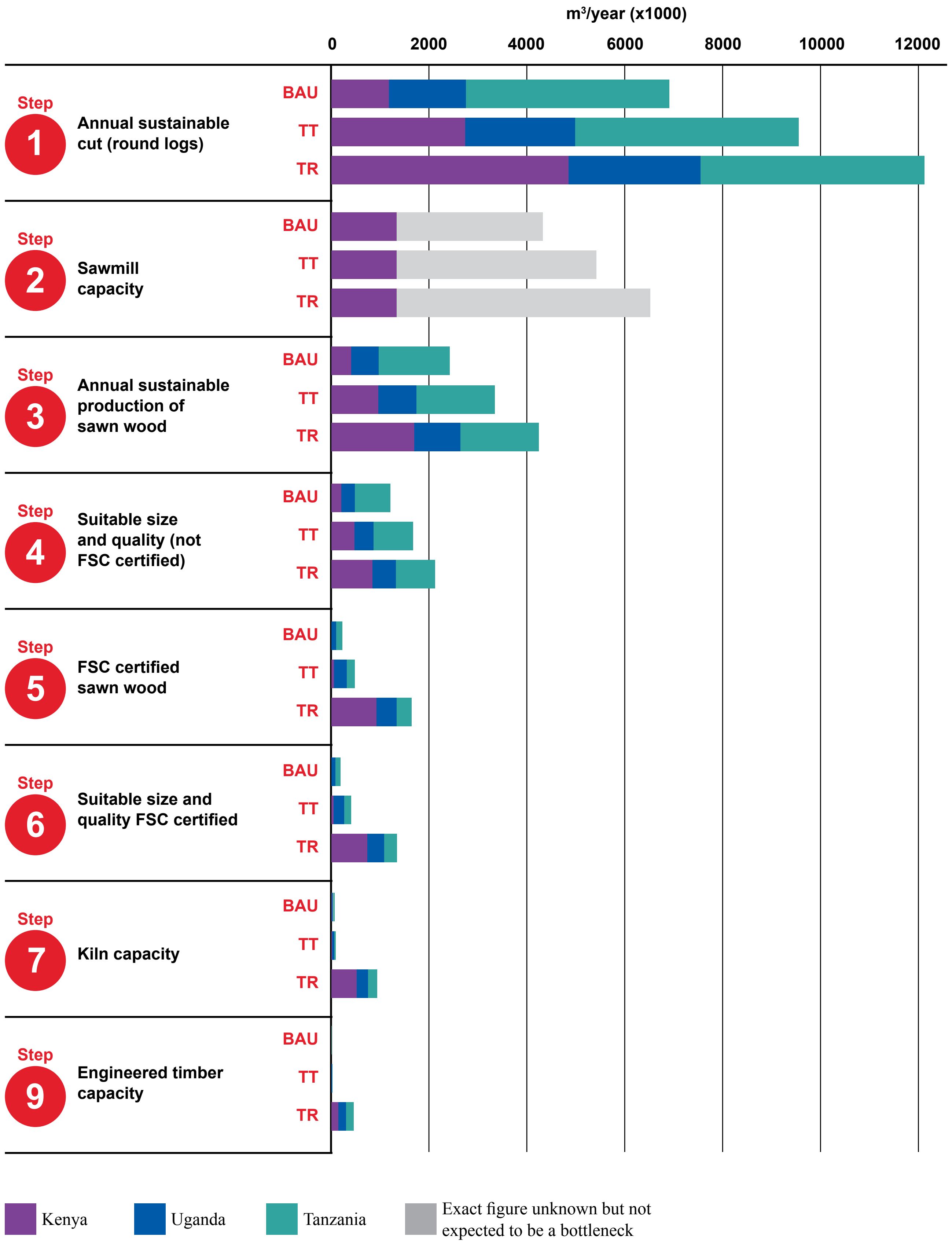
Regional Supply

Scenario comparison

Under 'business as usual' there is effectively no MET capacity and there are significant drops in capacity at each step illustrating the need for investment along the supply chain. FSC certification and kiln capacity are key constraints where capacity should be increased if MET factories are to be established. Sawmill capacity may also need to increase, depending upon the total regional capacity (which is currently unknown).

Whilst the annual sustainable cut far exceeds the capacity of subsequent step it is assumed it would also need to increase. This acknowledges the fact that timber flows outside of the construction industry are not accounted for in this study.

	BAU	TT		TR	
Regional plantation area (ha x1000)	519	739	▲ 42%	917	▲ 77%
(m³/year (x1000))	BAU	TT		TR	
1 Annual sustainable cut (round logs)	7,000	9,600	▲ 37%	12,200	▲ 74%
3 Annual sustainable production of sawn wood	2,450	3,375	▲ 37%	4,275	▲ 74%
4 Suitable size and quality (not FSC certified)	1,225	1,675	▲ 37%	2,150	▲ 74%
5 FSC certified sawn wood	225	485	▲ 115%	1,660	▲ 640%
6 Suitable size and quality FSC certified	190	410	▲ 115%	1,350	▲ 640%
7 Kiln capacity	63	88	▲ 40%	950	▲ 1400%
9 MET capacity	0.2	40	N/A	470	N/A



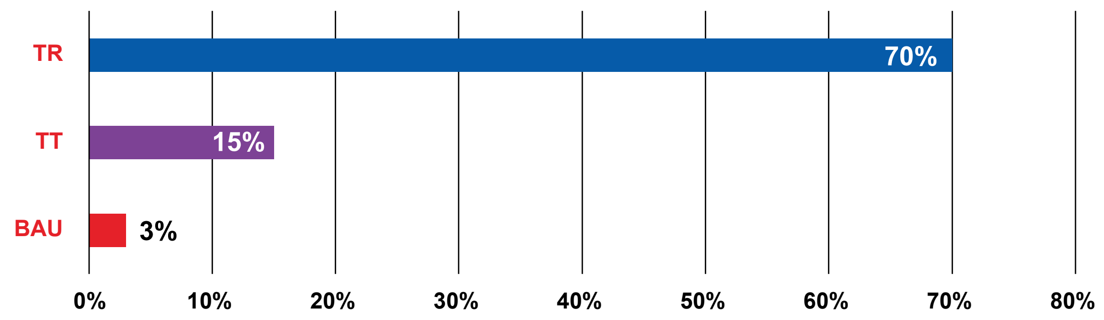
Findings

Kenya Demand

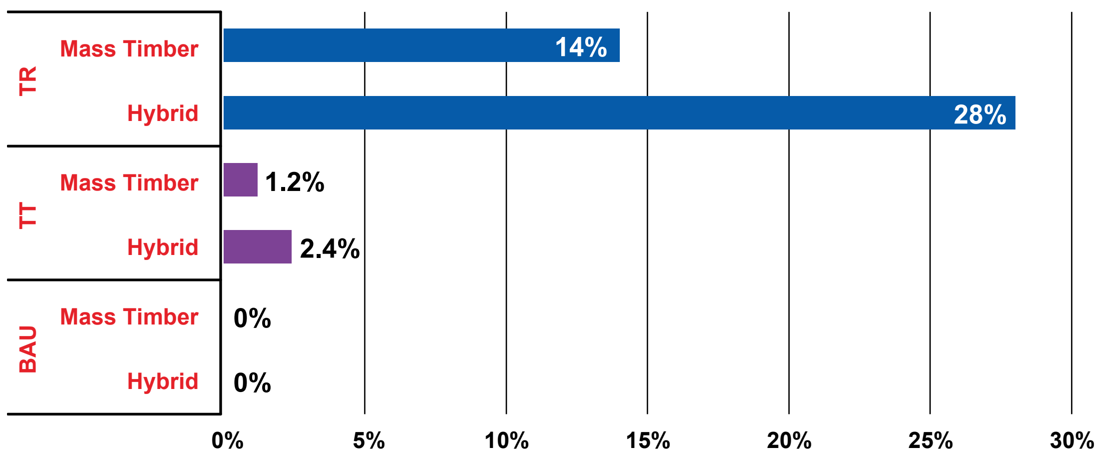
Scenario comparison

Comparing the three scenarios in terms of market share, resulting demand for new buildings and volume of timber required in the year 2040. A cumulative market share of 3.6% under ‘timber transition’ scenario would require between one and two large MET factories. A 42% market share under the ‘timber renaissance’ scenario would require between 17 and 25 large factories.

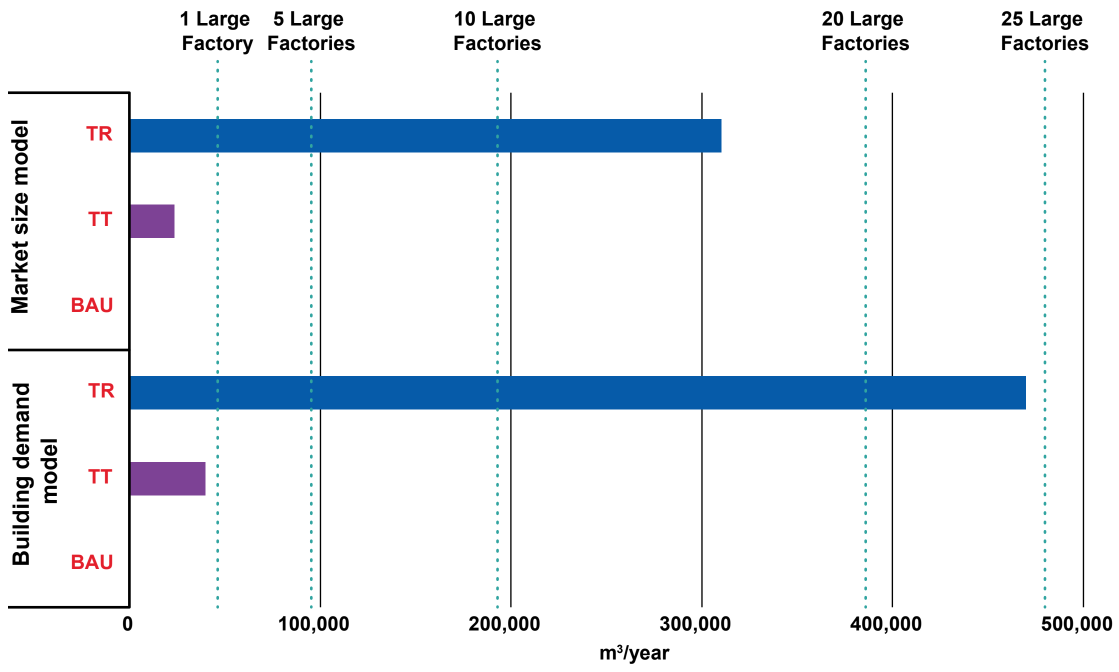
Green Building Market % in 2040



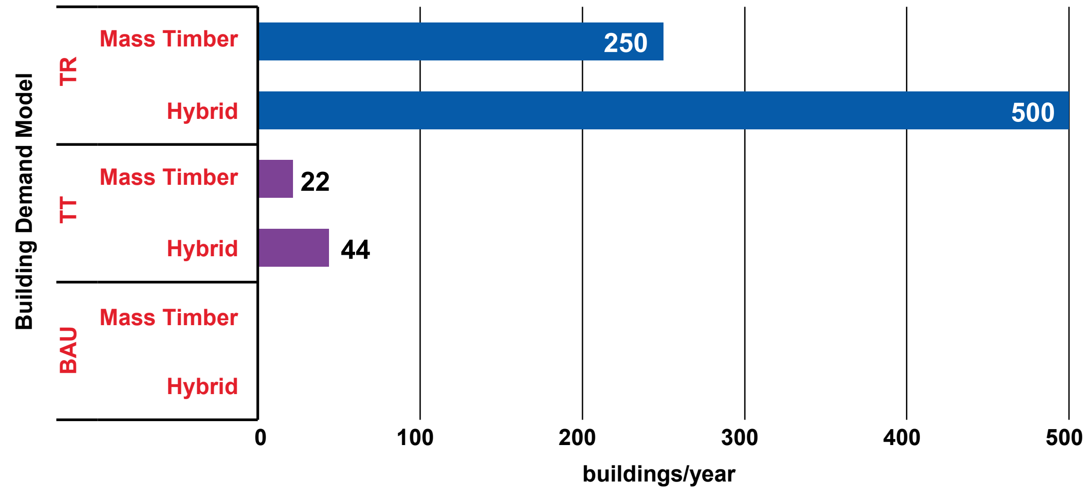
Timber Market % in 2040



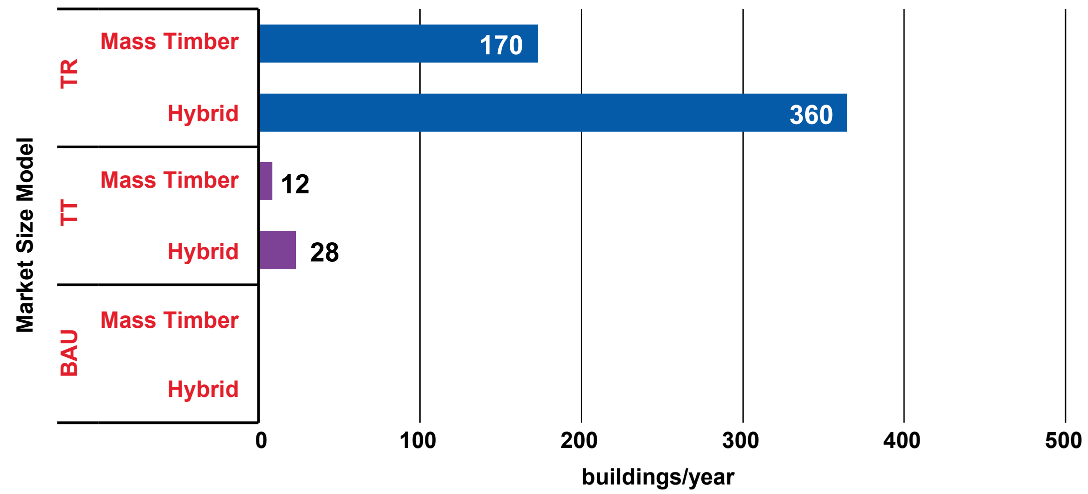
Estimated Volume Demand of Mass Timber in 2040



Estimated No. of Buildings Constructed in 2040 based on the Building demand model



Estimated No. of Buildings Constructed in 2040 based on the Market Size Model



Supply vs Demand

The demand for sawn timber across the construction industry accounts for ~30% of the annual sustainable sawn timber supply in all three scenarios. The assumption is that the remaining timber continues to be used in other industries.

The demand for MET takes up 30 to 50% of all of the suitable sawn timber in the ‘timber transition’ and ‘timber renaissance’ scenarios.

This would leave 50 – 70% for other uses of structural grade sawn timber. This is high compared to present day economies that have MET capacity where it remains a small part of the overall timber construction industry.

Supply and demand volumes for ‘green’ sawn timber and MET in 2040

Regional supply			Kenya demand (residential and commercial sectors)	
Sawn timber	Sawn timber suitable for MET		Sawn timber	MET timber
Step 3 Annual sustainable sawn timber before considering FSC, kiln capacity, size and quality	Step 7 Kiln dried, fSC certified sawn timber with required size and grading for MET		Estimated demand for sawn timber used for all informal construction e.g. trusses, formwork etc.	Estimated range of demand for MET based on indicative demand models.
2,500,000 m^3/year	**63,000** m^3/year	BAU	**750,000*** m^3/year	**0** m^3/year
3,400,000 m^3/year	**88,000** m^3/year	TT	**975,000*** m^3/year	**23,500-40,000** m^3/year
4,300,000 m^3/year	**946,000** m^3/year	TR	**1,300,000*** m^3/year	**310,000-470,000** m^3/year

*BAU sawn timber demand estimates are based on extrapolations to 2040 from current demand estimates (with an estimated annual growth of 4.2%).[3] An arbitrary 30% and 75% increase has been applied to represent sawn timber demand increases in the ‘timber transition’ and ‘timber renaissance’ scenarios, representing increased uptake of timber construction generally.

Decarbonising the Built Environment

The overall embodied carbon saving that could be achieved in Nairobi by the year 2040. The model assumes an incremental increase in the use of timber up to 2040.

This calculation combines the embodied carbon calculation from the mid rise residential typology study with the indicative building demand model.

	BAU	TT	TR
Total number of buildings by 2040	N/A	**400** hybrid buildings	**4,500** hybrid buildings
	N/A	**200** mass timber buildings	**2,250** mass timber buildings
Total embodied carbon saving by 2040	N/A	**~234,000** tCO_2e	**~2,970,000** tCO_2e

Action plan

This section describes a prioritised action plan with short, medium and long term actions in line with the research framework. It is recognised that the owners for particular actions will represent a broad range of stakeholders and ability to influence will vary. Further detail on actions to be taken can be found in the scenarios.

	Short term	Medium term	Long term
Enabling environment	Industry body dedicated to advancing the use of sustainable timber in the construction industry is established. Kenya logging moratorium lifted for sustainably managed forests. National Timber Sector Development framework is authored and implemented. National Building Code 2020 to be approved.	EDGE certification is championed by government and applied to increasing proportion of the industry with target levels increased over time. Uganda SPGS is replicated across the region. Eurocode National Annexe for Kenya authored for design and construction of timber and MET. KEBS develops MET testing standards. Kenya develops a carbon taxation mechanism, with a forward pricing corridor tied to the Paris agreement.	Import duties are set to encourage regional trade. Ministries develop decarbonisation plans for commercial, industrial, residential construction sectors.
Supply	Timber manufacturers invest in MET and kilns in particular. Existing plantations are managed sustainably.	Quality increases through improved forest management practices. FSC certification increases, as does practice of grading.	
Demand	Landmark showcase projects are completed. Industry awareness campaign initiated, focussing initially on link to EDGE.	Kenya specific courses developed for design professionals. Local university/educational institution to incorporate a timber design course within its curriculum. Mechanism to be put in place that allows lessons learnt from first timber/MET projects to be shared throughout the industry. An awareness campaign is established to champion benefits of timber construction linked to sustainability, EDGE, fire safety.	Local engineering firms to develop capacity in performance based fire engineering. National Building Code subsequently updated to include carbon emissions targets.

Priority actions

Priority Actions

Near term priority actions, balancing the need to address supply and demand in tandem, supported by a strengthened enabling environment.

Regional coordination and cooperation will be key, particularly around supply.

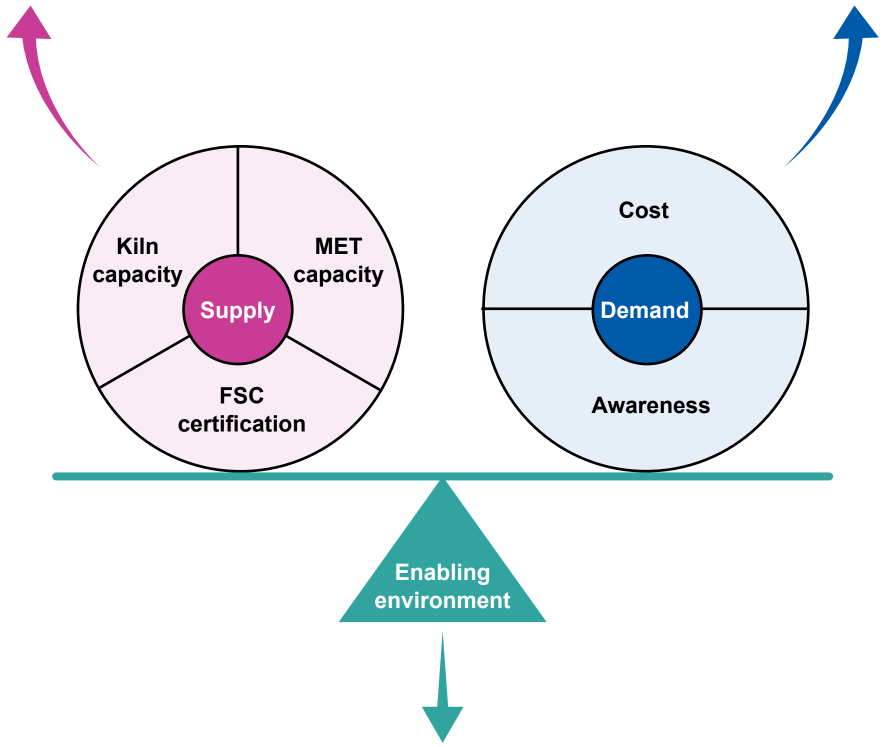
Any investment in MET first requires a reliable supply of kiln dried sustainable timber of suitable size and quality. Supply chain investment should seek to increase structural grade sawn timber as well as engineered timber recognising demand particularly for single family dwellings as well as mid rise residential.

Further investigate fire protection costs.

Commission econometric model to understand impact of carbon markets on the cost of timber over time.

Promote use of timber as a way to achieve EDGE certification and access climate finance.

Raise awareness through landmark demonstration projects and reassure the industry of viability.



Establish a body dedicated to promoting sustainable timber in construction with aim to influence at highest levels. Priorities include developing a National Timber Sector Development Framework.

Further work

Plantation area

Recent studies proposing shift to timber construction have flagged concerns over the impact on land-use and bio-diversity. This area needs further work particuarly as it relates to the increase in plantation area suggested within the 'timber renaissance' scenario.

Carbon pricing

Commission an econometric model for timber sector to understand impact of carbon trading on cost of timber over time.

Timber flow

Better understand the flows of timber into other industries and for export market.

Sawn timber demand

Research into demand for sawn timber both green and structural grade kiln dried timber.

Supply chain

Confirm sawmill capacity outside of Kenya.

Data

In some instances data used is incomplete or out of date. For example, estimated demand for sawn timber used in all construction is based on an outdated study.

Building supply estimates to be updated once more up to date information is available. Current values are based on projections using IFC data from 2018.

Insurance

Further map out requirements and understand premiums for hybrid and MET construction, building on current research. Local insurance firm to be engaged to provide a quote/price for first hybrid or MET building project being planned in Nairobi.

Embodied carbon

Expand on existing embodied carbon study to include all construction materials e.g. finishes and MEP fit out.

Whole life cycle carbon assessment

Carry out a whole life cycle assessment including operational carbon.

Thermal performance

The impact that lightweight materials e.g. CLT, being used as a replacement for traditional materials, to be investigated to see what impact this has on the thermal comfort of buildings within a Kenyan context. Increased use of air-conditioning will incur increased operational cost and carbon.

Awareness

Benchmarking of awareness campaigns in other countries to understand what has worked.

Seismic performance

The impact that lightweight materials e.g. CLT, being used as a replacement for traditional materials to be investigated. Note that reducing the load of the structure will result in a reduced seismic load and is therefore advantageous.

End notes

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Glossary

CLT — Cross Laminated Timber

CLT panels consist of layered timber boards stacked crosswise at 90-degree angles. Glue is applied between layers and then pressed hydraulically, pneumatically or by vacuum. Finger joints and structural adhesive connect the boards length ways.

EDGE — Excellence in Design for Greater Efficiencies

EDGE is an innovation of International Finance Corporation, a member of the World Bank. EDGE was created to respond to the need for a measurable and credible solution to prove the business case for building green and to unlock financial investment.

FSC — Forestry Stewardship Council

FSC is an international, NGO dedicated to promoting responsible management of the world's forests. FSC's certification system, enables businesses and consumers to choose wood, paper and other forest products made with materials that support responsible forestry.

LULUCF — Land Use, Land-Use Change and Forestry

LULUCF is one of the sectors under the United Nations Framework on Climate Change that measures and accounts for emissions and removals of CO_2 from land and forests.

MET — Mass Engineered Timber

MET is a collective term for a group of building materials comprising engineered wood products with improved structural integrity. Usually consisting of structural panels or beams made from multiple solid pieces of timber bonded together.

SPGS — Sawlog Production Grant Scheme

SPGS is an European Union funded scheme in Uganda providing financial grants and technical support to commercial tree planters, rural communities, public and private institutions, to promote investment in commercial tree planting and increasing the income of rural populations.

Disclaimer

This report is not intended for and should not be relied upon by any third party and no responsibility is undertaken to any third party. In preparing this report we have relied on information provided by others and we do not accept responsibility for the content, including the accuracy and completeness, of such information. Forward-looking projections, forecasts, or estimates are based upon interpretations or assessments of available information at the time of writing. We accept no responsibility for the realisation of any projection, forecast, opinion or estimate. Findings are time-sensitive and relevant only to conditions at the time of writing.

We caution that data scarcity, complexity of interdependent factors and resulting assumptions require the supply and demand model be treated with caution. The value of the model, the qualitative scenarios and the typology study (as detailed in the full report) is in identifying bottlenecks and areas for further work.

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