FOOTPRINTS AFRICA


# Building for the African Century

## Case studies in architecture and the built environment

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Front cover picture courtesy of Buildher. Buildher equips women in Kenya with accredited construction skills leading to greater financial prosperity, changing male attitudes and promoting gender equality within the construction industry.

# Introduction

By the end of this century the world's three largest cities will be in Africa: Lagos, Kinshasa, and Dar-Es-Salaam. The combined population of these three cities is expected to be a staggering 244 million. In other words, the kind of population growth that happened in Europe over centuries is happening in Africa in the space of just a few decades (although not necessarily with the expected dividends of urbanisation[1]). These future megacities will dwarf their current global equivalents. Architects, urban designers and planners will need to think as never before about social and environmental challenges: urban sprawl, people's access to basic services, climate change, and access to materials.

Try to square that projection with today's challenges in relation to the built environment. Already every African country has a huge shortage of affordable, decent housing: an estimated 2 million units in Ghana (population: 33 million), 2 million in Kenya (population: 54 million), and 3.7 million in South Africa (population: 50 million). The list goes on[2]. We are not on track to achieve access to sanitation, to clean water and electricity as set out in the Sustainable Development Goals. Meanwhile, we are already seeing some of the most profound effects of climate change on human habitats in Africa: droughts in the Horn of Africa, floods in South Africa, or cyclones in Mozambique.

**So: how can we design, build and adapt the structures and man-made environments in which we live and work across Africa to tackle these challenges?**

At Footprints Africa, our job is to uncover and research examples of the forward thinking that is needed to tackle these problems and bring about inclusive, sustainable development. The case studies we have mapped reframe the role of the built environment. These examples are showing us that we need to move from talking just about physical structures to the built environment as a medium for providing access to what people need to thrive. We need to rethink the physical structures within the built environment as banks of material hosting flows of resources, such as water, light, energy, and biological materials.

We don't have time for incremental change or sustainability approaches that are 'less bad'.

We need decisive adoption of circular and regenerative practices in all sectors: fast, and at scale. What is encouraging are the emerging

## Talking about Africa

In our work we are aware of the risks and contradictions in talking in general terms about a continent of 54 countries, 1.2 billion people and over 1,500 languages. We are even more aware of doing so when talking about the built environment and ways of doing things that are culture- and context-specific.

But Africa has been largely left out of the global discussion so far. By that we mean two things. The first is a lack of good information on the ideas that underpin the circular economy. And the second is compelling examples of business models.

Our approach in this report is both to address those information gaps, and to connect and create the networks that make change happen.

This report has been made possible through the generous support of Sitra, the Finnish innovation fund that is working to accelerate the transition to a fair and competitive circular economy.

## What do we mean by the built environment?

In this report we define 'built environment' broadly as the human-made environment that provides the setting for human activity, ranging in scale from buildings to cities and beyond. This includes buildings (residential, commercial, institutional…), infrastructure networks (transport, water, waste management, electricity…) and open spaces (parks, community gardens…). It's helpful to take this broader view, we believe, because the case studies are applicable to types of infrastructure, and speak to people working across different value chains.

business models, advances in materials science, and development of appropriate technologies that make this possible. And not least, the wisdom of the architects and designers that we have spoken to across the continent.

In this report we talk about how that can be done - and is being done - by taking you through some interesting ideas, case studies, and the people who are at the forefront of new approaches to the built environment across the continent.

## Why the built environment?

In our last thematic report, Roots of the Future, we focused on regenerative agriculture businesses. We chose this theme because we wanted to highlight ingenious business models working to improve food security and reverse environmental degradation.

This time we have chosen architecture and the built environment. After food systems, we believe this is the most critical topic for human and planetary wellbeing. However, this is a theme that has not been given the attention it deserves in Africa. Sharing knowledge and innovation is one step towards bridging this information gap and helping us rethink the way humans interact with their physical environment.

The circularity challenge is different in Africa in many ways, but one fact stands above all others. In the northern hemisphere the infrastructure needed by 2050 has already been built; it mostly needs to be repurposed, rehabilitated, insulated, or used more efficiently. Across Africa it's the other way around: an astonishing one third of the infrastructure that will be needed by 2050 has yet to be built[3]. Consider that if we continue on our business-as-usual trajectory that means an incredible amount of raw materials used (mainly steel and cement), of emissions and of land degradation. And just building more won't necessarily mean an improvement in people's quality of life and livelihoods.

## The value of case studies

We believe sharing accessible examples of what is happening in practice is an effective first step to galvanise change. This is why we choose to group our thematic reports around case studies. They offer you glimpses into the business models needed to transition to circularity. They allow you, the reader, to make mental links with other contexts and parts of the value chain. And they help alleviate the risks and doubts we all have when considering trying out an idea that's new and untested.

In our mapping of case studies we make these more impactful by asking specific questions to the people whose work we feature: what is their story? What impact are they having, or projecting to have? What are the success factors that they would like to share?

It's important that we point out that the case studies we have chosen may not be perfect examples of circularity in practice. Some projects are still in the pipeline and their claimed benefits are yet to be proven. Other examples are early adopters, meaning their costs are often higher. And as architects, engineers and builders will readily testify, there are always trade offs when innovating: deadlines, tight budgets and client specifications can limit circular ambition. But we believe that's also a good reason to include them: they illustrate the journey that many businesses are on and what future pathways to improvement and innovation might look like.

## Complicating factors and favourable conditions

First let's talk about some contextual complications:

**Construction and building use are incredibly energy and resource intensive, and big carbon emitters:** In 2019 in Africa, buildings used 57% of the total energy and accounted for 32% of the process-related CO2 emissions (that is, during the construction phase).[4] Globally, infrastructure is responsible for 53% of greenhouse gas emissions and 12% of the world's freshwater use. Conventional methods of construction are intensely polluting. Production of cement alone is responsible for some 8% of global emissions.[5]

**Housing access is a primary issue that needs a fundamental rethink:** When it comes to housing, the scale of the problem is so big it's almost impossible to visualise. As we have outlined, only a small proportion of households in Africa live in 'formal' housing. In 2018, about 57% of the continent's urban population was estimated to be living in slums.[6] This means there is increasing pressure and opportunity to enhance the quality of housing for the vast majority of people living in African cities through more affordable approaches. Most of Africa's economic activity is also informal, and that means affordable housing will look very different. It implies a rethink of the use of natural resources to construct or repurpose infrastructure to make decent housing within reach to more people.

**Rapid urbanisation adds another layer of complexity:** Africa's population is projected to grow from 1.3 billion in 2020 to 2.5 billion in 2050. The continent is urbanising at 4% per year, according to UN-Habitat - twice the global average - meaning the urban population is projected to reach 59% of Africa's total population by 2050, up from a current estimate of some 42%. Naturally we cannot take that projection as a hard-and-fast prediction, but it does point towards the urgency of reconfiguring the urban landscape: planning more intelligently and using denser, low-rise approaches. What about the barriers to moving towards circularity in the built environment? We identify three main ones:

> "Addressing affordable housing has for too long been supply driven and based on off-the-shelf materials and delivery chains, crowding out the dynamic and creative builders and designers of future cities. Africa, where there is an overdue need to reassess urbanisation, is an important example of this trade-off.
>
> 
> **Etta Madete Mukuba**
> *BuildX*
>
> 
> **Donovan Storey**
> *REALL*

**Innovating in construction is hard compared with other sectors:** Construction is an inherently conservative sector; projects have long lead times and, significant sunk costs. Mistakes are expensive and hard to remedy, which can be a natural brake on innovation. We are also talking about a diverse and fragmented value chain involving multiple players: designers, financiers, clients, regulators, professional and standards bodies, manufacturers, materials suppliers, contractors, subcontractors, and users. Making progress means closing the gaps between them and aligning incentives.

**Experimenting with new materials faces challenges getting to market:** Users may be sceptical of alternative construction materials and technology, or dramatically different ways of living and working. Regulatory standards sometimes simply do not recognise new products or fail to provide the incentives for the use of recycled or renewable materials. The cost of virgin materials can be lower than that of recycled

## Adapting to future city dwellers' needs? Makoko Floating School

Makoko Floating School, built in 2016, is a floating school adapting to people living in city waterside environments. It's located in Makoko, a waterfront settlement in Lagos, Nigeria, estimated to be home to around 250,000 people. Designed by architect Kunlé Adeyemi, the school is supported on stilts, powered by photovoltaic cells and harvests its own rainwater. It's also an interesting example of how public services - in this case education - can be provided more flexibly. Think, for example, of the many African coastal cities threatened by rising sea levels and the measures they will need to take to adapt.

Photo credit: Public Delivery.

materials because of subsidies, costs of extraction, underdeveloped secondary value chains **and so on**. The costs associated with the upskilling and logistics for circular practices can also be perceived as higher in contexts where there is already a significant skills gap.

**In order for them to work, circular solutions need to outcompete linear ones:** For circular approaches to succeed, we need design and building solutions that are altogether more compelling. They need to be more convenient and better performing from a technical, social and environmental and economic point of view. On top of that, people have to want them. The circular economy transition won't happen unless people desire and aspire to it. That means a huge shift in perceptions and behaviours.

**Having outlined some of the challenges we can look at some of the upsides.** First, circularity is not new in Africa. It's already widespread in vernacular practices in many contexts. Think, for example, about bio-based materials that can be upgraded or degrade naturally: rammed earth, timber or bamboo, for example.. These materials provide many benefits: local availability, better temperature performance, a reduced need for high-value construction equipment, or lower embodied energy. On the other hand, traditional or bio-based materials are often perceived as 'primitive'. In many cases imported materials are viewed as higher quality and more aspirational. We talk about this in case study examples such as Easy Housing below.

What's also promising about African contexts is the opportunity for lower-cost leapfrogging. There is less 'linear lock-in'. There is less 'legacy' infrastructure that is inappropriate for future needs, or which has a heavy carbon footprint. To accelerate this, digital technologies can act as enablers in the built environment as never before. And because so much still has to be built across the continent there is a blank sheet, a better chance of incorporating circularity into present-day and future business models.

There are also a series of external levers which may stimulate circularity. Many major infrastructure projects in Africa are financed outside of the continent. Financiers and investors, under increasing pressure from environmental, social and corporate governance considerations, are starting to be more 'carbon light' in their footprint. Increasingly, we believe, that will force a rethink about how built environment projects in Africa are realised.

> "We're not going to build African cities from materials that we get from China. COVID-19 has highlighted how their design and their purpose needs to better match what works for the continent.

**Christian Benimana**
*MASS Design, Rwanda*

## The 'Uberisation' of construction equipment? A parallel from agriculture

Nigeria-based Hello Tractor gives smallholder farmers access to machinery which would otherwise be out of reach because of their high cost. It has the potential to revolutionise regenerative agricultural production and contribute to food security. Imagine if this concept were applied to the construction sector, which has comparable questions of access to high value assets? Picture credit: Atlas of the Future.

## What could the circular built environment mean in practice?

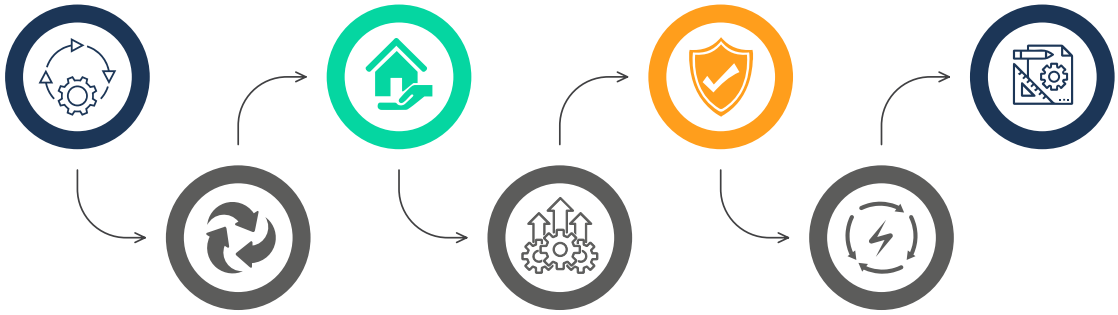
Often when we talk about circularity it can become a bit abstract, so here we break it down. Circular building design and construction optimises the use of resources while minimising waste throughout its whole life cycle. More simply, here is what we mean:

Looking upstream, minimising the need to build by adapting and retrofitting existing building stock.

Creating affordable housing with access to basic needs (sanitation, clean water, electricity, food and work).

Building for longevity, resilience, durability, easy maintenance and reparability of buildings and their components.

Design for outcomes aligned to circularity: if it's a hospital, design for health; a school, for learning and creativity; a home, thriving families and so on.



Choosing and using construction materials that are lower impact throughout the lifetime - secondary, non-toxic, sustainably sourced, or renewable, reusable or recyclable materials.

Creating space and use efficiencies over time through shared occupancy, flexible/ mixed use, modularity and adaptability. That is, lowering the pressure to constantly build new things.

Using regenerative approaches to manage operations: maximising renewable energy, capturing value from the nutrients that pass through buildings (or in the 'waste' that buildings produce).

All of these steps are underpinned by making design - both human -centric and planet-centric - the focus of the built environment. In the sections below we present case studies to better illustrate what this looks like in practice.

For an overview of the core elements of circularity and what they mean in African contexts, see our first report the Circular Economy: Our Journey in Africa So Far.

## 3D printing with biobased materials?

14Trees, a joint venture company between cement producer Holcim and British International Investment, has pioneered the introduction of 3D printing in construction in Malawi for schools and housing. In doing so they have made significant time and materials savings, with an estimated CO2 reduction of up to 70%. For us, this is a fascinating example of what could come next. Imagine if, rather than cement, that the printer were to use biobased materials such as wood fibres and bio-resins. Photo credit: 14Trees.

## The benefits of going circular

Circular strategies in the built environment have massive potential to tackle the challenges we have outlined. They can reduce negative externalities impacting the environment, communities and countries. They can bring new value and create new markets. They have the potential to create opportunities for new kinds of industrial development, diversification and value creation, in turn increasing the resilience of African economies. Quite simply, they can improve people's lives.

It is still hard to estimate specific benefits of circular approaches compared with linear ones because of the relative paucity of data on this theme in Africa. That is one challenge we are trying to address at Footprints Africa through our work with circular businesses to measure their impact.

One clear benefit comes from the fact that the circular economy is more labour intensive, which is important in African contexts with an abundant young labour force. To pick one example, managing forests sustainably for construction could generate 3 million jobs across the continent.[7] Another example: globally, deconstruction ('disassembling' rather than 'demolishing') is estimated to produce five to eight jobs for every one job in demolition.

Beyond this, circular approaches have an inherently positive impact on emissions, particularly carbon, by keeping materials and resources in use for as long as possible and reducing the carbon footprint of buildings. In principle, circular approaches preserve the value of resources to manage demand on virgin materials and reduce waste that's generated.

What we still need to do is substantiate these hypotheses, build the business cases and change perceptions of circular solutions.

## Five insights from this case study research

Based on the experience and expertise of the people we interviewed, we have summarised some of the insights that have been shared and the patterns we have observed.

We set five of these out here as a way of focusing attention on what is needed to promote businesses working at the forefront of circularity:

- **Create better conditions for innovation:** rules that could unlock circular construction need to be re-thought, from building codes, to specifications for building materials, to (circularity) clauses in public works contracts.[8] This is not something to be done lightly, since the rules often exist to promote the health and safety of people who build and use buildings. National building standards can dis-incentivise or prohibit the use of recycled, second-hand, circular building materials for safety purposes. These innovative materials are not included in material specifications and standards (soil blocks are one example). Right now this prevents the reuse of safe, high-quality secondhand materials in new buildings and constructions.
- **Make financing more appropriate for circularity:** Our own research (see below) tells us that financing is the single biggest barrier for circular businesses that are trying to grow sustainably. For the built environment, we suggest that more can be done to:
    - » Address the high cost of capital for circular projects;
    - » Create accessible financial products, such as mortgages, for owners and users;

## Trees as natural infrastructure: The case of Freetown

There is increasing recognition of the importance of trees to improve the living environment in cities and urban areas for all their inhabitants. They regenerate soil, reduce heat island effects, offer food or shade, support urban biodiversity or lower energy usage. Mindful of this, Freetown is providing monetary incentives for its people to replant trees in order to establish a tree-trading market that funds additional reforestation. Using geospatial tagging for each new tree, the initiative creates tree tokens in the hopes of developing a new market focused on the reforestation of the city. Picture credit: Freetown City Council.

  - » Support equipment sharing, minimising idle assets, material use and costs;
  - » Adapting financing for circular businesses.

  Other ways of strengthening the business case include increasing asset value (through looking at the end-of-life value of materials), lowering land acquisition and leasing costs.

- **Focus on circularity's role in creating affordable housing with access to basic needs:** sanitation, clean water, electricity, food and jobs. Circular construction does not currently come cheap. The cost of circularity in certain contexts can be high since the concept is in its pioneering stage. But over the whole life of buildings it can reduce costs significantly. That means we need to work to help people think of buildings in terms of its environmental impacts and lifecycle to put upfront costs into perspective.
- **Focus on whole-life carbon emissions from the built environment:** Here we are talking about 'embodied carbon' - the greenhouse gases emitted in the manufacturing, transport, installation, maintenance and disposal of building materials. In the words of one interviewee, this has been the industry's blind spot to date. It's all very well when building to focus on orientation, ventilation, insulation, solar shading and use of daylight, but these considerations may be outshadowed by the negative impacts of a building's construction. It gives a more complete measure of the carbon emitted throughout a building's life and focusing on it is critical to understanding circular construction's role in achieving emissions targets.
- **Prioritise standardisation:** agreeing and implementing standard approaches is fundamental to making construction better. It also plays in favour of circularity: buildings can be designed with more modularity to reduce waste within construction and allow a standardisation of both building and infrastructure projects to make their future deconstruction. Why do we say this? If buildings and their components are standardised their value can be sustained for longer. After disassembly they can be used in other constructions more easily.[9] And that means they retain their value for significantly longer.

Some of these insights are echoed in the World Green Building Council's powerful recent Africa Manifesto for Sustainable Cities and the Built Environment, which talks to the materials transformations needed by policymakers and business leaders.

**Do you agree? What do you think could be added?**

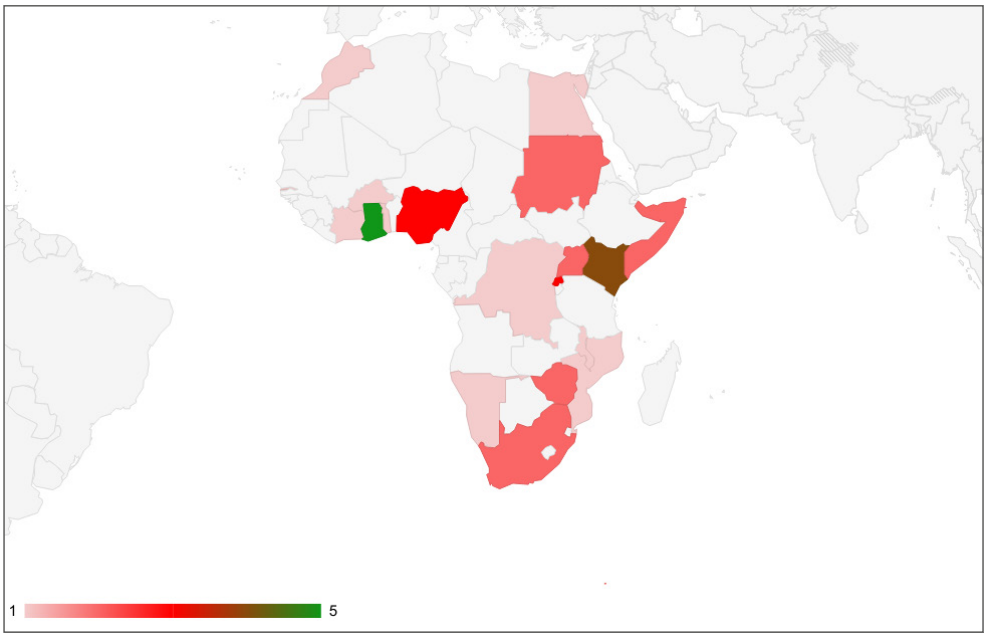
> "If we live to build with local materials, we have a future.

**François Kéré**
*Architect and winner of the 2022 Pritzker Prize*

# What circular businesses are telling us

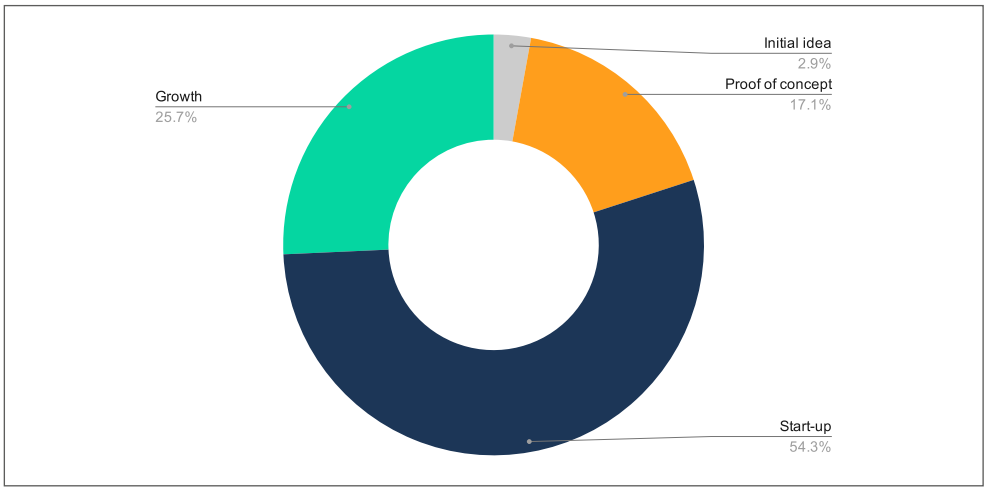
What are the enablers and barriers for businesses working in circular construction in Africa? What do they need to flourish or scale? We have been surveying circular businesses as part of our mapping work. Here we set out a selection of insights from 35 construction businesses which were surveyed by Footprints Africa as part of a wider survey between October 2021 and May 2022.[10]

## Concentration of circular businesses in the built environment across the continent

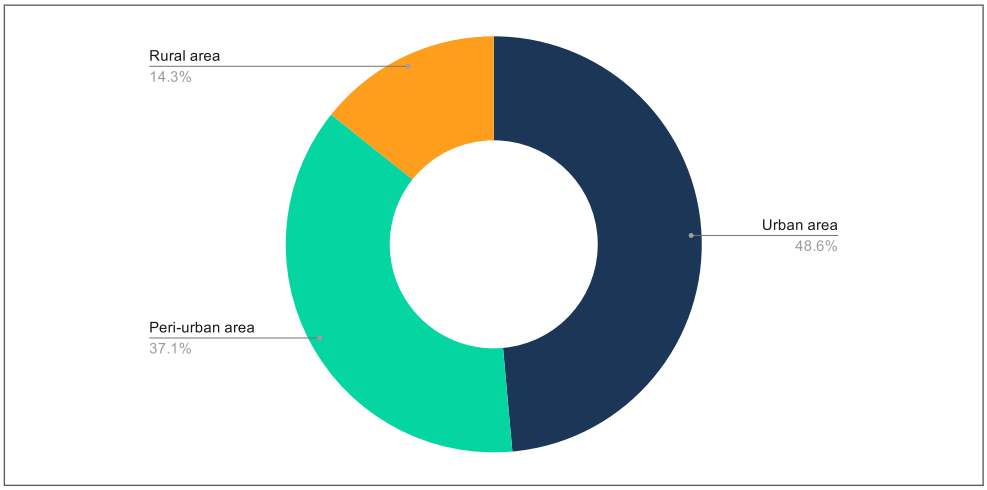



This heatmap shows the geographical distribution of 52 circular businesses that we have mapped across the continent.

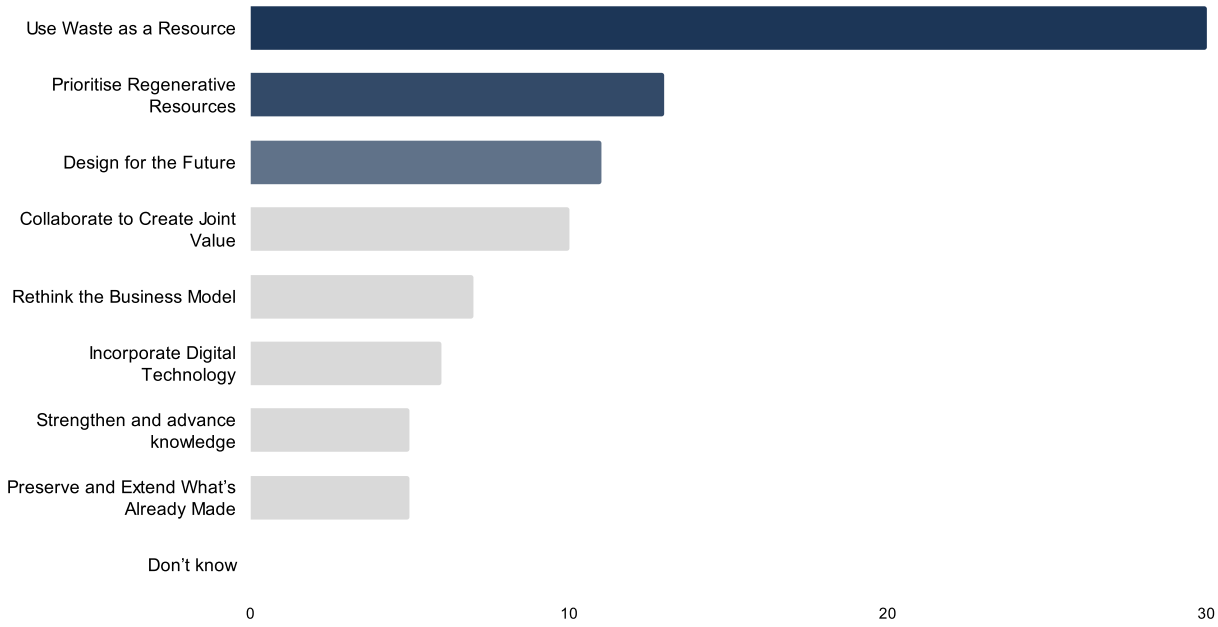
## Most circular construction businesses are in the start- up phase



## There is a smaller focus by construction initiatives on rural areas




## Using waste as a resource is the most popular strategy



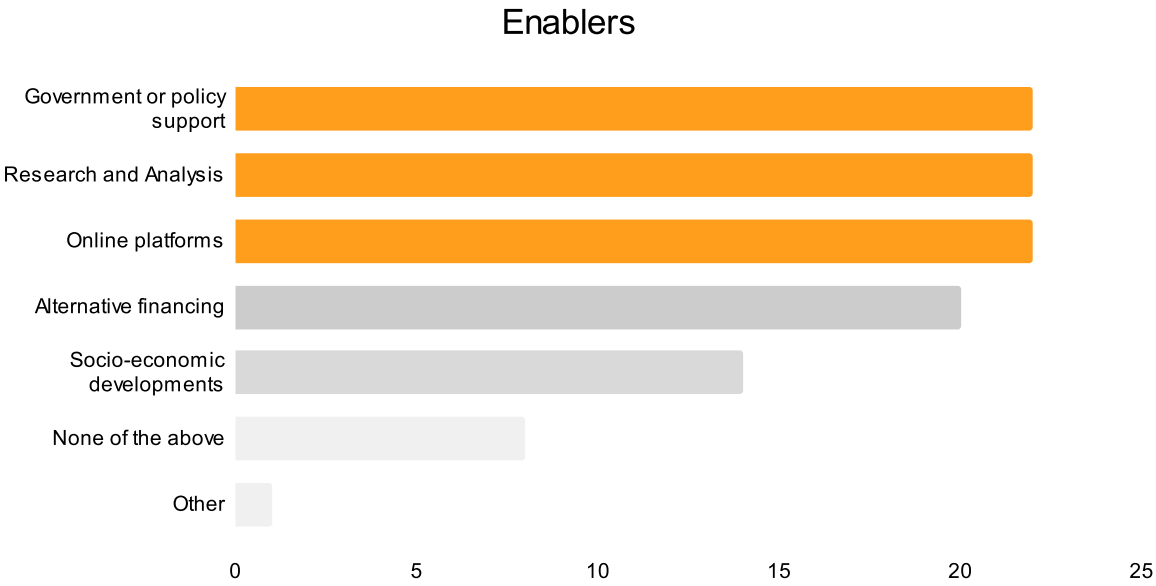

Respondents were asked to choose more than one circular strategy, using Circle Economy's Key Elements as the reference.

### 9, 11 and 13 are the top three Sustainable Development Goals

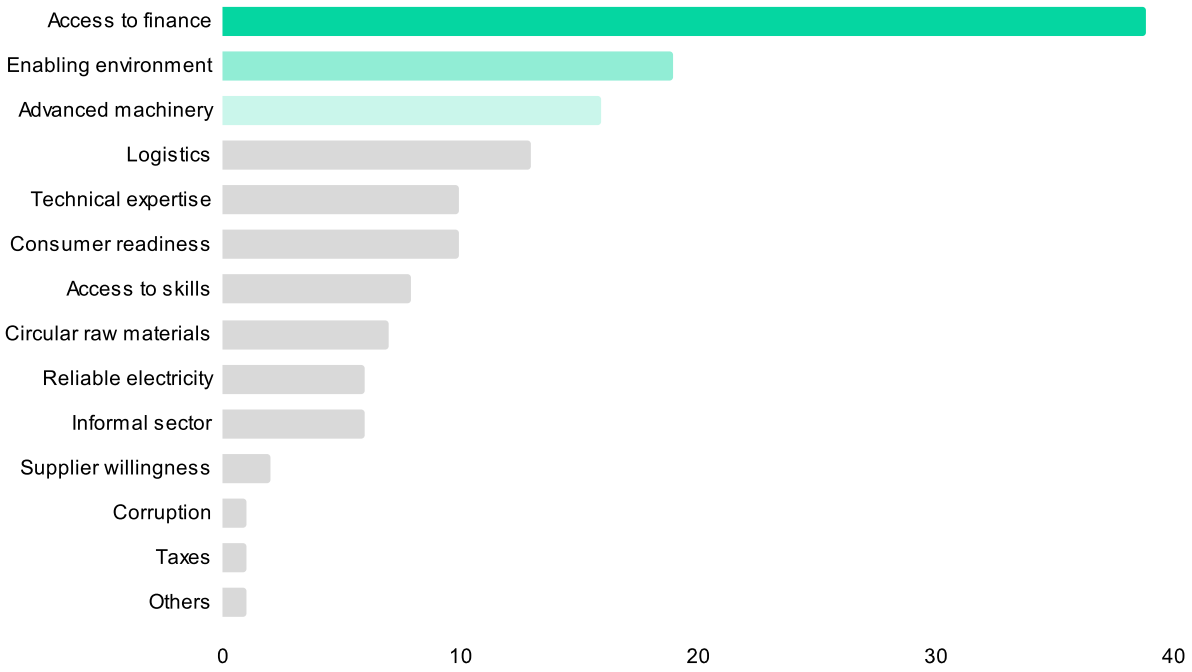

This summarises responses to the question: Which UN Sustainable Development Goals does your initiative contribute towards? Respondents were asked to pick a maximum of three Sustainable Development Goals on which their business is focused.

## Barriers, enablers and areas of support

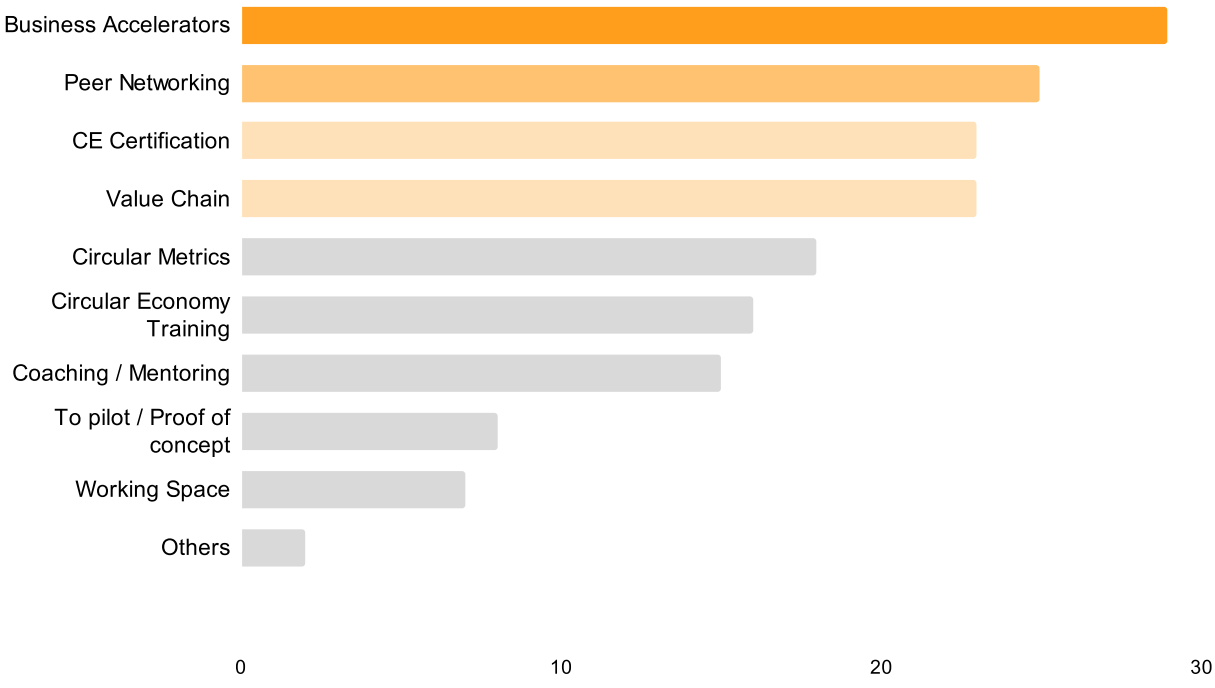
Speaking more broadly on the circular economy in Africa we want to share insights on enablers, challenges and support required by businesses working in the circular economy in Africa. This is drawn from 51 responses to our detailed survey of circular businesses. For the insights outlined below respondents were allowed to choose more than one option.



**Top 3 Barriers to Circular Initiatives In Africa**




**Top 3 Priority Areas of Support**



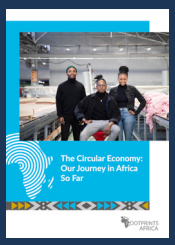
# About Footprints Africa's work

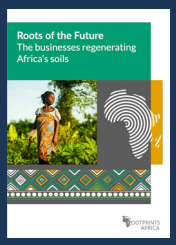
At Footprints Africa we focus on empowering SMEs in Africa to be part of the circular economy. We map what is happening. We help circular businesses measure their impact. And we give direct support through tools and training to de-risk the circular journey.

We started work mapping the circular economy in Africa because we believe in its importance in the light of the extraordinary changes that will happen on the continent over the coming decades. We are focusing on helping circular businesses build evidence of their impact and explore new business models.

To highlight what is happening we publish reports - such as this one - on the practices that we are learning.

Our first report showcasing circular economy businesses across Africa, is here and our second report on Regenerative Agriculture, Roots of the Future, is here.



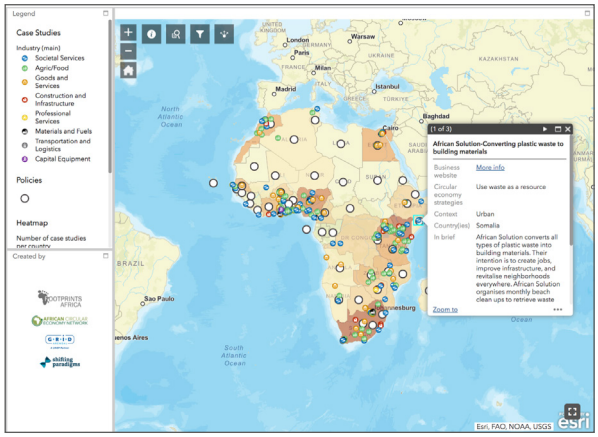




We also recently published a report setting out the early-stage work we are doing to help measure African businesses' circularity and impact. We believe that circular businesses need to have proof of concept to grow sustainably and for the transition to gain momentum. That needs evidence, gained through a rigorous approach. You can find the full report, Building Africa's first circular business measurement framework here.

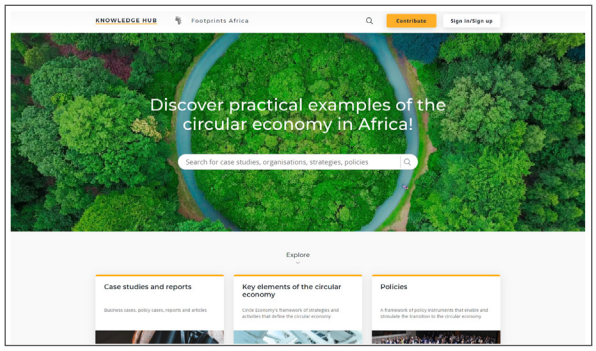

You can find more information and a presentation on our case study work on our site: www.footprintsafrica.co.

## Our case study work

In response to demand from the businesses we work with on our B-Corp programme we looked for tangible examples of the circular economy in Africa. We found very few examples that illustrated well enough the practice and potential of circular businesses; information about the circular economy in Africa was still fragmented and difficult to access. So we decided to create what we were looking for. This was the start of a database which now features more than 600 case studies of circular businesses.




A screenshot of our geolocated map which plots over 500 case studies and over 200 examples of policies, laws and regulations.




Footprints Africa's library on Circle Economy's Knowledge Hub, which links our case study database with a broader set of over 4,000 circular economy examples.

## Relocalising supply chains: Ilima conservation school

Circularity in the built environment means localised, more resilient supply chains that boost African economies. In 2015 MASS Design completed this primary school in the remote Congolese village of Ilima with the African Wildlife Foundation. With all materials sourced from the region, and 99% of materials sourced from within ten kilometres of the site, the construction of Ilima resulted in more money going to the local economy and boosting the labour force. Building Ilima also meant innovating in construction techniques to make them more durable: adding palm oil to earth blocks, for example, or replacing palm leaf roofs with wood shingles. Picture credit: MASS Design.

## Going deeper: other reports to explore

This report builds on a series of excellent and complementary pieces that are exploring circularity in the built environment in Africa. Some examples we can point towards are:

- ICLEI's 2020 discussion paper Realising opportunities for the Circular Economy in African Cities includes a chapter on buildings and construction systems, which looks specifically at barriers and enablers.
- The One Planet Network's 2021 case study report Circular Built Environment: Highlights from Africa focused on the circular built environment in Burkina Faso, Rwanda, Senegal and Uganda.
- The Africa Circular Economy Alliance's Five Big Bets report from 2021 highlights five opportunity areas to transition Africa to a circular economy development model based on a set of criteria including: circularity potential, economic significance, transformative impact potential and momentum.
- The Ellen MacArthur Foundation published its article Circular economy in Africa: examples and opportunities - Built Environment in 2021 to explore the potential of the circular economy in the built environment, setting out specific circular economy strategies for buildings and construction.
- The European Commission's 2021 report, Circular economy in the Africa-EU cooperation (Continental report) looks at a number of entry points for construction and the built environment, primarily through the lens of opportunities for collaboration between the two continents. The report suggests pathways for knowledge transfer between the two continents.
- This year, BRITER BRIDGES published its report Towards More Liveable Cities in Africa. It sets out the explosion of urban innovators that can operationalise circularity across four cities: Cairo, Cape Town, Lagos and Nairobi.

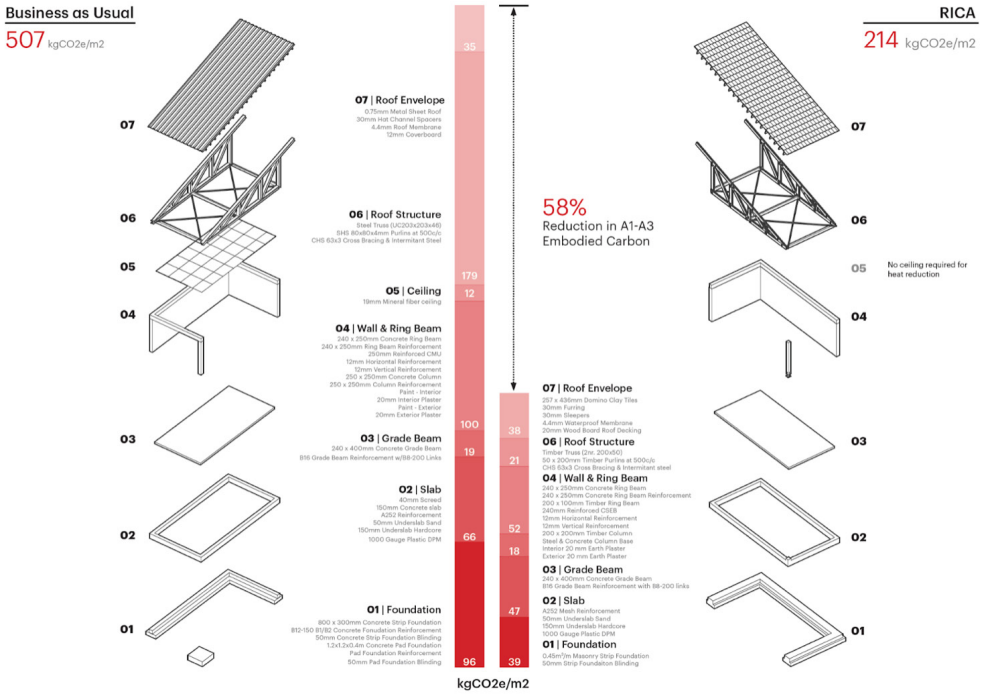
In this report our aim is to further with compelling illustrations of what is happening. We want it to be a launchpad for further discussion, particularly with the people who are not yet aware of or convinced of circularity's potential in this area.

# Case studies

To make reading easier we have grouped case studies around five phases in the built environment value chain. These are:

- Planning: Thinking in interrelated parts;
- Building design;
- Repurposing;
- Innovating (and rediscovering) materials;
- End of life: Rethinking waste

Naturally these are not hard and fast categories; there is much overlap between them. But we believe they are useful to give structure and guide you through our presentations of the case studies.




Schematic showing the emissions difference between 'business as usual' construction and the low-carbon approach employed by the Rwandan Institute for Conservation Agriculture. Picture credit: MASS Design.

# Planning: Thinking in interrelated parts

How can we achieve the benefits of circularity at the macro level in the built environment? By this we can mean a neighbourhood, an industrial park, or even an entire city. The circular economy is often discussed in relation to material recycling, design for disassembly, or material passports. But the ideas are most effective when we talk about them on a bigger scale. As we have discussed, the continent's rapid urbanisation underlines the importance of looking at the relationship between the buildings and surrounding infrastructure. There they bring the benefits of shortening supply chains, saving energy, and cycling materials to preserve their value.

How can this happen in practice? To start with, it means thinking not just in terms of components or materials, but also in terms of infrastructure as interrelated parts which can be efficient and resilient in the longer term. It means thinking about how they can be re-adapted for future uses with minimal intervention. This also means giving careful consideration to considerations such as location, density, urban design, and services to maximise its useful life.

Here we present three examples of how these ideas are being put into practice, looking at creation of a carbon-negative university campus, a successful industrial symbiosis programme and a model of structured urban redevelopment.

Projection of the Green Heart of Kenya, a planned regenerative town and agricultural landscape across 750 acres in Kilifi, on Kenya's coast. The project consists of housing, education, commercial and industrial activities, agroforestry and agriculture – all intended to be integrated into a mutually supportive circular system. Picture credit: Green Heart of Kenya.

# Rwanda Institute for Conservation Agriculture

## The first climate positive university in the world

**Bugesera, Rwanda**

**2022-ongoing**

Web
www.massdesigngroup.org

**Noella Nibakuze**
*MASS Design group*

We believe that design is never neutral. It either hurts or heals. Therefore our mission is to research the world and advocate for architecture that promotes justice and human dignity.

Projection of the RICA campus. Picture credit: MASS design

Its construction is being done entirely on site, greatly reducing transport costs and emissions. All the furniture - the lights, chairs, tables - have been manufactured locally in collaboration with a network of over 85 local artisans. In building the campus, an estimated 96% of all the materials will have been obtained locally.

Construction of the campus results in an embodied carbon level estimated at 40% of the global average. Its climate positivity will then be secured by the 40 acre forest that is on site.

MASS led the master planning, architecture, landscape, engineering, and construction for the new campus. The project was conceived and funded by the Howard G Buffett Foundation and supported by the Government of Rwanda.

The Rwanda Institute for Conservation Agriculture is partnering with MASS Design Group to design and build an ambitious new campus in Bugesera, Rwanda. It will ultimately be the first climate positive university in the world. It's also a pertinent example of how to think in terms of resilience and regeneration within a defined space.

The campus design includes landscape, housing, academic space, barn storage, and processing space for the institute. Each academic building across the campus is dedicated to one of six different agricultural enterprises, both plant- and animal-based, that students will study and engage with throughout their three years at the institute. Mechanised practices are situated on the west end of the campus, and smallholder first-year student farms are placed on the east end. The campus uses pivot irrigation and will be energy independent, with its own four hectare solar farm and water treatment plant.

RICA campus. Image courtesy of transsolar.com

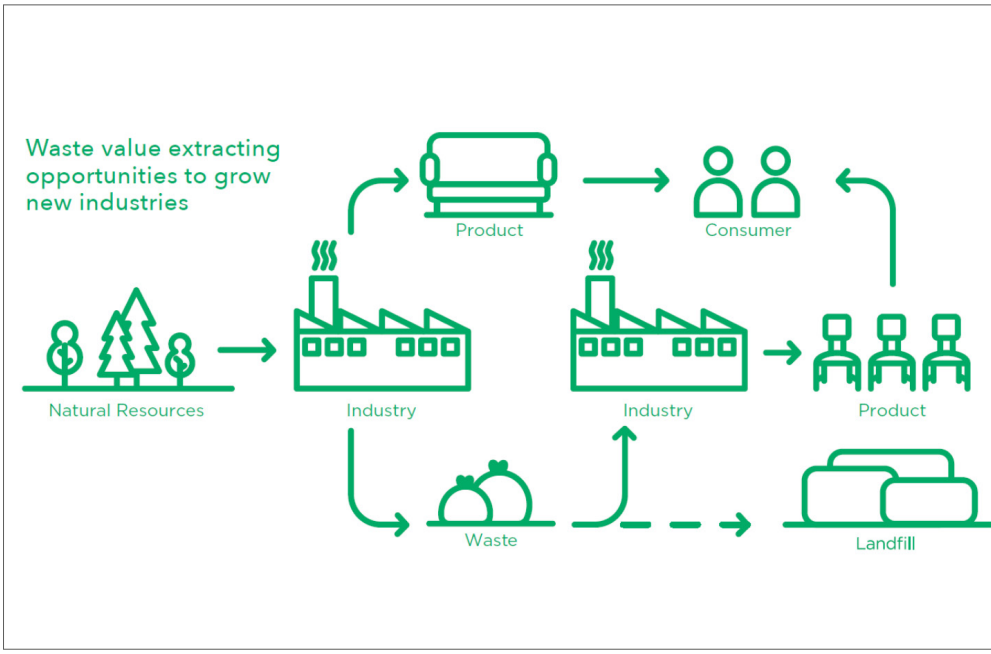
# Western Cape Industrial Symbiosis Programme

## Networking industries for resource efficiency

## South Africa

## 2013 - ongoing

Web
greencape.co.za




Western Cape Industrial Symbiosis Programme process schematic.
Picture credit: Western Cape Industrial Symbiosis Programme

**Taahirah Ghoor**
*Senior Analyst, Circular Economy, GreenCape*

The business case for industrial symbiosis in developing countries differs to that of the developed world; Industrial Symbiosis is a means of building business resilience and unlocking economic benefits, resulting in increased competitiveness facilitated by the productive use of companies' resources.

How can the physical built environment be designed or reconceived conducive to maximising material efficiencies and minimising waste? The Western Cape Industrial Symbiosis Programme (WISP) is a compelling example of how businesses in a specific city context can identify and realise the business opportunities by using unused or residual resources. The programme demonstrates how these collaborations can be built in existing urban contexts or designed into future such developments such as special economic zones (see LADOL below).

In 2013, the Western Cape province of South Africa in collaboration with GreenCape launched WISP to help unlock economic opportunities and job creation within the region by facilitating symbiotic relationships among co-located businesses. The WISP facilitators identify underutilised resources (such as materials, energy, waste, water, assets and technical expertise) and possible linkages between firms and then offers support in helping these firms establish mutually beneficial relationships.

The programme not only diverts waste from landfills, it also ensures the maximum extraction of the embedded value within material resources by prolonging material use through multiple applications, and the creation of new opportunities for businesses. WISP has been operating for more than 9 years, with the latest statistics demonstrating that the programme has been able to divert over 135 000 tonnes of waste away from landfills, prevented 435,000 tonnes of greenhouse gas emissions, generated over R150 million in economic benefits, and created 400 economy wide jobs.

In terms of wider benefits, WISP reduces importation of materials, creating stronger localised economies. Its success has catalysed the development of other industrial symbiosis programmes in other South African provinces such as Gauteng, KwaZulu Natal, Mpumalanga and demonstration activities in the Eastern Cape. As a result of WISP's experience being shared across the continent, similar programmes have also been established in other African countries such as Ghana and Mauritius.

Waste plastic sorting as part of the Western Cape Industrial Symbiosis Programme. Picture credit: Global Opportunity Explorer

# Green City Kigali

## Pivoting towards sustainable urban development

Projection of Green City Kigali development. Picture credit: Green City Kigali

**Rwanda**

**2018-ongoing**

Web
www.greencitykigali.org

**Teddy Mugabo**
*Managing director, Rwanda Green Fund*

Kigali Green City will demonstrate that it is possible to achieve sustainable urban development on a large scale.

Green City Kigali is an example of how a country can take anticipative action when building new infrastructure becomes a necessity. Urban sprawl, growing inequalities, poverty and environmental degradation militate in favour of early action to adopt smart city and regenerative solutions. Rwanda is projected to have 35% of its population living in cities by 2024. Like many African cities, particularly in East Africa, Kigali has been affected by prolonged droughts, coupled with rapid urbanisation and housing shortages. It launched the Green City Kigali pilot supported by several partners including the German Government through KfW.

The GCK project seeks to develop a model community in the 600 hectare Kinyinya Hill area of Gasabo, a district in the capital city, Kigali. The model will provide affordable housing for target groups in sustainable and culturally compatible, climate-resilient urban communities, establishing new standards that can be replicated elsewhere in Rwanda and beyond.

The first pilot phase will result in 1,700 affordable flats for 7,000 to 8,000 people across 16 hectares and alternating residential units with commercial units as well as social infrastructure in the form of a community centre, public squares and a school. The concept of the green model city also includes the construction of a rain water harvesting, wastewater recycling, a stormwater collection system, sewage treatment systems and renewable energy sources. Landscaping will prioritise nature based solutions that promote natural drainage, heat and climate mitigation and biodiversity. Cycle paths and footpaths will also be built to minimise road traffic. Local and low-carbon building materials are being used.

The Government of Rwanda set up the Green City Kigali Company as a Community Benefit Company responsible for stewarding the design and implementation of the 16 hectare first phase, with the potential for scale up to the full 600 hectare planning area, and thereafter replication in the secondary cities of Rwanda and the region.

Main Community Square. Image credit: Kigali Green City

# Building design

How do we design to create buildings with a better material footprint? It's very easy - and often more cost effective in the short term - to repeat the patterns of the past. But rethinking buildings' design represents an enormous potential for reducing waste at all stages and creating better spaces to live and work. And although it is not a central consideration for circularity, healthy buildings can maximise people's wellbeing, rehabilitation, and productivity.

**What does this involve in practice? Here are some of the critical considerations:**


Below we present four examples of business models - all in housing - that are working to embody these approaches. As you read on you will get a sense of how each one is trying to reconcile the sometimes competing considerations of cost, sustainability, and practicality.

The Mahali Hub is an innovative, modular 'house in a box' which won the City of Cape Town's My Clean Green Home competition in 2021. It's designed as a net-zero concept home which incorporates many of the principles we have mentioned above: solar power generation, energy efficient appliances, passive cooling, rainwater harvesting and autonomous food production. Picture credit: Team Mahali.

# Easy Housing

## Sustainable, modular timber housing

**Uganda and Mozambique**

**Established 2017**

Web
www.easyhousing.org

One of Easy Housing's modular timber homes. Picture credit: Easy Housing

**Wolf Bierens**
*Easy Housing*

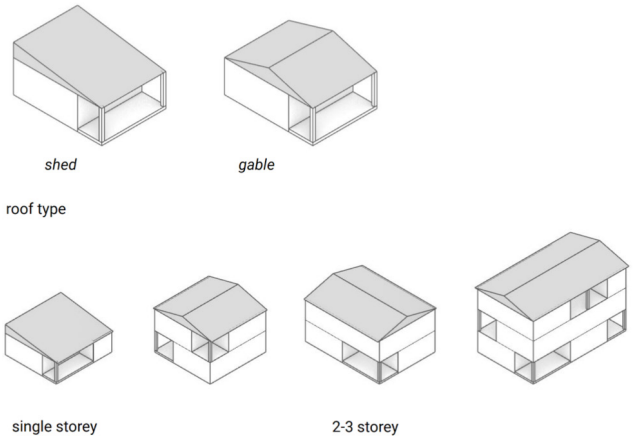
We envision a world in which everyone has access to a safe and sustainable home.

We have pointed out that closing the housing gap by using current approaches to construction will have massively detrimental environmental effects. Easy Housing offers a solution: they design modular homes that can withstand natural disasters like floods and earthquakes and are built to be affordable, circular and carbon negative. Easy Housing's homes are constructed mostly out of locally sourced timber which can store CO₂. Their approach focuses on localising the supply chain, and through stimulating demand for timber can result in an increase in sustainably managed forest areas.

Easy Housing integrates energy and water cycles into the concept of the home, for example using solar home systems to create renewable energy for the consumption of its users. Interestingly, Easy Housing's homes can also be built in two and three-storey configurations, which allow for higher urban density, itself an important concept in making cities more sustainable. Because the designs are modular they can be reused, repurposed and rebuilt.

Easy housing also incorporates circular principles in their design and construction process creating homes that can easily be reused, repurposed, relocated, or rebuilt. They have currently built housing projects in Uganda and Mozambique and are looking to expand to Ghana.

In terms of impact, EasyHousing collaborated with the Climate Smart Forest Economy Programme to quantify the impact of their carbon storage and carbon substitution. They have calculated that for an average home of 100 square metres it is possible to fully substitute cement and steel and store more carbon than has been produced in construction.




Concept buildings offered by Easy Housing showing modularity and design flexibility. Picture credit: Easy Housing.

# BuildX / Zima Homes

## A sustainable and affordable housing project in Nairobi

**Kenya**

**2020-2024**

Web
www.buildxstudio.com

Projection of the planned Zima Homes courtyard. Image courtesy of BuildX

**Etta Madete Mukuba**
*Affordable Housing Lead, BuildX*

We don't need to discover new, complicated technologies—but rediscover those simple, sustainable and accessible solutions used by our ancestors.

Kenya-based architects BuildX Studio envisage a world made for people and the planet by creating the buildings of a radically better tomorrow. To achieve this vision, they take a low carbon approach to design and construction. Their design improves health and human experience in buildings, and their goal is for all their buildings to be inclusively designed and built with a particular focus on women. Market research and participatory design strategies are a core element to achieve this during the design process.

One of their current projects, Zima Homes, is an affordable housing development of 137 units which addresses two key challenges in the Kenyan market: the low-quality affordable housing and the need for more sustainable building. BuildX is the designer, contractor and developer of the project. As with some of the other case studies we profile, these are two challenges which are difficult to reconcile - 'green' versus 'sustainable'. Zima Homes still uses 'conventional' building materials such as concrete and steel but in a smart way to reduce embodied carbon, including using prefabricated wall and floor slab components that are scalable, replicable and precisely factory designed to use only the concrete and steel needed.

BuildX closely collaborates with their sister company BuildHer, a social enterprise that works to help women across Kenya actively contribute towards urban development to create safe, inclusive, resilient and sustainable cities. Buildher equips women in Kenya with accredited construction and manufacturing skills to create greater financial prosperity, changing male attitudes and promoting gender equality within the construction industry.

BuildHer trainees. Picture credit: BuildX.

# Casa Real

## Accessible, climate-smart housing in Mozambique's second city

Casa Real's development in Beira. Picture credit: Casa Real

**Mozambique**

**Founded in 2017**

Web
www.casareal.co.mz

**Marie-Odile Zanders**
*Co-Founder, Casa Real*

Teachers, health workers, fishermen, technicians and domestic workers now have the opportunity to use their formal ánd informal incomes to access quality and climate-smart homes... Just imagine the affordable housing markets that can be ignited with local affordable housing developers on the rest of the continent.

Climate change will have a serious impact on poorer people living in cities across Africa as the number and intensity of climate-related disasters increase. In 2019 cyclone Idai devastated central Mozambique and was the second deadliest tropical cyclone on record, leaving 1,300 people dead and Mozambique's second largest city, Beira, in ruins.

In this context, Casa Real is working to develop effective climate-resilient housing. We have included Casa Real as an example since it shows affordable and resilient housing can be made commercially viable. Its business model is centred on designing, building, and selling houses that people can afford. Their first project is a development in the Inhamizua community of Beira for 180 houses, providing homes for around 900 people.

The World Bank estimates that roughly 80% of jobs in Africa are informal. Without an employment contract, no bank will provide a mortgage, immediately excluding the majority of the population. This is why Casa Real launched a lease to buy scheme earlier this year to improve accessibility to their housing. Previously, only 3% of Beira's urban population could afford a quality home through the local mortgage system. With Empowa's lease to buy tool housing accessibility has now been expanded to over 60% of the urban population. Results so far confirm that these lower income clients are paying their leases on time and saving up diligently to buy their home.

Casa Real's houses incorporate passive design principles; they are naturally ventilated, for example, which is important in the face of rising temperatures and humidity levels. They are modelled on an incremental building approach, allowing their users to expand according to their needs - but in a structured way. In order to further its path into climate-proofing its houses, Casa Real is increasingly including simple but effective solutions such as solar panels and natural wastewater treatment plants with local water recharging systems. Together with South African partners Afrimat Hemp and Wolf and Wolf Architects, Casa Real has started pioneering industrial hemp based construction. Over the last few months Africa's first affordable hempcrete based and climate-resilient home was delivered in Beira by the team.

Casa Real's development under construction. Picture credit: Casa Real

# Hustlenomics

## Providing sustainable housing in South African townships

Members of the Hustlenomics team. Picture credit: Hustlenomics

**South Africa**

**Founded in 2015**

Web
www.hustlenomics.co.za

**Nhlanhla Ndlovu**
*Founder, Hustlenomics*

Hustlenomics focuses on creating opportunities for women and youth by training them to replace informal backyard shacks with durable structures using alternative building technology.

Apartheid transformed the urban infrastructure of South Africa, forcing thousands of coloured and black Africans to move into underfunded and underdeveloped townships. Now, over 20 years after the Reconstruction and Development Program was implemented under Nelson Mandela's leadership, over 3.5 million South Africans are members of households in a precarious situation: they earn too much to qualify for state-subsidised housing, yet they cannot afford safe and secure housing on the private market.

This gap in the rental market is continuing to worsen at an alarming rate. Many South Africans are obliged to live in informal and unsafe shack structures without electricity or running water.

Hustlenomics is addressing rising needs within these informal human settlements by providing affordable and sustainable housing options. A South African Black Owned Company founded in 2015, Hustlenomics is a Level One Broad-Based Black Economic Empowerment impact-driven social enterprise with the mission to replace backyard shacks with quality and durable homes. Annually, at least 51% of the company's revenue is reinvested back into the business to create more homes and jobs in South Africa.

By using interlocking brick technology, Hustlenomics is able to build a home for a family in about one month. Building materials are generally made from natural soil and recycled construction waste. This process reduces the structures' carbon footprint and costs less than traditional building methods.

Through this approach, shacks are replaced by affordable, durable, and dignified rental homes that are equipped with electricity, running water and an indoor bathroom.

Training of Hustlenomics' team. Picture credit: Hustlenomics.

# Repurposing: Adaptive reuse

How do we find a use for infrastructure which no longer serves its current purpose? If we take a circular economy lens we should preserve - or upgrade - what already exists. Adaptive reuse of buildings refers to repurposing or reusing an existing structure or set of structures, often for a completely different purpose than what it was designed for.

There are advantages in this approach; finding alternative uses for outdated assets not only saves costs of demolition but also material acquisition costs elsewhere. Importantly, it reduces the demand for building purpose-specific new stock.

In multiple African contexts there is a need and opportunity to plan for adaptive reuse and regeneration of neighbourhoods using the old building stock. In Uganda there is Old Kampala and Jinja town; Kenya has Nairobi City;Johannesburg has its Central Business District, and Pietermaritzburg.[11]

There are countless examples elsewhere - particularly of colonial era buildings - which have been repurposed pragmatically and ingeniously across the continent. But there are other examples that we have found of more deliberate transformations.

Here we set out case studies on how infrastructure can be repurposed and - looking upstream - designed and built with those changes in functionality in mind. Again, we take a broad view, from specific buildings, to complexes, to entire networks.

An example of ambitious repurposing: the Zeitz Museum of Contemporary Art Africa in Cape Town, which opened in 2017, is the largest collection of contemporary art from Africa and its diaspora. It was constructed from the conversion of the 57 metre-tall historic Grain Silo built in 1924. Picture credit: Frank Gärtner

# Norrsken House, Kigali

## Innovative adaptive reuse

## Rwanda

## Completed in 2022

Web
www.norrsken.org/eastafrica

Norrsken Kigali House. Image credit: MASS Design

**Anton Larsen**
*MASS Principal*

Norrsken Kigali House expands the view of what's possible for urban development.

Norrsken House is a dynamic example of how existing infrastructure can be repurposed. The new Norrsken House hub is housed on the historic École Belge site in central Kigali, and marks the first adaptive reuse project in the area.

With the historic classrooms and former school playgrounds at risk of being demolished for high-rise commercial use, MASS Design aimed to preserve the historic structure of the École Belge and illustrate how adaptive reuse could work within the neighbourhood to create a combination of green and public spaces. It offers a new model of how restoration and mixed use development can be done in harmony.

It consists of repurposed classrooms, as well as a main building, which together form the largest hub for entrepreneurship on the continent. The École Belge de Kigali, established in 1965, is one of the oldest international schools in Rwanda and an educational pillar of the country. Following the school's relocation to new premises, the existing site became one of a few mid-century properties remaining in Kigali's central business district.

The main Norrsken House was designed with a circular economy approach in a number of ways. By using a steel and timber structural framing system, which is more lightweight than concrete, it was possible to reduce the amount of materials needed for the foundation by 28%. Deconstruction and reuse of materials was prioritised, including benches, walls, and pathways. The steel of one existing building was entirely salvaged, and then reused to build the complex' outdoor pergola event space. Combining these conservation measures, the campus design achieved a 32% embodied carbon reduction compared to the global average for similar buildings.

Aerial projection of Norrsken Kigali House. Image credit: MASS Design

# LADOL Special Economic Zone

## Reorganising as a sustainable special economic zone around circular principles

### Nigeria

### Operational since 2006

Web
www.ladol.com

Aerial view of LADOL. Picture credit: LADOL.

**Dr Amy Jadesemi**
*CEO*

In order to secure our supply chains today, in order to secure our economy and industries tomorrow, we must develop more local ecosystems, just as we have done in LADOL, which support a wide range of industries.

How might large-scale, industrial infrastructure support the transition to circularity? Lagos Deep Offshore Logistics Base (LADOL) offers one such story. LADOL, operational since 2006, is a 114-hectare privately owned free zone located on an island within the Apapa Port in Lagos. In its first phase it supported ship building and provided logistics for the oil and gas industry. Its next phase consists of reinventing its serviced industrial space purportedly designed around circular economy principles and supporting the creation of sustainable businesses. As such it can be argued to offer a glimpse of how inclusive economic development might happen across the continent, particularly in contexts where, like in Nigeria's case, the future of fossil fuels is highly uncertain.

40 hectares of the site is now transitioning with the help of sustainable project developer SAVO to become a 'sustainable' special economic zone. Its goal is to become net zero by 2035. One way of achieving this goal is through reconfiguring its power generation. Whereas the zone is currently powered by diesel, the plan is to have it increasingly powered by solar, biomass and liquid natural gas. Biomass power generation will come from cashew husks that are processed on site, reducing cost of power production by 80%.

LADOL raises interesting questions about how a system such as a special economic zone can incentivise its tenants to reduce its overall footprint and move to entrench circular principles. Companies are brought to LADOL because they can halve their costs of logistics service delivery in the region, and benefit from ISO standards that facilitate their operation. With those companies onboarded LADOL can then engage them in its sustainability goals.

Picture credit: SAVO.

# Innovating (and rediscovering) materials

What does the shift to a circular economy look like in terms of materials?

It's increasingly important to look afresh. Common building materials, such as concrete and steel, tend to be energy- and carbon-intensive to produce. Africa also has a high import dependence in the construction sector. That means construction materials can often be expensive, and the lack of localised production does not contribute to local business and skills development. It also means that negative impacts such as resource depletion, carbon emissions and pollution related to manufacturing affect other communities and are less visible and not accounted for locally.

The advantage is that the African continent has an abundance of bio-based resources the extraction of which has a lower footprint and which are by their very nature regenerative. With the application of the right technology they can be transformed into materials that outperform their 'linear' equivalents.

There is also massive potential to valorise 'waste' streams from materials such as plastic to agricultural by-products for affordable construction materials.

Here we give you a selection of business models who are pushing the boundaries with new and traditional materials.

Rammed earth construction in progress in Ghana. Using rammed earth creates a very low carbon footprint, and typically uses locally-sourced materials. Walls constructed this way can reduce daytime temperatures by 4 or 5 degrees, reducing energy consumption. This is just one of a series of techniques to build using earth which are strong and versatile. Picture credit: Hive Earth Studio.

# Arena Recycling Industry

## Valorizing plastic waste in construction

**Tanzania**

**Founded in 2018**

Web
insert

**Helena Sailas**
*Founder*

Plastic waste is not a problem, the problem is the management of it. Initiatives that work on managing plastic waste should be supported.

Arena Recycling Industry's founder, Helena Sila, and their plastic bricks. Picture credit: Arena Recycling Industry

The company sells their products directly to individual customers. In addition, the products are sold to donors and NGOs that have construction projects. To collect the material for producing their products, Arena Recycling Industry buys material from waste collectors and collects plastic waste from shops and restaurants. They also sell beach clean-up services to hotels that have beaches. The collected material is used for the production of building bricks.

Arena Recycling Industry recycles between 30 and 40 tonnes of plastic per month, which reduces the need of virgin construction materials, altogether over 200 000 tonnes of plastic waste has been recycled through the solution. The solution removes pollution from the environment.

About 740 tonnes of plastic waste are thrown out in Dar es Salaam every day. This is a major source of pollution and creates negative environmental impacts. At the same time Dar es Salaam faces housing challenges because of the cost of building materials.

Arena Recycling Industry is a social enterprise that recycles plastic waste to eco-friendly building bricks for construction. The CEO and Founder of Arena Recycling Industry, Hellena Sailas, became aware of the problems that plastic waste has on the environment. Hellena developed a formula for producing bricks through experiments and Arena Recycling Industry began producing building bricks from LDPE and PET plastics. Currently they work mostly on water and sanitation projects because the product is waterproof (septic tanks, water tanks and so on). Arena Recycling has five operation plants in different parts of Dar es Salaam. They are able to produce about 100 bricks a day. Usually Arena Recycling Industry works on one building project at a time because the projects require even thousands of bricks.

Plastic waste sorting at Arena's facilities. Picture credit: Arena Recycling Industry

# XLAM

## Pioneering cross-laminated timber

XLAM's Knysa project. Picture credit: XLAM

**South Africa**

**Founded in 2016**

Web
www.xlam.co.za

**Jamie Smily**
*Director XLAM South Africa*

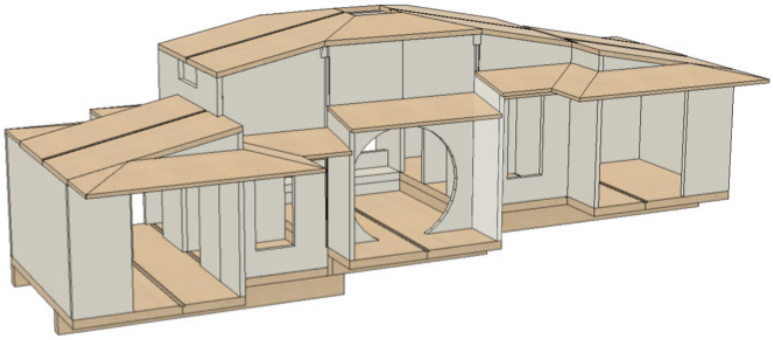
After hearing about cross-laminated timber (CLT), I visited the big European factories to learn more about the process and see about bringing it to markets in Africa. They had other priorities at the time, but they gave me all the advice I needed to get started on my own.

XLAM South Africa is a startup working with cross-laminated timber based in Cape Town Cross-laminated timber (CLT) is a prefabricated timber product that has been dubbed 'the concrete of the future'. It offers an alternative to concrete, masonry, and steel for many construction applications. CLT panels consist of three to seven layers of timber oriented at right angles and glued together. This process creates a structural building material that delivers outstanding strength, stability, and rigidity.

CLT can be used in conjunction with other building materials or as the sole building material. It is also well suited to mid-rise buildings from 4-12 stories where the benefits of lower weight and faster construction have the greatest economic benefits.

The panels are manufactured off-site with all the openings and services already included and are delivered to site on open bed trucks. Once on site panels are lifted into place by means of a crane and mechanically fixed in place.This system of construction is very efficient and in case studies has been shown to reduce building times by up to 40%.

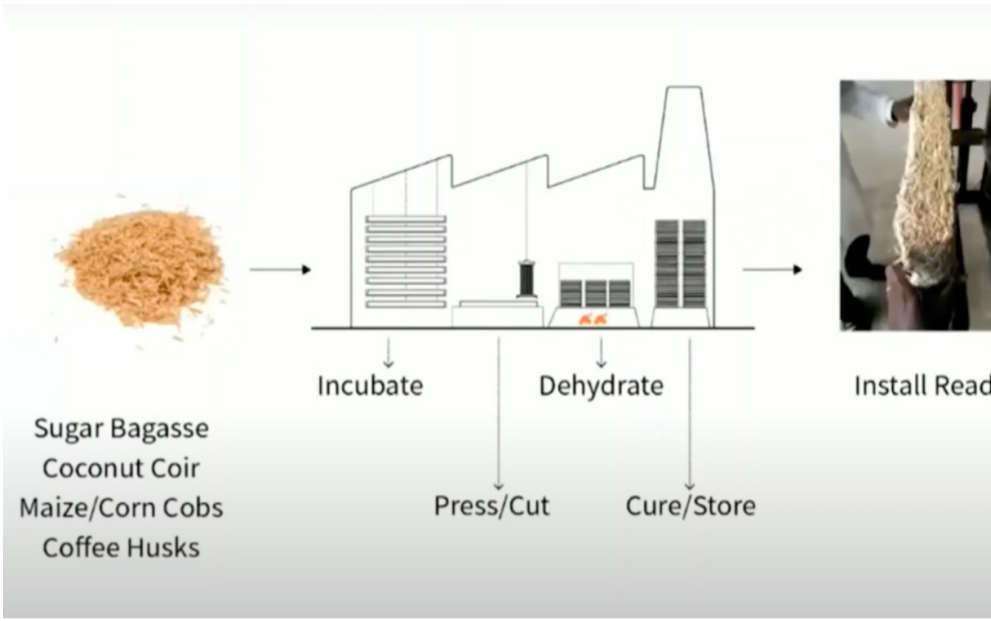
XLAM's timber comes from local sustainably managed forests, meaning both the trees that are felled are replaced and the supply chain is shorter. The carbon that is stored by the trees is built into the project, capturing carbon in the building structure. As with Easy Housing, this demonstrates how CLT can be the basis for a carbon neutral building.



Rendering of CLT house design in Westlands, Cape Town.
Picture credit: XLAM.

# MycoTile

## Construction materials from fungi




MycoTile's production process simplified. Picture credit: MycoTile.

**Kenya**

**Founded in 2019**

Web
www.mycotile.co

**Mtamu Kililo**
*Co-founder and CEO*

The construction industry is quite conservative. It's hard to convince people that they can make a wall from mushrooms, but we are steadily receiving positive feedback and acceptance.

Imagine a tough, fire-resistant building material that could simply grow from a combination of mushrooms on agricultural waste. In Kenya, most construction materials are imported, and for this reason are relatively expensive and often simply not the best quality. The country has an annual housing demand of 250,000 units with an estimated supply of just 50,000. That means an 80% deficit. At the same time, there are natural resources whose potential application in construction is largely untapped. One is agricultural waste produced by small-scale farmers. Another is mycelium, a natural fungal material with industrial-level strength.

Their solution MycoTile offers a high performance and cheaper alternative to traditional building materials. MycoTile uses a carbon negative process to bond agricultural waste (such as maize cobs, coffee husks, coconut coir and rice husks) with mushroom mycelium. The product is denatured through heat treatment in order to inhibit mycelium growth. Their first product was suspended ceiling panels, which have superior acoustic performance and fire-retardant properties compared to the available alternatives. The fire-retardancy is naturally enhanced by the chitin that is present in mycelium. They have big plans and are prototyping a larger portfolio of products, such as wall insulation, construction blocks, MDF-style panels and even furniture.

Although the major challenge has been changing public perception on the use of mycelium in construction, MycoTile currently has more demand than they can supply. A recent important step in their growth was the conclusion of a co-manufacturing contract with a government entity. They are establishing partnerships with small scale farmers, who they pay for agricultural waste, to assure a constant supply.

Mtamu Kililo is a Kenyan architect and designer at Cave Bureau. During his fellowship with the architecture studio MASS Design Group in Rwanda, he was given the space and time to pursue his own research interests. He came across examples of 'leather' being made using mushroom mycelium and this sparked his imagination on applications for the technology in the construction industry. He went on to co-found MycoTile.

MycoTile Co-Founder and CEO Mtamu Kililo demonstrating MycoTile panelling prototype. Picture credit: MycoTile.

# End of life: Rethinking waste

In a circular scenario buildings will still need to be taken down and replaced. They will invariably contain valuable materials with potential for reuse. How do we better design for deconstruction and circulating building materials back into resource loops? And where buildings aren't designed in a modular way, what kind of business models can be put in place to capture value more effectively?

Too often in African contexts buildings are simply demolished and their contents landfilled. Construction waste is expected to rise to 516 million tonnes per year by 2050. To compound matters, more than 90% of this waste is disposed of at uncontrolled dumpsites and landfills, often followed by open air burning. That leads to air and water pollution, with severe adverse impacts on human health.[12]

While the adoption of building information modelling and materials are still in their infancy, businesses are stepping in to valorise construction 'waste' in very pragmatic ways. Here we present three case studies with different approaches to this phase in the value chain: one crowd-sourced initiative, one launched through development financing and a third created by one of the world's largest engineering and design firms.

Building with reclaimed timber. Image credit: Arup/DigiYard.

# Endelevu

A construction crowdfunding and material sharing platform

## Kenya

## Founded in 2020

Web
www.endelevu.africa

Construction site waste recovery in Nairobi. Picture credit: Endelevu.

**Nickson Otieno**
*Architect and founder, Endevelu*

I created Endelevu as a digital marketplace to demonstrate the applicability of green building principles. People can connect to buy, sell or donate leftover, recycled and natural building materials.

Kenya-based Endelevu is helping divert reusable materials from landfills through a digital marketplace encouraging circular construction in the process. The second-hand materials range from reusable 'waste' generated from manufacturing, distribution, construction or demolition processes, as well as surplus or redundant materials from building operations. Endelevu was motivated by the need to transform the practices in the construction industry to make it responsive to the challenges of environmental degradation, waste proliferation and social inequality.

Endelevu aims at solving the problem of construction waste. It is estimated that 10-15% of new building materials are wasted, while the construction industry is responsible for 32% of all landfill waste. This contributes to 23% of air pollution and 40% of water pollution, making construction one of the leading polluting industries in Kenya, and globally. Kenya is facing a huge social infrastructural gap.

Endelevu's digital platform promotes social value and circular economy in the following ways: (1) estimating accurate material requirements for construction projects, (2) crowdfunding for under-resourced social construction projects, (3) crowd-sourcing an empowered youth workforce to design and construct the funded projects, and (4) trading in reclaimed materials and products.

The crowdfunding function enables raising of resources for community projects while earning the organisation revenue in service fees. The company also creates revenue through commissions from sales of materials and project consultancy and delivery fees.

Endelevu provides a marketplace for construction companies and individuals to sell or donate their excess materials or buy them affordably and calculate their material needs. Registered users can trade in reclaimed materials and products through a secure virtual platform that is supported by a network of physical re-use collection centres.

Endelevu's Design Challenge also recruits, trains, mentors and rewards campus students and underemployed graduates to support the design and construction of better, inclusive and climate-friendly social facilities.

Construction work in Nairobi. Picture credit: Joshua Wanyama

# Korylé

## Recovering demolition waste in Abidjan

Demolition works for the creation of the Abidjan metro. Picture credit: Le Metro Abidjan.

**Côte d'Ivoire**

**2021-ongoing**

**Christelle Hien-Kouamé**
*Bouygues Construction*

This project has been well-received since it will be a source of jobs and income... Following this pilot phase and with the support of our various partners and stakeholders, we hope to deploy the Korylé solution on a larger scale: to the entire Ivorian territory and the sub-region.

Korylé is being carried out by Bouygues Bâtiment International, Néo-éco, Valame and materials exchange platform Backacia. Bouygues will supply the construction waste from the rehabilitation of building projects in the capital. Backacia is creating a digital map connecting people involved in 'waste' recovery. Neo-éco and Valame are developing the process required to convert rubble into valuable materials and treat asbestos (prevalent in these infrastructures). This project is expected to be carried out over a period of 1.5 years resulting in the setup of a sector for the treatment and recovery of construction waste, especially rubble and asbestos and help turn Abidjan into a more sustainable city.

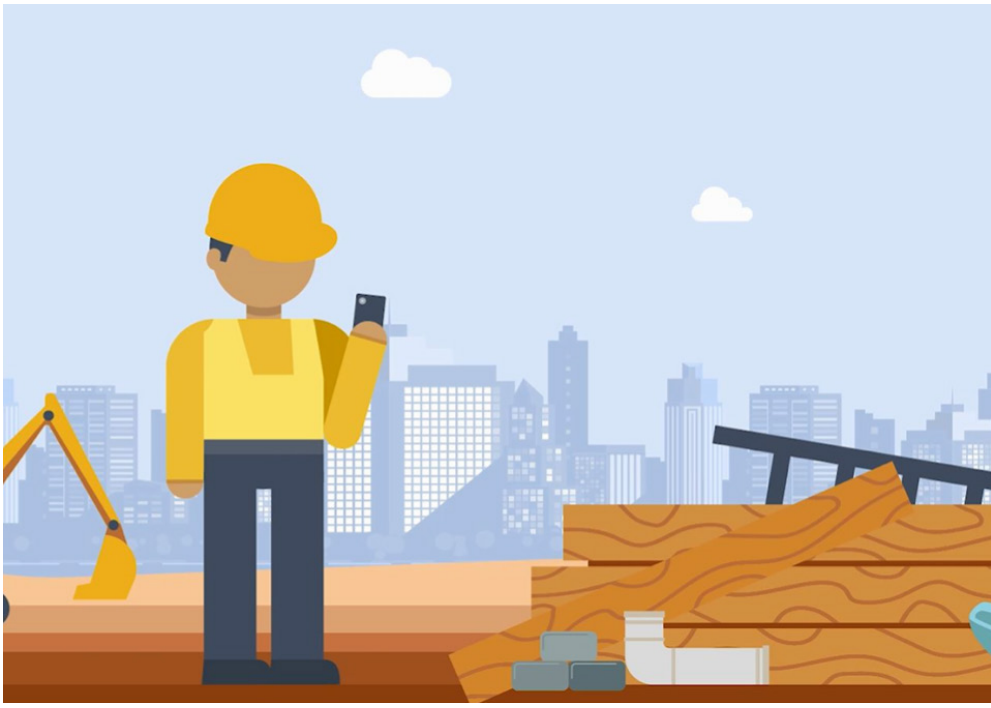
Rapid urbanisation, increasing population growth and development have led to a rise in construction projects. Following a linear trend in the construction sector means large amounts of resources extracted for construction work will eventually become waste. Also effective waste management is still a challenge for most countries. Thus, large amounts of waste generated from construction and demolition activities will eventually find their way into the environment causing harm.

The situation in Cote d'Ivoire is little different. The capital city, Abidjan, suffers from the recurring case of illegal dumping of construction waste. In a bid to provide solutions, the Ministry of Environment and Sustainable Development together with the French government and a quartet of French companies signed a memorandum embarking on Koryle, a project to minimise illegal dumping of construction waste in Abidjan by recycling it into valuable materials to be reused in other construction activities.

Aerial view of Abidjan. Picture credit: Noursaid Gamal.

# DigiYard

An open access platform for reuse of construction materials



Picture credit: DigiYard

## South Africa

## 2018-ongoing

Web
www.research.arup.com/projects/article-digiyard

**Kausar Khan**
*ARUP*

Ultimately our goal is to create a self-sustaining service which could be rolled out in cities across South Africa - and the wider world.

The construction industry in South Africa has for a long time worked on the basis that waste is an inevitable by-product of doing business. Some 30% of all materials delivered to construction sites is wasted, usually ending up in landfill. At the same time, South Africa has an acute shortage of appropriate and affordable housing. Millions of people live in townships on the peripheries of cities - a legacy of the Apartheid era. Their low quality construction and distance from basic services and economic opportunities reinforce structural inequalities. To address this imbalance it is critical not just to recycle more construction materials, but also to repurpose perfectly good salvaged materials. Together with its partner the Craft and Design Institute, Arup has been developing a digital platform service, DigiYard.

DigiYard aims to solve (1) the inefficient nature of the construction sector, in which quality timber, glass, bricks and many other types of materials are often still sent to landfill, and (2) the social challenge of millions of people living in informal housing who are forced to build homes using substandard materials. The process on the platform will work as follows:

- The site manager at a construction site photographs and uploads pictures of unused materials to the platform;
- The app uses artificial intelligence to classify the material type, quantity and price. This information is then displayed on an app where builders in townships can view the materials that are currently available;
- Builders collect the materials directly from the construction site if possible, or from a warehouse;
- The materials are used to build or upgrade homes and build furniture, arts and crafts from low cost but high quality materials. The platform also encourages users to attend building training programmes where they can gain information on building practices and material use cases, to improve the quality, comfort and safety of the homes they build.

In the beginning, the source of revenue for DigiYard was projected to come from the sales of the materials. Materials would be received for free from construction sites and be sold to customers. In the future the platform will also collect a service fee from the construction sites for the collection and management of their excess materials and in return the construction companies would receive data on the materials that are coming from their sites, enabling them to increase material usage efficiencies and report on their carbon footprint reduction per site.

The team will soon be raising funding to incubate and refine the initiative over the next year.

Informal housing in Khayelitsha township, Cape Town. Picture credit: Nikolai Link.

# Endnotes

1 Benefits can include: labour market access, better education, housing, and safety conditions, and reduced time and expense of travel. Conditions such as density, proximity, diversity, and marketplace competition are elements of an urban environment that are traditionally deemed beneficial.

2 Centre for Affordable Housing Finance in Africa 2021 Yearbook, available at: housingfinanceafrica.org/app/uploads/2021/11/2021-cahf-yearbook.pdf.

3 International Resource Panel and UN Environment Programme. The weight of cities: resource requirements of future urbanization, 2018, available at: www.wedocs.unep.org/xmlui/handle/20.500.11822/31577.

4 Global Status Report for Buildings and Construction 2019: Towards a zero-emissions, efficient and resilient buildings and construction sector, International Energy Agency, available at: www.iea.org/reports/global-status-report-for-buildings-and-construction-2019.

5 Toward electrochemical synthesis of cement. An electrolyzer-based process for decarbonating CaCO3 while producing useful gas streams', Leah D Ellis, Andres F Badel, Miki L Chiang, and Yet-Ming Chiang, Proceedings of the National Academy of Sciences of the United States of America, available at: www.pnas.org/doi/full/10.1073/pnas.1821673116. Cement's use is so prevalent in construction that it is sometimes considered the second most used resource in the world after water.

6 UN Habitat's Housing, Slums and Informal Settlements | Urban Indicators Database available at: www.unhabitat.org.

7 International Union of Forest Research Organizations Special Project World Forests, Society and Environment, Making Sub-Saharan African Forests Work for People and Nature, 2009, available at: www.iufro.org/download/file/11001/133/wfse-pol-brief-africa_pdf.

8 Some countries such as Ghana, Kenya, Rwanda, and South Africa have started to recognise the need for a refocus on housing goals and carbon footprints. Action has been slow, however. For a succinct overview of recent policy measures in leading African countries, see: 'Shaping circular economy in the built environment in Africa. A bibliometric analysis' by Jacob Mhlanga, Theodore C. Haupt, and Claudia Loggia, Journal of Engineering, Design and Technology, November 2022, available at: www.emerald.com/insight/1726-0531.htm.

9 On this point, the International Standards Organization (ISO) Technical Committee 323 is working with a network of experts, including across Africa, to develop standards for circularity which will be applicable to the built environment. The ISO's objectives include the strengthening of national and regional standards bodies across Africa.

10 These responses are from a subset of 52 businesses that we have mapped classified as working in construction and the built environment. The full set of over 500 case studies are available on Footprints Africa's geolocated map and Circle Economy's Knowledge Hub.

11 ICLEI discussion paper Realising opportunities for the Circular Economy in African Cities (2020).

12 What A Waste: Innovations In Africa's Waste Material Management', AUDA-NEPAD, July 2021, available at: https://www.nepad.org/blog/what-waste-innovations-africas-waste-material-management.

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All opinions expressed in this report are those of Footprints Africa.


This report has been produced for information purposes only.

See www.footprintsafrica.co for more information on the programmes Footprints Africa runs to support businesses to develop purpose-driven cultures and so empower their employees to improve their social and environmental impact.

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