Book

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AFRICAN CIRCULAR ECONOMY ALLIANCE

BANQUE AFRICAINE DE DEVELOPPEMENT · AFRICAN DEVELOPMENT BANK

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WORLD ECONOMIC FORUM

Five Big Bets for the Circular Economy in Africa

African Circular Economy Alliance

INSIGHT REPORT

APRIL 2021

Cover: Getty Images

Contents

Preface

In 2017, the African Circular Economy Alliance (ACEA) was launched with a mission of spurring Africa's transition to a circular economy (CE) that delivers economic growth, jobs and positive environmental outcomes.

The alliance seeks to achieve this through: 1) policy development; 2) leadership and advocacy; and 3) support in scaling CE businesses. The alliance, through the technical committee, governs the implementing organ (the secretariat).

The ACEA was launched with three founding co-chairs of Rwanda, Nigeria and South Africa. In 2019, Ghana and Côte d'Ivoire agreed to join the alliance, bringing the total of countries to five. The charter was signed at the 2019 African Ministerial Conference on the Envionment (AMCEN) in South Africa. At the same meeting, the African Development Bank (AfDB), with support from the World Economic Forum, announced that it would host its secretariat to support the alliance's mission more broadly on the continent. Since then, other countries such as Niger, Senegal, Malawi, Cameroon and the Democratic Republic of the Congo have indicated an interest in joining the alliance.

The secretariat commissioned market research on the CE, focused on priority areas in line with the tasks mandated by the charter. This research is anchored on food systems, packaging, the built environment, electronics, and fashion and textiles as areas with a high potential for impact. These areas were prioritized based on their circularity potential but included additional criteria to ensure that prioritized sectors have: economic significance on the continent; the potential for transformative impact; momentum.

This report was created on behalf of and in consultation with the alliance by Dalberg, the World Economic Forum, AfDB and with support from Danida. We are also thankful to the many partners whose inputs supported the insights in this report. In particular, we would like to thank all of the technical committee members who were vital in ensuring a comprehensive report. To find out more about ACEA please go to www.aceaafrica.org.

Supported by: MINISTRY OF FOREIGN AFFAIRS OF DENMARK Danida

Foreword

There is a unique opportunity to rebuild green and resilient post-COVID-19 economies across the continent.

Barbara Creecy
Minister of Forestry, Fisheries and Environmental Affairs of the Republic of South Africa;
Co-Chair, African Circular Economy Alliance

In the face of growing global concerns regarding resource use and economic sustainability, the concept of a circular economy has emerged as an alternative production and consumption model. The circular economy promotes the conservation of finite resources while preserving the environment. It also presents opportunities for economic development, job creation and building new enterprises.

For African countries, circular solutions can be leveraged to attain various climate action obligations and sustainable development goals. This is an opportunity to tackle issues such as poverty, poor infrastructure and unemployment, among others that have hindered economic development.

The COVID-19 pandemic has exacerbated the challenges of poverty, inequality and unemployment facing the African continent. Globally, COVID-19 has affected more than 1.6 billion informal workers and small, medium and micro enterprises, mostly in developing countries, with women being the most affected. The pandemic-induced recession has drained resources and disrupted supply chains, hindering trade in commodities on which African economies rely.

In addition, the effects of climate change have compounded the health and economic impacts of COVID-19. Africa has been hit by extreme weather events, putting a strain on already fragile safety nets and infrastructure. Countries now spend between 2% and 9% of their GDP in response to climate-related events such as floods, droughts and landslides.

There is a unique opportunity to rebuild green and resilient post-COVID-19 economies across the continent. Putting in place the right circular economy initiatives and policies will support the recovery and trigger new market opportunities.

This report identifies the circular economy baseline, market gaps and opportunities existing in Africa. The research objective was to inform the development of robust interventions and programmes to guide the African Circular Economy Alliance's (ACEA) interventions in its regional member countries. The Alliance is a government-led coalition of African nations with a mission to spur Africa's transformation into a circular economy that delivers economic growth, jobs and positive environmental outcomes.

The research findings highlight 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 thematic areas identified as a result are food systems, packaging, built environment, fashion and textile, and electronics.

Finally, the report calls on relevant stakeholders to leverage identified enablers critical to the transition to a circular economy. These enablers include the development and implementation of policies and regulations, the provision of business support, investments in quality infrastructure, increased access to financing and technology, and greater availability of data and information.

Acronyms

ACEA	African Circular Economy Alliance
AfCFTA	African Continental Free Trade Area
AfDB	African Development Bank
AMCEN	African Ministerial Conference on the Environment
AMP	Agbogbloshie Makerspace Platform
B2B	Business-to-business
BDS	Business development services
CE	Circular economy
CLT	Cross-laminated timber
CO2	Carbon dioxide
CSA	Climate-smart agriculture
DPW	Department of Public Works
EBIDTA	Earnings before interest, taxes, depreciation and amortization
EEE	Electrical and electronic equipment
EPBP	European PET Bottle Platform
EPR	Extended producer responsibility
EPRON	E-waste Producer Responsibility Organisation of Nigeria
EUPR	European Union Plastics Recyclers
FAO	Food and Agriculture Organization
FONERWA	Rwanda Green Fund
FSC	Forest Stewardship Council
GDP	Gross domestic product
GHG	Greenhouse gas
LAB	Lead acid battery
MSMEs	Micro, small-, and medium-sized enterprises
MSW	Municipal solid waste
PET	Polyethylene terephthalate
PHL	Post-harvest losses
PPPs	Public-private partnerships
SHC	Second-hand clothing
SMEs	Small- and medium-sized enterprises
SSA	Sub-Saharan Africa
UNIDO	United Nations Industrial Development Organization

Executive summary

There are several major opportunities for increased circularity on the continent, in food systems, packaging, the built environment, electronics, and fashion and textiles.

To assess market opportunities for the circular economy (CE), we used four criteria to prioritize areas for further research:

1. **Circularity potential** – assesses the potential to narrow, close and slow material loops by eliminating waste and emissions, and limiting resource use
2. **Economic significance** – measures the importance to the African economy using a set of key economic indicators
3. **Transformative impact potential** – assesses the potential for positive social and economic outcomes
4. **Momentum** – measures current and potential CE progress as indicated by factors such as the presence of regulatory frameworks in support of the CE and sector commitments

This approach led to the identification of five themes: **food systems**, **packaging**, **the built environment**, **electronics**, **and fashion and textiles** are highly promising thematic areas for further assessment.

Across the five thematic areas, this report identifies numerous CE solutions to creating new loops, as well as slowing and narrowing flows. In each theme, the report prioritized solutions that provide the most significant impact potential on the continent.

Opportunities in thematic areas

There are several opportunities in food systems, packaging, the built environment, electronics, and fashion and textiles for increased circularity.

CE solutions in food systems can help the continent feed its growing population while driving green growth and employment. Food systems are important to the continent not only due to the prominent role of agriculture in the region's economy, but also because of the challenges associated with feeding a growing population despite increasingly scarce resources, exacerbated by the pandemic. A more circular food system requires a more efficient use of resources such as energy and water, an increase in productivity, a reduction in post-harvest losses through better storage and transportation, more efficient agro-processing, a reduction in consumer waste and an improvement in waste management. **Solutions for improved waste management, particularly for waste-to-compost/soil enhancers conversion, offer an immediate opportunity for increased circularity in the system**. By 2030, we can help create a trillion-dollar industry while driving millions of inclusive green jobs through a circular food system.[1]

In packaging, opportunities for scaling plastic recycling offer an immediate opportunity for increased circularity. Plastic packaging is the most widely adopted packaging product, with production surging (from 15 million to 350 million metric tonnes) over the past 50 years.[2] Most plastic packaging is used only once and is non-degradable, leading to a massive amount of plastic pollution. Polyethylene terephthalate (PET) is the largest driver of plastic waste due to its cheap price acting as a disincentive for increased reuse. **PET recycling is thus a critical solution when it comes to managing large amounts of plastic waste.** There are opportunities for design innovation and the reuse of other types of plastic. Increasing the CE in plastic packaging can be a driver for green jobs, support improved livelihoods and help in minimizing pollution.

CE solutions will support a low-carbon built environment that drives green growth and employment. Given Africa's rising population and rate of urbanization, the built environment will become ever more critical as new buildings and infrastructure are constructed to support these developments. Only a minority of Africans (30%) can afford to live in formal built environments. A circular built environment requires improved design, the use of recyclable materials, green buildings that are energy- and water-sufficient, and proper waste management. **The use of mass timber as a more sustainable building material can create a new industry by rethinking building techniques**. Africa has an opportunity to explore this opportunity through strengthening the low-tech mass timber industry and gradually moving towards high-tech mass timber construction materials.

In electronics, there are significant CE solutions for improved electronic waste management. Since 2014, the global generation of e-waste has increased by 9.2 million metric tonnes (21%).[3] Although significant improvements have been made, e-waste management in Africa still has some way to go. **Investing in recycling facilities and increasing producer responsibility will be crucial to improving outcomes in the sector**. Special attention should also be paid to smart product design to reduce resource consumption and energy use, facilitating the reuse of product components and extending product lifetimes.

CE solutions in fashion and textiles will drive green manufacturing and growth on the continent. The fashion and textile industry plays a significant role in the global economy; however, changes in demand trends (particularly for fast fashion) will only increase the environmental pressure**. There are CE solutions to revolutionize second-hand clothing (SHC) by upcycling products to meet the growing global demand for sustainable fashion** and using green manufacturing with regenerative cotton as an input.

There are several other opportunities that cut across the areas highlighteD – with water and waste management, and energy systems being key among them.

Enablers

Following the assessment of market opportunities, we identified sets of “enablers” that will be crucial to support the transition to a circular economy across all five themes. These enablers are:

- **Supportive policy** to encourage CE businesses and activities, ensure standards and facilitate trade across countries
- **Business development services (BDS)** such as advisory services and training, market linkages and strategic partnerships to increase the survival rates and performance of CE enterprises
- Increasing the availability of **relevant data and information** to support informed policy-making and investment decisions
- Supporting increased **access to technology** to facilitate consumer use of CE solutions (through mobile phones) and access to imported green technology for processors
- Increasing **access to relevant financial services** for CE enterprises, particularly informal MSMEs
- Investing in appropriate **infrastructure solutions,** particularly for waste collection and treatment

1 Introduction

The circular economy is key to achieving sustainable growth.

1.1 Why is the circular economy key to achieving sustainable growth?

“ Between 2015 and 2017, globally extracted resources increased from 84 billion to 92 billion metric tonnes, while the total amount of waste generated grew from 19 billion to 32 billion metric tonnes.

Current trends in global resource extraction and the rapid pace of consumption growth are incompatible with internationally agreed sustainability targets. Between 2015 and 2017, globally extracted resources increased from 84 billion to 92 billion metric tonnes,[4] while the total amount of waste generated grew from 19 billion to 32 billion metric tonnes.[5] Furthermore, the global economy is reaching a critical resource constraint as more resources are extracted from the planet. This is particularly pertinent for the African continent due to the large number of extractive-reliant economies.[6] The usual way of working – the making, using and disposing of resources, known as the “linear economy” – has only served to heighten these concerns and has proven to be unsustainable. The circular economy (CE) – an economy in which products and materials are recycled, repaired and reused rather than disposed of – is fast gaining traction as a new model for sustainable growth. With the right enabling environment, the CE offers a promising opportunity for economic development, value creation and skills development. And with the COVID-19 pandemic forcing countries across the globe to restructure their economies, Africa is in a strong position to take advantage of these emerging opportunities.

The CE concept is gaining traction as a new model for resilient growth globally. The CE offers a promising alternative strategy for industrial development and job creation to the traditional manufacturing-led growth pathway. In informal economies, which employ an estimated 61% of all workers globally,[7] sectors such as e-waste and phone repairs, for example, could engage in higher-value CE supply chains, aiding a shift to formalization. In developing countries, where large numbers of young people are entering the labour market each year, ensuring adequate employment opportunities will be vital to encouraging economic growth. In Africa, this shift towards CE is increasingly being driven by the private sector – from waste processors in South Africa[8] to a digital solution that supports informal refuse collectors in Nigeria.[9]

A greater emphasis on promoting circularity in international value chains and investment activities is required to enable global sustainable growth. To support the transition to CE, national governments should identify priority sectors for reform in support of CE activities, while investors should develop finance mechanisms to support and de-risk investment in CE value chains. Furthermore, activities associated with linear resource extraction and processing often attract the bulk of financing in lower-income countries. Between 2008 and 2015, multilateral development banks provided more than $83 billion in public financing to fossil fuels alone.[10] Weak regulation in certain sectors is leading to substandard results from investments in the CE. For instance, weak e-waste regulation in some countries on the continent has resulted in workers being exposed to hazardous substances in the recycling of copper wire (once the insulation is burned off), negatively affecting their health.[11]

The success of the CE in Africa will be critical to global efforts to ensure sustainable growth. Africa is the only region in the world where the youth population (up to 24 years old) is increasing and is expected to rise to 51% of the total population by 2050.[12] As a result, a young and fast-growing middle class will inevitably want a higher standard of living, leading to greater consumption. However, there are positive signs of economies attempting to accommodate this growth through more circular activities, with some of the most ambitious CE-related policy-making occurring in middle- and lower-income African countries. For example, Rwanda and Kenya have imposed total bans on plastic bags to stem growing waste crises.[13] Furthermore, through capturing the value of materials previously lost to the economy, the CE is expected to drive job creation and economic growth. For example, an e-waste recycling facility opened in 2017 in Rwanda created 400 green jobs,[14] while a similar facility in Kenya established in 2013 created 2,000 green jobs in its first four years of operation.[15] Restructuring economies to become more circular will require additional efforts, with changes to industrial processes and government priorities being the most crucial.

1.2 Prioritizing Africa's circular opportunities

To prioritize CE opportunities, a sector assessment was conducted. This assessment was undertaken based on circularity potential, economic significance, transformative impact potential and momentum of sectors on the continent as highlighted in Figure 1 below.

FIGURE 1 **Sector prioritization framework**

Criteria	Sub-criteria	Rationale	Weight
Circularity potential (CP)	– Energy and resource intensity – Waste and CO_2 emissions	Will help assess sector circularity potential by analysing the intensity of material and energy consumption, and existing inefficiencies within a sector (waste and CO_2)	**30%**
Economic significance	– Sector GDP and gross/total output – Labour force size – Export/import flows – MSME involvement	Will identify sectors with the largest relevance to African economies through contribution to GDP, employment, trade flows and growth, as well as MSME involvement	**30%**
Transformative impact potential	– Inclusion of marginalized communities – Socioeconomic outcomes – Potential to drive industrialization	Will help assess sectors based on the inclusion of marginalized populations on the continent (women, youth and rural residents), the potential for positive socioeconomic outcomes and potential to drive industrialization on the continent	**20%**
Momentum	– Sectoral commitments – Regulatory/policy frameworks – Disruptive potential – COVID-19 resilience	Will provide information on the willingness/ability to engage in CE opportunities, government and international institution priorities, and potential opportunities for developing the circular economy in the region. The COVID-19 criteria will aid in identifying opportunities to build resilience from pandemic shocks. Opportunities with momentum are likely to lead to immediate outcomes for the alliance	**20%**

Source: Dalberg analysis, 2020

Based on this approach, agriculture, manufacturing and construction are the most promising CE sectors for sub-Saharan Africa (SSA). When measured against the criteria of resource and energy intensity, waste management and emissions management, several opportunities present themselves across the three sectors. For example, in agriculture, food systems can support Sustainable Development Goal (SDG) 2, zero-hunger, while boosting growth. In manufacturing, opportunities exist to reduce resource-use intensity through the manufacturing of disposable cups. Waste can be converted to consumer goods such as clothes, and circularity in electronics can support resource recovery. In construction, adopting circular design principles (e.g. modular housing units) in the built environment can help to deliver quality housing and infrastructure at a low economic and environmental cost.

1.3 Emerging trends in the circular economy

To identify areas for further assessment, an opportunity mapping was conducted on the priority sectors. Significantly, these priority sectors have substantial interactions with other sectors, creating a need to also consider a cross-sector approach for CE opportunities. This assessment was conducted for the top three sectors (agriculture, manufacturing and construction) that can support relevant opportunities to significantly drive the circular economy. Figure 2 provides details of the ranking of these sectors in comparison to others.

FIGURE 2

Sector prioritization

Sectors	**Circularity** (30%)	**Economic significance** (30%)	**Transformative impact** (30%)	**Momentum** (30%)	**Overall Rating**
Agriculture	3	3	3	2.5	**2.9**
Manufacturing	3	3	2	2.8	**2.8**
Construction	3	2.5	2.7	2	**2.6**
Transportation and storage	3	2.8	2.3	1.5	**2.5**
Electricity, gas, etc. supply	3	1.5	2.7	2	**2.3**
Mining and quarrying	3	1.8	2.3	1.5	**2.2**
Water and waste management	3	1.3	2	2	**2.1**
Tourism	1.5	2	2.7	2	**2.0**
Information and communication	2	1.8	2.3	1.5	**1.9**
Wholesale and retail	1.5	2.8	1.7	1.5	**1.9**
Health and social work	1.5	1.3	2.7	2	**1.8**
Other services	2	2	1.3	1.3	**1.7**
Financial and insurance	1	1.8	2.3	1.8	**1.6**
Education	1.5	1.3	2.3	1.5	**1.6**
Real estate	1.5	1.8	1.3	1.5	**1.5**
Public admin and social security etc.	1.5	1.5	1.7	1.5	**1.5**
Arts, entertainment and recreation	1.5	1	1.7	1.3	**1.3**
Professional and technical activities	1	1	1.7	1	**1.1**
Administrative and support services	1	1	1.3	1	**1.1**

High (2.5–3) Medium (1.5–2.4) Low (1–1.4)

Source: Dalberg analysis, 2020

Note: To get the numerical system above, we averaged the scores Low = 1, Medium = 2, High = 3 across sub-criteria across countries and weighted them to get to the final score

Food systems, packaging, fashion and textiles, electronics and the built environment are thematic areas for the prioritized sectors selected for further exploration. Other themes that do not cross-cut to the same extent and have limited room for additionality and relevance in the short term may still be worth pursuing.

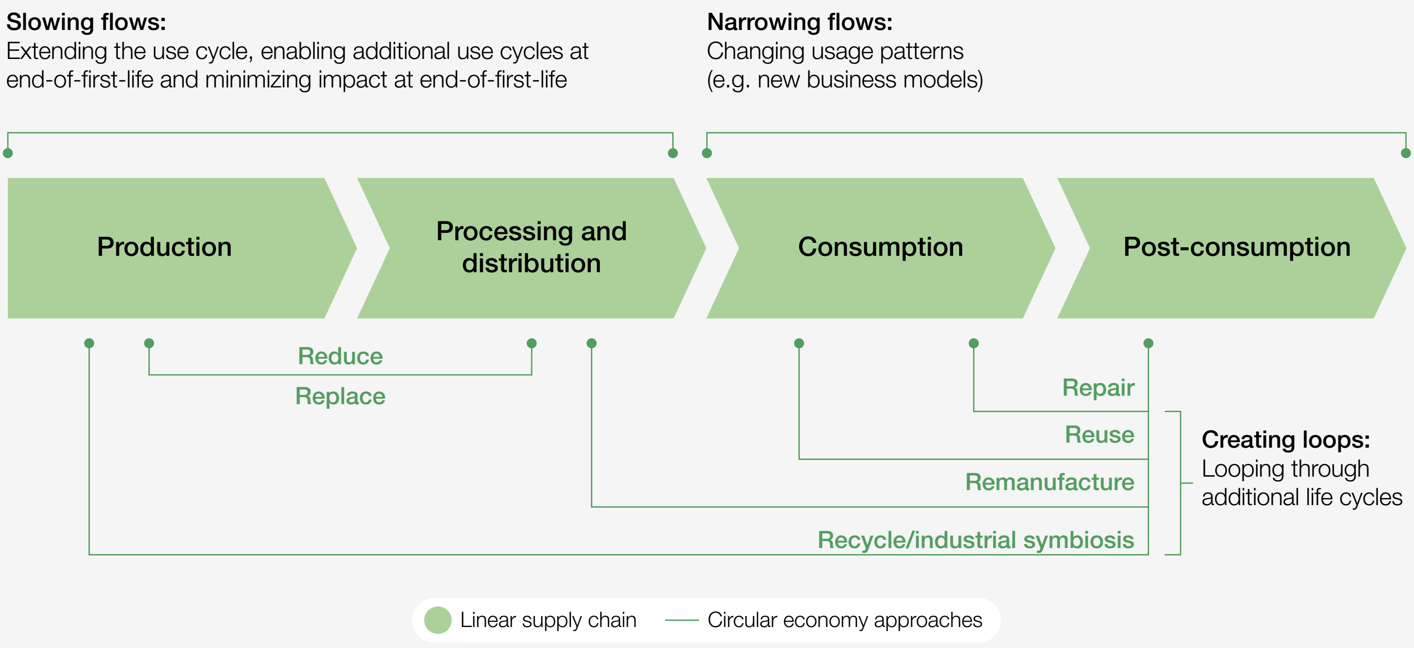
1.4 The spectrum of circular economy solutions

Circular opportunities can be classified into solutions to create new loops, slow flows/loops and narrow flows/loops. These solutions vary from opportunities to rethink and redesign how we make products and use services to solutions for improved waste management and conversion. This report identifies and assesses opportunities across the three categories but prioritizes opportunities with the most potential for impact.

These strategies combined constitute the full breadth of circularity:

- **Solutions to create new loops** advocate for different approaches in reusing, repairing and recycling products when they reach the end of their designed operational life. Solutions here are focused on recycling and the elimination of leakages; they include food-waste conversion, wastewater recovery, PET recycling, building waste recycling and e-waste recycling
- **Solutions to slow flows/loops** are focused on shifting to new ways of designing and making (manufacturing) products that ensure extended use while minimizing resource and energy intensity. Such solutions are focused on extended use and reuse and include climate-smart agriculture (CSA), green manufacturing (including green textile industries), improved design for plastics and redesigning the built environment with more sustainable inputs (e.g. mass timber)
- **Solutions to narrow flows/loops** shift the market to more efficient ways of using products and services through changing usage patterns. These solutions focus on resource and energy efficiency by changing usage patterns and include sharing and product-as-service models across thematic areas

FIGURE 3 **Spectrum of CE solutions and approaches**[16]

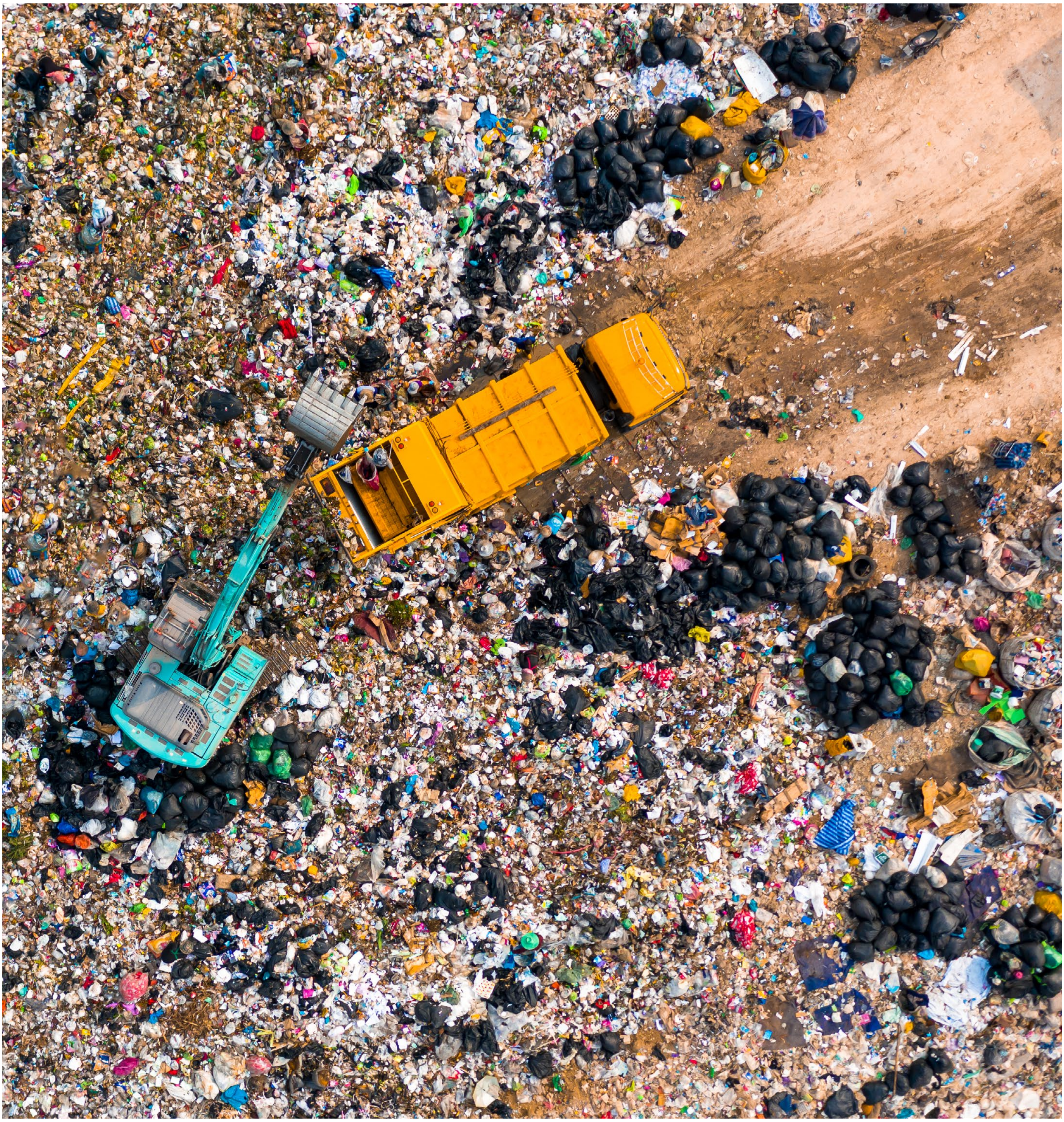


Source: Preston et al., An Inclusive Circular Economy: Priorities for Developing Countries, 2019

The set of solutions to create loops, slow flows/loops and narrow flows/loops will support the development of more sustainable economic systems on the continent. These systems will focus on minimizing resource and energy intensity in production, increase efficiencies and reduce emissions across processing and distribution, support more sustainable consumption and minimize waste.

2 Thematic opportunity areas

The five big bets for the circular economy on the continent are food systems, packaging, the built environment, electronics, and fashion and textiles.



2.1 Food systems

Context

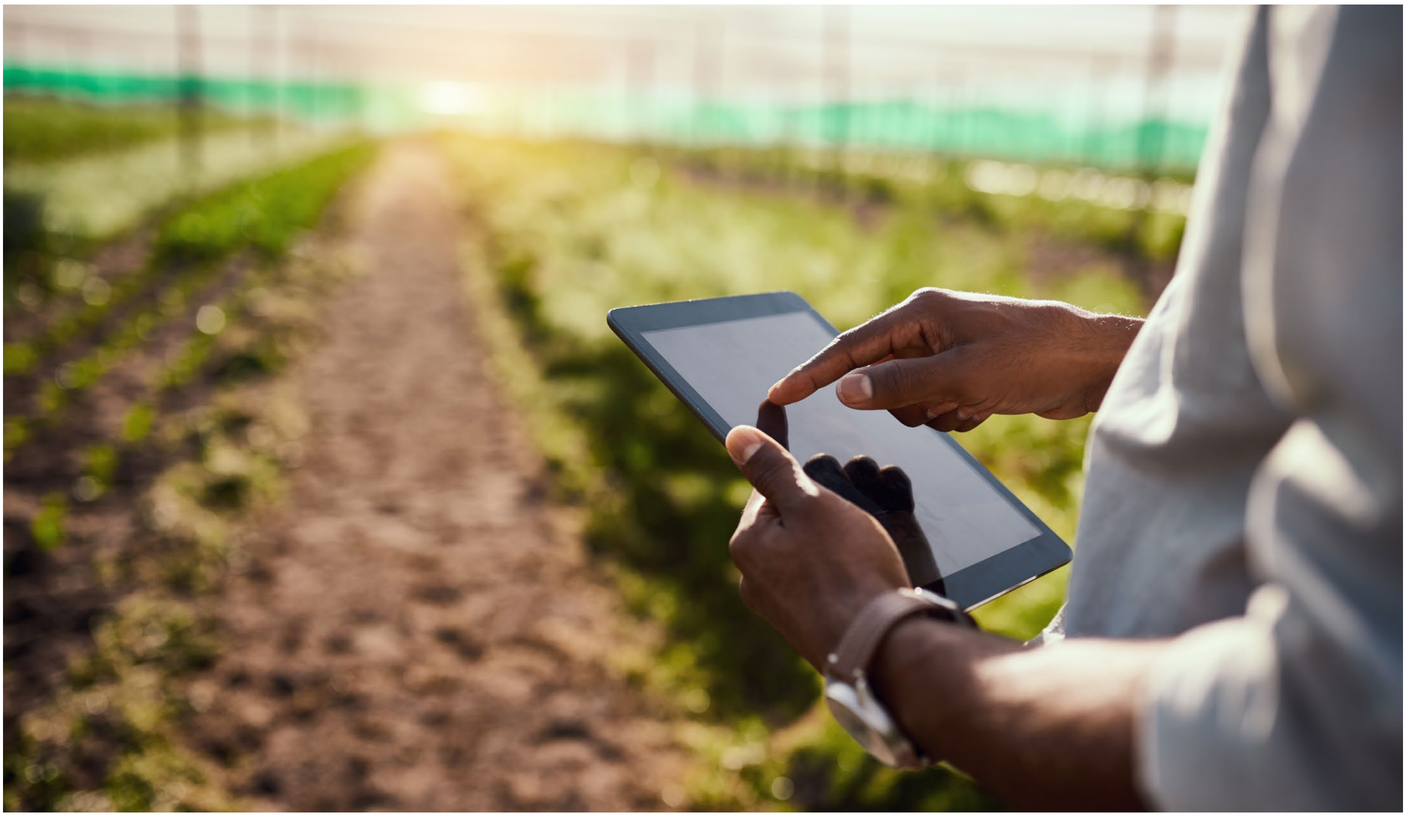
Food systems refer to the complex chain of activities, processes and infrastructure involved in feeding people. A food system includes the production of crops and livestock, processing and distribution, consumption and post-consumption. The system interacts with and affects a variety of sectors such as agriculture (core sector), manufacturing, construction (e.g. vertical farms, irrigation facilities), transport and storage, water and waste management, wholesale and retail, and others. The food system is economically significant on the African continent and an anchor for growth.

Food systems are essential to the African continent due to the prominent role of agriculture in the region as well as the growing challenges of feeding a growing population with increasingly scarce resources. Agriculture contributes roughly 23% of the continent's total GDP and employs close to 60% of the active population,[17] playing a vital part in economic activity. A report by the World Bank estimates that the food market on the continent could be a trillion-dollar business by 2030.[18] In West Africa, the food system accounts for 66% of total employment, although the majority of these jobs are in agriculture (78%).[19] However, approximately half of Africa's population suffers from food insecurity (of those, more than 250 million are classified as severely food insecure).[20] The impact of the pandemic on food systems and the continued growth of the population will further exacerbate the feeding challenges on the continent. COVID-19 has created a recession (Africa's economic activity shrank by 3.7% in 2020),[21] which correlates with food insecurity on the continent, in addition to disruptions of supply chains that are vital for production (e.g. fertilizer and pesticide imports). This pressure on food systems will increase with a population that is expected to double by 2050 (close to 2 billion people).[22]

Challenges

Food systems face various well-documented challenges on the continent resulting in inefficiencies and losses across functions.

Food system production faces declines in land and fishery productivity, post-harvest losses (PHL), and issues with accessing water and energy. The growing demand for resources has led to unsustainable production models that have resulted in declines in land and fisheries. In West Africa, approximately 35% of the land is under threat of desertification due to land degradation



Food waste (waste and residues) is a massive challenge on the continent and contribute close to half (49%) of the waste generated in Africa.

and climate change.[23] Agriculture also influences climate change on the continent as sectoral greenhouse gas (GHG) emissions rose from 17% in 1990 to 21% in 2016.[24] PHL (declines in the quantity and quality of food production from harvest to consumption) in SSA constitutes 30–50% of production. In grains alone, an estimated $4 billion is lost annually on the continent.[25] Only 6% of farmland is irrigated (in comparison to 37% in Asia),[26] and electricity access stands at 43% (half the global average).[27]

Limited competitive domestic manufacturing and access to supporting infrastructure are the major challenges in processing and distribution. While manufacturing investments in the region have increased over time (the total sector value more than doubled between 1996 and 2015), the share of manufacturing's contribution to GDP declined from 12% to 10% during the same time. In distribution, the lack of conducive infrastructure and transport services to connect producers (particularly rural producers) and markets is the main contributor to PHL.

Unsustainable eating patterns and their environmental and health implications are the main challenges in consumption. These habits include eating more meat (particularly more wasteful centre cuts), consuming imported food produce and using grains for fuel and feed. Health has also been affected by rising food-related health issues such as diabetes and obesity.[28] These challenges can, in part, be resolved by opportunities that reiagine how we eat.

The main post-consumption challenge is the sustainable management of food waste, with opportunities to also reduce losses in the supply chain. Food waste (waste and residues) is a massive challenge on the continent and contributes close to half (49%) of the waste generated in Africa.[29] In South Africa, a third of all edible food is never consumed and ends up in landfills, adding pressure to already burdened waste systems.[30] The sustainable disposal of food waste is also vital in addressing infectious diseases such as cholera and dysentery.

Country: South Africa

Company: Kleinskuur Aquaponics

Kleinskuur runs aquaponics farms, provides training and sells aquaponic systems modified for the continent. The systems use solar energy to pump water for use in a soil-less growing system; they are also used for temperature control. This minimizes land and water demand (90% less) and increases resilience to climate change.

For large farms, every 6 square metres employs one person, costing $78 for installation, with $84 in annual profits. Small aquaponic farms can also be installed ($2,800) with break-even in year 1 (annual profits ~$3,100).

Opportunities

There are numerous opportunities in food systems that can help address existing challenges. Specifically:

– In production, opportunities include the use of climate-smart agriculture (CSA) and improved access and use of equipment, particularly storage equipment (using sharing models)

– In processing and distribution, the opportunities are focused on green manufacturing and shared logistics services, respectively

– Consumption opportunities exist for embracing improved cuisines and in food diversion driven by the hospitality sector

– In post-consumption, there are numerous opportunities for waste conversion, particularly in waste-to-energy and waste-to soil enhancers/fertilizers

Production

Climate-smart agriculture (CSA) is an emerging CE opportunity that minimizes resource need, builds resilience and minimizes emissions by redesigning how we produce. CSA includes a range of practices such as conservation agriculture, livestock management and the use of soil-less systems. Soil-less systems such as hydroponics, aeroponics and aquaponics are gaining popularity in urban and peri-urban locations where land is scarce. Aquaponics is particularly interesting due to the potential for closed-loop systems that can address both declines in land availability and fishery productivity using little water and no plant fertilizers. In addition to providing fish, the yield per square foot in aquaponics is 20 times the yield from traditional farming methods.[31]

Since aquaponics is a newer production model on the continent, a major challenge is in relevant technology transfer. Aquaponics systems designed abroad need tweaking to work given the local context. Some businesses (such as Kleinskuur

Aquaponics in South Africa) are based on adapting and selling aquaponics systems that are less reliant on electricity, using fish that are highly tolerant of pH variations, temperature fluctuations, and low oxygen and high nitrate levels. Policy changes can also scale soil-less systems by increasing access to premium organic markets. Current legislation in countries such as South Africa does not consider these products to be organic because they did not grow on soil.[32]

CE opportunities in improved use and access to storage, monitoring and drying technology will minimize food loss but require catalytic funding and localized solutions. There are numerous businesses on the continent that are supporting expanded access to storage and drying equipment. In Rwanda, Serap (a France-based firm specializing in designing and manufacturing milk-cooling tanks) offers solar-powered milk coolers to help curb PHL by reducing the rate of milk spoilage, particularly in areas with energy scarcity.[33] Furthermore, innovations such as dry cards (affordable moisture monitors for grains) are increasing the use of monitoring technology to prevent losses.[34] The spread of mobile phones also creates opportunities, as seen in Uganda, where farmers in drought- and flood-prone areas can access early-warning weather systems on their phones.[35] A major challenge is the lack of established business models and the informality of many MSMEs, which limits the potential for traditional financing and products. For instance, SokoFresh (a Kenyan company providing movable cold storage services) has struggled to get insurance coverage as insurance firms have no experience with its model.

Opportunities in productive appliances using renewable energy and the recovery and reuse of waste streams can address both water and energy challenges. **The market for productive appliances slowing flows of non-renewable energy is large and growing, with the potential for increased scale through asset financing and sharing models.** For instance, the serviceable market for solar water pumps alone in SSA is currently worth $456 million and is estimated to grow to $1.6 billion by 2030.[36] Despite its size, the market is below potential due to buyers' limited ability to pay given prices. Key equipment such as solar pumps cost between $600 and $2,000 in a region where the average GDP per capita is $1,573. Asset financing (rarely available) for such equipment can reach monthly payments of $20–$75. These challenges also present opportunities for circular innovations such as sharing models to increase access and scale markets. For instance, while the SSA serviceable market for solar water pumps is $456 million, the total market in the region is estimated to be $3.5 billion (almost eight times the serviceable market figure).[37] For businesses, suitable patient (long-term) financing is needed. For instance, due to support from donor/grant funding, solar-powered irrigation specialist SunCulture in Kenya was able to spend more than five years conducting R&D and product-testing before it was able to commercialize in 2019.[38]

Wastewater recovery and reuse is an underused opportunity requiring innovative financing and consumer awareness campaigns to scale. There is a large potential market to create loops for wastewater, with a city such as Lagos producing 1.5 million cubic metres of wastewater a day that ends up untreated in the Lagos Lagoon.[39] In comparison to productive appliances, the recovery of sewage is less common due to barriers such as high upfront capital costs and the limitations of water sanitation infrastructure across the continent. In Lagos, a water treatment system that could handle the daily volumes of wastewater would cost an estimated $5.5 million without additional costs for connecting infrastructure.[40] The required capital investments raise challenges due to competing interests for public funds. These costs necessitate innovative financing and public-private partnerships, given the challenges in public funding, particularly amid a pandemic-induced recession. In Namibia, a joint venture company (Ujams) has incorporated government financing for its wastewater treatment plants through partnerships with global wastewater management firms.[41]

Processing and distribution

In processing, embracing green manufacturing and CE principles can lead to cost savings and increased competitiveness. Green manufacturing is the renewal of production processes and the establishment of environmentally friendly operations that slow flows and create new loops for by-products/waste. While these practices are commonplace due to established business cases (lowering costs and/or increasing revenues), manufacturers on the continent require adoption support. In edible oils, for instance, most processors (particularly small and medium operations) on the continent use mechanical crushing that leaves ~20% of oil content in seedcake.[42] In contrast, global suppliers use solvent extraction to unlock leftover oil, thus increasing their competeveness.

Processors often need financial and technical support to access opportunities for improved economic and environmental outcomes. The United Nations Industrial Development Organization (UNIDO)'s Green Industry Initiative worked with six agro-processing firms in Tunisia to facilitate average investments of $280,000 that led to average cost savings of $295,000 per firm (savings on water and energy).[43]

In distribution, the most promising CE opportunities focus on reducing food loss through sharing models for transport services

(particularly cold-chain services). The opportunities for reducing food loss through shared models result from the lack of a conducive infrastructure to support farmers. While cold-storage services are growing on the continent, they do not meet demand and are often inaccessible/unaffordable to MSMEs and smallholders. Limited seasonal demand for cold-chain services across geographically dispersed actors limits this opportunity.[44] As a result, most cold-chain services have been built for the high-value fresh-cut flower export industry, and increasingly other horticultural exports, particularly fresh fruit and vegetables. This has created an opportunity for innovative cold-chain service models that are accessible for local markets. SokoFresh provides movable cold-chain services to farmers through a shared model built on the production calendar. The firm rotates between value chains and locations (based on harvesting season) to ensure that smallholders have access to services. They have also innovated with financing mechanisms (e.g. pay-as-you-hold) to ensure access.[45]

Country: Kenya

Company: Twiga Foods

Twiga Foods operates a mobile-based business-to-business (B2B) food supply platform to address the issue of fragmentation within the food market. It sources produce from farmers and delivers to vendors via its cold-chain supply system at prices that are 15% lower than the wholesale market. Twiga has engaged more than 4,000 farmers, 35,000 vendors, 25 collection centres and 50 delivery vehicles. It makes 1,000-plus M-Pesa electronic payments to farmers weekly and employs more than 240 people. It aims to unlock more than $225,000 in additional income and reach more than 289,000 beneficiaries with its distribution model.

Consumption

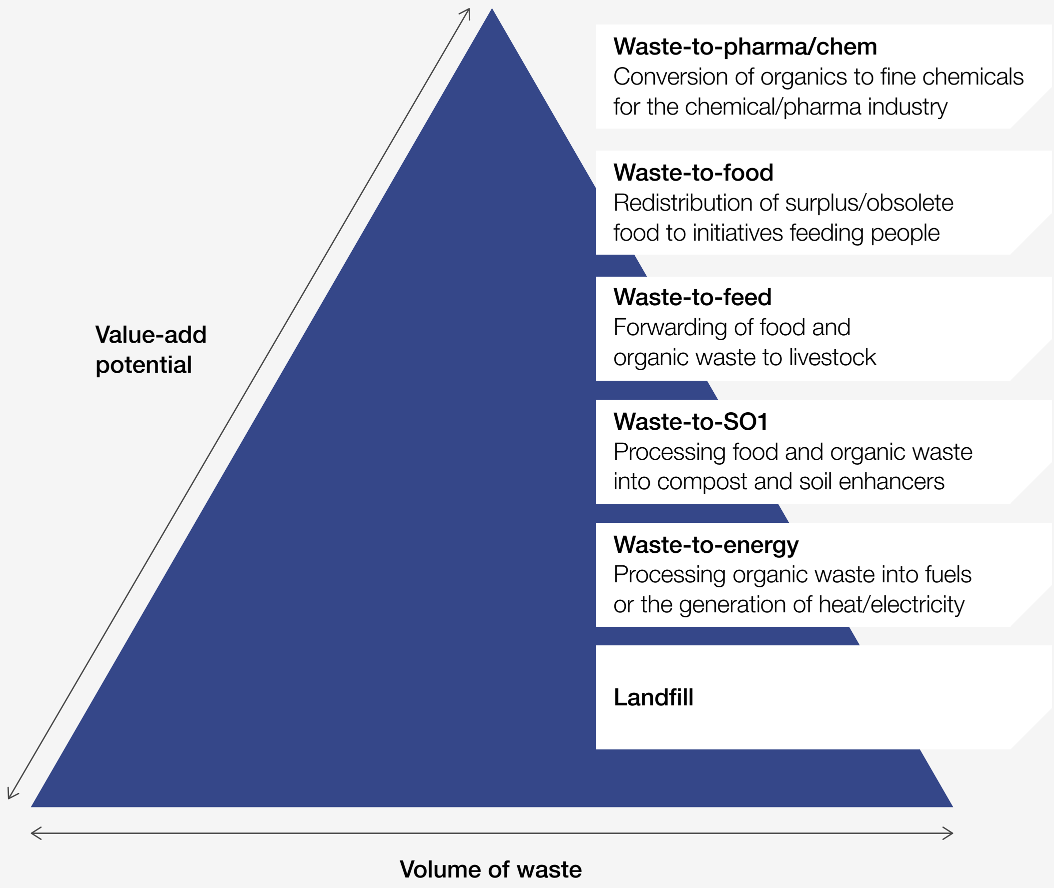
A return to African traditional cuisines will support improved health outcomes and minimize environmental harm. Traditional cuisines focus on nutritious locally available inputs with minimal resource intensity, thereby slowing flows of resources. These cuisines are high in fibre and low in fat, with plenty of vegetables and little meat. Most inputs in traditional cuisines are locally sourced, reducing the impact of transporting food produce over large distances. While these diets still exist on the continent, the spread of fast food and the growth of a middle class located in urban areas hinders market growth.[46]

In addition, there are various opportunities to scale cuisines that minimize food waste and to promote waste-to-food conversion, given supportive regulations. The development of global cuisines and menus also creates a segment of global food waste. Various parts of vegetables (e.g. carrot ribbons, broccoli cores) and animals (e.g. chicken feet) are often discarded as waste in modern cuisines. These parts are still edible, and markets exist, particularly within Africa, for waste-to-food conversion. Recipes for meals such as ponmo (using cow hides) and chicken feet are popular and minimize food waste. These cuisines need to be mainstreamed and markets scaled across income groups and countries to create new loops. Additionally, there are opportunities to return some of the waste generated by institutions, particularly in the hospitality industry. While this practice is not commonplace on the continent, global brands such as Hilton are working with food diversion programmes including Hotel Kitchen that can be replicated on the African continent.[47] Through the programme, Hilton is reducing food waste by purchasing locally sourced and in-season products, working with “imperfect produce”, and using the whole product wherever possible.

Post-consumption

There are numerous opportunities to address food waste and recover value with promising activities in converting waste-to-energy and soil enhancers/fertilizer. Figure 4 showcases the value-add potential across waste conversion activities and the volume of refuse used by each activity. Activities towards the top of the pyramid (e.g. waste-to-pharma/chem) have the largest value addition. Still, they are feasible only with a smaller volume of waste, requiring efficient sorting and standards enforcement. In addition, there is limited pharmaceutical and chemical manufacturing in most countries in SSA, minimizing the potential viability of the opportunity. Some of these activities are also uncompetitive in the short term, given the existing alternatives. For instance, while food waste can be turned into chemicals to be used as inputs for biodegradable plastics, current costs are up to four times that of traditional plastics.[48]

FIGURE 4 | **Food waste value-add heuristic** [48]



Source: GreenCape, *Food Loss and Waste*, 2020

The conversion of food waste to biomass energy is a high potential CE opportunity that can help address food waste and energy challenges. More than 80% of the population in SSA relies on either wood, crop or animal residues in meeting household energy needs (mainly for cooking). Biomass can provide cleaner energy through both industrial and domestic opportunities. The most successful large-scale projects are built on food waste from industries, reducing transaction costs, ensuring scale and guaranteeing markets. Mauritius has a large biomass-generation program from bagasse (sugarcane residue) cogeneration, using waste from the sugarcane industry to generate heat and power for mills and lowering costs to power electrical grids. This has allowed 100% access to electricity in the country.[50] In addition, there are opportunities to convert household/ individual food waste into clean, affordable energy. In East Africa, SimGas manufactures and sells modern biodigesters (made from recycled plastics) that turn manure into biogas for cooking fuel and produce a bio-slurry that can be used as fertilizer. In Kenya alone, it has provided more than 75,000 families with a combined biodigester and stove that lowers indoor air pollution, emissions and the use of firewood.[51] Despite the potential benefits, the opportunity requires quality assurance and regulatory enforcement to ensure digesters do not leak materials or gases before complete combustion. Access to water is an important challenge as well, given that biodigesters use equal volumes of manure and water. In addition, dissemination strategies and strong after-sales services are needed to ensure safe adoption and use.[52]

Country: Kenya
Company: Safi Organics

Safi Organics turns waste into carbon-negative fertilizer (biochar).

It works with more than 4,000 farmers (and is aiming to scale to more than 30,000 by 2021), has one plant (scaling to four by August 2021), directly employs 30 people (mainly youths) and more than 200 people indirectly. It has unlocked $600,000 in increased yield for farmers and is looking to scale regionally.

There are also opportunities to turn food waste into carbon-negative compost fertilizer that improves soils and creates new loops in food systems. In Kenya, Safi Organics is turning food waste into carbon-negative fertilizer that enhances soil health (e.g. by reducing acidification) and sequesters carbon. The potential for food waste as a soil enhancer is high in Africa, given the extent of acidic soil.[53] This opportunity can also offer lower prices and reduce supply shocks to farmers due to localized production models rather than current norms of importing fertilizers in most countries. Awareness is also a challenge, given that producers often undervalue compost fertilizer; the same is true for regulators because biochar is new and unregulated. As a result, Safi Organics has had to develop its own standards.[54] In scaling, supportive policy and regulation frameworks for new products such as biochar will need to be implemented to support market growth.

Impact

CE solutions in production can help mitigate and build resilience towards climate change, improve incomes, optimize resource use and address food security. CSA focuses on production practices that lower emissions and build resilience for farmers. This will strengthen food security as smallholders supply an estimated 80% of the food produced on the continent.[55] Soil-less systems such as aquaponics can also aid in reducing deforestation for agricultural land, further mitigating climate change.

Addressing PHL creates immediate opportunities to increase incomes for farmers. For instance, a USAID programme trains tomato pickers in Rwanda in harvesting and handling, helping reduce PHL – which, on average, accounts for 21% of production – creating additional incomes for farmers and pickers. In addition, this slows resource flows by preventing the loss of roughly 21 kg of fertilizer and 86 cubic metres of water per metric tonne of tomatoes produced.[56] Minimizing losses will increase the supply of food, reducing concerns about food security. A 2015 meta-study on PHL in SSA demonstrated that the magnitude of food loss over 10 years exceeded the value of total food aid received.[57]

The food system can also minimize emissions through increased domestic agro-processing and the use of compost fertilizer. Increased agro-processing on the continent can reduce transport-related emissions from the system by reducing the export of raw food and imports of agro-processed food. Increased competitiveness from green manufacturing will also support industrialization on the continent.

Converting waste to soil enhancers and fertilizers (compost), will improve productivity and promote closed-loop systems that minimize emissions. While Africa constitutes only a limited portion of global fertilizer consumption (2%), demand is rapidly growing (130% growth between 2008 and 2016),[58] partly due to the degradation of cropland (~12%) and the need to increase yields to match the demand for food.[59] This growth in demand is largely for synthetic fertilizers that do not support microbial activity in soils and contribute significantly to emissions.

The system will anchor the opportunities for green jobs on the continent, but support is needed to ensure quality jobs. Food systems currently employ 82 million people in West Africa alone.[60] Trend analysis across six SSA countries (Ethiopia, Malawi, Mozambique, Tanzania, Uganda and Zambia) estimates that 70% of total jobs in the countries will be in food systems by 2025.[61] Given that it is an informal sector, greater efforts are needed to ensure that these green jobs in the system pay a liveable wage, are inclusive and ensure health standards. This requires supportive policy and regulation, integration of informal workers, adoption of operational guidelines for workers, advocacy and promotion of acceptable practices.

Women in Africa have a large role in boosting circular food systems, realizing these opportunities and ensuring impact. Women grow 70% of Africa's food and are often found in nutritious food systems, in comparison to men who engage in commodities production.[62] Despite this role, women have limited access to vital resources such as finance, land and the information needed to efficiently engage CE solutions for food systems. For instance, 70% of women-owned SMEs in developing countries are unserved or underserved by financial institutions.[63] Innovative solutions (e.g. text-based extension services) and regulatory changes are required to address these challenges and support improvements in food systems. According to the United Nations Food and Agriculture Organization (FAO), if women farmers had the same resource access as men, food production could increase by 20%–30% and address food insecurity for more than 150 million people.[64]

2.2 Packaging

Context

Demand for packaging in Africa is growing, driven by growth in local industries (particularly agro-processing). Packaging acts as an enabler for multiple industries, particularly for producers of non-durable household goods such as packaged foods, beverages, toiletries, confectionery, cosmetics, over-the-counter drugs, dry goods and other consumables. Packaging includes materials such as paper and board, aluminium/metal, glass, and rigid and flexible plastic.

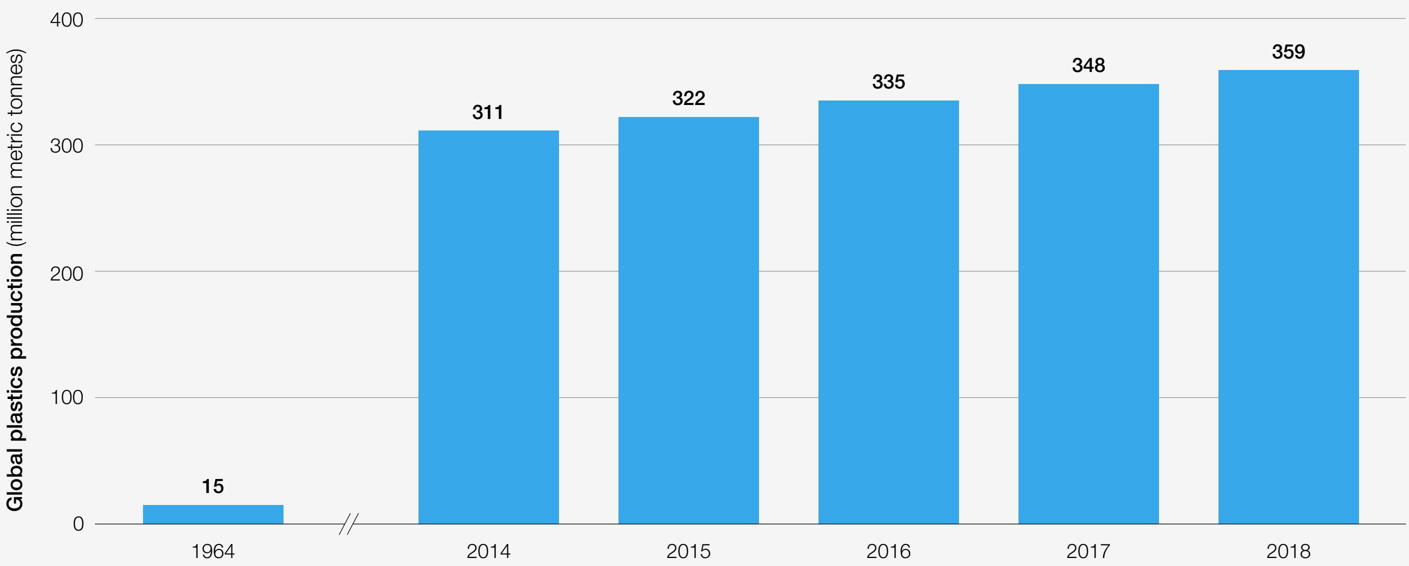
Plastic packaging is the most popular type of packaging for the consumer goods industry due to cost and ease of use. In 2015, plastic packaging as a share of global packaging volumes increased from 17% to 25%.[65] During the past half-century, overall plastics production has surged from 15 million metric tonnes to more than 350 million metric tonnes. Its use is expected to double over the next 20 years.[66]

Unfortunately, most plastic packaging is used only once and 95% of its value, estimated at $80 billion to $120 billion annually globally, is lost to the economy after its initial use.[67] The recent global outcry against plastic pollution has led to the increasing regulation of single-use plastic across countries, creating a market for environmentally sustainable packaging. Sixteen countries in Africa have banned the use of single-use plastics and are introducing measures to enforce the ban.[68]

PET resin makes up a significant share of plastic found in waste streams. PET makes up about 8% of plastic produced but has a 20% share in terms of plastic packaging.[69] Growth in PET is attributed to the increasing demand for its use in food packaging, clingfilm, and hygiene and medical applications, among others.

The effects of plastic accumulation have implications for different sectors such as tourism, agriculture and livestock. For example, plastic causes visual pollution (litter) that affects such sectors as tourism; it also blocks drains, creating serious flooding or stormwater problems (and breeding areas for disease vectors such as mosquitoes). Furthermore, plastic waste that finds its way into the sea and other bodies of water can be fatal for aquatic wildlife when mistakenly ingested, and there are also cases of its ingestion causing livestock deaths.

FIGURE 5 **Global production of plastics (millions of metric tonnes)**



Source: Statista, Production of Plastics Worldwide from 1950 to 2019, 2020. Dalberg analysis, 2020

Country: Kenya

Company*:* Eco Post

Eco Post recycles waste plastic and manufactures it into eco-friendly plastic lumber profiles with application in numerous industries, from fencing to road signage to outdoor furniture.

Its achievements include recycling more than 3 million kg of plastics, with 20.9 million kg to be recycled over the next 10 years. It has created 40-plus direct jobs and 5,000-plus indirect jobs. Over the next five years, Eco Post hopes to create at least 150 direct jobs and 20,000 indirect jobs.

Challenges

A few obstacles have made the management and recycling of plastics challenging

The quality and accessibility of used plastic remain far lower than that of virgin plastic, inhibiting investment and scale of recycling plants.

Sufficient consumer focus and incentives to support recycling efforts are lacking. Consumer incentives to use and support sustainable packaging are not yet strong enough to support companies – either producing or importing such materials – in rolling out innovation at scale.

Besides PET, other plastic products have poor recyclability. There are thousands of different plastic products that are categorized under seven resin codes. For recycling, these plastics must be sorted differently given the variations in characteristics even among the same resin group (mainly melting points). This dynamic affects the recyclability potential of other plastics requiring investments in infrastructure to allow for cost-effective collection and sorting of these plastics.[70]

Country: Côte d'Ivoire

Company*:* Coliba

Coliba is a web, mobile and SMS platform that connects households and businesses with Coliba-affiliated waste pickers.

Coliba has processed more than 300 metric tonnes of plastic waste and collected plastic bottles from more than 4,500 monthly active users on its mobile app, recycling up to 2 metric tonnes of plastic a day. As of July 2019, more than 8,000 households and 25 business partners have used the Coliba app. Coliba also formally employs 45 waste collectors and 23 full-time employees.

Opportunities

Working to alleviate plastic packaging pollution through the following approaches can help create new economic opportunities while removing threats from the aforementioned sectors:

1. Increase recycling and innovation in PET collection methods as a way of creating loops
2. Incentivize investments in PET recycling facilities through regional harmonization of legislation and the introduction of tax incentives
3. Explore longer-term opportunities in design innovation and reuse of other types of plastic packaging

Increase recycling and innovation in PET collection methods as a way of creating loops. To increase the quality and accessibility of used plastic, collection needs to be scaled up and the cost streamlined**.** Many initiatives are launched each year, focused on areas such as improving collection schemes and installing new sorting and reprocessing technologies. A notable initiative is the African Plastics Recycling Alliance launched in early 2019 by leading consumer goods companies to promote innovation and collaborate on technical solutions and to facilitate and launch local initiatives to improve plastics collection and recycling. The initiative includes Coca-Cola, Nestlé, Diageo and Unilever, the biggest players in terms of the amount of plastic packaging produced.

Apart from the common bottle collection from streets and dump sites, other options include collection through a deposit system similar to that of glass bottles in some countries. This model is currently being tested in countries such as South Africa to determine the potential uptake.

“ The African Plastics Recycling Alliance launched in early 2019 by leading consumer goods companies aims to promote innovation and collaborate on technical solutions and to facilitate and launch local initiatives to improve plastics collection and recycling.

Incentivize investments in PET recycling facilities through regional harmonization of legislation and the introduction of tax incentives. In terms of legislation, more countries need to allow the use of recycled plastic for food-grade packaging and harmonize regional standards. Only two countries in Africa have allowed the use of recycled plastic in food-grade packaging, despite the fact that its safety and efficiency as packaging material is established.[71] There also need to be regional standards and certification for recycled plastics. A uniform standardization system allows for easier plastic trade between countries and helps ensure sufficient raw material/feedstock for large investments and scaling in recycling plants. This means recycling plants in smaller countries such as Rwanda do not have to depend solely on an in-country supply of feedstock. Clearly, PET offers better investment feasibility compared to other types of plastic as it is more abundant and can be easily recycled. In North America, recycling of PET bottles has offered earnings before interest, taxes, depreciation and amortization (EBIDTA) of ~$400 per metric tonne – with profits driven by higher recycling rates and plastic waste production in the region.[72] Large multinational operators using PET packaging have made commitments to recycling; for instance, Coca-Cola's pledge to use at least 50% recycled material in its packaging by 2030.[73] This will require higher inputs and Coca-Cola will therefore need to source material at a regional level in Africa. Once the material is collected, sorting and mechanical recycling is currently cash-positive for approximately 75–80% of plastic, and in most instances generates sufficient margin to provide an acceptable return on capital. In the US, reclaimers purchase scrap plastic and sell pellets at prices within 10–20% of virgin resin prices, capturing a margin that also covers the cost of capital. Other regulations can be used to generate incentives for investment in recycling by reducing cost elsewhere and discouraging the use of virgin plastic. Recycling can be promoted by offering tax holidays for recycling infrastructure, e.g. Ghana offers a seven-year tax exemption for companies recycling plastic and polythene material for agricultural or commercial purposes.[74] The government can also introduce an added tax on the use of virgin plastic.

Explore longer-term opportunities in design innovation and reuse of other types of plastic packaging. These opportunities are challenging for the continent given the lack of manufacturers in developing regions. As such, it is important to acknowledge that, for developing regions, immediate opportunities will focus on establishing basic collection and recovery infrastructure.

Reuse could play an important role, especially in the B2B segment. Reusable B2B packaging can create substantial cost savings, especially if used in pooled systems across companies and industries. In the business-to-consumer (B2C) segment, reuse is more challenging for many applications, but could be pursued for targeted applications and could be increasingly enabled by new business models. For example, Unilever participated in Loop – an innovative waste-free shopping and delivery model for reusable packaging innovations and refillable product formats: products are shipped directly to consumers and then returned to be refilled. This opportunity focuses on narrowing the flow of products by changing usage patterns.

Design and innovation: there should be a global plastics protocol aiming to redesign and converge materials, formats and after-use systems. This will help slow flows during the production and processing phase of the product life cycle. Clear design guidelines, such as the use of mono-material, can make it easier to treat or recycle packaging – e.g. Dow Chemical recently developed, together with Printpack and Tyson Foods and for a specific set of applications, a mono-material stand-up pouch with improved recyclability versus the existing multi-material alternatives. By aligning operators along the value chain – such as plastics and packaging producers, brand owners, retailers, and after-use collection and reprocessing companies – such standards could fundamentally improve the circularity of material flows. Existing work on design guidelines from organizations such as Recoup, the Waste and Resources Action Programme (WRAP), the European PET Bottle Platform (EPBP), European Union Plastics Recyclers (EUPR) and the Consumer Goods Forum could be adopted.

Explore bioplastics plastic for future use. The emergence of bioplastics will have a positive impact on growing consumer markets. Currently, the cost of bioplastics is three to four times higher than for conventional plastic.[75] Opportunities for bioplastics are likely to be with second-generation feedstock (made from waste) due to the competition that could arise with food and animal feed when using first-generation feedstock (i.e. corn, wheat, potatoes and other crops that are key for food security). There are also emerging opportunities in third-generation feedstock derived from algae that require the development of commercially viable models.[76]

Impact

“ In Ghana, a newly established waste and plastics recycling plant will create green jobs for 2,300 people – 800 directly and 1,500 indirectly.

PET and plastic recycling initiatives have already created numerous job opportunities for marginalized groups, including young people and women. In Ghana, a newly established waste and plastics recycling plant will create green jobs for 2,300 people – 800 directly and 1,500 indirectly.[77] In South Africa, according to Plastics SA, the plastic waste industry provided stable employment for around 7,800 people in 2018.[78] In Nairobi County, Kenya, Unilever's Zero Waste project created 70 green jobs for young Kenyans and opportunities for 1,700 collectors.[79] The establishment of these end-to-end recycling facilities has also been a promoter of industrialization through technology and skills transfer. Previously, PET bottles were sent to other countries for recycling and then shipped back.

Formalizing the process will also help alleviate some of the oppression faced by women waste pickers within the plastic waste sector. Relatively little is known about informal waste picking; national statistics are generally ineffective at identifying and measuring employment in this sector. The gender composition seems to differ from one context to another. It is not clear if this is due to data constraints or the importance of the local context in determining whether waste picking is more concentrated among women or men. Despite the changes in gender composition, it is clear that the forms of inequalities women face affect their earning. These include:

- Women waste pickers may not be allowed access to high-value recyclables and are often paid less for the same recyclables. They also face greater health risks as a result of handling waste and/or working in unhygienic environments[80]

- Women also do not find opportunities to occupy positions of authority within their workgroups or, when they do occupy those positions, they may not be as respected as their male counterparts[81]

Collectivization models have been successful in addressing some of these challenges for women waste pickers. In Brazil, cooperatives have helped waste pickers (particularly women) to address a wide range of important day-to-day issues, including negotiating with public authorities and private intermediaries, occupational safety and health (particularly during the pandemic), gender-based violence, legal protection, social protection and access to storage space and local marketplaces.[82]

2.3 Built environment

Context

The built environment refers to all man-made structures that support human activities. This includes buildings (residential, commercial, institutional, etc.), infrastructure networks (transport, water, waste management, electricity, etc.) and open spaces (parks, community gardens, etc.). The built environment is integral to urbanization; hence, it must be developed sustainably and promote occupants' health and well-being. COVID-19 has revealed the negative impact of poor-quality built environments on the execution of lockdown guidance such as self-isolation and improved sanitation. Hence, sustainability is integral to a resilient built environment.

As the urban population increases, so does the expansion of the built environment, resource consumption and pollution. Africa's urban population is expected to nearly triple by 2050, reaching 1.34 billion people,[83] increasing the demand for buildings and building materials such as cement, iron and steel. The manufacturing of these materials contributes to 11% of total CO2 emissions from construction. Emissions are bound to increase by 2050, as the cement and concrete market grow by 12–23%, while the global steel market will grow by 15–40%.[84] Moreover, buildings in the existing built environment are rarely refurbished, recycled or remodelled and produce significant emissions during operation and demolishment. This growing demand and limited recycling could increase pollution in the next decade if sustainable construction is not introduced.

CE principles in the built environment reduce the use of virgin materials by increasing material efficiency and maximizing use of recovered construction materials. The use of CE principles – for instance, recycling and reusing construction materials – will reduce the extraction of virgin materials such as ore for steel and iron as well as limestone for cement production, consequently reducing energy consumption and CO2 emissions. Furthermore, constructing regenerative and restorative buildings will increase energy efficiency for buildings and minimize waste generation. The concept is similar to the green building; however, CE is holistic as it integrates all built elements in the urban ecosystem.

Africa's built environment could be categorized as a formal and informal built environment. The informal built environment is characterized by unplanned and unregulated construction of buildings with inadequate access to essential infrastructure such as water, power and sanitation networks. MSMEs dominate the informal built environment economy, making up more than half of the sector's enterprises in some African countries. For example, 80% of the Kenya Federation of Master Builders, representing 2,500 contractors, are small and medium enterprises (SMEs).[85] Unlike the informal built environment, the formal built environment is regulated, planned and capital-intensive. The formal built environment has access to most infrastructure networks and promotes the health of its occupants. In Africa, a few large corporate companies thrive in this space. However, only 30% of households in Africa can afford to live in a formal built environment.[86]

Africa's urban population will reach 1.2 billion by 2050, about half of whom will live in an informal built environment. Moreover, Africa has not yet constructed 80% of the buildings it will need by 2050.

Challenges

Africa's growing population and rapid urbanization will increase resource pressure and the continent's vulnerability to climate change. Africa's urban population will reach 1.2 billion by 2050, about half of whom will live in an informal built environment.[87] Moreover, Africa has not yet constructed 80% of the buildings it will need by 2050.[88]

The expense of building materials is one of the main challenges in constructing a sustainable built environment in Africa. In some parts of the continent, building materials account for 40% of the total construction cost.[89] The cost is higher in countries that import building materials from other countries. For example, the cost of sand and cement per metric tonne is higher in Rwanda than in Germany due to transport costs.[90] Furthermore, high costs can lead to prolonged construction, especially in the informal built environment. It could take 10–15 years, with gradual investment, to build a home depending on a household's financial capabilities, for example.[91] These challenges lead to poorly constructed buildings, especially in informal settlements.

Poor design of the built environment and population increase in African cities hinder proper waste management, thus polluting natural resources and increasing health risks. Large cities such as Johannesburg and Lagos respectively produce about 6,000 and 10,000 metric tonnes of waste daily and could run out of landfill sites in less than a decade.[92]

Opportunities

Africa's built environment can be sustainable and create economic opportunities by exploring opportunities that use these four CE principles or actions:

1. Make design the core of a sustainable built environment
2. Use environmentally friendly construction materials
3. Promote the construction of green buildings to increase their sustainability
4. Use regenerative approaches to manage household rubbish and wastewater

Make design the core of a sustainable built environment. Design determines the building life cycle, refurbishment needs, materials to be used in construction and the sustainable integration of the built environment and nature. Designing CE buildings must go beyond the requirements of creating closed energy, waste, water and construction systems to also incorporate the importance of ecological custodianship. "Human-centric design" needs to evolve towards a "planet-centric design" for sustainability. Four entry points must be considered when thinking of circularity in the built environment: large-scale service infrastructure (superstructures of buildings); intermediate building components (such as major machinery and auxiliary equipment requiring significant maintenance or complete refurbishment every 10 years); contact elements (requiring maintenance or replacing on a bi-annual basis, for example, light bulbs); and consumables and waste generated in daily operation.[93] Considered together, these opportunities point to a net-zero carbon future, in which the planning, construction and retrofitting of the built environment is dramatically changed.

Use environmentally friendly construction materials. Replacing concrete – which contributes 8% of global GHG emissions[94] – with alternative materials such as mass timber, recycled aggregates, recycled plastic bricks, flooring and roofing materials will reduce emissions from building materials.

– **Mass timber is a more sustainable building material than concrete and its use in construction is an opportunity to create new circular loops in the industry.** There are two categories: high-tech mass timber construction (e.g. cross-laminated timber [CLT]) and low-tech mass timber construction materials (wood-based panels such as veneer sheets and dry-process fibreboards). High-tech mass timber is already being used, particularly in Western countries, Asia and Australia. Africa has an opportunity to explore this opportunity by first strengthening the low-tech mass timber industry and gradually moving towards high-tech mss timber construction materials. Building using wood is sustainable because wood is recyclable throughout its life cycle; it is also cheaper compared to conventional construction because it cuts the cost of labour by half. In addition, it produces less waste during construction because the materials are typically prefabricated before being sent to the building site.[95] Moreover, timber is one of the few fully recyclable materials. Wood absorbs carbon from the atmosphere and, depending on its end-of-life disposal, most of the carbon released can be recaptured, sequestered or result in net-zero carbon emissions if burned for biomass energy (assuming a fossil fuel offset). Using mass timber for 90% of new urban buildings could prevent nearly 8 billion metric tonnes of CO_2 emissions by 2050, equivalent to a 4% annual reduction in global emissions from manufacturing and construction.[96]

– **Upcycling plastic waste for formal and informal built environment construction materials** such as plastic bricks, roofing tiles and floor tiles is an emerging innovation that can be explored to provide affordable building materials while removing plastic waste from the environment. For example, according to Conceptos Plasticos, a manufacturer of bricks made from secondary plastics, plastic bricks are 40% cheaper than conventional bricks, and approximately 27 metric tonnes of plastic could make enough bricks for one house. A recently established plastic brick factory in Benin is said to recycle 9,600 metric tonnes of plastic annually.[97] There are also existing opportunities in the informal built environment, where MSMEs often employ second-hand building materials, repurposing and refurbishing construction materials such as fixtures and fittings. Such options could reduce resource consumption of construction materials and increase material usage while offering households an affordable alternative.

Country: Rwanda

Company*:* Nyarutarama Plaza

Nyarutarama Plaza is the first certified green commercial building in Rwanda. The building uses energy-saving and water-saving technology to ensure efficiency in utility management and maximizes natural ventilation and natural daylighting while reusing wastewater.

The building could save 15% energy, 47% water and reduce 92 metric tonnes of CO2 emissions annually.

Promote the construction of green buildings to increase their sustainability. This is another way to create new loops in construction because such buildings are designed to take circularity into consideration. The formal construction of these buildings must incorporate regenerative and restorative designs that generate and conserve energy, use green roofs and skins, and harvest rainwater. By reducing energy use and maintaining bio-nutrients in the ecosystem, the buildings will reduce their environmental impact. Moreover, using CE models for efficient building fixtures and fittings – such as a product-as-a-service, leakage monitoring and clean energy technologies – will reduce resource consumption, consequently lowering the cost of running buildings, particularly commercial and institutional constructions.

Use regenerative approaches to manage household rubbish and wastewater. A quarter of the urban population in Africa live without electricity.[98] Wastewater and municipal solid waste (MSW) offer an alternative source for energy generation: through anaerobic digestion, biological waste can be converted into energy. In South Africa, at the Northern Works wastewater treatment plant, sewage is turned into energy in the form of biogas. The facility produces methane gas that powers about 15% of the plant's electricity needs. Engineers hope to add more facilities to increase that total to 50%.[99]

To realize the above opportunities, clear policies are needed to regulate or provide incentives for the industry to shift towards circularity and mobilize MSMEs to industrialize.

Develop clear market push-and-pull policies that will accelerate the implementation of CE principles in construction. For example, realizing the potential for mass timber in construction will require mandatory regulation for sustainable forestry conservation. Partnering with organizations such as the Forest Stewardship Council International (FSC) will help create tools to certify that no deforestation was involved in wood used for construction and that biodiversity and local communities who rely on the forest in question were protected. Another initiative would be to adopt green building policies to guide and regulate the construction sector, such as those created by South Africa's Department of Public Works and the Green Building Code in Rwanda.[100] Market pull policies such as financial incentives like tax breaks for green buildings, green mortgages, revolving funds that can be repaid with cash flow from energy savings, and energy efficiency certificates that can enable building owners to trade their emissions allowances could be instrumental in accelerating the adoption of sustainable and CE built environment projects.

Support MSMEs to align with the industrialization strategy. Linking informal MSMEs with industrialized/formal players will allow skill transfers and enable MSMEs to access larger markets. Consolidating MSMEs in informal clusters will create value chains within the informal built environment that could increase economies of scale and the productivity of existing CE activities. Another alternative is to formalize current construction activities by allowing a large player to invest in informal built environments.

Country: Australia

Building: Forte Living

Forte Living is the first Australian cross-laminated timber (CLT) building. This 10-storey apartment, standing 32.2 m high, is the world's tallest modem timber apartment building made from CLT.

The wood used to construct Forte Living stores (sequesters) 761 metric tonnes of CO2, saves approximately 7.7 million litres of water and lowers eutrophication (water pollution) by 75%.

Additionally, the smart design and efficient systems of the building could save residents an average of more than $300 per year on energy and water bills. The building is targeting a 5-star green star rating.

Some 485 metric tonnes of CLT were used in the building construction. This volume of CLT equates to 216 metric tonnes of stored carbon, which has also absorbed 792 metric tonnes of CO2 during its growth as trees.

Impact

Sustainable forest management has an opportunity to create green jobs in Africa. Globally, forest conservation has the potential to create a total of ~16 million jobs. With Africa's share of the world's forest standing at 17%, forest management could generate about 3 million jobs across the continent.[101]

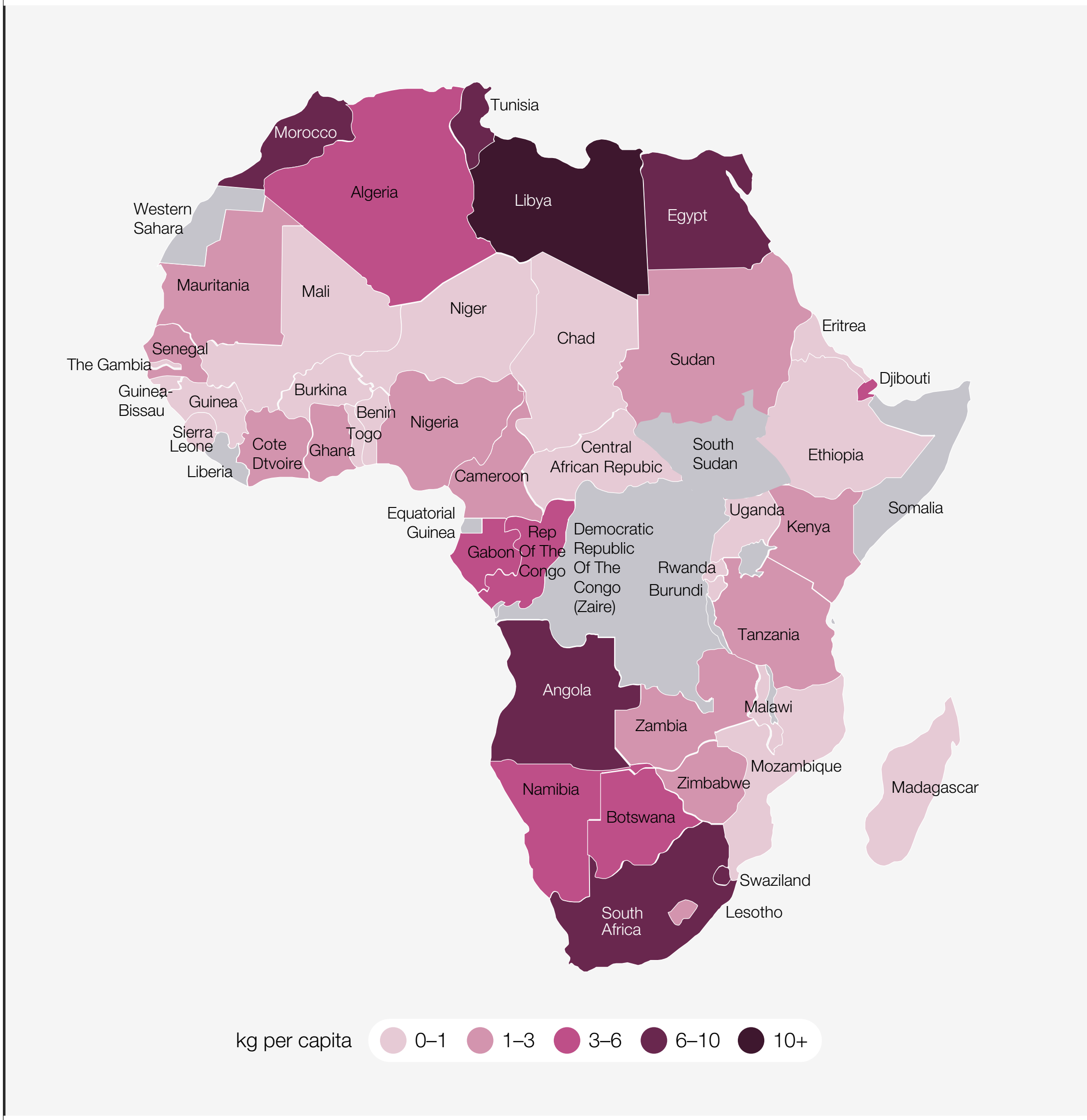
These opportunities will not only improve Africa's built environment but also enhance livelihoods. CE presents Africa with opportunities to achieve sustainable construction through efficient resource usage and reduce emissions while building affordable homes. With five plants like Benin's plastic brick factory mentioned above, the country could recycle more than 45% of its annual plastic production and use the bricks to build about 355 affordable houses per year.[102]

Women's roles in waste management efforts need to be considered when designing impactful solutions. Women play a significant role in household waste disposal as well as consumption habits. In addition, women are mostly the ones who collect, use and dispose of wastewater from households. Anchoring these opportunities to women will provide them with jobs and accelerate the adoption of CE behaviours such as recycling and reusing at the community level as well as directing waste to the correct place. Also, projects such as the Benin plastic brick factory are expected to buy plastic waste from about 1,000 women in the first year of operation.

“ Anchoring these opportunities to women will provide them with jobs and accelerate the adoption of CE behaviours such as recycling and reusing at the community level.

2.4 Electronics

FIGURE 6 **E-waste generated in Africa in 2019**



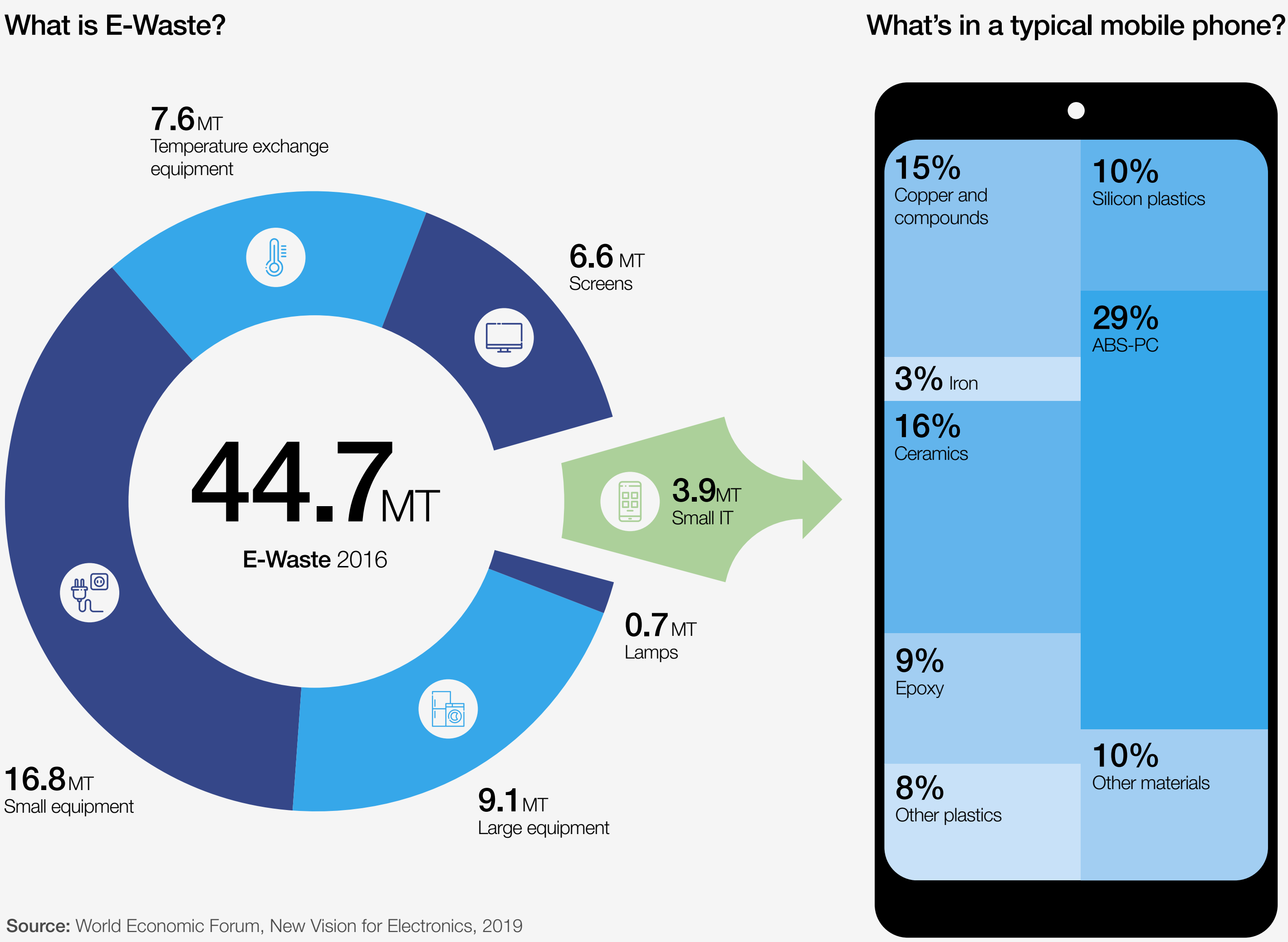
Source: ITU, Global E-waste Monitor 2020

Context

The development of new technology has rapidly evolved and intersects with multiple industries and sectors such as personalized healthcare and artificial intelligence (AI). Electrical and electronic equipment (EEE) includes a wide range of products with electrical circuitry or components requiring mains or battery power. Electronics are often grouped into six general categories that correspond closely to their afterlife management characteristics based on the UN categorization.

These groups are: 1) temperature exchange equipment; 2) screens and monitors; 3) lamps; 4) large equipment; 5) small equipment; and 6) small IT and telecommunication equipment. It is important to note that current systems and schemes do not yet cover any kind of batteries, accumulators or electrical components of vehicles under the definition of electronic waste.[103] Figure 7 illustrates the proportion of global e-waste categorized into the groups highlighted above.[104]

FIGURE 7 | **Mapping global e-waste by group**



Source: World Economic Forum, New Vision for Electronics, 2019

E-waste is a growing challenge, matching the growth of the information and communication technology industry. Since 2014, the global generation of e-waste has grown by 9.2 million metric tonnes (21%).[105] Proper disposal of e-waste requires training and investment in recycling and management technology as improper processing can have severe health effects. This waste is often burned, releasing heavy metals and toxic chemicals into the air, soil and water. In Africa, the potential release of harmful substances from undocumented disposal is estimated at 9.4 megatonnes of CO2 GHG emissions, 0.01 kilotonnes of mercury and 5.6 kilotonnes of brominated flame retardants (BFR).[106]

Illegal imports of second-hand electronics are a driver of e-waste in Africa in addition to growing domestic waste generation. While the Basel Convention forbids developed countries from carrying out the unauthorized dumping of e-waste in developing countries, enforcement challenges have led to a lucrative illicit trade. In Ghana, more than 150,000 second-hand electronics are imported each year.[107] Nigeria receives more than 60,000 metric tonnes of used electronics and electrical equipment from other countries through Lagos ports. More than 25% of this e-waste is classified as "dead on arrival" (not operational).[108] Growing technology adoption is also increasing the domestic generation of e-waste, with Nigeria producing 290,000 metric tonnes of e-waste in 2017.[109] As such, adressing e-waste growth in Africa would require a dual approach focused on both stopping illegal imports and creating systems to deal with domestic generation.

Research has found that unregulated e-waste recycling is associated with an increasing number of adverse health effects. Adults and children can be exposed by inhaling toxic fumes and particulate matter, through skin contact with corrosive agents and chemicals, and by ingesting contaminated food and water. Children are also at risk through additional routes of exposure. Some hazardous chemicals can be passed from mothers to children during pregnancy and breastfeeding. A study in Ghana found that e-waste workers have elevated cadmium (Cd) and lead (Pb) levels in their blood and elevated arsenic (As) levels in their urine. Some concentrations were 20 times above the American Conference of Governmental Industrial Hygienists threshold limit.[110]

Country: Ghana

Company*:* Agbogbloshie Makerspace Platform (AMP)

Agbogbloshie Makerspace Platform is a transnational youth-driven project to promote maker ecosystems in Africa. The project prototypes tools and has co-created a hybrid digital-physical platform for recycling, making, sharing and trading. Scrapyard workers are also encouraged by buyers to use green methods of dismantling and collecting waste.

So far, the project has been able to conduct more than 30 workshops for scrapyard workers and provide them with tools and a fabrication lab using locally sourced materials. Items created at the marketplace are sold to nearby communities.

Challenges

Although there has been an improvement in the legal and institutional infrastructure for managing e-waste, it is still rather weak. Globally, only 40% of countries are covered by an e-waste policy, legislation or regulation.[111] In Africa, 10 countries have a national e-waste legislation/policy.[112] Ghana and Nigeria are two of the countries that are also working to enforce these regulations. In Ghana, Technical Guidelines on Environmentally Sound E-Waste Management for Collectors, Collection Centers, Transporters, Treatment Facilities and Final Disposal have been developed and are being enforced. In Nigeria, the E-waste Producer Responsibility Organisation of Nigeria (EPRON) was set up by electrical and electronic producers – including HP, Dell, Philips and Microsoft. Organizations works with both consumers and producers to ensure the safe management of waste electrical and electronic equipment, including an incentive buyback/recovery and recycling programme for consumers.

There are limited resources to tackle the illegal importation of used electronic goods. In Nigeria, for example, a study found that almost 70% (41,500 metric tonnes) of the used electronics reaching Lagos each year arrived packed inside vehicles destined for Nigeria's second-hand auto market, an import route that is never thoroughly assessed[113] due to limited searches and functionality tests at Nigerian ports.

E-waste management in Africa is dominated by the informal sector, including collectors and recyclers. There is no organized system for take-back or licensed provisions for sorting and dismantling e-waste. The handling of e-waste is often processed in small junk shops or scrapyards, with electronic boards manually stripped for resale, unprotected burning of wires to recover base elements (e.g. copper, aluminium and iron), and the disposal of other bulk components, often in open dumps.

The presence of an unstructured informal sector can also inhibit the growth of recycling facilities. In countries such as South Africa and Morocco, facilities have struggled to scale up processing due to the nature of the large informal sector. This informal sector competes for waste with recycling facilities, is more localized and faces lower compliance costs, increasing access to e-waste at lower prices. Other challenges include lack of adequate public awareness, lack of effective collection and extended producer responsibility (EPR) infrastructure, lack of adequate recycling facilities and poor financing of hazardous waste management activities.

Opportunities

There is an opportunity to convert an e-waste challenge into an economic opportunity using a three-step approach:

1. Create and enforce legislation focused on limiting the amount of foreign e-waste
2. Achieve a zero e-waste circular economy through EPR principles
3. Establish proper recycling and collection facilities for current and domestic e-waste that incorporate both formal and informal operators

Create and enforce legislation focused on limiting the amount of foreign e-waste. In addressing this issue, African countries will have to find the balance between preventing the import of e-waste and near-end-of-life equipment and maintaining the socioeconomically valuable trade of good-quality used EEE.[114] Distinguishing second-hand EEE from e-waste hampers the work of enforcement officers, especially at the stage of screening documents that accompany the shipments of EEE and during visual inspections. This requires ensuring the proper definition of waste and adopting the technical guidelines on transboundary movements of e-waste – the latest of which was developed by the working group of the 2018 Basel Convention. This will reduce the number of devices coming in that are at the end of their life cycle or completely non-functional.

Achieve a zero e-waste circular economy through EPR principles. As Africa continues to import electronic devices and grows its manufacturing, there is a need to push for increased producer responsibility and accountability. EPR consists of three main objectives: 1) incentivizing manufacturers to improve the environmental design of their products and the environmental performance of their supply chains; 2) achieving a high product-usage rate; and 3) preserving materials through effective and environmentally sound collection, treatment, reuse and recycling. Products should be designed for durability, reuse and safe recycling, with unsustainable inputs phased out. Higher usage rates can be achieved through reintegration of manufacturing scrap, repair, second life and durability, including adopting product-as-a-service models. Higher product collection with incentives for returns and advancing recycling will preserve materials. The main barriers for an EPR policy are enforcement, lack of clarity on the definition of a producer, the prevalence of “no-brand” equipment and lack of formal treatment facilities. The most common approach is to designate each local distributor and retailer importing EEE as the responsible party for e-waste management because these entities are the conduits through which EEE enters the market. These firms are formal businesses with legal registration allowing ease of engagement. For no-brand equipment, any company selling above a designated threshold of EEE can be required to register as a producer or legislation can be drafted broadly such that the definition of a producer captures the importer of EEE and the local manufacturer to ensure a level regulatory playing field.[115] A lack of formal treatment facilities is addressed in the next section. EPR regimes can assign responsibility individually, where producers are responsible for their products, or collectively, where producers with the same product category fulfil requirements as a group, e.g. EPRON in Nigeria.

Establish proper recycling and collection facilities for current and domestic e-waste that incorporate both formal and informal operators. Countries need to work on building a recycling system that is inclusive of both the formal and informal sectors**.** This means investing in recycling plants and developing collection systems that promote green recovery methods. China provides a good example of a system that incorporates both formal and informal operators. Its system created a division of labour between the informal sector and formal recycling plants by providing a subsidy to the latter to buy waste products collected by the former. As a result of this effort, the emission reduction benefits of solid waste are estimated at $770 million from 2013 to 2017 in 29 provinces.[116] The recovery of expensive and scarce materials – such as gold, copper and iron – from e-waste represents a significant opportunity for the economy. The value of raw materials in Africa’s e-waste is approximately $3.2 billion.[117] In Rwanda, an e-waste facility costing $1.5 million and with an annual capacity of 15,000 metric tonnes (the total potential e-waste generated in the country) has been able to run successfully for three years, with the government also profiting from the lease agreement. Capital was provided by the Rwanda Green Fund (FONERWA) and will be recovered through the leasing agreement with EnviroServe.[118] The plant, which has employed 300 people and is expected to employ more than 1,000 people at full capacity, offers incentives for informal e-waste collection – individuals who collect e-waste from the community and bring it to the plant for recycling are paid $100 per 13–15 kg of e-waste.[119]

Country: Nigeria

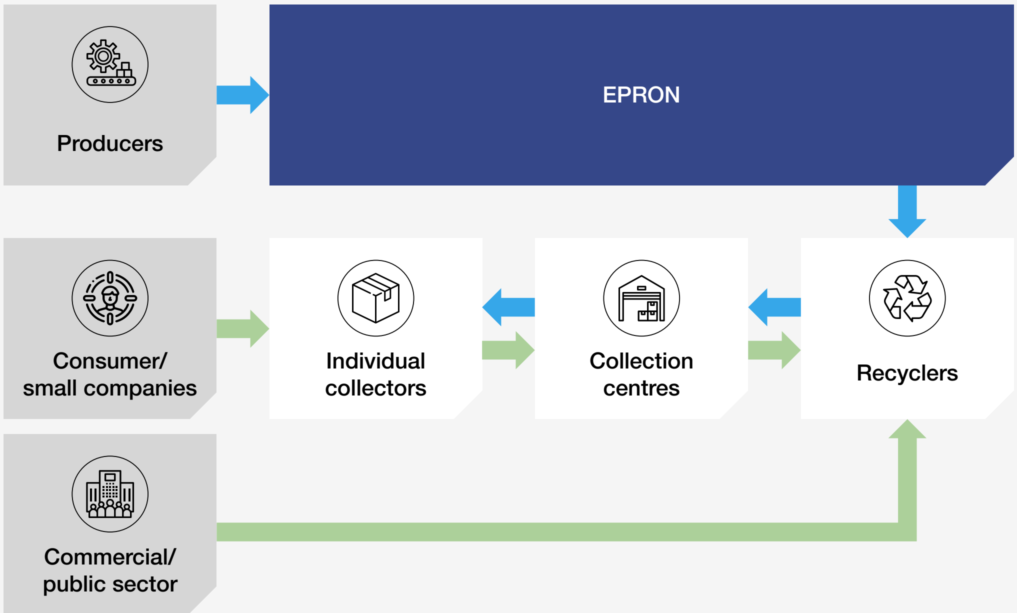
Organization: EPRON

EPRON plays the role of an interface between the regulator (National Environmental Standards and Regulations Enforcement Agency) and other important stakeholders in the EEE sector.

EPRON collects appropriate fees and levies from producers to adequately finance the collection and treatment of product waste streams on behalf of producers.

All parties involved in the e-waste value chain are also required to register under EPRON, from importers all the way to recycling facilities – which also supports e-waste data collection.

FIGURE 8 **E-waste generated in Africa in 2019**



Source: EPRON, 2020

Impact

Recycling of e-waste has created employment opportunities, although these are mostly limited to men**.** Through dismantling and refurbishing electronic equipment, workers can pick up skills in the repair and reuse of items that they later sell to the community. The recycling and dismantling facility in Rwanda has been able to create 300 green jobs, while the collection centres have created more than 1,000 jobs.[120]

2.5 Fashion and textiles

Context

The fashion and textile industry makes a significant contribution to the global economy and everyday life. Fashion and textiles is a $1.3 trillion market, employing more than 300 million people globally along the value chain.[121] In Africa, textile/fashion combined with the footwear market is estimated to be worth $31 billion, employing mostly women and young people; almost 80% of the workers employed in Ethiopia's apparel sector are women.[122]

The change in textile/fashion demand trends is heightening pressure on natural resources and increasing pollution. Globally, the fashion industry has almost doubled in size (currently worth $1.5 trillion) due to the fast-fashion phenomenon and middle-class growth.[123] Some clothes are currently discarded after just 7–10 wears, and overall less than 1% of material used to produce clothing is recycled into new clothing.[124] These trends have increased the industry's production of clothes and, therefore, the pressure on natural resources and the environment. The sector contributes 20% of global wastewater and emits 10% of global CO2; by 2050, the fashion industry will use up a quarter of the world's carbon budget. Moreover, the impact of fast fashion has led to a large influx of second-hand clothing (SHC) in Africa. As a result, an increasing amount of unsold SHC ends up in landfills and water bodies in Africa because most countries have no formal collection and recycling facilities. In Kantamanto, Ghana, one of the largest second-hand markets in Africa, 50 metric tonnes of unsold clothes are discarded a day, equivalent to 40% of all imported second-hand clothing.[125]

However, global consumers are becoming more environmentally conscious and increasing pressure on the industry to become more circular. New business models such as cloth repair and upgrading services of garments, leasing services, the resale section for pre-owned brand garments within stores, and peer-to-peer exchange are the emerging trends in the industry to mitigate the sector's impact. Fortunately, these trends are already developing in the continent through local designers and tailors. Hence, scaling the momentum on the ground puts Africa at the forefront of the emerging circular fashion industry.

Challenges

> It takes 20,000 litres of water to produce 1 kg of cotton, equivalent to a single T-shirt and a pair of jeans.

Cotton growing is vital to Africa's textile industry; however, it is one of the most resource-intensive cash crops. It takes 20,000 litres of water to produce 1 kg of cotton, equivalent to a single T-shirt and a pair of jeans. Globally, cotton-growing uses 4% of global fresh water for irrigation, 200,000 metric tonnes of pesticides and 8 million metric tonnes of fertilizer annually.[126] Cotton-growing across the continent will increase as the region looks to industrialize the textile industry. Making the cotton-growing industry more sustainable and less resource-intensive will enable cotton farmers to participate in the growing circular fashion industry.

Developing cotton processing and textile manufacturing could increase the pressure on resources and emissions if not established sustainably. Currently, the industry consumes 93 billion cubic metres of water annually – enough to meet 5 million people's consumption needs.[127]

Second-hand clothing (SHC) markets are raising concerns about "dignity" and local industry competitiveness in Africa. SHC markets are thriving in Africa; however, some African governments have discussed banning or increasing tariffs for SHC because the market competes with local industries. Additionally, some governments have claimed that SHC are undignified. Joseph Rwagatare, a columnist for the *New Times*, a Rwandan newspaper, wrote: "No one goes around proudly showing off someone else's discards."[128] This could affect the clothes recycling market and force exporter countries of SHC, mostly the US and European countries, to find an alternative to recycling discarded clothes.

Country: India

Company: RESET programme

RESET is a cotton improvement programme co-founded by MetaWear and the Grameena Vikas Kendram Society for Rural Development in India. The programme trains farmers in regenerative organic farming practices that build soil health, sequester carbon and remove toxic chemicals from the farms and surrounding communities.

RESET farmers enjoy lower costs, greater yields and higher profits. The programme has reduced the cost of cultivation by 50%, increased on-farm efficiency and yields by 25%, and offers 5% higher profits with rotation crops such as pulses, doubling farmers' incomes.

In five years, RESET is expected to increase water retention capacity by 20–30%, increase farm biodiversity by 100%, remove 337,500 kg of toxic pesticides and eliminate GMOs from 62,500 acres.

Opportunities

The African textile industry has an opportunity to pursue a three-pronged strategy focused on circularity:

1. Develop recycling industries that convert fashion and textiles waste into garments for commercial export markets
2. Spearhead the transformation of conventional textile industries to green industries that use safe and renewable inputs for textile manufacturing
3. Recycle textile cotton waste and cloths into yarns that can be upscaled into cloth to reduce the use of virgin resources

Develop recycling industries that convert fashion and textile waste into garments for commercial export markets. While there is a lot of pushback in using SHC for the local market, there is also the potential to create recycling industries that add value to SHC and re-export back to Western markets to meet the growing consumer demand for circular clothing. Currently, less than 1% of the material used to produce clothing is recycled, of which approximately 95% could be recycled. Africa has an opportunity to create a textile recycling industry that upcycles, repurposes and converts SHC into added-value garments or products. In the initial stages, countries could employ local MSMEs that are already recycling and upcycling SHC to grow the industry. For example, Suave in Kenya upcycles SHC into backpacks, purses, laptop bags, etc. However, these businesses are small, fragmented and informal. Hence, in the long term, Africa could industrialize these activities by investing in structured collection and sorting centres, recycling facilities and sufficient value addition on SHC, thereby creating jobs, increasing global recycling efforts and transforming the economy in the continent.

Spearhead the transformation of conventional textile industries to green industries, with the right enabling environment. Although the industry is not operating at full capacity, current government efforts across the continent will revitalize the textile and apparel industry. This allows Africa to leapfrog the conventional inefficient textile industry by establishing green textile industries that use renewable inputs (clean energy) and source sustainable raw materials (regenerative organic cotton) for fabric and garment manufacturing. Programmes such as Clean by Design could provide producers with guidance on how to build efficient textile industries, while the RESET cotton improvement programme in India could support the creation of efficient textile industries. These moves will increase the efficiency of the textile manufacturing industry. Most importantly, the manufacturers will benefit economically by developing a competitive advantage in the rapidly growing circular fashion industry.

Employ emerging technologies to recycle textile waste into yarns, which will reduce the reliance on virgin resources for garment-making. Because cotton growing is resource-intensive, recycling yarns to be used in textile manufacturing could create job opportunities for young people and women. For example, Khaloom is a social enterprise in India that produces sustainable fabric made from recycled textiles using traditional Indian hand-spinning and hand-weaving techniques. Khaloom has created jobs paying weavers two to three times India's minimum wage whereas more than 51% of weavers traditionally receive less than half of the minimum wage.[129]

To ensure that the fashion value chain is sustainable, guidelines and policies must be established to support cotton growers and manufacturers, encourage MSMEs to create green industries and influence consumer behaviour to shift towards responsible consumption of textile products. There is a need to:

- **Develop guidelines and enforce policies that will provide incentives for the growers and textile manufacturers to embrace sustainability.** Governments must develop guiding principles and increase the number of knowledgeable extension officers to help farmers and manufacturers understand the opportunity offered by circular fashion. Creating a guide such as the Clean by Design programme will provide the industry with a framework to becoming sustainable. In 2014, Clean by Design saved 36 million kilowatt hours of electricity and 3 million metric tonnes of water, reduced chemical usage by 400 metric tonnes and helped factories save $14.7 million through its sustainable guidelines.[130] This will go hand in hand with sound monetary and non-monetary policies to influence green industrialization.

- **Support the formation of circular textile clusters that will consolidate the efforts of MSMEs and increase productivity and industrialization.** The potential for scaling and industrializing the textile sector is high. Integrating formal and informal enterprises in cluster formation will improve scale, skills transfer, productivity and competitiveness. The textile industry is one of the specific sectors that can easily create natural clusters in Africa. Textile clusters tend to be successful if well mobilized. For example, in 2001, the Tamil Nadu cluster in India hosted an agglomeration of more than 7,000 SMEs, which exported $650 million worth of cotton garments to the EU, Japan and the US, representing more than 80% of all Indian exports of such goods.[131] The strategic formation of successful circular textile clusters is a major opportunity that could further support inclusive green industrialization across the continent.[132] However, strategic and resilient clusters will need government commitment and policies to enable business development and synergies.

Impact

These opportunities will improve Africa's textile/fashion industry and enhance livelihoods, particularly for women. The African Development Bank (AfDB) states that textile/fashion can create millions of jobs for African women and young people as the industry is labour-intensive.[133] Using a CE approach in the existing fashion/textile industry could create new initiatives that recycle and upscale materials, generating additional job creation avenues. New jobs would be derived from recent developments in logistics, more significant innovation in research and development, entrepreneurship activities, the creation of new medium and small companies willing to adopt this circular business model or a new economy based on services.[134]

Regenerative organic cotton growing will decrease the impact of conventional cotton growing on the environment and grant African farmers access to premium organic cotton markets. Organic and regenerative cotton growing could reduce global warming by 46%, acidification and eutrophication by 70% and 26% respectively, primary energy demand by 62% and blue water consumption by 91% relative to traditional production.[135] The market for organic cotton is also attracting global players in the fashion industry. Global sales of organic cotton products reached an estimated $15.76 billion in 2015. The top 10 users of organic cotton in 2015 were C&A, H&M, Tchibo, Inditex, Nike, Decathlon, Carrefour, Lindex, Williams-Sonoma and Stanley & Stella.[136]

3 Enablers

Harmonized supportive policies, business development support, data availability, technology, access to financial services and infrastructure are all vital in harnessing the circular economy opportunity.

Enablers include harmonized supportive policies, business development support, data availability, technology, access to financial services for CE enterprises and appropriate provision of infrastructure solutions.

Across thematic areas, a set of enablers is required to support CE solutions. These enablers include harmonized supportive policies, business development support, data availability, technology, access to financial services for CE enterprises and appropriate provision of infrastructure solutions.

Supportive harmonized policies can enable and expand current CE solutions across the continent. In Africa, the existence of enabling policies or lack thereof affects the promotion of circularity. Creating supportive policy and enforcement raises challenges due to the informality of most operators and the prominent role of innovative products that regulators may now know about. For instance, Safi Organics' compost fertilizer (biochar) was categorized as synthetic fertilizer because regulators had no prior experience with the product in the market. Supportive policies can be a vital enabler for both the quality and quantity of trade. For example, a harmonized regional policy on food-grade plastics can enable economies of scale and the safe recycling of plastics. Current policy developments such as the African Continental Free Trade Area (AfCFTA) will further support regional markets. Country-level policies are also vital to supporting CE increased trade such as Ghana's seven-year tax exemption for companies recycling plastic and polythene material for agricultural or commercial purposes.[137]

Supporting the growth of enterprises by providing business development support has demonstrated results, with an increasing body of best practices for success. CE firms (mainly MSMEs) need support through advisory services and linkages to wider value chains, as well as policy and research. Primarily, advisory services focused on upskilling, technical assistance and links to finance will support informal CE MSMEs' success and growth. A study by Kluve et al.[138] shows that entrepreneurship support programmes (including advisory services to growth-stage entrepreneurs) improve business performance, employment and incomes.

Increasing the availability of data and information will support the decision-making needed to maximize investments in the CE. There is a scarcity of relevant CE data in the continent, with current data (e.g. waste data) either outdated or based on assumptions. This is a challenge as data is used to inform policy-making and investment opportunities. Additionally, there is a scarcity of collated information and effective practices regarding relevant CE opportunities on the continent. This is partly driven by the limited CE academic focus on the continent. CE knowledge dissemination will be vital to ensuring that lessons learned from efforts across the continent are shared. In the long term, incentives and support need to be in place for increased academic research on CE relevant to Africa.

Efforts to expand access to technology will also support the scaling of CE solutions for individuals and industries. Several solutions, such as Twiga Foods and Coliba, use mobile phones to reach consumers. With an estimated 475 million people in SSA predicted to be mobile internet users by 2025, more work needs to be done to ensure the other half of the region has access to the internet.[139] Separately, technology to allow for green manufacturing is often imported, creating a need for technology transfer programmes to support industries looking to increase green manufacturing.[140]

Increased access to financial services is also key to ensuring the realization of these solutions. Given the emerging nature of CE innovations and the informality of many CE MSMEs on the continent, access to financial services (e.g. credit and insurance) is a challenge. This is driven by the risk-averse nature of financial institutions on the continent, which are often unaware of CE business models. For instance, SokoFresh struggled to receive insurance coverage as brokers in Kenya had no experience of estimating premiums for products in mobile cold storage.[141] This requires catalytic funding, such as guarantees to allow financial institutions to develop CE products with minimal risk. Additionally, existing funding for green businesses requires scaling and coordination to maximize impact. Funding can be scaled through innovative financial modalities that allow increased private-sector participation in green investments. Coordinated investments will also be vital in scaling current financing, particularly from climate-related funds such as the Adaptation Fund, the Global Environment Facility, the Green Climate Fund, and the African Solidarity Trust Fund.[142] These funds will not only support CE solutions but aid in COVID-19 recovery.

Conducive infrastructure will also support CE solutions, particularly in ensuring the effective waste collection needed for circularity. Infrastructure is vital in realizing multiple CE opportunities across thematic areas ranging from food systems to e-waste. In food systems and wastewater management, piping and collection infrastructure is required to allow opportunities for wastewater use in irrigation. In e-waste, recycling infrastructure is needed to ensure the safe recovery and processing of waste. The investments required for infrastructure are often expensive and need innovative financing models such as public-private partnerships (PPPs).

4 Conclusion: circular resilience

The big bets described in this report offer an opportunity for accelerated recovery from COVID-19 but require coordinated involvement of all stakeholders if they are to be realized.

The pandemic has caused unprecedented health and economic impacts globally and has exposed and exacerbated economic and societal challenges, with ripple effects expected to continue for many more years. This has also created a unique opportunity to reset the African economy on a pathway towards greater environmental sustainability and low-carbon development.[143] This opportunity requires the coordinated involvement of all actors, including governments, the private sector, donors and consumers to adopt the CE as a recovery tool. This will require collective action by stakeholders to address challenges and develop incentives such as innovative finance to stimulate investment in the CE. The African Circular Economy Alliance can advance these recommendations through its core functions by supporting policy, enabling businesses and scaling data and knowledge in the CE. Partnerships will be vital in achieving this, given the existing work and resources invested by other stakeholders.

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