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KNOWLEDGE BRIEF

# Harnessing Technology in the Circular Economy for Climate Action in Africa

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## Abbreviations

| | |
|---|---|
| ACEA | African Circular Economy Alliance |
| ACEN | African Circular Economy Network |
| AfDB | African Development Bank |
| AMCEN | African Ministerial Conference on the Environment |
| AUDA-NEPAD | New Partnership for Africa's Development |
| CBO | Community-based organization |
| CE | Circular Economy |
| CGEM | Confédération Générale des Enterprises Marocaines |
| CSIR | Council for Scientific and Industrial Research (South Africa) |
| CTCN | Climate Technology Centre and Network |
| EAC | East African Community |
| EC | European Commission |
| ECOWAS | Economic Community of West African States |
| EPR | Extended Producer Responsibility |
| EPRON | E-waste Producer Responsibility Organization |
| EU | European Union |
| GACERE | Global Alliance on Circular Economy and Resource Efficiency |
| GHG | Greenhouse Gas |
| GPAP | Global Plastic Action Partnership |
| KEPSA | Kenya Private Sector Alliance |
| MDGs | Millennium Development Goals |
| MSMEs | Micro, small, and medium enterprises |
| MSW | Municipal Solid Waste |
| NDC | Nationally Determined Contribution |
| NGOs | Non-Governmental Organizations |
| RDF | Refuse derived fuel |
| SADC | Southern African Development Community |
| SDGs | Sustainable Development Goals |
| UNCTAD | United Nations Conference on Trade and Development |
| UN-DESA | United Nations Department of Economic and Social Affairs |
| UNDP | United Nations Development Programme |
| UNEA | United Nations Environment Assembly |
| UNEP | United Nations Environment Programme |
| UNFCCC | United Nations Framework Convention on Climate Change |
| UNIDO | United Nations Industrial Development Organization |
| WCEF | World CE Forum |
| WEC | World Economic Forum |
| WEEE | Waste Electrical and Electronic Equipment |

# Foreword



On behalf of the UN Climate Technology Centre & Network (CTCN), I am pleased to introduce this regional knowledge brief, the second in a series of collaborations exploring important trends in climate technologies across different regions. This brief is the product of a collaboration with Kenya Climate Innovation Centre (KCIC) and other partners, including researchers and practitioners. It provides a valuable overview of an important and growing trend in technology and sustainable resource management, the transition to a circular economy (CE). The brief reviews the origins of the CE and its history in Africa, discusses the main actors and their roles, and highlights examples of technical assistance supporting CE undertaken by the CTCN and its implementing partners in Africa. It also illustrates the progress of four countries on their CE pathways. Importantly, it aims to showcase a diverse array of technological solutions for an equally broad set of sectors.

The African Continent is well positioned to make the CE transition, as many of the practices that are now categorized as part of the CE are intrinsic and integral to many African nations and cultures. Africans are both resourceful and innovative, and their adoption of circular practices is more urgent than ever with the onset of climate change. They are at the beginning of this journey toward a more circular and sustainable future – and they are gathering momentum.

In recent years, the CE concept has gained traction, as it can be applied across several sectors and achieve benefits for climate mitigation, adaptation, and sustainable resource management. Following the COVID-19 pandemic, some African governments seized the opportunity to mainstream circular policies into their green recovery plans. At the CTCN, we have seen a marked increase in the number of requests globally to support the development of CE roadmaps, and Africa is no exception.

We must remember that CE practices and technologies do not necessarily deliver 'sustainability' by themselves, or in a vacuum. They do, however, disrupt the traditional linear economy that has relied upon an unsustainable model of production and consumption, accompanied by an ever-growing quantity of waste. It is time we design systems and technologies that increase resource efficiency and extract maximum value from materials by keeping them in use, while decoupling economic growth from resource consumption. It is important to use regenerative materials and eliminate waste and pollution, and by tapping into CE principles African nations can also meet their climate change and sustainable development goals while reaping a myriad of environmental, social, and economic benefits.

Going forward, technologies across sectors – including agriculture and food systems, the built environment, e-waste, plastics, and textiles – will serve as key enablers of the CE in Africa and beyond. However, countries also need support in strengthening their enabling environments to increase adoption of technologies, practices, and policies. This includes bolstering institutional coordination, stakeholder engagement, and mainstreaming CE principles into policies and regulatory frameworks. Lastly, we must remember – as emphasized in this report – the role of women and youth in advancing this agenda, and the ways in which education is key in shaping the leaders of tomorrow who will be driving it.

**Rose Mwebaza, Director of the CTCN**

# Executive Summary

The African population is projected to double by 2050, exerting undue pressure on resources and economic activities while greatly increasing the generation of waste materials (Emenike 2013). Waste production globally has long been steadily increasing, exacerbating a host of environmental, social, economic, and health issues. Roughly 70–80 per cent of the municipal solid waste generated in Africa is recyclable (UNEP 2018), but only 4 per cent is currently recycled. Only half of the generated waste is collected, and often disposed of in dumpsites, rendering Africa home to 19 of the 50 world's largest dumpsites (AUDA-NEPAD 2021). Weak institutional structures and slow adoption of relevant technologies contribute to the lack of sustainable waste management systems, alongside inadequate funding, poor enforcement of existing legislation coupled with corruption, and low public awareness, increasing conflict, and political instability (AUDA-NEPAD 2021).

The concept of a circular economy (CE) is a promising solution to sustainable resource management challenges in Africa and beyond. Globally, CE is gaining momentum and increasingly recognized and embraced as the appropriate alternative to the current linear 'take-make-waste' model so embedded in our supply chains across the world. The CE promotes extracting the maximum value from finite resources by extending their lifetimes, while protecting and improving the environment, advancing economic development and job creation, bolstering the roles of women, and providing opportunities for youth. Africa has traditionally embraced resourceful practices, which have gained ground again under the CE concept, as demonstrated by several new policies, partnerships, alliances, and initiatives across the continent. Africa is uniquely positioned to use CE systems to avoid technological lock-in and leapfrog to a more sustainable development pathway.

This knowledge brief aims at highlighting the role of technology in supporting the CE, and providing insight into technology-based solutions, including support for fostering the enabling environment that improves the uptake potential of circular technologies, practices, and policies. It features case studies from selected African countries emphasizing the role of technology in promoting CE through initiatives supported by the United Nations Climate Technology Centre and Network (CTCN), as well as a brief glimpse into the trajectories of four countries (Ghana, Kenya, Morocco, and South Africa) at different stages in the development of circular economies.

The brief underscores opportunities to harness technology for the CE across several diverse sectors. It is evident that Africa demonstrates a higher proclivity to adopting circular practices and business models as compared to other continents whose infrastructures have already been built without their next life cycles in mind. It is this backdrop that provides Africa with a 'head-start' of sorts, and with opportunities it can seize in certain key areas to fulfil CE potential. The sectors presenting the greatest opportunities for Africa are food systems and organic waste, e-waste, plastics, textiles and fashion, bio-waste to feed, and the built environment.

The key lessons and insights emerging from this dive into the current state and future potential of the CE underscore the imperatives to: mainstream and integrate CE principles into economic growth and development strategies; adopt a truly multi-stakeholder approach to operationalize the CE concept along product and waste supply chains; recognize local conditions and strengthen the enabling environment to tailor specific technology transfer, RD&D, endogenous innovation capabilities, and stakeholder collaboration; increase access to financing, networking opportunities, and knowledge sharing of data and information to facilitate decision-making; and enhance the role of women and youth in advancing circularity agendas while expanding educational opportunities for the continent's next generation to better prepare them to lead in this arena.


WEEE CENTRE

# 1. Introduction

The circular economy (CE) and sustainable resource management entail managing resources to ensure that future generations can benefit from them, avoiding depletion of natural resources, and maximizing product use potential through reuse, recycling, and refurbishment to extract the maximum value. Sustainable consumption and production have been incorporated into the UN Sustainable Development Goals (SDGs) as goal 12, "Ensure sustainable consumption and production patterns." The goal aims at "doing more and better with less" and is about "decoupling economic growth from environmental degradation, increasing resource efficiency and promoting sustainable lifestyles" (UNEP 2021a).

Waste management, one component of the CE, is a global issue that is becoming increasingly critical vis-à-vis a wide array of environmental, social, economic, and health issues. Over 90 per cent of waste is openly dumped or burned in lower income countries, with profound effects on the most vulnerable (Kaza et al. 2018). The African population is growing rapidly and projected to double by 2050, reaching 2.5 billion (Statista 2021). This rapid growth exerts pressure on resources and economic activities while greatly increasing the generation of waste materials (Emenike 2013). It is projected that the amount of waste generated will triple from 174 million tonnes in 2016 to approximately 516 million tonnes by 2050 per year across Africa (Kaza et al. 2018). Currently, only half of the generated waste is collected, and often disposed of in dumpsites, rendering Africa home to 19 of the world's 50 largest dumpsites (AUDA-NEPAD 2021).

Roughly 70–80 per cent of the municipal solid waste generated in Africa is recyclable (AUDA-NEPAD 2021), but only 4 per cent is currently recycled. Informal waste pickers recover items of value with minimal compensation to municipalities and the private sector, leaving roughly 50 per cent uncollected and dumped indiscriminately on streets and in water bodies (AUDA-NEPAD 2021). These practices have negative public health and environmental implications, which are likely to worsen alongside urbanization.

The key contributing factors to deficient waste disposal systems are weak institutional structures and slow adoption of relevant technologies to enable sustainable waste management (AUDA-NEPAD 2021). These factors are underpinned by insufficient funding, poor enforcement of existing legislation coupled with corruption, and low public awareness, increasing conflicts, and political instability, which compound the already complex issues surrounding waste management on the continent.

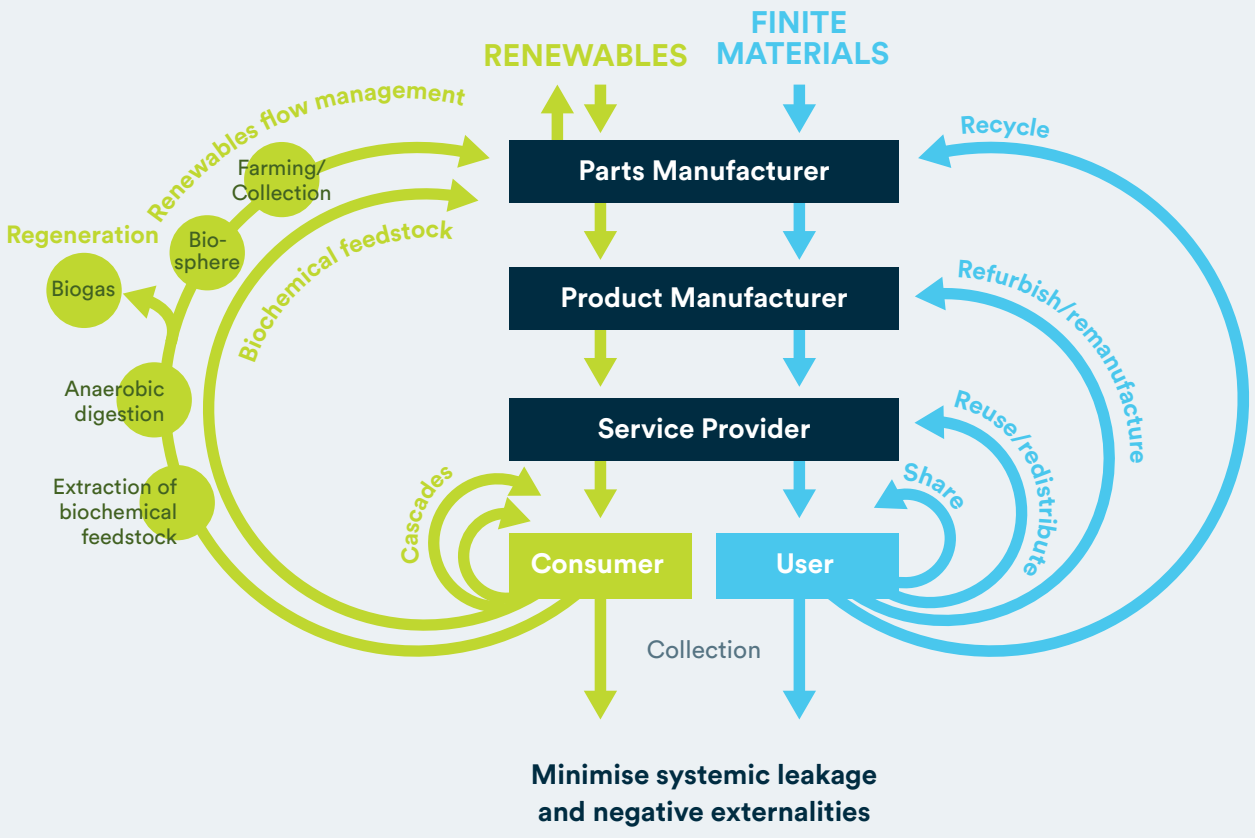
The concept of a CE presents a promising solution to sustainable resource management challenges in Africa and beyond, and if implemented in a timely fashion, can also support the continent in a leapfrogging of the industrialization and technological lock-in often instigated and/or reinforced by the linear economy. A CE is based on the idea that there is no waste. This idea stands in contrast to the linear economy, where raw natural resources are taken, transformed into products, and disposed. The CE model aims to close the gap between the production and the cycles of natural ecosystems – upon which humans ultimately depend (youmatter 2020).

Although several definitions of the CE concept exist, this knowledge brief uses the definition provided by the Ellen MacArthur Foundation (Ellen MacArthur Foundation 2012) which is based on the following actions:

- Eliminate waste and pollution;
- Circulate products and materials (at their highest value); and
- Regenerate nature.

FIGURE 1

**CE Systems Model Diagram**




*Ellen MacArthur Foundation 2019*

The Foundation emphasizes that the CE is supported by a transition to renewable energy and materials, and that this system "decouples economic activity from the consumption of finite resources" (Ellen MacArthur Foundation 2012). The adoption of circularity concepts is even more urgent now with the onset of climate change and unpredictable variability. Production of energy using non-renewable resources and increased consumption are directly linked to the emission of greenhouse gases (GHG) and broader environmental degradation. In contrast, the CE maximises the use of existing assets, while reducing dependence on new raw materials and minimising waste, thus narrowing the energy and material loops.

The CE Gap report (Schmidt et al. 2020) finds that the global economy is only 9 per cent circular, indicating that only 9 per cent of the 92.8 billion tonnes of minerals, fossil fuels, metals and biomass entering the economy are re-used every year. Significantly, 62 per cent of global GHG emissions are released during the extraction, processing and manufacturing of goods – contributing 12.5, 10 and 9.3 Gt $CO_2e$, respectively – with only 38 per cent emitted in the delivery and use of products and services (Schmidt et al. 2020). Given this reality, the CE concept would contribute substantially to climate action. Essentially, CE principles offer the possibility to reduce GHG emissions across value chains, retaining the embodied energy in products and materials, and regenerating natural systems to sequester carbon in soil and products (Ellen MacArthur Foundation 2019b).

The CE has gained international traction during the last decade; however, its application in the African context is still lacking (European Commission 2021). Increased circularity in Africa would synergise well with its development agenda through economic diversification and industrialisation. Circularity would provide a paradigm for the development of new economic activities while simultaneously addressing urgent environmental issues (e.g. plastic waste pollution) and social issues (e.g. employment and health) amidst the increased demand for natural resources. Further development of the CE would produce various positive outcomes, including:

- **GDP growth and increased employment:** The implementation of circular measures even in a limited set of priority sectors could create positive GDP and employment outcomes for African economies. According to the Ellen MacArthur Foundation, by 2030, Africa's combined GDP is projected to be 2.2 per cent higher in the CE scenario than in a business-as-usual situation. Approximately 11 million additional jobs would be created in a CE scenario by 2030, reducing Africa's unemployment from 94 million by 12 per cent to around 83 million (Ellen MacArthur Foundation 2012).
- **A larger and more competitive manufacturing sector:** A shift to CE in Africa could contribute to a larger, more competitive and resilient manufacturing sector, as CE strategies can help businesses better utilize the material resources available in waste streams, reducing dependence on imported materials.
- **Support in leapfrogging the industrialization and technological lock-in** that characterise the linear economy.
- **Reduced pollution:** As circular businesses reduce their waste production and use more environment-friendly production and waste management processes, air and water pollution can be decreased.
- **Enhanced climate mitigation and adaptation, biodiversity and ecosystems:** Most African governments believe that climate adaptation should be a key component of their Nationally Determined Contributions (NDCs) alongside mitigation, and this is now being prioritized. CE strategies have numerous benefits related to reduced GHG emissions, enhanced biodiversity, and more resilient ecosystems.

There are major differences across African countries, both in the level of technology development and private sector and governmental involvement in promoting CE activities (European Commission 2021). Recently, the continent has become increasingly inclined to explore activities that enhance the green economy and environmental conservation and protection, some of which include forming partnerships and alliances such as the African CE Alliance (ACEA). These, together with advancements at the national level, have led African countries to redirect their focus to the formulation and implementation of policies linked to the CE. However, mainstreaming its principles into economic growth and development strategies, both within countries and across countries considering inter-regional trade, will be an important requirement to realize the full potential of CE practices on the continent. The highlight of this journey is the anticipated African CE Action Plan currently under development (European Commission 2021).

This knowledge brief aims at highlighting the role of technology in supporting the CE, identifying key sectors and technological solutions that support its development, and exemplifying cases in which the CTCN has supported the use of these technologies to promote the CE, as well as case studies beyond the CTCN that emphasize the role of technology to support its overall development in Africa. The brief summarizes stakeholder groups, key opportunities and barriers, and insights and lessons learned that shed light on enabling future progress, and concludes with recommendations for policy makers, the general public, and private sector actors to accelerate the development, adoption, and implementation of CE practices. It should be noted that CE is not a new concept. It is constantly evolving with ongoing technology R&D and business innovation, encompassing a very broad range of activities. Therefore, some of these may not have been captured in this report.

## About the CTCN

**The CTCN is the operational arm of the UNFCCC Technology Mechanism, hosted by the UN Environment Programme (UNEP). The CTCN has been promoting accelerated transfer of environmentally sound technologies for low carbon and climate resilient development at the request of developing countries since 2013. The CTCN delivers technology solutions, capacity building and advice on policy, legal and regulatory frameworks tailored to the needs of individual countries by harnessing the expertise of a global network of technology companies and institutions.**

**More on CTCN's work in Africa can be found at: https://www.ctc-n.org**

# 2. The Context: Circular Economy in Africa

This section provides a brief historical overview of the CE and its associated technologies in Africa as well as a summary of the actors supporting circularity. It concludes with a glimpse into the future of circularity on the continent.

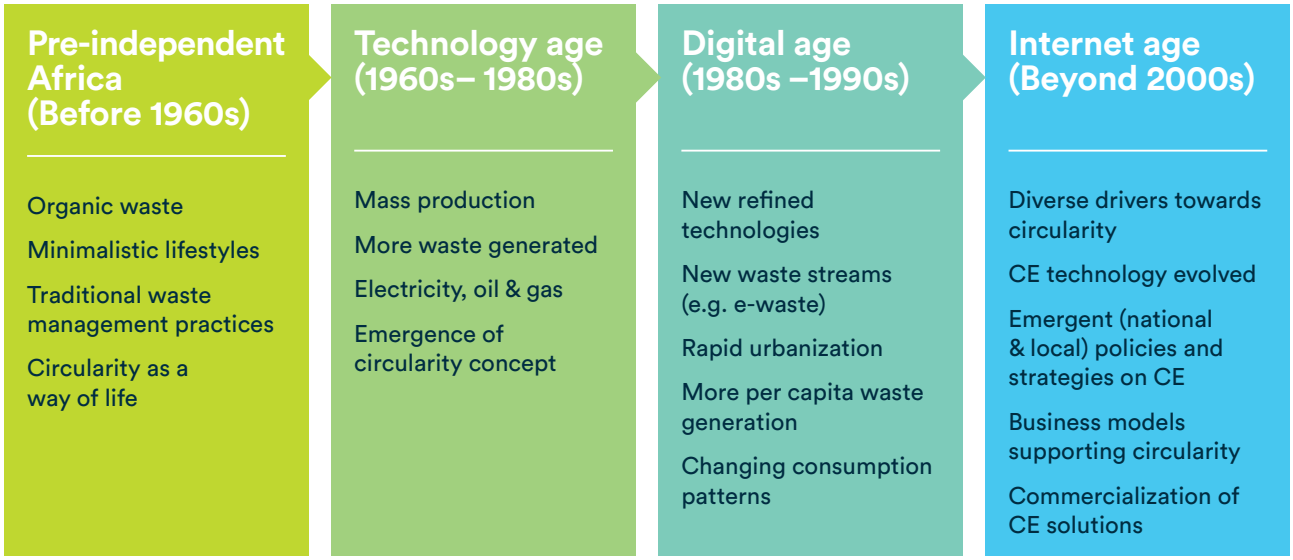
## Circular economy adoption in Africa

Pre-independent Africa embraced traditional and minimalistic consumption and production practices. Due to an abundance of resources coupled with economic scarcity, the population was naturally accustomed to participating in practices such as composting animal waste to use as fertilizer for crop production, making organic clothing material from animal skins, and using biodegradable construction materials like wood, grass, and mud in rural villages. During the initial stages of development, mechanization in production systems began to emerge; however, the use of plastic, for example, was not as widespread as in other parts of the world. Thus, Africans inherently practiced components of circularity in their everyday lives, embracing a minimalistic lifestyle in which people produced more than they consumed.

The accelerated adoption of technology between the years 1960 and 1980 saw the increased introduction of electricity, oil, and gas. During this period, resource constraints were still not a significant issue; however, due to increasing mass production and changing lifestyles, the volume of waste production rose immensely. This era coincided with the advent of circularity, and marks the period in which researchers Walter Stahel and Genevieve Ready sketched the vision of an economy in loops (or CE), building on the concept of resource efficiency, and its impact on job creation, economic competitiveness, resource savings, and waste prevention (Stahel & Reday-Mulvey 1981). When they presented this concept in 1976, it was one of several posited, including biomimicry (Benyus 1997) (which studies nature and imitates its designs and processes to solve human problems);

FIGURE 2

**Circularity adoption history in Africa**




*Source: Onyango et al. 2021*

the Cradle-to-Cradle concept (McDonough & Braungart 2007) (which advocates for extending a product lifespan); the discipline of Industrial Ecology (focusing on the redesign of industrial society as a specific ecosystem within the biosphere) (Graedel 2010; Wautelet 2018); the Performance Economy (a set of strategies to overcome the shortcomings of the present industrial economy and focused on doing the right things – rather than doing things right[1] — by "favouring resources sufficiency over resources efficiency and by promoting systems solutions over product and manufacturing business models") (Stahel 2010, p. 6); and the Blue Economy (which combines diverse environmental problems with open-source scientific solutions based upon natural processes to create solutions with a wide array of benefits) (Chiba et al. 2019). Circularity as an established strategy and its associated technologies were nascent and still largely lacking attention in Africa.

Following the 1980s, environmentalists began warning of growth limits and finite resources. This was the digital age, which ushered in the rise of electronics, telecommunications, and computers in Africa. Waste types in Africa became more diversified, as new waste streams beyond plastics and organic wastes entered the picture – including electronic waste. Initially, there was minimal consideration of how to manage the diversity of waste streams accompanying urbanisation and rapid population growth. Waste volumes continued to rise steadily, a reality which ultimately compelled governments and other stakeholders to search for more sustainable waste management strategies. The turn of the millennium gave greater attention to waste management, exemplified in the transition of global discourses from the Millennium Development Goals (MDGs) to the Sustainable Development Goals (SDGs), which placed more emphasis on sustainability as a crucial part of development.

The continent began to articulate the need for collective policy and strategic action to promote circularity as a fundamental part of development with various national and continental strategy declarations (Africa Union 2014). Recent initiatives include the launch of the African CE Alliance (ACEA) by Rwanda, South Africa, and Nigeria at COP23 in 2017, committing to share information and best practices, raise awareness and build partnerships. ACEA aims to encourage other African countries to build CE policies like Nigeria's Extended Producer Responsibility[2] (EPR) Programme. Additionally, a campaign banning the use of single plastics in Africa was launched by the First Ladies at AU Summit in 2019. In October 2019, at the AU 3rd Specialized Technical Committee on Agriculture, Rural Development and Water, AU MS ministers implemented a decision requesting the AU Commission to widen the scope of collaborative work aiding the ban of single-use plastic to embrace the CE, touting its environmental and economic benefits. The decision was then complemented by the 17th Session of the African Ministerial Conference on Environment (African Ministerial Conference on the Environment 2019) (AMCEN) in November 2019, where environment Ministers adopted the Draft Durban Declaration on taking action for environmental sustainability and prosperity in Africa, which conveys CE commitments for the whole continent.

Also on the continental level, CE-specific policy advancements have been driven by joint initiatives of the AU and the African Development Bank (AfDB), as well as the ACEA, under which progress is restricted to the conviction and motivation of a few countries and their concrete steps to move CE forward. The African CE Network (ACEN) was established in July 2016 to "build a restorative African economy that generates well-being and prosperity inclusive of all its people through new forms of economic production and consumption which maintain and regenerate its environmental resources" (ACEN 2021). The ACEN Foundation was formed by ACEN and Trinomics, one of the key international policy consultants in the field of environment, energy and climate change (ACEN 2021). It was established after the two organisations worked on the European Commission-funded project "The CE in Africa-EU Cooperation." The foundation's goal is "to accelerate the just transition to an inclusive, circular and sustainable economy in Africa which is in line with ambitious global climate change and the UN Sustainable Development Goals and promotes an economy within social and planetary boundaries," and in this manner "to deliver tailored and ambitious solutions for various needs related to the CE agenda in African countries." These solutions are focused on capacity building, knowledge transfer, incubation and business support, awareness raising, projects, and fundraising (ACEN 2021).

There has been a gradual recognition that CE can be mainstreamed and integrated as a fundamental component of economic development. Most CE initiatives at the regional level are focused on commerce and the harmonization of intra-African rules and standards.

The East African Community (EAC), which includes Kenya, Tanzania, Uganda, Rwanda, Burundi, and South Sudan, was the first to adopt laws to enable CE among Africa's five regions (Personal communication, Johanna Tilkanen, Chatham House 2021). The regional Polythene Materials Control Bill, passed in 2020, establishes regulations on the continued introduction of polythene into the EAC that apply to polythene makers, importers, vendors, and other users, with the goal of eliminating polythene competition between EAC members. However, acceptance in 2020 moved slowly, as some EAC members were hesitant due to lacking concrete data on the environmental and commercial success of the plan (Cocker & Maduekwe 2020).

Africans have also sought private sector partnerships to encourage innovation. A series of regional meetings held under the SWITCH Africa Green program resulted in the development of a waste management partnership strategy. Regional meetings do not necessarily result in new laws, but they do raise awareness, improve political debate, put CE on the agenda, and pave the way for innovative policies and policy modifications in the longer term. The topic of Integrated Waste Management was highlighted at a regional sector forum in Ghana in 2019, where the countries of Burkina Faso, Ghana, Ethiopia, Kenya, Mauritius, South Africa, Uganda, Nigeria, and China, brought together micro, small, and medium enterprises (MSMEs) and government officials. Experts and stakeholders in the waste sector (UN Environment & Switch Africa Green 2019), regional economic communities such as Economic Community of West African States (ECOWAS) and Southern African Development Community (SADC), the European Union, financial institutions, and UN agencies, were in attendance. A similar regional meeting was held in February 2020 in Uganda with the goal of enhancing regional efforts to scale up circular and green enterprises while motivating policy development. An important final policy suggestion was the upgrading of current policies and legislative frameworks to incorporate business models that account for green economy and CE concepts in the formulation of sector guidelines (UN Environment & Switch Africa Green 2020). Several African countries are now pursuing the development of ambitious, cross-sectoral CE action plans. One example is Rwanda, which has developed the first CE action plan that was launched during the October 2022 World CE Forum (WCEF) in Kigali. Lastly, the African CE Facility was launched at the 2019 WCEF following negotiations between the African Development Bank, Government of Finland, the Nordic Development Fund and the Finnish Innovation Fund Sitra. This partnership established a €4 million multi-donor trust fund to support a five-year continental programme (2021-2025) promoting the diffusion of circular practices in member countries, focusing on three areas: 1) institutional capacity building for the creation of enabling environments to enable the uptake of CE practices; 2) private sector support through a business skills development programme for start-ups and SMEs; and 3) the promotion of country ownership through a strengthened ACEA.

## Overview of circular economy progress in select countries

Almost every African country has developed at least one type of policy that will help lay the foundation for CE. Current national political initiatives either overlap with sectors that promote CE or incorporate CE ideas, and therefore, the majority of African countries promote some form of CE concepts, technologies and business models. Twelve countries already have national policies with explicit references to CE principles (see Table 1): Tunisia, Egypt, Algeria, Gabon, Kenya, Rwanda, Madagascar, Morocco, Senegal, Nigeria, Ghana, South Africa. Other governments have or are currently working on national CE road maps that depict a national agenda: Senegal, Morocco, Zambia, Zimbabwe, Malawi, Mauritius, Kenya, and Côte d'Ivoire. These policy developments show the progress of African countries on CE and sustainability more generally. Countries have largely designed policies and legislation that incentivize waste recovery and recycling, demonstrating that CE development is shifting away from being mostly driven by private sector entrepreneurs to being more heavily influenced by policy-making (GRID Arendal 2021). The pursuit in particular of sustainable waste management approaches will contribute to the achievement of the African Union's Agenda 2063, Goal 7, which aspires to develop environmentally sustainable and climate-resilient economies within African communities (AUDA-NEPAD 2021).

Table 1 summarizes policy and legislative support for CE.

TABLE 1

**Overview of categorization of policies integrating or supporting the CE for a selection of countries in Africa**
(the numbers in parenthesis represent the number of policy documents in the category)

| National Policies | Countries |
|---|---|
| **CE Roadmaps**<br>(contain legislative and non-legislative measures that consider the entire life cycle of products to advance CE; also added roadmaps currently under development with the support of the CTCN) | Zambia, Zimbabwe, Malawi, Mauritius, Kenya, Côte d'Ivoire, Rwanda, Senegal (in progress), Morocco (in progress) |
| **CE-related policies**<br>(include any national CE policies already in place as well as national green growth or sustainable development strategies which integrate CE principles) | Tunisia, Egypt, Algeria, Gabon, Kenya, Rwanda, Madagascar, Morocco, Senegal, Nigeria, Ghana, South Africa |
| **Product policies**<br>(define any policies that support circular practices relating to the design, manufacture, distribution or import of specific products and materials (mostly plastic bans or levies) | Benin, Burkina Faso, Burundi, Cameroon, Cape Verde, Ivory Coast, Democratic Republic of Congo, Egypt, Eritrea, Ethiopia, Gabon, Guinea-Bissau, Kenya, Madagascar, Malawi, Mali, Mauritania, Mauritius (2), Morocco, Mozambique, Namibia, Niger, Republic of Congo, Rwanda, Senegal, Seychelles, Somalia, Sudan, Tanzania, Togo (2), Tunisia (4), Uganda, Zambia, Zimbabwe (2) |
| **Extended producer responsibility (EPR) policies**<br>(These relate to policies that place the responsibility for the environmental impacts of products throughout the product life cycle on producers and are often applied to the collection, processing and re-utilisation of waste) | Cape Verde, Ivory Coast, Cameroon, Gambia, Ghana, Madagascar, Mali, Mauritius, Mozambique, Nigeria (9), Rwanda, Senegal, Uganda, Zambia, Zimbabwe, South Africa, Kenya |
| **Waste management and recycling policies**<br>(include policies that encourage circular practices relating to the management of waste covering generation, segregation, transfer, sorting, treatment, recovery and disposal) | Algeria (3), Angola (2), Benin (3), Botswana (3), Burkina Faso (3), Burundi, Cameroon (6), Cape Verde (2), Central Africa Republic, Chad, Comoros, Ivory Coast, Democratic Republic of Congo, Djibouti (2), Egypt (5), Eswatini, Ethiopia, Gabon, Gambia (2), Ghana (4), Guinea, Kenya (2), Liberia, Libya, Madagascar (3), Malawi, Mali (2), Mauritania, Mauritius (3), Morocco, Mozambique (3), Namibia (4), Nicaragua (2), Niger (3), Nigeria (2), Republic of Congo, Rwanda (3), Senegal (2), Seychelles, Sierra Leone, Somalia, South Africa (5), Sudan, Tanzania (4), Togo (3), Tunisia (3), Uganda (4), Zambia (3) |
| **Fiscal policies**<br>(include government tax and spending policies that incentivise circular practices) | Algeria, Benin, Botswana, Burkina Faso, Cape Verde, Ghana, Guinea, Lesotho, Mauritius (2), Namibia, Seychelles, South Africa |

*Source: Based on European Commission (2021) and Chatham House (2021)*

This section provides four country overviews that address CE development and describe the status quo while outlining important opportunities and challenges for each country. The countries were selected to represent different regions of Africa and illustrate various stages of CE progress.

## Ghana

Ghana has been prone to increasing challenges on waste and sustainable resource management over the last decades. The country's resource extraction and domestic material consumption have almost doubled over the past two decades (EC 2020). With its strong dependence on raw commodity exports, Ghana is vulnerable to global commodity prices. The country also has the largest e-waste dumpsite globally, named Old Fadama Scrap Yard or "Agbogbloshie," which attracted international attention on the issue of e-waste and more broadly municipal solid waste in Ghana. This stems partially from the fact that Ghana is the final destination of huge amounts of second-hand electronic equipment originating from industrialized countries. Furthermore, a large extent of waste management practices are conducted by the informal sector, accounting for 88 per cent of the country's workforce and 75 per cent of its economic activity, which has repercussions on safety and sustainability (EC 2020).

Ghana has taken important steps in its transition to a CE, even though the country still lacks important regulatory and institutional arrangements to set up a beneficial environment for sustainable resource and waste management practices to scale. To accelerate the transition, Ghana's government has made partnership and collaboration key to its strategy, considering the cross-cutting nature of CE across sectors and along value chains. The National Environmental Sanitation Policy from 2010 has largely driven the involvement of the private sector in providing waste management services. The market survey of Keesman (2019) has shown that 80 per cent of the services in the Ghanaian waste sector are now provided by the private sector (including both formal and informal activities). CE is progressing mainly in two sectors, namely e-waste and plastic waste. Ghana introduced an environmental excise tax on imported plastics and plastic products in 1996. More recently, the Ghana Recycling Initiative by Private Enterprises was established under the Association of Ghana Industries, including eight multinational companies with a stake in the plastics sector to integrate sustainable waste management solutions around plastics. In October 2019, following the implementation of its National Plastics Management Policy, Ghana took another step forward and became the first African nation to join the Global Plastic Action Partnership, thus establishing the partnership as a platform to share ideas among key actors. In terms of e-waste initiatives, the Government passed the Hazardous and Electronic Waste Control and Management Act (Act 917) in 2016 to place more stringent regulations on imported goods. Furthermore, several e-waste repair and recycling companies are active in Ghana.

According to a 2020 study conducted by the European Commission on CE in Ghana, promising sectors both politically and economically for CE are agriculture, housing and construction, and waste management, which are also well-aligned with Ghana's national development priorities. Additionally, the European Commission has identified tourism, urbanization and digitization as "enabling factors" to a multitude of opportunities for a CE transition. With regard to technology, digitization can bolster cross-sectoral innovation and raise awareness.

## South Africa

South Africa is relatively advanced among African countries in its promotion of a green economy agenda, underpinned by its policy framework for a post-COVID green recovery and green economy strategy, which supports a transition to CE approaches. The country's economy, which is the second largest on the continent and represents 15 per cent of its GDP, relies upon the service sector and contributes less from agriculture to GDP than the sub-Saharan average. The country has prioritised plastics and established a decent recycling industry, which can serve as a foundation to ease a CE shift that creates waste recycling jobs and businesses. Nonetheless, South Africa generates up to 122 million-tonnes of waste per year, 90 per cent of which ends up in landfills (Stubbs 2021). An additional priority is preventing solid organic

BOX 1

### Ghana Waste Recovery Platform

In 2018, UNDP facilitated the establishment of the Waste Recovery Platform with the aim to connect stakeholders along the waste management value chain, stimulate partnerships to collect waste management data, and address policy implementation gaps to promote the transition towards a CE. The platform is owned and driven by both traditional and non-traditional stakeholders with more than 300 stakeholders having actively participated in the co-designing process. This multi-stakeholder process offers the opportunity to enhance ownership and sustainability.

The Government intends to use the Platform as a tool to support the implementation of key policies such as the National Plastic Policy. Under the platform, the first edition of the 'Waste Recovery Innovation Challenge' showcased the variety of solutions, innovations and approaches for waste recovery being tested by researchers and the private sector. With the launch of the UNDP Accelerator Lab, the work of the Ghana Waste Recovery Platform is being deepened further, with a focus on collective intelligence to inform policy and action (Darkwah, Coffie and Antwi 2021).

**Staff of Sesa Recycling sorting plastic bottles. Employment made possible through UNDP WRIC support as part of the Ghana Waste Recovery Platform.**

waste from entering landfill sites and implementing biogas technology to produce electricity and fertilizers.

The South African government recognises the role that CE plays in sustainable development, and has mandated the Department of Environment, Forestry and Fisheries (Richards 2020) to "ensure the protection of the environment and conservation of natural resources and provide policy direction and necessary legislation in addressing integrated waste management." The country has set forth an ambitious goal of sending zero waste to landfills by 2030 and has instituted legislation to this end. The South African CE Guideline was finalized in 2019 with a focus on waste-related activities.

Importantly, the South African Plastics Pact is a collaborative initiative bringing together key stakeholders from the local plastics value chain to tackle plastic waste by stimulating innovation on new business models and generating job opportunities. The SA Plastics Pact aims to build on prior initiatives and meet the following targets by 2025: tackling unnecessary plastic packaging through redesign, innovation or alternative (re-use) delivery models; making 100 per cent of plastic packaging reusable, recyclable or compostable; recycling 70 per cent of plastic packaging; and averaging 30 per cent recycled content across all plastic packaging.

A 2021 study mapped the level of circularity in South Africa's economy (Krige 2021). The study compiled information for 82 materials and revealed that the economy is dominated by export-oriented extractives that will be increasingly difficult to sustain as global policies continue to emphasize the necessity of shifting away from the use of non-renewable resources. The study also found that there are "pockets of high circularity in the domestic economy, and significant informal activity around cascade use, reuse and recycling" with established recycling loops focusing on metals, paper and glass—however, the study points out that circular economies prioritize reuse over recycling, and that South Africa has some progress to make in reaching this goal. Lastly, the study reports an unexpectedly low rate of domestic stock building, uncovering the need to "stimulate alternative local businesses through the reuse and refurbishment of stocks in communities that need infrastructure, housing and durable consumer goods."

The Council for Scientific and Industrial Research (CSIR) reported early findings from its 'Science, Technology and Innovation for a CE' (STI4CE) Project, highlighting the implications of a more circular economy in South Africa (Iyer-Raniga & Huovila 2020). The study showed that a more circular economy can create opportunities to decouple development from resource consumption, thereby rendering the South African manufacturing sector

BOX 2

### Arup in South Africa — DigiYard

In South Africa, roughly 30 per cent of construction materials ends up in landfills. Strict construction timelines, limited space on construction sites, transport costs and limited recycling facilities are some of the reasons why the construction sector currently sends large amounts of materials to landfills. Meanwhile millions live in low-quality housing in townships located on the city outskirts. Townships are a legacy of apartheid and reinforce inequalities due to their distance from services and poor construction. The construction of permanent structures on land that one does not own is illegal in South Africa, and thus temporary structures are built from salvaged inferior quality materials. These 'shacks' (the local term) are often vulnerable to weather extremes and events, and pose a high fire risk since they are located very close to each other and often lack electricity, which necessitates the use of open fires for heating, cooking, and lighting. Recycling and repurposing quality construction materials could provide an avenue to address these challenges. Arup, together with external partners at Craft Design Institute (CDI) have developed DigiYard, a digital platform that facilitates the flow of usable building materials from construction sites to low-income communities in need of materials. The goal of the platform is to reduce construction materials in landfills while meeting the demand for affordable high-quality building materials in the informal sector. Using the platform as a materials marketplace, construction companies can redirect materials in an efficient manner, making affordable and quality materials accessible, saving low-income customers money and improving the quality and safety of their buildings. The platform will provide information on material usage and building practices. The platform contributes to the achievement of SDGs 11 (Sustainable Cities and Communities), 12 (Responsible Production and Consumption) and 13 (Climate Action). It will benefit construction firms by saving them money and time in waste management, reducing their carbon footprint, and supporting their compliance with environmental regulations and corporate social responsibility.

It will save township builders time and money otherwise spent searching for affordable materials and enable them to build more resilient homes. Lastly, the app will benefit the community by generating jobs, reducing fire and other safety hazard risks, and reducing pressure on landfills.

Read more about DigiYard here: https://knowledge-hub.circle-lab.com/article/7888?n=DigiYard---Repurposing-reusable-construction-waste

**Two truckloads of timber were among the first materials exchanged through the DigiYard pilot program and diverted from landfill. The materials were instead used by a local carpenter to create furniture and complete wooden flooring for a client.**

more competitive. The transition is also slated to improve food security through regenerative agriculture, improve mobility systems, create more sustainable cities, and ease the burden on already stressed energy and water systems.

South Africa has also progressed on its use of the biorefinery concept for commercial sugarcane and forestry industries via the CSIR, and by 2025, South African Breweries will be using dung from 7,000 cows to generate electricity for its operations. The holding company Anheuser-Busch InBev's global sustainability programme set the target of deriving 100 per cent of its electricity from renewable sources by 2025 and aims to reduce emissions by 25 per cent across the entire value chain. Since the solar power system at SAB's Chamdor Brewery in Krugersdorp began operations, all of SAB's breweries have been equipped with solar panels that generated more than 9.7GWh of renewable electricity during the first eight months of 2021. Ultimately, the biogas project will achieve a capacity of 4.7MW by supplying SAB with renewable energy generated from manure of the cows, whose main purpose is providing milk to Clover, and waste from neighbouring farms (Business Insider 2022).

The European Commission (EC) envisions the largest opportunities for South Africa in agriculture and food waste, plastics, mining, Waste Electrical and Electronic Equipment (WEEE), and construction sectors. For plastics, the EC points out that South Africa is emulating European models in its use of EPR and the Plastics Pact, but that "there is a need to actively engage and interpret models through an African lens," which means accounting for the role of the informal sector. Integration of the informal sector is also critical for WEEE recycling.

A South African example of innovation in the construction sector is presented in Box 2.

## Kenya

Kenya's increased urbanization coupled with rapid population growth has led to higher rates of waste generation and related waste flow challenges in recent decades. Urban centres have been especially affected by unsustainable waste management practices leading to serious environmental and health impacts. At the same time, Kenya's resource extraction has been steadily increasing over the last two decades, especially around biomass and minerals (UN SDG Indicator 12.2 Domestic Resource Extraction).

Whilst Kenya has yet to fully mainstream CE principles, it has made significant progress in response to these challenges. CE concepts in Kenya have been gaining recognition since the development and implementation of the Environmental Management and Coordination Act (EMCA) of 1999 which has led to the establishment of institutions that support environmental sustainability, such as the National Environment Management Authority (NEMA) and the National Environment Action Plan Committees (NEAP). In 2008, the Vision 2030 was launched, a long-term blueprint toward the achievement of sustainable development in Kenya by 2030. It also played a key role toward the promotion of CE, as it advocates for the adoption of industrial ecology, cleaner production principles, and other sustainable practices. These approaches support green growth that reduces environmental harm while maximizing economic gains. More recently, the transformation has been driven by the Kenyan government's green economy strategy that seeks to consolidate, scale up and embed green growth initiatives in national development goals. The Green Economy Strategy and Implementation Plan (GESIP) provides the overall policy framework to facilitate this transition, and outlines the need to mainstream and align green economy initiatives across the economic, social, and environmental spheres (IISD 2014).

Several legal frameworks and legislation have been introduced to enhance sustainable implementation of CE strategies in recent years. These include: the introduction of the National Solid Waste Management Strategy (2015); a ban on single-use plastic bags (2015), which rendered Kenya the second African country to completely ban the use of single-use plastic carrier bags; a ban on the use of single-use plastics in parks and nature areas (2020); the Sustainable Waste Management Bill (2020); and the draft EPR regulations (2021) aiming to involve the private sector in the development, implementation and enforcement of the new policy since the Ministry of Environment lacks the enforcement capacity.

The Kenya Plastics Pact (KPP), established in October 2021 by Sustainable Inclusive Business Kenya (SIB-K), a knowledge centre under the Kenya Private Sector Alliance (KEPSA), is the second Plastics Pact to be established on the continent after the SA Plastics Pact. The pact is an ambitious, collaborative initiative that brings together businesses, governments, researchers, NGOs, and other stakeholders across the whole value chain to set time-bound commitments to transform the current linear plastics system into a circular plastics economy. The KPP unites the sector behind a set of targets that are aligned with the CE principles of the Ellen MacArthur Foundation's New Plastics Economy. It focuses on addressing the barriers to circularity in the plastic packaging sector through public-private collaborations that enable solutions to eliminate unneeded plastics, bring innovation to packaging design, and capture the value of the plastics we use. The pact seeks to eliminate unnecessary single-use plastic packaging items through redesign, innovation, and reuse delivery models, and ensure that 100 per cent of plastic packaging is reusable or recyclable, 40 per cent of plastic packaging is effectively recycled, and 15 per cent average recycled content is used across all plastic packaging by 2030.

Kenya is addressing the green and CE transition through different approaches in priority sectors, including municipal waste management, agriculture, WEEE and construction. Within the agri-food sector, post-harvest food losses are targeted to be reduced through the National Agriculture Investment Plan 2019 – 2024 (NAIP) and organic waste is at the centre of attention to produce organic fertilizer and generate biogas within organic conversion sites. In August 2021, the Ministry of Environment and Forestry announced the launch of the Nairobi City County Environmental Sustainability and CE awareness campaign (dubbed "Taka ni Malii") that aims to promote sustainable consumption and reduced municipal waste generation. The aim is to extend this campaign to other urban areas across Kenya. Lastly, several CE-based building products and services are emerging in Kenya, despite a lack of regulations and standardization in the construction sector.

The steady growth of the Kenyan economy provides an opportunity to rethink business models, redesign products, and promote CE solutions. Key opportunities are in the agriculture sector, packaging, and construction. The agriculture sector holds large potential, as organic waste is the country's largest waste stream, and packaging waste is growing, requiring a focus on prevention as well as adequate management of waste. Ultimately, a national CE plan with a comprehensive set of policies encompassing a more integrated approach across sectors and ministries would further benefit the CE transition.

## Morocco

The CE is still an emerging concept in Morocco. However, national awareness is growing, and industries and businesses are realising the economic potential offered by innovative green and circular business models.

Recently at the fifth session of the United Nations Environment Assembly (UNEA) (5.2) in March 2022, Morocco announced its plans to join the African CE Alliance (ACEA) alongside members Ghana, Cote d'Ivoire, Nigeria, Rwanda and South Africa. The country has

BOX 3

### Kenya WEEE Centre

With Kenya's economic development and growing middle class, the usage of EEE has increased tremendously. The rising consumption also results in more disposal – Kenya generated more than 51.000 tons of e-waste (1.0 kg per capita) in 2019. As an adequate e-waste infrastructure is largely missing, most of the e-waste is disposed in dustbins, on the streets, in gardens, dumped into water bodies or kept in the homes of citizens. Most existing recycling and waste picking activities are informal, small in scale or limited to community-based organizations (CBOs) and NGOs.

Since 2012, the Waste Electrical and Electronic Equipment Centre (WEEE Centre) has provided e-waste collection, dismantling and automated processing services in Nairobi and in other major cities in Kenya, and has parallel systems, one for repair and refurbishment and the other for dismantling and recycling. By 2019, about 10,000 tonnes of e-waste had been processed and materials worth USD 10.6 million were recovered, corresponding to a total $CO_2$ emissions avoidance of 14,400 tonnes.

Initiated by the NGO Computers for Schools Kenya, the WEEE Centre is now owned and operated by local entrepreneurs with sustained support from various local and international partners. To raise awareness with regular awareness campaigns and to increase collection points across the country, partnerships have been forged with entities like Ecandi Ecoshop and Shamba Café, but also large companies like Safaricom, MAF Carrefour and Total energies. Also, partnerships with organizations like Rotary, Kenya Alliance of Resident Associations (KARA), Interreligious Council of Kenya (IRCK) and the County Governments where WEEE Centre Collection Centres have been established, are essential for the sensitization of inhabitants on responsible disposal of e-waste. See here more information on the WEEE Centre: https://weeecentre.com

been focused on waste management and recovery. In the waste sector, a consequential initiative called the National Program for the Recovery of Waste was launched in 2008. This strategy outlines objectives for waste reduction and recovery, including targets of a 20 per cent recycling rate by 2020 followed by a 100 per cent collection rate by 2030.

Both the public and private sectors have channelled efforts into the end-of-life stage. The Confederation Générale des Enterprises Marocaines (CGEM) established the Green Economy Commission to support companies that have pledged their commitment to the green economy. CGEM has also collaborated with the Moroccan Centre for Clean Production to provide technical assistance and resource mobilization services to support manufacturers in adopting technologies that enhance resource efficiency and preserve the environment.

The SwitchMed Programme was launched in 2013 by the European Union to accelerate the shift to sustainable consumption and production patterns in the Southern Mediterranean with a special focus on CE approaches benefitting 8 countries, including Algeria, Egypt, Israel, Jordan, Lebanon, Morocco, Palestine and Tunisia. The programme is being implemented by the United Nations Industrial Development Organisation (UNIDO), the United Nations Environment Programme Mediterranean Action Plan (UN Environment/MAP), the Regional Activity Centre for Sustainable Consumption and Production (SCP/RAC) and the UN Environment's Economy Division. The programme supports capacity building and training, engagement with policymakers, empowerment of citizens, and an action network of stakeholders to lead socially innovative solutions and bolster the market for sustainable products and services and resource efficiency improvements.

Under the SwitchMed Programme, the Moroccan Ministry of the Environment launched a process to develop a National Action Plan for Sustainable Modes of Consumption and Production (PNA-MCPD), starting with an in-depth evaluation of the MCPD concept, the results of which pointed toward a key focus on agriculture and construction. Three documents were then prepared, including a national framework and two sectoral plans.

The resulting National Framework Plan for Sustainable Consumption and Production contributes to the National Strategy for Sustainable Development (SNDS) to ensure the transition to a green economy and support the consolidation of a development model that can meet the needs of both present and future generations.

The EC identified agriculture and food production, waste (household), water (wastewater), and construction and demolition as sectors presenting potential CE opportunities. Urban household waste comprises the largest share of waste generation in the country (70 per cent), and given that there is also a low recycling rate, household waste could present a promising opportunity. Being an arid country that experiences frequent water scarcity and sanitation issues, plans to address water treatment and management are particularly important, given that these practices have been largely neglected to date.

BOX 4

### The SwitchMed Switchers Support Programme in Morocco

The Switchers Support Programme focuses on supporting green entrepreneurship. To this end, 10 local partners were selected for follow-up while a training methodology was being developed to support green business creation. This methodology used a handbook and workbook on green business model development and incubation to guide green entrepreneurs through the process of turning their green business ideas into full-grown enterprises. It also provided tools to test and validate business model hypotheses with customers and stakeholders.

One of the selected green entrepreneurs was ENRD2-Engrais Bio. Its aim was to "give new life" to organic waste by supporting cattle farms in installing biogas plants to transform their waste into renewable energy that can be used for electricity, heating, and fertiliser. The team received eight months of incubation support to develop a green business plan, mentoring from two technical advisors, and network and knowledge exchange opportunities with other entrepreneurs.

The impacts include the following:

- 32 tonnes of organic waste per cow collected per month
- 3,400 tonnes of organic waste saved annually
- 38 million tonnes of $CO_2$ were avoided by 2020
- 40 per cent of organic waste was reduced (sludge to be treated)
- 24 full time jobs were created over 10 years

Read more about ENRD2-Engrais Bio and the Switchers Support Progamme here: https://switchmed.eu/wp-content/uploads/2021/06/Switchers-Support-Programme.pdf

## Circular Economy Stakeholders in Africa

The primary stakeholders in the CE can be categorised as: (1) national government/ministries; (2) local government/municipalities; (3) partnerships, alliances, NGOs, and civil society organizations; (4) the private sector; (5) international/regional/continental agencies; and (6) research, innovation, and support (RIS) organizations.

Working at different levels, these stakeholders are integral to CE development and possess unique roles and responsibilities.

### National governments/ministries

The fundamental role of national government agencies has been to establish and enforce policies, regulations, and legal frameworks. These take the form of CE roadmaps and associated product policies, producer responsibility regulations, and waste management, recycling, and fiscal policies. Some governments are realizing they need to prioritise support for the implementation of existing laws and policies that already promote circularity, and to focus on harmonizing and streamlining cross-sectoral policy to enable a government-wide transition. Due to the cross-sectoral nature of the CE, a diverse array of ministries may be involved, including Ministries of Environment, Trade, Industry, Housing, Agriculture, Local Government, Rural Development, Finance, Planning, Economic Development, Green Economy, Climate Change, Tourism, Animal Resources, Fisheries, Solid Waste Management, Water, Energy, Science, Technology, and Innovation. However, in most cases the Ministry of Environment oversees CE-related policies, while a coherent governance structure with regular collaboration among ministries is often largely lacking. In any case, as exemplified in this brief, several governments have recently enacted policies that support CE, and there is indeed growing momentum that is effecting change from the top down.

### Local Governments/municipalities

Most waste is categorized as municipal solid waste (MSW). According to UNEP, 125 million tonnes of municipal solid waste (MSW) was generated in Africa in 2012, which is expected to double by 2025 (UNEP 2018). UNEP asserts that “the first priority for Africa is to address the public health imperative by ensuring that all citizens have access to proper waste management services.” These services are provided by cities and municipalities via regular city cleaning and disposal of waste, which is “the foundation of every integrated waste management system” (UNEP 2018). Thus, local governments and municipalities are responsible for developing strategies and targets that help create conditions conducive to improved waste management and the adoption of circularity, and in turn supporting the business community in achieving their sustainability objectives. This can take the form of providing subsidies and loans, enabling infrastructure, or promoting networking and information sharing to support capacity building. With rising urbanisation, local governments are expected to play an increasingly substantial role.

A reality that needs to be confronted in African cities is the inability of most citizens to pay for waste management services. It is worth considering shifting the system away from one requiring payment for these services to one that focuses on waste as a resource from which maximum value can be extracted to produce value chains that create jobs and opportunities, thus ensuring a just transition.

In recent years, several local governments have made great strides. The Koshe dump site was the only landfill in Addis Ababa until 2017, when the municipal government pushed to transform the dumpsite, first into a waste-to-energy plant incinerating approximately 1,400 tonnes of waste materials daily, to then supplementing approximately 30 per cent of household electricity in the city (UNEP 2017). Cape Town committed to developing a CE Action Plan and various associated local initiatives. The city collaborated with GreenCape to develop a CE roadmap by investigating the enterprise development, economic, and investment potential of the city (Ellen MacArthur Foundation 2021d). Ghana's municipalities are in the early stages of adopting CE, but in urban centres there is already a functioning household waste collection system financed by the municipalities and tendered to private companies such as Zoomlion and Liberty Waste.

## Partnerships, alliances, civil society, and non-governmental organizations (NGOs)

Pan-African alliances have substantial weight in ensuring that the CE discourse is sustained at the regional level, and that contributions – such as to the WCEF – are continued. As mentioned in section 2.1, a ministerial-level regional forum, ACEA was launched in 2017 by Rwanda, South Africa, and Nigeria to promote circularity in Africa. Then, in November 2019, the Durban Declaration for environmental sustainability authored by the African ministers for the environment marked the first Pan-African policy announcement that included CE ambitions for the continent. Also, as mentioned previously, ACEN was formed in 2016, and has conducted learning and knowledge-sharing events for CE professionals in both developed and developing countries to enable the application of lessons learned on CE implementation in different contexts (Desmond & Asamba 2019).

Other partnerships include the SWITCH Africa Green programme, funded by the European Union and implemented by UNEP in partnership with the African Roundtable on Sustainable Consumption and Production, which is supporting CE activities in seven countries, including Ethiopia, Burkina Faso, Ghana, Mauritius, Kenya, Uganda, and South Africa. The aim of the program is to (1) achieve sustainable development through engaging member countries in transition towards an inclusive green economy based on sustainable consumption; and (2) turn environmental challenges in Africa into opportunities with the understanding that an inclusive green economy is at the core of sustainable development and accomplishes multiple benefits alongside environmental protection, notably job creation, poverty reduction, and economic diversification. The programme focuses on key enablers for the transition by providing access to green financing, and enabling policies, standards, circular practices, awareness and skills on eco-entrepreneurship, and innovative solutions.

ACEN also initiated the development of a CE Platform for South Africa in conjunction with the Netherlands Enterprise Agency due for completion in mid-2022. The coordination and implementation of this and other CE activities have used a multi-stakeholder approach, following the successful launch of the Circular Business Platform for Lagos (CBPL) developed with the same partners in 2021.

Industry organisations are emerging across the continent. In Kenya, New Plastics Economy Kenya (NPEK) Partnership is a program funded by the P4G (Partnering for Green Growth and the Global Goals 2030) with an aim of curtailing the country's overall plastic waste by first raising collection rates and then transforming the waste materials into recycled products for commercial use. The implementing partners are the Ministry of Environment and Forestry, county governments of Nairobi and Kiambu County, BESIC Group, Coca-Cola Beverages Africa, PETCO-Kenya, Discover Brands, Tech4Trade, Qutron, Kenya Climate Innovation Centre (KCIC), Retail Trade Association of Kenya (RETRAK), Danish Strategic Sector Co-operation, Centre for Clean Air Policy (Chile), and the Kenya Private Sector Alliance (KEPSA).

In 2021, the African Union's Economic Social and Cultural Council (ECOSOCC) Secretariat committed to engage Africa's Civil Society Organizations (CSOs) to enhance a sustainable and waste free continent. The secretariat further committed to form a working group for solid waste management on the continent, and to coordinate the World Clean Up Day across Africa.

## The private sector

Private sector institutions play a double role in the CE context as they are both important material consumers and waste generators, as well as CE solution providers. With global supply chains, the private sector landscape not only includes local enterprises and SMEs, but also multinational companies that produce and distribute goods in Africa as well.

The private sector also plays a vital role in market development, creating circular products and jobs, and in leveraging the environmental, economic, and social opportunities provided while making a profit. Though their success is also dependent on other stakeholder groups critical to functionalizing the market system, clearly the private sector's role in CE production is central to the circularity agenda. There is a landscape of private sector companies that have developed circular solutions across the food, e-waste, plastics, built environment, and textiles sectors, and ideally, CE policies and roadmaps are aligned with and/or developed in tandem with these solutions. Several will be highlighted in Chapter 4.

## International, regional, continental, and development agencies

Global and regional organizations engage with a suite of issues while serving as conveners of dialogues that guide international development. In order to cultivate CE on an international level, inherent value and patterns of cooperation must be fostered at various levels (Henrysson & Nuur 2019). International organisations play a key role in facilitating, fostering, and accelerating the transition toward a CE. They set and enforce norms across individual socio-technical systems as well as internationally (Schot & Kanger 2018), and promote CE through the provision of policy-related or technical expertise for both research and implementation. They also importantly provide platforms for knowledge sharing and networking, disseminating a multitude of CE-related knowledge resources and technology. These knowledge platforms also promote policymaking. Multilateral Development Banks provide funds to advance larger initiatives and support governments in developing national strategies.

**African Development Bank (AfDB):** The African Development Bank (AfDB) is setting up the Africa CE Facility, a multi-donor trust fund for the proliferation of initiatives across the continent. CE principles also play a role in advancing the AfDB's High-5s development priorities to 'Feed Africa,' 'Light-up Africa,' 'Integrate Africa,' 'Industrialize Africa,' and 'Improve the Quality of Life for the People of Africa.' (African Development Bank Group 2022).

The **Global Alliance on CE and Resource Efficiency (GACERE)** was initiated by the European Commission and UNEP in coordination with UNIDO. It aims to provide a global impetus for initiatives related to the CE transition, resource efficiency and sustainable consumption and production, building on existing international endeavours and cooperating with other regional alliances. (European Commission 2022).

**United Nations Conference on Trade and Development (UNCTAD):** UNCTAD began its work on CE in 2015 in collaboration with the Ellen MacArthur Foundation examining resource circularity potentials in India and China. Circularity is already integrated into many areas of UNCTAD's work, including addressing fossil fuel subsidies. (United Nations Conference on Trade and Development 2022).

**United Nations Department of Economic and Social Affairs (UN-DESA):** UN-DESA seeks to improve knowledge and information that can inform policy and facilitate a transition to sustainable production and consumption through CE, embedded within their social and solidarity economy concept. (UN DESA 2021).

**United Nations Development Programme (UNDP):** Funded through Global Environment Facility (GEF) grants, UNDP manages a global project portfolio targeting waste management, e-waste, plastics, sustainable agriculture, green and sustainable chemistry, textiles, artisanal and small-scale gold mining, and sustainable production and consumption/CE. (UNDP 2022).

**United Nations Environment Programme (UNEP):** The UNEP circularity platform promotes knowledge sharing and a common understanding of the circularity concept and how it contributes to sustainable production and consumption patterns. UNEP is playing a leading role globally. (UNEP 2021b).


Community members participating in a beach clean up organised by UNDP and Plastic Punch, a member of the Waste Recovery Platform

**UN-Habitat** launched the "Waste Wise Cities" campaign to address the global solid waste management crisis. Over 200 cities joined the campaign, 10 city-to-city partnerships were established, and UN-Habitat contributed to the training of 50 waste management offices from 30 African countries in waste SDG monitoring and capacity development on solid waste management. (UN Habitat 2022).

**United Nations Industrial Development Organization (UNIDO):** Several UNIDO projects inherently address the fundamentals of CE in their support of resource efficient and cleaner manufacturing, and the development of sustainable products with longer lifetimes. UNIDO promotes industrial energy efficiency and renewable energy. (United Nations Industrial Development Organization 2022).

**The World Bank Group Municipal Solid Waste Management (MSWM):** The World Bank Group (WBG) is "the leading source of lending and knowledge on solid waste management" (Independent Evaluation Group 2022). WBG provided loans of USD 3 billion for MSWM between 2010 and 2020. During the same period, the WBG produced two flagship reports on the state of MSWM worldwide—What a Waste and What a Waste 2.0. WBG has also conducted technical certification courses on MSWM for professionals and policymakers.

## Research, innovation, and support (RIS) organizations

The RIS organizations play a large role in catalysing the shift towards a CE and bringing together a diverse wealth of expertise. Innovation hubs accelerate the development, deployment, and transfer of locally relevant CE technologies. In Africa, strengthening research and innovation will enhance the development and uptake of technologies.

The continent has several universities, innovation hubs, think tanks and research institutions which have contributed to the agenda. Regional research organizations that have provided knowledge on greening as well as enhancing the transition towards circularity include the African Union Scientific Technical and Research Commission (AU-STRC), African Centre for Technology Studies (ACTS), the Africa Sustainability Hub (ASH), the Institute for Climate Change and Adaptation (ICCA), and African Economic Research Consortium.

According to the Ellen McArthur Foundation, there has been global growth among universities on CE engagement through teaching, research, campus management, student-led projects, and leadership. The outstanding universities and higher education institutions in Africa integrating CE principles and practices are Stellenbosch

University and the Inscape Education Group in South Africa, and the African Leadership University in Rwanda and Mauritius (Ellen MacArthur Foundation 2021f). Vaal University in South Africa is one of 20 universities globally to become an organizer for the CE Club (CEC), the non-profit arm of its parent organization, the CE Institute (CEI) (CE Institute (CEI) 2022). CEI is an international network of 3,500 individuals and organizations working to implement CE concepts in 100 countries. The club has 180 organizers leading CEC chapters that bring together key stakeholders and 50 experts providing mentoring to start-ups and young researchers. In 2018, CEC launched the CEC Organizers program in universities with the goal of embedding circularity into the curriculum of least 200 universities by 2022. SAUoT is a University of Technology in South Africa that is positioning itself to make significant impact through the development of technologically innovative solutions for sustainable development, focusing on improved CE implementation performance within the institution and its host city, Bloemfontein (Sinxadi et al. 2021).

Lastly, several innovation hubs are serving to accelerate CE solutions. The Africa Hub is working in concert with ICLEI Africa and closely with ACEN to build relationships with academic, private sector and city actors while exploring CE principles for cities of the ICLEI Africa Network, such as Accra, Cape Town, Nairobi, Entebbe, Rabat, Kampala, Lilongwe, Blantyre, Makinde, Johannesburg, and Cairo (ICLEI 2022). Working in Nairobi are the Kenya Climate Innovation Center and the Circular Innovation Hub, which fosters CE innovation through programs and trainings for business and young innovators (Circular Innovation Hub 2022).

## Opportunities and barriers for circular economy in Africa

The future of the CE in Africa depends upon the identification, implementation, and promotion of technologies, strategies and policies that would enhance its benefits across the continent. Policymakers and stakeholders are increasingly recognizing that CE can support the achievement of a wide array of diverse environmental, economic, and social objectives, while also contributing to climate goals such as NDCs under the UNFCCC Paris Agreement and the UN SDGs, particularly SDG12 – Responsible Consumption and Production. There are also constraints that may bar full realisation of the benefits. This section provides an overview of both general and sector-specific opportunities and barriers in Africa.

### Opportunities for circular economy in Africa

The universal benefits of the CE are vast, as it represents a triple-win in many cases where environmental, economic, and social advantages are available through policies and measures that are capable of seizing on synergies.

**Environmental opportunities.** A diverse array of opportunities exists in Africa, beginning with those that support meeting climate, biodiversity, and sustainability (SDG) goals. NDC targets and CE strategies are complementary, sharing the ultimate objective of achieving long-term low carbon growth (UNDP 2019). CE strategies can help countries achieve NDC targets, given that CE practices can contribute to GHG emissions reductions, with over half of global emissions coming from material use. The World Economic Forum projects GHG emissions in Africa will increase by more than 2.5 times before 2050 due to rapidly increasing urbanization, industrialization, and electrification (Dorsouma 2021). Though estimates are scant, one study in Cote d'Ivoire estimated that the GHG emissions reduction potential of a decentralized composting plant was 87 per cent fewer emissions when compared to waste disposal (Yeo et al. 2020). Authors asserted that decentralized composting could be a feasible method by which Sub-Saharan Africa governments improve their waste management systems while reducing emissions. It would behove more African countries to explicitly include CE measures in their next NDC updates, which could also serve to increase climate ambition levels in a way that is appealing for African countries, due to a focus that is not solely on typical mitigation actions, but rather considers CE enablers. These would include: the conservation of existing natural capital, prioritisation of regenerative resources and use of waste as a resource, the rethinking and redesigning of business models, use of digital technologies to strengthen connections between supply chains, and collaboration to create value along these supply chains (UNDP 2019).

A study on CE measures and their mitigation impacts and co-benefits was undertaken by UNDP in the Gambia. Twenty circular GHG mitigation opportunities were proposed, which were estimated to reduce national GHG emissions by 36 percent, the national carbon footprint by 38 percent, and national solid waste volumes by 37 percent. The opportunities were also estimated to lower government spending on fertilizer and subsidies, and to encourage job creation while reducing the trade deficit by USD 116 million, or 7 percent of import volumes. Additionally, when combined with measures already proposed in The Gambia's NDC and nature-based solutions, the total mitigation potential reached 83 percent (United Nations Development Program 2021).

**Plastics.** Per capita plastic consumption is low in Africa compared to the rest of the world. Globally, roughly 85 per cent of plastic packaging ends up in landfills or elsewhere in the environment after a single use. Imports of plastics are expected to double by 2030 in countries such as Algeria, Egypt, Morocco, Nigeria, South Africa, and Tunisia, and in the same timeframe, 165 million tonnes of plastics are expected to reach their end-of-life in African countries. The Ellen MacArthur Foundation stresses the point that solutions to the plastic problem must begin at the source – we must decrease our production and use of plastic upstream, as we cannot solve the problem with recycling and waste management alone. A systemic CE approach is the only solution.

Other environmental opportunities include improved air and water quality, conservation and management; improved wastewater treatment; decreased depletion of raw materials; increased energy efficiency and energy conservation; more efficient use of waste streams; and increased biodiversity, as discussed further below.

**Biodiversity.** According to the Ellen MacArthur Foundation (Ellen MacArthur Foundation 2021g), more than 90 per cent of biodiversity loss is due to the extraction and processing of natural resources, and therefore results from the current linear economy's waste and pollution. Agricultural productivity in Africa has been increasing since the 1960s, but this has come at a cost to agri-ecosystems and biodiversity, having been accomplished via expansion of land under cultivation rather than via yield-per-hectare improvements.

The Intergovernmental Science Policy Platform on Biodiversity and Ecosystem Services (IPBES) asserts that global biodiversity loss should be tackled through transformative economic, social, political, and technological changes (IPBES 2019). This entails the complete transformation of production and consumption systems. CE provides opportunities to decouple economic growth from environmental degradation, with a host of other benefits such as improved air and water quality. Three principles to tack biodiversity loss, as elucidated by the EMF, are:

- Eliminating waste and pollution, such as removal of plastics so they don't pollute the environment;
- Circulating products and materials to reduce demand for natural resources, leaving nature intact;
- Regenerating nature to rebuild biodiversity through regenerative agricultural approaches such as agroecology, agroforestry, and managed grazing, which can all sequester carbon and increase biodiversity in surrounding ecosystems, conserve/restore productivity in agricultural lands.

Most African countries are Parties to the UN Convention on Biological Diversity (CBD). They have participated in the global biodiversity discussion, specifically in relation to the post-2020 global biodiversity framework that aims to galvanize transformative action by governments and all of society (UNEP Convention on Biological Diversity (CBD) 2020), and through the formulation of biodiversity targets that can be met in part through pursuing a CE agenda.

**E-waste.** Globally, Africa is home to the fastest-growing mobile phone market, and consumer spending on EEE is on the rise and slated to double by 2030. Thus, e-waste is increasing steadily alongside international and domestic consumption. Africa generated 2.9Mt, or 2.5kg/capita in 2019, which is the second lowest globally, while 60 per cent is a result of imports. In Africa, e-waste is often handled by breaking, manual stripping, burning to recover selected materials, and open dumping. These practices expose workers and the public to pollution, heavy metals, and chemicals. For these reasons, e-waste management has become a priority in several African countries, including Ghana, Nigeria, Rwanda, and South Africa. Several have introduced EPR polices, however more work remains to be done. This creates a diverse assortment of opportunities for recovering value from e-waste, keeping electronic products in use for longer, and then reusing, refurbishing, or repairing them.

**Sustainable development goals (SDGs).** The UN recognized the CE and zero-carbon energy as one of the six "SDG Transformations" needed to achieve sustainable development (Sachs et al. 2019). The UN SDGs 2020 progress report asserted that SDG12, focused on Sustainable Consumption and Production, has remained underfunded, while it is well acknowledged that CE solutions play a key role in achieving this SDG, among others (UN Economic and Social Council 2018). Examples include CE solutions to address the need for clean water and sanitation (SDG6) or clean and affordable energy (SDG7). CE practices and business models can help contribute directly to achieving 21 targets and indirectly to another

Staff of Nelplast converting plastics into pavement blocks with support from the UNDP Waste Recovery Innovation Challenge

28 targets (Ghosh 2019). This is important to African countries, many of whom have incorporated SDGs into NDCs and development planning. However, investment is needed. Most CE finance initiatives and investments are still taking place in the industrialised economies of Europe, USA, and China, whereas in Africa projects can be delayed by several years due to a lack of funding.

**Economic opportunities.** It is often believed that sustainability efforts are misaligned with potential economic growth. However, this is not necessarily the case. In applying circularity, countries can align their national development goals to incorporate both sustainability and economic growth (UNDP 2019). According to UNEP, the value of potentially recoverable resources not currently being collected in Africa is estimated at USD 7.6 billion per year (Ellen MacArthur Foundation 2021c). The economic opportunities available in Africa vary by sector, but more generally include the creation of new business and employment opportunities. For example, in 2019, the plastic recycling sector created 58,500 income opportunities for South Africans, while directly contributing 2.3 per cent to South Africa's GDP and 18.5 per cent to the manufacturing sector GDP. Circular models also increase efficiency and reduce expenses, enabling companies to save on costs associated with obtaining raw materials, which comprise 40-60 per cent of production process costs (ACEA 2021). CE opportunities in Africa are abundant across food and agriculture, packing and plastics, built environment, electronic waste, mining, textiles and fashion, and automotive industries. Additionally, economic opportunities afforded with CE measures also include increased international competitiveness; increased trade/exports; the valorisation of waste products, which raises funds for innovative solutions; decreased cost of production; increased GDP; and job creation.

**Private sector investment and finance opportunities.** African MSMEs are experiencing a huge finance gap estimated to be over USD 331 billion in 2018 (The Africa Report 2020). De-risking of private sector investment in circular solutions is required to scale up start-up businesses and pilot projects. Blended finance, such as risk insurance, guarantees, concessional capital, and technical assistance funds can support the CE in Africa, especially via support of African SMEs in the textile, plastics, and manufacturing sectors (Ellen MacArthur Foundation 2021c). The MSME gap can also be addressed by identifying new related CE business models that could attract additional funding or applying innovative finance models, such as asset-based leasing, which provides financial resources based on the value an asset (e.g. machinery) will obtain during its lifecycle, thus possibly replacing the credit ranking of the MSME itself. Lastly, access to finance can be facilitated by easing administrative processes and adjusting finance/loan eligibility criteria to MSMEs, and by lowering high interest rates associated with micro loans.

**Impact investing presents potential opportunities for CE in Africa.** In 2020, over 40 percent of impact investment funds were earmarked for African countries, and more than 50 percent of investors asserted their plans to increase Africa exposure over the next five years (Ellen MacArthur Foundation 2021c). It would benefit CE solutions to be associated with SDG finance mechanisms as well. Government policies, regulations, and commitment to green recoveries are also providing new opportunities for the private sector to invest in CE solutions by reducing the risk.

Lastly, CE comprises part of the way that private companies can deliver on environmental, social, and governance (ESG) and corporate social responsibility (CSR) targets while propelling economic growth. CE can help companies to meet their bottom lines and their reporting requirements in the new world of net-zero commitments.

**Technology opportunities.** Some have posited a higher likelihood that Africa transitions to a CE than elsewhere because in other regions most infrastructure has already been constructed without accounting for subsequent life cycles (GRID Arendal 2021). The African Development Bank asserts that two thirds of the infrastructure investment needed by 2050 is not yet built (African Development Bank 2018). African businesses are becoming more aware that the linear system increases their exposure to risks, most notably higher resource prices and supply disruptions. They feel squeezed between rising and more volatile prices in resource markets on the one hand and high competition and stagnating demand for certain sectors on the other.


ColdHubs in Nigeria

The success of CE is linked to technological innovation, including digital, biological, and physical technologies. Digital technologies will help optimize resource use and enable more sustainable consumption patterns. Services are being automatized, and many physical services are moving online, which could shift the economy from an ownership model to a shared-use model (Ellen MacArthur Foundation 2015). In fact, according to Circle Economy, one of the key elements of a CE is to "incorporate digital technology" to "track and optimise resource use and strengthen connections between supply-chain actors through digital, online platforms and technologies" (Hoogzaad 2020; Circle Economy 2021).

In Africa especially, technological enablers of innovation in CE are growing, as evidenced by an upsurge of tech hubs, of which the GSM Association counted around 450 across Africa in 2018, while in 2019, there were about 700,000 professional developers (Google & International Finance Corporation 2020; Footprints Africa 2021).

On the other hand, it will be important to make sure that technological shifts are part of a just and inclusive transition, and that the impacts of such shifts are considered from the perspective of social and labour policies. Technology transfer could create new jobs and entrepreneurial opportunities for new industries, including machine learning and robotics, but also in the formalization of informal labour markets, such as for waste collection in several countries.

Vast technology opportunities for advancement of CE in Africa cut across food systems, plastic packaging, fashion and textiles, built environment and electronic waste (African CE Alliance & Dahlberg 2021). Sector-specific analysis is a useful approach to describing the assortment of potential opportunities in the African CE transition, and this will be taken up in section 3.

**Social opportunities** encompass a wide variety of potential benefits, such as improved health conditions resulting from safer waste management practices, cleaner air/water, and increased sanitation; food security through improved sustainable and resilient agriculture practices; awareness of CE initiatives and their benefits by the general public and a diverse array of stakeholders; improved gender equality; and improved livelihoods alongside increased dignity as, for example, informal waste employees are integrated into more formal systems (with regard to payment, social security, and health insurance). Indeed, greater attention is needed here, as there are an estimated 300 million Africans working in the informal sector (Footprints Africa 2021).

As described in section 2 regarding the history of the continent, Africans engage in many collaborative practices used to manage scarcity, which gives them a cultural

advantage on the road to circularity. For example, in Rwanda, local communities gather on every last Saturday of the month for Umuganda, where they contribute to an assortment of activities such as waste collection, building construction, and road repair (Footprints Africa 2021).

Importantly, agriculture and food production are the foundation of several African economies. Despite increased productivity over recent decades, the food system often still fails to provide a sufficient food supply, adequate nutrition, and improved livelihoods for farmers across the continent. It is imperative to re-examine the greater agri-food system since Africa's urban population is projected to double during the next 30 years, necessitating greater food production while generating more waste (Ellen MacArthur Foundation 2021e). This presents an opportunity to ensure ample food supply and nutrition, reduce food loss and waste, and improve labour practices through CE practices. There is also an opportunity through CE for the development of new cross-sectoral policies to overcome these challenges.

**Gender opportunities.** Women have been more likely to experience poor working conditions, especially in the waste sector, and in the fashion industry they have remained vulnerable to toxic chemicals and other products used in textile manufacturing (The Circular Collective 2021). Formalizing informal waste sector work can help alleviate some of these issues. Women may not have access to high-valuable recyclables or may be paid less for the same recyclables. They may also experience higher health risks as waste pickers, and may be less likely to hold positions of authority (African CE Alliance & Dahlberg 2021).

CE policies can harness opportunities to be more inclusive with regard to gender dimensions than the linear economy has been historically. CE can also use collectivization whereby cooperatives can address gender issues. According to the International Labour Organization (International Labour Organization 2020), raising women's awareness about sustainable consumption and production and engaging them in CE can help to create less oppressive working conditions and gender equality while fostering the circular system. Women have typically exhibited more conscientious behaviour in their choices regarding how to use income on food, education and health; thus, women are slated to play a fundamental role in moving consumption in a more sustainable direction (The Circular Collective 2021).

UNEP has stated that "waste sector reforms will only be effective and sustainable if they adopt a gender perspective and are committed to ensuring gender equality" (UNEP-IETC & GRID-Arendal 2019). Therefore, moving from a linear to CE would help to introduce some relief for women who bear the burden in numerous sectors. CE policies that incorporate gender reforms can also support the achievement of SDG 5 on "Gender Equality" in addition to SDG 12 on "Sustainable Consumption and Production." As mentioned regarding technology, it is critical to account for the gender dimension in designing a just transition (Allcot et al. 2021).

**Education opportunities.** Africa is home to the youngest population in world. The AfDB projects that 450 million working-age people will enter the job market by 2035 (Mikomangwa 2022). Education focused on CE can create important advantages for this workforce. CE presents an opportunity to kickstart the education of youth at early stages in Africa so that they don't miss out on opportunities the CE transition may provide. Knowledge and skills can be transferred in secondary schools, colleges, or through online learning platforms (The Circular Collective 2021). As mentioned in section 2, engaging universities capitalizes on an excellent opportunity to create networks and platforms that can be used to raise public awareness, educate students, and engage local communities in CE initiatives. As mentioned on gender, the education of women should be prioritized, and CE initiatives can be used as a lever or mechanism by which to achieve greater educational distribution for women in African countries.

## Barriers to circular economy in Africa

Recently, more than 50 per cent of Africa's economic growth has been driven by only five countries – Algeria, Egypt, Morocco, Nigeria and South Africa (African Development Bank Group 2020). Significant cultural and economic differences exist among African countries that influence their development, economic strategies, and readiness and capacity to adopt circular policies and technologies.

As several authors have pointed out, barriers are usually associated with the context of specific sectors (GRID Arendal 2021). African countries encounter barriers in implementing CE policies and business models because of power relations and vested interests embedded in global values chains. These value chains tend to create power imbalances and economic inequality in African countries that provide cheap raw materials as inputs for higher value products (Desmond & Asamba 2019; GRID Arendal 2021).

It is important to note that many barriers are interconnected. Policy barriers, for example, may affect incentives and financing, which ultimately trickle down to consumers. Addressing one set of barriers may improve others. If political will and stakeholder engagement are strengthened, policy barriers may become easier to overcome. Tackling educational barriers can address a myriad of tangential issues, from technological challenges to cultural barriers that are broken when citizens are educated, realize the benefits of sustainability, and subsequently demand circular products, and when Africa's youth are educated on CE principles and can then take this knowledge into the workforce.

**Regulatory and policy barriers.** There is a lack of integrated CE roadmaps and plans to promote sustainable CE business models. Exacerbating this problem is the fact that African ministries may exhibit a proclivity to the linear viewpoint and work "in silos," reducing the likelihood of successfully enacting policies. Waste management is cross-sectoral, typically requiring different ministries to work together. In West Africa, poor inter-ministerial communication has compounded the uncertainty regarding whether decision-making on plastic waste falls under the department of urban planning or waste (UNDP 2019). In most cases, more comprehensive and cohesive waste management strategies are needed to curb regulatory barriers.

It should be noted that indicators and methods for collecting and measuring information on policy implementation are needed in order to track progress (Albagoury 2020). Governments often need to monitor implementation and develop frameworks and indicators to accomplish this. They can play a role in establishing environmental and/or sustainability requirements with which companies must comply, which may compel them to overcome potential resistance to switching practices (Albagoury 2020).

Sometimes competing priorities between development and CE-related strategies, especially with regard to the extractives industry, can become barriers. There may be uncertainty and/or a lack of consensus on the regulatory options appropriate to promote CE. Some governments embed or mainstream CE objectives into development plans, while others package CE relevant activities within green growth strategies.

In any case, governments may just end up being key players in accelerating the CE transition (Kirchherr et al. 2017), as they increasingly come to the realization that CE can address several problems simultaneously (e.g. GHG emissions from production, waste management, and resource issues).

**Financial barriers.** Given that the CE is not formerly organized in most African countries and largely operated by the private sector, the risk-related costs of CE practices such as recycling and uncertainties regarding the quality of end products have been a challenge.

Companies are often unwilling to invest due to market uncertainties. Two of the biggest barriers have been low virgin material prices and high upfront investments costs for circular business models (Kirchherr et al. 2017). Economic value associated with materials recovered from waste streams is often dismissed by private companies since the waste sector is not viewed as lucrative.

In most cases, the short-term profitability calculations that result in low tolerance for longer payback periods render it difficult for most companies to invest in CE technologies. Non-comprehensive cost evaluations and cost-benefit analyses are not often used to determine the effectiveness of innovative approaches. Many African companies are more focused on production for profit and not the associated returns or benefits some technologies offer. This of course does not align with CE measures requiring a sizable amount of upfront investment with a long pay-back period. Furthermore, financial support mechanisms and appropriate tax and other incentives are often lacking.

For instance, waste management in Kenya is regulated by the National Government, though the county governments have a significant role. Part of the management involves issuance of licenses to operate waste disposal sites, which are usually levied by both NEMA and the County Government. The lack of understanding and difficulty in predicting future liability costs (e.g., cost of waste disposal) has proven to be a hindrance.

Other barriers along the value chain include inadequate budgetary allocations and funding for the waste management sector and infrastructure by national and county governments, inadequate waste collection receptacles, transfer stations and waste treatment, and lacking upgrades for this waste management infrastructure. Budget allocations are needed to enforce policies and monitor the effects of legislation, and to prevent the emergence of unsustainable alternatives such as in the case of plastic bans, for example, where plastic bags are merely replaced by a different type of plastic rather than sustainable cloth-fibre solutions.

Low investment in CE technologies extends to lack of funding for research and development. Financial barriers are also associated with regulation, such as taxation and incentive policies that promote CE. In Ghana, the lack of an enabling environment, including fiscal and other incentives, is a major constraint particularly for entrepreneurs seeking to set up informal repair businesses.

**Technological barriers.** There is a shortage of state-of the-art technology and expertise essential to fully employ the CE model. Existing waste management systems and infrastructure in Africa are largely low-tech and unable to optimally utilize recovered materials, while they also tend to exacerbate environmental degradation. This infrastructure needs new and innovative technologies for materials recovery, and the associated research and development to further develop technological upgrades. This can be enhanced through increased collaboration and partnerships between more advanced frontrunner and African countries, or simply through sharing learning experiences. Limited knowledge, education, and skills relating to circularity concepts hinder the effective design of systems for material recovery and use of recycled materials.

Key CE players in the informal and private sector have limited or no access to funding or financial support that would come with more formalized employment, which impedes their access to available technologies. Based on market surveys, new technologies for effective waste management are expensive, especially for plastic waste, as they must be sourced from overseas. Technology transfer and distribution is a separate but related obstacle, given that technical capacity, expertise, and access to appropriate tools are lacking in several countries. Overcoming these barriers requires significant policy and regulatory support to foster innovation, increase research and development, create an enabling environment for technology to gain traction, increase the competitiveness of the circular model, and create a larger demand for products. Governments must collaborate with the private sector to bring new technologies into the arena, to pilot and ultimately scale them up. Awareness raising and education are also necessary for technological development in the form of capacity building and knowledge sharing, so that stakeholders will 'buy into' the implementation of new technological solutions and encourage changes from the status quo.

**Cultural barriers.** Several cultural barriers can slow the adoption of CE, including a general lack of consumer interest and awareness, and rigidity and reluctance to change (Cantú, Aguiñaga & Scheel 2021) for both consumers and producers based on simple inertia or lacking information about or appreciation of environmental and sustainability concerns. Since CE is still an emerging concept in Africa, businesses might have a culture that is hesitant to adopt circular designs and strategies. A vicious cycle may begin when businesses fail to adopt circular designs and consumers remain unaware since there are no circular products being offered on the market. Again, barriers are connected, and hesitancy to invest on the part of businesses—for whatever reason— contributes to lacking awareness on the part of the consumer. Furthermore, consumers sometimes harbor misperceptions about reused and recycled products, viewing them as inferior or defective (Cantú, Aguiñaga & Scheel 2021). Misperception can also be a problem vis-à-vis waste sector jobs.

Additionally, there may be a low level of collaboration between businesses in the supply chain (lack of integration), or within the company itself. Company culture may not be conducive to developing or fostering CE practices. For example, discussions about CE are often limited to the CSR or sustainability/environmental departments within firms, while other perhaps more powerful or influential departments possess little awareness of or willingness to engage in CE. This is often yet again an issue of working "in silos." Likewise, product manufacturers are components of larger supply chains, and one firm's commitment to adopt CE practices cannot produce truly circular products if the entire supply chain has not embraced these practices as well.

Governments can also help overcome cultural barriers through increased awareness campaigns and/or regulations.

**Gender barriers.** Gender constraints related to cultural norms, customs, and gendered roles and responsibilities contribute to women's unequal participation in the workforce, and in policy and decision-making. A 2021 study funded by the African Development Bank and Climate Investment Funds (Allcot et al. 2021) found that the most important drivers of waste management and plastics recycling sector problems are exacerbated by gender inequalities. Eighty per cent of waste pickers in Kampala are women who would benefit from better work conditions and training to "further professionalize" their activities. The study points out that existing gender dynamics determine men and women's interactions with waste and recycling and highlights extant structural inequalities that have a disparate negative impact on women.

**Educational barriers.** As mentioned, barriers are linked. Lacking research and development leads to a dearth of technologies ready for market. In addition, the CE transition is dependent on individuals and organizations embracing and engaging with CE concepts, demanding circular products, and spurring youth to learn about new technologies and innovate themselves, ultimately applying what they've learned in real-world examples. Education plays a vital role in ensuring students of all ages are equipped with the key skills and knowledge to apply circular thinking in their chosen careers. There has been slower progress on the inclusion of CE programs in African institutions. According to the profiled universities by the Ellen McArthur Foundation, only three universities and higher education institutions in Africa are integrating CE principles and practices (Ellen MacArthur Foundation 2021f). Inadequate CE training programs in higher learning institutions alongside a lack of vocational training is indeed a barrier worth addressing.

Another potential educational barrier is the shortage of knowledge and awareness about CE principles by consumers, and this is sometimes better addressed by governments in the form of education campaigns. Alternatively, it may be addressed by the private sector in their promotion of circular products. Organizational capabilities within firms are also often absent, whereby they fail to come together to establish circular practices across diverse organizational functions, which may be addressed using employee training and education initiatives (Cantú, Aguiñaga & Scheel 2021).

**Sectoral Barriers.** Common barriers occurring across sectors include lacking/inadequate legislation, limited finance, deficient infrastructure, missing incentives, and scant support on several levels for the adoption of new technologies, including adequate technical expertise. Within sectors, it is important to create and foster the appropriate enabling environments, and policymakers can help do this by addressing market and regulatory failures, such as misaligned market incentives that favour unsustainable products. They can also "steer and stimulate market activity by setting targets, implementing circular and total cost of ownership-oriented public procurement, and investing in innovative pilots and R&D" (Ellen MacArthur Foundation 2015).

# 3. Circular Economy Technologies in Africa

Technologies are key enablers of the CE across sectors and waste streams, as they lead to higher efficiencies in existing material loops and unlock new opportunities for circularity, ultimately reducing waste and GHG emissions, creating new economic activities and jobs, and benefiting human and ecosystem health. CE technology opportunities exist along the material value chain, from product conception and production to distribution and consumption to end-of-life. Proven CE solutions are both low-tech, such as composting and using local building materials, and high-tech, such as anaerobic digestion, material science and digital material marketplaces.

A multitude of CE technologies is already in use across Africa and other technology options are emerging with a high potential for being scaled across the continent. However, the level of CE technology adoption strongly varies between countries. Countries such as Côte d'Ivoire, Egypt, Ghana, Kenya, Morocco, South Africa and Tanzania are pioneering various CE technologies as the concept has gained momentum at national level. Successful technology adoption and scale-up largely depends on the national or local context, as technologies integrate into a system of material (or waste) availability and resource demand and may require physical or digital infrastructure.

This section highlights some of the key technologies that are implemented or emergent in Africa across 6 thematic areas: food systems and organic waste, packaging, low carbon-built environment, electronic waste management, fashion and textiles sector, and the advent of digitalization in circularity.

## Food systems and organic waste

Agriculture is the backbone of the African economy, with more than 60 per cent of the population of sub-Saharan Africa being smallholder farmers, and about 23 percent of sub-Saharan Africa's GDP coming from agriculture (McKinsey & Company 2019). Agricultural productivity is largely undermined by poor soil quality, extreme weather events, pests, and high input costs. Post-harvest losses further add to resource scarcity and food insecurity.

From a waste management perspective, organic material comprises up to 60 per cent of the waste fraction of MSW flows in African cities (Ellen Macarthur Foundation, Urban Biocycles, 2016), and the total figure is slated to double in the next 30 years with population growth and increasing urbanization. Its decomposition in landfills generates a considerable amount of methane emissions.

Circular business models and technologies enable significant opportunities across food production, distribution, consumption, and post-consumption to increase food yields, reduce waste generation and GHG emissions, and make use of organic waste:

- **Resource efficient production:** Climate-smart agriculture (CSA) methods such as regenerative and conservation practices, agroforestry, or combinations with livestock management can minimize resource requirements and build resilience. Besides traditional CSA methods, soil-less systems such as hydroponics, aquaponics, and aeroponics are increasingly popular in urban settings where space is limited. These systems are particularly interesting as they can be designed in closed-loop systems. The Guinean AquaFarms is an emerging agri-tech company specializing in aquaponics. Moreover, several initiatives across Africa have demonstrated that powering water pumping and irrigation systems through solar energy can facilitate resource recovery whilst reducing non-renewable energy consumption. One example is Bonenergie Irrigation which is piloting Solar Powered Irrigation Systems (SPIS) across rural Senegal.
- **Reducing food loss throughout processing and distribution:** Reducing post-harvest losses addresses both food security and the livelihoods of smallholder farmers. Food processing and conservation are effective practices to reduce losses. In this context, sun-drying is a proven low-tech solution as practiced by AgriCycle in Kenya, Tanzania and Uganda. Beyond food processing, the Kenyan SokoFresh offers farm level cold-storage as a service and has established a digital market linkage platform to integrate farmers, traders, and exporters into professional value chains. This allows for reduced distribution times and gapless cold chains. Initiatives like the Nigerian ColdHubs allow decentralized solar powered cold storage. Twiga Foods and Taimba, also from Kenya, connect fresh food producers directly with manufacturers and retailers without any further intermediaries to bring production and consumption closer together, which ultimately reduces food loss and prices.
- **Waste transformation:** Waste biomass to compost conversion involves biological degradation processes in which microorganisms transform organic materials into a soil-like material with a high nutrient content. The South African Compost Kitchen, uses vermicomposting, a method in which food waste is collected and recycled into compost with the help of earthworms. Furthermore, the valorisation of organic by-products into organic biochar fertiliser, as done by Safi Organics in Kenya, can improve yields, save costs, and generate additional revenue. Lastly, bio-methanation involves generation of electricity using methane from organic waste and sewerage sludge through installation of advanced anaerobic digesters and gas generator. This helps stave off methane emissions, generates biogas, and can create jobs. Every tonne of organic waste and sewerage sludge recycled using anaerobic digestion as an alternative to landfill prevents between 0.5 and 1 tonne of $CO_2$ emissions. The first grid-connected anaerobic digestion plant in Africa is the 2.2 MW George Farm Energy Park in Kenya.

ColdHubs employee sorting vegetables in front of a ColdHubs storage facility in Nigeria.

## Circularity in packaging practices

Africa's rapid population growth, urbanisation, and international trade increased the production and utilisation of plastic products. The high numbers of disposable plastic products have overwhelmed the continent's ability to dispose of them properly. In Sub-Saharan Africa alone, about 17 million tonnes of plastic waste are produced annually, mostly disposed of in open dumpsites (AUDA-NEPAD, 2021a). Consequently, plastic waste finds its way to rivers, lakes, and the ocean, threatening life on land and at sea.

However, political momentum and voluntary actions around the reduction of plastic waste have been growing in Africa. At UNEA 5.2 in 2022, countries agreed to an internationally legal binding instrument by 2024 to end plastic pollution. Several African countries have already banned plastic bags or single-use plastic, including Cameroon, Egypt, Eritrea, Mauritania, Senegal, and Botswana. Circular approaches and technologies aim to valorise plastics in circulation through recycling and reuse, finding environmentally friendly alternatives, and reducing plastics usage overall. Thereby, economic, social, and environmental benefits can be maintained while negative impacts are eliminated.

- **Keeping plastics in circulation:** Recycling and reuse are cornerstones of circularity in plastics for which functioning ecosystems for collection, separation, and recycling are required. Besides public sector-led schemes, private plastics collection and recycling services are emerging in several African countries that effectively use digital platforms and incentive models to increase the levels of plastics collection and recycling. RecyclePoints in Nigeria has created an incentive model to collect post-consumer waste directly from households. Other successful initiatives are Mr Green Trading Africa Limited in Kenya as well as Coliba Africa in Côte d'Ivoire which are both integrating informal waste collectors into their value chains and leveraging digital technology for plastics collection. The collected waste is then used to produce plastics feedstock for reuse. Plastics recycling plants are present across the entire continent. Plastic waste and feedstock are used in different manners, including for new plastic-based products or as construction material.
- **Development of biodegradable packaging:** While it is important to improve recycling, innovation needs to focus more upstream to stop waste from being created at the outset. Beyond regular synthetic packaging material, companies such as Hya Bioplastics in Uganda, EcoPack in South Africa, and Swetwise Pty Ltd. in Botswana produce recycled or biodegradable consumer packaging from plant fibres.
- **Reducing or eliminating plastics packaging:** Another option is to phase out the use of single-use plastic entirely. Refillable or returnable packaging can create more affordable products. Reuse models and deposit-return schemes (DRS) are growing in Africa, where there is great potential for reuse. In Tanzania and Kenya, refillables represent over 25 per cent of the sales portfolio of the Coca-Cola Company (Coca-Cola Company 2019). The South African i-Drop initiative has created "waterpods" that are self-service purified drinking water refill dispensers launched across several African countries. Connected to the main water supply, the in-built filtering system and Internet-of-things (IoT) device allow users to buy or dispense purified water using reusable bottles/containers.


Coliba waste collection box at a service station in Côte d'Ivoire.

## Low-carbon built environment technologies

Africa's urban population is projected to grow by an additional 950 million people by the year 2050 (OECD/SWAC 2020). Urban areas increasingly struggle to keep up with this growth, which leads to the establishment of informal settlements that often lack access to electricity, water, sanitation, and waste management. In Sub-Saharan Africa alone, about 4.5 million additional people are housed in informal settlements each year (World Bank 2015). The expected housing demand will drastically increase the need for building materials such as cement, iron and steel, the manufacturing of which contributes 11 per cent of total $CO_2$ emissions (African CE Alliance & Dahlberg 2021).

The application of CE principles and technologies in the built environment can reduce the use of virgin materials, increase material efficiency, and maximize the use of recovered construction materials, ultimately ensuring equitable access to housing services and a reduction of GHG emissions. The Ellen MacArthur Foundation claims that the "greatest circular opportunities in African countries lie in the design of buildings and infrastructure yet to be constructed" (Ellen MacArthur Foundation 2021a). In particular, improving design, consuming renewable energy, using recyclable materials, and constructing green buildings with better waste management systems are requirements for a circular built environment (Gibberd 2020). Two circular technology approaches are particularly promising in Africa:

- **Bioclimatic and modular building design:** Developing infrastructure and buildings in a way that integrates natural elements or responds to climate can significantly contribute to material efficiency and GHG emissions reductions. In South Africa, the Ecomo modular home uses timber frame construction instead of carbon-intensive construction materials, and is pre-fabricated and assembled on-site, minimising waste. Its carbon footprint is 50 to 55 per cent lower than that of buildings made of conventional materials, while the application of each cubic metre of a timber frame can sequester an average of 0.8 to 0.9 tonnes $CO_2e$ (Hoogzaad et al. 2020). Bioclimatic design through incorporation of vegetation (green roofs, green walls, green infrastructure), as well as biomimicry can improve energy efficiency, provide ecosystem services, and improve population health. The ABC 21 Africa-Europe Bioclimatic Buildings for XXI Century project highlights bioclimatic case studies across Morocco, Senegal, La Réunion, Kenya, and Sudan. There are also opportunities in earth construction using Compressed Earth Block Technologies with low-carbon applications, creating highly thermally efficient housing using local resources with RamBrick or Hydraform.
- **Usage of alternative and local building materials:** Reusing materials can save between 20 per cent and 95 per cent of their embodied energy (Australian Government 2022) and reduce waste and virgin materials usage. Several initiatives across Africa have commercialized alternative building materials based on recycling, repurposing, and upcycling of waste, such as MIPROMALO from Cameroon that promotes the use of local materials in construction, including the production and use of roofing tiles and stabilised earth bricks, the Kenyan MycoTile using agricultural waste and fungal mycelium, the first plastic brick factory in Côte d'Ivoire converting plastic waste into bricks based on a partnership between UNICEF and the Colombian social enterprise Conceptos Plasticos, and EcoAct Tanzania that is transforming post-consumer waste plastics, packaging materials, and agricultural waste into durable and environmentally friendly plastic lumbers for construction. Lastly, industrial symbiosis programmes, like the Western Cape Industrial Symbiosis Programme (WISP) in South Africa, can ensure closed material loops in industries through material remanufacturing for construction. Additional opportunities exist to use available waste resources in fly ash and slag to produce geopolymer cements or hybrid cement alternatives that offer up to 95 per cent lower embodied carbon.

Ecomo home modular design houses that minimise waste production in South Africa.

## Electronic waste management circular technologies

The growing consumption of electrical and electronic equipment (EEE) in Africa is strongly linked to economic development, fuelled by trends such as urbanization, industrialization, and a growing middle class. EEE has become indispensable in modern societies and is enhancing living standards, but its production and usage are very resource intensive. An increasing amount of e-waste is being generated due to short life cycles and few repair options. Africa also suffers from the import of used or obsolete EEE finding its way to the waste streams in an even shorter time (East African Communications Organisation 2017). According to the latest Global E-waste Monitor, Africa generated a total of 2.9 Mt of e-waste (2.5 kg per capita) in 2019 but only 0.9 per cent were collected and recycled (Forti et al. 2020). In addition, the great majority of e-waste flows are currently not even documented, which eventually leads to lower collection and recycling numbers. In the case of e-waste especially, clear targets for reuse rather than recycling are needed to avoid damage during disposal, among other issues. Valuable materials in electronic products include precious metals (e.g. gold, tantalum and silver) as well as non-hazardous components (including plastics, copper, and other metals). Only considering recycling as a value retention mechanism, it is estimated that the e-waste generated in Africa holds an annual value of USD 3.2 billion (Forti et al. 2020). Other CE options and value retention processes (VRPs) hold an even greater value, as they extend the life cycle of products. VRPs and recycling are not only economically beneficial but also reduce the environmentally damaging and pollutive extraction of new resources.

- **Targeting the entire e-waste value chain:** Tackling e-waste starts at the source with increasing the responsibility and accountability of producers. For that purpose, several African countries have adopted EPR schemes that raise recycling rates, reduce GHG emissions, create jobs, and create incentives for companies to design easily recyclable and repairable appliances. In this context, the E-waste Producer Responsibility Organisation Nigeria (EPRON) was introduced as a non-profit organisation set up by electrical and electronic producers in the country to ensure safe management of WEEE. EPRON is a platform to share knowledge on CE approaches and introduce levies to adequately finance the collection and treatment of WEEE.
- **Value retention processes for e-waste:** E-waste management technologies in Africa are evolving with efforts such as those led by E-Terra Technologies Limited in Nigeria, the WEEE Centre in Kenya, SetTIC Senegal, and the evolving ability to collect e-waste from companies, NGOs, government, and individuals, while repairing what can be repaired, upcycling, recycling, or extracting its valuable components for reuse. This may also involve the use of digital solutions in e-waste management and recycling value chains to enhance efficiency.
- **Recycling of solar panels:** An emerging topic for circularity in e-waste is the repair and recycling of solar panels. Besides extracting valuable material from solar PV waste, effective recycling and reuse is important to prevent hazardous content from reaching soil and water streams. Solar PV panels have a life expectancy of between 20 and 50 years. IRENA estimates that global PV waste streams will grow from 250,000 tonnes at the end of 2016 to more than five million metric tonnes by 2050 (IRENA 2021). Beyond repair, effective waste management systems for solar PV have yet to be established in Africa. So far, only a few recyclers such as the South African Reclite are active in this area.

EPRON: Processing of the box TV sets at the E-terra Technology Recycling Facility in Nigeria.

## Fashion and textiles sector circular technologies

Cotton and textile production plays a historical role in Africa and is gaining traction again alongside the biggest textile-producing countries in South-East Asia. Currently, in sub-Saharan Africa, the combined apparel and footwear market is estimated to be worth USD 31 billion (Mordor Intelligence 2021). However, the exponential global consumption of fashion, and in particular fast fashion, leads to the disposal of millions of tonnes of textiles each year, a considerable quantity of which are shipped to Africa for a second life. In Accra, Ghana alone, some 15 million used garments arrive every week, but an estimated 40 per cent are of such poor quality that they are deemed worthless on arrival and end up in local landfills (Linton Besser 2021).

Circular approaches in the textiles industry have the potential to extend lifecycles, reuse waste material, and introduce garment substitutes that are more durable and sustainable. But circular business models in this industry are by no means new in Africa – they are culturally embedded, as there are significant know-how and skills among tailors, fashion designers, and other entrepreneurs across the continent who create, remake, and repair clothes daily, generating employment across formal and informal sectors.

- **Textile recycling technologies:** Textile waste can be placed into recycling loops again to produce fibres for a variety of purposes. The South African company Rewoven bridges the gap between fashion & sustainability by diverting textile waste from landfill to be reused for the production of fibres and textiles. Sharabati Denim in Egypt is an integrated and eco-friendly denim and flat fabric manufacturer who recycles pre-consumer cotton at its Tadweer recycling plant.
- **Extending the lifetime of textiles:** Giving fashion products of good quality a second life can reduce textile waste and generate economic opportunities for individuals. Companies like Lukhu in Kenya and Yaga in South Africa are developing a social app for buying and selling fashion.
- **Usage of alternative fibres:** Diversifying the material used for fibre production can reduce waste and lower the burden on ecosystems to ensure a regenerative production of cotton. Promising alternatives are being developed by the Ugandan Texfad that uses banana leaves and by Salubata in Nigeria, which makes use of plastic waste for garment production.

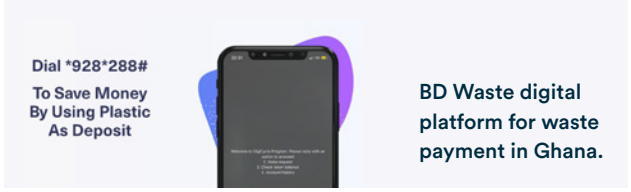
Circular Sharabati Denim fashion worn in front of textile to be recycled at the Tadweer recycling plant in Egypt

## Digital technologies for circularity

The application of digital technologies advances opportunities for CE across industries from food to recycling to fashion. Digital technologies, such as artificial intelligence, internet of things (IoT), blockchain, and digital marketplaces could lower costs, increase efficiency, and enable transparency, leading to a reduction in waste and the creation of economic value.

The foundations for a digital transformation in Africa are being set. Today, more than 80 per cent of Africa's population has a mobile phone subscription (International Telecommunication Union (ITU) 2020) and the digital economy is one of the main drivers of growth in several African countries. The potential of digital technologies to further circularity in Africa is mainly recognized in the following areas:

- **Digital platforms for waste collection/trading:** Digital marketplaces are used to support the trade of secondary raw materials. These platforms allow secondary material suppliers and buyers to find each other on a web-based application. This can create more market liquidity and provide more supply and demand security for recyclers and their customers. For example, DigiYard (Arup) from South Africa is currently developing an app-based service connecting unused construction site materials and waste with small-scale builders and traders in the informal sector, closing construction waste loops. Other digital platforms directly target households and provide waste collection services with monetary incentives, such as Bekia and Plstka in Egypt, or BD Waste in Ghana.
- **Information provision:** To eliminate waste, it is important to understand the product composition and lifecycle, from where a product is sourced to where it goes after use. Currently, information is rarely shared along value chains, and as a result, most stakeholders do not have access to key product data. Product and information tracing technologies help track materials so they remain in play, also helping to enable their repair or recycling at the highest value-retention level. The South African Recycling Platform Kudoti designs and Basadi Solutions develop digital solutions along value chains for waste tracing, trading, and tracking.




BD Waste digital platform for waste payment in Ghana.

# 4. The Role Of The CTCN in Supporting Circular Economy in Africa

This chapter presents and analyses past and ongoing activities of the UN Climate Technology Centre and Network (CTCN) in CE in Africa.

As mandated by the UNFCCC, the CTCN provides technical assistance, capacity building, and knowledge sharing on environmentally sound technologies for low carbon and climate resilient development to developing countries. Its support spans the entire technology development cycle (research and development, identification and prioritization, feasibility studies, and piloting), with a specific focus on creating favourable enabling environments for technology adoption through policy development, private sector engagement, and financing facilitation.

The CTCN has received a steadily growing number of technology assistance requests related to the CE, which represents an important area for both climate change mitigation and adaptation. As described in Chapter 3, technology is an essential building block of the CE, whether it is to unlock economies of scale in recycling, find new use cases and markets for waste streams, or create more efficient collection and distribution networks. The CTCN is in a unique position to transfer CE-related technologies and knowledge. Considering the cross-cutting nature of the CE concept, CTCN activities in this area are rarely limited to waste management, but rather extend into related sectors such as energy, infrastructure, agriculture, and industry. The holistic support along the technology development cycle also allows for a variety of different projects that are tailored to the specific requirements of each country. Projects are implemented at local through regional levels, meaning that the CTCN is engaged in implementing pilot projects in local contexts while also facilitating coordination efforts for interdependent waste streams and production systems among neighbouring countries. For the implementation of technical assistance, the CTCN relies on its network of more than 720 implementation partners who possess expertise in a wide range of different CE domains. The Centre also hosts one of the biggest information platforms on climate technologies, including resources linked to CE.

To date, the CTCN has implemented close to 20 CE-specific technical assistance projects globally, eight of which are in Africa. Recent progress has led to innovations such as methane capture for biogas and waste-to-energy technologies, as well as ambitious CE roadmaps for specific high-potential waste streams. The technical assistance cases highlighted below illustrate some of the past and ongoing successes in the application of CE technologies, differentiated between projects supporting the CE enabling environment and those focusing on CE technology development.

## Supporting the circular economy enabling environment

As identified in Section 2, most barriers limiting the adoption of a CE are not actually related to the unavailability of certain technologies, but rather to the enabling environment that is required for scaling these technologies. A supportive and enabling environment is essential for CE technology innovation and implementation. Enabling environments include both formal (such as policies and regulations, governance structures, investment programs, and innovation support) and informal elements (such as social, cultural, and economic norms, rules, and practices).

In Africa, policy and regulatory gaps are often the easiest to identify and yet the most laborious to overcome due to the multitude of stakeholders involved and potential conflicts of interest. Cultural aspects with regard to awareness of value retention and waste management strategies are equally fundamental. Moreover, regional coordination between neighbouring countries, waste systems, and production industries is vital for the uptake of CE technologies.

The CTCN is implementing a series of projects focusing on the development of waste-stream specific CE roadmaps with the aim to establish action plans for CE transitions, including regulatory, governance, capacity building, and technology adoption initiatives. The objective is to create a common ground for potential CE benefits, to systematically build a CE to reduce GHGs and waste, and to create new economic activities and jobs. Initially, a regional project including five countries was foreseen in East Africa, but given the different priority sectors and stages of CE advancement, regional coordination proved difficult. Therefore, individual projects were taken forward on a national level. A selected group of projects with a focus on e-waste infrastructure in Kenya, organic household waste in Zimbabwe, and educational programmes in Côte d'Ivoire is detailed below.

KENYA

# Development of an action plan to improve the circularity of large household appliances in Kenya


**LOCATION**
Kenya, nation-wide

**STATUS**
Completed

**TYPE OF CE**
Waste management infrastructure, value-retention processes (VRP), waste from electric and electronic equipment (WEEE), large household appliances (LHHA) waste

**TIMEFRAME**
May 2021 – April 2022

**APPROACH**
Governance and planning, economics and financial decision-making, communication and awareness

**IMPLEMENTED BY**
The Netherlands Organisation for Applied Scientific Research (TNO)

**BENEFITS**
Reduced WEEE, creation of new economic activities, reduced GHG emissions

**SCALE-UP**
Upgrade of management infrastructure for WEEE, implementation of a pilot project

**MORE INFORMATION**
https://www.ctc-n.org/technical-assistance/projects/developing-circular-economy-roadmaps-abating-ghg-emissions-waste-2

In considering recycling only as a value retention mechanism, the e-waste generated in Africa has been estimated to hold an annual value of USD 3.2 billion. Other VRPs hold an even greater value, as they extend the life cycle of products. VRPs and recycling are not only economically beneficial, but also reduce the environmentally damaging and pollutive extraction of new resources. Currently, the steel industry accounts for 7-9 per cent and the plastics industry for about 2 per cent of global $CO_2$ emissions. According to recent studies, steel production based on recycling would emit 87 per cent less GHG emissions compared to production based on extraction. Similarly, plastics production based on recycling would emit 37 per cent fewer GHG emissions than primary production.

Kenya is the most industrially developed country in East Africa, and its usage of EEE has grown rapidly alongside its economic development and rising living standards. Subsequently, e-waste has also increased. The country lacks a sufficient e-waste infrastructure, and most existing recycling and waste picking activities are informal.

The CTCN, in collaboration with TNO and SIB-K, provided a detailed e-waste infrastructure analysis that identified current and future infrastructure gaps, assessed informal and formal practices, and provided the foundation for a concrete action plan addressing the improvement of e-waste management infrastructure.

The action plan outlines an effective roll-out for the upgrade of current processes and infrastructure while presenting opportunities for circularity. Recommendations are structured along the short-, medium-, and long-term and target, inter alia, the implementation and enforcement of EPR policies, the inclusion of the informal sector, and the enhancement of infrastructure and up-stream extension to better value retention processes. Furthermore, a business model for a pilot project has been developed, recommending digital platforms for e-learning and knowledge sharing, as well as to connect households, collectors, repair shops, and recycling facilities. It is proposed that the business model be implemented in a phased manner.

ZIMBABWE

# Developing a sector-specific circular economy roadmap for abating GHG emissions from the waste sector in Zimbabwe

**LOCATION**
Zimbabwe, nation-wide

**STATUS**
Completed

**TYPE OF CE**
Waste-stream specific CE roadmap, organic waste

**TIMEFRAME**
February 2021 – April 2022

**APPROACH**
Governance and planning, economics and financial decision-making, communication and awareness

**IMPLEMENTED BY**
The Netherlands Organisation for Applied Scientific Research (TNO)

**BENEFITS**
Reduced GHG emissions, increased renewable energy

**SCALE-UP**
Improvement of organic waste circularity, implementation of pilot project

**MORE INFORMATION**
https://www.ctc-n.org/technical-assistance/projects/developing-circular-economy-roadmaps-abating-ghg-emissions-waste-1

Owning to its wealth in natural resources, Zimbabwe's economy is dependent on sectors that are contributing to the current linear model, with key industries in mining, steel, cement, and agriculture. The country has focused on the extraction and partial processing of these resources, generating little economic benefit and significant environmental degradation, while neglecting industrial activities that could generate added value and hindering industrial development based on technology and innovation. Zimbabwe also generates up to 3 kg of waste per capita daily in urban areas, which largely exceeds the global average.

Zimbabwe has implemented first public policies and private initiatives towards integrated waste management and a CE. These have been characterized mainly by regulations, programs and initiatives contributing to the establishment of a framework for waste management that has promoted recycling, recovery, and reuse to protect the health of its citizens and the environment. However, lacking and asymmetrical information regarding the actors and circular initiatives under development and their potential benefits and existing barriers have also been underpinned by coordination failures. Zimbabwe requires a national strategy for a CE that collects and systematizes experiences, provides information on existing benefits and barriers, defines objectives and establishes clear goals, and identifies and launches promising pilot projects.

The CTCN together with its network members TNO and SIB-K have supported Zimbabwe by developing a waste stream-specific road map for the CE. After a baseline analysis of different inorganic and organic waste streams, organic household waste was prioritized for the roadmap and pilot project, as it is the largest waste stream and shows the highest CE potential as demonstrated by a multi-criteria analysis. The following circularity analysis uncovered key challenges and gaps within organic household waste for knowledge, physical infrastructure, stakeholder collaboration, and institutional capacity.

The strategic national roadmap intends to guide the country's transition to a CE in organic waste management with clear short-, medium-, and long-term targets, including, inter alia, the improvement of inter-institutional collaboration; the inclusion of the informal sector, women and entrepreneurs; the improvement of collection levels; investments in R&D and innovation; and the introduction of incentives for market development and local trade. A pilot project was also conceptualized that suggests the establishment of a facility producing compost and organic fertilizer on a commercial scale from a mixture of household organic waste and agricultural waste to provide a large-scale solution for Zimbabwe's vast volumes of domestic organic waste.

CÔTE D'IVOIRE

# Identification and dissemination of technologies and practices for the transition towards a circular economy

Coliba agent at a waste collection location in Côte d'Ivoire.

**LOCATION**
Côte d'Ivoire, nation-wide

**STATUS**
Completed

**TYPE OF CE**
Waste-stream specific CE roadmap

**TIMEFRAME**
August 2021 – October 2022

**IMPLEMENTED BY**
Trinomics, ACEN Foundation

**BENEFITS**
Reduced GHG emissions, increased renewable energy, increased awareness, increased education and skills

**SCALE-UP**
Improvement of waste-stream specific circularity, implementation of pilot project, roll-out of educational programmes

**MORE INFORMATION**
https://www.ctc-n.org/technical-assistance/projects/identification-and-dissemination-technologies-and-practices

Côte d'Ivoire is experiencing a sharp increase in urban waste production linked to population growth and economic development. According to the Ministry of Sanitation and Hygiene, the annual production of solid household and similar waste is estimated at 3,000,000 tonnes, of which only 70 per cent is collected. In the city of Abidjan (the economic capital) alone, the daily production of household waste is 3,000 tonnes, leading to a total annual production of 1,080,000 tonnes. Similarly, as an agricultural country, Côte d'Ivoire produces large quantities of agricultural waste, which is unfortunately abandoned in the countryside. It is estimated that between 15 and 17 million tonnes of agricultural waste are produced each year. All this waste is a source of GHG emissions estimated at 1,582 kilotonnes of CO2 equivalent out of a total of roughly 16,000 kilotonnes nationally, or 10 per cent of the country's total emissions, according to its 2015 NDC.

The government of Côte d'Ivoire has affirmed its commitment to the fight against climate change and the transition to a CE through several initiatives and interventions in the waste sector. However, the transition is still hampered by a set of obstacles related mainly to a lack of knowledge, the absence of a specific institutional framework and governance, a lack of funding, and an educational deficit. A CE strategy is currently being developed in Côte d'Ivoire. In order to operationalize this strategy, and with the assistance of the CTCN and its implementing partners Trinomics and ACEN Foundation, Côte d'Ivoire has developed a CE roadmap. This roadmap collects and systematises experiences, provides information on existing benefits and barriers, defines objectives and sets clear goals, identifies best practices, and evaluates their impacts. The CE roadmap sets a focus on organic waste, plastic waste and WEEE, and highlights clear actions to be taken that reach from policy development, governance and collaboration, capacity building, financing and incentives, RD&D and technologies, all the way to infrastructure implementation. Furthermore, a key aspect of the project was to integrate the CE concept into educational programmes to teach the next generation about the importance of CE and the opportunities it provides to foster innovation, entrepreneurship, and job creation. Recommendations on education programmes are integrated into the CE roadmap.

## Supporting circular economy technology development

The technological and economic viability of CE technology options varies markedly depending on their stage of development and the specific requirements of communities, enterprises, and countries to develop and adopt them. High investments costs for R&D and/or implementation, as well as technology and infrastructure lock-in effects render decisions about circular technology pathways even more sensitive. The public sector seeks out CE technologies that are cost efficient, while the private sector is motivated by those that demonstrate a clear business case.

The CTCN has been instrumental in promoting CE technology development and adoption at different stages and geographic scales. However, it should be noted that CTCN technology development ends at the stage of piloting, meaning that the full-scale implementation of larger technology and infrastructural projects is outside the scope of the CTCN's support. The CTCN technical assistance cases presented in this section depict an evaluation of energy supply from waste in cement factories in Mozambique, capacity building for sustainable briquette value chains in The Gambia, and a feasibility study for anaerobic digestion of the organic fraction of solid wastes in Mauritius.

MOZAMBIQUE

# Feasibility study to use waste as fuel for cement factories in Mozambique

**LOCATION**
Mozambique, industry-based

**STATUS**
Completed

**TYPE OF CE**
Waste management, refuse derived fuel (RDF), cement industry

**TIMEFRAME**
Submitted 04/2015

**APPROACH**
Technology feasibility
(technical, economic, and regulatory)

**IMPLEMENTED BY**
UNEP DTU Partnership

**BENEFITS**
Identification of requirements for RDF feasibility, reduced GHG emissions

**SCALE-UP**
Improvement of solid waste management practices

**MORE INFORMATION**
https://www.ctc-n.org/technical-assistance/projects/feasibility-study-use-waste-fuel-cement-factories-mozambique

MSW management is a growing problem in Mozambique. It is estimated that Mozambique generates 2.5 million tonnes of MSW per year, of which organic waste constitutes 60 per cent. The destination of solid waste in Mozambique is mostly open bins and uncontrolled dumpsites, with little or no waste treatment. Simultaneously, the cement industry has been developing rapidly in recent years. The cement manufacturing process requires extremely elevated temperatures, which consume about ten times more energy than the average amount required by other manufacturing processes. Mozambique's Ministry of Earth, Environment and Rural Development requested support in assessing the technical and financial feasibility for utilisation of MSW as refuse derived fuel (RDF) to power its cement factories.

The CTCN and its network member UNEP DTU Partnership conducted a detailed feasibility study to assess using waste as fuel for cement factories.

This included:

- a technical feasibility study on the potential and requirements for applying RDF at cement factories;
- an economic feasibility study of such fuel and its usage in cement factories;
- an assessment of the current legal and regulatory framework for promoting waste to energy; and
- the development of a measuring, reporting and verification system covering the production and use of RDF in cement factories, quality aspects, and GHG emissions.

The feasibility study indicated that it is technically feasible to produce a medium-quality RDF from the unsorted MSW generated in Maputo. However, the final RDF would not be able to meet the calorific requirements of the cement industry. Additionally, the use of MSW for RDF production would not be economically feasible, even if the cement industry were to lower its calorific requirements for RDF. The sale of RDF would not provide enough revenue, as RDF would have to compete with natural gas, which is currently the main fuel utilized. The NPV (after taxes and debt services) of and RDF facility for unsorted MSW is estimated at USD 8,590,795.

The economy of the RDF plant could be improved if Mozambican authorities introduced a gate fee/waste handling tariff for waste disposal, thus providing a potential additional revenue stream for the production of RDF. Redirecting the focus of the project to other MSW treatment options and/or their combination with RDF would provide different sources of revenue, probably with better prices than both RDF and natural gas, and with more developed markets (for instance: recyclable materials (plastic, metal, glass, etc.), compost, electricity, heat recovery, etc.).

Lastly, the existing legislation addresses waste to energy only superficially, but the waste management principles are compatible with processing MSW in RDF to be used by the cement industry. Specific goals targeting GHG emission reductions, rate of use of alternative energy sources or replacement of fossil fuels, as well as material recovery targets should be included in national strategies for the relevant sectors more generally, including the cement sector in Mozambique.

In summary, it was evaluated that the production and usage of RDF has the potential to reduce about 23,000 $tCO_2e$/year by 2040. However, its application will require enhanced waste management, financial support in order to be technically feasible and financially viable, and the development of targeted regulations.

GAMBIA

# Improving capacity for recycling of waste & organic materials

**LOCATION**
Gambia, nation-wide

**STATUS**
Completed

**TYPE OF CE**
Technology for waste management, infrastructure, cooking and heating, plastic recycling

**TIMEFRAME**
January 2017 – March 2019

**APPROACH**
Community-based, capacity building

**IMPLEMENTED BY**
ECO Consult Sepp & Busacker Partnerschaft; Gambia Technical Training Institute

**BENEFITS**
Increased awareness of the importance of CE, reduced GHG emissions from the waste sector, reduced deforestation and degradation, low rates of carbonation

**SCALE-UP**
Effective CE training and implementation (ultimately reaching an adequate level of sustainability)

**MORE INFORMATION**
https://www.ctc-n.org/technical-assistance/projects/improving-capacity-recycling-waste-organic-materials

The Gambia is among the poorest countries in the world with a per capita GDP of USD 473 in 2016 and nearly 40 per cent of the population living on less than USD 1 per day. Agriculture and services are the largest sectors: agriculture provides 25 per cent of GDP and employs roughly 70 per cent of the work force, while the service sector contributes 60 per cent of GDP.

A vast majority of Gambians rely on firewood or charcoal for cooking. Charcoal consumption is growing due to population growth, urbanization, and a dearth of alternatives, despite the commodity being officially banned. While a part of the demand is being met through illegal trade from Senegal, charcoal production is still contributing to the degradation of Gambia's forests, although generally as the result of agricultural expansion to meet the growing population's needs for food and other natural resource-based products.

There are significant opportunities to meet some of the energy and livelihood requirements by utilizing waste materials that are generally either not collected or dumped at a small number of designated yet entirely uncontrolled sites which pose significant health and groundwater contamination risks. Burning is the only way of controlling the accumulation of inorganic materials and uncontrolled decay of organic waste.

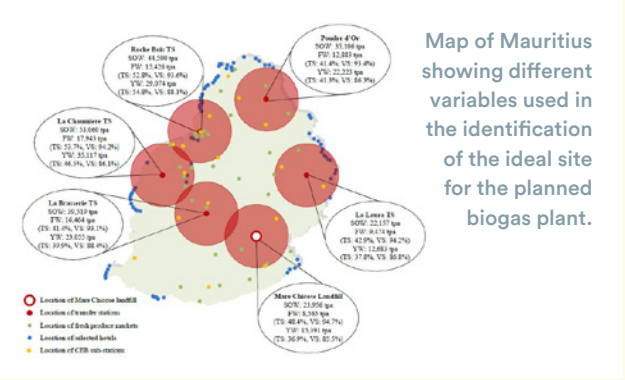
For the past eight years, the Women's Initiative Gambia (WIG) has been working with women's groups to transform by-products of fishery, coconut, and groundnut production into valuable resources. By training the CBOs in charcoal production, preparation of fishmeal for chickenfeed and composting, business management, entrepreneurship, and environmental awareness and protection, WIG is offering a highly valued and sought-after solution to improving livelihoods, managing waste, and reducing the need for wood fuels.

However, given the great lack of information on the availability and amount of waste materials, demand for energy, extent of forest degradation from fuel wood production, and need for capacity development, it is very difficult to assess the scalability of the activities for generating income or the potential impact of efficient technologies on reducing the pressure on forests.

In this context, The Gambia requested CTCN technical assistance to develop a sustainable waste management value and supply chain for energy and livelihoods that can be scaled up to the national level, with a focus on local women's groups. Together with its network member ECO Consult, an in-depth analysis of the fuelwood, charcoal, and agricultural residues sectors was conducted, a competitive briquette value chain compared to traditional fuels was established, and training on the production and use of briquettes was provided. In total, 316 women and 6 men from 17 communities were trained. It was estimated that about 32,500 tonnes of $CO_2e$ will be avoided each year by using briquettes instead of charcoal.

MAURITIUS

# Feasibility study of anaerobic digestion of the organic fraction of solid wastes in Mauritius



Map of Mauritius showing different variables used in the identification of the ideal site for the planned biogas plant.

**LOCATION**
Mauritius, nation-wide

**STATUS**
Completed

**TYPE OF CE**
Organic waste, waste-to-energy, anaerobic digestion, biogas

**TIMEFRAME**
April 2021 – April 2022

**APPROACH**
Technical and economic feasibility study

**IMPLEMENTED BY**
Council for Scientific and Industrial Research (CSIR), South Africa

**BENEFITS**
Reduced GHG emissions, reduced organic waste, increased generation of renewable energy, job creation

**SCALE-UP**
Construction of the biogas plant

**MORE INFORMATION**
https://www.ctc-n.org/technical-assistance/projects/developing-circular-economy-roadmaps-abating-ghg-emissions-waste-3

Mauritius is facing challenges related to its management of solid waste and heavy dependence on fossil fuels to meet energy requirements. Economic growth, urbanization, and improved living standards coupled with changes in consumption patterns have created an unsustainable waste situation. Over the past 10 years, solid waste generation has been increasing at an average annual rate of 2.8 per cent, reaching almost 540,000 tonnes in 2019. More than 60 per cent of the solid waste in Mauritius is organic, mainly coming from households, markets, and agriculture.

Large waste quantities are rapidly filling landfills and producing methane, an extremely powerful GHG. Alongside this issue, Mauritius is heavily dependent on fossil fuels, which are being used to meet 87 per cent of the country's total primary energy requirement.

With its only existing landfill, Mare Chicose, rapidly reaching saturation, Mauritius has identified anaerobic digestion as a promising solution for the organic fraction of the MSW, a process during which biogas is used as an electricity source while digestates can also be generated to use as organic fertilizer. The treatment of organic waste through anaerobic digestion is considered a highly beneficial alternative to landfill disposal that can also contribute to reduced GHG emissions and reliance on fossil fuels.

The CTCN, together with its Network member the Council for Scientific and Industrial Research (CSIR) South Africa and the University of Mauritius, supported the Solid Waste Management Division under the Ministry of Environment, Solid Waste Management and Climate Change, with a study on the technical and economic feasibility of anaerobic digestion of the organic fraction of solid wastes in Mauritius, specifically focusing on waste from markets, households, and hotels. The initial baseline analysis on the current value chain and the quantification of organic waste provided transparency on collection, transportation, treatment, and ultimate organic waste disposal, as well as the total quantity of the solid organic waste fraction. The following anaerobic digestion analysis determined the biogas/methane production potential from the solid organic fraction waste, including the electricity generation and heat recovery potential from 100 tonnes/day (30,000 tonnes/annum) anaerobic digestion of food waste supplemented by yard waste. The biogas plant could produce 42,270 kWh/day of electrical energy, which would supply about 32,000 individuals with electricity, equating to a savings of 16,500 tonnes of $CO_2$/year (corresponding to 330,000 tonnes of $CO_2$ over a 20-year lifetime).

Furthermore, CSIR screened different anaerobic digestion technology options and identified a continuous Single-Stage High Solids (SSHS) system as the most suitable, adding to it other relevant infrastructure and cost estimations. Potential sites for the future biogas plant were identified based on site accessibility, extent of land available, waste supply, and connection to the grid network. Subsequently, a design of the plant including flow diagram, isometric diagrams, and sizing of the units was developed. Having evaluated different revenue models, the economic feasibility study has demonstrated high initial investment costs (USD 12.5 million) but relatively low operating expenses. Finally, an implementation plan was developed and a public-private partnership proposal was prepared that outlines the general arrangements with key stakeholders.

This chapter has illustrated the role of the CTCN in promoting CE in Africa through technology and knowledge transfer. The fostering of favourable enabling environments in Kenya, Zimbabwe, and Côte d'Ivoire supports the development of roadmaps and action plans that lay out concrete regulatory, technological, and capacity building recommendations to advance CE in specific waste streams. Each of the projects includes a contextual focus area like education (Côte d'Ivoire), household capacity building (Zimbabwe), or public-private sector coordination (Kenya). The CTCN has assisted African countries at different stages of the technology development cycle, as demonstrated by the feasibility studies in Mozambique and Mauritius, and capacity building on technology adoption in The Gambia.

Thereby, the CTCN was able to overcome some of the barriers identified in Section 2 to harness the climate mitigation and adaptation potential of CE technologies. The CTCN will continue to support the acceleration of the CE transition in Africa, recognizing the following lessons for future CE technology support:

1. **Importance of the enabling environment:** The uptake and success of CE technologies is dependent on a functioning ecosystem of enabling factors including regulations, awareness, and public-private sector collaboration. The CTCN's experience in Africa has shown that these factors are highly country specific.
2. **Relevance of regional coordination:** Even though a contextual approach is essential, coordination at a regional level is needed to identify CE opportunities that connect and harmonize waste management strategies and to produce industries that extend across borders and foster knowledge exchange.
3. **Context-sensitive CE technology implementation:** There are no one-size-fits-all CE technologies and decisions regarding certain circularity pathways are sensitive due to technology lock-in effects. A comprehensive analysis to identify and evaluate promising CE technologies is paramount for successful implementation and operation.
4. **Preparation for CE technology scaling:** Even though the CTCN's mandate does not include the implementation of technology and infrastructure projects, a particular focus needs to be set on creating potential for CE technology scale-up through piloting, financing facilitation, or preparation.


SPEAKERS

# 5. Key Insights and Recommendations

## The momentum of CE should be harnessed through mainstreaming and harmonizing the concept across economic sectors and development strategies.

Mainstreaming and integrating CE principles into economic growth and development strategies is essential to realize the full potential of CE practices on the continent. This is 'the moment' on which to capitalize, as demonstrated by recent developments like the 2022 UNEA 5 resolution to draft a legally binding plastic treaty, the growing number of CE initiatives and coalitions regionally, and the early strides taken by African countries in passing regulations and laws banning single-use plastics. This has been spurred by a focus on the SDGs, the green economy, and several COVID green recovery plans. CE can be mainstreamed and integrated as a fundamental component of economic development. An increasing focus on seizing synergies among the SDGs, NDC, MEAs and development planning processes facilitates the harmonization of policies and M&E frameworks. CE can play a role in helping to meet climate action and sustainable development objectives and in streamlining efforts to do so, as the concept receives attention for both climate mitigation and adaptation, as well as biodiversity.

Africa is on a strong growth trajectory (i.e. two thirds of the infrastructure investment needed by 2050 is not yet built), and the time to usher in CE is now. CE can propel Africa's development. Circularity provides a framework for the development of new economic activities, providing these benefits while simultaneously addressing urgent environmental issues. Economic growth provides an opportunity to rethink business models and promote CE solutions.

## Taking a multi-stakeholder approach is critical to operationalize the CE concept along product and waste supply chains.

The CE concept requires a rethinking of production and consumption systems in Africa involving a multitude of local, national and regional stakeholders. Private sector institutions are responsible for material usage and waste generation, but are also drivers of innovative CE solutions and market creation. Therefore, private sector engagement is critical. Regulations through the public sector to create transparency and accountability are essential, and local governments play a great role in the operationalization of CE given that most of the waste in Africa is MSW. However, there is a tendency to work "in silos" which causes information asymmetry and a lack of clear responsibilities that ultimately slows down the transition to a CE and leaves out important economic opportunities.

Coordination and communication between multiple stakeholders are essential and a few existing initiatives have proven highly successful. These include inter-ministerial working groups to tackle the cross-cutting nature of CE, producer organizations that join forces to introduce holistic end-of-life collection and recycling systems, and the growing number of Africa's regional alliances and partnerships that provide platforms to create peer-to-peer learning, allow south-south-cooperation, enable information exchange, raise awareness among practitioners and the public, and contribute to changing behaviour and increasing the adoption of sustainable waste management practices.

## Context-sensitive deployment of CE technologies with the required enabling environment can accelerate the transition to a CE in Africa.

Technologies are being harnessed across all sectors in Africa to enable circularity at different stages of product and waste supply chains. Some of the most promising sectors for CE in Africa include food systems, built environment, textiles, e-waste, and packaging. Prominent solutions reach from 'hard' technologies such as material recycling facilities to 'soft technologies' like digital waste and material marketplaces, as well as from low-technology solutions such as composting to high-technology solutions like biomimicry in construction. Interventions beyond technology deployment are also needed, including favourable taxation schemes.

However, the coverage of CE technologies in Africa is still sparse with only a handful of countries leading by example. Limited technology implementation is mainly due to differing levels of economic development and investment capabilities, a lack of financial and technical viability of technology solutions in certain contexts, knowledge gaps, and a lack of national and local enabling environments. To overcome some of these barriers and achieve a successful circular transition in Africa, it will thus be important to systematically provide context-sensitive technology transfer, and build enabling environments that foster CE technology RD&D, endogenous innovation capabilities, stakeholder collaboration, and ease of doing business for investment.

## Gender and youth are essential stakeholders in African CE efforts and increasing their involvement benefits CE development.

Emphasizing gender equality is a win-win and can help CE policies succeed and 'catch on' as the benefits accrue to women, who have been exposed to challenging working conditions in the waste and fashion sectors in particular. CE policies can capitalize on this synergy to meet gender equality and gender equity goals. Focusing on youth is a great investment with a potentially large return, as the population in Africa is disproportionately young and eager to take on sustainability issues.

Education is a critical component of an enabling environment that must be nurtured on the continent. A university, secondary, and general educational curriculum focus on CE is still lacking in Africa. Integration of CE principles into the curriculum is needed to enhance awareness, spur research programs, familiarize future leaders with emerging concepts, and to foster innovation, entrepreneurship, and job creation. Universities and research centres need to prioritize CE.

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1 According to Stahel, 'doing things right' refers to approaches that solve problems (e.g. waste generation) in order to reduce environmental impacts. He was critical of these approaches, since they don't address the source of the problem (though they do lead to the development of end-of-pipe solutions (e.g. recycling, clean-tech)). These solutions have reduced waste generation, for example, through more efficient recycling, but Stahel criticized this approach for its lack of systemic solutions that might also provide greater potential for wealth and job creation.

2 Extended Producer Responsibility is a concept where manufacturers and importers of products should bear a significant degree of responsibility for the environmental impacts of their products throughout the product life-cycle, including upstream impacts inherent in the selection of materials for the products, impacts from manufacturers' production process itself, and downstream impacts from the use and disposal of the products. Producers accept their responsibility when designing their products to minimise life-cycle environmental impacts, and when accepting legal, physical or socio-economic responsibility for environmental impacts that cannot be eliminated by design (OECD: https://www.oecd.org/env/waste/factsheetextendedproducerresponsibility.htm).

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