A Circular Economy Guideline for the Waste Sector

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ABOUT THE STUDY

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Executive summary

This guideline focuses on the transition to a circular economy (CE) in the waste sector in South Africa. The guideline places emphasis on materials flow and the materials value chain, which is just one aspect of a wider circular economy. A circular economy approach, in turn, is just one of several ways to achieve a green economy through sustainable consumption and production. The guideline provides an entry point for understanding the many opportunities and potential benefits that a circular economy may provide for South Africa. It also concludes that an enabling policy and regulatory environment in South Africa, would be able to support the implementation of a circular economy.

Consideration of the South African waste economy shows that the potential contribution to Gross Domestic Profit (GDP) is significant if the materials currently being lost to landfill, can be recovered and beneficiated. Several of the CE initiatives discussed in the guideline are geared towards employment creation, new business development and socio-economic upliftment. There are also environmental benefits associated with circular systems: a waste-free environment, resource conservation, pollution prevention, and greenhouse gas (GHG) emission reduction. There are even more prospects available if the current waste management practices, mind-sets and consumptive patterns can be transformed and the vision of a circular economy, embraced and realized.

The guideline identifies opportunities for adopting circular practices along the materials value chain, from resource extraction, processing, eco-design of products, production, and consumption to beneficiation, with associated benefits of new work opportunities, more efficient and sustainable use of materials and innovative changes to the way materials are managed and shared. Many existing greening initiatives which apply circular economy principles and practices are already being implemented in South Africa. Such initiatives include resource-efficient and cleaner production (RECP) methodologies that lower costs through reduced energy, water and materials usage, eco-innovation, a value chain-based approach to improve sustainability and value retention across the entire life cycle of products, and waste minimization and industrial symbiosis programmes that minimize waste and improve the circularity of material flows among participating industries.

The transition to a circular approach requires a shift away from current wasteful practices, driven by a consumption-focused economy, towards separation of material flows at source, to retain their value and maximise their beneficiation potential, to keep biological and technical materials circulating at highest value within the economy.

One of the requirements is for municipalities to improve basic collection services to ensure that waste materials do not “leak” into the environment. Collection and processing of materials along the value chain present both informal and formal work opportunities and associated enterprise development. Recycling is recognized as having strong potential for employment creation, given that nearly 90% of waste, still containing a high recyclable content, is landfilled in South Africa.

Informal waste picking activities, while prevalent, are associated with hazardous working conditions. Inclusive opportunities for decent work in the waste management sector must be maximized along the entire value chain, i.e. from recovery at source to waste beneficiation.

Biological materials make up a large proportion of the waste materials which are currently being disposed to landfill. Improving the diversion of organics from landfill will result in a significant saving of scarce airspace as well as reduction of GHG emissions, odours and leachate. The organic fraction can be diverted into a range of different technologies that include (aerobic) composting, anaerobic digestion, biogas to energy generation, bio-refining to produce high value products (fuels, animal feeds), pyrolysis, and co-incineration. Some of these technologies are more appropriate for a developing country context than others.

Non-biodegradable, technical materials that include metals, plastics, and bulky industrial waste streams (ash, Construction and Demolition materials) can be diverted from landfill by extending the life of these technical materials through maintaining functionality, repair, re-use, refurbishing, re-manufacturing and recycling. Within the private sector, many emerging initiatives within the private sector that improve opportunities for maintenance, especially of items such as Waste Electrical and Electronic Equipment (WEEE), furniture, vehicles, tools and equipment. Opportunities may be created for bringing the informal sector, which is already active in this space, into the formal economy, by providing them with access to space, tools and equipment. There are several examples of "maker movement" initiatives already operational in South Africa with great potential for further rapid uptake.

Transitioning to a circular economy must also improve opportunities for re-use and re-distribution of materials. Keeping materials within the technical loops of the circular economy implies improving opportunities for refurbishment and repair, for example, of vehicles, machinery and equipment. There are many opportunities for increased recycling in the current SA system and an increasing trend that favours more localized, decentralized beneficiation operations.

Since the concept of the circular economy is still not widely familiar to the public or in the business community, programmes aimed at informing and increasing awareness are important for changing ingrained patterns of behaviour and ways of thinking that companies and individuals have developed. Collaboration platforms provide essential opportunities for networking, sharing information and building trust among circular economy stakeholders. As such, it is recommended that business support schemes be considered to assist in overcoming skills gaps and economic constraints, such as a lack of access to capital and technology, and challenges to profitability and markets.

Education and skills are vital for the uptake of CE. Those in traditional jobs will require upskilling and reskilling to prepare them for the new skills required for alternative work opportunities in dramatically different circular economic systems.

Research and development are important if South Africa is to keep up with research into cyber-physical, artificial intelligence, and robotic systems. Innovative product design is an enabler of transition to CE, since products need to be adapted for multiple life cycles and upgradability. Therefore, upskilling and reskilling will be required in various sectors to prepare people for the new skills and alternative work opportunities in dramatically different circular economic systems.

The roles of the various actors and the part that they have to play in the transition to a circular economy in the waste sector are discussed.

Policy is one of the biggest drivers for change. South Africa is well positioned to transition to a circular economy. The existing policy and regulatory environment in South Africa is sufficiently developed to support the implementation of a circular economy. A legislative and policy framework for a low carbon, resource efficient and green economy to promote the transition to a circular economy already exists in South Africa. Within this context, however, the transition to circular activities is currently obstructed by a lack of consistent implementation and enforcement of existing legislation, as well as some non-aligned legislation.

In the waste sector, the Constitution mandates municipalities to provide refuse removal and disposal services. Waste minimization and diversion of waste from landfill tend not to be prioritized when budgets are allocated by municipalities. Policies and regulations are nevertheless in place to effect diversion of materials from landfill, separating out specific material flows, such as organics and recyclables. Costs associated with disposal to landfill are expected to increase dramatically over the next few years as new regulations are implemented. This poses a risk to all businesses relying on landfill for disposal of waste. Forward-thinking businesses have developed strategies to divert organic waste and recyclables from landfill with many aiming to become zero-waste-to-landfill facilities and to operate independently of the external factors. The core policy interventions need to go beyond waste management policies. These are indeed imperative, as they need to be coupled with other policy instruments.

Green procurement policies may be designed to align with circular economy principles. Circular economy principles may be incorporated into procurement law or guidelines for example, by drawing up lists of preferred suppliers or materials, and by building capabilities and skills in procurement departments around concepts such as total cost of ownership and measures of material circularity.

The planning and policy landscape for the circular economy must incorporate much-needed reskilling of existing workers whose traditional or conventional waste management practices will become obsolete. Additional skills training could include aspects of collection, repair and maintenance of products, or introducing new service-type activities.

A transition to a circular economy requires cooperation amongst multilateral actors, often with very different interests. Government has an important enabling role to play in facilitating the collaboration which is required. Implementation also requires capacity, tools, and methods to develop new approaches, guidelines, and decision-support tools. The policy and legislative frameworks should be developed consultatively with all actors along the value chain, including product designers, mining operators, producers, distributors, consumers, collectors of end-of-life products, recyclers, inclusive of the informal sector and youth. Government recognises that, in addition to government-led “top down” enabling measures, the “bottom up” buy-in and co-operation of civil society, business and labour are an essential part of implementing a circular approach.

This guideline provides an entry point to the transition towards a circular approach within the waste sector in South Africa. It is anticipated that in the future, the “waste” sector will ultimately be referred to as the “materials” sector as products and services are increasingly designed to keep materials within the biological and technical cycles, thus designing waste out of the system.

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List of Acronyms

ACEN	African Circular Economy Network
ACR+	Association of Cities and Regions for Sustainable Resource Management
AESA -	Accelerating Excellence in Science in Africa
APC	Australian Packaging Covenant
BIDF	Biorefinery Industry Development Facility
CCEA	Chinese Circular Economy Association
CeSTII	Centre for Science, Technology and Innovation Indicators
CICSA	Climate Innovation Centre South Africa
CO_2	Carbon Dioxide
C&D materials	Construction and demolition materials
CD	Compact Disk
CE	Circular Economy
CSIR	Council for Scientific and Industrial Research
DEA	Department of Environmental Affairs
DEFF	Department of Environment, Fisheries and Forestry
DHEST	Department of Higher Education, Science and Technology
DST	Department of Science and Technology
DVD	Digital Video Disk
EMF	Ellen MacArthur Foundation
EPR	Extended Producer Responsibility
ESDSA	Enterprise and Supplier Development, South Africa
EU	European Union
GDP	Gross Domestic Product
GEF	Global Environmental Facility
GHG	Greenhouse Gas
IDZ	Industrial Development Zones
IndWMPs	Industry Waste Management Plans
IoT	Internet of Things
IPAP	Industrial Policy Action Plan
ISP	Industrial Symbiosis Programme
IWEX	Integrated Waste Exchange

IWMP	Integrated Waste Management Plan
LCA	Life Cycle Assessment
MSW	Municipal Solid Waste
MTSF	Medium-Term Strategic Framework
NCPC-SA	National Cleaner Production Centre, South Africa
NEMA	National Environmental Management Act
NEMWA	National Environmental Management: Waste Act
NEMWAA	National Environmental Management: Waste Amendment Act
NEPAD	New Partnership for Africa's Development
NGO	Non-Governmental Organization
NWMS	National Waste Management Strategy
OECD	Organization for Economic Co-operation and Development
OEM	Original Equipment Manufacturer
OFMSW	Organic Fraction Municipal Solid Waste
PAGE	Partnership for Action on Green Economy
PAMSA	Paper Manufacturers Association of South Africa
PRASA	Paper, Recycling Association of South Africa
R&D	Research and Development
RDI	Research, Development and Innovation
RECP	Resource Efficiency and Cleaner Production
SAG	Switch Africa Green
SA-LED	South Africa Low Emission Development
SARS	South Africa's Revenue Services
SCP	Sustainable Consumption and Production
SDG	Sustainable Development Goals
SME	Small and Medium Enterprises
SMMEs	Small, Micro and Medium Enterprises
STEM	Science, Technology, Engineering and Mathematics
TCO	Total Cost of Ownership
TIPs	Trade & Industrial policy Strategies
the dti	Department of Trade and Industry
UK	United Kingdom
UN	United Nations

UN Environment	United Nations Environment Programme (formerly UNEP)
UNIDO	UN Industrial Development Organization
USD	US Dollar
WEEE	Waste Electrical and Electronic Equipment
WRAP	Waste and Resources Action Programme
WSSD	World Summit on Sustainable Development
WWF	World Wide Fund for Nature

Glossary

Term	Explanation
Biocomposites	Biocomposites are formed by combining two or more distinct constituents or phases, one or more of which phases are derived from biological origins. There is a reinforced phase of stiff, strong material, often fibrous in nature, embedded within a continuous matrix phase which is usually weaker and more compliant. This combination produces a material with enhanced structural or insulation properties; entirely different from those of the individual components. The fibrous strong materials are usually derived from plant fibres from crops such as cotton, flax or hemp, or from recycled wood, waste paper, crop processing by-products or regenerated cellulose fibres such as viscose/rayon. The matrix phase within a biocomposite may often take the form of a natural polymer, possibly derived from vegetable oils or starches, or a synthetic fossil-derived polymer (e.g. 'virgin' or recycled thermoplastics).
Biogas	Biogas refers to a mixture of different gases, including methane and carbon dioxide, produced by the microbial breakdown of organic matter in the absence of oxygen. Biogas can be produced from raw materials such as agricultural waste, manure, municipal waste, plant material, sewage, green waste or food waste. Biogas is a renewable energy source.
Biomimicry	The design and production of materials, structures, and systems that are modelled on biological entities and processes.
Biosphere	The biosphere is the global ecological system integrating all living beings and their relationships, including their interaction with the elements of the lithosphere, geosphere, hydrosphere, and atmosphere. The biosphere deals with biological nutrients, materials which are biodegradable and can be returned to the biosphere through various technology options such as composting, anaerobic digestion (biogas recovery) and biorefinery (biochemical recovery). In a circular system, biological nutrients should be put back into the biosphere safely for decomposition to become valuable feedstock for a new cycle. In the biological cycle, products are designed by intention to be consumed or metabolised by the economy and regenerate new resource value.
Circular economy	An economy that is restorative and regenerative by design and aims to keep products, components, and materials at their highest utility and value at all times, distinguishing between technical and biological cycles. This new economic model seeks to ultimately decouple global economic development from finite resource consumption. It enables key policy objectives such as generating economic growth, creating jobs, and reducing environmental impacts, including carbon emissions.
Cleaner production	The production and use of goods and services that respond to basic needs and bring a better quality of life, while minimizing the use of natural resources, toxic materials and emissions of waste and pollutants over the life cycle of those goods and services, so as not to jeopardize the ability to meet the needs of future generations (Oslo Symposium, 1994)[1].

1. Norwegian Ministry of Environment, Oslo Symposium on Sustainable Consumption, 1994; Retrieved from https://scpgreenbuild.files.wordpress.com/2011/01/unep_background_paper_second_na_scp_workshop.pdf (accessed Sept 2018)

Term	Explanation
Climate change adaptation	Putting measures in place to adapt to the climate change already in the pipeline (“adaptation”). Adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities. Various types of
Climate change mitigation	Reducing and stabilizing the levels of heat-trapping greenhouse gases in the atmosphere (“mitigation”) and/or strategies and measures to reduce greenhouse gas sources and emissions and enhance greenhouse gas sinks. Examples of mitigation measures are renewable energy
Cradle to cradle	A design philosophy that considers all material involved in industrial and commercial processes to be nutrients, of which there are two main categories: technical and biological. "Cradle to cradle” design perceives the safe and productive processes of nature’s “biological metabolism” as a model for developing a “technical metabolism” flow of industrial materials. Product components can be designed for continuous recovery and re-utilisation as biological and technical nutrients within these metabolisms. Principles: ⇒ Eliminate the concept of waste. “Waste equals food.” ⇒ Power with renewable energy. “Use current solar income.” ⇒ Respect human & natural systems. “Celebrate diversity.” Guide operations and stakeholder relationships using social responsibility.
Dematerialization	Redesigning products to use less material than their predecessors of the same model type. This may include using new or different materials or simply designing to use less of the same material in the new product.
Disruptive change	Change that is not merely incremental. It also introduces innovative business models and revolutionary new technologies, often driven by multilateral collaboration and pressure.
Downcycling	Recycling that involves breaking an item down into its component elements or materials. Once the constituent elements or materials are recovered, they are re-used if possible but usually as a lower-value product.
Eco-design	The design of products with special consideration for the environmental impacts of the product during its whole lifecycle including procurement, manufacture, use, and disposal. Eco-design involves designing or redesigning products, services, processes or systems to avoid or repair damage to the environment, society and the economy. Examples include green energy heating systems, eco-friendly packaging and even recyclable products.
Eco-innovation	Eco-innovation is a methodology to design sustainable business strategies and business models, as well as supporting policies, which lead to waste prevention and circular economy.
Eco-labelling	The practice of marking products with a distinctive label so that consumers know that their manufacture conforms to recognized environmental standards. An eco-label identifies products or services proven environmentally preferable overall, within a specific product or service
Extended Producer Responsibility	A policy approach in which the producer’s environmental responsibility for a product is extended to the post-consumer stage of a product’s life cycle i.e. up to the end-of-life management of a product they sell. Intended to reduce waste and encourage environmentally responsible
Fourth Industrial Revolution	The Fourth Industrial Revolution, also referred to as Industry 4.0, is a fusion of technologies that blurs the lines between the physical, digital, and biological spheres, collectively referred to as cyber-physical systems. It makes use of mobile connectivity, artificial intelligence, Big Data, the Internet of Things (IoT), next-generation robotics, additive manufacturing (three-dimensional printing), blockchain software, nanotechnology, quantum computing, biotechnology, wearable technologies, genetic engineering, fifth-generation wireless technologies (5G) and fully autonomous vehicles. The First Industrial Revolution used water and steam power to mechanize production. The Second used electric power to enable mass production. The Third used electronics and information technology to automate production. Now a Fourth Industrial Revolution is building on the Third, the digital revolution that is characterized by a fusion of physical, digital, and biological technologies.
Humansphere	The humansphere[2] is the regenerative link (in-between the biosphere and the technosphere that inspires innovative actions and new ways to use manpower with the aim of preserving both the natural capital (the biosphere), on one hand, and enabling circulation of technical nutrients (the technosphere) on the other hand. The humansphere business model framework ensures that all human functions, capabilities, abilities and energies will be valued first, involving humans as-a-resource or as-a-service, prior to looking for alternative “logical mechanics” solutions. Preserving the humansphere takes into account diverse geographies, standards of living, desires, and cultural needs of people.

2. https://medium.com/@AlexLemille/circular-economy-the-social-imperative-cdab460e1de9

Term	Explanation
Industrial symbiosis	Industrial symbiosis (IS) is the study of material and energy flows through industrial systems which focuses on connections between operators within the "industrial ecosystem" with the aim of creating closed-loop processes in which waste from one process serves as an input for another process, thus eliminating an undesirable by-product.
Just transition	Just Transition is a framework that has been developed by the trade union movement to encompass a range of social interventions needed to secure workers' jobs and livelihoods when economies are shifting to sustainable production, including avoiding climate change, protecting biodiversity, and ending war, among other challenges. It has been broadened beyond a focus on protecting workers only, but also encompasses wider society, especially the most vulnerable, viz poor and working class communities[3].
Linear economy	A linear economy works according to the "take-make-use-dispose" step plan. Resources are extracted and commodities are manufactured. Products are used until they are discarded and disposed of as waste. Value is created by maximizing the quantity of products manufactured and sold, thus depleting resources in an environmentally unsustainable way.
Maker space	A maker space is a collaborative work space inside a school, library or separate public or private facility for making, learning, exploring and sharing that uses high tech to low tech tools. These spaces are open to youth, adults, and entrepreneurs and have a variety of maker equipment including 3D printers, laser cutters, CNC machines, soldering irons and even sewing machines.
Materials value chain	A "materials value chain" refers to that part of the life cycle of a product or process which includes the material sourcing, production, consumption, recycling and disposal of the product. It also incorporates the full range of actors and activities that are required to bring a product or service from its conception to its end markets.
Natural capitalism	"Natural capital" refers to the world's stocks of natural assets including soil, air, water and all living things. "Natural capitalism" in a global economy in which business and environmental interests overlap, recognises the interdependencies existing between the production and use of human-made capital and flows of natural capital.
Negative externality	A negative externality is a cost suffered by a third party as a result of an economic transaction/activity. In a transaction, the producer and consumer are the first and second parties, and third parties include any individual, organisation, property owner, or resource that is indirectly affected. Externalities are also referred to as spill over effects, and a negative externality is also referred to as an external cost. Certain externalities, such as waste, arise from consumption, while other externalities, like carbon emissions from factories, arise from production.
Performance economy	An economy in loops (or circular economy) with impacts on job creation, economic competitiveness, resource savings, and waste prevention. Its main goals: ⇒ product-life extension ⇒ long-life goods ⇒ reconditioning activities ⇒ waste prevention. It also emphasizes the importance of selling services rather than products, an idea referred to as the 'functional service economy', now more widely subsumed into the notion of 'performance economy'.
Positive externality	This is a gain experienced when the costs to undertake an activity are borne by one party, but the benefits are realised by another party e.g. recycling.
Recycling	The recovery of materials from products (post-consumer) or manufacturing processes (pre-consumer) and returning them to the feedstock for some other process.
Reduce	Minimizing waste at its source to reduce the quantity that must be treated and disposed of, usually achieved through improving product design and/or process management. Also called "waste minimization".
Refurbishment	The repair and reconditioning of products so that they can be returned to use for another life cycle. Refurbishment may be performed by the original manufacturer or a third party qualified to perform the necessary parts replacement or repairs.
Re-manufacture	Repairing and re-using previously used products or recovered components or materials in new products as part of the manufacturing process. Re-manufacturing is a specific case of refurbishment where the original manufacturer is involved in reprocessing used equipment they have recovered from takeback programmes.
Renewable resource	A renewable resource is a substance with economic value that can be replaced or replenished in the same or less time than it takes to draw the supply down. Some renewable resources are essentially in endless supply, such as solar energy, wind energy, and geothermal pressure, while other resources are considered renewable even though some time or effort must go into their renewal, such as wood, oxygen, leather, and fish.

3. National Planning Commission, South Africa: Essop, T (2018). National Development Plan – 2030. A Just transition to a low carbon, climate resilient economy & society. Where are we? Where should we be? How do we get there? Presentation at theTalanoa Dialogue 23-24 August 2018. https://www.environment.gov.za/sites/default/files/docs/justtransitiontoalowcarbon_telenoadialogue.pdf

Term	Explanation
Resource efficiency	An approach that minimizing wasteful use of scarce and non-renewable resources in the development and operation of facilities and services
Re-use	To re-use whole products after their current users no longer have use for them. This may include testing or minor repairs to ensure that products will perform reliably in the next life cycle. Multiple re-use cycles may be possible for a given product, especially if durability and re-use have been considered during its design.
Reverse logistics	Reverse logistics refers to monitoring the life-cycle of a product after it arrives at the end consumer. This could include monitoring how the product could potentially be re-used, how it should be properly disposed of after use, and any other way in which the expired product creates value. Reverse logistics that impact supply chains most directly involve the return of products from the end consumer back to the manufacturer
Sustainable consumption and production	The Oslo Symposium in 1994 defined sustainable consumption and production (SCP) as "the use of services and related products, which responds to basic needs and bring a better quality of life while minimizing the use of natural resources and toxic materials as well as the emissions of waste and pollutants over the life cycle of the service or product so as not to jeopardize the needs of further generations"[4].
Technosphere	The practice of circularity is focused on and grounded in the technosphere which deals with non-biological materials such as metals and plastic. These materials can be returned to the technosphere – directly or in a cascade of consecutive uses – by maintaining, re-using, refurbishing/re-manufacturing or recycling. Technical materials should be designed to circulate at high quality within the economy without ever entering the biosphere. Cycling materials in the technosphere must be a necessary element of the design, since this is not something that generally happens without intervention[5].
Tool libraries	Tool libraries store and maintain tools, equipment and "how-to" instructional materials for members to check out or borrow. A tool library functions either as a rental shop, with a charge for borrowing the tools, or more commonly free of charge as a form of community sharing.
Upcycling	Re-use of post-consumer products or materials in an application that has a higher market value than the original product, or than the value of the product recycled through traditional recycling routes.
Value chain	A value chain is the entire sequence of activities or parties that provide or receive value in the form of products or services (e.g. suppliers, outsourced workers, contractors, investors, R&D, customers, consumers, members). Partners in the value chain are parties that provide or receive value including suppliers, outsourced workers, contractors, customers, consumers, clients, members, and others[6,7].
Waste	Waste is defined in terms of NEMWAA (Act No. 26 of 2014), as any substance, material or object, that is unwanted, rejected, abandoned, discarded or disposed of, by the holder of the substance, material or object, whether or not such substance, material or object can be re-used, recycled or recovered. Once it is re-used, recycled or recovered the material ceases to be a waste.
Waste management hierarchy	The "hierarchy of waste management" is a priority sequence for managing waste, the most desirable option being to avoid waste in the first place. Where it is not possible to avoid waste completely ways to reduce, re-use or recycle the unwanted material should be considered. If waste cannot be made useful, only then should it be collected, treated and disposed of.
Waste value chain	A waste value chain describes how money is earned at each stage of waste management, from collection to sorting, recycling and production of new products. When waste management organizations expand into multiple activities, they have the opportunity to earn more money because materials are worth more when they are processed for future use.

*Note: Glossary words appear as **bold** format in the guideline text.*

4. Norwegian Ministry of Environment, Oslo Symposium on Sustainable Consumption, 1994; Retrieved from https://scpgreenbuild.files.wordpress.com/2011/01/unep_background_paper_second_na_scp_workshop.pdf (accessed Sept 2018)

5. https://www.uschamberfoundation.org/circular-economy-toolbox/about-circularity/circularity-vs-sustainability

6. ISO 26000:2010

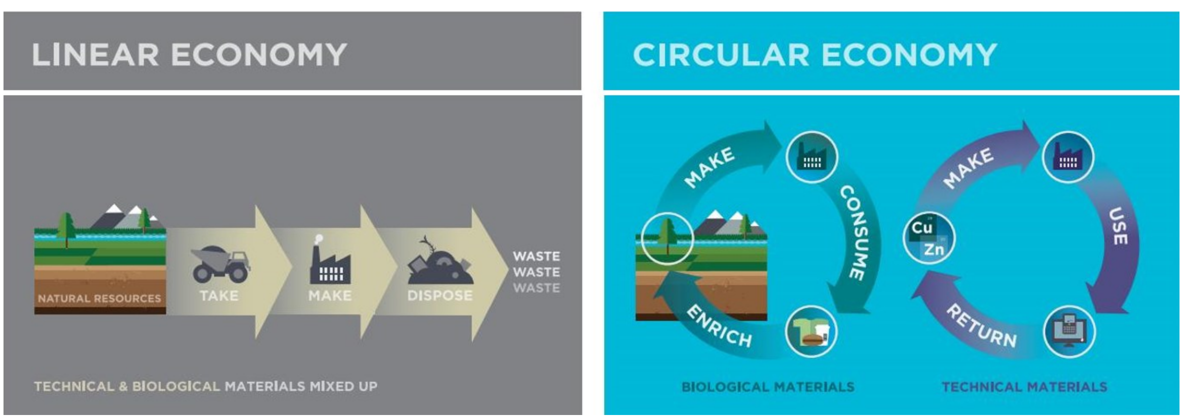
7. UNEP (2015), Business case for eco-innovation

CHAPTER 1: INTRODUCTION

1.1 Background

There is a growing understanding worldwide that global, regional and local consumption and production practices are unsustainable. Governments, businesses and citizens are concerned about wasteful practices that are depleting resources and causing pollution, environmental degradation and extreme climate events. The world's population is expected to reach almost 9 billion by 2040. If we continue in the prevailing **linear economy mode** (Figure 1a)[8] , without drastic action to change the way we currently take, make, use and dispose of natural resources, and without a move towards closing materials flow loops (Figure 1b), the prospects will be detrimental to the environment and human wellbeing.

The linear economy promotes unsustainable consumption patterns that deplete our natural resources and contribute to environmental degradation and extreme climate events.



Figures 1a and 1b: Transitioning from a linear to a circular economy
Source: Ellen MacArthur Foundation

8. *Note that definitions of terms in bold format can be found in the glossary at the front of the guideline*

1.2 Sustainable consumption and production

The concept of circularity as shown in Figure 1b is key to achieving **Sustainable Consumption and Production** (SCP) through the promotion of **closed material loops** and enhanced **resource efficiency** along **value chains**. SCP is defined in the Africa Review Report (2009)[9] as a holistic approach to minimizing the negative environmental impacts of production and consumption in society. It is a practical implementation strategy for achieving sustainable development. An SCP approach aims for social and economic development within the carrying capacity of ecosystems, as well as to decouple economic growth from environmental degradation. SCP promotes resource and energy efficiency, sustainable infrastructure, green jobs and improved quality of life. This approach is crucial if the world is to achieve the 2030 Sustainable Development Goals (SDGs) (Godfrey, 2017)[10]. The circular economy aligns strongly to Sustainable Consumption and Production principles.

Sustainable consumption and production promote social and economic development within the carrying capacity of ecosystems.

The **circular economy** (CE) is defined by the Ellen MacArthur Foundation[11] as "one that is restorative and regenerative by design and aims to keep products, components, and materials at their highest utility and value at all times, distinguishing between technical and biological cycles". The principles underlying a CE have become global drivers of change, moving production and consumption patterns from a linear economy that inevitably leads to unsustainable resource depletion, to a circular economy, a system which regenerates resources and is therefore sustainable in the medium to long-term.

A circular economy is one that is restorative and regenerative by design and aims to keep products, components, and materials at their highest utility and value at all times, distinguishing between technical and biological cycles.

Source: Ellen MacArthur Foundation

The South African government recognises the role of the CE in developing a sustainable, low carbon, resource-efficient and globally competitive economy. The late Minister of the Department of Environmental Affairs, Minister Edna Molewa, made the following comments relating to CE:

*"Many developing countries are still behind when it comes to the implementation of circular economy. This is evident in South Africa where 90% of **waste** is still being disposed of in landfills. However, the circular economy is now gaining traction in many countries - both developed and underdeveloped."*

"South Africa has adopted the circular economy as one of our sustainable development models. Studies have suggested that governments should play a leading role in promoting the circular economy concept by reforming existing laws, enacting new regulations, promoting the application of new environmental technologies, and organising public education on the benefit of this concept. By prioritising the implementation of the circular economy in line with the 2030 Development Agenda, the South African government

9. United Nations Economic Commission for Africa (UNECA), 2009 Africa Review Report on Waste Management. Retrieved from: https://sustainabledevelopment.un.org/content/dsd/csd/csd_pdfs/csd-18/rims/AfricanReviewReport-onWasteManagementSummary.pdf

10. Godfrey, L. (2017). African challenges for achieving the Sustainable Development Goals (SDGs) and the role of knowledge Transfer. Africa-Europe Dialogue Symposium on Innovation for Sustainable Development, 29 November 2017, Pretoria, South Africa.

11. Ellen MacArthur Foundation. Circular Economy: Concept. Retrieved from https://www.ellenmacarthurfoundation.org/circular-economy/overview/concept

is contributing significantly to unlocking much of the value to be found in waste products. By focusing on the development of the waste economy, many more jobs can be created in the formal and informal sectors."

"*Significant economic and environmental benefits could accrue to South Africa, particularly poorer communities, through the development of green jobs within the circular economy. Opportunities for job creation exist in moving waste away from landfills and towards alternative waste treatment options across the entire waste hierarchy. This can be achieved through* ***cleaner production****, industrial efficiency, dismantling, refurbishment and re-use, as well as new methods of collection, sorting, reprocessing and manufacturing."*[12]

The circular economy therefore provides a means to achieve sustainable consumption and production.

1.3 A circular economy guideline for South Africa

The circular economy involves sustainable materials management and is about "keeping resources in flow, for as long as possible, at their maximum value" (Godfrey 2018)[13]. The Department of Environment Forestry and Fisheries in partnership with the European Union, through the Switch Africa Green Programme and recognised that there are opportunities for circularity in the South African waste sector which should be explored. This is further explained in Chapters 2 and 3.

With a focus on the waste sector, Chapter 3 of this guideline identifies immediate opportunities for greater materials circularity. Chapter 4 details best practice models, by providing case studies at both the national and local level respectively and, where appropriate, successful international case studies that could relate to the South African context.

It aims to deepen an understanding of the circular economy and its benefits, and to show how the transition to circularity can be achieved with collaborative effort from actors at every step in the value chain. Chapter 5 includes a brief review of current legislation relevant to the circular economy and provides suggestions for policies and mechanisms to incentivize the transition to circularity, along with innovative, practical ways for practitioners in municipalities, business, and civil society, to implement and manage the process. Issues, gaps and challenges are discussed in Chapter 6, while monitoring and evaluation of implementation of the transition to a circular economy are the focus of Chapter 7.

Practical measures for initiating the process for the transition to circularity are recommended in Chapter 8 and summarised in Chapter 9.

1.4 Limitations of the guideline

The focus of this guideline is on the "waste" sector, which is one of other key sectors within a circular economy. The circular economy for waste is therefore just one means of achieving sustainable consumption and production as illustrated in Figure 2.

The guideline does not address the broader issues of resource- or energy-efficiency, of sustainable materials management, or wider opportunities within the sharing economy. However, it provides an entry point for understanding the opportunities that a circular economy can provide for South Africa.

12. DEA May 2017. Minister Dr Edna Molewa's speech at the South Africa – European Union Seminar on Circular Economy https://www.environment.gov.za/speech/molewa_SA_EUseminaroncirculareconomy

13. Godfrey, L. 2018. The Circular Economy – What does it mean for development and green industries: A perspective from Africa. Keynote address, 5th Green Industry Conference for Sustainable Development, 3 October 2018, Bangkok. https://www.unescap.org/sites/default/files/Keynote%20Presentation_LG%2018-10-03%20UNIDO%20Green%20Industry%20Conference%20Bangkok_0.pdf

The guideline also highlights the elements within the South African planning, policy and legislative environment that are most relevant to promoting circularity. However, it is not intended to be a full review of the circular economy.

While the guideline discusses overarching principles and frameworks needed to implement the circular economy, and while various techniques, tools and examples are mentioned, the guideline does not prescribe specific methodologies, as these can only be selected as applicable to particular contexts, programmes or practitioners.

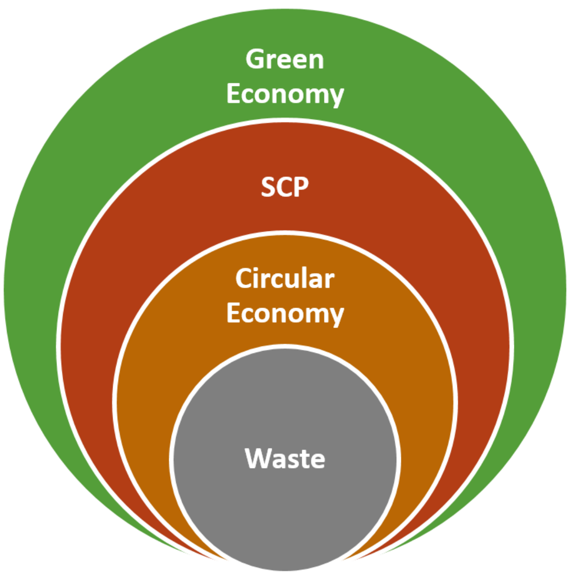


Figure 2: Waste management is a part of the circular economy which, in turn, is part of the green economy and a means of achieving sustainable consumption and production.

In developed countries, there are advanced examples of best practice for indicators and tools to monitor the transition to circularity. Many of these indicators and tools are not yet practical for emerging economies, as many of the corresponding metrics are not yet monitored or even available. The monitoring and evaluation aspects as indicated in the guideline, are based on applicability in the context of a developing economy.

CHAPTER 2: THE CIRCULAR ECONOMY

Sustainable development requires **disruptive changes** in the way our societies and businesses are organized. The circular economy (CE) model offers a new paradigm for innovation and integration between natural ecosystems, businesses, our daily lives, and waste management.

The circular economy is not a new concept. However, of late there has been more urgency to transition from the current linear economy model to a circular one in pursuit of resource efficiency. Thought leaders regarding the circular economy have developed, policies and procedures that are useful references, including those listed in Table 1.

A Circular Economy is a system that is restorative or regenerative by intention and design. It replaces the "end-of-life" concept with restoration, moves towards the use of renewable energy, eliminates the use of toxic chemicals which impair re-use, and aims to eliminate waste through the superior design of materials, products, systems, and, within this, business models.

Source: Ellen MacArthur Foundation, 2013.

Table 1: Key references for information on CE

Organization	Reference
Ellen MacArthur Foundation (EMF)[14]	Circular Economy: Concept
United Nations Environment Programme[15]	Closing the loop: how a circular economy helps us #BeatPollution UN Environment (2017), Mainstreaming Eco-innovation in Sustainable Consumption and Production Policies Mainstreaming eco-innovation http://unep.ecoinnovation.org/wp-content/uploads/2018/03/UNEP_157-Mainstreaming-ecoInnovation_web.pdf
European Union (EU)[16]	"Circular Economy" tag, UNEP Knowledge Repository.
Organisation for Economic Co-operation and Development (OECD)[17]	The Macroeconomics of the Circular Economy Transition: A Critical Review of Modelling Approaches
Waste and Resources Action Programme (WRAP) programme in the UK[18]	Resource efficient business models/ innovative business models
Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ)[19]	Economic instruments in solid waste management: Applying economic instruments for sustainable solid waste management in low and middle-income countries.

14. See: Ellen MacArthur Foundation. Circular Economy: Concept. Retrieved from https://www.ellenmacarthurfoundation.org/circular-economy/concept and Cities and Circular Economy for Food. Retrieved from https://www.ellenmacarthurfoundation.org/our-work/activities/cities-and-circular-economy-for-food

15. Stone, S. (2017). Closing the loop: how a circular economy helps us #BeatPollution. UN Environment, (27 November). Retrieved from https://www.unenvironment.org/news-and-stories/story/closing-loop-how-circular-economy-helps-us-beatpollution. See also "Circular Economy" tag, UNEP Knowledge Repository. UNEP. Retrieved from http://apps.unep.org/repository/free-keywords/circular-economy

16. UN website, EU. Retrieved from http://www.un-page.org/

17. OECD. (2018). The Macroeconomics of the Circular Economy Transition: A Critical Review of Modelling Approaches – Environmental Working Paper No. 130. OECD. Retrieved from http://www.oecd.org/officialdocuments/publicdisplaydocumentpdf/?cote=ENV/WKP(2018)4&docLanguage=En. See also De Groene Zaak, Dutch Sustainability Business Association. Governments Going Circular. Retrieved from http://www.greengrowthknowledge.org/sites/default/files/downloads/resource/governments-going-circular.pdf

18. WRAP Programme, UK. Retrieved from http://www.wrap.org.uk/resource-efficient-business-models/innovative-business-models and https://www.recyclenow.com/about-us

19. GIZ. (2015). Economic instruments in solid waste management: Applying economic instruments for sustainable solid waste management in low and middle-income countries. GIZ. Retrieved from https://www.giz.de/en/downloads/giz2015-en-waste-management-economic-instruments.pdf. See also GIZ. Concepts for sustainable waste management project: https://www.giz.de/en/worldwide/15109.html

It is not the intention of this guideline to repeat all available information here. Readers are instead referred to existing literature to expand their understanding of the circular economy.

2.1 Concept of a circular economy

The circular economy is intended to enable economic growth that optimises the chain of consumption of materials[20]. Production chains and consumption patterns must be significantly transformed to reduce the quantity of raw material resources used as inputs in our production systems and to keep materials circulating in the economy for as long as possible.

Circularity goes beyond the pursuit of waste prevention and waste reduction and must inspire technological, organisational and social innovation across and within value chains.

An understanding of value chains (Figure 3), which incorporate the supply chains, is important in transitioning to the circular economy and moving towards sustainable consumption and production.

The circular economy presents significant opportunities in Africa for more inclusive economic growth, creation of job opportunities and sustainable environmental practices. However, adoption of a circular economy agenda has to be inclusive of enabling policy environment and supporting infrastructure needs.

The circular economy is often depicted in a so-called "butterfly diagram" (Figure 4) which represents the complexity of interlinked material and service elements in the **biosphere** (represented by the "loops" on the left side of the diagram) and the **technosphere** (represented by the "loops" on the right side of the diagram).

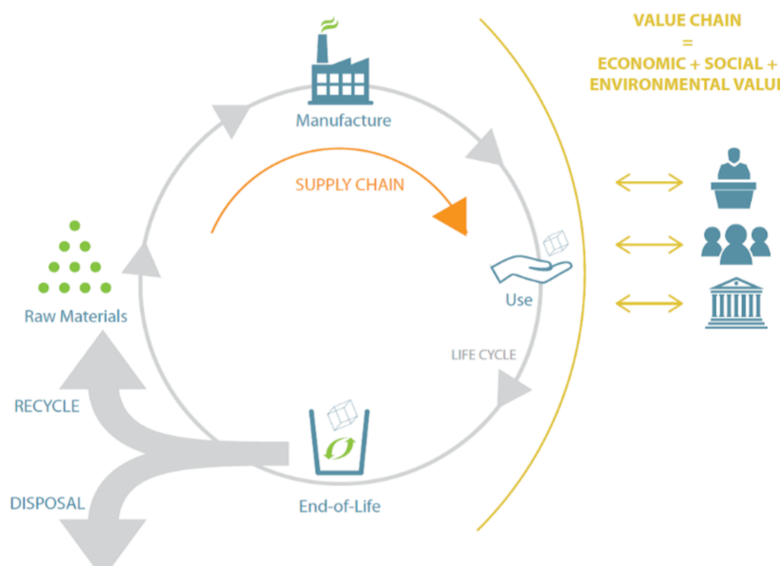


Figure: 3 Value chain diagram

Source: UN Environment (2017), Mainstreaming Eco-innovation in Sustainable Consumption and Production Policies

20. Zvimba, JN. 2019. Op-Ed: Water sector in South Africa needs to transform to a circular economy. http://firstthing.dailymaverick.co.za/article?id=121668#.XH5sUIgzaUk

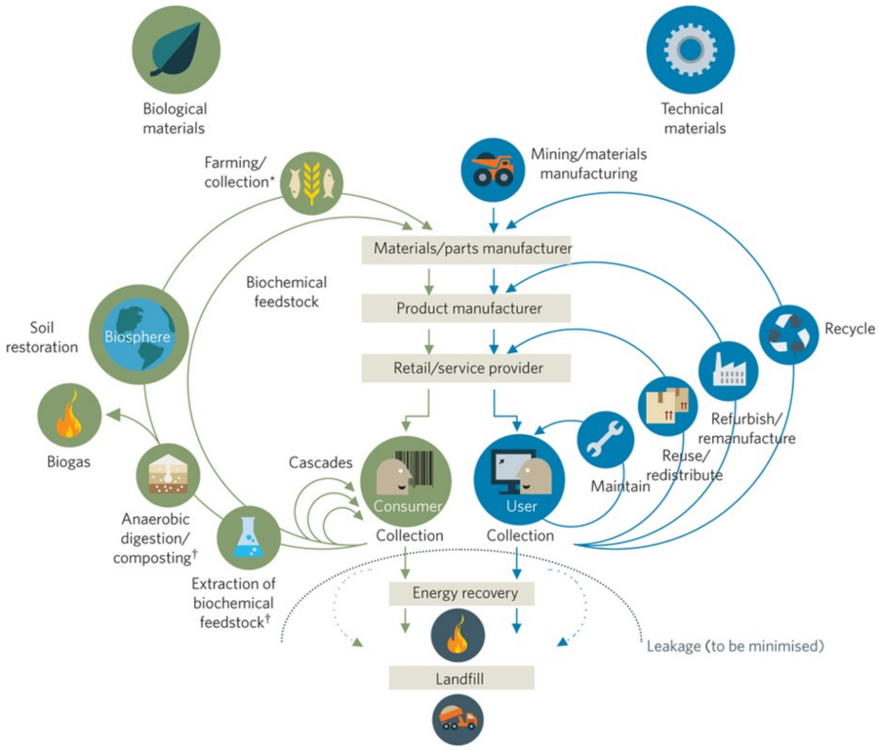


Figure 4: Diagram illustrating the Circular Economy and material flows

Source: Ellen MacArthur Foundation[21]

The biosphere, on the left of the diagram, deals with biological nutrients – materials which are biodegradable and can be returned to the biosphere through various technology options such as composting, anaerobic digestion (**biogas** recovery) and biorefinery (biochemical recovery). It would include solutions for applications such as food and food processing waste, garden waste, agricultural waste, forestry and forest product waste. In a circular system, biological nutrients should be put back into the biosphere safely for decomposition to become valuable feedstock for a new cycle. In the biological cycle, products are designed by intention to be consumed or metabolised by the economy, thus regenerating new resource value.

The technosphere, on the right of the diagram, deals with non-biological materials, such as metals and plastic. These materials can be returned to the technosphere – directly or in a cascade of consecutive uses – by maintaining, re-using, refurbishing/remanufacturing or **recycling**. Technical materials are designed to circulate at high quality within the economy without ever entering the biosphere.

In choosing options for circular resource flows, the closer the "loop" is to the user (Figure 4), the lower the load on the environment. Wherever possible the tighter, inner loops (for example maintenance) will preserve more energy and other value than the outer loops (e.g. recycling). The number of consecutive cycles and/or the time spent in each cycle should be maximised by extending product life and optimising re-use.

Sharing, in turn, increases product utilisation. In a circular system, the essence of value creation lies in the opportunity to extract additional value from products and materials by cascading them through other applications.

21. Ellen MacArthur Foundation. Circular Economy: Infographic. Retrieved from https://www.ellenmacarthurfoundation.org/circular-economy/infographic

The "butterfly diagram" (Figure 4) is used in Chapter 4 and forms a basis for discussion on opportunities in for improving materials circularity, in South Africa.

2.2 3R HIERARCHY

implementing circular systems, the 3R principles of **recycling**, re-use and repair/refurbish should be prioritized over reducing. The separation of materials along with recycling activities are fundamental components of materials recovery. However, it should be recognized that recycling has traditionally been part of the linear economy, which is based on extracting resources, manufacturing products which are consumed on a once-off basis, and then disposing of them. When discarded materials are recycled, they are already regarded as "waste" in terms of linear thinking. In general, recycling involves breaking up the materials into fragments, from which new products are made, often to be used only once and thereafter discarded. That process is referred to as "**downcycling**" because the materials produced from recycled materials are generally of lower quality and functionality than the original material.

The circular economy is a way of creating value and, ultimately, prosperity. It works by extending product lifespan through improved design and servicing, and relocating waste from the end of the supply chain to the beginning—in effect, using resources more efficiently by using them repeatedly.

Source: UNIDO

In contrast, in a circular economy these materials are not regarded as "waste" but rather considered as useful resources, which can be processed in such a way as to add value to the materials, that is, "**upcycling**" them.

To increase the recovery of materials, redesign of products is required in the medium term to increase the value of collecting the materials for repurposing. This ultimately means that the products are greener or more eco-friendly. In a linear economy, industries and manufacturing processes are generally very wasteful, as it is common practice to anticipate the generation of waste as part of the production cycle. Resource efficiency and cleaner, more responsible production are therefore crucial to reduce wasteful practices. Beyond this, a shift in business models is essential. Eco-innovation is a methodology that can support sustainable business strategies and business models, such as extending the product lifecycle through repair and refurbishment.

When extending a product's lifecycle, it not only provides products that last longer, but also requires people and skills to carry out these regenerative services, stimulating a secondary economy and additional work opportunities as illustrated in Figure 5.

Collection systems for end-of-life materials at both commercial and household level are essential in a circular economy and will need to change from current models to optimise the recovery of materials, both by private sector waste management service providers and by municipalities. Therefore, possibilities for collaboration between waste management service providers, the informal sector and municipalities, should be explored not only for collection systems, but also for all activities taking place after collection.

The re-use and recycling of materials must become an integral part of the systemic activity as materials are recirculated and repurposed.

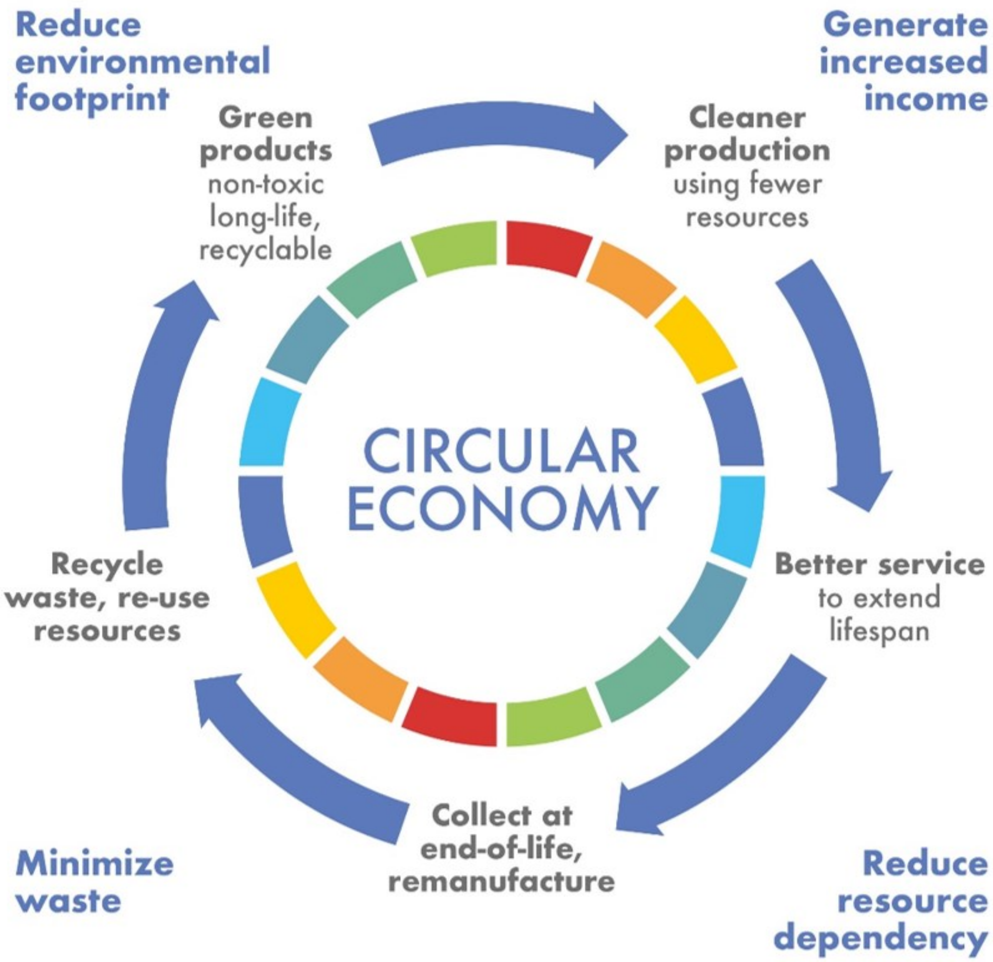


Figure 5: Waste minimization activities within a circular economy.
Source UNIDO (2017)[22]

2.3 Common principles

The Ellen MacArthur Foundation's (2015) *Toolkit for Policymakers*[23] identifies a set of six actions when moving towards a circular economy: Regenerate, Share, Optimise, Loop, Virtualise, and Exchange – together, the "ReSOLVE" framework. The ReSOLVE framework offers businesses and governments with a tool for generating circular strategies and growth initiatives (Table 2).

The six actions listed in Table 2 increase the utilisation of physical assets, prolong their life, and shift resource use from finite to renewable sources. Each action re-inforces and accelerates the performance of the other actions. The ReSOLVE framework should be considered in the formulation of any CE action plan.

22 United Nations Industrial Development Organisation. https://www.unido.org/sites/default/files/2017-07/Circular_Economy_UNIDO_0.pdf
23 Ellen MacArthur Foundation. (2015). Delivering the Circular Economy: A Toolkit for Policymakers. Retrieved from https://www.ellenmacarthurfoundation.org/assets/downloads/publications/EllenMacArthurFoundation_PolicymakerToolkit.pdf

Table 2: Adapted from "The ReSOLVE framework: six action areas for businesses and governments wanting to move towards the circular economy"[24]

Action area	Action required
REgenerate	• Shift to renewable energy and materials • Reclaim, retain, and restore health of ecosystems • Return recovered biological resources to the biosphere
Share	• Share assets (cars, rooms, appliances) • Re-use/second-hand • Prolong life through maintenance, design for durability, upgradability etc.
Optimize	• Increase performance/efficiency of product • Remove waste in production and supply chain • Leverage big data, automation, remote sensing and steering
Loop	*Keep components and materials in closed loops and prioritize inner loops, for example:* • **Re-manufacture** products or components • Recycle materials • Digest anaerobically • Extract biochemicals from organic waste
Virtualize	*Resource use by delivering utilities virtually, for example:* • **Dematerialize** directly (books, CDs, DVDs, travel) • Dematerialize indirectly (online shopping, virtual office)
Exchange	• Replace old materials with advanced non-renewable materials • Apply new technologies (for example, 3D printing) • Choose new product/service (for example, multi-modal transport)

The above six actions increase the utilisation of physical assets, prolong their life, and shift resource use from finite to renewable sources.

Each action re-inforces and accelerates the performance of the other actions. The ReSOLVE framework should be considered in the formulation of any CE action plan.

2.4 Objectives and benefits of a circular economy

The waste sector in South Africa provides a good entry point for the transition to a broader circular economy. In the ideal circular economy, as in nature, there should be no waste.

The objectives of implementing the circular economy in the waste sector are to design waste out of the system, at every step along the value chain, to maximize the opportunities the CE creates for job creation, enterprise development, new business models, and to realize the benefits to the SA economy.

Potential benefits of the circular economy for South Africa:

⇒ Additional work opportunities through repair, remanufacturing and recycling practices, with new designers and mechanical engineers making lasting, easily disassembled products and materials at the transformation/production stages;

⇒ More resilient supply chains using fewer raw materials and more recycled (or even reusable or easily transformed) inputs that have a higher proportion of labour costs, leaving companies less dependent on the volatility of raw material prices;

⇒ Potential to create demand for new services and new work opportunities:

- Collection and **reverse logistics** companies that support end-of-life products being reintroduced into the system
- Parts and component remanufacturing and product refurbishment offering specialized knowledge

24 Ellen MacArthur Foundation. (2015). Delivering the Circular Economy: A Toolkit for Policymakers. Retrieved from https://www.ellenmacarthurfoundation.org/assets/downloads/publications/EllenMacArthurFoundation_PolicymakerToolkit.pdf

- Productivity and employment can be increased.

The positive effects of a circular economy extend beyond saving materials and leaving a smaller footprint on the environment. New economic opportunities emerge from innovative services and business models which transform the relationship between producer and consumer, and products and their users.

The benefits of this shift will include raw materials conservation, innovation, durable products, creation of work opportunities, resource efficiency and the reduction of carbon emissions as illustrated in Figure 6.

Figure 6 illustrates that the **eco-design** of a product begins at the conceptual stage and addresses every stage of its lifecycle to its end use and re-use, anticipating the material flow and consciously incorporating resource recovery and re-use into its design.

A circular economy is based on the concept that there is no such thing as waste. To achieve this, products are designed to last (good quality materials are used) and optimized for a cycle of disassembly and re-use that will make it easier to handle and transform or renew them.

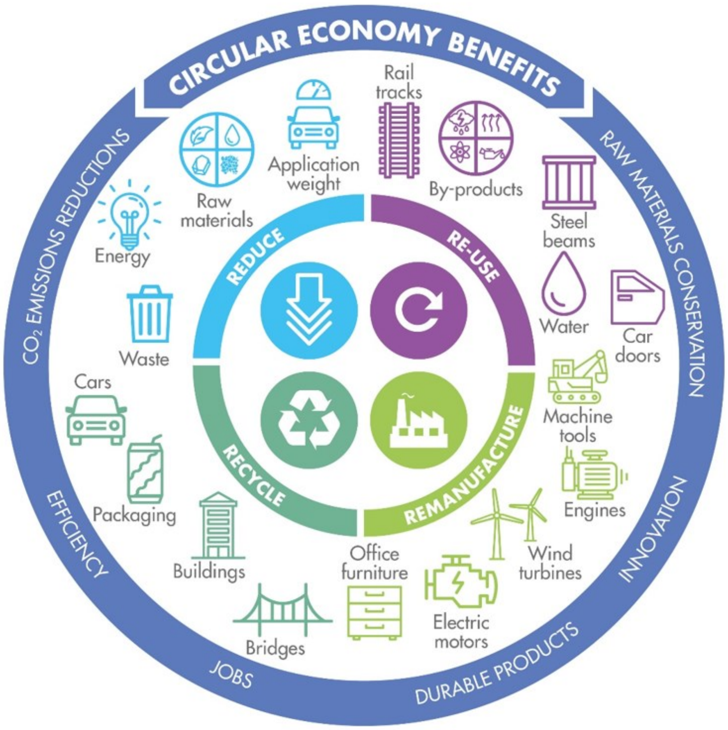


Figure 6: Benefits of the Circular Economy

Source: UNCTAD website[25]

25 United Nations Conference on Trade and Development (UNCTAD). Circular Economy. UNCTAD. Retrieved from https://unctad.org/en/Pages/DITC/Trade-and-Environment/Circular-Economy.aspx

The UN Environment's 2017 review, *Closing the Loop: How a Circular Economy Helps us #BeatPollution,* reports that the health costs from air pollution associated with linear economy practices are estimated at over USD 5 trillion per year. Worldwide, 8 to 9 million avoidable deaths occur annually from pollution; over 6 million tonnes of plastic are discharged into the oceans every year; 83% of a sample of global water supplies from public taps contain microplastics; and 95% of all plastics are discarded after a single use. Such costs represent a loss of USD 80 to 120 billion per year, which does not even account for **negative externality**[26] costs. These statistics, taken together with other evidence, illustrate the close link between the prevailing linear economy and pollution – along with the serious impacts on human health and sustainable environmental management.

26 United Nations Conference on Trade and Development (UNCTAD). Circular Economy. UNCTAD. Retrieved from https://unctad.org/en/Pages/DITC/Trade-and-Environment/Circular-Economy.aspx

CHAPTER 3: OVERVIEW OF THE SOUTH AFRICAN WASTE SECTOR

This section highlights opportunities for increased materials circularity in the South African waste sector – both for specific waste streams and for specific waste management activities.

3.1 Waste types and quantities

The state of waste management in South Africa has been captured in a number of national government reports (DEA, 2012[27]; DST, 2013[28]; Mintek, 2017[29]; StatsSA, 2017[30];and GIZ SABIA, 2016[31]). The *South Africa State of Waste Report: First Draft Report*[32], as well as the Industry Waste Management Plans (IndWMPs) for tyres[33], paper and packaging[34], and the electrical and electronic industry and lighting sectors[35], contain useful updated information on specific waste streams. Information on the state of economy for the South African waste sector can be found in the Partnership for Action on Green Economy (PAGE) reports, PAGE (2017)[36] and PAGE (2018)[37].

Details regarding the South African waste sector and unlocking opportunities for circularity may be obtained from sector-specific reports, such as the Industry WMPs.

According to the most recent official statistics for South Africa, published by DEA in 2012, 90% of all general, hazardous and unclassified waste generated was disposed of to landfill, controlled waste disposal sites or to uncontrolled dumpsites with associated open burning (Figures 7 and 8). This represents a huge loss to the South African economy of viable secondary resources, estimated at approximately R17 billion (DST, 2014)[38].

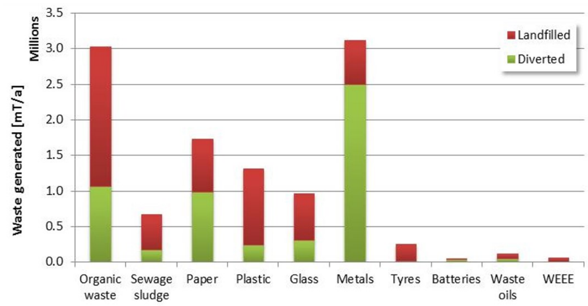


Figure 7: Quantity of waste diverted (recycled, treated) and landfilled
Source: DEA, 2012

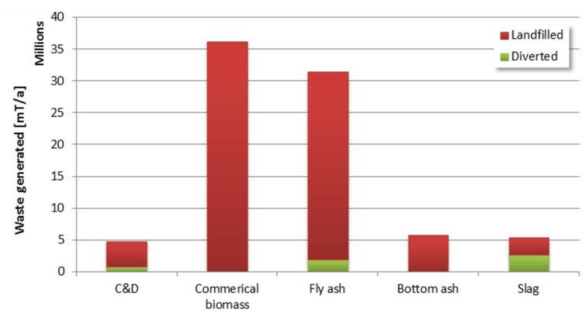


Figure 8: Quantity of bulky waste diverted (recycled, treated) and landfilled
Source: DEA, 2012

27 Department of Environmental Affairs (DEA (2012). National Waste Information Baseline Report; DEA: Pretoria, South Africa. Retrieved from http://sawic.environment.gov.za/documents/1880.pdf
28 Department of Science and Technology (DST) (2013). South African Waste Sector – 2012. An analysis of the formal private and public waste sector in South Africa. A National Waste RDI Roadmap for South Africa: Phase 1 Status Quo Assessment. Department of Science and Technology: Pretoria.
29 Mintek, (2017). Mapping South Africa's Waste Electrical and Electronic Equipment (WEEE) Dismantling, Pre-Processing and Processing Technology Landscape. M Lydall, W Nyanjowa, Y James. Waste. Research Development and Innovation Roadmap Research Report
30 StatsSA, (2018). General Household Survey 2017
31 GIZ SABIA (2016). Biogas Industry in South Africa. An Assessment of the Skills Need and Estimation of the Job Potential
32 Department of Environmental Affairs (DEA). (2018). South Africa State of Waste Report: Second Draft Report. Retrieved from http://sawic.environment.gov.za/documents/9066.pdf
33 Tyre IndWMP retrieved from http://sawic.environment.gov.za/?menu=348
34 Paper and Packaging IndWMP retrieved from https://www.packagingsa.co.za/waste-management-plan/
35 Electrical and electronic industry and lighting IndWMP retrieved from http://eranpc.co.za/download-the-indwmp/
36 Partnership for Action on Green Economy, PAGE (2017). Green Economy Inventory for South Africa: An Overview. Pretoria. South Africa.
37 PAGE (2018). A Green Economy Industry and Trade Analysis: Assessing South Africa's Potential.
38 Department of Science and Technology, DST (2014). A National Waste R&D and Innovation Roadmap for South Africa: Phase 2 Waste RDI Roadmap. The economic benefits of moving up the waste management hierarchy in South Africa: The value of resources lost through landfilling. Pretoria, South Africa. Retrieved from https://www.wasteroadmap.co.za/download/economic_value_sa_waste_rep.pdf

As shown in Figures 7 and 8, current rates for diversion from landfill for "technically" recyclable waste streams vary from less than 10% for commercially exploitable biomass, bottom ash, fly ash, and waste tyres, to more than 80% for metals and batteries. Paper and packaging recycling rates have increased from approximately 18% in 1990 to 57.1% in 2015[39]. Significant opportunities for diversion from landfill (Figure 9) still exist for the organic fraction of municipal solid waste (OFMSW) and industrial biomass, construction and demolition (C&D) materials, paper and packaging materials (particularly plastic), waste electrical and electronic equipment (WEEE), tyres and the bulky waste streams from the mining and power generation sector.

Figure 9: Municipal waste in SA showing mixed organic waste, paper and packaging

Image credit: JE Lombard

3.2 Economic opportunities related to specific waste streams

Minister Barbara Creecy of the Department of Environment, Fisheries and Forestry in her 2019 world environment day speech mentioned that: "the National Waste Management Strategy has the potential to contribute 69 000 jobs in the green economy and support the development of countless Small Micro & Medium Enterprises and Co-operatives, therefore, the Department encourages communities to view waste as a potential source of income". Diversion of approximately 20 million tonnes of waste may unlock an anticipated further R11.5 billion per year, by 2023 (DEA 2017[40]). The overall target, as set by DEA, is to increase waste diverted from landfill from an estimated 13% (14 million tonnes) in 2016 to 25% (29 million tonnes) by 2023[41]. There are economic opportunities related to specific waste streams such as WEEE, plastics, C&D wastes, textiles and organic wastes.

There are opportunities for improved waste collection, alternative collection methods and decentralised management of waste in South Africa.

3.2.1 Waste electrical and electronic equipment

Research undertaken by Mintek[42], for the Department of Science and Technology indicated that a large percentage of WEEE, including printed circuit boards (PCBs), plastic, glass, and lithium ion batteries (LIBs), is exported for reprocessing to foreign destinations such as Belgium, Sweden, Canada, China, as well as to Asia, due to limited reprocessing facilities in South Africa. The result is a loss of these resources to the South African economy, together with the potential associated work opportunities.

39. Godfrey, L. and Oelofse, S. (2017). Historical Review of Waste Management and Recycling in South Africa. Resources, 6(4), 57.
40. DEA (2017). SWITCH Africa Green: Review of laws, policies and business environment. Country Implementation Report and Plan: South Africa. Pretoria, South Africa: Department of Environmental Affairs
41. GreenCape Market Intelligence Report https://www.green-cape.co.za/assets/Uploads/20180622-GreenCape-Waste-MIR-FA-LR.pdf
42. Mintek, 2017 Mapping South Africa's Waste Electrical and Electronic Equipment (WEEE) Dismantling, Pre-Processing and Processing Technology Landscape. M Lydall, W Nyanjowa, Y James. Waste. Research Development and Innovation Roadmap Research Report

As with other waste streams, the implementation of alternative waste treatment technology for WEEE is, in most instances, limited availability (or lack thereof) of technology, and having a sustainable feedstock (supply of waste) to warrant private sector investment in the technology. Economic opportunities associated with electrical and electronic wastes, particularly relating to repair, refurbishment and recycling activities are discussed further.

Materials from discarded electrical and electronic equipment and the packaging industry, offer rich opportunities for further beneficiation.

3.2.2 Plastic waste

Information published by Plastics SA (2018)[43] indicates that whilst plastic recycling rates have increased in South Africa between 2010 and 2017, so have tonnages of waste plastic being exported.

The reason for exporting "waste" plastic recyclables is essentially an economic one; i.e. a better price per tonne to export.

The export of plastic waste to China, was no longer an option post the announcement by China of the ban of imported plastic waste.

However, this has led to many waste management companies exploring alternative options amongst which included: access and reach to alternative markets in the short markets and in the medium term exploring the re-use of plastics in the system within the production line as input material, alternative uses of plastics in other manufacturing sectors, and promoting innovation to identify alternative materials to replace plastics.

The unintended consequence of limited markets for the export of plastics may imply and increase in the in landfilling of plastics if not, recycled or re-used.

3.3.3 Construction and demolition waste

Construction and demolition (C&D) waste and other bulky waste streams such as mining residues and power generation waste, offer opportunities for secondary use in road-building and building construction[44].

3.2.4 Textile waste

While no data exist for South Africa, re-use and recycling of clothing and textiles offer many circular opportunities for community involvement and low-skilled work opportunities with an associated positive impact on the environment[45].

3.2.5 Organic wastes

There are also economic opportunities associated with organic waste streams that can be beneficiated as biological nutrients in a circular system. The assessment report, *A Green Economy Industry and Trade Analysis: Assessing*

43. PlasticsSA (2018) National Plastics Recycling Survey 2017.
44. EMF. Case studies Finding and utilising 'waste' materials for construction purposes Retrieved from: https://www.ellenmacarthurfoundation.org/case-studies/finding-and-utilising-waste-materials-for-construction-purposes
45. Clothing recycling retrieved from https://www.dailymaverick.co.za/article/2014-01-15-a-homeless-bazaar-cape-towns-street-store-where-everythings-for-free/; http://thegreentimes.co.za/where-do-all-the-clothes-go/ and http://www.theclothingbank.org.za/theclothingbank/
46. PAGE. (2018). A Green Economy Industry and Trade Analysis: Assessing South Africa's Potential. UN PAGE. Retrieved from http://www.un-page.org/files/public/green_economy_industry_and_trade_analysis_-_south_africa.pdf

South Africa's Potential[46], found that there were gaps and opportunities for trade in green goods, although the potential may be realized with strong support from both government and the private sector. The report identifies opportunities for the establishment of local expertise and capabilities, particularly in the **biocomposites** field and development of the **biogas**-to-transport value chain.

3.2.6 Industrial symbiosis

The 2004 National Waste Management Strategy (NWMS) Implementation Project, which was aimed at giving effect to the 1st NWMS for South Africa (DEAT, 1999), identified waste exchange as a mechanism of improving materials circularity within industry.

Opportunities exist for improved materials circularity in industry through industrial symbiosis initiatives.

The revised and updated 2018 National Waste Management Strategy (NWMS) has the concept of the "circular economy" at its centre and highlights circular economy as a useful way of understanding implementation of the waste management hierarchy in terms of its contribution to the green economy and the decoupling of economic activity from harmful environmental impacts.

However, it is only recently that South Africa has strengthened waste exchange activities through various provincial **industrial** symbiosis (IS) programmes, such as the Western Cape Industrial Symbiosis Programme (WISP)[47]. Industrial symbiosis programmes significantly improve materials circularity within industry clusters, creating opportunities to reduce costs, improve resource efficiency and increase global competitiveness.

The NCPC-SA provides industry with opportunities for training, knowledge sharing and access to technical expertise as well as serving to facilitate communication between companies and sectors in order to identify business partnerships that keep resources in production cycles that avoid waste, thereby implementing the concept of a circular economy.

3.3 Waste management services

According to StatsSA (2018), the percentage of households for which refuse was formally removed at least once per week, increased from 56.1% in 2002 to 65.9%, in 2017. This implied that 34.1% of households in South Africa "dump or leave their rubbish elsewhere", make use of their "own refuse dump" or a "communal refuse dump", or have access to a less frequent service. Lack of access to regular waste collection services is particularly problematic in rural areas in South Africa, with only 9.9% of rural households having access to a weekly waste collection service.

This has the potential to cause significant "leakage" of waste into the environment (Figure 10). While wastes such as paper, food, animal waste and garden waste will biodegrade, emerging non-biodegradable waste streams such as plastic or WEEE instead accumulate in these rural environments, with the potential to cause significant environmental pollution.

47. Western Cape Industrial Symbiosis Programme http://greencape.co.za/wisp/

Figure 10: Windblown plastic litter and localized illegal dumping

Image credit: J E Lombard

Figure 11: Recyclable materials with value collected by informal salvagers/reclaimers

Image credit: S Käsner; DEA

Informal waste pickers play an important role in circular economy initiatives (Figure 11) and are responsible for the recovery of between 80% and 90% (by mass) of paper and packaging material waste streams at little or no cost to business or government[48].

The informal sector already plays a vital role in the circular economy of South Africa

Opportunities exist in the informal sector to increase collection and recycling rates. However, it is imperative to remain cognisant of the need for addressing “decent work”.

Private sector waste contractors provide the bulk of waste management services to South Africa’s commercial and industrial sectors, particularly for hazardous materials. Such services include advisory and waste minimisation programmes to assist in separating materials at source for further treatment or beneficiation. Current waste services address the minimisation of waste incrementally but transformative changes in product design and innovative waste prevention measures are required higher up the **materials value chain** to achieve true circularity.

The circular economy encourages inter-company exchanges and synergy-building, leading to better economic, social and environmental performance.

Source: UNIDO (2017)

48. Godfrey, L., Strydom, W. and Phukubye, R. (2016) CSIR. Briefing Note. Integrating the Informal Sector into the South African Waste and Recycling Economy in the Context of Extended Producer Responsibility Retrieved from https://www.wasteroadmap.co.za/download/informal_sector_2016.pdf (Accessed December 2018)

Waste management services also offer potential economic opportunities associated with improved waste collection, alternative collection methods and decentralised management of waste in South Africa.

CHAPTER 4: CIRCULARITY WITHIN THE WASTE SECTOR

As recognised by government, opportunities for circularity within the waste sector "*can be achieved through cleaner production, industrial efficiency, dismantling, refurbishment and re-use, as well as new methods of collection, sorting, reprocessing and manufacturing*" (Minister Edna Molewa, DEA 2017)[49].

This chapter provides practical examples and case studies from South Africa, Africa and other waste sector-related initiatives where improved materials circularity may be achieved. It addresses the materials value chain, the waste hierarchy (3Rs) (Figure 27) and the CE framework (Figure 4).

4.1 Waste prevention

Preventing the production of waste must commence at the earliest stages of planning and design of the materials value chain. Waste must be designed out of the system using Resource Efficient and Cleaner Production (RECP) methodologies that lower costs through reduced energy, water and materials usage, and waste management. It is also during these early stages that take-back schemes and reverse logistics inform minimal waste generation.

Voluntary industry initiatives may be effective where a circular economy opportunity requires change along the value chain. Local and International examples include:

⇒ PETCO - the PET Recycling Company addresses Extended Producer Responsibility as the end-of-life solution for the PET bottle sector in South Africa on a collaborative basis, both financially and operationally[50].

⇒ Polyco - The Polyolefin Responsibility Organisation NPC, trading as Polyco, is a not-for-profit industry body that was established in 2011 to focus on reducing the amount of polyolefin waste going to landfill by increasing the sustainable collection, recycling, recovery and beneficiation of polyolefin plastics. Its mission is to support the creation of a society where litter is minimised and the value of waste is maximised, through facilitating the responsible management of used polyolefin plastic packaging material[51].

⇒ Polystyrene Association of South Africa - The Polystyrene Association of SA (previously known as the Polystyrene Packaging Council) was established in February 2007. Representing the major players in South Africa's polystyrene manufacturing industry, the association has expanded its operations to become a facilitator between the recyclers and suppliers of recycled polystyrene (post-consumer and post-industrial), and the buyers representing the various end-markets[52].

⇒ Metpac-SA – The initiative's mission is to establish the industry as a valuable and recognised contributor to sustainability throughout the supply chain and beyond. It provides support and represents members on industry matters related to operational, regulatory and environmental issues. It also promotes the benefits of metal packaging and the sustainable attributes of steel and aluminium[53].

⇒ The Glass Recycling Company - The Glass Recycling

49. DEA May 2017. Minister Dr Edna Molewa's speech at the South Africa – European Union Seminar on Circular Economy
50. PETCO - http://petco.co.za/about/
51. Polyco - https://www.polyco.co.za/
52. Polystyrene Association of South Africa - https://www.polystyrenesa.com/about_us
53. Metpac-SA - http://www.metpacsa.org.za/

Company (TGRC) is South Africa's official organisation for promoting glass recycling. The Company's core objective is to conserve glass by promoting the practice of recycling and re-using this environmentally friendly packaging. Our strategic objectives also focus on the promotion of the reuse of returnable bottles; entrepreneur development and job creation; capacity building and development of synergies with all levels of Government as well as NGOs[54].

⇒ RecyclePaperZA - RecyclePaperZA became the new name of the Paper Recycling Association of South Africa (PRASA) in October 2018. The 15-year-old paper recycling arm of the Paper Manufacturers Association of South Africa (PAMSA) was formed in 2003 to represent companies that process recovered paper and make new paper products. It also represents some manufacturers of liquid board packaging in the form of milk and juice cartons, paper cups and bowls[55].

⇒ The Australian Packaging Covenant (APC) is an agreement between government, industry and community groups to improve packaging sustainability.

⇒ Ecoprofabrics is a joint project, part-funded by the EU Eco-Innovation Initiative, of six companies in the Netherlands focused on closing a clothing production loop.

⇒ *Voluntary Design Guidelines for Designated PET Bottles*[56] in Japan, a document that prescribes requirements for bottles, labels, closures and other components of PET bottles, so as to ensure that containers have a high suitability for recycling. This includes the use of only clear PET bottles in Japan.

⇒ The National Cleaner Production Centre of South Africa (NCPC-SA), a legacy of the World Summit on Sustainable Development (WSSD) of 2002, and hosted by Department of Trade and Industry (the dti), assists industries to select RECP methodologies that lower costs through reduced energy, water and materials usage, and waste management[57]. The NCPC aims at preventing waste, improving resource efficiency (through reducing virgin material consumption) and circulating secondary resources within manufacturing processes, as the first step towards a CE. The NCPC assists companies to carry out in-plant RECP assessments using RECP assessment tools. Such tools include:

- Assessment of process flows for identification and evaluation of RECP opportunities
- Input/output analysis for materials, energy, water, chemicals
- Embedded source and root cause analysis
- Cleaner Production Toolkit (for experts)
- Resource Efficiency Toolkit (for SMEs).

The Switch Africa Green (SAG) programme has developed a training manual for RECP assessments[58] as well as various other useful resources to assist in waste prevention strategies[59].

⇒ Initiatives undertaken by NCPC and SAG include:
⇒ Industrial systems optimisation
⇒ Energy and water management
⇒ Life-cycle management
⇒ **Eco-innovation**
⇒ Industrial symbiosis.

54. The Glass Recycling Company - https://theglassrecyclingcompany.co.za/who-we-are/
55. RecyclePaperZA - https://recyclepaper.co.za/about-us/
56. The Council for PET Bottle Recycling (JAPAN). 2016. Voluntary Design Guidelines for Designated PET Bottles http://www.petbottle-rec.gr.jp/english/pdf/guidelines2016_matterial_e.pdf
57. DEA. 2017. SWITCH Africa Green. Review of laws, policies and business environment. Country Implementation Report and Plan. South Africa
58. SAG Training manual: Retrieved from https://www.switchafricagreen.org/images/toolkits/ISL/SAG-REEEP-Training-manual----final-version.pdf
59. SAG Resources: Retrieved from https://www.switchafricagreen.org/index.php?option=com_docman&view=list&slug=green-economy-and-scp-resources&Itemid=1326&lang=en ; https://www.switchafricagreen.org/index.php?option=com_docman&view=download&alias=7-resource-efficient-cleaner-production&category_slug=green-economy-and-scp-resources&Itemid=1326&lang=en

Collaborative platforms promote industrial symbiosis (IS), public-private agreements, research and development (R&D) clusters and facilitate voluntary industry initiatives. They provide information and reduce costs for companies looking for collaboration partners in circular business ventures.

South African and international examples of IS programmes include:

⇒ South Africa's Western Cape Industrial Symbiosis Programme (WISP); as well as the IS platforms in Gauteng and Kwazulu-Natal

⇒ Various innovation/incubation hubs around SA, including the Innovation Hub in Gauteng; Workshop 17 in the V&A Waterfront, Cape Town; and the newly launched Atlantis Special Economic Zone which focuses on green technologies

⇒ The Green Industrial Symbiosis Programme in Denmark

⇒ Eco-industrial parks in China

⇒ The Textiles Recycling Valley initiative in northern France, where the local government is directly fos-

CASE STUDY 1: INDUSTRIAL SYMBIOSIS: WASTE EXCHANGE PROGRAMMES, WESTERN CAPE, SOUTH AFRICA

Overview: Two waste exchange programmes operate in the Western Cape: the City of Cape Town's Integrated Waste Exchange (IWEX) and the Western Cape Department of Environment and Planning's Western Cape Industrial Symbiosis Programme (WISP).

The need: General wastes, including industrial and agricultural wastes, usually end up at landfills where they take up valuable airspace and generate leachate and greenhouse gases that are potentially harmful to the environment.

The solution: The City of Cape Town's IWEX is a public online system for the purpose of exchanging waste materials. It is a free, user-driven service that supports the diversion of waste from landfill and saves resources. The underlying premise is that "one person's garbage is another person's gold". An easily accessible IWEX catalogue online contains a list of available items and a list of wanted items. The service is freely available to anyone who generates or uses waste.

The WISP is a provincial networking service that offers free support to business and industry from specialists working for GreenCape, a non-profit Sector Development Agency for the green economy in the province. It is funded by the Western Cape Department of Economic Development and Tourism under its green economy portfolio. The GreenCape team assists in linking companies that can exchange or use residual resources optimally, creating a network of opportunities to maximise the beneficiation of resources, close material loops, and work towards zero waste.

What makes it circular? These two programmes promote partnerships between the public and private sectors via free-to-use digital information-sharing platforms, by facilitating the exchange of materials for use as resources in other processes, instead of resorting to landfill. In this way unwanted materials can be beneficiated into higher value products, waste disposal costs can be reduced, and resources, energy and scarce landfill airspace can be conserved.

IWEX helps businesses turn the fixed costs for waste storage, transport and disposal into savings, enhancing competitive edge through cost savings and environmental benefits.

Find out more: http://www.capetown.gov.za/Family%20and%20home/Residential-utility-services/Residential-solid-waste-services/Integrated-waste-exchange-(IWEX); http://web1.capetown.gov.za/web1/IWEX/Pages/IWEX_WP_Catalogue_List; http://greencape.co.za/wisp/; and https://www.greencape.co.za/content/sector/wisp tering collaboration around textiles flows in four clusters to develop innovation in recycled textiles.

The National Cleaner Production Centre of South Africa supports several industrial symbiosis programmes (ISPs) to improve the circularity of material flows among participating industries. Examples include the Western Cape Industrial Symbiosis Programme (WISP), successfully hosted by the Western Cape provincial environmental ministry through the GreenCape organisation, as well as the Integrated Waste Exchange Programme hosted by the City of Cape Town (Case Study 1).

Cooperation may be centred on an association or institution with or without government involvement[60], for example:

- ⇒ African Circular Economy Network (ACEN)[61]
- ⇒ African Circular Economy Alliance
- ⇒ The Chinese Circular Economy Association (CCEA)
- ⇒ The Circular Economy Institute in France.

Research and development collaboration examples include:

- ⇒ The Biorefinery Industry Development Facility (BIDF) launched at CSIR by the SA Government in March 2018. – Currently it has R55m allocated to SMME development in the biorefinery space, with an initial focus on lignocellulose.

- ⇒ National Cleaner Production Centre South Africa (NCPC-SA), is also part of the CSIR, which is a research facility. The centre focuses on the industrial and manufacturing sectors, promoting resource efficiency and providing cleaner production assessment and support through regular cross sector training and knowledge sharing platforms.

- ⇒ Rethink Resources is a Danish centre for resource-efficient production and product design innovation. The initiative is a partnership between universities, technology centres, manufacturing companies and the Danish Ministry of Environment and aims to support resource efficiency in companies. It makes available new knowledge about product design, manufacturing processes, closed-loop, life-extension and new business models.

- ⇒ The UK government funds research clubs on integrated bio-refineries and bio-based processing[62]. The 2019 AWP is the sixth gathering scheduled on the critical path towards 2020. The ongoing focus is on accelerating of the development of new, sustainable value chains from biomass feedstock supply, via efficient processing, to the acceptance and application of bio-based products in the end-markets.

4.2 Waste Collection

In South Africa, the collection of municipal solid waste is the legal mandate of the local municipality. The business sector often makes use of private sector waste management service providers to fulfil waste collection services. The transition to a circular economy approach would require a shift from the current linear model structure towards the separation of material flows at source, a crucial requirement to retain the value and maximise the beneficiation potential of end-of-life products.

Many countries have been pursuing the recycling of organic waste both at household and commercial level. At a household level the focus has been to encourage mulching, uptake of the Bokashi[63] bin for the production of organic fertiliser, methane gas production for direct use and

60. Government involvement is not a deal-breaker but is encouraged

61. The African Circular Economy Network is a Registered Not for Profit Organisation

62. Announcement: The sixth BBI JU Call for Proposals 2019 is now open (4 April 2019) with indicative budget of EUR 135 million for a total of 21 topics with 10 Research & Innovation Actions topics, 4 coordination & support actions, 4 demonstration projects and 3 flagship projects. covering feedstock, process, products, and market uptake. https://ktn-uk.co.uk/news/ktn-to-host-a-consortia-building-workshop-to-support-organisations-interested-in-european-funding-for-bio-based-industries-bbi

63. www.bokashishop.co.za

biogas to energy generation. At a commercial level the uptake of anaerobic biodigestors have advanced significantly in pursuit of cleaner renewable energy generation. An added benefit to the latter initiative, also allows for the use of the resultant slurry as an organic ferteliser, either in the form of liquid fertiliser (in its existing state) or alternatively the separation of liquids and solids to produce a dry organic based fertiliser.

Collection of waste presents both informal and formal work opportunities. The quantities of waste and geographical service coverage within a municipal area can be improved by implementing community-based, small or one-person contracts, particularly in areas where the

CASE STUDY 2: Wecyclers Recycling and Awareness, Lagos, Nigeria

Overview: An innovative start-up programme, Wecyclers brings domestic waste collection and treatment to Nigerian households through a fleet of cargo bikes working at community level, a waste sorting hub and innovative collection incentives for recyclables and waste awareness at household level.

The need: Many Nigerians do not have access to waste collection services, resulting in waste being dumped along open spaces. This leads to a number of health issues and the rapid spread of diseases, particularly for the population living in slums near open landfill sites. In Lagos, Nigeria, for example, approximately 40% of waste is collected and approximately 13% recycled. Many African countries experience similar challenges of poor waste collection services due to lack of infrastructure and rapidly growing populations.

The solution: The Wecyclers model uses a fleet of bicycles to collect recyclables such as paper, plastic bottles, sachets and aluminium cans from households in densely populated, low-income neighbourhoods which are not easily accessible to waste disposal trucks. For every kilogram of material that families recycle with Wecyclers, they receive points via their cell phones, in return. Points can be redeemed for goods such as cell phone minutes, basic food items, and household goods. After collection, Wecyclers aggregates the materials to sell to local recycling processors, thus providing a consistent supply of well-sorted, high quality recyclables to processors. Awareness and encouragement are necessary for people to make the first step towards sorting their waste.

Figure 13: Cargo-bicycles for recyclable collection

What makes it circular? Through a simple, low-cost, labour-intensive collection service and innovative reward programme, Wecyclers can collect and reintroduce recyclable material back into the economy. Wecyclers makes money by selling the recyclables to bigger companies that process and then sell them on, thus reducing the number of people on dangerous landfills searching for waste at the mercy of brokers. Wecyclers claim to be the first operation of its kind in Africa. The use of a mobile phone-based incentive programme is innovative, as is the attention paid to the human element in the system.

The result: As the operation has grown, motorized tricycles, vans, and trucks have been added to expand Wecyclers' reach across the Lagos metropolis and provide materials to manufacturers who turn the recyclable material into new items including tissue paper, stuffing for bedding, sturdy plastic furniture, aluminium sheets, and nylon bags. Partnerships have included government, business (including brand owners) and academia. By 2016, Wecyclers have served 15,000 households, reaching 60,000 beneficiaries, creating more than 150 jobs and recycling 3,000 tonnes of waste. Waste volumes in programme areas in Lagos have been reduced by over 35% owing to this entrepreneurial, social innovation.

Source: http://wecyclers.com/; http://venturesafrica.com/trash-is-cash-bilikiss-kola-abiola-is-building-an-economy-out-of-waste/; http://www.lionessesofafrica.com/lioness-bilikiss-adebiyi-abiola/; http://wecyclers.com/category/press/videos/

infrastructure does not allow easy access to collection trucks. Such small contracts can be overseen by a middle level management contract where a private sector company can monitor performance and assist in contract administration and revenue collection. An example where the collection efficiency (volumes collected) and sorting is incentivised and enhanced and communities and the informal sector have been incorporated into the waste economy, is that of the Wecyclers Recycling and Awareness initiative in Lagos, Nigeria (Case Study 2).

4.3 Biological processes

Biological materials make up a large proportion of the waste materials currently being disposed of at landfills, across African and other developing countries. Improving the diversion of organics from landfill will result in a significant saving of scarce airspace as well as reducing greenhouse gas (GHG) emissions, odours and leachate. The organic fraction can be diverted into a range of different technologies that include (aerobic) composting, anaerobic digestion, biogas to energy generation, and biorefining to produce high value products (fuels, animal feeds, pharmaceutics, bio-materials and other high value chemicals).

Existing landfill airspace in South Africa is rapidly decreasing, while waste volumes disposed of at landfill sites, continue to rise. Many cities have less than 5 years of landfill space remaining. In response to the ever-growing waste problem in the Western Cape Province, the Western Cape Department of Environmental Affairs and Development Planning (DEA&DP) announced a 100% reduction on organic waste to landfill[64] by 2027, with achievement of 50% of the 50% by 2022. To ensure compliance, existing waste disposal facilities and new applicants alike will have to start reducing their intake of organic waste.

The diversion plan requires municipalities to set annual targets and identify procedures to meet those targets. The ban will put pressure on waste management companies and municipalities to manage organic waste better, and will ensure that all organic waste in the province is diverted from landfill. The policy announcement communicates a clear signal, stimulating the private sector to invest in alternative waste treatment technologies for organic waste generated in the province.

The cost associated with disposal to landfill is expected to increase dramatically over the next few years as a result of recent norms and standards for landfill design and operational controls which have increased the cost of site construction and development, as well as the increasing difficulty of establishing new landfills. Increased landfill costs serve as motivation for all businesses relying on landfill for disposal of waste, to find alternative options for their unwanted materials. Municipal by-laws increasingly require integrated waste, management plans to demonstrate how businesses will minimise waste streams and rely less on landfill technology. Forward-thinking businesses have developed strategies to divert organic waste from landfill with many aiming to become zero-waste-to-landfill facilities and to operate independently of these external factors.

4.3.1 Composting

One of the simplest methods of treating biodegradable, organic waste materials such as garden refuse, food waste and wood waste is through composting. Composting is a biodegradation process, carried out by various microorganisms, which include associations of bacteria, and fungi,

64. Retrieved from https://www.esi-africa.com/western-cape-bans-organic-waste-in-landfills/

CASE STUDY 3: COMPOSTING – TURFNET, JOHANNESBURG, SOUTH AFRICA

Overview: A Gauteng-based landscaping business in South Africa, established in 1995, has grown into a major player in the organic recycling industry, operating in a specialist niche market in South Africa. From suburban and urban landscaping, the company plans to expand into mining and corporate agriculture, which are two sectors that tend to destroy soils and pollute streams and rivers with runoff of inorganic chemicals. Turfnet plans to undertake rehabilitation projects followed by contractual maintenance and support.

The need: The owner of the company observed that in spite of the use of inorganic fertilizers, the plants and grass still became diseased and did not fare well. He wanted to find a better way of conditioning the soil to improve the condition of the vegetation.

The solution: The owner started his own composting operation, to which he added vermiculture. The earthworms in turn produced "compost teas" which have a range of organic applications to rehabilitate and maintain soils.

Figure 14 Wheeled loader moving steaming compost pile at Turfnet
Image credit: JE Lombard

What makes it circular? Degraded, badly managed soils, in areas such as mine dumps, road cuttings or abandoned agricultural fields, are rehabilitated and maintained using organic methods Turfnet introduces a new medium, based on fungal-dominated compost, blended with clay, inoculated with protozoal teas and with paramagnetic dust and vermicasts added. The medium is fed back into the biological cycle, thus closing the material loop.

The result: The company and its subsidiaries have operated successfully and now employ over 250 people and utilize a wide range of equipment. It has become one of the largest landscapers and producers of organic material in Gauteng to enable people to produce healthy food, parks and sports fields through its products that build healthy soils.

Source: https://www.turfgreen.co.za/home

most commonly under aerobic conditions (i.e. in the presence of oxygen). Aerobic composting generates heat and does not have an unpleasant odour.

Organic materials are chipped or milled, then placed in windrows or in composting vessels to be broken down by microbes into simpler substances under aerobic conditions and with optimal conditions of oxygen, moisture, temperature and carbon and nitrogen sources in the organic materials. In the composting process, various microorganisms, including bacteria and fungi, break down organic matter into simpler substances and eventually into carbon dioxide and water. The composted material may be graded and utilised as a soil ameliorant.

Retailers are currently researching alternative food packaging options with many investigating, or already using, biodegradable compostable packaging. The switch to biodegradable packing materials must be informed by evidence to ensure that it provides the best circular materials option with least environmental impact.

4.3.2 Anaerobic digestion

Anaerobic digestion (AD) is a technology widely used to generate methane gas from the biodegradation of organic waste streams for electricity and heat generation. Anaerobic digestion is a method of treating biodegradable, organic waste materials such as food waste, organic agricultural and forestry wastes and effluents containing organic materials. Anaerobic digestion is a biodegradation process carried out by microorganisms that include complex associations of bacteria, fungi and archaea under anaerobic conditions (i.e, in the absence of oxygen). Anaerobic digestion is a cooler process than aerobic processes such as composting and tends to have an unpleasant odour due to the traces of odorous gases in the biogas, which is mainly composed of colourless, odourless methane and carbon dioxide gases.

Organic materials are chipped or milled, then placed in airtight vessels. In the anaerobic digestion process, microorganisms break down organic matter into simpler substances and eventually carbon dioxide, methane and water, in the absence of oxygen. The pH, moisture, temperature, carbon and nitrogen inputs is carefully controlled. The methane gas may be flared off or utilised as fuel for heating, lighting or generating electricity. The residual digested matter can be used as a soil ameliorant.

Anaerobic digestion is a sensitive technology requiring careful control of material inputs. If there are significant quantities of sand and grit in the organic feedstock for digesters, they tend to clog up and render the plant inoperable. Anaerobic digesters rely on a biological system, to break down organic materials to methane, carbon dioxide and water. If the temperature, composition or pH of the material being fed into the digesters fluctuate dramatically, the microbes will not function consistently. The inability of microbes to function will result in the decrease in biogas generation.

The uptake of anaerobic digestion both at commercial level and in the rural context in South Africa is progressing at a slow pace compared to other developed and developing countries. This is attributed to intensive capital investment requirements, slow and hindering associated legal processes, and inadequate understanding of the sensitivity of the biological system[65].

To beneficiate organic waste streams, ways to create a conducive environment for private sector investment in biogas should be established, for example set up of incentive schemes for an interim period as seed funding for industry establishment. There are numerous practical case studies available which demonstrate both the process and benefits of implementing a circular economy. Both industrial and agricultural practices inevitably produce wastes. These perceived waste streams may be used in a number of innovative ways as primary input material for further processing activities. The biogas-to-energy sector clearly details this interplay between waste (organic and agricultural) used as a primary input (feedstock) for the generation of energy (Case Study 4).

65. *GIZ SABIA (2016). Biogas Industry in South Africa. An Assessment of the Skills Need and Estimation of the Job Potential. Retrieved from https://www.crses.sun.ac.za/files/research/publications/SAGEN%20Job%20Pot%20-%20Digital%20(low-res).pdf*

CASE STUDY 4: THE MIDLANDS BIOGAS PROJECT

In September 2017, Renen Energy Solutions successfully applied for a $198 235.00 USD grant from the Global Environment Facility (GEF) to undertake a Biogas-to-Energy project where waste (organic and agricultural) is used as a primary input (feedstock) for the generation of energy. The energy is then utilized for other agricultural operations. The grant forms part of a programme jointly implemented through the United Nations Industrial Development Organisation (UNIDO) and the South African Government through its Department of Environmental Affairs.

The project comprises two phases:

⇒ Phase 1: Design, construction and commissioning a 110 kW CHP capacity digester at Sunshine Nursery Services in KwaZulu Natal, South Africa

⇒ Phase 2: Development of an additional 10 sites to “ready for construction” stage.

The anticipated capacity output for both phases is envisaged to be 1.5 MW. Construction under phase 1 was completed with an output capacity of 50 kW. The plant is located in close proximity to Sunshine Seedling Nursery, 25 km to the north of Pietermaritzburg in KwaZulu Natal. A number of agricultural activities are undertaken within the vicinity of the plants. The nursery and other agricultural activities have led to a crucial diversification of income beyond that of the initial sugarcane production. Furthermore, the nursery specialises in the production of essential oils, an industry which provides a very high rate of return on investment and is targeted at both the local and export markets.

The aforementioned agricultural activities result in the production of significant quantities of organic and agricultural waste which need to be managed. The bio-digester constructed under phase 1 provides a solution to managing these waste streams. In addition to addressing waste management requirements, the production of energy from waste material further provides the nursery with a dependable, renewable source of energy for use during daily operations.

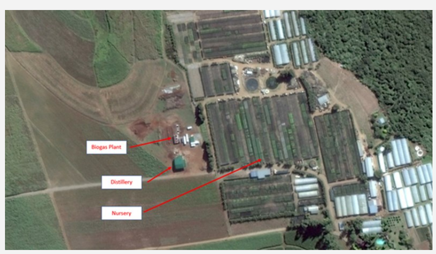


Figure 15 Biogas plant location in relation to the Nursery. *Source: Renen Energy*

The nursery services produce in excess of 50 million vegetable seedlings annually including 10 million forestry clones[66]. The biogas plant uses chopped nursery waste and cattle manure as its primary feedstock, to produce biogas and digestate slurry.

Figure 16 Loading of Feedstock Source: Renen Energy

The biogas which is produced, is used in a number of ways to provide energy, which is in turn sold back to the nursery. This includes (i) direct burn in boilers to provide hot water for heating tunnels, (ii) electrical generation by a gas fired engine generator, and (iii) direct burn in a modified gas boiler for steam generation in the essential oils distillery. Currently the resultant digestate slurry is used in its liquid form as a fertilizer, however trials are underway to separate the liquid and solid fractions for a broader range of application.

66. Retrieved from: http://www.sunshineseedlings.co.za/company/who-we-are/

Another example of small-scale anaerobic digestion is Another example of small-scale anaerobic digestion is the Uilenkraal Dairy Farm[67] which has established a bio-digester that uses cattle manure as input feedstock to generate electricity for the farm. The biogas that is produced powers two generators, resulting in a production capacity of 200 kWh of electricity per day for each generator. There is the potential to use the slurry from the bio-digester as liquid fertilizer on farm crops. Between mid-2014, at the start of its operation, and the end of that year, the farm reduced its monthly electricity bill from R110,000 to R45,000. From December 2014 to mid-2015, the monthly electricity cost dropped further to R12,000 as a result of the two new generators which run on Uilenkraal's purified biogas. The structure of the bio-digester allows for easy maintenance. Investment in the plant cost R10 million, with a payback period of 10 years.

Biogas to energy generation and composting provide ways of dealing with organic waste in a decentralized way. Several initiatives piloting the production of small-scale anaerobic digesters for generation of methane as an alternative source of energy for heating and cooking show that generation and uptake of biogas in rural, semi-rural and peri-urban, is a viable option for consideration.

4.3.3 Crop residues for animal feed and fuel

Agricultural wastes are burned during harvesting, re-

CASE STUDY 5: Crop residues for animal feed and fuel

Overview: Agricultural residues such as sugar cane green tops and dry trash, cereal straws, woody stalks, wheat stubble and even fallen palm leaves can form the basis of livestock feeds or a source of fuel.

The challenge and need: Much agricultural residues such as sugar cane trash are disposed of, by burning or landfilling, where their value is lost to the environment. Burning of crop residues leads to release of particulates and smoke causing human and animal health problems. Greenhouse gases are emitted, contributing to global warming and loss of minerals/chemical compounds nitrogen, phosphorus, potassium and sulphur nutrients. The heat generated from the burning of crop residues elevates soil temperature causing death of active beneficial microbial population. However, value may be recovered from agricultural residues and in producing affordable livestock feed.

What makes it circular? The sugar cane green tops can be utilized as an ingredient in livestock feed, closing a biological material loop. Dry sugar cane trash can be made into fuel briquettes and even into a biofuel, ethanol. To make a viable business model for this, it's essential to have researched on the following components:

⇒ Market price of each energy type in rural households
⇒ Energy consumption of each energy type in rural households
⇒ Market price of each energy type in urban households
⇒ Energy consumption of each energy type in urban households

There are initiatives in several African countries such as Uganda and Sudan, as well as other countries including India, Brazil, Australia and the USA.

67. Claasen, J., 2015. Affordable SA bio-digester powers local dairy farm. Farmer's Weekly, 26 June. Retrieved from: https://www.farmersweekly.co.za/agri-technology/farming-for-tomorrow/affordable-sa-bio-digester-powers-local-dairy-farm/

sulting in air pollution and nutrient/carbon recycling (Case Study 5). However, burning of ground litter and post-harvest agricultural waste is a way of returning carbon to the soil. In South Africa, agricultural wastes such as sugar cane trash can be converted into animal feed and fuel, thus increasing their value and offering opportunities for circularity, particularly for the sugar industry.

CASE STUDY 5: Crop residues for animal feed and fuel. Cont...

Figure 17: Sugar cane trash chopped up as silage for animal feed

Image credit: Paulo Tanaka. Source: http://spore.cta.int/en/dossiers/article/fodder-and-forage-solutions-sid0ce10359a-9b84-4a83-843f-8b726cd7fb83

Explore examples from the following countries:

Uganda: https://caes.mak.ac.ug/Documents/Web-stories/Utilizing-sugarcane-industrial-wastes-for-animal-feeds-and-fuel.pdf

Sudan: https://www.researchgate.net/publication/280320346_Sugarcane_tops_as_Animal_Feed

India: https://www.researchgate.net/publication/323218626_Utilization_of_Crop_Residues_for_Livestock_Feeding_A_Field_Experience and **https://**ijapsa.com/published-papers/volume-3/issue-6/utilization-of-unconventional-sugarcane-trash-as-feed-in-narisuwarna-x-kenguri-sheep.pdf

Brazil Bioethanol: http://pdf.blucher.com.br.s3.amazonaws.com/openaccess/sugarcane-bioethanol/SUGARCANEBIOETHANOL_56.pdf

Australia: http://www.abc.net.au/news/2018-07-28/bagasse-can-be-used-as-animal-feed-for-livestock-and-energy/10034466; https://research.qut.edu.au/biorefining/animal-feed-from-sugarcane-bagasse-and-trash-2/

USA: https://www.ellenmacarthurfoundation.org/case-studies/palm-fronds-to-cattle-feed-valorising-a-costly-waste-stream

4.3.4 Biorefinery

A biorefinery is a facility that converts biomass to energy and other beneficial bio-based products such as high-value speciality chemicals from wood wastes; nanocrystalline cellulose biopolymers from paper mill sludge; and biocomposites from plant fibres such as cotton, wood, waste paper, in addition to the recovery of energy. A biorefinery, therefore, creates greater economic value than composting or anaerobic digestion (Figure 18).

Opportunities for strengthening biorefinery in local industries are being developed. A case in point is the government-supported initiative the Biorefinery Industry Development Facility (BIDF)[68] in Durban (Case Study 6). There is still much research to be done in this area. Currently

CASE STUDY 6: Biorefinery, Durban, South Africa

Overview: The Department of Science and Technology (DST)-CSIR Biorefinery Industry Development Facility (BIDF) works with forestry, agro-processing, and other biomass industries to improve manufacturing technologies and to develop and implement biorefinery technologies to create additional high value products from biomass process materials.

The need: There is very limited processing of South Africa's pulp and paper industry wastes. The industry extracts less than 50% value from trees which represents a highly inefficient use of this natural resource. The wood, pulp and paper wastes are landfilled or burnt, stockpiled, or even pumped out to sea. The potential to extract value from these wastes is therefore lost, along with the associated economic opportunities. Landfill space comes at an increasing cost and scarcity, making it increasingly unavailable in South Africa.

The solution: The DST-CSIR BIDF was established to help local industry improve its competitiveness by providing access to specialised analytical and pilot scale facilities and skills that enable the more efficient use of biomass resources, overcome significant organic waste challenges, and develop new products for the market. High-value speciality chemicals can be extracted from sawmill and dust shavings, while mill sludge can be converted into nanocrystalline cellulose, biopolymers and biogas, diverting waste from landfill (Figure 18).

What makes it circular? Through biorefinery, the BIDF retains materials in the biological cycle feeding them into further production processes. These processes produce higher value products such as lightweight composites, super-absorbent materials, and cosmetic additives (such as keratin) from chicken feather waste. Through the biorefinery process, biomass can be used as building blocks for the generation of high-value products such as proteins, fine chemicals, carbohydrates and oils, which create opportunities for a viable industrial bio-economy.

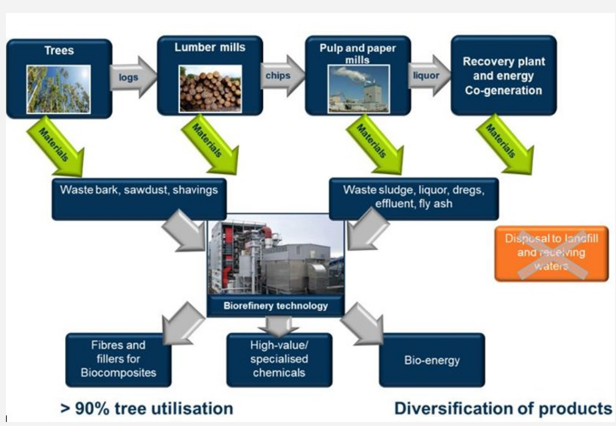


Figure 18 Circular economy opportunities in the forestry industry[69]

68. https://www.csir.co.za/biorefinery-industry-development-facility-0

69. Source: Presentation by Dr Henry Roman, A/Chief Director: Sector Innovation & Green Economy, Henry.Roman@dst.gov.za Circular Economy Dialogue. Elangeni Hotel, Durban. 13 August 2018.

CASE STUDY 6: BIOREFINERY, DURBAN, SOUTH AFRICA. CONT...

The result: At a macro level, in a low-carbon future, the BIDF biorefinery (which is comparable to a petroleum refinery) will use renewable biomass to produce bioenergy, biomaterials and bio-based chemicals. It will promote the development of an industrial bio-economy for the co-production of food and non-food (feed, chemicals, materials and energy) to facilitate the transition from fossil resources to renewable bio-resources. It will provide cost and energy-efficient ways to make optimal use of biomass for several applications. The impact can be measured via the revenues/sale of products, processes and services, as well as the number of new bio-innovation industries created. The role of technology transfer, collaboration and partnerships will also provide an indication of growth within the industrial component of the bio-economy.

Read more about this initiative here: https://www.gov.za/sites/default/files/NDP-2030-Our-future-make-it-work_r.pdf and https://www.csir.co.za/documents/biorefinery-brochure313marprintpdf

the main role-players in biorefinery research in SA include the Centre for Science Innovation and Research (CSIR), Stellenbosch University, University of KwaZulu-Natal and University of Cape Town.

Another organic material which is receiving increased attention globally, is food waste. The World Wildlife Fund for Nature (WWF) has published *The Food Loss and Waste: Facts and Futures report on the level of food waste globally, including in South Africa*[70]. The WWF report indicates at a glance:

⇒ A third of all food that is produced in South Africa, is never consumed and ends up in waste disposal sites and is in stark contrast to the millions of South Africans who are going hungry.

⇒ Water and energy costs means food wastage comes at a very high price to the economy and environment.

⇒ Many actions needed to reduce food waste are already well formulated knowledge and dissemination of information and knowledge related to food waste is essential in addressing this challenge. Communication products related to food waste should therefore be directed to specific target audiences.

As such, the SA government is equally committed to addressing the challenge of food wastage and subsequently reducing food wastage, in partnership with affected and interested stakeholders to contribute towards the achievement of SDG 12.3: "*By 2030, halve per capita global food waste at the retail and consumer levels and reduce food losses along production and supply chains, including post-harvest losses*".

Whilst not all food wastage can be avoided there are initiatives in place to address the problem. One such an initiative, uses the Black Soldier Fly to process significant quantities of food waste to produce high value products and animal feed (Case Study 7).

70. WWF.(2017) The Food Loss and Waste: Facts and Futures retrieved from: http://www.wwf.org.za/?21962/The-truth-about-our-food-waste-problem).

CASE STUDY 7: ORGANIC WASTE TO NUTRIENTS, AGRIPROTEIN, CAPE TOWN, SOUTH AFRICA

Overview: Agriprotein has developed an industrial scale waste-to-nutrient recycling technology where organic wastes is used as a food source for the black soldier fly (BSF) larvae. The larvae are then processed into several high value products including protein-rich animal feed, oil and soil conditioner.

The need: Most of South Africa's food waste is currently landfilled, using up valuable airspace, generating harmful greenhouse gases (GHG) and producing leachate with the ability to pollute water resources. There is a need for protein-based animal feed that is environmentally friendly, cost effective and a more sustainable alternative to fish meal.

The solution: AgriProtein sources and receives organic restaurant, factory and farm wastes that are graded, stored and blended into a scientifically controlled food waste mix that is optimised as a fly larva diet. The continuous supply of new batches of fly eggs is ensured through the breeding programme which is overseen by entomologists, who ensure that the strongest genetic strains are used whilst maintaining genetic diversity. Eggs become juvenile larvae that increase their weight over 200 times in 10 days as they eat through the larva food in optimal climatic conditions. The larvae are ready for harvest 14 days later. The larvae and food waste substrate are then separated into three product streams:

- ⇒ MagMeal™ is made from sustainable, dried and defatted insect larvae, that are ground into a high-quality protein meal, which can be blended into a variety of animal feeds.
- ⇒ MagOil™ is produced when whole dried larvae go through an extrusion process and become MagMeal™ and MagOil. No chemicals are used in the extraction of the natural fat from the larvae. It is a light golden brown solid at room temperature, highly palatable to animals and can be blended into a variety of animal feeds.
- ⇒ MagSoil™ is the organically broken-down residue of spent food substrate and residues after the processing of the larvae. It is a fine, homogeneous organic fertilizer, high in bio-available nitrogen, minerals and nutrients comprising a mixture of larvae tea, larvae castings, and undigested cellulose.

Figure 19 Black soldier fly larvae

Source: http://time.com/3825158/farming-flies-south-africa/

What makes it circular? The technology refines a natural process of using the larvae of black soldier flies to break down organic waste, effectively upcycling waste to high value products. The BSF larvae have a variety of uses in animal feeds and as compost in agriculture. The technological processes divert waste from landfill and the end products save valuable resources, including fish stocks.

The results: In 2015 the first full-scale factory diverted 110 tonnes of organic waste from landfill every day, using it to grow 22 tonnes of nutrient-rich larvae from which the main products – MagMeal, MagOil and MagSoil – were made. MagMeal has a 55% protein content and has proven to be an easily digested, safe, cost-effective alternative to fishmeal and a higher protein alternative to soybean for all non-ruminants, e.g. fish, pigs, poultry and pets, especially for animal development during their early life. The alternative to fishmeal saves fish with a calculated environmental cost saving of USD 2,000 per tonne. In using a high-tech blueprint developed and in partnership with Christof Industries, Austria, AgriProtein plans to roll out 100 fly factories by 2024, and a further 100 by 2027 to be operated as licensees of AgriProtein.

Source: https://agriprotein.com/; http://time.com/3825158/farming-flies-south-africa/ and https://www.businesslive.co.za/bd/life/2017-03-14-working-with-nature-to-help-feed-the-world/

4.4 Technological processes

Non-biodegradable, technical materials that include metals, plastics, bulky industrial waste streams (ash, C&D materials) can be diverted from landfill into a variety of different technological processes such as extending the life of the technical materials by maintaining functionality, repair, re-use, refurbishing, re-manufacturing and recycling.

4.4.1 Maintain, repair

There are many initiatives emerging that improve opportunities for maintenance, especially of items such as waste electrical and electronic equipment (WEEE), furniture, vehicles, tools and equipment. Opportunities should also be identified for including the informal sector, which is already active in this space, into the formal economy, by providing access to space, tools and equipment. SMME's are the stepping stone towards this transition into the formal sector and maker movement initiatives are currently being used to promote and support this transition. There are several examples of "maker movement" initiatives already operational in South Africa with great potential for further rapid uptake (Case Study 8).

CASE STUDY 8: Tool library or maker space

Overview: The Maker Station is an organisation that provides spaces for signed up members and provides shared learning, expertise, tools, and space where the tools and equipment are used and maintained on site. Tools and equipment are high quality and maintained.

The need: The need for new work opportunities in fast developing technical fields; affordable technical equipment, and skills to maximise the use of technology, plus the need to develop a competitive edge in the marketplace, are the main drivers of the initiative.

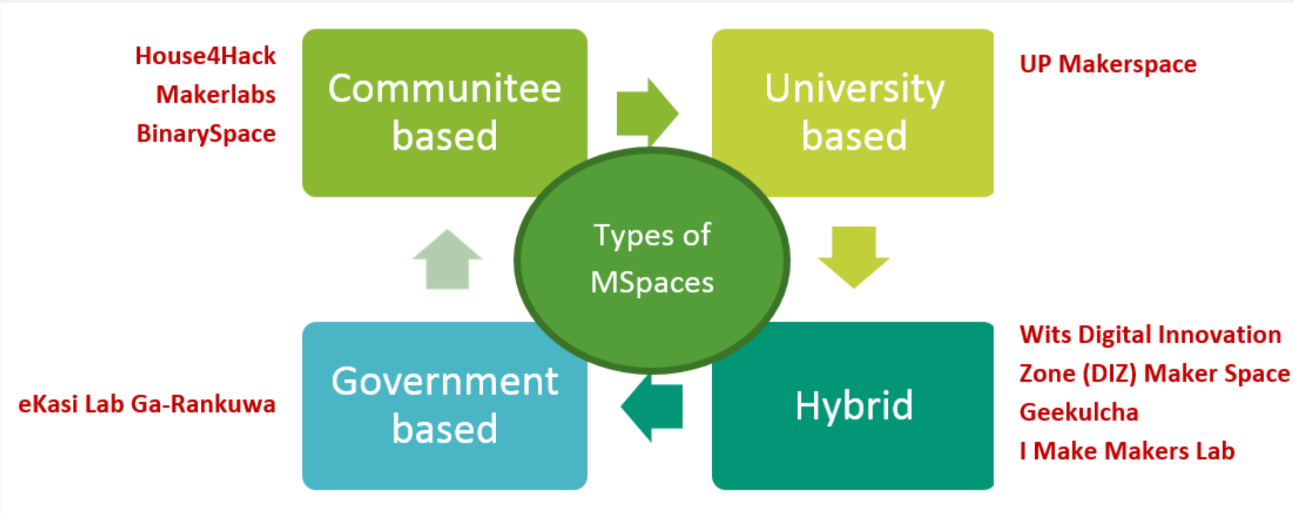
The solution: Repair, refurbishment or "maker-spaces" and tool libraries meet the need for repair or "maker-spaces". **Maker spaces** are collaborative learning environments where people come together to share materials and learn new skills. Maker-spaces might offer, for example, high technology electronics, 3D printing, 3D modelling, coding, robotic equipment, as well as lower technology equipment such as sewing machines, woodwork tools, and arts and crafts materials. Such spaces can also be utilized as incubators and accelerators for business start-ups.

Figure 20: Sandblasting station at Maker Station.
Source: https://makerstation.co.za/

In the Maker Station example, users pay a nominal, once-off sign-up fee of R250 to receive a permanent membership that does not expire. There are no ongoing monthly or annual subscription fees. There is more than one category of membership. Ordinary membership entitles to the user to a membership tag to access facilities. Full members can book a Hot Desk Workstation or any of the other Equipment Stations in the building that they qualify for. All members may use the free-to-use tools on the 1st floor tool-board in the building. All access must be booked in advance for every facility needed by the user. There are strict health and safety rules that must be adhered to. Members wishing to learn to use a piece of equipment, can book the additional services of a technician or commission a fellow member to supply the service. Workshops and courses on new skills are also offered at the centre. Members are allowed to bring their own tools and equipment at their own risk.

CASE STUDY 8: TOOL LIBRARY OR MAKER SPACE. CONT...

What makes it circular? This is an example of sharing economy where users do not own the tools or equipment, but pay for the functionality. The technical materials are maintained by the owner/operators of the maker space which extends the life of the tools and equipment.



The results: There is rapid uptake of this type of maker movement across South Africa in different forms (Figure 16)[71].

Figure 21: Types of maker spaces in South Africa

Source: Kramer-Mbula, Armstrong (2017)

The maker movement commenced in 2012/2013 and has grown rapidly. In 2014, there were 90 technical hubs in 24 countries; in 2015, 117 technical hubs, and by the end of 2016, 314 technical hubs and in 42 countries. Of these hubs, 12% are co-creation spaces or maker spaces, providing tools and machines for fabrication to users, serving as an incubation hub for start-ups, facilitating workshops, and conducting Science, Technology, Engineering and Mathematics (STEM) outreaches to secondary schools and other communities. In 2016, South Africa had the largest concentration – 54 active technical hubs in 2016 – followed by Egypt and Kenya[72].

4.4.2 Re-use/re-distribute

Transitioning to a circular economy must also improve opportunities for re-use and re-distribution of materials. Such a transition is highlighted in Case Study 9.

71. Kraemer-Mbula E and Armstrong C (2017) .Gauteng Makerspaces. Innovation, Skills development, Collaboration and Outreach. Presentation 31st March 2017 .
72. Ibid

4.4.3 Refurbish/remanufacture

Keeping materials within the technical loops of the circular economy means improving opportunities for refurbishment and repair, for example, of vehicles, machinery and equipment. South African examples of remanufacture include:

⇒ The repair and refurbishment of Caterpillar machinery parts that are re-sold with a remanufacturer's

CASE STUDY 9: TEXTILES - JEANS LEASE MODEL FOR ORGANIC COTTON JEANS

Overview: Jeans are manufactured from 40% recycled material and virgin cotton. For a nominal monthly fee which includes free repairs, users hire jeans, returning them to the organization, once they are no longer required. After one year, users have three options: they can swap their jeans for a new pair and continue leasing for another year; keep the jeans and wear them as long as they like; or end the relationship by returning the jeans and receiving a voucher for a new purchase. For those who decide to keep the jeans, the company offers financial incentives for return, to encourage recovery.

Figure 22: Jeans circular economy cycle; Old jeans being processed into denim fibre
Source: https://mudjeans.eu/circular-economy-our-story/

The need: The 'fast fashion' industry produces garments so cheaply that consumers buy and replace clothes regularly, discarding them rapidly, which generates waste. Less than 1% of raw material used to produce clothing globally is recycled into new clothing, which equates to a loss of USD 100 billion/ year. This consumption pattern is also associated with exploitation of vulnerable workers in developing countries, who work excessively long hours and in poor conditions for unsustainable poverty wages, trapping them in precarity. The new material content of the jeans, organic cotton, is a resource vulnerable to significant price fluctuation and supply disruption. The price of cotton tripled between 2010 and 2011. More effective use of the purchased virgin material is required to address these vulnerabilities.

What makes it circular? When jeans are returned, they are assessed, and the materials continue to flow through one of three loops: If the jeans are in good condition, they are cleaned and upcycled, sold as unique vintage pairs named after their former user. This is re-use and re-distribution. In some cases, repair is required, or the denim may be given a stone wash or enzyme wash. When they are beyond repair, the materials are returned to the denim manufacturer to be recycled. Discarded jeans are shredded and woven with virgin organic cotton to produce new denim material, from which more jeans can be made.

The solution: The subscription model enables a more consistent material supply chain and there are lower environmental and social impacts associated with the production of the jeans than when made from raw materials. Implementing circularity into a business makes it more resilient and gives it a competitive advantage. The novel idea of leasing clothing as well as the idea that an efficient throughput business model could yield better short-term sales demonstrates to the fashion world that cycling clothing is possible and profitable.

Find out more here: https://www.ellenmacarthurfoundation.org/case-studies/pioneering-a-lease-model-for-organic-cotton-jeans and https://www.youtube.com/watch?v=JaX60U2_Ibw guarantee from Barloworld Equipment in Boksburg

⇒ The refurbishment of printer cartridges for resale and dismantling for recycling by GreenOffice, Pinetown as outlined in Case Study 10.

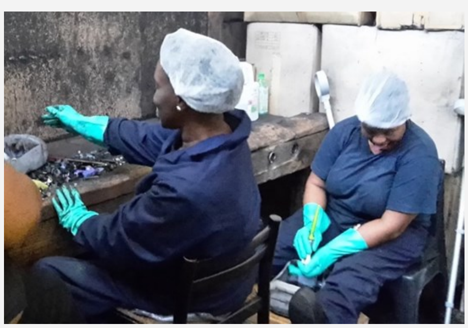
Refurbished products must be aligned to Original Equipment Manufacturer Standards (OEMS) for electrical and electronic equipment, machinery or vehicles, and must create synergies between refurbishment and new manufacturing.

CASE STUDY 10: GreenOffice and GreenAble: WEEE Refurbishing and Recycling, Pinetown, South Africa

Overview: Used printer cartridges from business and industry, which are classified as hazardous and would require disposal at a hazardous landfill, are refurbished for resale by GreenOffice. Printer cartridges that cannot be re-used further, are passed on to an associated Non-Governmental Organization (NGO), GreenAble, which employs people with disabilities, to dismantle the different plastic and metal components of the cartridges, for sale, as materials into the recycling market.

The need: In South Africa, of the 12 million printer cartridges that are produced per annum, 90% are landfilled. They are regarded as a hazardous waste but are often disposed, of at general waste landfills, which are not equipped to handle hazardous wastes. There is a great need for suitable employment for people who live with disabilities, particularly due to the current economic downturn in South Africa.

The solution: Printer cartridge refurbishment and recycling creates jobs, and the disassembly process can be carried out while still seated, which makes the work suitable for people with disabilities. The technology is labour-intensive and creates work opportunities.



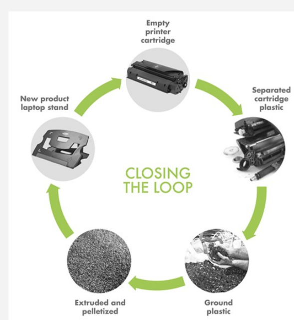


Figure 23. Dismantling of end-of-life printer cartridges for recycling

Image credit: JE Lombard

What makes it circular? The company collects the used items and delivers refurbished cartridges free of charge.
It recycles 305,690 printer cartridges per year equates to approximately 220 tonnes of waste being diverted from landfills and a reduction of carbon emissions by 263 tonnes each year. The company processes approximately 10 to 12 tonnes of plastic and 8 to 10 tonnes of metals monthly.
There are 44 previously disadvantaged disabled people employed at the GreenAble facility, who are provided with the necessary skills through workplace training.

Read more here: http://www.infrastructurene.ws/2013/11/28/introducing-greenoffice-and-greenable/ and http://greenable.co.za/

4.4.4 Recycle

A number of material organizations have been established across South Africa to support the recycling of paper and packaging, including (but not limited to):

⇒ Polyco – Polyolefins
⇒ PETCO – PET
⇒ METPAC – Metals
⇒ Polystyrene Association of South Africa
⇒ Packaging South Africa.
⇒ Paper Recycling Association of South Africa
⇒ The Glass Recycling Company
⇒ South African Vinyl Association
⇒ Plastics SA.

CASE STUDY 11: Compressed earth blocks, Pinetown, South Africa

Overview: Use-It manufactures compressed earth bricks/compressed earth blocks from waste soil and builders' rubble destined for landfill.

The need: The needs for affordable building materials, to use resources and energy efficiently, to divert waste from landfill, to grow the circular economy and to create green jobs are pressing:

⇒ • More than 30% by mass of the waste disposed of in landfills in South Africa is inert soil and rubble.
⇒ • There is a significant housing backlog in South Africa.

Unemployment in South Africa is sitting at 27.6%[73] and there is a critical need for job creation.
The construction industry is globally responsible for as much as 40% of man-made carbon emissions. There is a need to research and develop alternative low carbon building materials.

The solution: This RamBrick block system provides building products for all types of housing, with a far lower carbon footprint than conventional materials, thus reducing embodied energy content and footprint. The bricks are fully certified via the EcoStandard building system (Agrément, NHBRC, SABS and CIDB compliant).

What makes it circular? Use-It has, among other innovations, developed a local construction methodology that uses waste soils and construction rubble to create construction materials for building green, sustainable housing that are more cost-effective than conventional building products, water-efficient, bullet- and insect-proof, earthquake resistant, and thermally efficient (Figure 24).

Figure 24: Compressed earth bricks manufactured from builders' rubble.
Source https://www.use-it.co.za/

The result: The system diverts a percentage building wastes from landfill and, as a result saving airspace at landfill sites, where building/ construction rubble is often dumped. Manufacturing the bricks and using them in building projects develop skills and create jobs. Bulky, inert materials are converted into various housing products with 1/3 less carbon footprint than conventional materials. The bricks are 15 to 45% cheaper, 3 to 5 times stronger and, 3 times more thermally efficient than conventional bricks. They are bulletproof, waterproof, soundproof and eco-friendly, saving 1/2 a tonne of carbon per square meter built. **Read more here:** https://www.use-it.co.za/

73. Statistics South Africa: Quarterly Labour force Survey Q1 2019.

The material organizations are established as voluntary **Extended Producer Responsibility** (EPR) schemes. They currently focus on improving recycling of end-of-life products in South Africa, although their focus may be extended to support further circular economy opportunities in re-design of packaging products, re-use, repair, and/or re-manufacturing.

There are many opportunities for increased recycling of technical materials in the current SA system. Two examples of incorporating inert waste streams into building materials are provided in case study 11. Case Study 11 discusses the recycling of building wastes by incorporating them into bricks.

Case study 12 elaborates on recycling technical materials, with a specific focus on recycling of glass, by incorporating finely ground glass into cement and concrete.

CASE STUDY 12: Glass in concrete

Overview: Including glass in the preparation of concrete, as a cleaner alternative to other materials, such as fly ash, which contain toxic elements including heavy metals such as arsenic, cadmium, chromium, mercury and lead, would reduce the CO2 emissions associated with the cement in concrete.

The need: Post-consumer glass is a growing problem. Although it is 100% recyclable, it is costly to transport, of relatively low recycling value and therefore not very profitable. Additionally, finding end markets for recovered glass material is a challenge. Concrete is an essential building material comprising a mix of gravel, sand, water and cement (the binding element of concrete). Although concrete contains only 15% cement, cement is responsible for 96% of the CO_2 emissions from concrete, because during the production of cement, large amounts of CO_2 are generated. To reduce the carbon footprint of the concrete and to give it desired pozzolanic properties, waste substances such as fly ash or slag are substituted for some of the cement. Using an alternative non-hazardous material such as glass, would pose a lower risk to the environment and human health, and be more aligned with principles of the circular economy and SCP.

The solution: Research into using post-consumer glass, ground into a powder, as an alternative substitute material in concrete is being conducted by including glass, it would reduce the carbon footprint of concrete, minimize exposure to potentially toxic materials, and create an outlet for the post-consumer glass currently being lost to landfill. The Ellen MacArthur Foundation estimates that this new business model may result in an increase in the price of concrete by between 2–5%. For the initiative to be successful, both the private and public sectors must be involved at all levels. Companies purchasing concrete made with glass, would have to choose the more environmentally sustainable option to reduce long-term toxicity, lower CO_2 emissions, and choose a product that follows circular economy principles.

Figure 25: Powdered glass

Source: https://ars.els-cdn.com/content/image/1-s2.0-S0950061818313473-gr1.sml

What makes it circular? Using a material stream that would otherwise be discarded (glass) and feeding it into a new process (cement production) closes a material flow loop. It has been found that partially substituting glass for cement in concrete can reduce the carbon footprint of concrete by between 20–40%. The grinding of glass into pozzolan requires little energy and has lower emissions (18 kg CO_2 per tonne of glass[74]) compared with fly ash (201 kg CO_2e/tonne – a figure arrived at by attributing some of the emissions from coal combustion to fly ash production[75].

Read more here: https://www.ellenmacarthurfoundation.org/case-studies/the-circular-economy-and-the-promise-of-glass-in-concrete and https://www.ellenmacarthurfoundation.org/assets/downloads/circular-economy/The-Circular-Economy-and-the-Promise-of-Glass-in-Concrete.pdf

74. Glass Recycling - Life Cycle Carbon Dioxide Emissions. (2003). A Life Cycle Analysis Report Prepared for British Glass. Enviros Consulting Ltd, p.19.
75. Carbon Footprint of Fly Ash. (2015). AHSTRANS Conference. Danish Technological Institute, p.24.

4.5 Opportunities for circularity

In seeking out circular economy opportunities to support such initiatives, companies may face economic barriers such as lack of access to technology or capital, challenges to profitability, and access to markets such as insufficient competition, split incentives and transaction costs.

Policy interventions in this area can take the form of financial support, such as grants and subsidies, capital injections and financial guarantees, but also technical support, advice, training, demonstration of best practices, and development of new business models.

Particular recipients of these support schemes will likely be SMEs lacking the internal capacity, capabilities or financial resources to take advantage of new opportunities.

Examples on the ground typically offer a mixture of both financial and non-financial support:

⇒ Denmark's Fund for Green Business Development provides grants, advice, support for partnerships and pilot projects, and an acceleration programme for new green business models.

⇒ In South Korea the "Green Up" offers environmental management consultations with SMEs aimed at enhancing competitiveness, reducing resource costs and improving environmental performance.

⇒ There is an Eco-Design programme that provides technical and financial assistance to SMEs commercializing eco-innovation initiatives for their products and services.

⇒ REBus, an EU Life+ funded collaborative project in the UK and Netherlands, provides technical expertise to businesses to develop resource-efficient business models in textiles and electricals (in the UK the focus is on building the financial case for a transition to a circular business model; in the Netherlands it is through public procurement).

⇒ In South Africa, there are a number of innovation hubs/support programmes, including:

- The National Green Fund supports green initiatives to both promote South Africa's transition to a low carbon, resource efficient and climate resilient development path and to deliver high impact economic, environmental and social benefits.
- The Climate Innovation Centre South Africa (CICSA) provides business development support to start-ups in the South African green economy in collaboration with the World Bank's InfoDev (http://www.infodev.org/).

⇒ Industrial Development Zones such as the East London IDZ and Special Economic Zones such as the Atlantis Special Economic Zone (SEZ) that are focused on green technology.

Greening initiatives which align to circular economy principles and practices are already being implemented in South Africa. The case studies demonstrate only a few of many opportunities to adopt circular practices that avoid the creation of waste along the entire materials value chain.

Examples of circularity may be found at each step, from resource extraction, processing, eco-design of products, production and consumption, beneficiation with the associated benefits of new work opportunities, more efficient and sustainable use of materials and innovative changes to the way materials are managed and shared. Such initiatives include resource efficient and cleaner production methodologies that lower costs through reduced energy, water and materials usage, as well as waste minimization and industrial symbiosis programmes that minimise waste and improve the circularity of material flows among participating industries.

CHAPTER 5: PLANNING AND POLICY LANDSCAPE

5.1 Current legislative and policy landscape

A legislative and policy framework for a low carbon, resource efficient and green economy already exists in South Africa. A comprehensive review of the laws, policies and business environment has been published in SWITCH Africa Green: Review of Laws, Policies and Business Environment as an outcome of the SWITCH Africa Green programme for three key priority sectors in South Africa, namely manufacturing, agriculture and integrated waste management[76]. The waste economy-related legislation[77] that is most pertinent to the Green Economy and the Circular Economy includes the following:

- ⇒ National Environmental Management Act, 107 of 1998[78]
- ⇒ National Environmental Management: Waste Act, 59 of 2008[79]
- ⇒ National Waste Management Strategy (NWMS), (DEA 2010)[80]
- ⇒ National Environmental Management: Waste Amendment Act, 2014 (under revision)
- ⇒ The National Development Plan (NDP), Vision 2030[81]
- ⇒ 2009-2014 Medium-Term Strategic Framework and 12 Outcomes[82]
- ⇒ Integrated Resource Plan & Integrated Energy Plan[83]
- ⇒ 10-Year Innovation and Global Research Plan Department of Science and Technology[84]
- ⇒ New Growth Path[85]
- ⇒ Industrial Policy Action Plan[86]
- ⇒ National Water Resource Strategy[87]
- ⇒ Environmental Fiscal Instruments (e.g., carbon tax, Green Fund)[88]
- ⇒ National Strategy for Sustainable Development and Action Plan (NSSD1)[89]
- ⇒ National Climate Change Response Policy[90]
- ⇒ National Skills Development Strategy[91]
- ⇒ National Skills Development Plan (NSDP)[92]
- ⇒ National Green Economy Summit and Programmes' Reports[93]

Godfrey and Oelofse (2017)[94] define four stages in the development of the South African waste and recycling sector: "The Age of Landfilling", "The Emergence of Recy-

76. DEA (2017). SWITCH Africa Green: Review of laws, policies and business environment. Country Implementation Report and Plan: South Africa. Pretoria, South Africa: Department of Environmental Affairs. Retrieved from https://www.switchafricagreen.org/images/SA_Project/SA-Country-Implementation-Plan__PrintReady.pdf

77. Note – the licensing requirements or Norms and Standards linked to the overarching NEMWA and/or NEMA are not mentioned here, but should be borne in mind.

78. Chapter 1 (2)(3) and illustrated throughout the legislation.

79. Reference to Extended Producer Responsibility in Part 3 (18).

80. Currently under revision – but the intention of the strategy is to reduce waste to landfill following the waste hierarchy.

81. Department of Planning, Monitoring and Evaluation. National Planning Commission: National Development Plan. https://www.nationalplanningcommission.org.za/National_Development_Plan

82. Department of Planning, Monitoring and Evaluation. Medium Term Strategic Framework: 2014-2019. https://www.dpme.gov.za/keyfocusareas/outcomesSite/Pages/default.aspx

83. Department of Energy (2018). Draft Integrated Resources Plan 2018. http://www.energy.gov.za/IRP/overview.html

84. https://www.dst.gov.za/images/GCRP_Summary_2010.pd

85. Economic Development (2011) Green Economy Accord & Green Jobs Report. New Growth Path

86. Department of Trade and Industry (2018). Industrial Policy Action Plan 2018/2019-2020-2021.

87. Department of Water and Sanitation. National Water Resource Strategy. http://www.dwa.gov.za/nwrs/

88. National Treasury. (2006). Draft Policy Paper: A Framework For Considering Market-Based Instruments To Support Environmental Fiscal Reform In South Africa. http://www.treasury.gov.za/public%20comments/Draft%20Environmental%20Fiscal%20Reform%20Policy%20Paper%206%20April%202006.pdf AND Republic of South Africa (2019). Carbon Tax Act, 15 of 2019. Government Gazette 42483. https://www.gov.za/documents/carbon-tax-act-15-2019-english-afrikaans-23-may-2019-0000

89. Department of Environmental Affairs (2011). National Strategy for Sustainable Development and Action Plan. https://www.environment.gov.za/content/documents/strategic_docs/national_strategy_sustainable_development

90. Department of Environmental Affairs (undated). National Climate Change Response Policy. https://www.environment.gov.za/sites/default/files/docs/presentation_climatechange_responsepolicy.pdf

91. Republic of South Africa. Higher Education and Training (2019). Skills Development Act, 1998 (ACT No. 97 of 1998): Promulgation of the National Skills Development Strategy

92. National Skills Development Plan (NSDP) (2019). Government Gazette 42290. http://www.chieta.org.za/Portals/0/ndp2030.pdf

93. Green Economy Summit (2010). National Green Economy Summit and Programmes' Reports. https://www.sagreenfund.org.za/wordpress/wp-content/uploads/2015/04/Green-Economy-Summit.pdf

94. Godfrey, L. and Oelofse, S. (2017). Historical Review of Waste Management and Recycling in South Africa. Resources, 6(4), 57.

cling", "The Flood of Regulation", and "The Drive for EPR". There are other waste streams that offer opportunities for beneficiation as secondary resources: for example, organic wastes and biomass residues, construction and demolition (C&D) waste, and other bulky waste streams such as mining residues and power generation waste. Recognizing these streams has heralded the fifth, and global, phase: "The future is a Circular Economy".

In terms of Schedule 5 of the Constitution of the Republic of South Africa, municipalities traditionally and legally carry the cost of providing a waste collection and disposal services to households. The waste-related policy and legislation in South Africa has addressed each step of the **waste management hierarchy** progressively, gradually introducing measures for reducing waste generation; managing the handling and treatment of waste; incentivizing the diversion of waste from landfill; and ensuring that the environmental protection and "polluter pays" principles have become statutory requirements.

A fundamental requirement for effective materials management and achieving circularity is to keep re-usable and recyclable materials separate and to find collaborative mechanisms, often between the private sector and municipalities, to enhance a municipality's capacity to divert materials from landfill. Many municipalities, however, still struggle to provide even basic services[95]. Currently, many municipalities do not prioritize or allocate adequate budgets for the diversion of waste from landfill.

The current South African waste-related regulatory framework is not an entirely enabling one for transitioning to a circular economy. Challenges associated with the existing policy framework include a lack of consistent enforcement, compliance of regulatory requirements, and a lack of awareness and incentives in order to drive change. Within the CE environment, innovation and integration are key to transitioning. Therefore, emphasis needs to be placed on creating an enabling policy environment.

In transitioning to a circular economy, systems and technologies that are context-specific to developing countries should be used. It cannot be assumed that the same systems and alternative waste technologies that are appropriate in developed countries (for example, waste-to-energy), will be suitable for South Africa, or other developing countries, for that matter. Neither can it be assumed that the introduction of new disruptive technologies will have no adverse impacts on vulnerable, marginalized sectors of society where much of the unskilled informal waste-related work is undertaken.

The planning and policy landscape for the circular economy must incorporate much-needed re-skilling/upskilling and acquisition of new skills sets for existing workers whose traditional or conventional waste management practices are to be adapted. Additional skills training could include aspects of collection, repair and maintenance of products, or new service-type activities including, but not limited to, a milkman delivery-type system based on a token and refillable bottle system. Refer to Loopstore.com (https://loopstore.com) where this concept is being re-imagined.

5.2 Regulatory requirements

A review of the regulatory framework is needed to update regulations that have become outdated or no longer relevant. Such interventions can address obstacles of several types, including profitability and split incentives. If the issue causing obstruction is an inadequately defined legal framework, new or adapted regulations for products, waste, industry, consumers, competition and trade may be required. These could be introduced as restrictions on, or requirements relating to, existing activities. In cases where circular economy-related activity has been ham-

95. GreenCape (2018). Market Intelligence Report. https://www.green-cape.co.za/assets/Uploads/20180622-GreenCape-Waste-MIR-FA-LR.pdf pered by the unintended consequences of existing regulations, it has been helpful to form a task force on circular economy or resource efficiency to identify the necessary revisions.

Policymaking strategies to accelerate the transition to a circular economy include:

- *Retroactively update and revise market and regulatory aspects.*
- *Pro-actively stimulate market activity by setting targets, changing public procurement policy, creating collaborative platforms and providing financial or technical support to businesses.*

Examples of task forces for regulatory interventions that have been initiated in other countries include:

⇒ Denmark's Task Force on Resource Efficiency
⇒ Finland's working group on its National Material Efficiency Programme
⇒ The UK's Circular Economy Task Force.

Examples of regulatory requirements on existing activities include:

⇒ South Africa's call for Industry Waste Management Plans for Paper and Packaging, Lighting and Electronic waste, and tyres
⇒ New York City's ban of Styrofoam cups
⇒ France's requirements for manufacturers to display the length of time for which spare parts will be available on product labels and to offer free repair or replacement for the first two years after purchase
⇒ California's amendments to its rigid plastic packaging container regulations that require plastic resin manufacturers to use at least 25% of recycled resins in their products
⇒ France's proposal to ban large supermarkets from throwing away unsold food, instead donating it to charity, sending it for composting or for use as animal feed.

Examples of lifting restrictions include:

⇒ Prior to the development of South Africa's Norms and Standards for the Storage of Waste, many facilities storing recyclable waste had to apply for a waste license in terms of the Waste Act. This time-consuming process is no longer a requirement.
⇒ Japan's policy to give food waste to pigs under highly sanitary conditions.
⇒ Nevada's legislation to permit the licensing and operation of autonomous vehicles.
⇒ The USA's Good Samaritan Law that limits the liability of food companies and retailers for products they donate to charities.
⇒ The Basel Convention's new guidelines that could also allow countries to classify products and parts as destined for reuse or extended use, or for repair and refurbishment, to exempt them from the convention's requirements on the export of hazardous waste.

5.3 Fiscal Frameworks

Fiscal, or tax-based, instruments can complement and reinforce environmentally related regulatory measures to help achieve environmental objectives and support the transition to a circular, resource efficient economy. Since they are market-based, they are useful to address barriers to circular economy implementation which relate to profitability for companies, as well as to unpriced externalities. As with regulations, such tax-based instruments (environmentally related taxes, charges and incentives) can be applied either to discourage non-circular activities or to explicitly support circular economy opportunities. Market-based instruments can complement and reinforce regulatory measures to help achieve environmental objectives and support the transition to a circular, resource efficient economy.

There are several instruments ranging from "command and control", "economic", and "public-private" instruments that can be employed in different contexts to promote CE (Table 3):

South Africa still uses mostly command and control instruments in its policy framework. Economic instruments are tools that are intended to change behaviour by setting the level of tax (or subsidy) at or near the level of the external cost (or benefit). In this way, the externalities become internalized. A range of fiscal economic instruments is becoming more evident in the materials/waste management regulatory environment. South Africa is looking, increasingly, towards using economic incentives and disincentives to accelerate greening and circularity in the materials value chain. The instruments provide incentives for manufacturers, consumers, recyclers, and other actors along the product-waste value chain to reduce waste generation and find alternatives to final disposal to landfill, such as reuse, recycling or recovery (Figure 26).

Figure 26 illustrates the range of economic instruments that may be applied along the product-waste value chain (upstream and downstream) to achieve resource efficiency and/or to correct for market failures, such as the under-pricing of landfill disposal costs.

Measuring economic performance could encourage a systemic transition towards the circular economy. Shifting fiscal incentives towards labour from resources, complementing today's flow-based metrics, such as GDP, with measures of a country's stock of assets, and developing a long-term plan to rebalance factor costs and adequately price key externalities, are all instruments for policymakers to develop a new economic framework that would support the transition to a circular economy.

Table 3: Instruments for promoting circularity (Source: UNCTAD, 2018)[96]

Instruments for promoting circularity		
Command and Control	Economic	Public–private
Waste disposal and trade standards	Landfill and/or incineration taxes	Improved logistics and infrastructure
Minimum recycling requirements	Different taxation levels for reused or recycled products	Circularity certification and labelling schemes
Deposit refund systems, for example for plastic bottles	Reduced value added taxes for repair and reuse services	Extended producer responsibility schemes
Circular public procurement	Increased taxes on non-reparable products	Discounts for efficiency
Waste disposal and trade standards	Landfill and/or incineration taxes	Improved logistics and infrastructure
Extended legal warranties	Tax shifts from labour to consumption	Products designed for recycling
Streamlined regulations for leasing and sharing businesses	Incentives for access over ownership	Virtual platforms for asset sharing

96. United Nations Conference on Trade and Development (UNCTAD) (2018) Circular Economy: the new normal? Policy Brief No.61. Retrieved from https://unctad.org/en/PublicationsLibrary/presspb2017d10_en.pdf

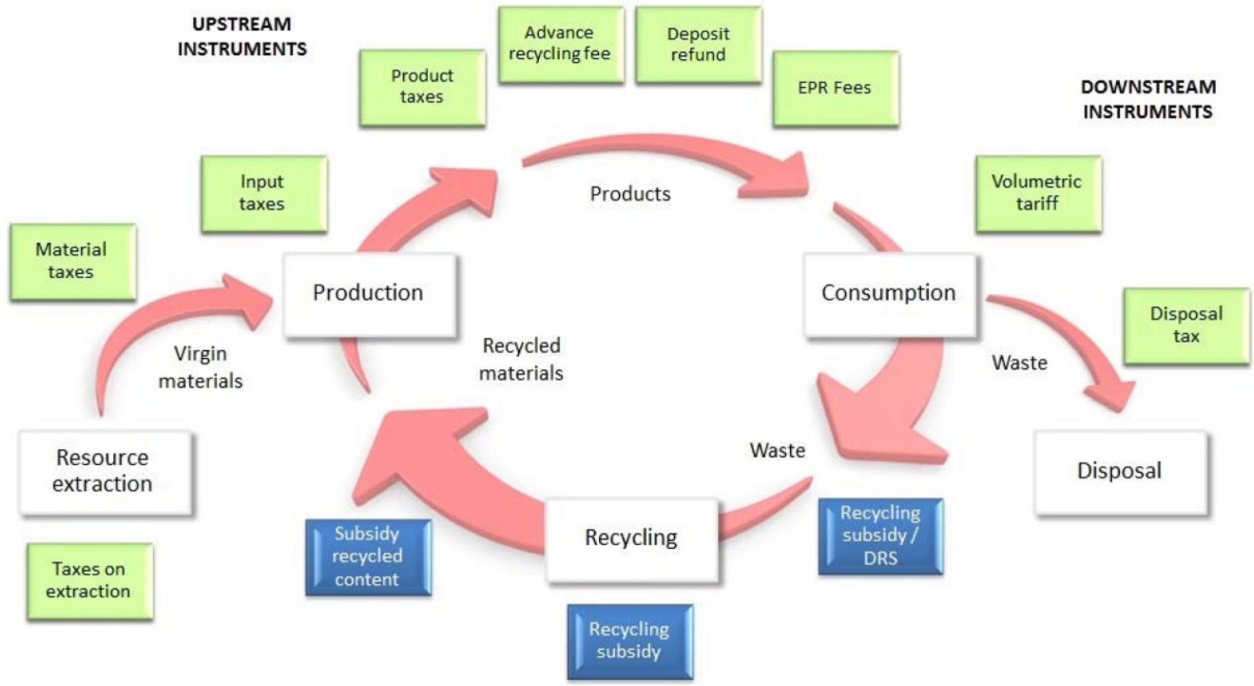


Figure 26: Examples of potential economic instruments along the product-waste value chain

Source: CSIR 2015[97]

Examples of fiscal instruments applied to a product that cannot easily be incorporated into a circular system include Ireland's and South Africa's respective levies on disposable plastic carrier bags.

Two examples of full cost accounting for negative externalities of waste (management) through fiscal interventions are Denmark's high and incrementally increasing taxes on landfilled or incinerated waste, and Finland's levy and deposit system on disposable drink containers.

Examples of tax incentives offered for circular economy-related products and processes include New York's tax credit in favour of remanufacturing firms and China's reduced or eliminated VAT on goods produced from recycled materials.

In Sweden, promotion of reuse and repair centres as well as tax breaks for the repair shops have been suggested[98].

In 2006, South Africa's National Treasury's Tax Policy Chief Directorate drafted a key policy paper referred to as "A framework for considering market-based instruments to support environmental fiscal reform in South Africa", which aimed "*to outline the role that market-based instruments, specifically environmentally-related taxes and charges, could play in supporting sustainable development in South Africa, and to outline a framework for considering their potential application. The paper focuses on the options for environmental fiscal reform and the policies and measures capable of contributing to both revenue requirements and environmental objectives*" (National Treasury, 2006).

97. CSIR (2015) Why a Pricing Strategy for South Africa A local and international perspective. Presentation by Dr Linda Godfrey. 12 March 2015 Retrieved from https://www.iwmsa.co.za/downloads/linda%20godfrey%2020150312.pdf

Since the 2006 draft policy paper, several environmental levies have been introduced in South Africa with the intention to stimulate behaviour change and contribute funds to the fiscus. Essentially these were based on a Pigovian Tax principle[99]. The environmental levies that currently exist are applied to the following products:

⇒ Plastic bags (implemented 01 June 2004) – aims to counter the dispersion of plastic bags that end up as wind-blown litter or in waste facilities
⇒ Fuel taxes – raise general revenue, fund compensation for road accidents, and help to address pollution and congestion
⇒ Electricity generation (implemented 01 July 2009) – applies to non-renewable based electricity generation including fossil and nuclear based generation
⇒ Motor vehicle CO_2 emission (implemented 01 September 2010) – aims to encourage consumers to use more fuel-efficient, low-carbon-emitting vehicles, and manufacturers to improve fuel efficiency
⇒ Electric filament lamps (implemented 01 November 2009) – to encourage the use of more efficient compact fluorescent bulbs and reduce electricity demand, electric filament lamps (i.e. non-energy-saving light bulbs) are subject to the payment of an environmental levy if manufactured in South Africa.
⇒ Tyres (implemented 01 February 2017) – intended to encourage reuse, recycling and recovery, and to discourage disposal to landfills.
⇒ Carbon tax (implemented 01 June 2019) – puts a price on the environmental and economic damages caused by excessive emissions of greenhouse gases.

The challenge with the current environmental levy structure implemented via the Customs and Excise Act, 1964 and collected *via* the South African Revenue Service (SARS) is that such levies filter directly into the fiscus. Thus, levy revenue cannot be ring-fenced for the purpose of contributing to a specific environmental/ sustainability project which directly influences behaviour change or assists in correcting the externality which the levy seeks to address.

The plastic bag levy is a case in point: the original intention of the levy was to discourage the use of plastic carrier bags and increase the use of re-usable bags; to make funds available to develop collection systems for the collection of plastic carrier bags, and to recycle such funds back into the market.

A Section 21 company, Buyisa-e-Bag, which was established to "promote waste minimisation and awareness initiatives in the plastics industry, expand collector networks and create jobs, as well as kick-start rural collection [by small, medium-sized and microenterprises] and create additional capacity in nongovernmental organisations" proved ineffective and was dissolved in 2011[100].

The Carbon Tax Act, 15 of 2019, intends to incentivise large generators to reduce carbon and carbon equivalent emissions; however, there are many exemptions included and calculating potential rebates as well as the tax rate applicable are complicated.

5.3.1 Extended producer responsibility

Public-private incentives are numerous in the private sector in South Africa, where partnerships, voluntary certification schemes, corporate social responsibility, and global competition based on environmental performance are drivers of CE. There is a growing focus worldwide on extended producer responsibility (EPR), which places the responsibility for managing products safely after end of life on the producers of the goods.

98. Kalmykova, Y; Sadagopan, M; Rosado, L. 2018. Circular economy – From review of theories and practices to development of implementation tools. https://www.sciencedirect.com/science/article/pii/S0921344917303701

99. A way of correcting for negative externalities, or consequences for society, arising from the actions of a company or industry sector, by levying additional taxes on that company or sector. http://www.businessdictionary.com/definition/Pigovian-tax.html

100. De Lange, R. (2015). Plastic bag levy – who derives the benefit? Engineering News. https://www.engineeringnews.co.za/article/plastic-bag-levy-who-derives-the-benefit-2015-04-07/rep_id:4136

In South Africa, EPR is used as an important mechanism to fund increased recycling, job creation and enterprise development in the paper and packaging sector and electronic waste and lighting sector.

The National Department of Environmental Affairs (DEA) issued the requirement for both the paper and packaging sector, and the electronic waste and lighting sector, to compile Industry Waste Management Plans (IndWMPs), based on the EPR model. In parallel with South Africa's legislative framework, the business sector has voluntarily adopted complementary initiatives, including EPR and cleaner production programmes. The tyre sector has also produced an IndWMP.

EPR fees are regulated by government for producers of plastic bags, waste tyres, incandescent light bulbs, and electricity derived from non-renewable resources.

Voluntary EPR fees are administered by the Product Responsibility Organizations (PROs) that are in place for certain waste streams, including paper and packaging; waste oil; and lead acid batteries.

Effective EPR mechanisms stimulate the public and private sector to work in collaboration to achieve a positive outcome. The producers take responsibility for the materials and provide financial support in order to manage the materials in a beneficial way.

Government, often local municipalities, who are tasked with municipal waste collection, is supported by EPR in various ways – often regionally specific – to provide diversified services.

5.3.2 Circular procurement

Procurement policies and regulations are very effective in changing consumer habits and developing markets for products and services that promote circularity. A procurement approach designed to promote circularity may be adopted by both the public and private sectors.

Circular economy specifications require organizations to provide goods and services through a value-for-money approach throughout their lifecycles, while minimizing material losses and environmental impacts. Lists of preferred suppliers or materials can be drawn up and, within procurement departments, staff capabilities and skills around concepts such as total cost of ownership and metrics for material circularity can be built.

Examples of public procurement strategies that promote circularity include:

⇒ In **South Africa**, the Western Cape Government in collaboration with World Wildlife Fund (WWF) has developed a document entitled "Moving towards sustainable performance-based procurement in the Western Cape: A guidebook for supply-chain managers and policy makers"[101]. It was released in 2018 and the progress of implementation may now be monitored using this guideline.

⇒ **Denmark's** Government Strategy on Intelligent Public Procurement, which includes initiatives to support circular procurement practices and puts in place dissemination activities and partnerships for green public procurement.

⇒ In **Flanders**, the government has created a market for high-quality recycled aggregates through their own procurement requirements.

The South African National Treasury intends to publish a draft Environmental Fiscal Reform Policy Paper during 2019 to reform existing environmental taxes and broaden their coverage. Additional taxes proposed include investigating a tax on "single-use" plastics. Policy and regulatory development in South Africa includes manda-

101. WWF (2018) Moving towards performance-based procurement in the Western Cape Province: A guidebook for supply chain managers. WWF South Africa tory consultation with all sectors of society to allow actors, including government, business (formal and informal sectors), organized labour, academia, community and, very importantly, the youth to be part of the conversation.

The effectiveness of South Africa's current environmental levies is not easy to evaluate. The introduction of any new levies, should have mechanisms in place to allocate taxes and levies collected directly to address the intended externality.

5.4 Management and implementation from a governance perspective

Circular economy principles take time to become adopted and embedded in society; therefore, a transition phase is necessary. The transition should be based on the developmental approach contained within the National Development Plan (NDP), which itself echoes the core values of the circular economy:

"National development has never been a linear process, nor can a development plan proceed in a straight line. Accordingly, a multidimensional framework is proposed to bring about a virtuous cycle of development, with progress in one area supporting advances in others".[102]

The NDP promotes environmental sustainability. Chapter 5 of the NDP requires an equitable transition to a low-carbon economy; sustaining South Africa's ecosystem by using natural resources efficiently; building sustainable communities; responding effectively to climate change **mitigation** and **adaptation**; managing a just transition; and enhancing governance systems and capacity to manage the transition to a circular economy. One of the stated goals in the NDP is that "[i]nvestment in consumer awareness, green product design, recycling infrastructure and waste-to-energy projects results in significant strides to becoming a zero-waste society".[103]

A transition to a circular economy requires the integration of complex relationships between multilateral actors, and should provide capacity, tools, and methods to develop new approaches, guidelines, and decision-support tools. Policy and legislative frameworks must be developed consultatively with all actors along the value chain (including product designers, mining operators, producers, distributors, consumers, collectors of end-of-life products, recyclers, etc).

Therefore, a governance structure is equally important to ensure that all the players in the value chain continually contribute, are monitored and held accountable for performance.

102. South African Government (2012). National Development Plan 2030: Our Future – Make it Work. Pretoria, South Africa: National Planning Commission. Retrieved from https://www.gov.za/sites/default/files/gcis_document/201409/ndp-2030-our-future-make-it-workr.pdf;
103. Ibid.

CHAPTER 6: CURRENT ISSUES, GAPS AND CHALLENGES

This section briefly highlights current issues, gaps and challenges that might present obstacles to transitioning to a circular economy.

6.1 Need to change perceptions

In a circular economy, the intention is not to have waste at all[104]. Therefore, there needs to be a shift in how we think about waste. Instead of referring to a "waste" sector we refer to a "materials" sector; instead of referring to a "**waste value chain**" we refer to a "materials value chain" which incorporates material flows from the time of extraction, through processing and manufacturing until consumption.

In a circular economy, waste does not exist, and is designed out by intention.

Source: Ellen McArthur Foundation, 2015

If products are not designed for end-of-use upcycling or beneficiation, the likelihood of recovery is decreased. Throughout the materials value chain, resource efficiency and cleaner production are crucial.

An additional recommendation is to shift the terminology from "job creation" and instead refer to developing work opportunities and enterprise development, as well as **maker spaces** and **tool libraries**

The terminology used by funding agencies relating to the financing of circular initiatives is, varies from that used by relevant role-players in the environmental field looking for access to funding.

Those in the finance sector commonly perceive applications for funding from the environmental sector that include references to risk assessment or full cost accounting as being too risky.

Venture capital investors and development financiers will respond more favourably to the term "market opportunities" than to references of environmental "risk" or "costs".

The circular economy principles and "language" must be included in the development of capacity and skills associated with the concept of circularity.

6.2 Data and information gaps

Data and statistics are essential for evidence-based decision-making, as information on economic potential and practicalities are important for mutual understanding and cooperation across traditional sectoral and functional silos.

Such information is often lacking, particularly data on material quantities discarded for disposal. In South Africa, changes in waste classification regulations and the inclusion of "unclassified" waste streams, which include both general and hazardous components, make it difficult to compare historical data sets and therefore to monitor generation rates and calculate resource efficiencies.

It is necessary to develop decision metrics and a measurement framework for the circular economy to enable

104. Ellen McArthur Foundation. 2015 Towards A Circular Economy: Business Rationale For An Accelerated Transition.

105. UN Paris Agreement 2015 Retrieved from https://unfccc.int/sites/default/files/english_paris_agreement.pdf (accessed 11 Aug 2018)

106. Resolution adopted by the General Assembly on 25 September 2015. 70/1. Transforming our world: the 2030 Agenda for Sustainable Development Retrieved from http://www.un.org/ga/search/view_doc.asp?symbol=A/RES/70/1&Lang=E

target-setting, evaluation and review. With appropriate metrics, performance can be benchmarked and progress may be tracked against longer-term global ambitions such as the Paris Agreement[105] targets and Sustainable Development Goals (SDGs)[106].

Suitable ways to measure progress on the implementation of the circular economy are discussed in the Circularity Gap Report 2018[107] and Circularity Gap Report 2019[108]. In South Africa, the metrics and a measurement framework for circularity must be formulated consultatively with all relevant stakeholders along the value chain.

There are currently several gaps that can undermine the potential of data-driven circular business practices: lack of common software interfaces, connectivity protocols and standard data formats.

6.3 Technical skills gaps

There are many technical processes, tools and instruments available to assist the transition to circularity. Policymakers and leaders driving the transition must, however, have sufficient knowledge to be able to select the most appropriate for their particular context and incorporate them into implementation plans accordingly.

Inadequate technical skills and understanding of CE options are current gaps that need to be addressed.

The Circular Economy is a central theme of the new draft White Paper on Science and Technology[109]. There is an immediate need for science, technology, engineering and maths (STEM) skills[110].

At the cutting edge of production systems is the use of digital, cyber-physical technology, referred to as the next wave of innovation, or the "**Fourth Industrial Revolution**", also referred to as "Industry 4.0". People who are competent in STEM skills are needed immediately to sustain the manufacturing industry[111].

Capacity- and skills development in the area of digital technology, essential to meet the Industry 4.0 requirements, must involve not only incremental change, but "disruptive change" in the manufacturing and services sectors[112].

The Department of Trade and Industry (the dti) is strengthening its cooperation with the industrial sector and the Department of Higher education, Science and Technology (DHEST) to take advantage of opportunities to convert a greater proportion of local innovations into commercial products.

Data skills with data analytics and visualization are needed to transform data into usable information that can drive these changes. Collaboration and business support schemes must facilitate the sharing of such data.

107. Circle Economy. (2018). The Circularity Gap Report: An analysis of the circular state of the global economy. Retrieved from https://docs.wixstatic.com/ugd ad6e59_733a71635ad946bc9902dbdc52217018.pdf

108. Circle Economy. (2019). The Circularity Gap Report. Closing the Circularity Gap in a 9% World. Retrieved from https://docs.wixstatic.com/ugd/ad6e59_ba1e4d16c64f44fa94fbd8708eae8e34.pdf

109. DST. (2018). Draft White Paper on Science, Technology and Innovation. Pretoria, South Africa: Department of Science and Technology. Retrieved from https://www.dst.gov.za/images/2018/white-pate-on-STI-7_09-FINAL.pdf

110. See, for example http://www.engineeringnews.co.za/article/aecom-focused-on-funding-stem-education-for-women-2018-07-27;; and http://www.engineeringnews.co.za/article/graduate-programme-ensures-pipeline-of-new-talent-2018-07-12

111. Creamer Media. (2018). Skills investment needed to sustain manufacturing industry. Engineering News, (5 July). Retrieved from http://www.engineeringnews.co.za/article/skills-investment-needed-to-sustain-manufacturing-industry-2018-07-04; and Kilian, A. (2018). Skills investment needed to sustain manufacturing industry. Engineering News, (29 May). Retrieved from http://www.engineeringnews.co.za/article/skills-investment-needed-to-sustain-manufacturing-industry-2018-05-29

112. Campbell, K. (2017). Fourth Industrial Revolution is upon us and South African industry must adapt. Engineering News, (27 October). Retrieved from http://www.engineeringnews.co.za/article/the-fourth-industrial-revolution-is-upon-us-and-south-african-industry-must-adapt-2017-10-27/rep_id:4136

6.4 Public awareness and involvement gap

There are still vast gaps in awareness and understanding of the circular economy in most sectors of society. Transitioning to a circular economy must include ongoing awareness-raising and capacity building of the many actors who are to be part of implementation along the entire value chain, including product designers, mining operators, producers, distributors, consumers, collectors of end-of-life products, recyclers, inclusive of the informal sector and youth. Alternative messaging may be needed for different recipient groups.

Municipalities would also require additional financial and logistical support for CE implementation via partnerships with the private sector. The means by which to implement these types of partnerships would need to be explored further.

6.5 Funding challenges

Significant private sector investment and new business models are needed, green eco-innovation must be incentivized, and policy tools must be developed to encourage the implementation of green technologies[113].

A variety of funding opportunities already exist, but they require well-researched proposals to ensure feasible and innovative business models packaged in such a way as to encourage investment.

A well-prepared, correctly-focused proposal will open the door to funding opportunities via government programmes that support green innovation; direct research and development (R&D) grants to new SMEs; equity and debt finance; or support for piloting circular, green technologies.

In South Africa, there are three main sources of potential funding: international climate and donor funding, public sector money, and private sector finances.

It is not easy, however, to access funding for projects, particularly those that introduce innovative technologies or that aim to create small business opportunities at community level. Funding organizations tend to regard such start-ups as being high risk initiatives.

The National Green Fund, however, is geared to driving the transition to a green economy and creating green jobs by providing funding for the establishment of such start-up projects. Application processes are onerous and require a significant amount of detailed specialist work to be undertaken in compiling funding proposals.

Entrepreneurs and small businesses often do not have the knowledge, capacity or resources to do the necessary detailed research required to formulate a proposal.

The lack of or limited knowledge on business plan development at an SME level may require interventions through capacity development provided in Incubator programmes to allow SME's to take advantage of funding opportunities.

6.6 Research and development challenges

Research is an essential requirement for innovation. The World Bank statistics, however, show that there are still too few researchers in Africa.

An understanding piece of work which was undertaken by the DST through the CSIR is the Waste Research De-

113. DST. (2018). Draft White Paper on Science, Technology and Innovation. Pretoria, South Africa: Department of Science and Technology. Retrieved from https://www.dst.gov.za/images/2018/white-pate-on-STI-7_09-FINAL.pdf

114. DST. (2014). A National Waste R&D and Innovation Roadmap for South Africa: Phase 2 Waste RDI Roadmap. Department of Science and Technology. Retrieved from http://www.wasteroadmap.co.za velopment and Innovation (RDI) Roadmap for South Africa[114]. The Waste RDI Roadmap has been developed in support of a number of strategic, national priorities. It is a 10-year plan which has contributed significantly to growing and transforming the South African waste sector in terms of technological innovation, access to more reliable data and establishing waste/resource-focused tertiary qualifications that meet the growing need for higher order skills in the waste management sector.

In addition to being aligned with national strategies, the Waste RDI Roadmap provides significant opportunity for international collaboration and investment on shared priorities.

Related waste streams, which require beneficiation also include the organic and agricultural material. In South Africa, there are large quantities of organic materials and agricultural biomass which are discarded without beneficiation. The challenge is to recover value from such biological materials and eventually make them available for uptake into the biological cycle instead of being lost to landfill.

The CSIR at the biorefinery facility described in Case Study 6 is investigating the value-added use of agricultural biomass residues, such as sugarcane bagasse and maize stalks, which are usually discarded into waste streams, for the development of sustainable bio-based polymer and biocomposite materials.

6.7 Value chain assessment challenge

When applying circular principles in a system, the full value chain must be analysed to identify opportunities where the principles may be applied, how risk may be limited and how value may be added at each stage. This is a challenging exercise because a value chain is more than just a "supply chain" (Figure 3) limited to the flow of materials from the extraction of raw materials through processing, manufacture of products and the logistics of organizing a supply system to the delivery of products and services to the consumer retail market.

The value chain not only incorporates the whole supply chain but also includes productivity, growth and job creation which are integral to the process of bringing products and services to markets in a way that adds social and environmental value[115].

Life cycle assessment (LCA) has typically informed the selection and evaluation of processes and products. A LCA focuses on the environmental aspects and impacts of a process or product only, whereas a value chain assessment is more challenging, in that it extends upstream to examine suppliers and materials, and downstream to customers and how the materials are re-used or disposed of. The value chain assessment also identifies key business risks and economic opportunities at each step.

115. ILO. (2015). Value chain development for decent work: how to create employment and improve working conditions in targeted sectors. 2nd edn. Geneva: ILO. Retrieved from https://www.ilo.org/wcmsp5/groups/public/---ed_emp/---emp_ent/---ifp_seed/documents/instructionalmaterial/wcms_434363.pdf

116. Creamer Media. (2018). Automated systems reduce production waste. Engineering News, (9 March). Retrieved from http://www.engineeringnews.co.za/article/automated-systems-reduce-production-waste-2018-03-09/rep_id:4136

117. Burger, S. (2018). New tech, automation to change but also create jobs. Engineering News, (31 August). Retrieved from http://www.engineeringnews.co.za/article/new-tech-automation-to-change-but-also-create-jobs-2018-08-31/rep_id:4136; and Green Alliance UK. (2018). Five factors that will ensure workers and communities benefit from the low carbon transition. Inside track blog, (9 August). Retrieved from https://greenallianceblog.org.uk/2018/08/09/five-factors-that-will-ensure-workers-and-communities-benefit-from-the-low-carbon-transition/

118. National Planning Commission, South Africa: Essop, T (2018). National Development Plan – 2030. A Just transition to a low carbon, climate resilient economy & society. Where are we? Where should we be? How do we get there? Presentation at the Talanoa Dialogue 23-24 August 2018. https://www.environment.gov.za/sites/default/files/docs/justtransitiontoalowcarbon_telenoadialogue.pdf

6.8 Challenge to counteract potentially negative impacts of the transition to circularity

The move to a circular economy is associated with disruptive change which has the potential to fundamentally change consumption and manufacturing processes. The transition to circularity, for example, may increasingly include automated manufacturing systems as an effective way to reduce production waste. Automation will make the South African manufacturing industry less wasteful and more competitive globally[116]. However, it is almost inevitable that some types of jobs might be lost to automation even though new types of skilled jobs may offset a proportion of the job losses[117].

The critical shortage of adequately trained, highly skilled operators to manage the machines and digital technologies required for an automated manufacturing industry, is both a challenge and an opportunity for upskilling of staff. The newly skilled operators, however, will not necessarily be the same people whose unskilled jobs have been replaced. It will be important to accommodate those who are replaced with options for alternative, decent work opportunities. The transition to a circular economy must be a **'just transition'**[118].

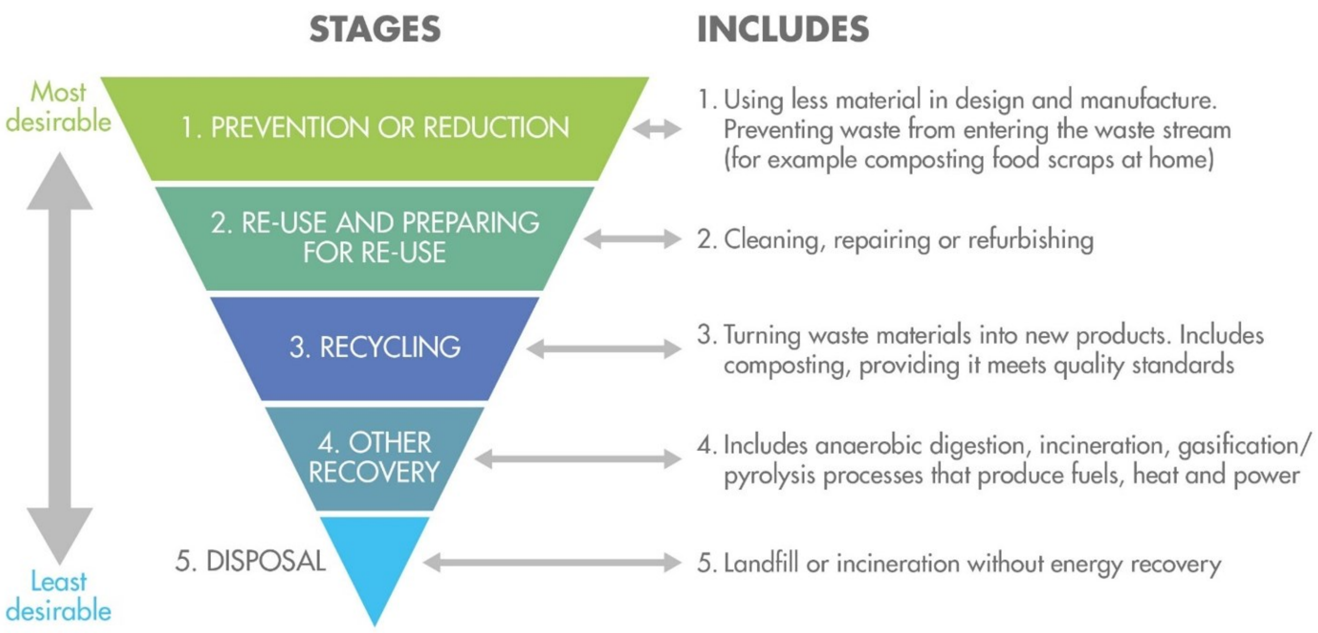


Figure 27: Waste management hierarchy including circular approaches at each stage

Source: DST, 2014[119]

119. DST. (2014). A National Waste RDI Roadmap for South Africa: Phase 2 Waste RDI Roadmap. The economic benefits of moving up the waste management hierarchy in South Africa: The value of resources lost through landfilling. Pretoria, South Africa: Department of Science and Technology. Retrieved from https://www.wasteroadmap.co.za/download/economic_value_sa_waste_rep.pdf

6.9 Challenge to move beyond the waste management hierarchy

The transition to a circular economy requires the current system to move beyond the waste management hierarchy. Once actors understand the value of resources lost to the South African economy when materials are discarded without beneficiation, they recognize the economic (as opposed to the financial) benefits of moving to a circular economy beyond the waste management hierarchy.

Figure 27 outlines the waste management hierarchy in its customary form, with the focus being on waste prevention or reduction. The challenges of implementing circular activities are given at each stage in the right-hand column of the diagram (with the exception of the last stage where no resource recovery takes place).

Meeting the challenge of applying circular principles to the waste hierarchy not only reduces quantities of materials used in design and manufacture, but also goes further to address the actual design of the products themselves, ensuring that materials that have an inherent value, are used at optimum value and recovered, to be returned to the technical or biological cycles.

CHAPTER 7: MONITORING AND EVALUATING THE TRANSITION TO A CIRCULAR ECONOMY

Key performance indicators, developed in consultation with key actors across the value chain, enable monitoring and evaluating of the transition to circularity.

In due course, it will become expedient to develop a national CE strategy for South Africa that will include an action plan which details milestones, main implementing agents and a formal monitoring and evaluation framework for the implementation of such a CE strategy.

7.1 Monitoring entity

Implementation of the circular economy as a government-led initiative cuts across multiple areas and government departments.

A collaborative multilateral approach is therefore required, both for CE implementation by the line function departments that deal with the environment, science, technology, trade and industry, and for setting up the monitoring and evaluation of CE activities. The monitoring entity would have to be decided amongst the key actors.

Within the private sector, implementation of circular systems is monitored within a particular business sector or individual organization using indicators and tools that have been selected for the particular context.

7.2 Circular economy indicators and tools

Monitoring of the transition to CE requires measurable indicators to assess, improve, monitor and communicate on CE performance[120]. At present, there is no globally agreed upon set of metrics or methodologies to measure progress towards a CE[121]. There is still much debate on the indicators for CE since they are required to monitor complex multi-sectoral and cross-cutting fields that include eco-design, resource efficiency and sustainability practice.

Suitable indicators for South Africa's waste sector to give a first-order indication of the resource and waste intensity of an economy may include volume of waste per unit of economic output or material consumption per capita. Such indicators are not very refined, and would have to be used with caution: for example, consumption of a litre of water has a much greater impact if the water is sourced from a drought-prone region. Tools to track resource flows and stocks in an economy – such as material flow analysis, input–output analysis and life cycle assessment – are useful at the national or city level, but depend on data availability, which is often inadequate in developing countries[122].

One of the few comprehensive, functioning examples of a CE monitoring framework has been developed for the EU as part of the EU Circular Economy Action Plan. Waste-related indicators form a substantial part of the CE monitoring framework, however most of the indicators would be a challenge for a developing country like South Africa, where reliable, regular data is not yet available.

For interest and a working example, the EU indicators for monitoring CE implementation can be accessed at

120. Ellen MacArthur Foundation (2015) Retrieved from https://www.ellenmacarthurfoundation.org/resources/apply/circularity-indicators

121. Preston F and Lehne J. (2017) A Wider Circle? The Circular Economy in Developing Countries Briefing. December 2017 Energy, Environment and Resources Department Retrieved from https://www.chathamhouse.org/publication/wider-circle-circular-economy-developing-countries

122. OECD (2008), Measuring Material Flows and Resource Productivity Volume I. The OECD Guide, Retrieved from https://www.oecd.org/environment/indicators-modelling-outlooks/MFA-Guide.pdf

123. Eurostat. Your key to European statistics https://ec.europa.eu/eurostat/web/circular-economy/indicators/monitoring-framework https://ec.europa.eu/eurostat/web/circular-economy/indicators/main-tables[123]. The formulation of suitable CE Indicators for a developing country like South Africa would be part of the required collaborative action going forward.

Although indicators for the monitoring of the CE performance are important, there is only one element in the whole transition to CE. Once measured, the information has to be translated into suitable actions for managing the CE transition using additional methods, tools and resources to complement the implementation of CE[124].

Globally, the implementation of CE strategies requires new organizational and business models, enhanced technologies (Haas et al, 2015)[125], augmented know-how and shared knowledge (Park and Chertow, 2014)[126], as well as a redefinition of industrial process and product innovations (EEA, 2016)[127]. Furthermore, such changes have to be economically, socially and environmentally sustainable to guarantee a successful effective and efficient implementation of the CE in the longer term[128].

124. British Standards Institution (BSI)(2017). Executive Briefing: BS 8001 – a Guide Retrieved from https://www.bsigroup.com/Sustainability/BS8001_Executive_Briefing.pdf

125. Haas, W., Krausmann, F., Wiedenhofer, D., Heinz, M., 2015. How circular is the global economy? An assessment of material flows, waste production, and recycling in the European Union and the world in 2005. J. Ind. Ecol. 19

126. Park, J.Y., Chertow, M.R., 2014. Establishing and testing the "re-use potential" indicator for managing wastes as resources. J. Environ. Manag. 137, 45e53.

127. EEA-European Environment Agency, 2016. Circular Economy in Europe - Developing the Knowledge Base. EEA Report No 2/2016, p. 37.

128. Saidani, M., Yannou, B., Leroy, Y., Cluzel, F., Kendall, A. (2019). A taxonomy of circular economy indicators. Journal of Cleaner Production, 207, 542-559.

CHAPTER 8: RECOMMENDATIONS

This section provides recommendations for accelerating South Africa's transition to a circular economy within the waste sector, from an application and policy perspective. Specific measures are proposed to address the issues, gaps and challenges (Sections 5 and 6) to the transition to circularity in South African waste sector.

The application of circular economy principles will require different approaches across the value chain with private and public organisations working together to achieve agreed outcomes. As this guideline specifically focuses on the waste sector, the applications recommended in this section will apply to the current waste management approach and how this will need to shift. The recommendations do not, therefore, extend to the broader circular economy, for example, to the energy, water, transport or construction sectors.

Table 4: Actors and roles in circular economy

Grouping	Actor	Role in CE
Public sector	Government departments dealing with environment, science, technology, trade, industry, energy, agriculture, labour, governance structures and the national treasury Department dealing with education and training	• Set policy and planning • Align regulations for CE • Set fiscal incentives, disincentives • Facilitate consultation, partnerships • Provide access to funding • Provide some services • Awareness raising
Private sector	Formal and informal business • manufacturing goods • services: transport, communications, IT, sales, reverse logistics, repair, refurbish, recycle,	• Investors • Provide products and services • Producers – eco-design, extract, make, • Value chain and supply chain management • Waste/materials handling and treatment • Awareness raising • CE implementation – M&E • Research and development • Skills development
Non-Profit Organizations	NPOs including Producer Responsibility Organisations and other consumer bodies, e.g. the Consumer Goods Council of South Africa (CGCSA) NCPC CSIR GreenCape Western Cape province African Circular Economy Network (ACEN) African Circular Economy Alliance.	• Align policies and behaviour with CE principles • Dialogue with government • Access funding • Awareness raising • Skills development
Labour	Organized labour unions	• Dialogue with government • Ensure workers' rights- Decent work
Academia	Researchers Trainers	• Research and development • Skills development
Media	Journalists Reporters	• Communication • Awareness • Promotion of CE
Consumers	Householders General public	• Users of products and services • Cooperation and participation in circular systems • Separation at source

8.1 Application perspective

8.1.1 Consultative and collaboration platforms

8.1.1.1 Multilateral consultation

The underlying the fundamental change in approach, that is required to move to circular systems, is the need for cross-sectoral integration and multilateral coordinated collaboration. A first step towards changing the way we think about waste and the circular economy, is to provide a multilateral consultative platform where the growing community of practice can share ideas, discuss initiatives and needs and interact with one another. This could take the form of a strategic CE partnership, or oversight advisory body. Such a partnership would include representatives from all relevant government departments (such as those that deal with the environment, science, technology, trade, industry, energy, agriculture, labour, governance structures and the national treasury); relevant organizations in the private sector; organized labour; and civil society.

An actors and roles matrix is provided in Table 4. While the recommended actions may seem broader in reach than the limited scope of this guideline, the intention is to show that the circular economy is cross-sectoral by nature and successful implementation will require cross-cutting application. This matrix would need to be fully workshopped with all the recommended actors prior to its adoption.

The preliminary proposed actors and roles matrix provides an overview of the actors and sectors on which to focus to start the transition to circularity. The matrix is not comprehensive or exhaustive since it needs to be workshopped and agreed with all proposed actors along the value chain.

8.1.1.2 Collaborative platforms

There are also more specific collaborative platforms for focused interactions such as industrial symbiosis, public-private agreements, research and development (R&D) clusters and voluntary industry initiatives. Recommended actions for collaborative platforms include:

⇒ Strengthen the capacity of the existing Industrial Symbiosis Programmes across the country; for example, a National Industrial Symbiosis Platform may be established.

⇒ Encourage the establishment of additional innovation/incubation hubs around South Africa to increase awareness of CE, innovative design and a change in mind-set.

⇒ Cooperation across government, civil society and business should be encouraged via existing organizations. There are public and private organizations that are practising and/or researching CE principles. The additional benefits associated with cooperation include knowledge-sharing and, in some instances, resource-sharing. Therefore, as opposed to working in parallel and in non-supportive ways, the recommendation is for these organizations to streamline and where possible collaborate and work together.

Both public institutions and private organizations procure many services and products. This immense buying power provides opportunities to influence the quantity and type of materials that need post-use management and, throughout the value chain. Green procurement policies that are based on circular economy principles should be developed and implemented.

In the private sector there are many opportunities to transition to circularity along the entire materials value chain including extraction and processing, manufacturing, procurement, resource utilization, re-use, refurbishment/

repair and recycling. Small, medium and large organizations should subscribe to green procurement policies designed around circular economy principles, to shift from current types and quantities of products and services that create post-use waste management processes for example here is in the catering, industry where large quantities of milk and beverages are used. Typically, these are provided in recyclable containers, however an alternative could be that they are supplied in returnable and refillable containers that go back to the supplier for re-use.

To promote CE, current business models of waste management service providers need to be expanded. Along with the on-site separation of materials, collection, transport and disposal services that they generally offer, service providers should also assist clients with circular procurement and resource efficient processes.

8.1.2 Information, data management and assessment

Data gathering for data-driven circular business practices, which is hampered by the lack of common software interfaces, connectivity protocols and standard data formats, may be facilitated in collaboration platforms that involve all actors across value chains. A positive spin-off of collaboration platforms is the development of trust among different companies and actors in the value chain, which is essential to enable data sharing and the tracking of a product or product parts. There may be concerns, however, related to sharing for commercially sensitive information. Policymakers must develop regulatory frameworks to address concerns on data privacy and ownership and thus provide trust and confidence in the markets[129].

A collaborative, multilateral approach is also required for the implementation of circular systems by government departments that deal with the environment, science, technology, trade and industry at the line function level, and for setting up the monitoring and evaluation of CE activities. In the case of a government-led CE strategy, a national monitoring entity would have to be decided upon among the key actors.

Monitoring indicators, standardized data-gathering tools and procedures and evaluation processes would also be outcomes of a multilateral consultative process.

8.1.3 Skills development and training

This guideline provides overarching principles and frameworks needed to implement the circular economy approach effectively. Various techniques and tools that may be appropriate are mentioned; however, the selection of techniques and tools has to be context-specific. More information and examples may be found in the following resources:

⇒ The Ellen MacArthur Foundation guideline on circular economy tools, the *Toolkit for Policymakers*[130], presents the ReSOLVE framework for businesses and governments. This is a tool for generating circular strategies and growth initiatives and approaches to

129. Rizos, V. et al. (2018). The Role of Business in the Circular Economy: Markets, Processes and Enabling Policies. Report of a CEPS Task Force. Brussels: Centre for European Policy Studies. Retrieved from https://www.researchgate.net/publication/324013764_The_Role_of_Business_in_the_Circular_Economy_Markets_Processes_and_Enabling_Policies

130. Ellen MacArthur Foundation. (2015). Delivering the Circular Economy: A Toolkit for Policymakers. Retrieved from https://www.ellenmacarthurfoundation.org/assets/downloads/publications/EllenMacArthurFoundation_PolicymakerToolkit.pdf

131. Ellen MacArthur Foundation. (2015).Towards a circular economy: business rationale for an accelerated transition. Retrieved from: https://www.ellenmacarthurfoundation.org/publications/towards-a-circular-economy-business-rationale-for-an-accelerated-transition

132. Eurostat. Resource efficiency indicators. European Commission Eurostat. Retrieved from https://ec.europa.eu/eurostat/web/environmental-data-centre-on-natural-resources/resource-efficiency-indicators accelerate the transition to circularity[131]

⇒ The EU's Eurostat website provides procedures and tools for gathering and monitoring statistical data, aligned to the EU's regulatory framework and according to agreed standardized parameters[132]

⇒ An international review of more than 100 CE implementation strategies and initiatives gives the range of current CE options, where they fit into the value chain and how they are being implemented (Kalmykova *et al*, 2018)[133]

⇒ Circular business models and fit-for-purpose systems, practices and tools that facilitate the transition to circularity are emerging in the growing body of research findings and proliferation of online, open-source collaboration platforms, readily accessible to anyone with access to the internet. These are discussed further under Section 7.2 and 8.1.

Data skills with data analytics and visualization must be developed to transform data into usable information that can drive the implementation of circular systems and the sharing of such data.

8.1.4 Awareness raising and public involvement

Implementing the circular economy requires the commitment and cooperation of all actors in the value chain, including the general public as consumers and service providers. People will not adopt the concepts and principles of circularity unless they understand the significance and urgency of changing our consumption behaviour. Media campaign approaches similar to popular advertisement campaigns for soft drinks (e.g. Coca-Cola), may be considered.

At a national level, the Department of Environment, Forestry and Fisheries developed the Waste Awareness Strategic Framework in 2016[134] to assist provincial and local authorities in implementing awareness-raising campaigns. The Department of Environment, Forestry and Fisheries also recently embarked on a national environmental outreach and awareness campaign, which included various communities and schools across the country (DEA, 2018)[135].

At the household level, effective source separation, which is central to maintaining the quality of materials for the application of the waste management hierarchy and the implementation of circularity, requires active cooperation by the public. This necessitates considerable outreach, engagement and education[136] and requires buy-in and partnerships from local municipalities that extend beyond their constitutionally-mandated refuse collection and disposal services. A number of municipalities are implementing capacity-building and awareness-raising campaigns, aimed at educating the general public about the different types of waste, waste minimization, recycling and recovery, and the impact of waste on human health and the environment. The importance of separating materials at source must also be emphasized as essential for circularity. These initiatives align with Goal 4 of the NWMS, which is to ensure that people are aware of the impact of waste on their health, well-being and environment.

> *The decoupling of economic growth and resource consumption is a specific example of sustainable production and consumption in action*
>
> *UNEP, 2011*

133. Kalmykovaa, Y., Sadagopanb, M., and Rosadoc, L. (2018). Circular economy – From review of theories and practices to development of implementation tools. Resources, Conservation & Recycling, 135, 190–201. https://doi.org/10.1016/j.resconrec.2017.10.034

134. DEA (2016) Retrieved from https://www.environment.gov.za/sites/default/files/strategic_plans/environmentalaffairs_startegicplan_2015-16_2019-20.pdf

135. Department of Environmental Affairs (DEA). 2018. South Africa State of Waste Report: First Draft Report. Retrieved from http://sawic.environment.gov.za/documents/8641.pdf

136. UNEP and UNITAR. (2013). Guidelines for National Waste Management Strategies: Moving from Challenges to Opportunities. UNEP. Retrieved from: http://wedocs.unep.org/handle/20.500.11822/8669

8.1.5 Funding

Enterprise and Supplier Development South Africa (ESDSA) is an initiative which sources funding for enterprises that are using technology to solve challenges and contributing to socio-economic transformation[137]. There are 260 different enterprise development programmes listed on the ESDSA website. Many enterprise development programmes focus on training and coaching. However, very few of these initiatives provide seed funding at early start-up stage, as does ESDSA. The ESDSA platform addresses the knowledge transfer challenge by making information readily available online without the need for physical travel to obtain it.

An alternate funding mechanism is the Green Outcomes Fund (GOF), currently being implemented as a collaboration by the Bertha Centre for Social Innovation and Entrepreneurship (UCT Graduate School of Business), the World Bank, WWF-SA, and GreenCape[138]. It is geared to financing early-stage small or growing businesses that are implementing innovative or untested green business models, which are inherently risky and often require costly technical assistance. The innovative financing structure incentivizes local, South African fund managers to invest in small green businesses that demonstrate a contribution to the country's green economy, as well as job and enterprise creation. The fund provides straight or re-imbursable grants to local fund managers in exchange for pre-agreed green outcomes being achieved by the investees. The outcomes are measured using a set of green metrics that have been developed to serve as potential payment triggers for local initiatives. The measurable outcomes relate to waste management, clean energy, green jobs and CO_2 emission reduction, among others.

8.1.5.1 Business support schemes

In seeking out circular economy opportunities in the transition to new business models, companies may face economic obstacles, such as lack of access to capital or technology, challenges to profitability, and market issues such as insufficient competition, split incentives, and transaction costs.

Along with policy interventions related to financial support, such as grants, subsidies, capital injections and financial guarantees, policy interventions focusing on business development could take the form of technical support, advice, and training, demonstration of best practices and development of new business models. A particular focus of these support schemes will likely be SMEs, which may lack the internal capacity, capabilities and financial resources to take advantage of new opportunities related to CE.

In South Africa, additional support is offered through the Green Fund, a national fund that supports green initiatives to assist South Africa's transition to a low carbon, resource efficient and climate resilient development path, while delivering high impact economic, environmental and social benefits.

The data and information gaps discussed earlier are a challenge for further research and development. The Trade & Industrial Policy Strategies (TIPS) institution[139], an independent, non-profit, economic research institution based in Pretoria, South Africa, conducting in-depth economic analysis into the amount of funding from public and private sector into green R&D. The Green R&D Investment Report is currently being updated to include a 7-year trend analysis. The Centre for Science, Technology and Innovation Indicators (CeSTII) is a statistical and

137. ESDSA. South African's Enterprise and Supplier Development Landscape. Retrieved from http://www.esdsa.com
138. World Bank Group. 2017. Monetizing Green Impact. Lessons from Africa's First Green Outcomes Fund. Climate Technology Program. In Brief no.11. Retrieved from http://documents.worldbank.org/curated/en/501811530120278091/pdf/127701-REVISED-PUBLIC-inBrief-11-WBG.pdf
139. Trade & Industrial Policy Strategies (TIPS). Retrieved from: http://www.tips.org.za/about-tips/company-profile AND http://www.tips.org.za/projects/current-projects

policy research unit located within the Human Sciences Research Council (HSRC). CeSTII conducts the National R&D Surveys for DST and will be incorporating the TIPS methodology into the R&D Survey for ongoing data collection on an annual basis. The R&D Survey is approved by StatsSA as a contribution to the official statistics for SA.

The USAID South Africa Low Emissions Development (SA-LED) Program bridges the gap between public institutions and investors, and catalyzes innovative low emissions development projects in municipalities across the country. Key opportunities lie in the area of waste management, transportation, renewable energy and energy efficiency.

The 5-year programme has run since 2013 in partnership with the Department of Environmental Affairs (DEA) and Department of Science and Technology (DST). The program works with local government to build capacity and develop projects that respond to climate change and support South Africa in transitioning to a green economy. USAID LEDS programme also prepares financial models to implement cleaner technologies.

The programme is near completion and is currently seeking ways to make the initiatives introduced more sustainable.

8.1.6 Research and development

South Africa introduced the Research and Development (R&D) Tax Incentive to incentivise private sector to undertake R&D and innovation in the country[140]. The R&D Tax Incentive is aimed at encouraging private sector investment in scientific and technological R&D in South Africa in terms of section 11D of the Income Tax Act, 1962 (Act No. 58 of 1962). The incentive allows companies undertaking R&D in the country to deduct their R&D expenditure when determining taxable income. The incentive can be accessed by companies of all sizes and in all sectors of the economy provided that they can meet the challenges in applying for the tax benefits.

Other opportunities for research funding also exist, for example, through the Alliance for Accelerating Excellence in Science in Africa (AESA) based in Nairobi, Kenya, which was established by the African Academy of Sciences in partnership with New Partnership for Africa's Development (NEPAD)[141]. The funding provides a platform for African scientists to speak with one voice when it comes to aligning a research and development agenda for African countries.

8.1.7 Awareness raising

Since the concept of the circular economy is still not widely known to the public or in the business community, policy interventions aimed at increasing information and awareness are important for changing ingrained patterns of behaviour, terminology used, and ways of thinking that companies and individuals have developed. Since the circular economy requires Business to cooperate across what have traditionally been sectoral and functional silos, an understanding of the economic potential and the practicalities is important, and is yet often lacking.

For interventions to be effective, the information communicated must be consistent across platforms. Therefore, proposed Governments role in terms of consistent messaging and information sharing is crucial.

Information and awareness campaigns could be broadcast to the general public (for example, being the food waste prevention campaign in Catalonia, Spain) or provided to consumers through product labelling (as in the case of South Korea’s Eco-label, which indicates polluting emissions associated with the product, as well as the conserva-

140. Research and Development (R&D) Tax Incentive. Retrieved from: https://www.gov.za/speeches/science-and-technology-esearch-and-development-rd-tax-incentive-programme-2-mar-2018-0000
141. AESA. Retrieved from https://aesa.ac.ke/

tion of resources achieved throughout the product's lifecycle relative to other products of the same category).

8.2 Policy perspective

8.2.1 Policy and regulatory

South Africa is well-positioned to transition to a circular economy considering that there are a number of existing policy and legislative drivers that promote a transition to a green economy. In this context, however, legislation must be refined to accommodate CE-related initiatives and create the necessary enabling environment for the transition to circular activities.

The guideline identifies opportunities for moving beyond the waste management hierarchy and adopting circular practices that avoid the creation of waste along the entire materials value chain, from resource extraction, processing, eco-design of products, production, and consumption to beneficiation. The associated benefits of CE are new work opportunities, more efficient and sustainable use of materials, and innovative changes to the way materials are managed and shared. Many greening initiatives which align to circular economy principles and practices are already being implemented in South Africa. Such initiatives include resource-efficient and cleaner production methodologies that lower costs through reduced energy, water and materials usage, waste minimization, and industrial symbiosis programmes that minimise waste and improve the circularity of material flows amongst participating industries.

Care must be taken to counteract any potentially negative impacts of a transition to circularity. The concept of a 'just transition'[142], referenced in the Paris Agreement, is discussed in several sources such as the ILO Guideline[143] and the Stockholm Environment Institute[144] document. Examples of contexts in which a just transition has been required to assist individuals and communities to adjust to a new paradigm include the move away from fossil fuels, the greening of the economy, and the move to alternative transport systems. For example, a rapid low-carbon transition may result not only in new industrial and employment opportunities, but also in stranded workers and communities.

The UNFCCC's 2016 Just Transition[145] report highlights skills development as being central to a successful transition to a green economy, with higher education and technology centres being key features of supporting a workforce equipped for a knowledge-based rather than coal and steel-based economy. In addition, the UNFCCC report outlines a number of important examples of how an existing workforce can put its skills to use in low-carbon sectors. The ILO's just transition guidelines provide a crucial set of principles around which to design transition policies and measures to avoid adverse impacts for workers:

⇒ High-level policy and corporate commitments are vital, including funding commitments.

⇒ Local communities and unions have a key role to play in the shift to a low-emission climate-resilient economy, including identifying activities that can be substituted for the declining high carbon ones.

⇒ An active social dialogue is necessary between un-

142. International Labour Organization (2018). Just transition towards environmentally sustainable economies and societies for all. ILO ACTRAV Policy Brief. Retrieved from: https://www.ilo.org/wcmsp5/groups/public/---ed_dialogue/---actrav/documents/publication/wcms_647648.pdf

143. International Labour Organization (ILO) (2015). Guidelines for a just transition towards environmentally sustainable economies and societies for all Retrieved from: https://www.ilo.org/wcmsp5/groups/public/---ed_emp/---emp_ent/documents/publication/wcms_432859.pdf

144. Stockholm Environment Institute (2019). Realizing a just and equitable transition away from fossil fuels. Piggot G; Boyland M; Down A; A.R Torre. SEI Discussion Brief January 2019. Retrieved from: https://www.sei.org/wp-content/uploads/2019/01/realizing-a-just-and-equitable-transition-away-from-fossil-fuels.pdf

145. United Nations (UN) UNFCCC (2016). Just transition of the workforce, and the creation of decent work and quality jobs. 59 (2016). Retrieved from: https://unfccc.int/sites/default/files/resource/Just%20transition.pdf ions, employers, and local or central government.

⇒ The transition needs to be anticipated years in advance in order to facilitate retraining and mobility plans.

⇒ Overall coordination, co-operation and trust among stakeholders is crucial.

Similar principles and requirements are applicable for a just transition to circularity in South Africa.

The transition to circularity must make economic sense. Recycling is a good example of an activity with **positive externalities**, where costs of undertaking the activity are borne by one party, although the benefits are realized by another party. In principle, given the large difference between the benefits and costs, there should be some opportunity for win-win compensation. According to South Africa's National Department of Science and Technology's Waste RDI Roadmap, preliminary evidence suggests that for many waste streams the benefits of recovery and recycling exceed the costs, and the benefits and costs are typically not shared equitably among the parties involved[146]. In the case of domestic waste, municipalities typically bear the cost of collection, separation and disposal, while the private sector realizes the financial benefit of recycling, having access to the recovered material. In such cases, the usual recommendation from an economic perspective (aside from mandatory regulations), would be to ensure that financial incentives are provided to those bearing the costs, through some form of transfer from the beneficiaries to the providers, for example, by means of subsidies or some form of trading or compensation scheme/incentive schemes.

Costs associated with disposal to landfill are expected to increase dramatically over the next few years, as landfill airspace becomes increasingly constrained and norms and standards for disposal are applied. This poses a risk to all businesses relying on landfill for disposal of waste. Forward-thinking businesses have developed strategies to divert organic waste and recyclables from landfill with many aiming to become Zero-Waste-to-Landfill facilities and operate independently of external factors.

8.2.2 Fiscal Frameworks

The main barriers to circular economy opportunities that fiscal instruments could address, are those of profitability for companies and unpriced externalities. As with regulatory frameworks, it is recommended that these should be used sparingly in the South African context and only implemented after thorough investigation, consultation and full cost accounting exercises have been completed.

8.2.2.1 Extended producer responsibility

Voluntary industry initiatives are likely to become mandatory through the implementation of the Industry Waste Management Plans, the first of which were submitted in September 2018. Various Producer Responsibility Organisations (PROs) across South Africa for packaging recycling include (but are not limited to):

⇒ Polyco - Polyolefins
⇒ PETCO – PET
⇒ METPAC –Metals
⇒ Packaging South Africa
⇒ Polystyrene Association of South Africa
⇒ Paper Recycling Association of South Africa
⇒ The Glass Recycling Company
⇒ South African Vinyl Association
⇒ Plastics SA.

146. Department of Science and Technology (2014). A National Waste Research, Development (R&D) and Innovation Roadmap for South Africa: Phase 2 Waste RDI Roadmap The economic benefits of moving up the waste management hierarchy in South Africa: The value of resources lost through landfilling. Department of Science and Technology: Pretoria. Retrieved from http://www.wasteroadmap.co.za

Producer Responsibility Organisations are included in the earlier-mentioned recommendations, as they have been operating very successfully on a voluntary basis for many years, recycling materials and reducing waste materials going to landfill. Government has actively engaged with these organisations during the preparation of the Industry Waste Management Plans, particularly in relation to policy or regulatory conditions under consideration.

8.2.2.2 Circular procurement and infrastructure

A circular procurement approach is achieved when public and private sector organizations meet needs for goods and services in a way that achieves value for money throughout the lifecycle, for the organization and for wider society, while minimizing materials losses and environmental impacts. Circular economy requirements are incorporated into procurement specifications; lists of preferred materials are drawn up; and capabilities and skills related to concepts such as total cost of ownership (TCO) and measuring material circularity are built in human resource capabilities.

In South Africa, the Western Cape Government has developed a useful document entitled "*Moving towards sustainable performance-based procurement in the Western Cape: A guidebook for supply-chain managers and policy makers*"[147]. Therefore, supply chain managers and departments in both the public and private sectors are encouraged to develop circular procurement policies.

147. WWF (2018). Moving towards performance-based procurement in the Western Cape Province: A guidebook for supply chain managers, WWF South Africa.

CHAPTER 9: CONCLUSIONS

The guideline provides an entry point for understanding the many opportunities and potential benefits that a circular economy may provide for South Africa. It also concludes that the policy and regulatory environment in South Africa in broad terms can support the implementation of a circular economy. The particular focus of this guideline is on transitioning to a circular economy in the waste sector in South Africa.

The discussion therefore placed emphasis on materials flow and the materials value chain, which is just one part of the broader value chain and wider circular economy. A circular economy approach, in turn, is just one of several ways of achieving SDG goal 12, sustainable consumption and production.

9.1 Application perspective

The transition to a circular approach requires a radical shift away from current wasteful practices driven by a consumption-focused economy towards separation of material flows at source, to retain their value and maximise their beneficiation potential, and a focus on keeping biological and technical materials circulating at their highest value within the economy.

Consideration of the South African waste economy indicates that the potential contribution to GDP is significant if the materials currently being lost to landfill are recovered and beneficiated. Several of the CE initiatives discussed in the guideline are geared towards employment creation, new business development and socio-economic upliftment. There are also environmental benefits associated with circular systems: a waste-free environment, resource conservation, pollution prevention, and GHG emission reduction. There are many new prospects available, for example, business models involving sharing or leasing options, and options for re-use, refill, repair and refurbishment. Such options, however, require a shift away from current waste management practices, mindsets and consumptive patterns, especially if the vision of a circular economy is broadened beyond the waste sector alone, as should be the case.

Collection and processing of materials along the value chain present opportunities for both formal and informal work and associated enterprise development. Recycling is recognized as having strong potential for employment creation, given that approximately 90% of waste, still containing a high recyclable content, is landfilled in South Africa. Manual informal waste picking, however, is associated with hazardous working conditions. Opportunities for decent work in sustainable waste management must be maximized along the entire value chain, from recovery at source to waste beneficiation.

Biological materials make up a large proportion of the waste materials currently being disposed to landfill. Improving the diversion of organics from landfill will result in a significant saving of scarce airspace as well as reducing greenhouse gas (GHG) emissions, odours and leachate. The organic fraction can be diverted into a range of different technologies that include (aerobic) composting, anaerobic digestion, biogas to energy, bio-refining to produce high value products (fuels, animal feeds), pyrolysis, and co-incineration. Some of these technologies are more appropriate for a developing country context than others. Many have been piloted with short-lived success, only to prove unsustainable because of the typically high organic and moisture content of municipal waste streams from low income areas and the relatively large volumes of sand and grit resulting from inefficient collection systems that tend to clog equipment, rendering it unserviceable.

Non-biodegradable, technical materials that include metals, plastics, bulky industrial waste streams (ash, C&D materials) can be diverted from landfill into a variety of different technology solutions such as extending the life cycle of technical materials by maintaining functionality, repair, re-use, refurbishing, re-manufacturing and recycling. There are many initiatives emerging within the private sector that improve opportunities for maintenance, especially of electronic items (i.e. appliances, computers, laptops, mobile phones), furniture, vehicles, tools and equipment. Opportunities should be found for bringing workers in the informal sector, already active in this space, into the "formal" economy, in recognising the services they provide and facilitating access to space, tools and equipment. There are several examples of "maker movement" initiatives already operational in South Africa with great potential for further rapid uptake.

Transitioning to a circular economy must also improve opportunities for re-use and re-distribution of technical materials. Keeping materials within the technical loops of the circular economy means improving opportunities for refurbishment and repair, for example, of vehicles, machinery and equipment.

Since the concept of the circular economy is still not widely known to the public or in the business community, policy interventions aimed at increasing information and awareness are important for changing ingrained patterns of behaviour and ways of thinking that companies and individuals have developed. Collaboration platforms provide essential opportunities for networking, sharing information and building trust amongst the circular economy actors. Business support schemes must also be in place to assist in overcoming skills, economic and knowledge obstacles.

Research and development are important if South Africa is to keep up with advances in cyber-physical, artificial intelligence, and robotic systems. Innovative product design is an enabler of transition to CE, since products need to be adapted for multiple life cycles and upgradability. Therefore, upskilling and reskilling will be required in many instances to prepare people for the new skills and alternative work opportunities in dramatically different circular economic systems.

9.2 Policy perspective

South Africa is well positioned to transition to a circular economy. In broad terms, the existing policy and regulatory environment in South Africa is sufficiently developed to support the implementation of a circular economy. A legislative and policy framework for a low carbon, resource efficient and green economy already exists in South Africa. There are a number of existing policy and legislative drivers to promote the transition to a green economy. Within this context, however, the transition to circular activities is currently obstructed by a lack of consistent implementation and enforcement of existing legislation.

Policies and regulations are largely in place to effect diversion of materials from landfill, separating out specific materials such as organics and specific bulky material. Costs associated with disposal to landfill is expected to increase dramatically over the next few years as landfill airspace becomes increasingly constrained. Forward-thinking businesses that have relied on landfill for disposal of waste have developed strategies to divert organic waste and recyclables from landfill with many aiming to become Zero-Waste-to-Landfill facilities and operate independently of external factors.

A circular public procurement approach should be implemented within all public sector organizations for goods and services, in a way that achieves value for money throughout the lifecycle, both for the organization and for wider society, while minimizing materials losses and environmental impacts. To assist in achieving this approach, circular economy standards could be incorporated into procurement requirements; lists of preferred materials could be drawn up; and capabilities and skills related to concepts such as total cost of ownership (TCO) and measuring material circularity may be built in the people tasked with developing procurement specifications.

A transition to a circular economy requires the integration of complex relationships between multilateral actors. Policy and legislative frameworks should be developed consultatively with all actors along the value chain (including product designers, mining operators, producers, distributors, consumers, collectors of end-of-life products, recyclers, etc.). Government in South Africa recognises that in addition to government-led “top down” measures to enable a transition to a circular economy, the “bottom up” buy-in and co-operation of civil society, business and labour are an essential part of implementing a circular approach.