Supported by:

Federal Ministry
for the Environment, Nature Conservation,
Nuclear Safety and Consumer Protection

based on a decision of
the German Bundestag

Building Partnerships for a
ENVIRONMENTAL PROTECTION made in Germany
Sustainable Infrastructure

STIMULATING SUSTAINABLE RESOURCE USE BY INDUSTRY IN SOUTH AFRICA, NAMIBIA AND BOTSWANA

Analysis of waste management, waste reuse and minimisation in industry

AHK
Deutsche Industrie- und Handelskammer für das südliche Afrika
Southern African-German Chamber of Commerce and Industry

Published by:

Southern African – German Chamber of Commerce and Industry (AHK Southern Africa)

P.O. Box 87078, Houghton, 2041
47 Oxford Road, Forest Town, 2193
Phone: +27 (0)11 – 486 2775
Fax: +27 (0)11 – 486 3625
Email: info@germanchamber.co.za

Website: https://suedafrika.ahk.de/

Authors:
Danilla van Jaarsveldt – Project Manager Waste and Recycling Portfolio
Jens Hauser – Head of Competence Centre Climate and Environment; and
Vera Massie - Project Manager Water Portfolio

Layout: AHK Southern Africa

Photo credit: Shutterstock

Publication date: 31 January 2022

The project is funded by the Export Initiative Environmental Technologies Programme of the Federal Ministry of the Environment, Nature Conservation, Nuclear Safety and Consumer Protection (Ger. Bundesministerium für Umwelt, Naturschutz, nukleare Sicherheit und Verbraucherschutz – BMUV).

More information: https://www.exportinitiative-umweltschutz.de/de

Supported by:

Federal Ministry for the Environment, Nature Conservation, Nuclear Safety and Consumer Protection

based on a decision of the German Bundestag

TABLE OF CONTENTS

ABBREVIATIONS

BA	Basic Assessment
BMUV	Federal Ministry of the Environment, Nature Conservation, Nuclear Safety and Consumer Protection (Ger. Bundesministerium für Umwelt, Naturschutz, nukleare Sicherheit und Verbraucherschutz – BMUV)
WMA	Botswana Waste Management Act (Chapter 65:06 of 1998)
BWWM	Botswana's Strategy for Waste Management
DFFE	Department of Forestry, Fisheries and the Environment
EA	Environmental Authorisation
EIA	Environmental Impact Assessment
EMA	Environmental Management Act
EPR	Extended Producer Responsibility
GHG	Greenhouse gas
MEFT	Ministry of Environment, Forestry & Tourism
NEMA	National Environmental Management Act (Act Nr. 107 of 1998)
NEMWA	National Environmental Management: Waste Act (Gesetz Nr. 59 von 2008)
NPSWM	National Pricing Strategy for Waste Management
NSWMS	National Solid Waste Management Strategy for Namibia
NWMS	National Waste Management Strategy
NPO	Non-Profit Organisation
PRO	Producer Responsibility Organisation
R&D	Research and Development
S&EIR	Scoping and Environmental Impact Reporting
SDG	Sustainable Development Goal
WtE	Waste to Energy

1 INTRODUCTION

1.1 Project background

Sustainable resource use, low-carbon economic development and environmental protection are gaining traction in Southern Africa, which is evident in the direction of environmental policy development. Environmental legislation is tightening and under the Paris Climate Agreement, countries have voluntarily committed to reducing their greenhouse gas emissions.

Industry is traditionally characterised by high resource consumption for value creation. However, in response to a changing political and policy environment, industry in southern Africa is beginning to reassess their resource use.

In order to support the growing shift towards resource efficiency in industry in Southern Africa, the German Federal Ministry of the Environment, Nature Conservation, Nuclear Safety and Consumer Protection (Ger. Bundesministerium für Umwelt, Naturschutz, nukleare Sicherheit und Verbraucherschutz – BMUV) is funding the project*: "Stimulating sustainable resource use in industry in South Africa, Namibia and Botswana".* The project forms part of the Export Initiative Environmental Technologies Programme. The Southern African-German Chamber of Commerce and Industry (AHK Southern Africa) has been appointed to lead the project, which is anticipated to be completed by January 2023.

The project aims to illustrate the benefits of modern environmental technology by means of concrete, replicable and scalable resource efficiency measures in industry, and to build knowledge with regard to the application and implementation in the target sector. It is envisioned that the project stimulates investment in environmental technologies to reduce resource consumption and waste generation in industrial processes.

Two situation analyses, detailing information on political, economic, social, technological, legal and environmental aspects for each country have been compiled covering the two main topics of the project:

1. Waste management, waste reuse and minimisation in industry
2. Water use efficiency and wastewater management

This document presents an analysis of waste management, waste reuse and minimisation in industry in South Africa, Namibia and Botswana. The analysis provides an overview of the factors currently influencing the readiness of industry to implement environmental technology relating to waste reduction and recycling.

1.2 Methodology

The analysis was completed through a comprehensive desktop review of existing information, including policy documents, governmental plans, laws and regulations, scientific and socio-economic research documents as well as online newspapers. Semi-structured interviews were conducted with experts in the field and the information was incorporated into the PESTLE analysis where appropriate.

The information gathered was synthesised using the PESTLE analysis approach, which studies the key external factors influencing the readiness of industry to implement environmental technologies. The key external factors considered in this study excluded general information on the target countries and focused on the aspects relevant to the industrial sector and the topic. The analysis provides an overview of the factors currently influencing the readiness of industry to implement environmental technologies. We reviewed the following topics for each target country:

- Political and institutional drivers – Policy drivers and goals, institutional structures.
- Economic factors – costs of waste disposal, financial incentives, readiness to implement technologies.
- Social considerations – polluter pays principles and social pressure, skills development and job creation.
- Technology - Project examples already implemented in the target country.
- Legal framework – legal requirements pertinent to waste disposal and Extended Producer Responsibility (EPR)
- Environmental aspects – environmental drivers for waste management, environmental impacts of poor waste management.

2 BACKGROUND INFORMATION

Global economic growth has been reliant on ever-increasing resource use. Finite resources have been used linearly by extracting resources to manufacture products, which are discarded after use. High waste volumes produced in a primarily linear economy coupled with poor waste management have caused negative environmental and socio-economic knock on effects. Worldwide, negative effects disproportionally affect poor and marginalised communities.

It has become apparent that this linear approach to resource consumption is unsustainable, which means that our planet will be unable to support the current trajectory of economic growth in future. To avoid a collapse of human civilisation, the global community has realised that countries must embark on a journey to decouple environmental degradation and resource consumption from economic growth, as well as by protecting and restoring remaining natural resources. The concept of a circular economy has emerged as a potentially powerful economic model to guide sustainable use of the remaining natural resources.

The current understanding of circular economy is based on the principles of eliminating waste and pollution, circulating products and materials at their highest value possible, as well as regenerating natural resources.[1] Key actions to achieve these principles involve design changes that facilitate waste prevention, repair, reuse and remanufacturing.

Circular economy is an important tool in implementing the paradigm shift articulated in the United Nations Sustainable Development Goal (SDG) 12: "*Ensure sustainable consumption and production patterns*".

Industrial activity forms the backbone of economic growth and industry must contribute towards achieving SDG 12. Several targets of SDG 12 are applicable to industry, namely:

12.4: By 2020, achieve the environmentally sound management of chemicals and all wastes throughout their life cycle, in accordance with agreed international frameworks, and significantly reduce their release to air, water and soil in order to minimize their adverse impacts on human health and the environment.

12.5: Substantially reduce waste generation through prevention, reduction, recycling and reuse.

12.6: Encourage companies, especially large and transnational companies, to adopt sustainable practices and to integrate sustainability information into their reporting cycle.

[1] (Ellen Macarthur Foundation, 2022)

Industry is likely to achieve improved waste management, waste reuse and minimisation by implementing one or more of the following interventions:

- Reduce material input;
- Reuse waste products within the factory;
- Find off-taker for by-products of manufacturing processes;
- Separate waste at source for responsible waste disposal (e.g. hazardous waste, recyclable waste, organic waste);
- Corporate Social Responsibility projects by working with local communities.

Globally, Extended Producer Responsibility (EPR) is considered an important policy tool to encourage more efficient use of resources in the manufacturing sector. Based on the *polluter pays principle,* EPR transfers a large part of the responsibility for the entire life cycle of a product, including the treatment and disposal of products consumed by society, from the taxpayer on the producer. EPR therefore incentivises producers to design products that are more recyclable and/or reusable. Registered Producer Responsibility Organisations (PROs) consisting of Non-profit Organisation (NPO) or individuals, support the implementation of a product-specific EPR scheme. These PROs are responsible for diverting waste materials from landfill and developing the end market, thereby addressing supply and demand aspects in waste management.[2]

Innovative, resource-minimising industrial processes and technologies play an important role in improved waste management, waste reuse and minimisation in industry. Such interventions can save costs, or even generate new revenue streams and business opportunities. A study by McKinsey shows that in more than 20 industrial sectors, circular economy interventions can lead to increased economic performance as well as lower production costs.[3]

The increasingly sophisticated nature of recycling and waste management worldwide is putting pressure on Southern Africa to keep up with trends. Waste has been labelled as a "commodity frontier" whose viability depends on the development of new technologies for extracting and restoring materials.[4] This includes a plethora of technologies, including those applied in recycling, as well as energy generated through anaerobic digestion and incineration technologies (waste to energy).

The readiness of the industry to adopt environmental technologies depends on various push-pull factors and differs between industry sectors and countries. The move towards resource efficiency must make economic sense and is determined by several factors. A transition will occur when:

- Policy and regulatory requirements change and are implemented rigorously;
- Financial incentives and disincentives pertaining to waste management are in place;
- Social pressure on popular brands or large corporation (e.g. plastic pollution in oceans)

These factors will be unpacked in Chapter 4 in the detailed findings for each country and have been summarised in Chapter 3 of this analysis.

[2] (GreenCape, 2021)
[3] (McKinsey, 2016)
[4] (Ernstson, et al., 2021)

3 KEY FINDINGS

The purpose of this study was to analyse the readiness of the industrial sectors in South Africa, Namibia and Botswana to begin with the transition towards improved waste management, waste reuse and minimisation. Key external factors were analysed for each country by means of a PESTLE analysis, including political and institutional drivers, economic factors, social considerations, technology, the legal framework and environmental aspects (PESTLE).

This Chapter summarises the key findings of the PESTLE analysis for the focus countries South Africa, Namibia and Botswana and concludes by synthesising the information through a SWOT (Strengths, Weaknesses, Opportunities, and Threats) analysis.

3.1 Summary of findings

Disposal of untreated waste to landfill is the main waste management mechanism in South Africa, Namibia and Botswana and the amount of waste disposed at landfill is increasing every year. Industries contribute towards most waste types discarded on landfill sites. However, it is currently unknown how much waste is disposed of by industries per year.

Many landfill sites in the region are poorly constructed or not maintained with limited implementation of waste management technologies. Consequently, a number of environmental impacts are associated with poor landfill management in the region. These include groundwater and surface water pollution, soil contamination, greenhouse gas, dust and odour emissions. Poor waste management disproportionally impacts marginalised and poor communities. Inequality is still high in the region and the most vulnerable group would arguably be the informal waste sector, which consists of waste pickers who work on landfills and collect recyclables door to door. Improved waste management, waste reuse and minimisation in industry is likely to have a net positive environmental and socio-economic impact.

South Africa's political, institutional and legislative framework is the strongest amongst the three countries. However, implementation of command and control mechanisms are still lacking, which diminishes this advantage. South Africa is the only country which has long-standing, industry lead voluntary Extended Producer Responsibility (EPR). Recently these activities were legislated, requiring all industry members in the electrical and electronic equipment sector, the lighting sector and the paper, packaging sector to comply with requirements EPR legislation. The importance of EPR is expected to grow in South Africa in the medium to long-term. Namibia is starting to engage with EPR, while Botswana has not prioritised EPR due to the underdeveloped manufacturing sector at this time. Other national economic incentives/disincentives (e.g. tax rebates/penalties) for industries to reduce virgin material inputs, minimise waste and divert waste from landfill have not been implemented in the region.

In all three countries, industries are responsible for disposing their waste at registered landfill sites, or to establish registered waste management facilities on their premises. Most commonly, this is achieved through the use of private waste management companies against a service fee. It is currently unknown how much waste disposal affects the bottom line in industries in the region. In Namibia, it is likely that industries pay a substantial amount for waste disposal, due to long-distance travelling required for waste disposal. In South Africa, waste disposal is most expensive in Cape Town and is expected to rise above inflation rates in the coming years.

Many companies in the region are changing their packaging suppliers to those that use a higher percentage of recycled material for their products. However, minimal information is available on technologies that have already been implemented to reduce the input of virgin material volumes (i.e. waste minimisation).

Even though the concept of circular economy can be applied to all sectors, it is important to focus on those sectors with economic importance to achieve maximum impact and replicability. Furthermore, industries that manufacture products that are exported to Europe could be interesting. The sectors identified as those with the most potential for circular economy are agriculture and food processing, plastics, mining and construction. However, a concrete market volume is currently not known.

Table 1: Political and institutional drivers.

South Africa	Political and institutional change is driven primarily by the reality that South Africa's landfill sites are fast approaching their capacity limits. Aside from well-developed national, regional, and local command and control mechanisms to regulate industrial waste minimisation and management, South Africa has prioritised the Extended Producer Responsibility (EPR) as the main economic policy tool for industrial waste management. Local municipalities are responsible to providing waste management infrastructure. However, industries are required to ensure safe disposal of their waste, usually through private waste management companies.
Namibia	The recently published National Solid Waste Management Strategy (NSWMS) is currently the main guiding policy instrument for improving the institutional, organisational and legal framework for waste management in Namibia. Weak national, regional and local command and control mechanisms are the only tool available to regulate industrial waste minimisation and management at present. Industries are required to ensure safe disposal of their waste, usually through private waste management companies. Namibia currently does not employ voluntary or legislated Extended Producer Responsibility (EPR) mechanisms for improved resource efficiency of industry. However, the NSWMS provides for the development and review of EPR policies by 2023 and new policies are currently underway for the management of e-waste.
Botswana	Despite the long-standing and comprehensive Strategy for Waste Management (BSWM), a lack of implementation of the strategy on national and local government levels has been evident. There are no clear guidelines on waste generators and public authorities alike and economic incentives have not been implemented. Overall, local authorities have been complacent in maintaining regulatory policies on waste management. Industries are required to ensure safe disposal of their waste. A change in policy direction is evident in the recent development of the Integrated Waste Management Policy and associated implementation strategy. Extended Producer Responsibility (EPR) is not considered a feasible economic tool to minimise waste going to landfill in Botswana. This is due to the fact that Botswana imports most of their products from neighbouring countries. As Botswana's economy diversifies and continues to grow, EPR may become a feasible economic tool in time.

Table 2: Legislative framework.

South Africa	South Africa has a dynamic and progressive regulatory framework for waste diversion from landfill and subsequent waste recovery. Various legal tools are applicable to industrial waste management. 1. National environmental legislation requirements, which demand environmental impacts assessments and environmental management plans. 2. National law prescribing the implementation of landfill bans of certain waste streams (e.g. organic waste, batteries, liquid waste, brine, persistent organic pollutants). 3. Local municipal by-laws for waste producers. 4. EPR Regulations applicable to the electrical and electronic equipment sector, the lighting sector and the paper, packaging and some single use products, came into effect in May 2021. Further regulatory shifts are expected to occur at local, provincial and national levels. However, there are concerns about the enforcement of these regulations, especially for breaches of municipal bylaws.
Namibia	Namibia's legislative waste management framework is considered weak due to the fact that there is no national legislation governing waste management in the country. Waste management is primarily regulated through the basic requirements of the national Environmental Management Act (Act No. 7 of 2007). The NSWMS lays the foundation for the development of legislation in future, which will focus on a more coordinated and integrated approach to waste management. Local municipalities regulate waste management within their jurisdiction through the enactment of bylaws.
Botswana	Unlike Namibia and South Africa, the Constitution of Botswana does not give individual citizens the right to an environment that is not harmful to their wellbeing. Botswana's environmental legislation thus does not give legal standing to individual citizens who wish to be heard in court on environmental matters (*locus standi*). The main legal instrument for solid waste management in Botswana is the Waste Management Act (Chapter 65:06 of 1998) (WMA). Industries can apply for a license to operate their own waste management facility. Environmental assessment requirements when obtaining a license are, however minimal. Enforcement of the WMA and associated regulations has reportedly been weak. A change in policy direction and renewed efforts to improve waste management and minimisation in Botswana are evident in the currently ongoing development of the Integrated Waste Management Bill.

Table 3: Economic factors.

South Africa	To date, only few economic tools have been implemented to create incentives for industry to become more resource efficient (i.e. produce less waste) and/or to find feasible alternatives to disposal of industrial waste to landfills. Although industry pays a fee for waste disposal, these fees are currently not high enough to internalise environmental/social externalities and therefore provide limited incentive to make changes. The cost of waste disposal varies according to municipalities and is highest in the City of Cape Town. It is expected, that disposal costs will continue to rise above inflation rates in all municipalities as municipalities implement alternative, more expensive waste treatment technologies to combat landfill capacity constraints. The application of EPR is currently still limited in South Africa, however it is expected that EPR will be implemented in many more sectors in the medium to long-term. Tools such as landfill tax and tax credits/rebates for using recycled materials may be implemented in future in South Africa.
Namibia	The cost of waste management in Namibia is comparatively high due to the low population density, long transport distances and low waste volumes produced per square kilometre. Economies of scale are thus difficult to achieve. Consequently, it is likely that industries are also affected by high transportation costs charged by appointed services providers. The cost born by industry for the disposal of waste is currently not known, however. There are currently no other economic incentives in place to encourage waste management, waste reuse and minimisation in industry.
Botswana	Industries appoint private waste companies to collect and dispose of their waste at registered landfill sites. Recycling companies also collect recyclables directly from industrial facilities. It is currently unknown how much industries pay for waste removal services. In 2011, the cost of disposing industrial waste at the Gabarone Regional Landfill Site was P40 per tonne. However, a recent audit found that managers of the site only collected 33% of the expected revenue during the period 2009-2015, which could indicate that waste management is not a costly overhead for industries in Botswana. A major challenge to the development of sustainable waste management in Botswana is the lack of economic incentives for waste producers (e.g. subsidies/levies), as well as the lack of incentives for recycling companies and individuals (financial support).

Table 4: Social considerations.

South Africa **Namibia** **Botswana**	The global community recognises that negative environmental and socio-economic impacts associated with unsustainable resource use and associated degradation of natural resources disproportionally affect poor and marginalised communities. Inequality is still high in the region and the most vulnerable group would arguably be the informal waste sector, which consists of waste pickers who work on landfills and collect recyclables door to door. The informal waste sector plays an important role in recycling of materials in the region. Integrating the informal waste sector into the transition towards a circular economy is complex. Integration initiatives need to be carefully tailored to suit the local context. For example, industry lead EPR initiatives must therefore consider the livelihoods of this sector. Transitioning towards more sustainable resource use in industry is anticipated to have a net positive social impact: • creation of new business and employment opportunities in the informal and formal waste sectors; • capacity building, knowledge sharing and up-skilling; • raising awareness among the public pertaining to sustainable resource use; and • reduced risks of health implication as a result of poor waste management.

Table 5: Technology.

South Africa **Namibia** **Botswana**	It is likely that industries have already implemented various projects to improve resource efficiency, especially in South Africa. However, the information is currently not readily available. One example is the beverage producer AB InBev, who has set a global sustainability target of producing one hundred percent of its products in reusable packaging or from mostly recycled content by 2025. Many opportunities exist in the industrial sector for the application of technological innovations in an effort use resources sustainably. It is anticipated that much of the technology would not be locally manufactured. Furthermore, South Africa has arguably the most established environmental technology market, which also provide a pool of interesting partners to German technology providers. It is likely that South Africa's environmental technology industry would be capable to provide regional support to Botswana and Namibia in project implementation.

Table 6: Environmental considerations.

South Africa **Namibia** **Botswana**	In all three countries, the main waste management mechanism is the disposal of untreated waste to landfill sites. Many landfill sites in the region are poorly constructed or not maintained with limited implementation of waste management technologies. Consequently, a number of environmental impacts are associated with poor landfill management in the region. These include groundwater and surface water pollution, soil contamination, greenhouse gas, dust and odour emissions. Solid waste such as plastic often is blown into nearby waterways and the ocean. Around 8 million tonnes of plastic (10% of discarded plastic) make their way into South Africa's marine environment per year (statistics on plastic pollution in Namibia and Botswana could not be found). Furthermore, in South Africa, the waste sector produced approximately 21 249 Gg of $CO2$ in 2017 amounting to 3.8% of South Africa's GHG emissions. No statistical information about how much industry contributes to the environmental impacts associated with landfilling. It is, however, safe to say that waste minimisation and improved waste management in industry will have a net positive environmental impact.

3.2 SWOT Analysis

The following SWOT analysis summarises the current situation pertaining to industrial waste management, waste reuse and minimisation in South Africa, Namibia and Botswana based on the information gathered in the PESTLE analysis. The SWOT analysis shows the strengths and weaknesses, from which German technology providers can derive opportunities and risks associated with participation in the market. For the purpose of this analysis, we define the SWOT analysis components in the following way:

Strengths: Factors that create a conducive environment for the adoption of technologies by industry.

Weaknesses: Factors that hinder the adoption of technologies by industry.

Opportunities: Opportunities for German companies to partake in the market.

Threats: Threats to German companies when partaking in the market.

Table 7: SWOT Analysis for South Africa.

Strengths	**Weaknesses**
• Established and diverse industry sectors. • Long-standing voluntary and recently legislated Extended Producer Responsibility (EPR) practice in the packaging sector. EPR seen as the main economic tool for transitioning towards a circular economy. • Advanced and well developed legal framework. • Waste disposal fees in place in metropolitan municipalities. • Well established engineering sector that can partner with German technology providers and offer after sale services.	• Implementation of legislation and performance monitoring suboptimal due to lack of financial and human resources. • South African business culture still tends to focus on short-term benefits. This can lead to exaggerated profitability requirements. • Viability of more complex solutions marginal • Unstable investment climate and stagnation in some sectors of the economy • Shortage of skilled workers • In the case of a subsidiary: BEE compliance in order to participate in public tenders
Opportunities	**Threats**
• Price of waste disposal likely to increase in the medium to long-term as landfill sites reach capacity and are modernised. • Most innovative, environmental technologies have to be imported. • German technologies are valued for their quality. • South Africa as a platform to enter the regional market.	• Competition from technology providers from other countries. • Exchange rate risk - volatile exchange rate to EUR

Table 8: SWOT Analysis for Namibia.

Strengths	**Weaknesses**
• Waste disposal costs likely to be high, representing potentially significant overheads to companies. • Transition to EPR strategy in the medium to long-term.	• Limited industrial activity and small overall market (population only 2.4 Mio.). • Legislative framework is still relatively weak and needs to be improved. • Implementation of legislation and performance monitoring suboptimal due to lack of financial and human resources. • Viability of more complex solutions marginal. • Limited number of experienced local partners.
Opportunities	**Threats**
• Strong reliance on imported technologies. • German technologies are valued for their quality. • German as business language not uncommon.	• Future direction of transformation policy unclear • Competition from South African companies likely. • Exchange rate risk - volatile exchange rate to EUR

Table 9: SWOT Analysis for Botswana.

Strengths	**Weaknesses**
• Stable political climate, no corruption policy. • Positive investment climate and low entry barriers for foreign companies.	• Limited industrial activity, which is dominated by the mining sector; and small overall market (population only 2.2 Mio.) • Legislative framework is weak and needs to be improved. • Lack of economic incentives for waste producers, viability of more complex efficiency solutions marginal • Engineering sector not established, after sale service difficult to implement. High investment requirements to build local capacity. • Local partners necessary to successfully participate in public tenders
Opportunities	**Threats**
• Strong reliance on imported technologies. • German technologies are valued for their quality. • Diversification of Botswana's economy and promotion of new industries opens access to new customers in medium to long-term.	• Partner with local knowledge indispensable. • Competition from South African companies likely

4 DETAILED FINDINGS BY COUNTRY

4.1 South Africa

South Africa's main waste management mechanism is disposal of waste to landfill sites. Consequently, landfill airspace is reaching capacity and pressure is mounting to divert waste from landfills wherever possible. South Africa produced approximately 55 million tonnes of general waste in 2017[5], of which just over one third were recovered for recycling in the same year.[6] This is a major improvement compared to 2011, when 90% of general waste was disposed in landfill sites.[7]

Waste incineration is uncommon in South Africa and primarily used to incinerate health care risk waste. In 2017, only 27% of health care risk waste was treated by incineration, amounting to approximately 13 000 tonnes.[8]

The momentum in the South African waste sector has moved towards waste management practices that are increasingly characterised by circularity, with an emphasis not only on recycling but also on a more progressive approach to reuse, remediate and repair. The focus is on preventing waste from going to landfill. Furthermore, waste recovery has accelerated in recent years and can be seen at all levels, from government to business, industry and the general public. As a result, the South African waste industry continues to grow and a keen interest in alternative waste treatment solutions and the associated value chains is developing.

Industry is a major contributor to general waste production (Table 10). The majority of waste produced by industry is organic in nature and comprises predominantly of biomass from the sugar mills, sawmills and paper and pulp industries. Currently 31% of organic waste is recycled in South Africa. Non-organic general waste produced by industrial and commercial waste[9] accounted for approximately 7% (~3.5

---

[5] The well-established mechanisms for collecting waste data at municipal level are unfortunately not fully utilised and/or enforced, which poses a challenge to producing regular and comprehensive national waste production statistics. The most recent assessment was conducted for the year 2017 and was first published in the 2018 State of Waste Report by the Department of Forestry, Fisheries and Environment (DFFE) (in 2018 the Department of Environmental Affairs). Since then, the DFFE has published several revised reports. With each iteration, the estimated waste production changed. Furthermore, the numbers published by GreenCape in the Waste Market Intelligence Report of 2021 (GreenCape, 2021) also differ slightly to those published in the second Draft of the State of Waste Report (DEA, 2018).

[6] Note that this number reflects the amount of material entering a recycling facility and does not reflect what is actually recycled and thereby diverted from landfill. No estimate of the actual recycled amount is available at present.

[7] (DEA, 2018)

[8] (DEA, 2018)

[9] Definition as per DEA, 2018: Code GW10. "*Waste excluding hazardous waste emanating from premises that are used wholly or mainly for commercial, retail, wholesale, entertainment or government administration purposes. In the context of the State of Waste Report, this commercial and industrial waste stream excludes the mainline recyclables (paper, plastic, glass, metals and tyres, but includes organic waste from retail and office*."

million tonnes) of total general waste produced[10] in 2017, of which only 10% were recycled. It is interesting to note that 90% of construction and demolition waste is recovered for reuse or recycling.[11] Industry also contributes to other general waste types, including glass and plastic, for example. The recycling rate of these waste categories is comparatively high, ranging between 43 and 78%. This achievement is likely due to the fact that South Africa is a great example of voluntary Extended Producer Responsibility (EPR) scheme implementation in the packaging industry. A number of voluntary EPR schemes applicable to various waste streams have been developed over the last two decades, including those for polyethylene terephthalate (PET), polyolefins, polystyrene, vinyl, glass, paper and metals. [12] Producer Responsibility Organisations appointed and financed by the respective industries administer these voluntary schemes and work together with other actors in the product value chain (e.g. retailers, waste management companies).

Table 10: Estimated amount of general waste produced and recycled in various waste streams. (Source (DEA, 2018)).

General waste type	Does industry contribute?	Estimated waste amount (tonnes)	Proportion of total (%)	Recycling rate (%)	Level of confidence in data
Municipal waste	No	4 821 430	9	0	High
Commercial and industrial waste	Yes	3 550 505	7	10	Medium
Organic waste	Yes, includes municipal and industrial waste. Industrial sectors contributing include among others agriculture, aquaculture, food processing, wood processing and manufacturing, pulp, paper and cardboard.	30 499 455	56	31.1	Medium-high
Construction and demolition waste	Yes, construction industry	237 998	0	90	High
Paper	Potentially	4 482 992	8	58	High
Plastic	Yes	2 211 225	4	43.7	High
Glass	Yes	1 113 362	2	78.4	High
Metals	Yes	2 492 636	5	75	High
Tyres	Not in production processes	4 035 929	7	100	Low
Other	Yes, includes mixed waste	729 615	1	9.1	Low
	Total	**54 175 147**	**100**	**38.6**	**High**

[10] Note that the absolute amount in tonnes in the second Draft of the State of Waste Report differs to the number published in the GreenCape report.

[11] (DEA, 2018)

[12] (Bünemann, Brinkmann, Löhle, & Bartnik, 2020)

In 2017, between 52 and 60 million tonnes of hazardous waste were disposed of at landfill sites, accounting for approximately 50% of the total waste produced in South Africa.[13] The majority of hazardous waste is produced by industry. Only 6% and 0.3% of hazardous waste was recycled or treated in 2017.[14]

Fly and bottom ash, produced to a large extent by coal-fired power stations operated by the state owned energy producer Eskom and the petroleum company Sasol make up the majority of hazardous waste volumes (75%), of which only approximately 8% is currently recycled. Consequently, increased recycling of ash from power plants into products such as concrete or wallboard could significantly reduce the volume of waste to landfill in future.

The second largest contributor to hazardous waste are the ferrous and non-ferrous metal production industry, which produced approximately 8 million tonnes of slag in 2017, of which only 4% were recycled. The third largest hazardous waste component was brine with 5.8 million tonnes. Wastewater containing salts are largely generated by the mining, power generation, paper and pulp, petroleum, and steel/metal processing sectors. Industry also contributes to other hazardous waste types including but not limited to oil and grease, organic solvents, tarry and bitumen, mineral, and electronic wastes.

It is currently unknown how much industry contributes to each waste category when compared to domestic contributions. Unfortunately, due to the lack of implementation, monitoring of, and reporting on waste management plans by industry is linked to a lack of reliable data on waste streams in terms of types and volumes.[15]

Even though the circular economy can be applied to all sectors, it is important to assess which sectors to focus on when starting the transformation process linear economic model to a circular one. These sectors can be selected based on their general economic importance, the extent to which they affect resource or waste flows or the level of existing circular activities in South Africa. The sectors identified as those with the most potential for circular economy are agriculture and food processing, plastics, mining and construction. The selection of these sectors is based on their relatively high contribution to GDP and an enabling national policy framework.[16]

4.1.1 Political and institutional drivers

Political and institutional change is driven primarily by the reality that South Africa’s landfill sites are fast approaching their capacity limits with potentially disastrous environmental and socio-economic impacts if the situation is not urgently curtailed.

The Department of Forestry, Fisheries and Environment (DFFE) is responsible for waste management in South Africa. In accordance with its mandate, the DFFE has developed a number of strategies, policies and programmes, and has promulgated environmental legislation for the management of waste, including waste produced by industries. Local municipalities, however, are responsible for the waste management

[13] (DEA, 2018) (GreenCape, 2021)
[14] (DEA, 2018)
[15] (DFFE, 2020)
[16] (Potgieter, et al., 2020)

infrastructure and are legally required to provide waste disposal facilities for waste produced by society within their jurisdiction. Municipalities can chose to manage the facilities themselves, or outsource management to the private sector. Local municipalities are however, not obligated to collect waste produced by industry. Industries in South Africa are responsible for disposing of their waste safely and within the framework of legal regulations.

The National Waste Management Strategy (NWMS) of 2020 (updated strategy from 2011) aims to divert waste from landfill and to reduce the demand for virgin materials. South Africa should aim towards zero-waste going to landfill in the long-term. Waste prevention should be prioritised and where prevention is not possible, the strategy is to ensure that within the next five years, 40% of waste is diverted from landfill. Within the next 10 years, the aim is to divert 55% and at least 70% within the next 15 years. It is noteworthy that the NWMS recommends against incinerating waste for energy production in the case of materials, which can be beneficiated through recycling processes. The NWMS identifies organic waste as the main source for waste to energy projects.[17]

The NWMS identifies the circular economy as pivotal in the strategic approach to waste management. The concepts of waste prevention, and waste as a resource are strategic entry points into waste minimisation and the circular economy. This strategy constitutes the main institutional driver for tightening regulatory requirements for industrial waste management in the coming years. Current and anticipated regulatory requirements applicable to industry are discussed in more detail in Section 4.1.2.

In line with international practice, South Africa has prioritised the Extended Producer Responsibility (EPR) legislation as the main economic policy tool for waste management. EPR Regulations applicable to the electrical and electronic equipment sector, the lighting sector and the paper, packaging and some single use products, came into effect in May 2021 (Section 4.1.2). Implications for industry are discussed in more detail in Section 4.1.2. The approach to EPR in South Africa is industry lead with a co-operative approach between government and industry.[18] Currently, a number of voluntary PROs exist, including[19]:

- PET Recycling Company (http://www.petco.co.za/)
- The Polyolefin Responsibility Organisation (POLYCO) (http://www.polyco.co.za/)
- Polysterene Association of South Africa (https://polystyrenesa.co.za/)
- South African Vinyl Association (SAVA) (http://savinyls.co.za/)
- The Glass Recycling Company (TGRC) (https://theglassrecyclingcompany.co.za/)
- Fibre Circle (PAMDEV) (https://fibrecircle.co.za/)
- RecyclePaperZA (currently no website)
- METPAC-SA (http://www.metpacsa.org.za/)

It is to be expected that EPR Regulations applicable to other products will follow suit in the coming decade.

[17] (DEA, 2018), (DFFE, 2020)
[18] (Bünemann, Brinkmann, Löhle, & Bartnik, 2020)
[19] (Bünemann, Brinkmann, Löhle, & Bartnik, 2020)

Waste prevention and recycling is also an important part of South Africa's Low Emission Development Strategy 2050 and the Nationally Determined Contributions (NDCs) under the Paris Agreement. Although economic growth and industrial development policies recognise environmental and sustainable development strategies and policies, better integration on policy and institutional level is still required to action intrinsic changes in the trajectory of economic development in South Africa.[20]

4.1.2 Legislative framework

South Africa has a dynamic and progressive regulatory framework for waste diversion from landfill and subsequent waste recovery. Over the last three decades, the regulatory environment has shifted from landfill management to material recovery and recycling, and more recently to extended producer responsibility. Further regulatory shifts are expected to occur at local, provincial and national levels. However, there are concerns about the enforcement of these regulations, especially for breaches of municipal bylaws.

National legislation

Waste management in South Africa is governed by the National Environmental Management Act (Act 59 of 2008) (as amended) (NEMA) and its specific environmental act, the National Environmental Management: Waste Act (Act 59 of 2008) (as amended) (NEMWA) and associated regulations. The NEMWA prohibits the disposal of waste unless the disposal is authorised by law. Of particular note are regulations promulgated in terms of NEMWA, which provide a list of activities, for which environmental authorisation (EA) in terms of NEMA are required (GN 921 of 2013) (as amended). These regulations are of particular interest to industries with no access to municipal or private sector disposal facilities and need to store, treat, recycle or dispose of waste on their own accord.

These activities are deemed to have a detrimental effect on the environment. Depending on the severity of the potential impacts of an activity, a Basic Environmental Assessment (BA) (Category A) or a Full Scoping and Environmental Impact Reporting (S&EIR) process (Category B) is to be undertaken prior to obtaining a waste management license. Activities that must be licensed include the storage, recycling or recovery, treatment and disposal of waste. The potential severity of environmental impacts are measured by the type of waste (e.g. inert, general or hazardous), the size of the facility, the amount of waste that is recycled/treated/disposed. For example, a BA is required for the disposal of general waste covering an area of 50 m^2 or more. In contrast, the disposal of any quantity of hazardous waste requires a full S&EIR process.

Finally, certain waste management activities are subject to Norms and Standards promulgated in terms of NEMWA (Category C). Currently, Norms and Standards exist for the (1) storage of waste below a specified threshold, (2) extraction, flaring or recovery of landfill gas, (3), scrapping or recovery of motor vehicles, (4) sorting, shredding, grinding, screening or baling of general waste. These Norms and Standards may be required in addition to an EA or replace the need thereof.

[20] (DFFE, DTI&C, DSI, 2020)

According to the national norms and standards for the disposal of waste to landfill (R.636 of 2013) promulgated in terms of NEMWA, the following waste streams are no longer permitted on landfill sites (enforced since August 2021):

- Brine / waste with high salt content.
- Hazardous electronic waste.
- Batteries.
- Persistent organic pollutant (POP) pesticides listed under the Stockholm Convention.
- Macro-encapsulation of waste.

These bans will affect industrial waste management and has the potential to stimulate a change in production processes in affected industry sectors. Common industrial sources of brine include heavy industries, oil and gas, textile, coal-to-chemical, desalination, food and dairy or battery industries. The ban on hazardous electronic waste and batteries will affect producers of these products and the EPR Regulations will support the transition towards responsible production of these products.

It is noteworthy, that the current trajectory of industrial waste management has moved away from the requirement to implement industry waste management plans as provided for in Part 7 of the NEMWA.[21] Instead, the focus has shifted to rather enforcing EPR as the main policy instrument. Section 18 of the NEMWA provides for the promulgation of regulations pertaining to EPR for specified products or class of products. So far, regulations applicable to the electrical and electronic equipment sector, the lighting sector and the paper, packaging and some single use products, came into effect in May 2021 (GN 400, 5 May 2021).[22] All producers in these sectors must register with the DFFE and are obligated to either join a registered PRO, form a new PRO or develop and submit an independent EPR Scheme for their facility/company. It is expected that EPR Regulations for other products or class of products will be drafted in future.

Local municipal requirements

Local municipalities may choose to regulate waste management within their jurisdiction through the enactment of bylaws, which usually specify obligations for both waste producers and waste handlers, including licensing and reporting requirements.[23] Municipalities are not obligated to collect waste from industrial facilities but must ensure that waste management facilities are in place. Industry can enter into an agreement with municipalities for the collection of waste from their facility, or choose to appoint an independent service provider to dispose of their waste. Local municipal by-laws may differ from municipality to municipality.

In October 2020, the National Ministry of Mineral Resources and Energy announced the amendments to the Electricity Regulations on New Generation Capacity. These regulations allow financially sound municipalities to procure electricity from independent power producers or generate their own electricity

[21] (GreenCape, 2021)
[22] (DFFE, 2021)
[23] (GreenCape, 2021)

in accordance with an integrated resource plan (IRP). Procurement can facilitate the business case for waste-to-energy projects that rely on selling electricity to a power grid[24].

4.1.3 Economic

It is estimated that waste valued at more than ZAR 17 billion was lost to landfilling in 2017. According to new market data, South Africa's waste management industry is currently worth around ZAR 25.3 billion (EUR 1.4 billion) and has the potential to contribute significantly towards the country's economic growth.

South Africa has been focusing on command and control mechanisms (extensive legal requirements) for the management of industrial waste. To date, only few economic tools have been implemented to create incentives for industry to become more resource efficient (i.e. produce less waste) and/or to find feasible alternatives to disposal of industrial waste to landfills. The impact of those that do exist is currently limited.

Economic instruments such as pricing are internationally recognised as effective incentives and disincentives for improved waste management. In line with international approaches, the DFFE[25] promulgated the National Pricing Strategy for Waste Management[26] (NPSWM) in Terms of the National Environmental Management: Waste Act (Act No. 59 of 2008) (as amended) in 2016. Unfortunately, not much has changed since the promulgation of the NPSWM in 2016.[27]

Industry must safely dispose of their waste, either at their own licensed waste facility, enter into a waste disposal agreement with municipalities in exchange for a service fee, or contract a private waste company. Specialised private service providers usually collect, treat and dispose of hazardous waste from industrial facilities without the involvement of local municipalities[28]. When compared to other more developed countries, the cost of landfilling in South Africa is comparatively low and does not cover the cost of the service provided by the governmental institution.

This is due to many landfill sites being unregulated, unlicensed and/or non-compliant. This means that landfills are external costs associated with environmental/social impacts have not been internalised. Addressing these would increase the cost of disposal to landfill. Furthermore, the full cost of operating, maintaining and rehabilitating landfill sites has not been established for many landfill sites, preventing municipalities from developing financially sensible pricing structures. Waste management fees imposed on waste producers should be adjusted to incentives for diverting waste away from landfill.[29]

Nevertheless, waste disposal is considered a costly overhead to waste producers.[30] Disposal of waste on a landfill is subject to gate fees, which differ across municipalities. In the City of Cape Town Municipality, gate fees have been increasing above inflation rates since 2014, making it the most expensive

[24] (GreenCape, 2021)
[25] Department of Environmental Affairs in 2016.
[26] Government Gazette No. 40200. 11 August, GNR 904.
[27] (Nahman, Oelofse, & Haywood, 2021)
[28] (GreenCape, 2021)
[29] (Nahman, Oelofse, & Haywood, 2021)
[30] (GreenCape, 2021)

metropolitan municipality for waste disposal to landfill (Figure 1). It is expected, that disposal costs will continue to rise above inflation rates in all municipalities as municipalities implement alternative, more expensive waste treatment technologies to combat landfill capacity constraints.[31]

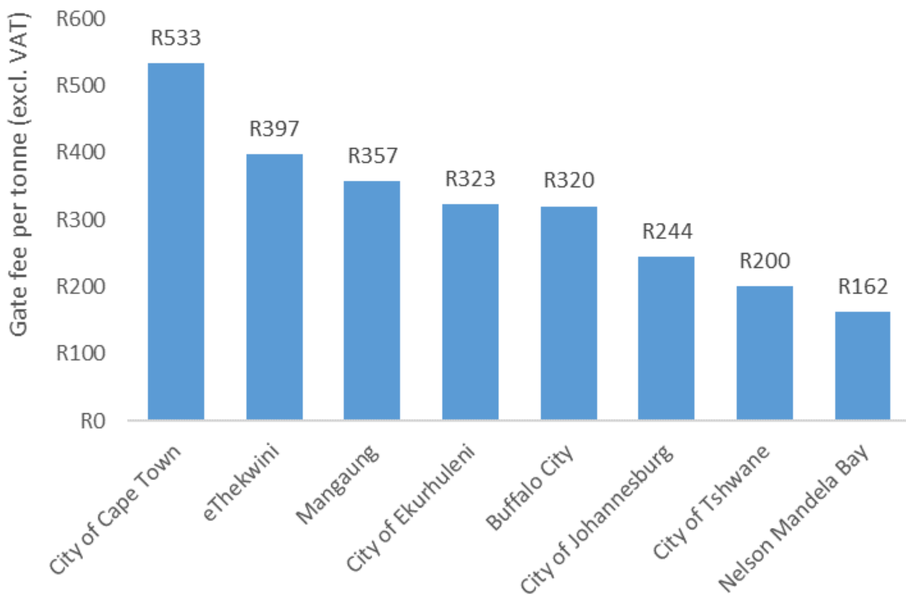

Figure 1: Landfill gate fees for the disposal of general waste at the eight Metropolitan Municipalities in South Africa. (Source: (GreenCape, 2021).

EPR Regulations for the management of the electrical and electronic equipment sector, the lighting sector, and the paper, packaging and some single use products came into effect in May 2021. Industry members are required to pay the extended producer responsibility fee to fund the extended producer responsibility scheme. The EPR regulations will stimulate more resource efficient production, influencing product design decisions as well as encouraging research and development in the affected sectors. The application of EPR is currently still limited in South Africa, however it is expected that EPR will be implemented in many more sectors in the medium to long-term.

A landfill tax and tax credits/rebates for using recycled materials have been recommended by the recently published guidelines on Implementing Economic Instruments and Incentives for Municipalities to Divert Waste from Landfill. [32] Furthermore, the guideline recommends that virgin material subsidies be replaced with virgin material taxes to allow recycled products to compete with products made from virgin materials.

[31] (GreenCape, 2021)
[32] (Nahman, Oelofse, & Haywood, 2021)

4.1.4 Technology

South Africa's policy and strategy environment includes technology development as an important component towards achieving the goals of the NWMS. For example, the National Waste Research, Development and Innovation (RDI) Roadmap supports industry in the implementation of technologies, which contribute towards waste diversion from landfill sites. The initiative funds the development, evaluation, demonstration and deployment of new technologies.[33]

The DFFE is investing into Research and Development (R&D) of new and improved technologies to meet the objectives of the NWMS. Operation Phakisa for Chemicals and Waste Economy prioritises several initiatives for the advancement of dealing with bulk industrial waste by means of technology.[34] Note that these technologies are destined for implementation at municipal waste management sites and not on individual industrial facilities. Successful implementation of these projects will influence the readiness of industry to implement their own waste management technology on site.

Prioritised initiatives include:

- Increased integration of ash produced in the coal-fired energy sector into alternative building materials;
- Accelerate innovation and commercialise of existing R&D pertaining to ash as a soil ameliorant and use in acid mine drainage treatment and backfill mines;
- Anaerobic digesters for biogas to energy projects;
- Fluidised Bed Reactor for wastewater treatment; and
- Technologies for reducing meat production waste to landfill.

The DFFE recognises that one of the biggest challenges for the treatment of biological waste includes matching feedstock to the right technology.

Minimising resource use

It is likely that industries have already implemented various projects to improve resource efficiency, especially in South Africa. However, the information is currently not readily available. One example is the beverage producer AB InBev, who has set a global sustainability target of producing one hundred percent of its products in reusable packaging or from mostly recycled content by 2025.[35]

Waste management at source

Due to high unemployment, the relationship between technology and labour is crucial to current discussions on waste management in South Africa. Waste management in South Africa is often a labour-intensive and a largely manual process. While the term 'technical' may be associated with images of expensive automated systems of waste sorting, technological solutions for waste separation at source in industrial facilities have to compete with an abundance of available and cheap labour.

[33] (Godfrey, 2021)
[34] (DFFE, 2017)
[35] (ABInBev, 2020)

Waste to energy

Waste to energy (WtE) refers to various treatment technologies that convert waste to electricity, heat, fuel or other usable forms of energy. At present, WtE technologies are hardly used in South Africa. Incineration of waste is far from common and application of pyrolysis is mainly limited to tyre recycling.

Anaerobic digestion is the first WtE technology that has gained considerable traction in South Africa, with several biogas plants operating for either grid electricity supply or, more commonly, for energy self-supply in industry. The production of biogas has proven to be a viable instrument for waste treatment and energy generation, when organic waste from a production process is handled on site of its origination. Also the viability is driven not by energy tariffs, but by the avoided waste handling costs.

4.1.5 Social

The global community recognises that negative environmental and socio-economic impacts associated with unsustainable resource use and associated degradation of natural resources disproportionally affect poor and marginalised communities.

South Africa remains one of the most unequal societies in the world and improved resource use across the entire value chain is therefore becoming more important to mitigate these impacts. The continued increase in the amount of waste produced in South Africa has raised health concerns, especially for people living near poorly managed landfill sites[36] or relying on water sources polluted by poor waste management.

South Africa's industry forms the backbone of economic growth and at the same time can pose a threat to the well-being of surrounding communities. Sustainable resource use in industry can be achieved through waste reduction, treatment, recycling and reuse. The transition is likely to have a net positive socio-economic benefit if the transition assesses and mitigates the potentially negative impacts on the currently well-established and growing informal waste sector. In 2016, estimates indicated that the informal waste sector supported approximately 80 000 livelihoods.[37]

It is recognised that the current activities of the informal waste sector require careful consideration and integration on national policy level (see for example the Waste Picker Integration Guidelines[38]), municipal waste management level, by EPR schemes as well as by individual industry actors. This is particularly important when industry considers waste to energy projects, as informal industries require the same feedstock. An exception are organic waste to energy projects.[39]

[36] (Tomita, 2020)
[37] (GreenCape, 2021)
[38] https://wasteroadmap.co.za/wp-content/uploads/2021/02/Waste-Picker-Integration-Guidelines.pdf
[39] (Ernstson, et al., 2021)

Accordingly, the newly legislated EPR scheme obligates the electrical and electronic equipment sector, the lighting sector and the paper/packaging sectors to ensure the integration of the informal waste sector into the scheme structure.[40]

Integrating the informal waste sector into the transition towards a circular economy is complex. Integration initiatives need to be carefully tailored to suit the local context. As an example, Distell advocates for a value-driven approach with their GreenUp Initiative.[41] They are formalising the informal sector through empowerment and dignity processes such as training, provision of personal protective equipment (PPE), and working with buy-back centres and waste processors. Throughout the country, post-consumption waste is being beneficiated to empower communities.

Transitioning towards more sustainable resource use in industry could have several positive social impacts associated with various waste streams that include:[42]

- creation of new business and employment opportunities in the informal and formal waste sectors;
- capacity building, knowledge sharing and up-skilling;
- raising awareness among the public pertaining to sustainable resource use; and
- reduced risks of health implication as a result of poor waste management.

The transition to a circular economy requires a wide range of skills, from simple to highly specialised. This offers the opportunity to give many different occupations a place in the circular economy. Building these capacities through training or educational programmes where they do not yet exist will have a positive impact on workers and their professional development.[43]

4.1.6 Environmental

South Africa's main waste management mechanism is the disposal of untreated waste to landfill sites. Many landfill sites do not meet the required National Norms and Standards due to financial and professional capacity constraints in municipal institutions. Consequently, a number of environmental impacts are associated with poor landfill management in South Africa. These include groundwater and surface water pollution, soil contamination, greenhouse gas, dust and odour emissions. Solid waste such as plastic often is blown into nearby waterways and the ocean.

Growing global and local public concern about plastic in the environment has also put immense pressure on brand owners, retailers and the general plastics sector to make greater use of biodegradable packaging options for their products. Around 8 million tonnes of plastic (10% of discarded plastic) per year make their way into South Africa's marine environment.[44]

---

[40] Regulations 5A(1)(m) and 5B(1)(l), which place the obligation on the PROs/Producer to integrate informal waste collectors, reclaimers and pickers into the post-consumer collection value chain.
[41] (Distell, 2021)
[42] (Potgieter, et al., 2020)
[43] (Potgieter, et al., 2020)
[44] (WWF, 2018)

According to the 7th National GHG Inventory Report, the waste sector produced approximately 21 249 Gg of CO_2 in 2017 amounting to 3.8% of South Africa's GHG emissions. Solid waste contributed to 80% of emissions by the waste sector, followed by 16.6 % produced through wastewater treatment and discharge. GHG emissions have been increasing steadily since 2000.[45] The contribution of industry to waste related GHG emissions is currently unknown but potentially significant.

Industrial waste is a major contributor to worsening environmental impacts and efforts to improve waste management, waste reuse and minimisation have the potential to contribute significantly to improve the current situation and to change the trajectory.

4.2 Namibia

National waste management is generally underdeveloped in Namibia. Namibia has the second lowest population density in the world, making centralised waste disposal more expensive due to high transport costs. Regulated waste disposal with separation of recyclable materials and recycling in Namibia is limited to the cities of Windhoek, Walvis Bay and Swakopmund. Windhoek Municipality is considered the pioneer of good waste management in the country. While waste collection within local municipalities is well organised, waste disposal remains substandard, especially regarding the disposal of hazardous waste. The administration of waste within regional councils remains poor as many councils do not have a waste collection systems in place.[46] It follows that minimal data and information are available on the amount and types of waste produced in Namibia.

The main waste disposal mechanism in Namibia is via landfilling and waste burning at landfill sites has been common practice. Recent policy changes require municipal landfill facilities to adhere to specified minimum standards and advocate for the phasing out of open burning. Private waste management companies offer recycling collection services. For example, the company Rent-A-Drum provides the private waste management and recycling services in Namibia to industries and citizens in a number of urban centres.[47] The company supplies over 12 000 tonnes of non-recyclable material to the Ohorongo Cement's factory to fuel for the cement manufacturing process. Namibia exports recyclable waste to neighbouring countries, including South Africa. The amounts exported are, however, currently unknown.[48]

The Namibian economy is greatly dependent on income from the export of primary commodities in some important sectors, including minerals, especially diamonds, livestock and fish. Waste treatment and value addition at the industrial enterprise level is not yet common in Namibia. Around 30 companies account for a significant share of industrial waste generation, mainly in the mining and food sectors. Wastewater and medical / clinical waste are the only types of waste that are treated. At present, there are disposal plants for electronic waste in Windhoek and Walvis Bay.

[45] (DFFE, 2020)
[46] (MET, 2019)
[47] (Rent-A-Drum, 2021)
[48] (Mbathera, 2021)

The economic sectors that offer the biggest economic opportunities for the circular economy in Namibia are mining, agriculture, and food processing. Mining accounts for about 12.5% of GDP, but provides more than 50% of foreign exchange earnings. Mining activities yield hazardous waste, which must be disposed of with appropriate expertise and care in order to minimise harmful environmental impacts.

Agriculture is one of Namibia's significant economic sectors, with the majority of Namibia's population dependent directly or indirectly on the agricultural sector for their livelihoods. The agricultural sector contributed approximately 4% towards the country's GDP (which excludes fishing) over the last five years.[49]

The fish processing sector also offers great opportunities. In 2018, seafood processing facilities generated approximately 71 176 tonnes of waste.[50] The Namibian government intends to increase marine product processing to around 40% of the total catch by 2022. In this context, significant investments have been made in the construction of new processing facilities since 2018. This will increase the amount of fish waste in the future, for which a disposal strategy must be developed. Some of this waste is suitable for the production of biogas with subsequent energy generation. Another approach is the production of fishmeal and oil as animal feed or food supplements.[51]

Under the government's National Solid Waste Management Strategy (NSWMS) programme of 2018, a gradual improvement in waste management standards is planned. The focus is currently on the eleven Namibian towns with more than 20,000 inhabitants. In this context, several new landfills have recently been opened. Four mobile recycling plants are planned for Rundu, Okaukuejo, Divundu and Otjiwarongo.[52]

4.2.1 Political and institutional drivers

The Ministry of Environment, Forestry & Tourism (MEFT)[53] is responsible for waste management in Namibia and recognises the urgent need for improved waste management. In the absence of national waste legislation, the recently published National Solid Waste Management Strategy (NSWMS) is currently the main guiding instrument for improving the institutional, organisational and legal framework for waste management in Namibia.[54] The NSWMS gives effect to international commitments (e.g. Basel Convention) and aligns with the objectives of other relevant national policies, strategies, action plans and legislation, including the National Development Plan No. 5 (NDP5) and Vision 2030. The NSWMS has relevance to industrial waste management in Namibia. The strategy prioritises command and control mechanisms specified in waste management and environmental licenses (See Section 4.2.2 for more details). The NSWMS focuses on better separation of hazardous waste types at source and provision of safe storage facilities until hazardous waste treatment and disposal facilities have been established. To

[49] (Namibia - Country Commercial Guide, 2021)
[50] (Erasmus, et al., 2020)
[51] (GBN, 2020)
[52] (Najjar, 2021)
[53] Previously the Ministry of Environment and Tourism (MET).
[54] (Takouleu, 2019); (MET, 2019)

encourage responsible waste disposal by industries, the NSWMS calls for the development of an inventory of waste management organisations that manage different types of hazardous wastes. The aim is to develop centralised hazardous waste treatment sites, including facilities for incineration of waste.

Namibia currently does not employ voluntary or legislated Extended Producer Responsibility (EPR) mechanisms for improved resource efficiency of industry. However, the NSWMS provides for the development and review of EPR policies by 2023. The UN specialized agency for ICTs (ITU) supported Namibian government in developing the draft National Policy on Management of Waste Electrical and Electronic Equipment as well as an implementation action plan. The policy is built on the principle of EPR and producers of e-waste are likely to be the first sector to be subject to EPR regulations.[55]

The Municipality of Windhoek champions waste management in Namibia. The Solid Waste Management Policy of the City of Windhoek was published in 2010 and is relevant to industry resource management in the region. The policy places the integrated waste management hierarchy at the centre of all efforts in waste management. The hierarchy advocates that waste should first be prevented before it is reused, recycled and treated. Disposal is only considered as a last resort. The policy calls on industry to implement measures for minimising waste through cleaner and more efficient production and lists technologies as one of the mechanisms to achieve this objective. The policy puts forward the polluter pays principle as an incentive for industries to reduce the amount of waste produced. Industry Waste Management Plans are considered an important tool in achieving the objectives of the policy.[56] Other municipalities have also implemented waste management policies, including Swakopmund.[57]

4.2.2 Legislative framework

Namibia's legislative waste management framework is considered weak due to the fact that there is no national legislation governing waste management in the country. The NSWMS described in Section 4.2.1 lays the foundation for the development of legislation in future. In the interim, waste management is primarily regulated through the basic requirements of the national Environmental Management Act (Act No. 7 of 2007) (EMA).[58] The EMA prohibits waste disposal to any site other than a declared waste management site and its principles speak to the need to reduce, re-use and recycling of waste. The management of industrial waste is however, limited to environmental clearance certificates, which are required for activities that have the potential to cause environmental harm (listed activities) and are applicable to most industrial facilities.

Local municipalities may choose to regulate waste management within their jurisdiction through the enactment of bylaws, which usually specify obligations for both waste producers and waste handlers, including licensing and reporting requirements. Municipalities are not obligated to collect waste from industrial facilities but are expected to ensure that waste management facilities are in place. Industry can enter into an agreement with municipalities for the collection of waste from their facility (excluding

55 (ITU, 2022)
56 (City of Windhoek, 2010)
57 (Kadhila, 2019)
58 (Republic of Namibia, 2007)

hazardous waste), or choose to appoint an independent service provider to dispose of their waste. Local municipal by-laws may differ from municipality to municipality. For example, the council in Windhoek can request a waste management plan from a waste generating industrial facility, while this is not provided for in the Municipality of Walvis Bay. Only the municipalities of Windhoek and Walvis Bay have solid waste management regulations in place at this time.[59]

4.2.3 Economic

The cost of waste management in Namibia is comparatively high due to the low population density, long transport distances and low waste volumes produced per square kilometre. Economies of scale are thus difficult to achieve. Consequently, it is likely that industries are also affected by high transportation costs charged by appointed services providers. It is important to note that hazardous waste can only be disposed of in Windhoek and Walvis Bay at this time. Waste management challenges may therefore limit establishment of hazardous waste producing industries outside of these municipalities. The cost born by industry for the disposal of waste is currently not known, however. There are currently no other economic incentives in place to encourage waste management, waste reuse and minimisation in industry.

4.2.4 Social

Namibia is focusing its effort on socio-economic development aimed at industrialising the country by 2030. Since independence, industrial production has increased significantly, leading to an increase in solid waste generation. At the same time, Namibia's society is still very unequal and negative environmental and social impacts associated with poor waste management disproportionately affects the marginalised and poor communities.

Waste disposal in Namibia is not well developed at this time, which means that informal waste pickers are exposed to dangerous pathogens and toxic waste.[60] It is currently unknown how many waste pickers rely on income generated by these informal activities. In 2017 waste pickers at the Oshakati dumpsite earned N$190 per month, representing as little as 2% of the average Namibian salary.[61] The lack of decentralised recycling processing facilities mean that private recycling companies incur high transporting costs, resulting in low wages for waste pickers. The NSWMS includes waste pickers in their plans to improve waste collection, disposal and recycling infrastructure in Namibia.

No information is available on the amount and types of wastes produced by industry. However, it is likely, that improved waste management by industrial facilities (e.g. separation at source) would contribute towards improved health and safety of waste pickers at disposal sites. The main income source for waste pickers is domestic recyclables[62] and improved industrial waste management is unlikely to negatively impact on opportunities for the informal waste sector. Overall, the transition of industry towards sustainable resource use is likely to have a net positive socio-economic benefit, including:

---

[59] (City of Windhoek, 2011); (Walvis Bay Municipality, 2011)
[60] (Bennet, Chretien, Gomarlo, & Hurley, 2017)
[61] (Haukena, 2017)
[62] (Haukena, 2017)

- creation of new business and employment opportunities in the informal and formal waste sectors;
- capacity building, knowledge sharing and up-skilling;
- raising awareness among the public pertaining to sustainable resource use; and
- Reduced risks of health implication as a result of poor industrial waste management.

The transition to a circular economy requires a wide range of skills, from simple to highly specialised. This offers the opportunity to give many different occupations a place in the circular economy. Building these capacities through training or educational programmes where they do not yet exist will have a positive impact on workers and their professional development.[63]

4.2.5 Technology

Namibian local government is in desperate need of improved technologies for waste collection and disposal facilities, including decentralised recycling processing equipment. For the implementation of the National Solid Waste Management Strategy and the improvement of waste management planned therein, the following machinery and equipment are needed to improve municipal services[64]:

- Vehicles for waste collection and transport to the respective treatment facilities.
- Machinery for the handling, compaction and further treatment of waste (excavators, presses, wheel loaders, caterpillars, shredders)
- Plants for the treatment of contaminated leachate
- If applicable, biogas plants for the utilisation of bio-waste, sewage sludge and animal carcasses
- Combined heat and power plants for decentralised use of landfill and biogas

No information is available on the types of technologies implemented by industry to become more resource efficient or the types of technologies that are available in the country. The NSWMS does not emphasise the technologies as a means to minimise waste production or for reuse and recycling of waste produced within an industrial facility. Awareness on the role of technologies in industrial waste management may be rising; during the launch of the National Clean-Up Campaign in Okahandja on 19 August 2021, Namibia's Deputy Minister of Environment, Forestry and Tourism, Heather Sibungo called on industries in Namibia to invest in zero waste technologies and cleaner production processes.[65]

4.2.6 Environmental

Namibia’s current main waste management mechanism is the disposal of untreated waste to mostly poorly constructed and unmaintained landfill sites. Consequently, a number of environmental impacts are associated with poor landfill management in Namibia. These include groundwater pollution, soil contamination, uncontrolled GHG, dust and odour emissions.

Growing global and local public concern about plastic in the environment is putting pressure on brand owners, retailers and the general plastics sector to make greater use of biodegradable packaging options

[63] (Potgieter, et al., 2020)
[64] (GBN, 2020)
[65] (Marenga, 2021)

for their products. Although terrestrial ecosystems are impacted by littering and wind dispersed plastic pollution, compared to other countries, Namibia does not seem to contribute significantly to solid waste pollution in the marine environment.[66] This may be due to its low population density near the coast, few perennial waterways and few landfill sites near the coast.

In general, industrial waste is a major contributor to worsening environmental impacts. Unfortunately, no national or industry specific statistics on the above-described impacts are available. Nevertheless, efforts to improve industrial waste management, waste reuse and minimisation have the potential to contribute significantly to improve the current situation.

4.3 Botswana

Botswana offers a stable political, fiscal and macroeconomic environment. Although Botswana is a middle-income country, it has one of the highest levels of income inequality in the world and suffers from high poverty and unemployment rates (24.5%).[67] With growing prosperity and urbanisation, the demand for solid waste disposal is increasing and Botswana's main waste management mechanism is storage and incineration at landfill facilities. Waste volumes entering the Regional Gamodubu Landfill in Gaborone illustrates this trend (Figure 2). In 2017, Botswana disposed just over 224 thousand tonnes of solid waste to landfill, of which general waste made up 52% of the total waste produced. The remainder of the waste was categorised into eleven types of waste streams. Commercial waste and building rubble accounted for nearly 40% of the total waste produced. Although industry sectors contribute towards most waste types, the extent of the contribution is currently unknown (Figure 3).

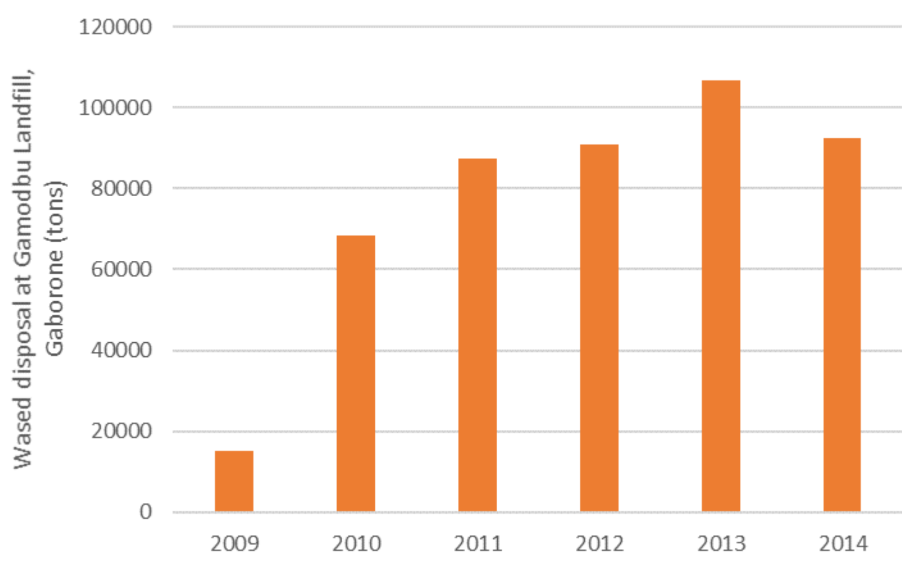

Figure 2: Waste disposal at the Regional Gamodubu Landfill Facility between 2009 and 2014. (Source: (Republic of Botswana, 2018).

[66] (the namibian, 2021)
[67] (Botswana - Country Commercial Guide Market Opportunities, 2021)

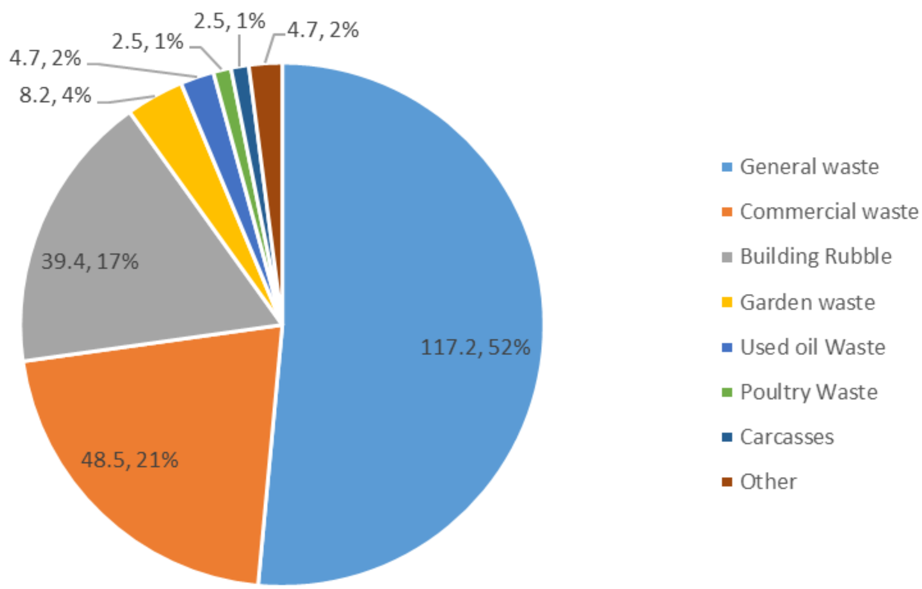

Figure 3: Waste composition in Botswana in 2017. Amount of waste measured in thousand tonnes. Note that other waste includes waste tyres (1375 t), waste sludge (1375 t), clinical waste (1061 t), stones/rocks/soil (440 t), scrap metals (350 t) and paper waste (66 t) (Source: Waste statistics extracted and processed from Appendices in (Statistics Botswana, 2020).

The majority of waste is disposed of at Francistown (83 thousand tonnes) and Gamodubu (76 thousand tonnes) landfill sites. Less than 1% of solid waste disposed of at landfill was salvaged (1516 tonnes) for reuse, storage or for later reuse.[68] Governmental landfill facilities are generally inadequately equipped and technological improvements would possible contribute towards increasing the proportion of waste recovery for reuse or recycling. It is important to note that recyclable waste is also from individual waste producers before reaching landfills. Recyclables are exported to South Africa and Zimbabwe for further processing and manufacturing of products.[69]

Botswana has a vital informal recycling value chain consisting of intermediate processors and scrap dealers. The informal recycling sector consists of door-to-door collection of recycling materials, and the waste recovery is limited to waste paper, bottles, plastics and scrap metals. However, the waste generated by villages, towns and cities in landfills is without pre-treatment since Botswana currently has no recycling or treatment units.[70]

[68] (Statistics Botswana, 2020)
[69] (Nagabooshnam, 2011)
[70] (Scheinberg, van den Berg, & Abarca, 2012)

The sectors that offer the most potential for circular economy in Botswana are mining, agriculture, energy and sustainable tourism. The United Nations Development Programme (UNDP) Botswana conducted a market study on the demand and opportunities for materials recycling (The Botswana Recycling Guidelines). There is a robust market for recyclables in Botswana and neighbouring countries.[71]

4.3.1 Political factors and institutional drivers

Botswana's Strategy for Waste Management (BSWM) was published in 1998 and forms the backbone of Botswana's policy and institutional framework for waste management development.[72] The main objective is to reduce waste generation, prevent pollution, promote efficiency and encourage reuse and recycling. The strategy remains mostly in keeping with international standards and promotes waste prevention as part of the waste management hierarchy, the polluter pays principle and considers waste as an economic good.

The BSWM calls on industry to minimise waste production and resource efficiency and identifies control of industrial waste disposal as one of the most important measures to achieve its objectives. The strategy encourages good housekeeping and materials management within the industrial facility as easy and cost effective ways to reduce waste production. The strategy also recognises that changing input materials, product design or manufacturing processes are more complex and require the commitment and financial investment on management level. Separation of waste at source is considered an important measure to increase recycling rates of industrial waste. Improved management of hazardous wastes produced or used by various industries are highlighted in the strategy, including oil containing wastes and solvents.

Despite the long-standing and comprehensive strategy, a lack of implementation on national and local government levels has been evident. There are no clear guidelines on waste generators and public authorities alike and economic incentives have not been implemented.[73] Overall, local authorities have been complacent in maintaining regulatory policies on waste management.[74]

A change in policy direction is evident in the recent development of the Integrated Waste Management Policy and associated implementation strategy. The Ministry of Environment, Natural Resources Conservation and Tourism developed the strategy, which was approved by Cabinet in April 2021. This policy aims to promote value creation from waste throughout the value chain. Treating waste as a valuable resource will not only reduce environmental impacts, but also bring significant economic benefits by creating opportunities for waste-based businesses.[75]

---

[71] (Charis, Danha, & Muzenda, 2019)
[72] (Republic of Botswana, 1998)
[73] (Mmereki, 2018)
[74] (Scheinberg, van den Berg, & Abarca, 2012)
[75] (Whande, 2021)

Extended Producer Responsibility (EPR) is not considered a feasible economic tool to minimise waste going to landfill. This is due to the fact that Botswana imports most of their products from neighbouring countries.[76] As Botswana's economy diversifies and continues to grow, EPR may become a feasible economic tool in time.

While national government is responsible for drafting legislation for waste management, local governments are the institutions responsible for management of waste produced within their jurisdiction. While local government provide waste collection infrastructure for households, it does not take responsibility for the collection of waste from industrial facilities. Industries are required to appoint recycling businesses for waste removal or enter into an agreement with the local municipality. Private companies that collect waste and recycling from industry include Skip Hire (all waste)[77], Scrapcor Ltd (metal), Collect-A-Can (metal cans), Dumatau (paper), and Simply Recycle (plastic). Non-governmental organisation also support waste management in Botswana.[78]

4.3.2 Legislative framework

Unlike Namibia and South Africa, the Constitution of Botswana does not give individual citizens the right to an environment that is not harmful to their wellbeing. Botswana's environmental legislation thus does not give legal standing to individual citizens who wish to be heard in court on environmental matters (*locus standi*). For example, a community impacted by environmental impacts related to illegal industrial activities has no legal standing to go to court. Only the state or competent authorities can bring illegal activities or undue environmental impacts to the attention of the courts.[79]

The main legal instrument for solid waste management in Botswana is the Waste Management Act (Chapter 65:06 of 1998) (WMA). The WMA provides regulatory measures for waste collection, disposal and recycling. For example, unless authorised in terms of the NWA, no person is permitted to dispose of or manage waste. Industries can therefore apply for a license to operate their own waste management facility.[80] Environmental assessment requirements when obtaining a license are minimal, although if the waste management facility is found to be harmful to the environment or people, the license can be revoked. Enforcement of the WMA and associated regulations has been reportedly weak.[81]

However, a change in policy direction and renewed efforts to improve waste management and minimisation in Botswana is evident in the development of new, more up to date legislation. The Ministry of Environment, Natural Resources Conservation and Tourism is currently drafting an Integrated Waste Management Bill.[82]

---

[76] (Scheinberg, van den Berg, & Abarca, 2012)
[77] https://www.skiphire.co.bw/
[78] (Charis, Danha, & Muzenda, 2019)
[79] (Madebwe, 2019)
[80] (Republic of Botswana, 2021)
[81] (Madebwe, 2019)
[82] (Mokwena, 2021)

4.3.3 Economic

Industries appoint private waste companies to collect and dispose of their waste at registered landfill sites. Recycling companies also collect recyclables directly from industrial facilities. It is currently unknown how much industries pay for waste removal services. In 2011, the cost of disposing industrial waste at the Gabarone Regional Landfill Site was P40 per tonne.[83] However, a recent audit found that managers of the site only collected 33% of the expected revenue during the period 2009-2015, which could indicate that waste management is not a costly overhead for industries in Botswana.

A major challenge to the development of sustainable waste management in Botswana is the lack of economic incentives for waste producers (e.g. subsidies/levies), as well as the lack of incentives for recycling companies and individuals (financial support).[84]

4.3.4 Social

Botswana is focusing its effort on economic development and diversification and prosperity of the people. Since independence Botswana has enjoyed sustained growth and rapid urbanisation, accompanied by increased solid waste generation. At the same time, local governments lack financial resources and capacity to keep up with the rapid growth. Although Botswana's economic growth has reduced poverty and inequality, regional differences in wealth distribution are still evident. Most landfills are situated in rural areas.[85] Therefore, poorer communities are still more likely negatively impacted by environmental, and health impacts associated with substandard waste management.

Private actors play an important role in waste management in Botswana.[86] Private waste recovery companies purchase recyclables from waste collectors and scavengers. These economic incentives offered by recycling companies are not standardised, and remuneration is based on the current market value of the material. The fees paid in exchange for material remains far below the minimum that waste pickers need to make a living.[87]

Furthermore, waste management and disposal in Botswana is not well developed at this time, which means that informal waste pickers are exposed to dangerous pathogens, toxic waste and respiratory ailments from atmospheric dust.[88] It is currently unknown how many waste pickers rely on income generated by these informal activities.

[83] (Nagabooshnam, 2011)
[84] (Mmereki, 2018)
[85] (Mmereki, 2018)
[86] (Phonchi-Tshekiso, Mmopelwa, & Chanda, 2020)
[87] (Mmereki, 2018)
[88] (Gwisai, Areola, & Segosebe, 2014)

No information is available on the amount and types of wastes produced by industry. However, it is likely, that improved waste management by industrial facilities (e.g. separation at source) would contribute towards improved health and safety of waste pickers at disposal sites. Assuming that the main income source for waste pickers is domestic recyclables, improved industrial waste management is unlikely to negatively impact on opportunities for the informal waste sector.

Overall, the transition of industry towards sustainable resource use is likely to have a net positive socio-economic benefit, including:

- creation of new business and employment opportunities in the informal and formal waste sectors;
- capacity building, knowledge sharing and up-skilling;
- raising awareness among the public pertaining to sustainable resource use; and
- Reduced risks of health implication as a result of poor industrial waste management.

The transition to a circular economy requires a wide range of skills, from simple to highly specialised. This offers the opportunity to give many different occupations a place in the circular economy. Building these capacities through training or educational programmes where they do not yet exist will have a positive impact on workers and their professional development.[89]

4.3.5 Technology

New technologies in the public and private waste management sectors are clearly needed, especially in the quest to divert waste from landfill, reduce waste incineration and commence with local recycling activities. Currently, Botswana exports all recycling to neighbouring countries for further processing and product manufacturing. The economic benefit of recycling is therefore limited to the market price per unit of material.

The public waste management sector would mostly benefit from technologies that would improve the infrastructure for waste collection, disposal and recycling. Technologies that would assist in improving waste management include landfill weighbridges, waste collection systems and recycling processing technologies. Biological treatment of waste and composting technology could also improve current organic waste management or pave the way for waste to energy projects. Incineration, anaerobic digestion, pyrolysis and torrefaction technologies have comparatively low investment requirements, maintenance costs and are technologically simpler to operate. Thus, these technologies would be suitable for implementation in Botswana.[90]

There are currently no examples on how industry has implemented technologies to decrease material use. In Botswana, feedstocks produced by industry and available in large quantities for potential waste to energy projects include cow dung and marula seeds. The Marula oil-producing sector produces large quantities of Marula nutshell waste, which could be considered as a source to produce bioenergy.[91]

[89] (Potgieter, et al., 2020)
[90] (Charis, Danha, & Muzenda, 2019)
[91] (Charis, Danha, & Muzenda, 2019)

4.3.6 Environmental

Solid waste management in Botswana remains a major problem that poses a serious threat to the environment and public health. Botswana's main waste management mechanism is the disposal of untreated waste to landfill sites. Merely 1% of the waste going to landfill enters into a recycling process. In general, most landfills in Botswana are inadequately constructed, unlined and lack efficient sanitation for employees and waste pickers.[92] Consequently, a number of environmental impacts are associated with poor landfill management in Botswana. These include groundwater pollution, soil contamination, GHG, dust and odour emissions. There is no data on greenhouse gas emissions produced by waste in Botswana.

It is currently unknown how much industrial waste is contributing to environmental degradation and socio-economic impacts in Botswana. Industrial activities are dominated by the mining sector and information on the environmental impacts and mitigation measures implemented is no readily available. Industry in Botswana is expected to grow in future and sustainable resource use through waste minimisation and management should be a priority in growing the economy sustainably.

[92] (Mmereki, 2018)

5 BIBLIOGRAPHY

(2021). Retrieved from Rent-A-Drum: https://www.rent-a-drum.com.na/

ABInBev. (2020). Retrieved from 2020 Environmental, Social & Governance Report: https://www.ab-inbev.com/content/dam/abinbev/news-media/press-releases/2021/02/AB%20InBev%20ESG%20Report%202020%20HD%20Final.pdf

Bennet, W., Chretien, E., Gomarlo, S., & Hurley, P. (2017). *A Proposed Recycling Facility for the Informal Waste.* Namibia University of Science and Technology. Retrieved from https://web.cs.wpi.edu/~rek/Projects/Oshakati_Proposal.pdf

Botswana - Country Commercial Guide Market Opportunities. (2021, October 10). Retrieved from International Trade Administration: https://www.trade.gov/country-commercial-guides/botswana-market-opportunities

Bünemann, A., Brinkmann, J., Löhle, S., & Bartnik, S. (2020). *Voluntary, industry-led EPR schemes for packaging and state policy initiatives in South Africa.* Bonn: Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH.

Charis, G., Danha, G., & Muzenda, E. (2019). Waste to Energy Opportunities in Botswana: A case study review. *2019 7th International Renewable and Sustainable Energy Conference (IRSEC).*

City of Windhoek. (2010). *Solid Waste Management Policy.* Retrieved from City of Windhoek: http://www.windhoekcc.org.na/pdf/infrastructure/SWMPolicy.pdf

City of Windhoek. (2011). *Windhoek Municipality: Waste Management Regulations: Local Authorities Act, 1992.* Windhoek: Government Gazette of the Republic of Namibia.

CSIR. (2021). *Intergrated Waste Management*. Retrieved from https://www.csir.co.za/integrated-waste-management

DEA. (1989). Retrieved from Plastic Bags Regulations Environment Conservation Act: https://www.dffe.gov.za/sites/default/files/gazetted_notices/eca_plasticbags_regulations_g23393rg7348gon543_0.pdf

DEA. (1998). Retrieved from National Environmental Management Act 107 of 1998: https://www.gov.za/documents/national-environmental-management-act

DEA. (2008). Retrieved from National Environmental Management: Waste Act 59 of 2008: https://www.gov.za/documents/national-environmental-management-waste-act

DEA. (2018). *South Africa State of Waste Report.* Pretoria: Department of Environmental Affairs. Retrieved from https://www.remade.co.za/wp-content/uploads/2020/01/South-Africa-State-of-Waste-Report.pdf

DFFE. (2017). *Operation Phakisa Chemical and Waste Economy - Lab Outcomes.* Department of Forestry, Fisheries and Environment (previously Department of Environmental Affairs. Retrieved from https://www.dffe.gov.za/sites/default/files/docs/operation_phakisa_wastephakisa_lab_outcomes.pdf

DFFE. (2020). *National GHG Inventory Report South Africa.* Department of Forestry, Fisheries and the Environment. Retrieved from https://www.dffe.gov.za/sites/default/files/docs/nir-2017-report.pdf

DFFE. (2020). *National Waste Management Strategy.* Department of Forestry, Fisheries and Environment. Retrieved from https://www.dffe.gov.za/sites/default/files/docs/2020nationalwaste_managementstrategy1.pdf

DFFE. (2021). *Amendment to the Regulations and Notices Regarding Extended Producer Responsibility, 2020.* Pretoria: South African National Department of Fisheries, Forestry and Environment. Retrieved from https://www.gov.za/sites/default/files/gcis_document/202105/44539gon400.pdf

DFFE, DTI&C, DSI. (2020). *Green Economy Policy Review of South Africa's Industrial Policy Framework.* DEFF, DTI&C, DSI, funded by the UNEP.

Distell. (2021). *2021 Sustainability Report.* Distell.

Ellen Macarthur Foundation. (2022, January 6). *Circular economy introduction*. Retrieved from Ellen Macarthur Foundation: https://ellenmacarthurfoundation.org/topics/circular-economy-introduction/overview

Erasmus, V. N., Kadhila, T., Gabriel, N. N., Machago, T., Thyberg, K. L., & Illungu, S. (2020). Assessment and quantification of Namibian seafood waste production. *Ocean & Coastal Management, 119*.

Ernstson, H., Lawhon, M., Makina, A., Millington, N., Stokes, K., & Swyngedouw, E. (2021). Turning livelihood to rubbish? The politics of value and valuation in South Africa’s urban waste sector. In M. Keith, A. Aruska, & S. de Souza, *African Cities and Collaborative Futures.* Manchester University Press.

FitchRatings. (2021, July 15). *Fitch Affirms Namibia at 'BB'; Outlook Negative.* Retrieved from Fitch Ratings: https://www.fitchratings.com/research/sovereigns/fitch-affirms-namibia-at-bb-outlook-negative-15-07-2021

GBN. (2020). *Partnership Ready Namibia: Abfallwirtschaft.* Eschborn: Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH.

Godfrey, L. (2021). *Waste Research Development and Innovation Roadmap South Africa - Annual Progress Report 2020/21.* Pretoria: CSIR.

GreenCape. (2020). *Market Intelligence Report Waste 2020.* Cape Town: GreenCape.

GreenCape. (2021). *Waste Market Intelligence Report.* Cape Town: GreenCape. Retrieved from https://www.greencape.co.za/market-intelligence/

Gwisai, R. D., Areola, O., & Segosebe, E. (2014). Respiratory and occupational health problems of scavengers and landfill employees in a municipal landfill site in Lobatse, Botswana. *Journal of Sustainable Development in Africa, 16-55*, 37.

Hauke Engel, M. S. (2016). *Ahead of the curve: Innovative models for waste management in emerging markets.* McKinsey Center for Business and Environment.

Haukena, M. (2017). *Evaluating the effectiveness of using a bicycle cart in the collection of recyclables from households in Oshakati, Namibia.* Namibia University of Science and. Retrieved from https://web.cs.wpi.edu/~rek/Projects/Oshakati_Proposal.pdf

ITU. (2022). *WEEE Policy Support Namibia*. Retrieved January 12, 2022, from ITU: https://www.itu.int/en/ITU-D/Environment/Pages/Spotlight/WEEE-Policy-Support-Namibia.aspx

Kadhila, T. (2019). *Implementation of a Municipal Solid Waste Management System in Swakopmund, Namibia.* Stellenbosch: Stellenbosch University.

Madebwe, T. (2019). Enhancing Botswana's Environmenta Performance by 2023. *Law Environment and Development Journal, 15*(1).

Marenga, N. G. (2021, August 20). *2021 National clean-up campaign launched at Okahandja*. Retrieved from Energy100FM: https://www.energy100fm.com/2021/08/20/2021-national-clean-up-campaign-launched-at-okahandja/

Mbathera, E. (2021, March 19). Retrieved from Keeping waste at bay: https://www.namibian.com.na/209810/archive-read/Keeping-waste-at-bay

McKinsey. (2016). *The circular economy: Moving from Theory to Practice.* McKinsey Center for Business and Environment.

MET. (2019). *National Solid Waste Management Strategy* . Retrieved from Ministry of Environment and Tourism: https://www.met.gov.na/files/downloads/43e_NSWM%20Strategy.pdf

Mmereki, D. (2018). Current status of waste management in Botswana: A mini-review. *Waste Management & Research: The Journal for a Sustainable Circular Economy, 36*(7), 555-576.

Mokwena, N. (2021, July 30). *Integrated Waste Management Policy approved*. Retrieved January 17, 2022, from Pressreader, Botswana Guardian: https://www.pressreader.com/botswana/botswana-guardian/20210730/281578063699100

Nagabooshnam, J. K. (2011). *Solid Waste Generation and Composition in Gaborone, Botswana. Potential for Resource Recovery.* Linkoping University. Retrieved from https://www.diva-portal.org/smash/get/diva2:488964/FULLTEXT01.pdf

Nahman, A., Oelofse, S., & Haywood, L. (2021). *Implementing Economic Instruments and Incentives to Divert Waste from Landfill. A Guideline for National Government.* Department of Science and Innovation. Report compiled by the CSIR.

Najjar, F. (2021). *Wachsende Bedeutung der Abfallwirtschaft.* Johannesburg: GTAI.

Nambuli, F., Togarepi, C., & Shikongo, A. (2021, June 08). Waste Scavenging a Problem or an Opportunity for Integrated Waste Management in Namibia: A Case of Keetmanshoop Municipality, Namibia. *Environment and Pollution; Vol. 10, No. 2; 2021*, pp. 47 - 60.

Namibia - Country Commercial Guide. (2021, October 20). Retrieved from Official Website of the International Trade Administration: https://www.trade.gov/country-commercial-guides/namibia-market-overview

Namibia. (2021, December 07). Retrieved from The World Factbook: https://www.cia.gov/the-world-factbook/countries/namibia/#economy

NamibianSun. (2018, November 09). *Plastic bags banned in parks*. Retrieved from Namibian Sun: namibiansun.com/news/plastic-bags-banned-in-parks2018-11-09

Phonchi-Tshekiso, N. D., Mmopelwa, G., & Chanda, R. (2020). From public to private solid waste management: Stakeholders' perspectives on private-public solid waste management in Lobatse, Botswana. *Chinese Journal of Population, Resources and Environment, 18*, 42-48.

Potgieter, J. E., Rajput, J., Hemkhaus, M., Ahlers, J., Van Hummelen, S., McGovern, M., & Artola, I. (2020). *Circular Economy in Africa-EU-Country Report for South Africa.* Brussels: Trinomics B.V., ACEN, adelphi Consult GmbH and Cambridge Econometrics Ltd.

Republic of Botswana. (1998). *Botswana's Strategy for Waste Management.* Republic of Botswana. Retrieved from http://extwprlegs1.fao.org/docs/pdf/bot163038.pdf

Republic of Botswana. (2018). *Management of Gamodubu Landfill - Performance Audit Report.* Gaborone: Office of the Auditor General. Retrieved January 14, 2022, from https://www.gov.bw/sites/default/files/2020-03/MANAGEMENT%20OF%20GAMOBUDU%20LANDFILL_0.pdf

Republic of Botswana. (2021). Retrieved from Waste Carrier License: https://cms1.gov.bw/meteorology-waste-management/waste-carrier-license

Republic of Botswana. (2021). Retrieved from Waste Management Facility License: https://cms1.gov.bw/meteorology-waste-management/waste-management-facility-license

Republic of Namibia. (2007). *Environmental Management Act (Act No. 7 of 2007).* Republic of Namibia.

Republic of South Africa. (2020). *The South African Economic Reconstruction and Recovery Plan.* Republic of South Africa.

Scheinberg, A., van den Berg, L., & Abarca, L. (2012). *The Botswana Recycling Guidelines Advice on Valorisation for Middle-Income Countries Volume 1 plus Annexes 1 & 2.* Gaborone: UNDP

Botswana. Retrieved from https://www.waste.nl/wp-content/uploads/2019/04/rgd_botswana_vol_2_final.pdf

Smith, E. (2021, November 19). *CNBC*. Retrieved from South Africa's rate hike leaves uncertainty over the rand and economic growth: https://www.cnbc.com/2021/11/19/south-africas-rate-hike-leaves-uncertainty-over-the-rand.html

StaffWriter. (2020, October 22). *Disposable income has halved in South Africa*. Retrieved from BUSINESSTECH: https://businesstech.co.za/news/finance/442620/disposable-income-has-halved-in-south-africa/

StaffWriter. (2021, October 14). *Unemployment rates in South Africa's major metros*. Retrieved from BUSINESSTECH: https://businesstech.co.za/news/government/529338/unemployment-rates-in-south-africas-major-metros/

Statistics Botswana. (2020). *Botswana Selected Environmental Indicators Digest 2020.* Statistics Botswana. Retrieved January 17, 2022, from https://www.statsbots.org.bw/botswana-selected-environmental-indicators-digest-2020-0

Stoddard. E. & Scheepers, J. (2021, December 07). *South Africa's economy contracts 1.5% in third quarter after looting and lockdowns*. Retrieved from Daily Maverick: https://www.dailymaverick.co.za/article/2021-12-07-south-africas-economy-contracts-1-5-in-third-quarter-after-looting-and-lockdowns/

Takouleu, J. (2019, August 22). *NAMIBIA: New solid waste management strategy in force.* Retrieved from Afrik21: https://www.afrik21.africa/en/namibia-new-solid-waste-management-strategy-in-force/

the namibian. (2021, February 25). *African countries assess state of marine litter*. Retrieved from the namibian: https://www.namibian.com.na/209102/archive-read/African-countries-assess-state-of-marine-litter

Thikusho, M. (2019, August 13). *Plastic levy now mandatory.* Retrieved from The Namibian: https://namibian.com.na/191856/archive-read/Plastic-levy-now-mandatory

Tomita, A. (2020). Exposure to waste sites and their impact on health: a panel and geospatial analysis of nationally representative data from South Africa, 2008–2015. *The Lancet*.

Trading Economics. (2021). Retrieved from Namibia Unemployment Rate: https://tradingeconomics.com/namibia/unemployment-rate#:~:text=Unemployment%20Rate%20in%20Namibia%20is,macro%20models%20and%20analysts%20expectations.

Velenturf, A. P., & Purnell, P. (2021). Principles for a sustainable circular economy. *Sustainable Production and Consump, 27*, 1437-1457.

Walvis Bay Municipality. (2011). *Walvis Bay Municipality: Solid and Hazardous Waste Management Regulations: Local Authorities,.* Windhoek: Government Gazette of the Republic of Namibia.

Whande, D. (2021, 09 17). *Kereng finalises Waste Management Policy*. Retrieved January 17, 2022, from Sundaystandard: https://www.sundaystandard.info/kereng-finalises-waste-management-policy/

WWF. (2018, October 2). *WWF Plastic File #1: linving in a plastic age*. Retrieved from WWF: https://www.wwf.org.za/?26021/plastic-file-01