MUNICIPAL BRIEF

The opportunity for waste-to-energy in Cape Town and the Western Cape

Waste-to-energy technologies have the potential to address two key challenges in the South African context; landfill airspace shortages and energy security and tariff challenges.

Main insights

- South Africa faces the dual challenges of significant landfall capacity shortages and increasing energy insecurity.
- Waste-to-energy (WtE) technologies provide a potential solution to both these challenges.
- The opportunity for WtE technologies is dependent on securing a suitable feedstock and selecting the most suitable utilisation pathway that provides viable revenue options.
- In South Africa, WtE technology business cases are not viable as solely energy based solutions, and they face legislative and contextual challenges in securing feedstock.
- However, in Cape Town and elsewhere in the Western Cape, it has been demonstrated that there are suitable potential feedstocks and off take clients for waste-to-energy projects.
- It is critical to the viability of the WtE technology business case that it identifies feedstocks from problem waste streams that are still disposed of to landfill.

  To investigate additional products such as alternative fuels and nutrient recycling, which can be established as additional revenue streams other than just electricity and/or heat generation.

Motivation and scope

As the interest and demand for more sustainable waste beneficiation technologies increases, there is a need to better understand the role of waste-to-energy (WtE) technologies within the developing circular economy in the Western Cape, and South Africa more generally.

This industry brief is written to provide an overview of the insights and potential opportunities gathered through engagements with stakeholders in, and research on, the national and Western Cape waste-to-energy sectors within the current context of a transitioning economy.

These WtE technologies may include biogas, thermal treatment and biofuel manufacturing technologies suitable for the beneficiation of waste streams that have underutilised value and are still being disposed of at landfills.

To gain a better understanding of the market potential and current context, the brief examines the current status of the sector; existing policies and strategies that create both an enabling environment and hinder the viability of the business case for WtE technologies.

Also covered are the WtE current and emerging drivers and challenges for feedstock, products, by-products and clients. It explains the need for cross sectoral application to enhance the offering and thus viability of WtE technologies and provides links to funding opportunities and incentives that would be available to bankable WtE projects.

Sector overview

The current South African WtE sector is considered to be in a nascent or infant state with a limited number of projects that have been implemented. Many stakeholders are interested in developing a WtE project as a solution for South Africa's decreasing landfill capacity and energy security issues.

Proposed solutions include a wide variety of technologies, which can be divided into three categories, as illustrated in **Figure 1**[1]:

1. **Biological and chemical;**
2. **Biofuel manufacturing;**
3. **Thermal**

The business case for and viability of each technology would be dependent on the local context for the region where it is being proposed for implementation.

Waste-to-Energy Technologies

Biological and Chemical	Biofuel and Manufacturing	Thermal
• Anaerobic digestion • Landfill gas	• 1st generation: energy crops • 2nd generation: lignocellosic • 3rd generation: Algae	• Combustion/ incineration • Gasification • Pyrolysis • Plasma arc • Thermal oxidation

Figure 1: Types of commercial WtE technologies[2]

[1] These are the current technologies being considered for the South African Waste to Energy Roadmap. Additional technologies to those highlighted in Figure 1 being considered for the South African Waste to Energy Roadmap are technologies with another primary purpose (such as cement kilns, fluidised bed boilers and bagasse boilers, which are all combustion technologies) and configurations of technologies to improve process effectiveness (such as aerobic digestion in series with anaerobic digestion). SANEDI has appointed University of KwuZulu-Natal, SARChi: Waste and Climate Change, Aquila Environmental and Jive Media Africa to develop the Waste-to-Energy Roadmap for South Africa.

[2] This list is based on GreenCape engagements and is not an exhaustive list

The feedstock suitable for the WtE technologies highlighted in Figure 1 may include urban organics, abattoir and agricultural waste, sewage sludge, general, hazardous, and medical waste, and can include specialised streams such as tyres and bagasse. The potential products produced include oils, fuels, syngas, char, charcoal, heat, energy, ash, other gases (CO2, N2O, NOx, NH3, CH4), and recycled materials.

In South Africa, biological and chemical WtE technologies are the most established in form of biogas plants, wastewater treatment works and landfill gas extraction projects. There is currently one landfill gas extraction and two biomass projects that are listed with the Renewable Energy Independent Power Producer Procurement Programme (REIPPPP)[3].

The most predominant thermal WtE technologies being considered in South Africa are pyrolysis and gasification. The untapped potential of invasive alien vegetation as a feedstock has been highlighted in the of BioEnergy Atlas for South Africa[4].

The potential for biofuel manufacturing technologies has been increasing ever since the mandatory fuel blending regulations[5] were gazetted in August 2012, and which came into effect on 1 October 2015. Further amendments were enabled on 01 September 2021, coupled with the Biofuels Regulatory Framework[6], which was gazetted on 7 February 2021. In 2019, the World Wildlife Fund (WWF) highlighted the potential for sustainable aviation biofuel potential in sub-Saharan Africa[7].

To develop the WtE sector, the South Africa's Waste to Energy Roadmap is being developed and is expected to be published by March 2022. The South African National Energy Development Institute (SANEDI) will be the custodian of the WtE Roadmap and have appointed SARCHI[8] Chair: Waste and Climate Change of the University of KwaZulu-Natal (UKZN) to develop the WtE roadmap. Once the WtE roadmap has been published, it is expected to be a living document with a preliminary implementation plan timeline of 2022 to 2024.

[3] Independent Power Producer Procurement Programme: https://www.ipp-projects.co.za/ProjectDatabase
[4] The BioEnergy Atlas for South Africa: https://bea.saeon.ac.za/
[5] Regulations mandate the blending with a minimum 2% bioethanol into petrol and 5% biodiesel into diesel - https://www.gov.za/sites/default/files/gcis_document/202109/45068rg11333gon794.pdf
[6] South African Government: https: //www.gov.za/documents/energy-mineral-resources-south-african-biofuels-regulatory-framework-and-national-biofuels
[7] WWF: https://www.wwf.org.za/our_research/publications/?26941/taking-off-understanding-the-sustainable-aviation-biofuel-potential-in-sub-saharan-africa
[8] SARCHi = South African Research Chairs Initiative

Legislation, regulation and policy

A number of legislative regulations and policies are required to be considered when developing and implementing projects that include WtE technologies in South Africa. An overview of the legislation, regulations and policies that require consideration for these projects is provided in Figure 2.

WtE legislation and policy considerations

Energy

- Petroleum Products Act, 1977
- Biofuels regulatory framework
- National Energy Act
- Gas Regulator Levies Act, 2002
- REIPPP
- South African Biofuels Industrial Strategy, 2007
- White Paper on Renewable Energy
- Electricity Regulation Act, 2006
- Minerals and Energy Act

Other

- Generally Recognised Accounting Practices 17 & 19
- Municipal Public Private Partnerships Regulations, 2005
- Municipal Structures Act
- Occupational Health and Safety Act, 1993
- Municipal Systems Act, 2000
- Municipal Finance Management Act
- Municipal by-laws
- South African National Standards
- Civil Aviation Act, 2009

Water and Agriculture

- National Water Act, 1 998
- Water Use Licence
- Conservation of Agricultural Resources Act, 1983
- Subdivision of Agricultural Land Act, 1970
- Fertilizers, Farm Feeds, Seeds and Remedies Act, 1947

Waste

- The Environmental Conservation Act
- National Environmental Management (NEM) Act
- NEM: Waste Act, 2008
- NEM: Air Quality Act, 2004
- Atmospheric Pollution Prevention Act
- National Waste Management Strategy
- White Paper on Integrated Pollution and Waste Management
- NEM: Integrated Coastal Management Act, 2008
- Restriction and Prohibition of Organic Waste to Landfill
- Norms and Standards for Organic Waste Treatment

Figure 2: Overview of legislation, regulation and policy that need to be considered for WtE projects

A more detailed breakdown of the legislation, regulation and policies can be found on the Department of Environment, Forestry and Fisheries' Alternative Waste Treatment Guide website[9], GreenCape's 2021 waste market intelligence report[10] and 2021 Waste-to-Energy industry brief[11].

[9] Department of Forestry, Fisheries and the Environment: http://awtguide.environment.gov.za/
[10] GreenCape: https://www.greencape.co.za/market-intelligence/
[11] GreenCape: https://www.greencape.co.za/content/industry-brief-waste-to-energy-is-it-viable-for-your-business/

Opportunities, drivers and barriers

For the successful development and implementation of a WtE project, the feedstock potential and security is critical. The viability of the business case of a WtE project is dependent on the selected utilisation pathway. As such, based on insights gained into the current[12] South African context, the WtE technologies most suitable in the Cape Town and Western Cape include anaerobic digestion of organics and wastewater; and pyrolysis and gasification of waste streams with a high calorific value and low moisture content such as plastics and lignocellosic organics.

However, legacy issues of WtE projects that have been developed and / or implemented in South Africa has resulted in scepticism due to the limited success such projects have had. These legacy issues have included a weak business case, poor project management and a limited understanding of the context in which the WtE technologies are best suited[13]. Therefore, it is critical to understand the key factors, which include feedstock and utilisation pathways, that influence the development and implementation of a WtE project and its business case[14].

Organics and plastics are considered the feedstock that hold the most potential for WtE technologies, and volumes within the Western Cape alone highlight the high potential of this feedstock source (see **Figure 3**). In addition, it has been estimated that the Western Cape has a market value estimated between R75.9 million and R315.1 million for a combination of municipal solid waste (MSW) and commercial and industrial (C&I) organics. Whereas, the market value for waste plastic is estimated to be between R321 million and R2.2 billion for the Western Cape[15].

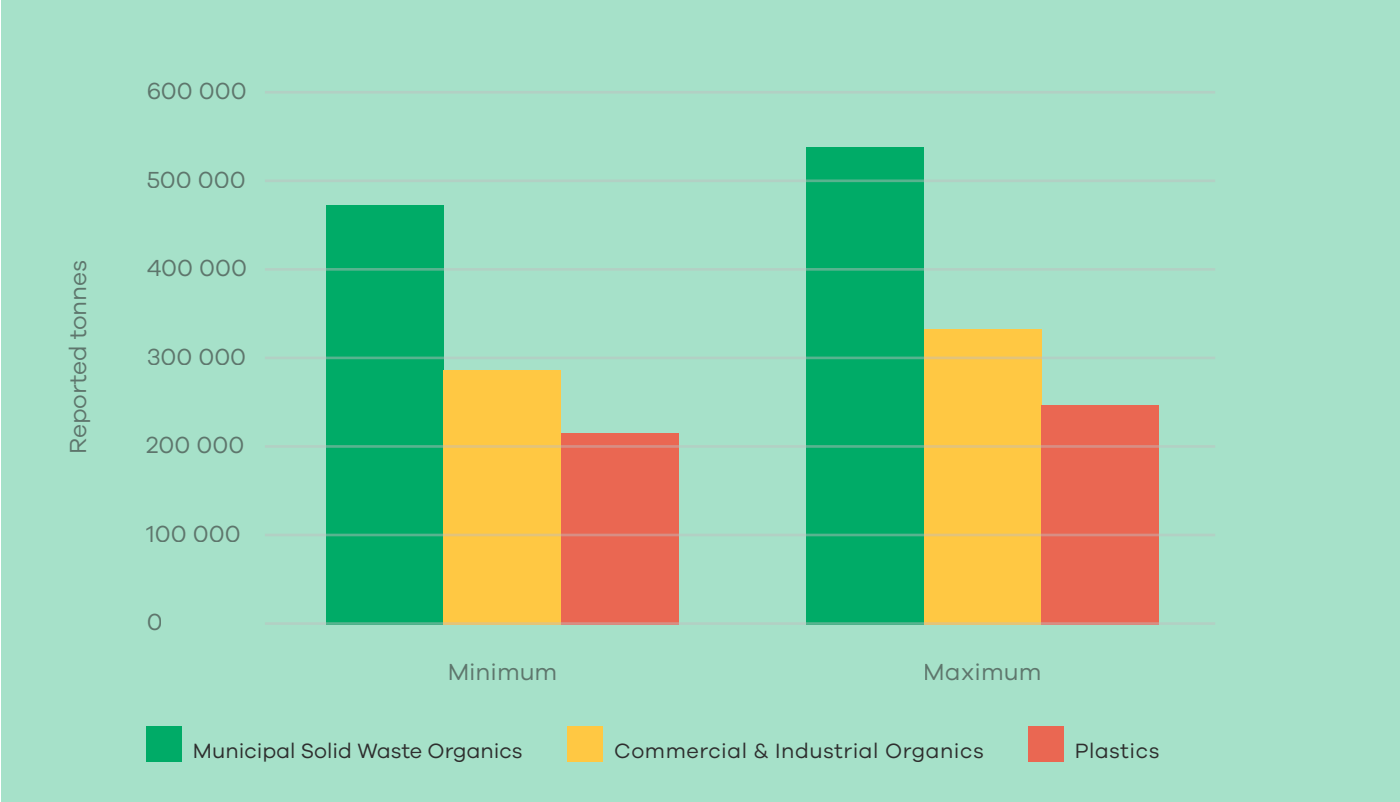

Figure 3: Reported tonnes of potential feedstock that WtE could beneficiate, Western Cape 2020

[12] At time of writing: December 2021
[13] Based on GreenCape stakeholder engagements and insights
[14] See also GreenCape: https://www.greencape.co.za/content/industry-brief-waste-to-energy-is-it-viable-for-your-business/
[15] Source: GreenCape's 2021 Waste Market Intelligence report; https://www.greencape.co.za/market-intelligence/

However, accessing and securing these feedstock options is challenging due to the increasing market value, location and ownership of the feedstock generated. This was highlighted in the South African Biogas Industry Association's (SABIA) market position paper launched in February 2021 where the feasible potential for biogas power generation in the next 5 years was estimated to be approximately 12% of the theoretical feedstock available within South Africa[16].

In addition, with the increasing extended producer responsibility requirements for producers of paper, packaging and some single-use plastic products, solutions for these waste streams are required to incorporate circular models. Government initiatives such as Operation Phakisa, private sector commitments, increasing costs of disposal and dwindling landfill capacity are all key drivers[17] for the opportunities presented for WtE technologies. The norms and standards of organic waste treatment are scheduled to be gazetted in early 2022. The development of a waste strategy by metros such as the City of Cape Town further provides an enabling environment for waste beneficiation solutions such as WtE technologies.

Furthermore, the Western Cape will be implementing 50% and 100% organic waste diversion from landfill restrictions in 2022 and 2027, respectively, creating a strong driver for the uptake of alternative treatment technologies for organics in the Western Cape.

Although businesses in South Africa are continuously searching for energy security options, WtE technologies are not the most suitable energy security option due to the high cost of producing electricity from WtE projects. This can been seen in the biogas sector where an indicative price for electricity provided by industry experts is expected to be R1.40 to R1.50 per kWh[18] for a project, while the price for solar and renewable energy is now typically less than R 1.00 / kWh[19]. It is therefore necessary to consider the revenue value of additional products and by-products for WtE technologies and projects. These may include:

- **The production of bio-methane, carbon dioxide and nutrient rich digestate for biogas projects.**
- **Production of pyrolytic oils in pyrolysis that can be used as an alternative to raw feedstock for plastic manufacturing.**
- **Production of bio-char that can be used for agriculture and energy applications.**

The utilisation pathway selected for a WtE project would highlight the potential of the products and by-products and is critical to the viability of its business case.

The selection of utilisation pathway for WtE projects is critical taking into consideration the 2025 targets set by South African Plastics Pact[20] that will reduce the plastics available as WtE feedstock. Therefore, WtE technologies that produce products that can be re-used within the plastics value chain are important. Another potential barrier is shown by competing technologies such as the emergence of black soldier fly farms that can generate higher value products from organics, and the established and expanding composting sectors. WtE technologies need to be flexible in configuration so that WtE can complement these technologies and improve the attractiveness of WtE as a waste beneficiation solution with a strong business case.

[16] Available via the World Biogas Association: https://www.worldbiogasassociation.org/wp-content/uploads/securepdfs/2021/03/SABIA_MARKET-POSITION-PAPER.pdf
[17] See GreenCape's 2021 Waste Market Intelligence report: https://www.greencape.co.za/market-intelligence/
[18] UNIDO's Biogas project development life cycle report: https://unfccc.int/sites/default/files/resource/Biogas%20to%20Energy%20Project%20Development%20Methodology.pdf
[19] GreenCape Energy Services MIR 2021 – https://www.greencape.co.za/market-intelligence/
[20] South African Plastics Pact: https://www.saplasticspact.org.za/2025-targets/

Funding and incentives

The WtE sector has limited funding options for WtE projects due to the business case having a limited ability to prove viability with a single revenue stream. Projects within the WtE sector are often financed through green economy, climate change and circular economy financing mechanisms and models.

Options for sources of financing can be found within **GreenCape's market intelligence reports** (MIRs) and **green finance database**[21].

Conclusion

WtE projects are developed and built on the availability and security of feedstock. However, the viability of the business case is driven by the selection of the utilisation pathway for the technology and the ability to collaborate and / or integrate with initiatives currently being developed for specific waste streams of value.

Therefore, WtE technologies can contribute to easing the strain of decreasing landfill capacity and energy security.

However, it cannot be considered as a leading solution for waste beneficiation or energy security only. It needs to be implemented in contexts where there is no alternative and conditions favour utilisation of all its offerings and related potential revenue streams. In the specific case of the Cape Town and the Western Cape more generally, WtE technologies need to focus on providing solutions to:

- **problematic waste streams that do not have alternative waste beneficiation solutions;**
- **providing an alternative and renewable fuel source; and**
- **providing more efficient material and nutrient recycling options.**

Acknowledgements

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Editorial and Review: Nicholas Fordyce and Lamees Martin

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[21]GreenCape: https://www.greencape.co.za/content/focusarea/green-finance-databases