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Review of Waste to Energy Policies in South Africa and International comparisons

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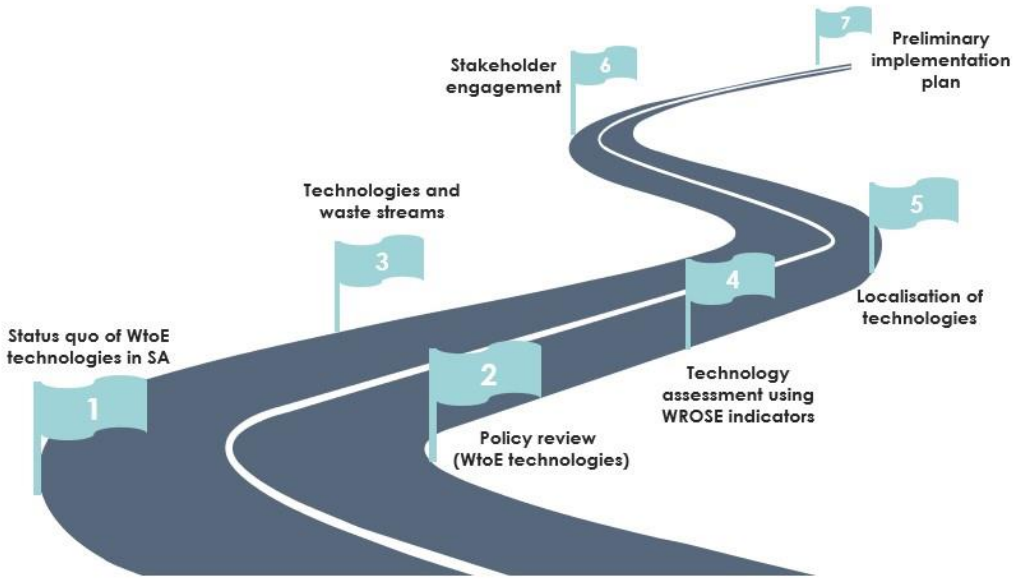

Review of Waste to Energy Policies in South Africa and International Comparisons

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Summary

This report is a review of the Waste-to-Energy (WtE) policy in South Africa within the framework of the IEA Bioenergy Task 36. In addition, drivers and barriers in the implementation of WtE solutions in different counties (i.e.,Germany, Ireland, Italy, Norway, Sweden and United States of America) are also presented and discussed. The purpose of this review is to provide countries with inspiration and support in implementing suitable policies and solutions in the waste-to-resources management and WtE sector that would facilitate their transition towards circularity.

The IEA Bioenergy Task 36, working on the topic "Material and Energy Valorisation of Waste in a Circular Economy", seeks to raise public awareness of the sustainable energy generation from biomass residues and waste fractions including municipal solid waste (MSW) as well as to increase technical information dissemination. As outlined in the 3-year work programme, Task 36 seeks to understand what role energy from waste and material recycling can have in a circular economy and identify technical and non-technical barriers and opportunities needed to achieve this vision. See http://task36.ieabioenergy.com/ for links to the work performed by IEA Bioenergy Task 36.

Background

The South African National Energy Development Institute (SANEDI), in partnership with the DSI/NRF/CSIR South African Research Chair in Waste and Climate Change at the University of KwaZulu-Natal, has developed a Waste-to-Energy Roadmap for South Africa to contribute to the country's Just Energy Transition with the aim to map the **potential for insertion of waste to energy technology in South African municipalities**. The South African Waste-to-Energy Roadmap identifies relevant technologies for the effective recovery of waste into biogas and energy, while mapping barriers and drivers for potential uptake at local level (Nell and Trois, 2022). One important element of the WtE Roadmap is a WtE Policy Review document (including institutional barriers and drivers) and detailed mapping of the policy and regulatory frameworks pertaining available WtE technologies for the treatment and valorisation of MSW in South Africa.

The development of a WtE Roadmap supports the South African Government in delivering an economic recovery from the COVID-19 pandemic that is green, clean, resilient and inclusive based on the following research question:

"How can South Africa transition to a sustainable smart energy system, implementing WtE as a resource, and how can different WtE solutions co-exist with other renewable energy technologies in a renewable South African energy system?".

There is global outreach to implement mitigation measures to reduce the amount of greenhouse gasses (GHG) emitted into the atmosphere and stabilize the impacts of climate change. Waste management in the South African context is an emerging sector with increasing emphasis placed on the development and application of integrated waste management strategies (Trois and Jagath, 2011). South Africa has recently adopted the Waste Hierarchy, through the National Waste Management Strategy and is progressively implementing policies aimed at maximizing the valorisation of waste as a resources, such as the Extended Producer Responsibility EPR and the Carbon Tax (Trois et al, 2022 (Task 36 Report); Roberts (Task 36 Report)) The National Waste Management Strategy (DFFE, 2018) drives the diversion of waste from landfills, the valorisation of waste as a resource, and assists South African municipalities in dealing with landfill airspace constraints. Over 70% of South Africa's waste goes to landfill resulting in loss of resources to the economy (DFFE, 2018), and social (human health) and environmental impacts, however, Municipalities face challenges in delivering services and diverting waste from landfills (Kissoon and Trois, 2022). In the absence of full cost accounting, alternative waste treatment typically appears more expensive than landfilling thus creating a lock in.

At the same time, South Africa is seeing a large-scale shift to low-carbon energy supplies and solutions with associated changes in infrastructure requirements and the way utilities provide energy services while continuing the drive for universal energy access for all South Africans with a particular focus on energy poverty and poverty alleviation initiatives in the country. The waste sector in South Africa contributes to >4.3% of the national GHG emissions (NIR, 2017). However, the nexus waste, climate change and renewable energy provision is not explicitly explored or addressed in current policies at national and/or local level, thus delaying the achievement of the nationally determined contributions (NDCs) in matter of implementing and rolling out projects towards the adaptation and mitigation of climate change from the waste sector.

There is a need to investigate how different WtE solutions can be integrated in the South African energy system and play together with a national sustainable energy transition that not

only reduces greenhouse gas emissions, but also improves security of supply and assists in an overall sustainable development for South Africa and similar emerging economies. The South African Waste to Energy Roadmap explores the following aspects of WtE development:

1) The current state of the art for WtE technologies (including considerations on their appropriateness for the South African context), and their potential role in the energy system;

2) The development of an energy system analysis and how it can assist in providing a renewable and secure energy supply for the country;

3) Key contributions to the sustainable development of the South African energy system and WtE sector, with particular focus on policy and institutional frameworks;

4) The development of an implementation plan and policy/institutional framework for the insertion of WtE technologies in South African Municipalities.

There is a need to develop decision-making tools for Municipalities to decide on the best Waste to Energy strategy that would achieve sustained waste reduction, resource recovery, carbon emissions reduction and job-creation. On the other hand, it is also necessary to facilitate the insertion and localisation of these WtE Technologies by analysing sustainable renewable energy systems on an hourly basis, by ensuring energy balance and assessing security of supply. These elements are crucial both in a South African context but also on a wider global level. Thus, in the development of the SA WtE Roadmap, the SARChI Chair Waste and Climate Change engaged with Task 36 of the IEA Bioenergy to compile a comprehensive Policy Review Report that compares barriers and drivers relevant to South Africa, with the policy frameworks and lessons learnt from the other member-countries of Task 36 (United States of America, Germany, Ireland, Sweden, Italy and Norway).

The South African Waste to Energy Roadmap

According to the World Bank (2018), 2.01 billion tonnes in 2016 were disposed in world cities with an expected increase to 3.40 billion tonnes by 2050. Moreover, it is estimated that waste generation rates will more than double over the next twenty years in lower-income countries. Solid waste has the potential to generate large quantities of methane, a greenhouse gas (GHG) that is principally impactful in the short-term (Hoornweg and Bhada-Tata, 2012). A proposed solution for the large quantities of waste is to initiate the widespread utilization of Waste-to-Energy (WtE) technologies. Table 1 shows some of the common Waste to Energy technologies that are currently being used world-wide.

Table 1: Summary of typical WtE technology and by-products (Campos, Zamenian, Koo and Goodman, 2015)

WtE Technology	By-products
Incineration	High pressure steam, ash and exhaust gases
Pyrolysis	Raw syngas, bio-oil, ash, char and metals
Conventional Gasification	Raw syngas, bio-oil, ash, slag and metals
Plasma Arc Gasification	Raw syngas, inorganic materials and vitrified slag
Anaerobic Digestion (Single and Double stage)	Methane gas, Hydrogen, digestate
Landfilling with Gas Extraction	Biogas, methane gas

There are many policies, reports and scientific papers relating to energy needs as well as climate change and emission control. In this report, WtE is considered in its wider acceptation including thermal, physical-chemical and biological systems for a variety of municipal solid waste streams.

The key elements of the South African roadmap were identified as in Figure 1 (Nell and Trois, 2022):

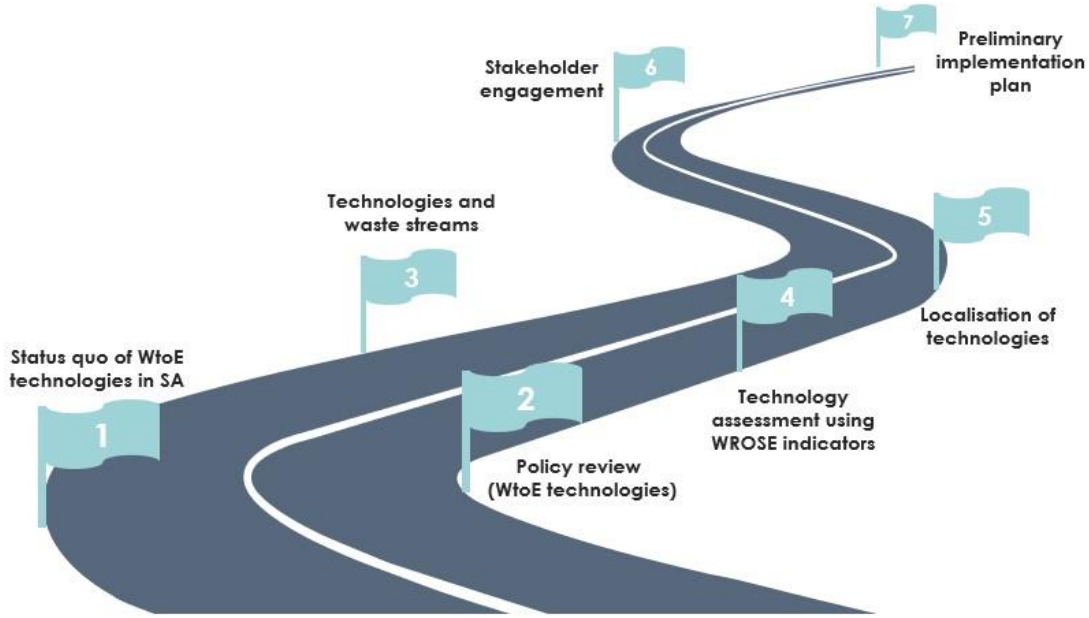

Figure 1: Key elements of the South African WtE roadmap (Nell and Trois, 2022)

During the development of the Waste-to-Energy (WtE) Roadmap, the importance of proactive engagement and meaningful consultation with key stakeholders was recognised. Stakeholders identified during the development phase of the WtE Roadmap included groups and individuals who are directly interested in or affected by the development of such Roadmap. Understanding of stakeholder's needs, interests, and expectations of a WtE Roadmap, provides input into the development thereof and enables a bottom-up approach in its development. Through this process, opportunities, drivers, barriers, recommendations, and other relevant factors were identified as reported in this document (Nell and Trois, 2022). This report focusses on a policy review at national level, comparison with policies implemented in the Task 36 member countries and, most importantly, on the alignments with the strategies of key stakeholders and drivers of the SA-WtE Roadmap.

The main motivation behind the development of the WtE Roadmap for South Africa was the lack of a specific institutional framework for guiding the various governmental sectors and decision makers in the successful implementation of the waste-to-energy sector in South Africa (SANEDI, 2021).

The roadmap aims to create a clear and concise pathway for the insertion of WtE technologies that is fully aligned with the aspirations, strategies and institutional policies of the South African Government, implementation agencies, national and international financial institutions, investors, and industry stakeholders.

The results of steps 1 and 4 of the SA-WtE Roadmap (Status quo of WtE technologies in South Africa and Technology Assessment using the WROSE indicators) are summarized in Tables Table 2 and Table 3 below.

Table 2: Summary of WtE technology vs waste streams as identified by the South African Waste-to-Energy Roadmap (SARChI Chair Waste and Climate Change, 2022)

WtE Technology	Waste Streams
Incineration	High pressure steam, ash and exhaust gases
Pyrolysis	Raw syngas, bio-oil, ash, char and metals
Conventional Gasification	Raw syngas, bio-oil, ash, slag and metals
Plasma Arc Gasification	Raw syngas, inorganic materials and vitrified slag
Thermal Treatment (Combustion/Incineration)	General Waste, Hazardous Waste, Medical Waste
Biological Treatment (Anaerobic Digestion)	Organics, Abattoir Waste, Agricultural Waste, Sewage Sludge
Chemical Treatment (Hydrolysis)	Plastic
Thermal Treatment (Pyrolysis)	Plastic, Glass, Metal, Paper, Tyres
Thermal Treatment (Thermal Oxidation)	Organics, Tyres
Thermal Treatment (Gasification)	Organics, Abattoir Waste, Agricultural Waste, Sewage, Plastic
Thermal Treatment (Plasma Gasification)	Organic, Medical Waste, Abattoir Waste, Agricultural Waste, Sewage Sludge, Tyres

WtE Technology	Waste Streams
Landfilling (Landfill with Gas Extraction)	General Household Waste, Organics, OFMSW
Biological Treatment (Aerobic digestion)	Sewage Sludge
Thermal Treatment (Fluidised Bed Co-Combustion)	Wood, refuse-derived fuel, peanut-hull, paper, cellulose and cardboard pellets, garden refuse, organics
Thermal Treatment (Cement Kiln Co-Combustion)	Tyres
Thermal Treatment (Bagasse Boiler)	Bagasse
Hydrogen (Double Stage Anaerobic Digestion)	Organic, Agricultural Waste, Sewage Sludge
Thermal/Chemical Treatment (CCS/CCUS/BECCUS)	Organic waste
Thermal Treatment (Oxygen Enhanced Combustion)	Organic waste

Table 3: Applicable WtE technology and relative waste streams in the South African context, as identified by the South African Waste-to-Energy Roadmap (SARChI Chair Waste and Climate Change, 2022)

Term	Technology Option	Waste Input Materials
Short Term Technologies that have been applied in the South African context. Low financial implications and skills requirements	Landfill Gas to Energy	General MSW, Residual Waste
Medium Term Technologies that have had some success when applied in the South African context. High financial implication for application. Applicable to local waste streams	Anaerobic Digestion	Organic Waste, Garden Waste, OFMSW
	Incineration	MSW, commercial and industrial waste
Long Term Technologies that have had no proven track record in South Africa, high capital and operational costs associated. Technologies are sensitive to specific waste streams	Gasification	MSW, commercial and industrial waste
	Pyrolysis	MSW, commercial and industrial waste
	Plasma Gasification	Treated residual waste, commercial and industrial waste
	Mechanical Heat Treatment	MSW, commercial and industrial waste

The current status of waste management and energy policies in South Africa is the focus of this report and will be discussed in the next section.

The methodology adopted for this report was to review the current applicable Waste to Energy legislations in South Africa as well as international Waste to Energy policies and roadmaps. The main approach used were a literature review and a stakeholder engagement to build a detailed WtE matrix framework that would enable decision-makers to navigate through the regulatory framework for implementation of WtoE systems in South Africa[1].

[1] The technology assessment of WtE systems reviewed for the South African WtE Roadmap was performed using the WROSE™ model/tool developed by UKZN (Trois and Jagath, 2011; www.wrose.co.za).

Institutional context in South Africa relevant to WtE

The National Waste Management Strategy (2020) showcases the key principles that municipalities need to implement at grass roots level. These include:

1. Waste Minimisation
2. Waste Prevention
3. Waste as a Resource
4. Sustainable Strategic Partnerships
5. Environmentally sound socio-economic growth and development

The South African energy situation is also a complex one, specifically the unreliability and the usage of coal as the main electricity source, there has been copious work done which is detailed by Res4Africa Foundation (2021) in Figure 2 there has been an increase in public and private green investment in environmental goods and services, as well as public policies that encourage environmental-related projects, such as the Carbon Tax Act 15 of 2019, which are pushing the focus of green energy generation. The renewable energy framework in South Africa has developed greatly with bidding processes in round six, which means there are sufficient institutional controls and guidelines for private industries to develop renewable energy plants in South Africa in a cost-efficient and clear directive manner.

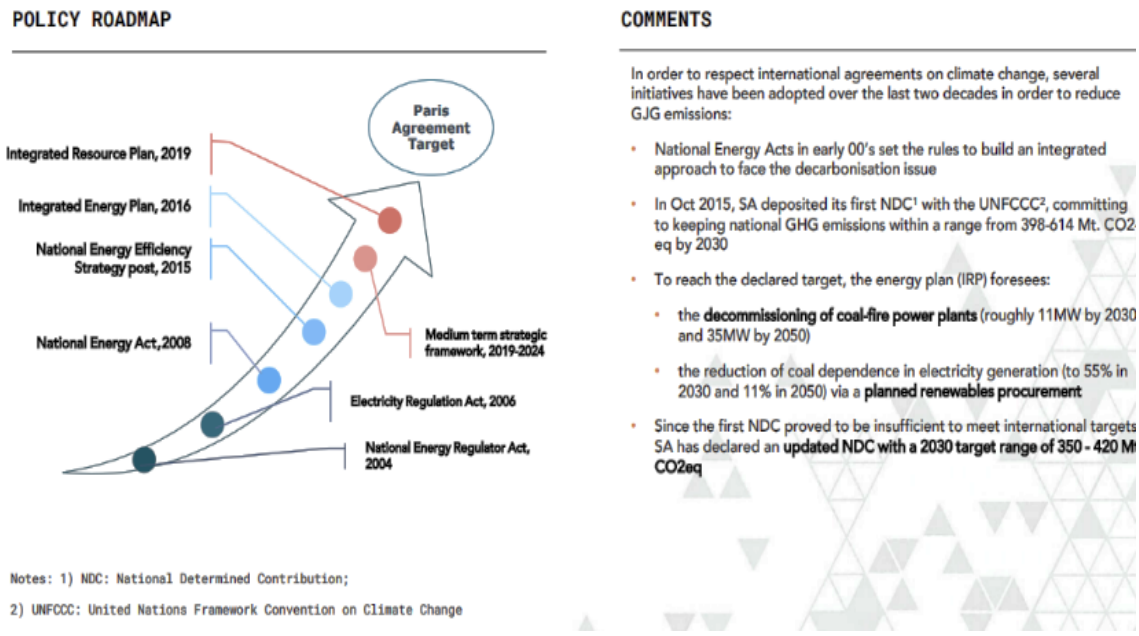

Figure 2: Energy policy Roadmap (Res4Africa Foundation, 2021)

It is important to note how policies are created and rolled out in South Africa. Law making is led by the Parliament which is the national legislative body. As such, one of its major functions is to pass new laws, to update existing laws, and to repeal or abolish old ones. This function is assisted by the Constitution of South Africa, which governs and applies to all laws and conduct within the country.

By-laws are managed by municipalities. The Constitution of South Africa gives municipalities the power to pass their own legislation, in the form of by-laws, for particular subject areas. These by-laws hold the same power and enforcement as other national and provincial legislation. It is also important to know the schedules which will now be discussed. Schedule 4 of the Constitution lists the functional justifications in which Parliament and the provincial legislatures jointly have the right to make laws. This includes sectors like agriculture, health, housing, the environment and education (but not tertiary or higher education). Schedule 5 of the Constitution lists the functional justifications in which only the provincial legislatures may make laws. This includes areas like provincial roads and traffic, liquor licensing, provincial planning and provincial sport. In exceptional circumstances Parliament may make provincial laws to maintain national security, maintain economic unity, establish minimum standards for service delivery, or to prevent unreasonable action by a province which affects the interests of another province or the country (Parliament of the Republic of South Africa, 2022). Figure 3 (see next page) also graphically shows the legislative process in South Africa.

It is critical to note that municipalities in South Africa are elected with the responsibility of identifying needs of the local communities through various streams, including public meetings, imbizos, ward committees and petitions. Policies are then developed in the form of integrated development plans (IDPs) and municipal budgets are allocated to address the identified community needs. It is a legislative requirement that all municipalities in the country develop and accept such plans in order to sufficiently respond to the needs of their respective communities. However, the lack of requisite capacity and political will to implement such policies is a noted challenge facing most municipalities in the country (Munzhedzi, 2020).

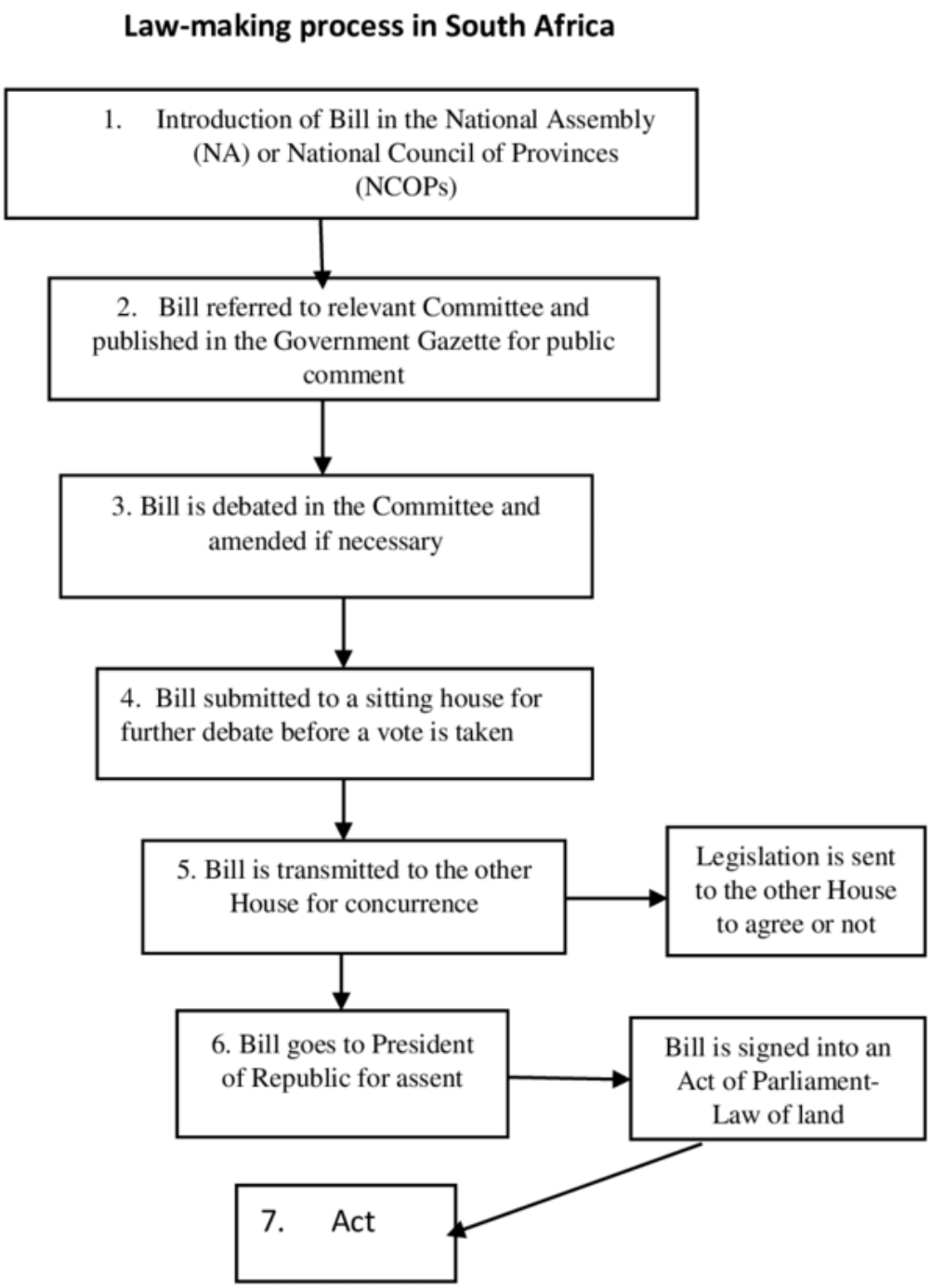

Figure 3: South African law-making process (Parliament of the Republic of South Africa, 2022)

Law making specifically relating to waste in South Africa is based on the National Environmental Management: Waste Act 59 of 2008 which is legislation which is structured around providing a guidance within the waste management hierarchy, which is the overall approach to waste management in South Africa. The various aspects of the Act detail the obligations to uphold norms and standards, integrated waste management plans, and industry management plans.

According to Chapter 3 Section 11 of the Act, each Municipality must:

i. Submit its integrated waste management plan to the MEC for approval;

ii. Include the approved integrated waste management plan in its IDP contemplated in the Municipal Systems Act.

Section 6 includes the exercising the power to monitor and support a municipality as contemplated in Section 31 of the Municipal Systems Act, the MEC for local government, in consultation with the Minister of Executive Council, must ensure that the municipal IDP is co-ordinated and aligned with the plans, strategies and programmes of the Department and provincial departments. Before finishing an integrated waste management plan, the Department and every provincial department contemplated in subsection (1) must follow a consultative process in accordance with sections 72 and 73. b) A Municipality must, before finalising its integrated waste management plan, follow the consultative process contemplated in Sect. 29 of the Municipal Systems Act either as a separate process or as part of the consultative process relating to its IDP (Kelly, 2015).

Comparison of international WtE legislative frameworks

The countries included in the comparison are limited to those being part of IEA Bioenergy Task 36.

Table 4: International comparison of Waste-to-Energy regulatory frameworks and relative barriers/drivers

Country	Barriers	Drivers	Policy Purpose & Short (2020-2030) or Long (2031-2050) Term
United States of America		Methane to Markets (M2M) programmes: supports technology demonstrations and pre-feasibility and feasibility studies at possible project sites; addressing market, institutional and other blockades to project development and building capacity through technology transfer and training. At the national level, omission is required through the Code of Federal Regulations (CFR) with general handling and disposal standards also defined within the CFR. These standards are to be imposed by a federal agency, which administers and operates the obligatory permitting system. In most situations, the promulgated standards allow local governments (e.g., states and cities) to develop more precise, and stricter management and permitting programs. The Renewable Fuel Standard (RFS) program was created under the Energy	Short term M2M: Assists with feasibility study Code of Federal Regulations (CFR): Is a national level standard regarding environmental permitting Renewable Fuel Standard (RFS): Is a national policy that mandates a specific volume of renewable fuel to replace the current non-renewable fuels utilized

Country	Barriers	Drivers	Policy Purpose & Short (2020-2030) or Long (2031-2050) Term
		Policy Act of 2005 (EPAct), which amended the Clean Air Act (CAA). The RFS is a national policy that mandates a specific volume of renewable fuel to replace the current non-renewable fuels utilized.	
Germany	Since the organics landfill ban in 2005, depending on its quality residual waste is either recycled or incinerated in waste-to-energy plants. The landfill gas is harvested from old landfills and used to produce energy. Shortage in landfilling capacity and in thermal waste treatment capacity	EU legislation including mandatory implementation of separate collection of different waste types such as paper & cardboard, food waste, glass, etc., recycling objectives for e.g., municipal solid waste, plastics waste.	CO_2 prices for the non-biogenic content in municipal solid waste incineration; regulatory initiatives for application product specific recycled content (plastics)
Sweden	Since 2013, Sweden includes WtE (incineration plants that use household waste as fuel for heat and electricity) in the Emission Trade System (ETS). After revising the ETS in 2021, the European Commission proposes that all combustion of fossil fuel will be included in the ETS. This could be a barrier for the sector to achieve their goals in emissions reduction. Some WtE plants in Sweden have shown their concern on this regard.(Reference: Avfallsförbränning i EU ETS (naturvardsverket.se) (only available in	There have been introduced landfill ban on combustible waste since 2001 and on organics since 2005. Compared to 2019, the percentage of waste incinerated decreased while the waste recycled increased, pointing out a trend towards a more circular resource/waste handling. This trend is due to the efforts made to develop national policies (in many cases stricter that the ones set by the EU) and guidelines for a more sustainable use of resources and waste handling, and to a	Short term The waste incineration tax (Avfallsförbränningsskatt | Skatteverket) introduced in 2020 was abolished from the 1st of January 2023. Different studies have shown that has neither a positive effect on increasing material recycling, nor leads to a decrease on the amount of waste incinerated (Reference: avskaffad-avfallsforbranningsskatt-och-slopad-energiskattenedsattning-for-datorhallar.pdf (regeringen.se), only available in Swedish).

Country	Barriers	Drivers	Policy Purpose & Short (2020-2030) or Long (2031-2050) Term
	Swedish))	rise of awareness of consumption and waste handling from the consumers. Establishment of a waste incineration tax; however, there has been delays in the implementation due to political differences. There are also concerns of public acceptance. In 2020, the Swedish Government adopted a The National Strategy for a Circular Economy and in 2021 released "The Action Plan for Circular Transition", a roadmap which is a detailed strategy for energy transition in Sweden for 2020-2030 as well as biogas incentives. (Reference: Handlingsplan cirkulär ekonomi (storage.googleapis.com)) In February 2022, it was presented a Bio-CCS strategy which aims to illustrate what is required for the district heating sector with the help of bio-CCS to be able to contribute to negative emissions before the year 2045. The strategy has been developed jointly by a 15- number of companies and organizations in the district heating sector. (Reference: Strategi för bio-CCS – vägen till negativa utsläpp 2045 - Avfall Sverige)	

Country	Barriers	Drivers	Policy Purpose & Short (2020-2030) or Long (2031-2050) Term
Ireland	Waste production in Ireland is closely related to economic activity, with MSW generation increasing by 4% in 2020, and packaging, construction and demolition, and hazardous waste producing all reducing in the same period. Reliance on incineration of waste in Ireland is growing with 43% of MSW and 71% of plastic packaging waste being incinerated in 2020.	Ireland must meet EU waste management targets under the EU Waste Framework Directive (2008/98/EC as recast by 2018/851/EC). Nationally, the 'Waste Action Plan for a Circular Economy, Ireland's National Waste Policy 2020-2025' contains measures on the circular economy, municipal waste, consumer protection and citizen engagement, plastics and packaging waste, construction and demolition waste, textiles, green public procurement and waste enforcement. Currently Ireland is meeting the EU targets, however significant improvements in reduction of waste generation and increase in municipal recycling and plastic recycling are needed in order to meet the EU targets for 2025; municipal waste recycling rate of 55% and plastic packaging recycling rate of 50%.	Short term. Ireland must meet the EU targets by 2025.
Italy	Landfilling of MSW in 2020 was still around 25%, mainly due to the lack of incineration facilities, mainly in the south of the country, and of the lower	Italy is pushing toward a circular economy in the management of MSW, mainly by enhancing the recycling and reuse, but also privileging the energy	The latest data on the recycling of waste (2021) show an increase of 68% of the total released for consumption, with an EU average of 35%. MSW recycling

Country	Barriers	Drivers	Policy Purpose & Short (2020-2030) or Long (2031-2050) Term
	gate fee and low tax on landfilling with respect to incineration. Incineration of MSW reached 18% in the same years with an additional 2% for co-incineration. Construction of new incineration facilities is problematic due to the low public acceptance	recovery of the unsorted waste, after separated collection, with respect to landfilling, as suggested by the European hierarchy of waste. The incineration of waste results in around 50% of renewable energy due to the biomass content, contributing to the decarbonization policy. The anaerobic digestion of sewage sludges and food waste is increasing with respect to other uses, including incineration (where applicable), or composting. The produced biogas can be directly used for energy production or put into the national distribution grid of natural gas, after upgrading to bio-methane, with economic incentives.	was 48% in 2019, with targets of 55, 60, and 65% in 2025, 2030, and 2035, respectively. Short-term policy (2020-2030) action already approved included: Transposition of Directive 851 2018/EU (Decree 116/2020), which provides that the recycling targets are calculated "upon entry into the recycling operations", with some exceptions only; the 2020 European Action Plan on the circular economy has identified textiles among the priority sectors announcing the publication of a Strategy on textiles by 2021, Complying with the EU directives included in the European package on the circular economy, Italy set the start of separate collection for textiles in 2022, anticipating the threshold established at the Community level for 2025; Transposition of the Single Use Plastic Directive (Decree 196/21). From 3 July 2021, a ban on the marketing of some products (cotton buds, cutlery, plates, straws, drink stirrers, etc.) and a gradual reduction of other disposable products made of plastic. Adoption of economic or fiscal tools to encourage the use of reusable products. Obligation to produce PET bottles using at least 25% recycled product by 2025 (30% by 2030); Italian national tax on virgin plastic packaging

Country	Barriers	Drivers	Policy Purpose & Short (2020-2030) or Long (2031-2050) Term
			(not containing recycled plastic) was established in 2020 by implementing one of the indications of the EU Directive on so-called “MACSI”. BUT was then postponed to 2023. This tax, set at € 0.45/kg, is due solely for the quantity of virgin plastic contained in the MACSI, and therefore is not due to the plastic material that comes from recycling processes; Transposition of Council Decision (EU, Euratom) 2020/2053 of 14 December 2020 (Law 262.21, n 2), which introduces a levy on the weight of non-recycled plastic packaging waste generated in each Member State, of € 0,80/kg. The tax is in force since 2021 but is applicable only after the transposition by all member states; In 2021, provisions were introduced that promote the return of plastic, glass, and metal packaging used for water and other beverages, via a cash deposit. The application of the rule is subject to the issue of regulation by the competent ministries which are still being drafted. Long policy (2031-2050), includes the bans on landfilling of MSW and/or the introduction of landfill tax as well as the increasing of recycling, energy recovery, and mainly reuse of waste.

Country	Barriers	Drivers	Policy Purpose & Short (2020-2030) or Long (2031-2050) Term
Norway	Currently, large quantities of municipal solid waste are being exported to Sweden to be recovered in their Waste-to-Energy plants and the Norwegian plastic waste is being exported to Germany for material recovery. => limited treatment capacity	EU upcoming regulation concerning separate collection (food waste, textiles etc.) and material recovery targets for several fractions. EC Green Deal EPR	Short term Currently no waste issue as they ship their waste to neighboring countries so waste recovery is low but probably not sustainable long term Waste incineration tax implemented since 2022 (will more than double in 2023) Circular economy EU Taxonomy
South Africa	Requires a focused and detailed waste to energy policy. Still requires further clarity on the plant size, minimum waste material volumes and licensing requirements (cost and timelines).	Improvements in policy creation.	Short and Long Term Many position papers and policy developments for Waste-to-Energy in South Africa; however, also many contradicting waste and energy institutional frameworks for successful implementation

Detailed discussion of barriers and drivers in South Africa

WTE POLICY BARRIERS IN SOUTH AFRICA

South Africa has numerous prominent waste management policies, plans and strategies that support the waste management hierarchy. However, the development and application of certain waste management alternatives, which would allow waste to be better managed within the waste hierarchy, have been limited partially due to the absence of decisive national policy related to waste treatment and retrieval through thermal processes, including dedicated incineration and co-processing in cement production. The privation in policy course has resulted in or underwritten to several limitations. In many occurrences, these limitations include poor environmental performance related to waste management in the country, the lack of, late or conflicting decision-making regarding the authorization of waste incineration and co-processing activities, uncertainty in Government and industry regarding investigating and developing these technologies as waste management options and noteworthy opposition from certain sectors of society that oppose any form of thermal waste treatment. Another element relating to the waste hierarchy, is that landfilling is seen as the best solution due to the ease of disposal and the costing feasibility with low gate fees, this barrier can therefore deter waste to energy projects as the solution for waste disposal.

An evident barrier is the legal costs of obtaining relevant permits regardless of the size of the plant. It is also noted the high cost of the permits and required steps, a Basic Assessment is approximately R100,000 (2021 estimate data) and Environmental Impact Assessment is approximately R170,000 (2021 estimate data) which does not include any specialist studies that could be required. According to the Municipal Finance Management Act (2003) under section 33, there are limitations on the contract terms up to 36 months however some off-takers require ten-to-fifteen-year commitments and therefore require a section 21A process, which is contrary to the act which can become a barrier in contracts or commitments of starting a waste to energy plant in South Africa. Therefore, cost analysis and financial management is a key aspect in the development of waste to energy plants and can become a barrier if not addressed correctly.

Another barrier includes the NEMA (Act 107 of 1998) which is an overarching framework for WtE technologies which include the applicable Basic Assessments or Environmental Impact Assessments, hazardous substance permit with the regional office with Department of Environment, Forestry and Fisheries. However, other permits are required from the Department of Water and Sanitation and Department Mineral Resources and Energy-and NERSA. There is great overlap regarding the processes and approvals and causing confession between stakeholders (developers and governmental officials).

Regarding thermal treatment through pyrolysis under the national policy on thermal treatment of General and Hazardous Waste (2009) despite detailed goals of this policy to assist with certain WtE technologies, it does not include assistance to pyrolysis plants.

Under the Management Restriction and Prohibition of Organic Waste to Landfill under the National Waste Management Strategy (20020), it states organic waste cannot go to landfill which can be seen as a barrier for lower volumes of waste input as organics cannot go to landfill.

A policy barrier under the NEM: WA (Act 59 of 2008) which is the application of a waste management license and handling/storage of hazardous substances/waste license. Some

argue, the "waste "being used is not classified as waste rather a raw material/resource so a license application is not required however then the process of waste classification to be endured. There is also no threshold on the volume of waste so even a micro WtE will require a permit which is not financially feasible and a lengthily process and the NWA (Act 36 of 1998) which is the application of water use license however there is still confusion on the applicable to WtE technologies. This barrier under the national policy on thermal treatment of General and Hazardous Waste (2009) despite detailed goals of this policy to assist with certain WtE technologies, it does stipulate the assistance of Department of Environment, Forestry and Fisheries to facilitate all permits between the departments for waste, water and air licenses, however in particular terms when a developer does go to Department of Environment, Forestry and Fisheries for WtE plants they are not assisted as per this policy for facilitation of permits. This is a useful policy however it still needs more input and tools for proper implementation a suggestion is to use a decision tree for the various types of WtE technologies available and include thresholds of waste. It is also evident that the various policies do not include financial terms and timelines for processing permits which is critical for project management and feasibility studies.

There are also developments of the Waste-to-Energy roadmap in South Africa of which one of the elements of this roadmaps was to conduct various stakeholder engagements in the creation of the roadmap. The findings of the stakeholder engagement were presented by Nell and Trois (2022), specifically showcase the industry and relevant stakeholders concerns of waste to energy legislation in South Africa and highlight this as a barrier to further development of waste to energy. The stakeholder engagement results are as follows relating to legislation in South Africa. It is noted during the stakeholder sessions that policy related discussions mostly focused around either the inclusion or exclusion of certain waste volumes of WtE technologies. As well as, the difficulty with approval processes were highlighted by stakeholders as well as the difficulty navigating policy and legislative requirements.

Another barrier mentioned by the stakeholders were that institutional barriers revolve around the engagement with government which has been described as "complex" and "difficult". The that the political term of elected local government officials is only 5 years is also a barrier seeing as it often leads to delays or changes in spending or implementation priority. There is also a lack of "thresholds" in current WtE legislation, requiring all projects to get the same licenses or approvals which increase the total cost and project timings. It is also noted that existing legislation has at times been interpreted inconsistently leading to project approval delays or complications. attainable. This is the reality on the ground for relevant stakeholders in the WtE industry in South Africa and work needs to be done in clarifying the WtE framework which this paper is hoping to pave the way for a clearer institutional roadmap from development to municipal implementation of WtE in South Africa.

WTE POLICY DRIVERS IN SOUTH AFRICA

A key policy driver is the national policy on thermal treatment of General and Hazardous Waste (2009), the Department of Environment, Forestry and Fisheries will remain endorsing the waste management hierarchy which seems to provide support for WtE technologies based on individual merit of each project. The SABIA market position paper discussed earlier is also a key driver for industry specific WtE plants in South Africa and they are working closely with government for a clearer institutional way forward.

Another driver is the National Environmental Management: Waste Act: Norms and standards

for the treatment of organic waste (Draft, 2021) details possible WtE technologies under organic waste and provides a good guideline on the process from construction to decommissioning.

The management Restriction and Prohibition of Organic Waste to Landfill under the National Waste Management Strategy (20020), states organic waste cannot go to landfill which can be seen as a driver under this technology as an alternative route from landfill and moves up the waste hierarchy which is aligned the National Waste Management Strategy.

Another driver, which is the latest amendment in 2021 under the Electricity Regulation Act 4 of 2006 under schedule 2 amendment which states an increase in the threshold for embedded generation from the previous 1 MW to 100 MW, without the need for a license. Project developers will be exempted from applying for a license, but they will still be required to register as an energy generator with NERSA.

As seen above, the National Policy on the Thermal Treatment of General and Hazardous Waste (2009), addresses the barriers of the development of WtE plants in South Africa and with the implementation strategy, it is seen as the South African government fully supporting this new way of managing waste through WtE technologies.

Another important framework for biogas plants in South Africa the is National Energy Regulator of South Africa (NERSA) which regulates the biogas plants relating to the production, importation, and distribution of the piped gas within South Africa. All biogas plants constructed in South Africa are required to register with NERSA and comply with relevant legislation which is based on the relevant municipality and national requirements. Biogas plants legislative requirements have been building momentum and one of the latest progressions in 2019 was from the NEM: AQA Section 21 notice on biogas installations under category 10 which states biogas installations are not a listed activity and therefore does not require an air emissions license however they are required to manage and monitor odour produced from the plants. This is progression for the biogas sector and shows improvements between industry and government in creating an easier and clear plan for more biogas installations.

There has been significant progress on Waste-to-Energy policies in South Africa especially with the National Waste Management Strategy (2020) which focuses on long term waste management practices which is the move in the right direction in creating a clear roadmap to the development of Waste-to-Energy technologies in South Africa.

One of the main developments for advocating WtE in South Africa is the development of the National Biogas Strategy by the South African Biogas Industry Association (SABIA), launched in 2022 and available at the link: www.sabia.co.za

The SABIA National Biogas Strategy presents a set of guidelines for the insertion of biogas-to-energy projects in directed to the South African Government and policy makers, as detailed in Table 5 below:

Table 5: SABIA National Biogas Strategy – Guidelines for the insertion of Biogas-to-Energy in South Africa (SABIA, 2022 available at www.sabia.co.za)

WtE Technology
1. Diversion of organics/food waste from entering a landfill site through the introduction of separate organic waste collection for treatment in biogas facilities across South Africa
2. Setting of targets and implementation strategies for the recycling of biodegradable wastes and feedstocks
3. Development, support and creation of the SABIA Biogas PES tariff (Payment for Ecosystem Services or Payment for Environmental Services) to stimulate the recovery of organic residues
4. Production of biogas through the installation of biogas technologies at a. agri-industry processing facilities, b. urban wastewater treatment plants and c. livestock farms
5. Adoption and implementation of the Organic Waste Norms and Standards developed by SABIA and partners in 2016
6. Drive the creation of an enabling market environment for the capture and utilisation of landfill gas at both private and public landfills
7. Ensure all municipalities and Eskom to buy-back surplus electricity generated from biogas plants at published Mega-flex rates from IPPs (Independent Power Producers)
8. Incentivise the energy generation and use from livestock manure via targeted policies such as specific rural schemes for micro-scale digestion that result in energy security and independence, reduced use of solid fuels for domestic cooking and heating, and reduced deforestation whilst improving agricultural security through the recycling of nutrient and water
9. Development of standards and certifications for safe trading and application of digestate (South African Biogas Industry Association, 2021).

Table 6: Extract from the SA-WtE Roadmap on barriers and drivers to the insertion of Waste to Energy in South Africa

Current Policies	Barriers	Drivers
National Environmental Management Act (NEMA) (Act 107 of 1998)	NEMA (Act 107 of 1998): Overarching framework for WtE technologies which include the applicable BA/EIA, hazardous substance permit with the regional office with DEFF. However, other permits are required from the Department of Water and Sanitation and Department Mineral Resources and Energy-and NERSA. There is great overlap on processes/approvals and causing confession between stakeholders (developers and governmental officials) Costly process (from approval to construction)- municipal finance management act to assist	The Department of Environmental Affairs will remain endorsing the Waste Management Hierarchy ~National Policy on the Thermal Treatment of General and Hazardous Waste, 2009
National Environmental Management Waste Act 59 of 2008	NEM: WA (Act 59 of 2008) Application of waste management license and handling/storage of hazardous substances/waste license. Some argue, the "waste "being used is not classified as waste rather a raw material/resource so a license application is not required however then the process of waste classification to be endured. There is also no threshold on the volume of waste so even a micro WtE will not a permit which is not financially feasible and a lengthily process. Still a lengthily process and requires more clarity around the NEM: Waste Act Regulation 921 Categories A & B: Waste Management License if this is applicable to waste to energy plants.	This act encourages the waste management hierarchy and influences decisions through the national waste management strategy

Current Policies	Barriers	Drivers
National Energy Act 34 of 2008. Electricity Regulation Act (Act 4 of 2006) (REIPPP & Gas regulators); Electricity Regulation Act, 2006 (Oct 2020, Amendments on New Generation Capacity, 2011) and (2021, Amendment on Schedule 2)	Despite progress in legislation there is still difficulty in understanding the legal context (developers and governmental officials are not aligned) and no specific WtE policy	Latest amendment in 2021 under the Electricity Regulation Act 4 of 2006 under schedule 2 amendment which states an increase in the threshold for embedded generation from the previous 1 MW to 100 MW, without the need for a license. National Energy Regulator of South Africa: According to the Electricity Regulation Act (Act 4 of 2006), any person who operates any electricity generation, transmission or distribution facility, imports or exports electricity or is involved in the trading of electricity must apply for a license from NERSA. Register to 1. Production of Gas, 2. Importation of Gas, 3. Transmission of gas for own exclusive use or 4. Small biogas projects not connected to the national gas pipeline grid
The National Water Act 36 of 1998	If applicable, General Authorization: Water Use License which requires specialist input and additional time and costs. Application of water use license however still confusion on the applicable to WtE technologies.	N/A

Current Policies	Barriers	Drivers
National Environmental Management: Air Quality Act 39 of 2004	Despite progress in legislation there is still difficulty in understanding the legal context (developers and governmental officials are not aligned)	Biogas plants legislative requirements have been building momentum and one of the latest progressions in 2019 was from the NEM: AQA Section 21 notice on biogas installations under category 10 which states biogas installations are not a listed activity and therefore does not require an air emissions license however they are required to manage and monitor odour produced from the plants.
National Environmental Management: Waste Act: Norms and standards for the treatment of organic waste (Draft, 2021)	N/A	National Environmental Management: Waste Act: Norms and standards for the treatment of organic waste (Draft, 2021) details possible WtE technologies under organic waste and provides a good guideline on the process from construction to decommissioning
White Paper on the Renewable Energy Policy, 2004	Requires a focused and detailed waste to energy policy	Introduces aspects of waste to energy plants, very high-level policy

Current Policies	Barriers	Drivers
The White Paper on Integrated Pollution and Waste Management, 2000	Requires more details on how waste to energy can assist with the waste management strategy and more tangible information	High level waste management policy, waste to energy can be seen under the strategic goals solution for future plans
NEMA: EIA listing Notice and triggers	Adds more cost and time to the project for either BA or EIA. Costly process from approval to construction	The Department of Environmental Affairs remains committed to promote the National Waste Management Strategy, the insertion of the EPR and the adoption of the waste hierarchy.

Note: The integral table of barriers and drivers related to all relevant South African policies is available in Grewan (2023. Manuscript in preparation).

Conclusions

Material and energy valorisation of waste are key solutions to waste problems around the world. Moreover, Waste-to-Energy (WtE) substitutes fossil energy at the local scale. In general, from the comparison of WtE deployment among the Task 36 countries, the various drivers and barriers identified in the policy frameworks, from development to implementation appear very similar despite the socio-economic and geographical disparities. It is acknowledged that all stakeholders need to work together to ensure the successful implementation of Waste-to-Energy technologies. South Africa has progressed in the development of strategies aimed at expanding the waste and energy sector, but there is still vast potential in creating a specific waste to energy management framework. In countries with further developed Waste-to-Energy implementation, every level of government is involved in setting and implementing the criteria for the permitting process of WtE projects while the local municipalities are responsible for the management and monitoring process. Best practice from the policy review international comparison suggests is that to have a locally drafted specific and fully aligned waste-to-energy policy and roadmap to advice all levels of government and stakeholders. Waste-to-energy technologies policies can be a driver in motivating and supporting WtE projects if they are developed in consultation with all levels of government and relevant stakeholders being included in an open and deliberated process.

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