A National Waste Research, Development (R&D) and Innovation Roadmap for South Africa: Phase 2 Waste RDI Roadmap

Trends in Waste Management and Priority Waste Streams for the Waste RDI Roadmap

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CSIR/NRE/GES/ER/ 2014/0016/A	Trends in waste management and priority waste streams for the Waste RDI Roadmap	Godfrey, L., Rivers, M and Jindal, N.

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CSIR/NRE/PW/ER/ 2012/0052/A	HCD: Current waste HCD initiatives in South Africa	Lombard, J., Lombard, R.K. Godfrey, L. and Roman, H.
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KEY INSIGHTS

ECONOMIC OPPORTUNITIES FROM WASTE

The opportunities that waste provides as secondary resource are recognised globally and locally. Materials and energy recovery from waste creates opportunities for local economic development. However, a waste economy will always compete with the availability and price of virgin materials.

GLOBALIZATION OF WASTE

The growing demand for resources globally is driving flows of recyclables to countries with market opportunities (demand). Unless local markets are stimulated, resources will flow out of South Africa.

OPPORTUNITY WASTE STREAMS

Opportunity waste streams, globally, include organic waste (industrial and agricultural biomass, municipal organic waste, food waste and sewage); recyclables (metals, plastic, paper, glass, e-waste); and large industrial waste streams (power generation & mining)

OPPORTUNITY AREAS

The fastest growth in waste management markets is expected in the emerging markets, most notably China, India and Latin America. South Africa is identified as one of five emerging markets with "exciting opportunities".

Global and local trends:

Waste generators, waste operators, government and society recognise the social, environmental and economic benefits of moving waste up the waste management hierarchy, away from landfilling towards prevention, reuse, recycling and recovery.

Targeted waste streams globally include organic waste and recyclables (e.g. plastic, metal, glass, paper), for diversion into materials and energy recovery.

Global and local drivers:

- Population growth and urbanisation
- Increasing quantity and complexity of waste
- Climate change
- Carbon economics
- Resource scarcity
- Commodity prices
- Energy security
- Globalisation
- Job creation
- Tightening regulation

PUBLIC-PRIVATE PARTNERSHIPS

Municipalities facing continued financial and capacity constraints are looking more and more to the private sector, globally, to achieve waste diversion targets.

IMPROVED FEEDSTOCK MANAGEMENT

Growing a local waste economy, and managing investment and technology risk, is dependent upon increased access to recyclables (quantity), and to clean recyclables (quality).

DIFFERENT PATHS TO ACHIEVING INTEGRATED WASTE MANAGEMENT

While the goal is to move waste up the waste management hierarchy, countries have followed different pathways in achieving it, and implemented different technology solutions.

TECHNOLOGY VERSUS LABOUR INTENSIVE MANUAL RECYCLING

For some recyclable waste streams, high-cost technologies have not been able to achieve the efficiencies in materials recovery achieved through labour intensive, manual recycling.

1 INTRODUCTION

This report outlines the current global trends in waste management and the drivers of these trends; South Africa's position relative to these trends; and the opportunities these trends provide for South Africa's young, but growing, waste economy.

The main questions explored were:

- What are the drivers behind a trend?
- What are the trends globally for developed and developing economies?
- What is South Africa's current and future position relative to the trend?
- What is the value and relevance of a particular trend for South Africa?
- What is South Africa's readiness to take advantage of a trend and what is the likelihood and impact of realising the implication associated?

The results will be used to identify sector opportunities, on which the Department of Science and Technology's (DST) Waste Roadmap (Implementation Plan and Framework) will be based.

2 TRENDS

2.1 Global trends in waste management

2.1.1 Developed countries

A recent study on the impact of a circular economy on the waste sector, found that the majority of businesses are moving waste up the hierarchy by focussing on increasing recycling rates; better waste prevention; a greater focus on waste reuse; setting zero waste to landfill targets; and energy recovery (Perella, 2013). Waste recycling and recovery have become the focus of integrated waste management.

> *"Around 70% of the municipal waste produced worldwide is driven to dumpsites and sanitary landfills, 11% is treated in thermal and Waste-to-Energy (WtE) facilities and the rest 19% is recycled or treated by Mechanical and Biological Treatment (MBT), including composting."* (ISWA, 2012).

Recent Eurostat data (2010) shows this transition away from landfilling towards recovery within the EU (EuroStat, 2013) (Figure 1). Statistics for South Africa are included for comparison. What is clear from Figure 1 is that countries are at different stages in transitioning up the waste hierarchy, and that there are different paths to take in achieving waste diversion. Some countries have prioritised thermal treatment, with a large percentage of their waste being sent for energy recovery and incineration (without energy), while other countries have prioritised recovery other than energy (e.g. recycling of waste). While differences in waste management approaches (technology mix) exist between EU member states, the EU, as with most developed countries, is showing a move away from waste disposal, to resource recovery (other than energy) (which includes recycling) and energy recovery (Eurostat, 2013). Countries such as the Italy, Germany, Denmark and Belgium have managed to reduce the quantity of waste disposed to land, to less than 20% (**Figure 1**).

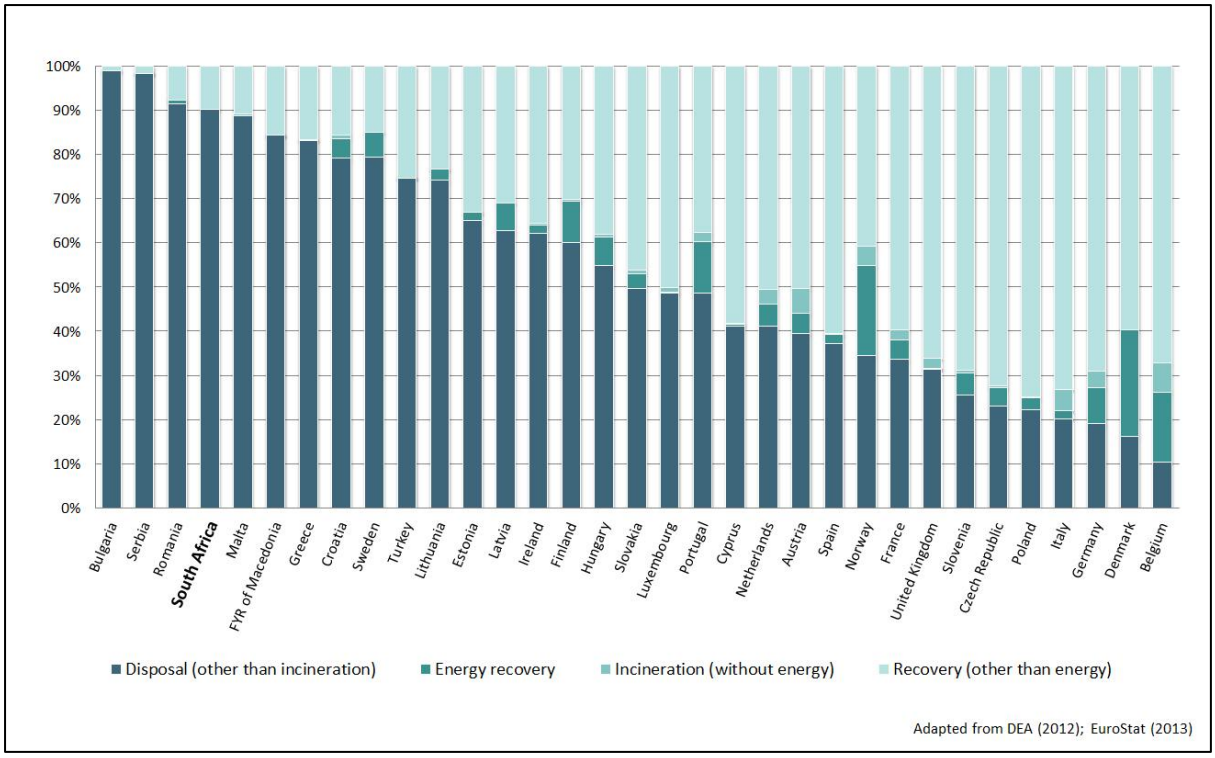

Figure 1. Approaches to total waste management (Europe, South Africa)

The trend is even more pronounced when it comes to waste management options for municipal solid waste (MSW) (**Figure 2**), where significant differences in technology solutions are evident.

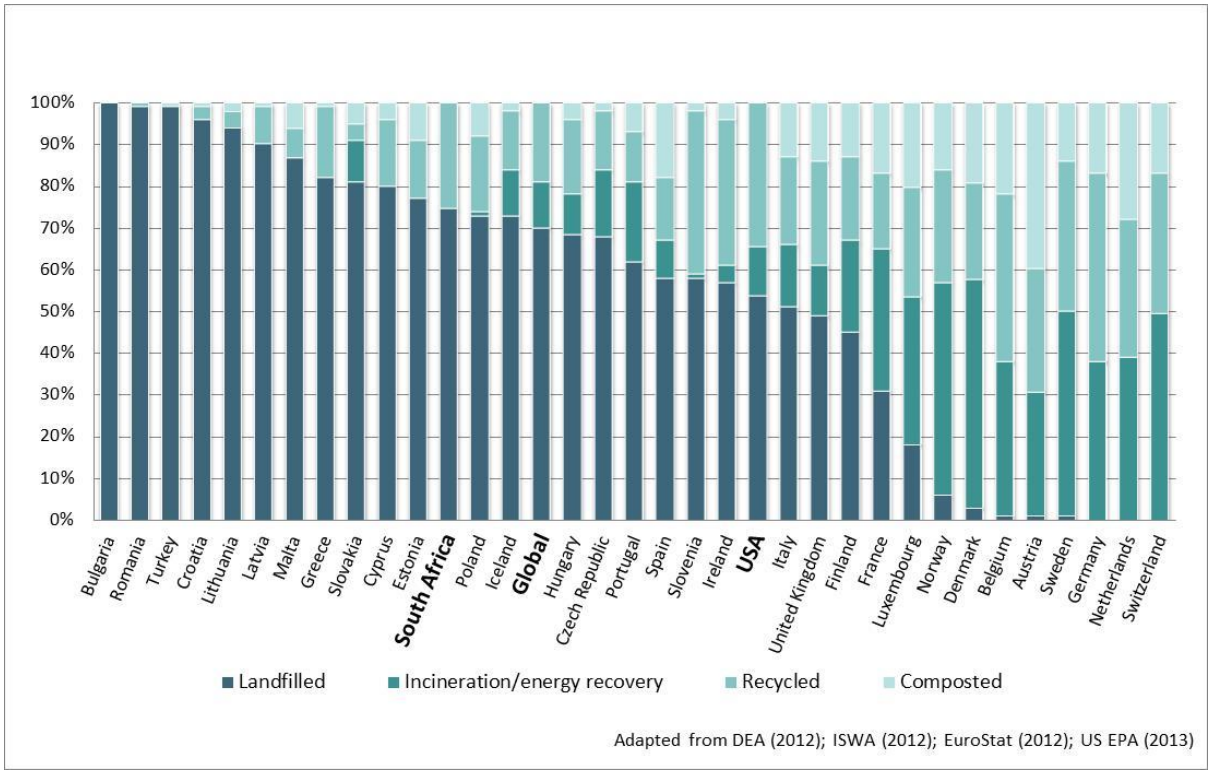

Figure 2. Approaches to municipal solid waste management (MSW) (2010)

The differences between countries and between technology options are also evident in plastic recovery. **Figure 3** shows total recovery rates of post-consumer plastic within the EU (for 2011), together with the split in materials recovery (recycling rate) and energy recovery. While high recovery rates (>90%) have been achieved in some countries, the materials recovery rates have yet to exceed 40%.[1] Interestingly, the top 9 countries with >90% recovery of post-consumer plastic waste, all have landfill bans in place for plastic.

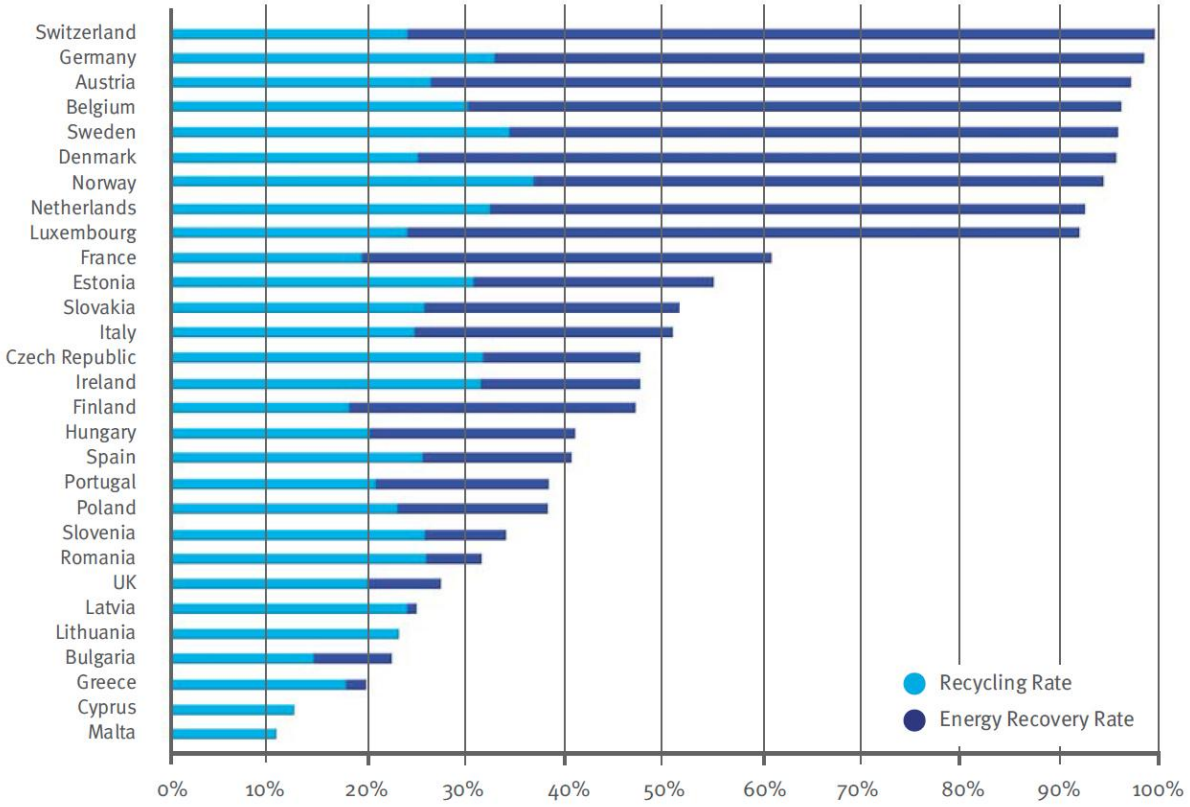

Figure 3. Total plastic recovery by country (2011) (post-consumer) (PlasticsEurope, 2012)

Data published by AcuComm (2013) shows a spate of new waste projects initiated around the world in 2013 (**Figure 4**). The focus of these projects is largely on –

- organic waste (agricultural, municipal/ household, wood/paper, food and sewage), and
- recyclables (metals, plastic, e-waste).

High value waste streams include organic waste and recyclables

In terms of technology type, the majority of new projects focus on WtE, biomass, anaerobic digestion and biofuel. The highest value projects are noted by AcuComm as Municipal/household and Wood/paper.

[1] South Africa's plastic packaging recovery rate currently sits at 34.3%

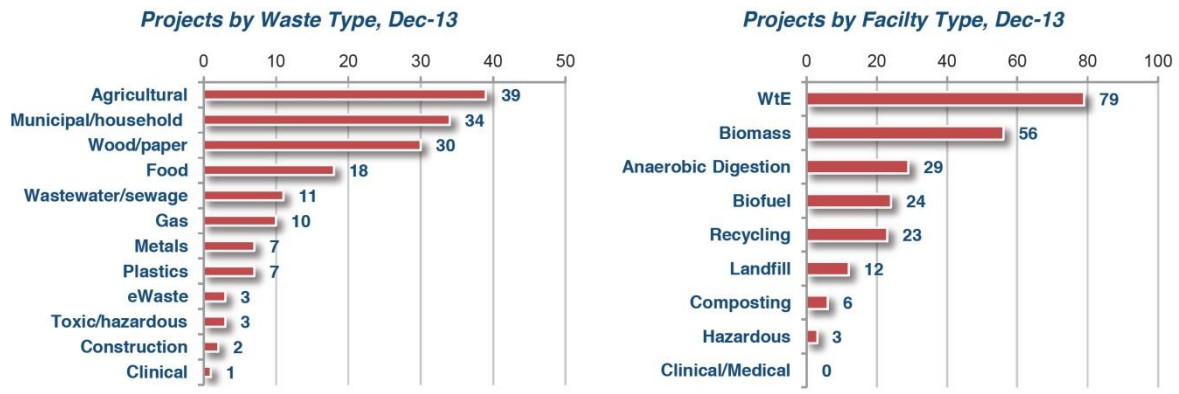

Figure 4. New waste projects (by waste type and facility type) (December 2013) (AcuComm, 2013)

The intention of these alternative waste management facilities is to recover viable resources from the waste, such as energy, polymer, fibre, ferrous- and non-ferrous metals, etc., and re-introduce them back into the economy. As the use of WtE technologies[2] grows and becomes part of the standard technology portfolio of a country, there is increasing debate around the trade-off between recycling and energy recovery. From a circular economy and resource recovery philosophy, WtE should be seen as a complementary technology to recycling, with the approach to integrated waste management being one of firstly waste prevention, followed by maximising waste reuse and recycling and finally recovery, including energy recovery (REA, 2011; DEFRA, 2013a). WtE technologies are therefore typically concerned with recovering energy from residual waste, once all economically viable recyclables have been removed (DEFRA, 2013). If countries are successful in achieving the top orders of the waste hierarchy, potentially less residual waste will be available for energy recovery. The list of new waste projects (YTD 2013) **(Table 1**) highlights that most are in developed countries. However, new projects for December 2013 include a number of emerging economies (*italics*).

> *"Government's aim is to get the most energy out of residual waste, rather than to get the most waste into energy recovery*" DEFRA (2013:22).

Table 1: Top 10 Countries by New Waste Projects (number) (from AcuComm Waste Futures, 2013)

	(YTD 2013)	
	Projects	% of Total
USA	295	20.4
UK	228	15.8
Canada	90	6.2
China	*67*	*4.6*
India	*64*	*4.4*
Japan	59	4.1
Germany	57	3.9
France	38	2.6
Finland	36	2.5
Australia	31	2.1
Others	482	33.3

	(Dec-13)	
	Projects	% of Total
USA	33	22.1
UK	27	18.1
Canada	13	8.7
Germany	12	8.1
India	*6*	*4.0*
Pakistan	*6*	*4.0*
Chile	*4*	*2.7*
China	*4*	*2.7*
France	4	2.7
Russia	*4*	*2.7*
Others	36	24.2

[2] Waste-to-Energy (WtE) technology is a blanket term for a range of technology types, including both thermal and non-thermal technologies, aimed at creating energy in the form of electricity, heat or transport fuels (DEFRA, 2013; ISWA, 2013)

2.1.2 Developing and emerging countries

Within the waste sector, BoAML (2013) see the fastest growth in the next decade coming from waste diversion, recycling, recovery, waste-to-energy, e-waste, and sustainable packaging, particularly in the emerging markets[3], in particular China, India and Latin America.

Fastest growth in the next decade expected in the emerging markets

Research[4] shows that many developing and emerging countries face many of the same waste management challenges as developed countries –

- Lack of adequate infrastructure to deal with growing volumes of waste
- Changing waste streams in terms of quantity and composition/complexity due to changing socio-economic conditions
- Dominant means of waste management is disposal of waste to landfill, typified by open dumps and open burning
- Problematic waste streams being organic (putrescible) waste, packaging waste, hazardous waste, and construction and demolition waste
- High tonnages of organic waste in the waste stream, often as high as 60-70%
- Low levels of recycling, largely carried out by an informal sector
- Lack of adequate environmental legislation regulating waste management activities

Many developing countries in Africa, South America and Asia are actively pursuing alternative waste management options, which are focussed on increased materials and energy recovery through increased recycling and recovery[4]. However, with respect to organic waste, t he complexity of technology responses varies between countries, from basic composting, to anaerobic digestion, to high temperature thermal destruction, e.g. incineration. China is also driving this trend towards increased recycling and recovery. The 12th five-year plan for National Economic and Social Development of the People's Republic of China (2011-2015) (CBI, 2011) has identified two specific areas of socio-economic development relating to waste –

Key issues facing global recycling and recovery include (VTT, 2012) -

- Increased efficiency in material recovery and recycling;
- Improved feedstock management, including increased access to recyclables (quantity) and to clean recyclables (quality); and
- Design for dismantling and recycling, in response to the increasing complexity of products and related wastes.

- Cultivating and developing strategic emerging industries, one of which focuses on an energy conservation and environmental protection industry, including recycling
- Vigorously developing a circular economy, including implementing circular production methods; enhancing the circular use of resources and recycling systems; popularizing the green consumption model; and strengthening policy and technical support

[3] Emerging markets are countries in the process of rapid growth and development. They include the 'BRICs' (Brazil, Russia, India, and China). They differ from 'developing countries'.

[4] Aydi *et al.,* 2013; Brahim, *et al.*, 2014; JoungDu *et al*., 2014; Karimi *et al*., 2013; Manuel *et al.*, 2014; Pereira, 2013; Shaida *et al*., 2014; Singh *et al*., 2014.

China's focus areas for waste recycling are very similar to those of Europe and include (China Briefing, 2012) –

- Waste recycling and recovery of metals (i.e. scrap metal, waste electronics, used electro-mechanical products) and plastic (recycled polymer)
- Recycling of large industrial waste streams, e.g. fly ash, gypsum, mining waste, etc.
- Energy recovery from waste, e.g. domestic and industrial waste, and sewage sludge

2.2 Local trends in waste management

South Africa is still largely at the periphery of this global transition towards a circular economy. The promulgation of the NEM:WA (No. 59 of 2008) (RSA, 2009), underpinned by the principle of the waste hierarchy, is prompting change within the South African waste sector. However, as at 2011, an estimated 90.1% of all general and hazardous waste generated in the country was still disposed of to landfill. In the case of municipal waste, often to uncontrolled open dumpsites. Only 9.8% of generated waste was recycled and 0.1% treated (DEA, 2012). The current portfolio of waste technology solutions for South Africa is therefore still heavily reliant on landfilling.



As with most developing countries, where recycling is occurring in South Africa, it is largely driven by the informal waste sector, currently estimated to provide a living for some 60 000 – 90 000 people (World Bank, 2012; DST, 2013). The informal sector in South Africa is thought to collect 80% of glass, 90% of PET plastic and the majority of the recovered paper into the recycling economy (BMI, 2013). This has resulted in fairly good (by international standards) recycling rates for packaging materials including glass, metal, paper and plastic (BMI, 2013).

The national Waste Sector Survey for 2012 (DST, 2013), also highlighted the heavy reliance on landfilling as a technology option in both the South African private and public waste sectors. The study showed that while the private sector is introducing (to some degree) alternative technology solutions, municipalities still rely very heavily on landfilling as the primary solution for the management of waste (**Figure 5**).

When one considers that approximately 13% of general waste generated in South Africa is municipal organic waste (DEA, 2012), collected predominantly by municipalities, and an additional 61% industrial and agricultural biomass waste, it is surprising that biological treatment (e.g. composting, anaerobic digestion) is not utilised more extensively in South Africa. Large quantities of waste biomass are being generated by industry, but yet thermal and biological technologies remain under-

utilised. Industrial biomass presents the largest, single type of general waste generated in South Africa at an estimated 36 mT/a for 2011 (DEA, 2012).

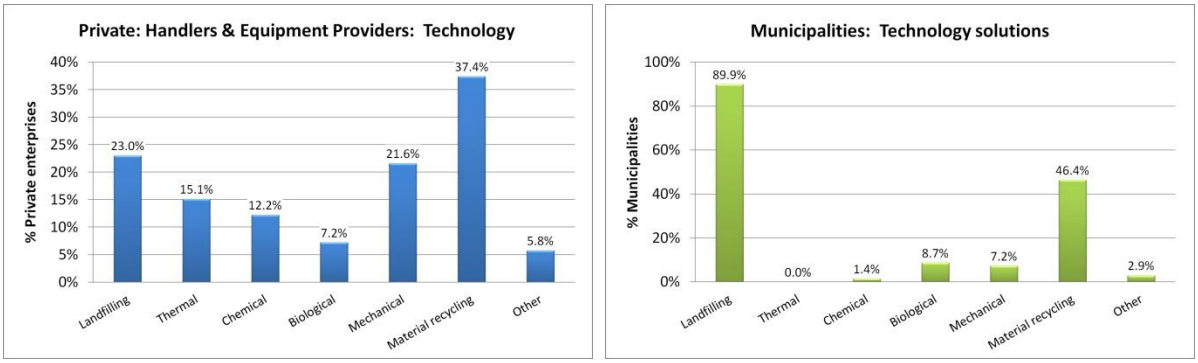

Figure 5. Technology solutions in the private and public waste sector in South Africa (DST, 2013).

Waste patents registered in South Africa provide an indication of new waste technology trends which may emerge in the future, as companies begin to protect their intellectual property. A review of registered patents (over the period 2007-2012) (**Figure 6**) shows a strong leaning towards high- and low-temperature WtE technologies ('fuel', 'incineration', 'combustion', 'anaerobic digestion' and 'pyrolysis') and recycling (DST, 2012), which mirrors international trends towards recycling and recovery. However, according to DST (2012), the majority of these patents (86%) are non-South African owned. This would suggest that international companies see South Africa as an attractive market for the introduction of waste technologies, and have begun to protect their intellectual property locally.

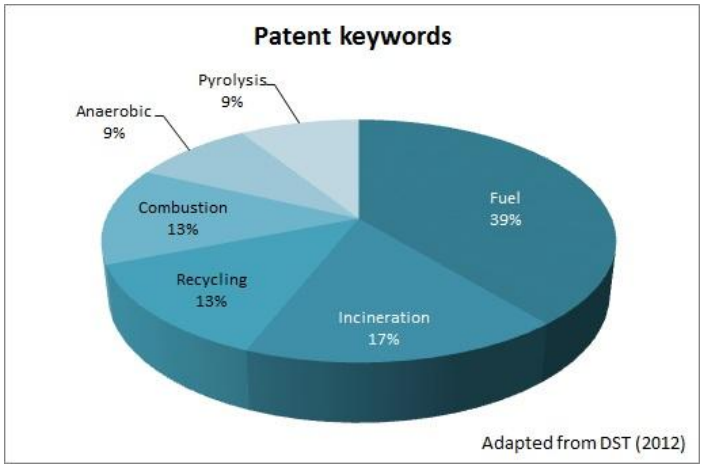

Figure 6. Patent keyword search results

2.3 Global waste and recycling flows

The global generation of solid waste is expected to increase from more than 3.5 million tonnes per day in 2010 to more than 6 million tonnes per day in 2025 (Hoornweg *et al.*, 2013). With waste

management being increasingly linked to resource management, a global network of material and recyclable waste flows has evolved, creating global recycling markets (ISWA, 2012). Much of these recyclables are directed towards China, which in 2010 "*imported around 7.4m tonnes of discarded plastic, 28m tonnes of waste paper and 5.8m tonnes of steel scrap. Between 2000 and 2008, European exports of plastic waste increased by 250% – and about 87% of these exports ended up in China (including Hong Kong)*"[5]. As noted by Moses (2013) "*The trade is being driven by tough EU legislation forcing local authorities and businesses to recycle more, and increasing landfill charges, making it cheaper to send the waste abroad. More than a third of the waste paper and plastic collected by British local authorities, supermarkets and businesses for recycling is sent to China*."[2]
The success in recycling by China has been ascribed to the high demand for the materials (markets), accompanied by the low labour costs, high unemployment rates, and developed recycling skills which allows for manual dismantling/recycling at higher recovery rates than can be achieved with high-cost technologies.[6] Recycled metal accounts for approximately 25% of Chinese aluminium production, 40% of copper production, and 15% of steel production.[7]

A recent study by StEP (Duan *et al*., 2013) mapped out the global flows in used electronics (e-waste), one of the fastest growing waste streams in developed and developing countries.[8] The results show that the bulk of the e-waste was transported to low-middle and low-income economies (**Figure 7**). Africa was noted as the least common destination.

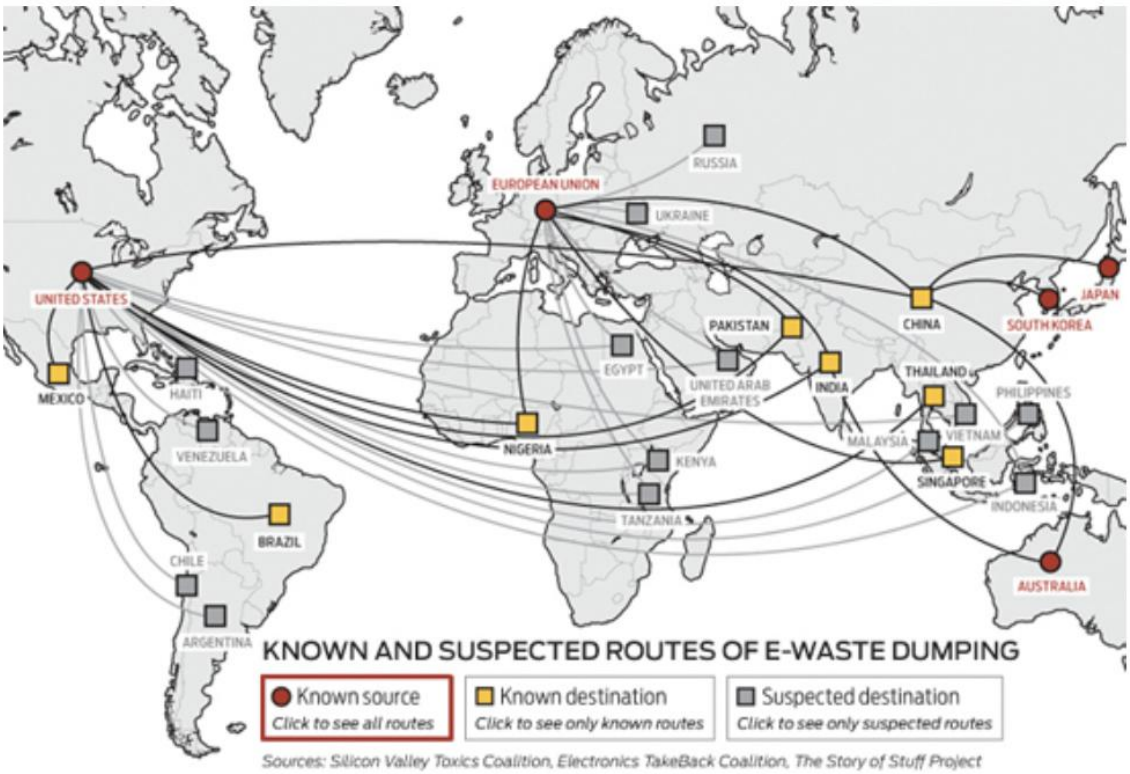

Figure 7. Global flows of used electronics (e-waste) [9]

[5] http://www.theguardian.com/environment/2013/jun/14/waste-trade-china-recycling-rubbish
[6] http://www.theatlantic.com/technology/archive/2011/03/the-metal-sorters-of-shanghai/71932/
[7] http://www.theatlantic.com/international/archive/2011/03/the-chinese-sample-room/72071/
[8] http://www.unep.org/gpwm/FocalAreas/E-WasteManagement/tabid/56458/Default.aspx
[9] http://www.ierc.com/e-waste-dumping-an-interactive-map/

Global trade in waste plastic, an estimated 12 million tonnes, is valued at $5 billion per year, with much of this (about 70% of the global market) being directed towards China. [10,11] China, the world's second largest plastics consumer, is home to the world's largest recycled plastics industry, "*an industry that (according to imprecise industry officials) includes 40,000 and 60,000 small, family-owned companies*."[12] South Africa has also seen growing exports of waste plastic, increasing over the past three years from 3.6% of recovered plastic in 2010, to 5.1% in 2012 (**Figure 8**).

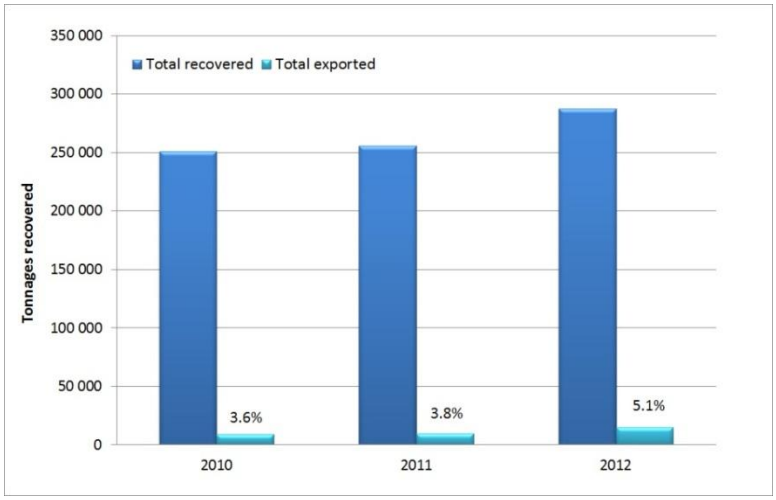

Figure 8. Recovery and export of waste plastic for South Africa (adapted from PlasticsSA, 2013)

The globalisation of waste is having a direct impact on global waste and resources economies. While it has created positive benefits (e.g. highlighting the waste-climate change linkage; and increased international financial flows in support of solid waste management), growing global demands for recovered resources will directly impact local recycling economies if local markets are not developed and maintained. Waste collectors will sell their recyclables for the highest price, whether that is to local or international markets. South Africa has attempted to address this matter for ferrous and non-ferrous waste, by putting export controls in place in 2013, which require that it first be offered to domestic users of scrap, at a price discount, in order to facilitate local rather than export sale (RSA, 2013). The export controls were strongly contested by the international scrap recycling community as a violation of South Africa's obligations under the international trade agreements of the World Trade Organization.

The globalisation of waste, including global waste and recycling flows, will impact upon local waste economies

2.4 Sector contribution to GDP

The diversion of waste away from landfilling towards recycling and recovery is creating both local and global waste economies. Global waste management is currently a US$1tn market (including municipal solid waste, industrial waste, waste-to-energy, and sustainable packaging),

South Africa is recognised as one of five emerging markets globally with exciting waste management opportunities

[10] http://www.bir.org/industry/plastics/

[11] http://www.theguardian.com/environment/2013/jun/14/waste-trade-china-recycling-rubbish

[12] http://www.theatlantic.com/international/archive/2011/03/the-plastics-shredders-of-china/71775/

which is expected to grow to US$2tn by 2020, with the fastest growth expected from emerging markets such as China, India and Latin America (BofAML, 2013). The Bank of America Merrill Lynch has identified South Africa as one of five emerging markets with "*exciting opportunities*" (BoAML, 2013). The others include Brazil, China, India, and Russia.

The waste sectors contribution to Gross Domestic Product (GDP), enterprise development and job creation is therefore of particular interest. The minimum financial value of the formal South African waste sector (public and private) was R15.3 billion, or 0.51% of GDP as at 2012 (DST, 2013).

The United States solid waste industry directly accounted for approximately 0.5% of the nation's GDP. Including all direct, indirect and induced effects, the US solid waste industry contributed just over 1% of U.S. GDP to the nation's economy. For every $1 of revenue generated by the industry, a total of $1.23 in additional revenue was generated in the economy through the multiplier effect. Similarly, for every job in the solid waste industry, the multiplier effect created an additional 1.58 jobs outside the industry.[13] According to GAA (2013), the revenue multiplier effect for the WtE industry in the US ranges between 1.52-1.95, with an average revenue multiplier of 1.77.

For the Hong Kong region, the economic activity "*Electricity, gas and water supply, and waste management*" accounted for between 2.4-1.8% of GDP (decreasing over the period 2008-2012)[14].

European Union (EU-27) environmental protection expenditure (EPE)[15], increased to 2.25% of GDP in 2009 (EuroStat, 2012a). Waste management made up the largest component of EPE. According to the European Commission (EC, 2006), the goods and services provided by eco-industries represented approximately 2.2% of GDP in the EU-25 area, where the major eco-industry sectors in terms of turnover included water supply, wastewater treatment and solid waste management.

South Africa's waste sector has the potential to grow from 0.51% to 1% of GDP

Given global trends and current drivers, the DST is confident that South Africa's waste sector has the potential to contribute more meaningfully towards GDP. That the direct contribution of the sector can grow from 0.51% to 1.0% of GDP, with additional indirect contributions to the economy through increased introduction of resources and further activity along the secondary resources value chain. The minimum *direct* revenue of the formal South African waste sector (public and private) would increase from R15.3 billion to R30 billion, with additional significant economic benefits believed possible through indirect revenue benefits.

[13] http://www.environmentalistseveryday.org/publications-solid-waste-industry-research/no-cost/size-of-the-industry-study/index.php

[14] https://www.censtatd.gov.hk/hkstat/sub/sp250.jsp?tableID=036&ID=0&productType=8

[15] Money spent on activities aimed at the prevention, reduction and elimination of pollution or any other degradation of the environment, including air, wastewater, waste and other related activities

3 DRIVERS

3.1 Global drivers

The solid waste management practices of any specific country have typically, not been a topic which has interested other countries. Whether a country chooses to landfill 100% of its waste, and the state of these landfills, has been of little interest to others. This is because solid waste, unlike water or air pollution, has little migration potential and therefore little influence regionally or globally. However, this view is changing, as we begin to realise the influence waste has on global climate change and global resource scarcity. Increasing demand for resources in countries with rapidly expanding economies is creating interest globally in 'waste' as a resource – what ISWA (2012) refers to as the integration of '*waste management*' with '*resource management*'. Similarly the impact of greenhouse gases from landfill sites has been quantified and its part within the global carbon balance recognised.

The drivers of waste and resources management globally, include -

- Population growth and urbanisation
- Increasing quantity and complexity of waste
- Climate change
- Carbon economics
- Resource scarcity
- Commodity prices
- Globalisation
- Tightening regulation

As a result, waste management is currently undergoing a major global paradigm shift. This shift is driven by issues of climate change, carbon economics, resource scarcity, and globalisation. This paradigm shift requires that waste no longer be viewed as an unwanted by-product requiring disposal to landfill, but rather as a renewable resource, suitable for re-introduction back into local and global economies (Perella, 2013). This paradigm shift from one of a linear to a circular economy creates significant economic and social opportunities. What the Bank of America Merrill Lynch refer to as "*Waste: a global thematic megatrend*" (BoAML, 2013).

While one would think that the sustainable development objectives of Rio (1992), reaffirmed at Rio+20 (2012), of protection of biodiversity, promotion of renewable energy, and conservation of natural resources, would be the drivers of waste management, the drivers appear to be largely economic in response to managing energy and resource security.

This paradigm shift is driving changes in waste technologies, as the sector seeks out alternative solutions to traditional disposal of waste to landfill. As noted by Perella (2013:21), as the resource management agenda unfolds, the biggest commercial opportunities will arise from "*smarter value extraction*

Figure 9. Waste hierarchy

techniques. This will require a strong need for technical innovation." Moving waste up the hierarchy (Figure 9) away from disposal towards waste prevention, reuse, recycling and recovery will require new technological innovation. Globally, government, business and academia are investing in alternative waste technologies which efficiently, and cost effectively recover resources from waste. While the drivers are mostly economic, the intention of moving waste up the waste management hierarchy is ultimately one of improved environmental and social outcome (DEFRA, 2013).

3.2 Local drivers

The vision for the South African waste sector has been set by government to be one of moving waste up the waste management hierarchy. South Africa has seen a surge in waste legislation since the promulgation of the National Environmental Management: Waste Act (2008). The intention of this legislation is to drive waste management away from landfilling towards alternatives, however, there are many who feel that current legislation is now constraining waste innovation (DST, 2012).

The drivers of waste management in South African include -

- Legislation
- Job creation
- Energy security

The opportunity that waste provides as a source of renewable energy is recognised. The electricity shortages experienced by South Africa in 2008 have sparked interest in alternative sources of energy, including waste-to-energy (WtE).

Due to the pressure on government to create jobs in a country with a very high unemployment rate (29.8% as at 2011), the goal of 69,000 new jobs to be created in the waste sector by 2016 has been set in the National Waste Management Strategy (NWMS) (DEA, 2011; StatsSA, 2012). The waste sector is recognised as an emerging economic sector with the opportunity to create new jobs, while at the same time absorbing relatively unskilled labour (Godfrey & Roman., in press).

The waste sector is recognised as an emerging economic sector with the opportunity to create new jobs, while at the same time absorbing relatively unskilled labour

4 RESEARCH

4.1 Trends workshop

In order to assess the relevance of current trends to South Africa, and South Africa's readiness to take advantage of these trends, three regional stakeholder workshops were held, in Johannesburg (18 February), Durban (20 February) and Cape Town (26 February). The aim of the workshops, facilitated by Mutualfruit Limited, was to obtain input from stakeholders on –

(i) current trends in waste management in South Africa (invited presentations) and

(ii) priority waste streams for the Waste RDI Roadmap.

Invited presentations were made by –

- Dr Johan Schoonraad (Enviroserv) – hazardous waste
- Mr Anton Hanekom (PlasticsSA) – plastic recycling
- Ms Mariekie Gericke (Mintek) – mining and metal waste
- Dr Bruce Sithole (CSIR) – organic waste (biorefinery)
- Prof Cristina Trois (UKZN) – organic waste (WtE) (*presented by Geoff Purnell*)
- Mr Keith Anderson (eWASA) – e-waste (*presented by Chris Whyte*)
- Mr Barry Coetzee (CoCT) – municipal waste
- Ms Cheri Scholtz (PETCO) – plastics (PET) recycling

A total of 199 persons were invited to the workshops (97 in Jhb, 50 in Dbn, 52 in CT). A total of 100 confirmed their attendance at the workshops, with a final number of 85 attending the workshops. The workshops were restricted in size to 30-40 persons to allow for a facilitated, focussed and interactive workshop. The sectors represented by workshop participants are indicated in **Figure 10**.

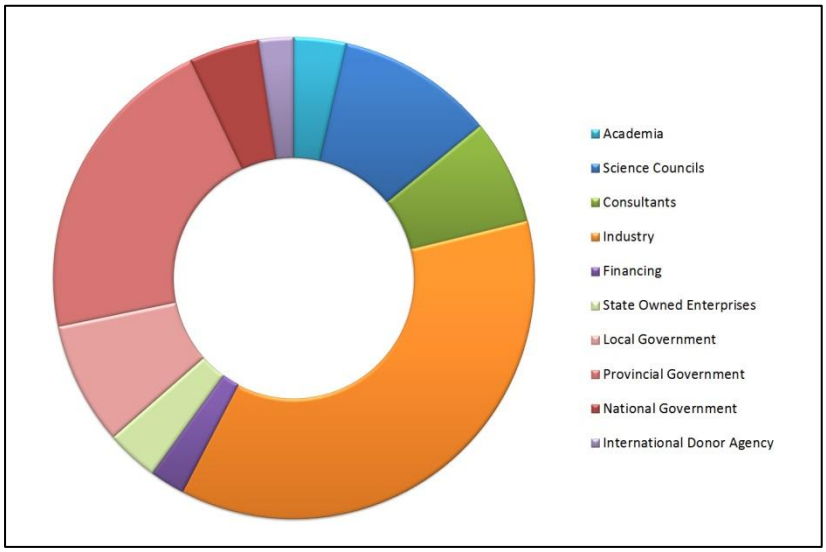

Figure 10. Sector representation of delegates attending the regional workshops

Stakeholders were asked to identify their top two priority waste streams for action, based on the following criteria –

- Problematic waste streams

- Moderate to high potential/opportunity for recycling/recovery (based on global trends)
- Magnitude of waste generated (high tonnage waste streams)
- Economic value in recycling/recovery
- Current low recycling / recovery rates
- Legislative requiring
- Other criteria (considered relevant)

4.2 Priority waste streams

The 24 waste streams, and their respective stakeholder (votes), are shown below. The total votes indicated per waste stream, are a sum of the votes from the three regional workshops:

- Organic waste (industrial & agricultural biomass) (36)
- Municipal waste (35)
- Tyres (18)
- Mineral waste (16)
- Plastic (13)
- Construction and demolition waste (12)
- Ash (7)
- Sewage sludge (6)
- WEEE (e-waste) (6)
- Waste oils (4)
- Health care risk waste (4)
- Slag (2)
- Glass (2)
- Brine (1)
- Paper (1)
- Metals (1)
- Mercury containing waste (1)
- Batteries (1)
- Asbestos containing waste (1)
- POP Waste (0)
- Inorganic waste (0)
- Organic halogenated &/or sulphur containing solvents/waste (0)
- Organic solvents/waste without halogens and sulphur (0)
- Tarry & Bituminous waste (0)

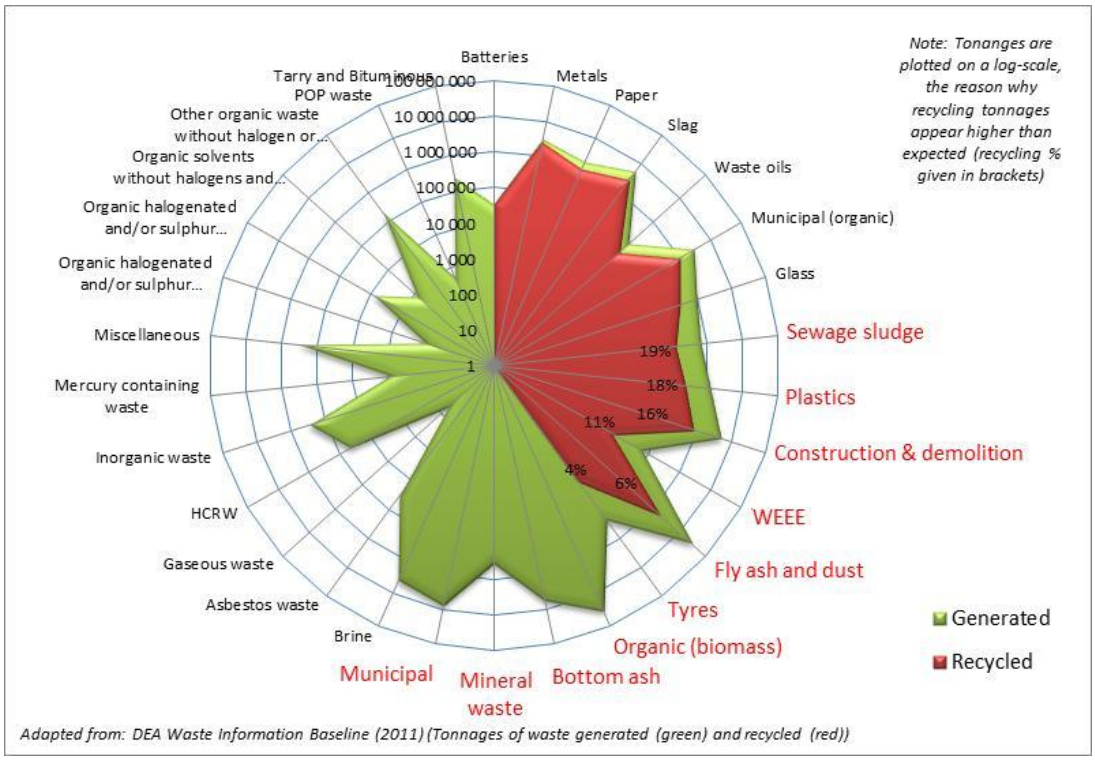

Figure 11. Stakeholder prioritised waste streams (against plot of generation and recycling tonnages)

The top prioritised waste streams were further discussed (in groups) in terms of –

- Trend analysis – Evaluation
- Opportunity analysis – Evolution
- Enablers to ensure success

The outcome of the stakeholder group discussions is presented in **Tables 3 - 11**[16]. The waste streams for which group discussions were held, are indicated in **Figure 11** *(highlighted in red)*.

4.3 Goal statements

The following goal statements were put forward by stakeholders for each prioritised waste stream, with an indication of likelihood of realisation in South Africa (**Table 2**) –

Table 2: Stakeholder goal statements (beyond 2024) for prioritised waste streams

Stakeholder Goal Statements 10+ Years (Beyond 2024)		Likelihood of SA Realisation
Organic waste	Zero organic waste to landfill, with maximum value extraction (materials and energy)	**Medium - High**
Municipal waste	Maximise diversion of municipal waste to landfill (50% reduction in municipal waste to landfill), with significant increase in recycling and WtE	**Medium – High**
Tyres	100% end-of-life tyres collected and recycled, and significant decrease in backlog (stockpiles)	**High**
Mineral waste	Minimise impact of mineral waste on land and biodiversity by moving up the hierarchy	**Medium**
Plastic waste	Zero plastic waste to landfill by 2030	Pre-consumer – **High** Post-consumer – **Low-Medium**
Electronic waste (WEEE)	50% diversion of e-waste from landfill by 2024 (*12% currently*)	**High**
Construction & demolition waste	100% diversion of C&D waste from landfills	**Medium**
Sewage sludge	All sewage sludge to be used in a recyclable manner	**Medium**
Ash	50% utilisation of ash through increased recovery	**Low – Medium**

[16] Electronic waste (WEEE) was not unpacked in any of the three regional workshops. However, at the request of DST, given that WEEE represents the fastest growing waste stream in South Africa (e-WASA), a table was also completed for WEEE (Table 11).

Table 3: Organic waste (industrial & agricultural biomass)

Evolution*: Organic waste (industrial & agricultural biomass)*

What?	Where?	Now 0-3 Years	Next 3-10 years	Later > 10 years	Drivers (PESTEL)

• Municipal and commercial organic waste (e.g. food waste, garden waste, retail)
• Industrial and agricultural biomass (e.g. food processing, pulp & paper processing,
• Animal waste (e.g. manure, abattoir waste)
• Sewage sludge
	Urban and rural	• Strategic plan for energy recovery from organic waste
		• Anaerobic digestion taking hold
		• Growth
		  ○ Consumer-based waste will increase with increasing population
		  ○ Agriculture ?
		  ○ Industry ?
		• Nature
		  ○ In agriculture, less efficient farming practices leading to more wastage
		  ○ Increase in numbers lead to more sewage and capacity in existing infrastructure being reduced
			• Legislation diverting organic waste from landfill
			• Systems in place for separation at source
			• Economic instruments in place to drive private initiatives
			• Financial instruments to overcome high capital costs
			• Tariff incentives for the interest repayments on capital
			• More composting
			• Increase in WtE opportunities
			• Anaerobic digestion
			• Biofuels
				Goal statement:
				• *Zero organic waste to landfill with maximum value extraction (materials and energy)*
				• Separation of organic waste at source
				• Change in collection systems
				• Co-operative investment modalities designed and established, in operation
				• Public-private mechanisms for mutually beneficial agreements
					What will drive the growth of this waste stream?
					• Urbanisation
					• Population growth
					• Economic development
					• Increasing agricultural activities (low efficiency)
					What will drive changes in practice?
					• Legislation (licensing streamlining)
					• Climate change
					• Groundwater protection
					• Energy security
					• Incentives
					• Technology
					• Cost and funding
					• People's awareness of waste issues
					• Monitoring and controls
					• Value attached to organic waste

Evaluation*: Organic waste (industrial & agricultural biomass)*

Benefit	Obstacles	Key Enabling Institutions	Likelihood of SA Realisation
• **To the Economy** ○ Reduced cost of energy ○ Savings at landfill ○ Foreign direct investment ○ Investor sentiment ○ Adds resilience ○ GDP • **Wealth** ○ Business development ○ New enterprises ○ Innovative technologies ○ Investment opportunities ○ Resource beneficiation • **Society** ○ Job creation ○ Alternative energy sources ○ Benefit for recyclers (cleaner recyclables) ○ Better quality feedstock • **Health** ○ Reduced emissions ○ Overall health improvement ○ Vermin reduction • **Environment** ○ Reduction in GHGs, water pollution ○ Reduction in landfill leachate ○ Land availability for other uses ○ Aesthetics	• **Market** ○ Energy market is difficult ○ Centralised buying ○ Behavioural change ○ Constant feed ○ Uptake market (agreements with) ○ Monopolisation • **Policy, legislation & regulation** ○ Organic strategy ○ Consultation process weak ○ NEMA, NEMWA, NERSA, DAFF, PFMA, MFMA ○ Costs associated with norms and standards ○ National waste collection standards need amendment ○ Tariff policies – NERSA & DOE ○ Wheeling regulation ○ Regulation sensible for big projects are not applicable to small projects • **Infrastructure** ○ Capability/Infrastructure to collect waste ○ Fragmentation of ownership (municipality vs Eskom) ○ Land availability ○ Price ○ Associated transport • **Investment** ○ Level of investment is prohibitive ○ Access to investments/funding ○ Risk (market and operational risk) ○ Long-lead payback ○ Technology fit • **Relationships** ○ Lack of collaborative relationships ○ Not well developed amongst role-players	• **Government** ○ National government (DEA, DOE, EDD, DAFF, CoGTA) ○ National Treasury ○ Provincial departments of Economic Development ○ Municipalities • **Industry** ○ Waste companies ○ Waste generators (energy demanding industries) ○ Consumer Goods Council ○ Industry bodies (institutes, associations) • **Research** ○ Science councils and universities ○ Translational agencies ○ It exists – need to optimise for local conditions (feasibility) • **Partnerships** ○ Banks, IDC, Foreign Donors ○ Between agricultural NGOs and environmental sector ○ Media ○ Research institutions • **Other** ○ NGOs	**Medium - High**

Enablers: *Organic waste (industrial & agricultural biomass)*

Enabler	Now 0-3 years	Next 3-10 years	Later > 10 years
Technology (Imported, Local) Product, Process, Business Model	• Map out availability of technologies (variety and complexity) (including geographic) (e.g. small and large-scale ADs, WtE) • Local anaerobic digestion (AD) plants • Depends on the waste and product (digestate and the gas)	• Appropriate technology in place in various sectors (composting, AD, WtE) • Pushing local content in imported technology • New businesses set up around new technologies	• Opportunities for exporting SA technology • Efficiency improvements • Fully functional waste treatment technology (recovery)
Capability Knowledge, Skills, Competence, Human Capital	• Map out capability in SA • Capacity building and skills development (e.g. AD, WtE) • Knowledge sharing among peers (everybody doing feasibilities) • Student exchange • Awareness at individual level of technologies and positive and negative impacts (HCD for RDI)	• More qualified waste professionals • Schools for artisans • Ongoing support for development of HCD and technologies for different types of organic waste • Organic waste management part of higher degree (not just WM degrees) • Collaborative curriculum development of capabilities	• Local knowledge-base on high-tech • Specialists trained in food waste management • Scientific skills, technical skills
Relationships Industry, Government, Research	• ID roleplayers, set up sector-based database • More collaborative actions / partnerships based on commonalities • More consultation with relevant stakeholders • More time for consultation • Business match-making (externally driven) • Align organic waste management and bio-economy strategy • Public buy-in/opposition for alternatives	• Business match-making on South African terms • Capabilities for pro-active joint action • Partnerships set up and functioning • Research projects set up and funded (relevant and contributing to organic waste management)	• Fully developed partnerships and collaboration
Infrastructure Support Systems Services	• ID infrastructure and support services already available and ID gaps • Decision-support system on what technology to use • Separation at source • Funding mechanisms • Capability for source separation • Set up systems (e.g. KPIs)	• Identified system gaps addressed • Demonstration plants funded • Well sited ADs • Compost certification • Laboratories for testing standards • Coordinated infrastructure • Planning, e.g. sewage plant with AD included	• Higher technology, better quality products • Employment opportunities realised • Ongoing monitoring and evaluation of goal achieved
Government Action Policy, Legislation, Regulations	• Economic incentives (tax rebate) • Streamlined processes • 'Disable' bad business practice through policing/enforcement of legislation • Regulatory capability and support mechanisms	• Norms and standards to mitigate against licences (where needed) • Alignment of regulation and other policies (fiscal, electricity) • Incentives for good business	• Ongoing and effective

Table 4: Municipal waste

Evolution: *Municipal waste*

What?	Where?	Now 0-3 Years	Next 3-10 years	Later > 10 years	Drivers (PESTEL)

• General waste
• Mixed waste streams with wet and dry organic and inorganic components
• Composition depends on municipal area (geographic, rural vs urban) (heterogeneous)
• Includes household and commercial waste (and may include non-hazardous industrial waste)
  ○ Recyclables
  ○ Organic (food, garden waste)
  ○ Building rubble
  ○ Electronic waste
  ○ Domestic hazardous waste (e.g. medical, paints, thinners)
	All urban areas in South Africa (local and metropolitan municipalities)	• Changes to collection practices –
		  ○ Smaller municipal waste bins
		  ○ Reduced frequency of collection (2-weekly)
		• Education and awareness programmes in place to change consumer behaviour
		• Skills development programmes in place
		• Enforcement of legislation
		• Revised municipal planning –
		  ○ IWMPs
		  ○ Municipal bylaws
		  ○ Infrastructure to support
		• Research initiated
		• Public-private partnerships options explored
		• Extended producer responsibility mechanisms explored
		• Industry Waste Management Plans (all industries) approved
			• Investment in alternative technologies
			• Advancement of technologies
			• Development and implementation of infrastructure to support
			• Incentives for implementation (e.g. tax incentives for higher volumes of recycling)
			• Separation of organics at source
			• Public-private partnerships options
			• Extended producer responsibility mechanisms in place
			• Education and awareness programmes (*ongoing*)
			• Skills development programmes (*ongoing*)
				Goal statement:
				• *Maximise diversion of municipal waste to landfill (50% reduction in municipal waste to landfill)*
				• *Significant increase in recycling and WtE technology*
				• Separation of at source (recyclables) to be legislated
				• Integrated waste management facilities (all elements of waste hierarchy at 1 facility)
				• Regional landfill sites
				• New technologies/ opportunities to use waste as a resource
				• Implementation of 'pay-as-you-throw' policy
					What will drive the growth of this waste stream?
					• Population growth
					• Urbanisation
					• Economic development
					
					What will drive changes in practice?
					• Enabling legislation
					• Removal of barriers (e.g. licencing processes)
					• Political will (prioritisation of waste)
					• Change in consumer behaviour (education & awareness)
					• Waste characterisation
					• Incentives
					• Opportunities for job creation
					• New industry opportunities
					• Available technology
					• Reduced bin sizes

Evaluation: *Municipal waste*

Benefit	Obstacles	Key Enabling Institutions	Likelihood of SA Realisation
• **To the Economy** ○ Resource recovery ○ Creation of new industries ○ Saving of landfill cost ○ Alternative energy sources ○ Reduced rehabilitation costs (environmental rehabilitation) ○ Extend availability of virgin resources • **Wealth** ○ Job creation ○ Potential revenue (municipalities and private sector) ○ Small business development • **Society** ○ Increased employment (job creation) ○ Improved quality of life ○ Environmental awareness ○ Up-skilling of communities (skills development) ○ Greater awareness • **Health** ○ Improved air quality ○ Reduced burden of disease (air- & water-borne) ○ Reduced contaminated land & exposure • **Environment** ○ Less waste to landfill ○ Reduced contaminated land & pollution ○ Less litter ○ Improved air quality	• **Market** ○ No end-market for certain recyclables (manufacturing capacity) ○ Cheaper alternatives (i.e. landfilling) ○ Subject to global trends and cycles (including markets) ○ Limited recycling and WtE companies ○ Economies of scale, increase supply • **Policy, legislation & regulation** ○ Lack of implementation of policy ○ Lack of implementation and monitoring ○ Loop-holes in legislation ○ Ineffective implementation of regulations of which it was intended for (i.e. plastic bag regulations) • **Infrastructure** ○ Cost of infrastructure ○ Lack of commitment to establish ○ Insufficient convenience for consumers (recyclables) • **Investment** ○ Access to funds (high risk investment) ○ Lack of funding for infrastructure ○ Expensive technologies ○ Tax incentives/disincentives • **Relationship** ○ PPPs between municipalities and industry are difficult to establish ○ Silo-based relationships ○ Lack of integration and coordination of relationship between industry, government and investors • **Skills** ○ Absence of relevant skills ○ Labour constraints (perceived as)	• **Government** ○ National departments (DEA, DST, the dti, Treasury) ○ Provincial departments ○ Municipalities ○ Cities Network ○ SALGA • **Industry** ○ Waste service providers (waste companies, recycling industry) ○ Waste-to-Energy industry ○ Manufacturing • **Research** ○ Science Councils (e.g. CSIR) ○ Universities • **Partnerships** ○ Donor agencies ○ Private sector ○ Government-Industry-Research • **Other** ○ Sector associations (e.g. IWMSA, eWASA) ○ National recycling forum ○ Reclaimers form (Trolley brigade) ○ Dept of Education (awareness)	**Medium - High** Recycling: High Technology: Low - Medium

Enablers: *Municipal waste*

Enabler	Now 0-3 years	Next 3-10 years	Later > 10 years
Technology (Imported, Local) Product, Process, Business Model	• Map out available technology, technology readiness and current use • Develop technology guidelines for municipalities (per waste stream) • Develop minimum technology standards • Review existing business models (focus on technology)	• More MRF, recycling and WtE technology emerge and develop • Strategic placement of these plants • Pilot technology guidelines and standards • Develop capability of municipality to deliver (local technology)	• Roll-out and upscale technology • Monitor and evaluate technology • Operating standards
Capability Knowledge, Skills, Competence, Human Capital	• Skills audit and training needs analysis • Identify training institutions and gaps • Public education • Waste & recycling education schools	• Encourage SME development and support infrastructure • Up-skill and train municipal officials • Waste awareness/recycling/WtE fully incorporated into school system	• Maintain training • Identify and develop new opportunities • Well-maintained skilled workforce
Relationships Industry, Government, Research	• Government intervention on large-scale WtE PPPs (to broker relationship) • Collaboration with academic institutions for training needs • Establish interaction and networking between industry and municipalities • Implementation of Industry WMPs • Political decision-makers (budget)	• Formation of a recycling industry body/association to facilitate interaction between government and private sector (dialogue facilitation) • Partnerships in place to ensure infrastructure implementation • Closer participation by local municipalities (e.g. pilots) to ensure RDI is implementable in practice	• Build, maintain and entrench relationships
Infrastructure Support Systems Services	• Understand infrastructure requirements • Municipal assessment of current infrastructure and identification of needs • Identify budget requirement • Roadmap – development of how to achieve	• Put infrastructure in place • Channelling investment in WtE and recycling • Reuse infrastructure creation • Benchmarking	• Fully operational • Maintain and improve infrastructure

Government Action
 	
Policy, Legislation, Regulations
	• Review of current policies
	  ○ Amend where gaps/contradiction
	  ○ Develop new policies (if/where required)
	• Development of waste minimisation plans
	• Development of Integrated WMP
	• Enforcement of Industry WMP and bylaws
	• Development of incentive strategies
		• Compliance and enforcement
		• Implementation of IWMPs
		• Implementation of incentive strategies
		• Economic instruments in place (incentives / disincentives)
			• Maintain, review and revise

Table 5: Waste tyres

Evolution*: Waste tyres*

What?	Where?	Now 0-3 Years	Next 3-10 years	Later > 10 years	Drivers (PESTEL)

• End-of life tyres
  ○ Passenger
  ○ Commercial
  ○ Mining
  ○ Agricultural
  ○ Other
• Stockpiles (backlog)
	Throughout South Africa
	• Urban areas
	• Mines
	• Rural, agricultural areas
		• Approval of IndWMPs
		• Develop collection infrastructure (national) including storage
		• Downstream value-add markets
		• Research and development
		• Initial WtE
		• Piloting technology and processing plants
		• End-use markets investigation
			• Detailed business model
			• Economic analysis to identify opportunities
			• Revisit IndWMPs
			• Investment in recycling plants
			• Component recovery and/or energy recovery
			• Markets for recyclate (mainly rubber crumb)
			• Processes to recycle
			• Phased development to more sophisticated processes
				Goal statement:
				• *100% end-of-life tyres collected and recycled, and significant decrease in backlog (stockpiles)*
				• Markets for recyclate
				• Network of processing sites
				• Developed secondary markets
				• Industry and government support
				• Zero illegal dumping
				• Technology/solutions specific to context of the region
				• Plants in place that can process/part process, linked to end-use markets
					What will drive the growth of this waste stream?
					• Economic development
					
					What will drive changes in practice?
					• DEA approve IndWMPs, EIAs
					• Effective IndWMP
					• Industry participation
					• Enforcement of legislation
					• Secondary markets
					• ARF subsidy
					• Education/awareness
					• Mass transport systems
					• Incentives
					• Government green procurement

Evaluation*: Waste tyres*

Benefit	Obstacles	Key Enabling Institutions	Likelihood of SA Realisation
• **To the Economy** ○ Foreign direct investment ○ Local resources (reprocessing) (carbon black and oil) ○ Investment ○ New markets ○ Potential energy benefit ○ Municipality budget relief • **Wealth** ○ New businesses, including small businesses ○ New value chains ○ New revenue streams ○ Probability of additional income for industry • **Society** ○ Burning stops ○ Dumping stops ○ Participate in economy ○ Job creation • **Health** ○ Reduced emissions/pollution (burning) ○ Reduced vermin ○ Safety (re-grooving of tyres) ○ Degradation toxins (heavy metals) • **Environment** ○ Stop illegal dumping ○ Reduced atmospheric emissions and toxins (burning) ○ Prevent flooding (tyres blocking stormwater) ○ Improvement of disposal practices	• **Market** ○ Low demand currently ○ Low economic value (end-use market) ○ Needs to be developed • **Policy, legislation & regulation** ○ DEA approve IndWMPs ○ EIA turnaround – obstacle to development ○ Waste licenses – bureaucratic ○ Enforcement ○ Tax on oils from tyres ○ All needs to be revisited ○ Conflicting legislation ○ Lack of communication • **Infrastructure** ○ Tyre sellers in place but logistics and processes to be put in place ○ Economics of it ○ Viability of space/place • **Investment** ○ High capital cost – needs long-term plan ○ No collection points ○ High transport costs ○ Industry needs to be involved • **Relationship** ○ Industry-DEA-Redisa ○ Questions around Redisa ○ Industry needs to be involved	• **Government** ○ National government (DEA, DST, DOE, EDD) ○ IDC, the dti, NEF • **Industry** ○ User industries (e.g. construction/roads and cement) ○ Industry associations (manufacturers, importers, dealers) ○ Chamber of mines • **Research** ○ Science Councils (CSIR) ○ All academic institutions • **Partnerships** ○ Well established in developed countries ○ Industry-DEA • **Other** ○ Industry communication to consumer ○ SATRP	**High**

Enablers*: Waste tyres*

Enabler	Now 0-3 years	Next 3-10 years	Later > 10 years
Technology (Imported, Local) Product, Process, Business Model	• Map technologies currently available (locally and internationally) • Available – once IndWMPs approved invest in plants to 'crumb' and start-up idle plants • Look at business model and end-use possibilities • Innovation alternatives	• Development of end-use markets – widen usage of recyclates • More plants built • Implementation of pilot projects (technology and infrastructure) • Local manufacture	• Plants and end-use established • Provincial plants based on the needs of the province (post-processing) • Full value chain of end-use market • Range of alternative processes in place (e.g. de-beading, de-sulphurization, de-vulcanization, clean carbon black for uplevel production)
Capability Knowledge, Skills, Competence, Human Capital	• Current expertise available • Status quo – backlog and rate of generation • Build corporate governance	• Development of relevant indicators and targets • Continuous evaluation and objectives (timeframes) • Development of skills and training programmes based on processes and end-use, e.g. resource economists • Innovation	• Ventures are sustainable • Ongoing • Export technology
Relationships Industry, Government, Research	• SATRP-REDISA-DEA-DTI-IDC • Tyre manufacturing industry to work with government structures for research, etc. • Industry and government must action roadmap • Industry and mining standards • Academia, Science Councils	• Maintain relationships • Ongoing for efficiency improvements and fostering of relationships in understanding processes, markets and industry (transparency) • Academia, Science Councils	• Local equipment industry grows • Development of independent governing body
Infrastructure Support Systems Services	• Logistics infrastructure • 'Collection point' determination (i.e. industry and retail), as well as provincial/municipal collection points • Effective collection, storage, processing	• Perfect/refine logistics • Growth of SMMEs involved in value chain • Production plants	• Further role out of new plants • Inclusive tyre component fractioning
Government Action Policy, Legislation, Regulations	• Legislate plans (IndWMPs) and enforce • Review of current legislation – enabling legislation • Allow commercial competition • Ring-fence recycling fee – not to national coffers	• Enforcement • Improvement in policy • Incentives • Norms & standards (to replace EIA)	• Enforcement • Measurement of monitoring for continuous improvement • Accountability • Incentives

Table 6: Mineral waste

Evolution*: Mineral waste*

What?	Where?	Now 0-3 Years	Next 3-10 years	Later > 10 years	Drivers (PESTEL)

• Waste rock / overburden
• Tailings
  ○ Mineral fines (slimes)
  ○ Coarse
	In proximity to operations (mining areas) (national)
	
	Across South Africa (Gauteng, KZN, Mpumalanga, Limpopo, Northern Cape, North West)
		• Growth
		  ○ limited ('flat')
		  ○ volume stay same
		  ○ timeframes too short
		  ○ grow but slowly
		
		• Nature
		  ○ Same categories and materials
		
		• Characteristics
		  ○ Stable
		  ○ Open to ideas to reduce rehabilitation liabilities
		
		• Key issues
		  ○ Limited reuse of mineral waste
		  ○ Key characteristics remain the same
		  ○ Illegal dumping
		  ○ Loss of productive land, biodiversity
			• Invest in R&D to look at reuse, recycling of different waste types (e.g. coal, platinum, etc.)
			• Incentivising retreatment of dumps
			• Better separation
			• Increased beneficiation
			• Secondary product (lower-grade products)
				Goal statement:
				• *Minimise impact of mineral waste on land and biodiversity by moving up the hierarchy*
				
				• Removing waste dumps and creating jobs and alternative products
				• Multiple end-users identified for all waste streams
				• Optimised extraction processes
				• Zero waste mine plan (IWMP)
					What will drive the growth of this waste stream?
					• Economic development (demand)
					• Investment in mining
					• Lack of enforcement of legislation – rehabilitation
					• Robust SLPs
					• Collectiveness & stakeholder engagement
					• Profitability and efficiency gains
					
					What will drive changes in practice?
					• Recognise value of mineral waste (by-products)
					• Investment in R&D
					• Social/environmental – land stewardship, biodiversity importance
					• Tax incentives
					• Value proposition
					• Legislation & compliance

Evaluation*: Mineral waste*

Benefit	Obstacles	Key Enabling Institutions	Likelihood of SA Realisation
• **To the Economy** ○ GDP ○ Alternative products/revenue streams (resource) (increased value chain) ○ Decreased disposal costs ○ Reduces liabilities • **Wealth** ○ New business development ○ Profit from waste (e.g. brick-making from slimes) • **Society** ○ Land rehabilitation/reclamation – available for settlement and alternative use ○ Aesthetics & image of mining companies ○ Job creation • **Health** ○ Reduced health risk for local communities – reduced toxins, dust, emissions • **Environment** ○ Smaller eco footprint ○ Decreased pollution (GHGs, AMD) ○ Restore biodiversity and landscape	• **Market** ○ Demand ○ Awareness ○ Location – distance to market • **Policy, legislation & regulation** ○ Objectives not supported by legislation ○ Loopholes allowing companies to get away with dumping, flawed ○ Poor government consensus/multiple acts ○ Inconsistent in application ○ Time to fruition ○ Differing news government, mining companies & NGOs ○ Conservative approach to following normal rehabilitation processes • **Infrastructure** ○ Cost/investment ○ To move chemically & reactive material, need special infrastructure • **Investment** ○ Cost vs benefit ○ Technology availability ○ In R&D to 'prove' the solution works • **Relationship** ○ Government (slow to react) – industry – society ○ Government – mining companies (to agree on solutions) ○ Sector 'collaboration' risk ○ Stakeholder engagement ○ Changing mind-sets on mineral waste	• **Government** ○ National (DEA, the dti, DST, DMR, DWA) ○ Provincial government ○ Municipalities • **Industry** ○ Chamber of Mines ○ Mining companies ○ BUSA • **Research** ○ Science Councils (CSIR, Mintek) ○ Universities ○ R&D Agencies • **Partnerships** ○ Local communities ○ Sector collaborations (e.g. Coaltech) ○ Government – mining companies • **Other** ○ Unions ○ NGOs ○ Funding agencies (THRIP, NRF) ○ Suppliers	**Medium**

Enablers*: Mineral waste*

Enabler	Now 0-3 years	Next 3-10 years	Later > 10 years
Technology (Imported, Local) Product, Process, Business Model	• Reliable data/inventory of 'waste' • What is currently being done (local and international) • R&D into potential products • Review of international practices and possible technologies	• Link national database to policy • R&D ongoing • Solutions that reduce mine liability (making mines more economically viable)	• Off-the-shelf interventions vs in-house technology relative to rest of world • R&D • Develop new technology based on R&D
Capability Knowledge, Skills, Competence, Human Capital	• Awareness & advocacy • Competency development linked to skills gap • R&D capacity for above • Recognised waste management degree set up	• Programme implementation	• Formal tertiary qualifications / skills
Relationships Industry, Government, Research	• Institutionalise / enforce recycling through demonstration & action • Understanding other sector needs as part of entry for 'waste' outputs • Multi-sector (government – industry – R&D – small business – labour) conversation	• Target setting (% recycling of mineral waste) • Ongoing • Understand needs of neighbouring communities for products	• Sustaining relationships – evaluation & monitoring • Ongoing
Infrastructure Support Systems Services	• Funding models • Transport (rail)	• Implementation of R&D • Link to tax incentives	• Other mechanisms
Government Action Policy, Legislation, Regulations	• Consistent implementation • Concise definition of 'mineral waste' • Inter-governmental engagement • Legislation • Lobby to government to invest in R&D	• Overseeing body monitoring governmental engagement & interaction (united vision) • Drafting and implementing appropriate regulation	• Revised / updated policy implementation

Table 7: Plastic

Evolution*: Waste Plastic*

What?	Where?	Now 0-3 Years	Next 3-10 years	Later > 10 years	Drivers (PESTEL)

• Pre-consumer
  ○ Factory waste
  ○ Industry waste
  ○ Retail
  ○ Mining waste (non-mineral)
  ○ Industry packaging
 	
• Post-consumer
  ○ From landfill
  ○ Households
  ○ Agriculture
 	
Mixture of different polymers which cannot be recycled together (requires separation)
 	
Visible, but only 6% of total waste
	• Urban areas (more predominant) – packaging, municipal waste, households, offices
	
	• Rural (less predominant) – mostly reused
	
	• Mining areas
		• Growth (high)
		  ○ Demand for plastic will increase (increasing plastic waste)
		  ○ Exponential growth (as population grows)
		  ○ It will grow ~ 10%
		
		• Nature
		  ○ More domestic waste
		  ○ Electronic waste
		  ○ Agriculture
		  ○ Decrease in plastic reuse
		  ○ Purchase cheaper grades of plastic
		
		• Key characteristics
		  ○ Environmental consciousness
		  ○ Waste separation at source
		
		• Key issues
		  ○ Awareness raising
		  ○ Infrastructure in place
		  ○ R&D
			• Centralized processing units
			• Fit for purpose processes
			• Increased public awareness
			• Proper R&D
			• Enabling legislation
			• Separation at source
			• Recycling and energy recovery from waste
				Goal statement:
				• *Zero plastic waste to landfill by 2030*
				
				• Proper infrastructure to collect waste
				• Vibrant and growing industry
				• R&D and testing
				• Whole value chain aligned
					What will drive the growth of this waste stream?
					• Population growth
					• Economics
					• Consumer consciousness
					• Systems fit for real conditions
					• Job creation
					
					What will drive changes in practice?
					• Public-private partnerships
					• Value waste
					• Politics
					• Economy
					• Technology
					• Legislation

Evaluation*: Waste Plastic*

Benefit	Obstacles	Key Enabling Institutions	Likelihood of SA Realisation
• **To the Economy** ○ GDP growth ○ Job creation ○ Enterprise development ○ Limited dependence of fossil fuel ○ Export (product & technology) • **Wealth** ○ Job creation ○ Business creation and expansion ○ Enterprise development ○ SMME ○ Revenue ○ Investment • **Society** ○ Income generation ○ Lower unemployment rates ○ Infrastructure development ○ Increased business opportunities ○ Co-operatives • **Health** ○ Healthier living conditions ○ Access to healthcare ○ Decrease in diseases and illnesses • **Environment** ○ Cleaner environment (litter) ○ Less animal death ○ Fewer landfills ○ Emissions decrease due to re-use of plastics	• **Market** ○ Access to grid ○ Economic viability ○ Municipalities ○ Consumer opinion ○ Lack of public awareness ○ Competitive market • **Policy, legislation & regulation** ○ Legislation hindrances ○ Directive policy are not enabling tool ○ Less is more (better) ○ Over regulated ○ Poor implementation of legislation, e.g. plastic bag regulations • **Infrastructure** ○ Lack of infrastructure ○ Budget constraints e.g. transfer stations ○ Poor planning – infrastructure of waste is not prioritised • **Investment** ○ Restricted by funding criteria ○ Guaranteed agreements for uptake ○ Licence = 2 years vs 10 years investment ○ Capacity issues in obtaining funding from outside sources • **Relationship** ○ Business seen as enemy No. 1 ○ No public private partnerships ○ Bureaucratic procedures	• **Government** ○ National government (DEA, the dti, Treasury) ○ Education ○ All spheres of government • **Industry** ○ Pre-consumer is working (no government interference) ○ Focuses on post-consumer ○ Plastics SA & Associations ○ Retail & brand owners • **Research** ○ Universities ○ Science Councils (CSIR) ○ Industries • **Partnerships** ○ PPP (industry/government) ○ Industry to industry ○ Community based entities (NPOs, retailers) • **Other** ○ Retailers ○ Brand owners ○ IDC ○ TIA	Pre-consumer – **High** Post-consumer – **Low-Medium**

Enablers*: Waste Plastic*

Enabler	Now 0-3 years	Next 3-10 years	Later > 10 years

Technology
 	
(Imported, Local)
Product, Process, Business Model
	• Status quo of current technology (available)
	• Pre-consumer – design change
	• Post-consumer – map WtE technology
	  ○ energy efficiencies
	  ○ economic model
		• Continuous improvement of technology
		• R&D focussed
		• Research and development of technology
			• Develop and support local technology
			• Energy efficient technology

Capability Knowledge, Skills, Competence, Human Capital	• Develop waste management qualification • Train waste managers • Develop economic model • Pilot implementation • Education and awareness to public, industries and government	• Establish standards • Accountability • Environmental consciousness established • High-level degrees and certificates	• Monitoring and evaluation • Ongoing development of competencies
Relationships Industry, Government, Research	• Integrated research • Industry specific research • Energy from waste • Working with municipalities • Government enabling environment • Government interventions and industry interventions	• Build on relationships (cooperation and strengthening of partnerships)	• Ongoing evaluation of partnerships
Infrastructure Support Systems Services	• Collection systems in place (fit for purpose) • Value chain developed accordingly • Focus on metropolitan municipalities • Decision-making process on the type of technology to be adopted (model)	• Focus on urban areas (roll-out of the plan in metros and district municipalities)	• Roll-out of the plan in local municipalities and rural areas
Government Action Policy, Legislation, Regulations	• Enabling environment • Self-regulation with government providing enabling support and unblocking bottlenecks • Consultation with industry • Incentives • Municipalities to develop by-laws	• Implementation and fine tuning • Implementation of bylaws	• Monitoring and evaluation • Adjustment with consultation with industry • Review and implementation

Table 8: Construction and demolition waste

Evolution*: Construction & demolition waste*

What?	Where?	Now 0-3 Years	Next 3-10 years	Later > 10 years	Drivers (PESTEL)

• Builders rubble
• Demolition waste
• Road construction waste
• Soils (excavation)
• Aggregates
• Asbestos cement
• Mixed wastes
• 15% contamination (and less)
• Bulk concrete
• Sand from street cleaning
	• Construction sites (residential and commercial)
	• Road construction
	• Illegal dumps
	• Urban and rural (dumps)
	• Demolition sites
	• Dense/urban areas more prominent
		• Growth
		  ○ Mirrored with SA's growth
		  ○ Volumes recovered
		• Nature
		  ○ 20%
		  ○ Composition (lack of consistency)
		• Key characteristics
		  ○ Legislation: standards in the building industry
		• Key issues
		  ○ How to account for quantities
		  ○ No market/legislation
			• Create opportunity
			• Separation at source
			• Enforcement and compliance (fine)
			• Building regulations for municipalities
				Goal statement:
				• *100% diversion from landfills*
				• Design for dismantling/ demolition
				• Regulated dismantling/ demolition
				• Separation at source
				• Standards for construction industry / roads
				• Environmental wrt noise standard will be established
				• Endorsement of alternative building materials by Government
				• Mainstreaming / regulatory legislation for reform such facilities
					What will drive the growth of this waste stream?
					• Focusing on IDZ
					• Political
					• Job creation
					• Reducing the impact of illegal dumping
					• Alternative technology / design
					What will drive changes in practice?
					• Regulatory reform
					• Infrastructure plans built into that
					• Green procurement legislation
					• Spatial planning (land use)

Evaluation*: Construction & demolition waste*

Benefit	Obstacles	Key Enabling Institutions	Likelihood of SA Realisation
• **To the Economy** ○ Benefit infrastructure investment (SIPs, IDZ, SEZ) • **Wealth** ○ Job creation ○ Cost reduction ○ EPWP ○ Investment ○ New market • **Society** ○ EPWP ○ Inclusion ○ Better living standards • **Health** ○ Less illegal dumping ○ Less exposure to particulates in the air (dust) • **Environment** ○ Resource efficiency ○ Minimisation of hazardous waste ○ Increased lifespan of landfills	• **Market** ○ Awareness / education ○ Ethics of the market • **Policy, legislation & regulation** ○ Building and road policy ○ Human settlements, road department ○ Waste classification • **Infrastructure** ○ Land for accommodating the rubble ○ Separation infrastructure • **Investment** ○ Cost / benefit analysis (cost of raw materials) ○ Transport investment ○ Infrastructure investment • **Relationship** ○ Fragmented / antagonistic construction industry ○ Relationship between regulator and industry	• **Government** ○ National (the dti, DPW, DPT, DUS, DEA) ○ Province and municipalities ○ DEDAT / GreenCape • **Industry** ○ CIDB ○ Master Builders Assocation ○ GBC • **Research** ○ Universities (UCT, US, UWC) ○ Sustainability Institute ○ Science Councils (CSIR) ○ TIA • **Partnerships** ○ Private partnership ○ Across all spheres (e.g. GreenCape coordinate) • **Other**	**Medium**

Enablers*: Construction & demolition waste*

Enabler	Now 0-3 years	Next 3-10 years	Later > 10 years

Technology
 	
(Imported, Local)
Product, Process, Business Model
	• Mapping existing practices / technology per sector
	  ○ Housing
	  ○ Roads
	  ○ Building
	  ○ Demolition / commercial
		• Existing facilities which recover sands / construction waste
		• Reuse of builders rubble
			• Growth in business opportunities
			• Acceptance of the technology
			• Innovation for industry
			• Big contributor to the green economy

Capability Knowledge, Skills, Competence, Human Capital	• Build local expertise in utilisation and maintenance • Assess the skill needs and human capital / research • Design for environment (tertiary institutions, e.g. architects) • Construction SETAs	• Established courses / programmes integrated in existing engineering and building engineering • Learnerships	• Information sharing between government, industry and academia • Entrenched programmes in schools, universities
Relationships Industry, Government, Research	• Co-ordinator role (e.g. GreenCape) • Cross-sectorial coordination / information sharing	• Industry must be more receptive to new technology • PPP between industry and government	• Balance / integration of knowledge / research – practical applications

Infrastructure
 	
Support Systems Services
	• Land availability
	• Separation system in place
	• Mitigation strategy
	• Tools for decision-making
		• Impacts of SIP/IDZ (lobby for better waste practices)
		• Pilot projects (small scale test)
			• Well established
			  ○ Road re-using builder
			  ○ Housing from recovered

Government Action Policy, Legislation, Regulations	• Building and road construction policy • Enforcement / compliance • EPR (submit waste plan) • Tax rebates for green building	• Fiscal incentives to support reuse • Mainstreaming government procurement process	• Review of strategy, implement • Less of carrot and stick approach from government • No longer a compliance issue but a business opportunity

Table 9: Sewage sludge

Evolution*: Sewage sludge*

What?	Where?	Now 0-3 Years	Next 3-10 years	Later > 10 years	Drivers (PESTEL)

• Waste produced by sanitation facilities (toilets, septic tanks, VIP toilets) that ends up at a sewage treatment plant	• National
	• Urban areas (flush toilets)
	• Urban & rural (septic tanks)
	• Rural (VIP)
		• Volume increasing
		• Municipality failing to cope with growth
		• Forces people to return to septic tanks and VIP toilets
		• Increasingly being used for organic compost
		
		• Issues
		  ○ Water scarcity
		  ○ Water pollution
		  ○ Health issues
		  ○ Municipality not able to cope
		  ○ Population growth
			• Can be better managed due to increased urbanisation in rural areas	**Goal statement:**
				• *All sewage sludge to be used in a recyclable manner*
				
				• Market for the sludge
				• Sludge as product
				• No problems associated with poor sludge disposal & water pollution, i.e. water purification costs
				• Health issues
					What will drive the growth of this waste stream?
					• If municipality manages sewage
					• Public become aware of their own practices
					
					What will drive changes in practice?
					• Perception
					• Education
					• Capital & upgrade and maintaining old facilities
					• Sludge value to the market
					• Reduced costs of disposing of it

Evaluation*: Sewage sludge*

Benefit	Obstacles	Key Enabling Institutions	Likelihood of SA Realisation
• **To the Economy** ○ Recycling the sludge – more jobs, financial value ○ Reduce pollution of water – reduce water purification costs • **Wealth** ○ Increased • **Society** ○ Jobs (unskilled) • **Health** ○ Decreased disease (cholera, typoid, etc) • **Environment** ○ Decreased pollution ○ Can work 'for' environment, i.e. compost	• **Market** ○ No market for sludge currently • **Policy, legislation & regulation** ○ Is in place – minimal ○ Implementation and awareness is key ○ Stricter policy required, i.e. 5% disposed, 95% recycled ○ Waste Act ○ Enforcement (but policy is too loose) • **Infrastructure** ○ Technology??? • **Investment** ○ Buy-in not there ○ Linked to technology • **Relationship** ○ Silo mentality	• **Government** ○ National (DEA, DWA, DAFF) ○ Local government • **Industry** ○ Compost facilities ○ Chemical industries ○ Packaging / storage • **Research** ○ Science councils (CSIR) ○ Universities ○ Consultants • **Partnerships** ○ All • **Other**	**Medium**

Enablers*: Sewage sludge*

Enabler	Now 0-3 years	Next 3-10 years	Later > 10 years
Technology (Imported, Local) Product, Process, Business Model	• Map out technologies	• Short-list of viable technologies and end-products will be understood	• Implementing technologies
Capability Knowledge, Skills, Competence, Human Capital	• Build local expertise and technology	• Could be developed quite substantially	• Increasing
Relationships Industry, Government, Research	• Public-private partnerships	• Ongoing	• Ongoing
Infrastructure Support Systems Services	• Processing plants – ideally joined to existing treatment facilities • Specific to rural and urban	• Directly related to technology • Municipality needs to implement systems	• Be well practiced nationally
Government Action Policy, Legislation, Regulations	• Tighter policy and legislation • Enforcement • Awareness	• Can be enforced	• Ongoing

Table 10: Ash (coal ash)

Evolution*: Ash*

What?	Where?	Now 0-3 Years	Next 3-10 years	Later > 10 years	Drivers (PESTEL)

• Focus here on coal ash
  ○ Fly ash
  ○ Bottom (boiler) ash
  ○ Clinker ash
	• Areas of power generation
	• Mpumalanga (Witbank, Secunda, Ermalo, Kendal)
	• Limpopo (Lephalale)
	• Gauteng (Vaal area)
		• Increase in volume of waste / quality
		• Increase in commercial use
		• Increase health / environmental care awareness
		• Increase in new markets
		• New technologies to deal with ash
		• Job creation
			• New products being developed
			• Research on minimising ash and clean technologies
				Goal statement:
				• *50% utilisation of ash, through increased recovery*
					What will drive the growth of this waste stream?
					• Awareness
					• Commercialisation
					• No stigma
					• Ash benefits
					• Increased infrastructure being achieved
					
					What will drive changes in practice?
					• Ease of legislation
					• Government initiatives
					• Economic benefits

Evaluation*: Ash*

Benefit	Obstacles	Key Enabling Institutions	Likelihood of SA Realisation
• **To the Economy** ○ GDP ○ Industrialisation • **Wealth** ○ Job creation ○ Revenue ○ Cost of dump savings • **Society** ○ Reduced social costs • **Health** ○ Decreasing health impacts • **Environment** ○ Emissions, pollution ○ Dump site reduction	• **Market** ○ Awareness ○ Funding • **Policy, legislation & regulation** ○ Existing policy classification ○ Introduction of new ○ Takes long to get a licence ○ Lack of guidance • **Infrastructure** ○ Capital costs • **Investment** ○ Funding • **Relationship** ○ Lack of collaboration amongst industries	• **Government** ○ National (DEA, DWA, DMR, DOE) ○ Local authorities • **Industry** ○ Industry ○ Industry forums • **Research** ○ Universities ○ Science councils ○ Colleges • **Partnerships** ○ Role players (industries) • **Other**	**Low - Medium**

Enablers*: Ash*

Enabler	Now 0-3 years	Next 3-10 years	Later > 10 years
Technology (Imported, Local) Product, Process, Business Model	• Map out technology available • Possible application of reuse (agriculture, road building, building and infrastructure)	• Role-out pilot projects • New innovation methods	• Full-scale implementation and re-evaluation to improve
Capability Knowledge, Skills, Competence, Human Capital	• Build local expertise • Completed research • Job creation	• Higher degrees and diplomas • Education and development	• Pool of skills and expertise
Relationships Industry, Government, Research	• Government interaction • Bi-lateral / international • Industry interaction • Research/industry forums	• Industrial forums	• Applied technology specialists
Infrastructure Support Systems Services	• Decision-support tools	• Infrastructure development	•
Government Action Policy, Legislation, Regulations	• Norms and standards • Review of legislation to be effective • Set goals and targets	• Implementation of new legislation • Monitoring statistics	• Benchmark and evaluate • Review goals and targets

Table 11: Electronic waste (WEEE)

Evolution*: Electronic waste*

What?	Where?	Now 0-3 Years	Next 3-10 years	Later > 10 years	Drivers (PESTEL)

• Adopted standard WEEE definition
• Any end-of-life item that is electrical (plug) or electronic (battery)
	Throughout South Africa
	• Urban areas
	• Rural areas
		• Growth (high)
		  ○ Fastest growing waste stream in South Africa
		  ○ White goods likely to become a major feature of e-waste volumes in future
		• Nature
		  ○ Valuable materials in e-waste (e.g. metals)
		• Key characteristics
		  ○ Recovery of e-waste from domestic users (households) as large percentage of existing e-waste
		  ○ Take-back schemes
		• Key issues
		  ○ Awareness raising
		  ○ Infrastructure in place for collection of e-waste
			• All categories of electronic / electrical equipment manufactured or imported included in collection systems	**Goal statement:**
				• *50% diversion of e-waste from landfill by 2024 (12% currently)*
				• *A national system in place that treats e-waste effectively, at no perceived cost to the consumer (difference of views on whether the cost of recycling is visible to the end-consumer)*
				Characteristics:
				• Full e-waste recycling of all fractions, including refrigeration
				• An effective national e-Waste Council in place – standards, auditing control, operations. IWM Plans are coordinated
				• Network of formally certified e-waste collection points
				• Technology and solutions specific to processing particular e-waste fractions and suitable for local beneficiation
				• Plants in place that can process all e-waste fractions and are linked to end-use markets
					What will drive the growth of this waste stream?
					• Economic development
					What will drive changes in practice?
					• Legislation, Enforcement, Awareness. Access to feedstock
					• Increased international interest in resource potential in e-waste streams
					• Greater adherence to Basel Convention
					• Mature local, regional and global markets for secondary resources
					• Consumer education and awareness
					• Incentives for responsible treatment of problematic waste streams – CRTs, printer cartridges and toner ink bottles, refrigeration, CFLs
					• Government import policy extends to clear recycling commitments and requirements for OEMs and producers to recover and recycle locally (offset)
					• Standardised approach to auditing of Government assets

Evaluation*: Electronic waste*

Benefit	Obstacles	Key Enabling Institutions	Likelihood of SA Realisation
• **To the Economy** ○ Job creation (transport & processing) ○ Enterprise development ○ Continued recycling of metals into the economy • **Wealth** ○ Take-back schemes may be carried out by a third party organizations (TPO) ○ Job creation ○ Enterprise development, including small collectors (SMMEs) • **Society** ○ Reduce unemployment ○ Up-skill (training of collectors and processors) • **Health** ○ Healthier working conditions (informal dismantlers) • **Environment** ○ Improved standards for e-waste recovery (no open burning) lead to cleaner environment (air quality)	• **Market** ○ Low demand locally currently – not seen as a priority emphasis by high-volume users: corporates, government ○ Low awareness by consumers of the need to reduce, refurbish, reuse and recycle responsibly and appropriately – people have emotional attachment to their equipment against the reality of a high volume, high cost, low margin business • **Policy, legislation & regulation** ○ DEA needs to approve a coordinated national set of IndWMPs that guides the e-waste sector as a whole. No provision in the Industry Waste Management Act to approve a plan. Amendment to the Act required ○ Should E-waste be identified as a Priority Waste Stream under the Act? Would imply further regulation that may not be beneficial to sector growth ○ EIA turnaround – need for acceleration ○ Differing standards drives need to enforce e-Wasa standards and implement guideline and codes of practice defined and propagated by Southern Africa e-waste Alliance ○ Hazardous waste certification – bureaucratic • **Infrastructure** ○ Collection points. Pre-dismantling before transport ○ Cost of logistics inhibits – hazardous waste • **Investment** ○ Local technologies, solutions, In particular, mobile solutions • **Relationship** ○ Industry-DEA ○ Industry needs to be involved	• **Government** ○ National government (DEA, the dti, EDD) ○ Municipalities • **Industry** ○ Manufacturers ○ Importers ○ Dealers ○ Waste management companies • **Research** ○ Universities ○ Science Councils • **Partnerships** ○ OEMs – practices, standards ○ SEPR ○ Recyclers, refurbishers • **Other** ○ Industry associations	**High**

5 CONCLUSIONS

A review of global and local trends in waste and resources management, and the drivers behind these trends, shows that waste generators, waste operators, government and society recognise the social, environmental and economic benefits of moving waste up the waste management hierarchy, away from landfilling towards prevention, reuse, recycling and recovery.

Waste streams which have presented as opportunities globally and which are emerging as opportunity streams in South Africa, include organic waste (e.g. food waste, biomass, sewage) and recyclables (e.g. plastic, metal, glass, paper, WEEE, tyres). These waste streams, recognised for their secondary resource potential, are being targeted for diversion from landfill into materials and energy recovery.

Countries are adopting different technology solutions in diverting waste from landfill. While a combination of materials and energy recovery is evident, the technology mix in some countries favours energy recovery, while in others it favours materials recovery. Some countries are investing in high-technology solutions (e.g. plasma, gasification) while other countries, at this stage, favour low technology solutions (e.g. composting).

It is suggested that the choice in waste streams and technology solutions targeted for waste diversion be guided by what makes local economic sense, based on, amongst others, the quantities and types of waste generated, the local cost of technology solutions, the value of waste streams to local markets, available skills, the local policy environment, and the local climate for business and investment.

6 REFERENCES

AcuComm (2013). Rubbish roundup, Issue 001, January 2014. Available online at http://www.acucomm.net/downloads/rubbish-roundup [Last accessed 13 February 2014].

Aydi, A., Zairi, M. and Ben Dhia, H. (2013). Municipal solid waste management in Tunis City, Tunisia. *Waste Management*, 33(7):1683-1684.

BofAML (Bank of America Merrill Lynch) (2013). No time to waste – global waste primer. Available online at http://www.longfinance.net/images/reports/pdf/baml_waste_2013.pdf [Last accessed 7 March 2014].

BMI Research (2013). Recycle Assessment Report, November 2013.

Brahim, B., Mohammed, H., Youcef, K. and Guy, M (2014). Integrated management of municipal solid waste (MSW) in the district of Oran (Algeria): Systemic and methodological approaches. *Waste Management*, 34(2): 562-564.

CBI (Confederation of British Industry) (2011). The twelfth five-year plan for national economic and social development of the People's Republic of China (*English translation*). Available online at http://cbi.typepad.com/china_direct/2011/05/chinas-twelfth-five-new-plan-the-full-english-version.html [Last accessed 19 December 2013].

China Briefing (2012). China releases 12th five-year plan for waste recycling technology, 25 June 2012. Available online http://www.china-briefing.com/news/2012/06/25/china-releases-12th-five-year-plan-for-waste-recycling-technology.html [Last accessed 17 December 2013].

DEA (Department of Environmental Affairs) (2011). National Waste Management Strategy. November 2011. Department of Environmental Affairs: Pretoria.

DEA (Department of Environmental Affairs) (2012). National waste information baseline report – Final, 14 November 2012.

DEFRA (Department for Environment, Food and Rural Affairs) (2013). Energy from Waste: A guide to the debate. Available online at https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/221036/pb13889-incineration-municipal-waste.pdf [Last accessed 17 December 2013].

DEFRA (Department for Environment, Food and Rural Affairs) (2013a). Incineration of Municipal Solid Waste. Available online at https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/221036/pb13889-incineration-municipal-waste.pdf [Last accessed 17 December 2013].

DST (Department of Science and Technology) (2012). A National Waste R&D and Innovation Roadmap for South Africa: Phase 1 Status Quo Assessment. Current and required institutional mechanisms to support waste innovation. Department of Science and Technology: Pretoria. Available online at http://www.wasteroadmap.co.za/ [Last accessed 17 December 2013].

DST (Department of Science and Technology) (2012a). A National Waste R&D and Innovation Roadmap for South Africa: Phase 1 Status Quo Assessment. Skills for an Innovative Waste Sector: Core waste management skills and implementation modalities. Department of Science and Technology: Pretoria. Available online at http://www.wasteroadmap.co.za/ [Last accessed 17 December 2013].

DST (Department of Science and Technology) (2013). South African Waste Sector – 2012. An analysis of the formal private and public waste sector in South Africa. A National Waste RDI Roadmap for South Africa: Phase 1 Status Quo Assessment. Department of Science and Technology: Pretoria.

DoE (Department of Energy) (2013). Introduction to DNA Host Country Approval Process and Landfill Gas to Energy Projects. Presentation made at the "Waste to Energy: Landfill Gas Projects" workshop, 25 July 2013, Manhattan Hotel, Pretoria, South Africa. Available online at http://www.energy.gov.za/files/esources/kyoto/kyoto_bulletins.html [Last accessed, 10 September 2013].

Duan, H., Miller, T.R., Gregory, J. and Kirchain, R. (2013). Quantitative Characterization of Domestic and Transboundary Flows of Used Electronics. Analysis of Generation, Collection, and Export in the United States. Available online at http://www.step-initiative.org/tl_files/step/_documents/MIT-NCER%20US%20Used%20Electronics%20Flows%20Report%20-%20December%202013.pdf [Last accessed 4 March 2013].

EC (European Commission) (2006). Eco-industry, its size, employment, perspectives and barriers to growth in an enlarged EU. Available online at http://ec.europa.eu/environment/enveco/eco_industry/pdf/ecoindustry2006_summary.pdf [Last accessed 11 August 2013].

EuroStat (2012). EuroStat News Release, 48/2012 - 27 March 2012 . Environment in the EU27: Landfill still accounted for nearly 40% of municipal waste treated in the EU27 in 2010. Available online at http://epp.eurostat.ec.europa.eu/cache/ITY_PUBLIC/8-27032012-AP/EN/8-27032012-AP-EN.PDF [Last accessed 6 March 2014].

EuroStat (2012a). Statistics in focus: EU-27 environmental protection expenditure increased to 2.25% of GDP in 2009. Available online at http://epp.eurostat.ec.europa.eu/portal/pls/portal/!PORTAL.wwpob_page.show?_docname=2770264.PDF [Last accessed 6 March 2013].

EuroStat (2013). Waste statistics, 2010. Available online at http://epp.eurostat.ec.europa.eu/statistics_explained/index.php?title=File:Waste_treatment,_2010_(1_000_tonnes)_T2.PNG&filetimestamp=20130903123155 (As at 3 September 2013) [Last accessed 18 December 2013].

Funk, K., Milford, J. and Simpkins, T. (2013). Waste not, want not: Analysing the economic and environmental viability of Waste-to-Energy (WtE) technology for site-specific optimization of renewable energy options. Joint Institute for Strategic Energy Analysis Technical Report NREL/TP-6A50-52829. Available online at http://www.nrel.gov/docs/fy13osti/52829.pdf [Last accessed 17 December 2013].

GAA (Governmental Advisory Associates) (2013). Nationwide economic benefits of the waste-to-energy sector. Available online at http://www.wte.org/userfiles/files/130820%20Berenyi%20Nat'l%20WTE%20Economic%20Benefits.pdf [Last accessed 6 March 2014].

Godfrey, L. and Roman, H. (in press). Opportunities for job creation in the South African waste sector: Lessons for the SADC region.

Hoornweg, D., Bhada-Tata, P and Kennedy, C. (2013). Environment: Waste production must peak this century. *Nature*, 502: 615–617 (31 October 2013).

HSRC (Human Sciences Research Council) (2011). South African Innovation Survey – Main Results 2008. HSRC: Pretoria.

ISWA (International Solid Waste Association) (2012). Globalisation and waste management. Phase 1 Concept and Facts.

ISWA (International Solid Waste Association) (2013). Alternative Waste Conversion Technologies. Available online at http://www.iswa.org/index.php?eID=tx_iswaknowledgebase_download&documentUid=3155 [Last accessed 17 December 2013].

JoungDu, S., Seung Gil., H., Kim, S-C., Yang, J.E. and Sung, S. (2014). Estimation of potential methane production of agricultural sector in Korea. *Waste Management*, 33(12):2811-2813.

Karimi, M.H.S., Pourkhabbaz, A.R., Ahmadpour, M. and Soltani, H.R. (2013). Six-year research of the quality of waste generation and evaluation of environmental recycling of paper and cardboard aspects from Rasht city, Iran. *Waste Management*, 33(9):1960-1961.

Manuel, M.J., Romina, M. and Ortega, N.F. (2014). Demolished concrete recycling possibilities in the city of Bahia Blanca, Argentina. *Waste Management*, 34(2):564-565.

McDonald International (2013). Waste to Energy (WtE). Available online at http://www.mcdonaldint.com/waste-management-systems/waste-to-energy-wte [Last accessed 17 December 2013].

Pereira, A. (2013). Dilemmas of municipal solid waste management in Sao Paulo, Brazil. *Waste Management*, 33(7):1682-1683.

Perella, M. (2013). Closing the loop: risk or reward. A White Paper highlighting the opportunities and challenges of a circular economy. Available online at http://www.edie.net/sustainability_report/closing_the_loop.asp [Last accessed 2 December 2013].

PlasticsEurope (2012). Plastics – the Facts 2012. An analysis of European plastics production, demand and waste data for 2011. Available online at http://www.plasticseurope.org/documents/document/20121120170458-final_plasticsthefacts_nov2012_en_web_resolution.pdf [Last accessed 7 March 2014].

PlasticsSA (2013). Annual Report 2012/13. Available online at http://www.plasticsinfo.co.za/annual_report_2013/annual-report-2013.html [Last accessed 2 December 2013].

REA (Renewable Energy Association) (2011). Energy from waste: A guide for decision-makers. Available online at http://www.r-e-a.net/pdf/energy-from-waste-guide-for-decision-makers.pdf [Last accessed 17 December 2013].

RSA (Republic of South Africa) (2009). National Environmental Management: Waste Act, 2008. Government Gazette Vol. 525, No. 32000, 10 March 2009.

RSA (Republic of South Africa) (2013). Policy directive on the exportation of ferrous and non-ferrous waste and scrap metal. Government Gazette No. 36451, Notice 470 of 2013.

SALGA (South African Local Government Association) (2013). Landfill gas to energy in municipalities. Presentation made at the "Waste to Energy: Landfill Gas Projects" workshop, 25 July 2013, Manhattan Hotel, Pretoria, South Africa. Available online at http://www.energy.gov.za/files/esources/kyoto/kyoto_bulletins.html [Last accessed, 10 September 2013].

Shaida, M.N., Kashyap, P. and Visvanathan, C. (2014). Municipal solid waste management practices and issues in Herat City, Afghanistan. *Waste Management*, 33(12):2813-2815.

Singh, P., Joseph, K. and Nagendran. R. (2014). Breaking the climate change-municipal solid waste dump nexus – A case study in Chennai, India. *Waste Management*, 34(1):238-239.

StatsSA (Statistics South Africa). (2012). Census 2011: Census in brief. Report No. 03-01-41. Available online at: http://www.statssa.gov.za/Census2011/Products/Census_2011_Census_in_brief.pdf. Last accessed 29 November 2012.

US EPA (Environmental Protection Agency) (2013). Municipal Solid Waste (MSW) in the United States: Facts and Figures. Available online at http://www.epa.gov/osw/nonhaz/municipal/msw99.htm [Last accessed 20 December 2013].

US EPA (Environmental Protection Agency) (2013a). Wastes: Paper Recycling Fact and Figures. Available online at http://www.epa.gov/osw/conserve/materials/paper/faqs.htm [Last accessed 20 December 2013].

VTT (2012). Directions of future developments in waste recycling. Available online at http://www.vtt.fi/inf/pdf/technology/2012/T60.pdf [Last accessed 20 December 2013].

World Bank (2012). WHAT A WASTE. A Global Review of Solid Waste Management. Urban Development Series Knowledge Papers 68135. Edited by: Daniel Hoornweg and Perinaz Bhada-Tata. Washington: World Bank.