

# Implementing Alternative Waste Treatment Technologies: A Comparative Study of South Africa and the European Union

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The South African Category A metropolitan municipalities have the highest population and they generate the biggest waste volumes. There are eight (8) Category A metropolitan municipalities in South Africa. According to the STATSSA (2011), the metropolitan municipalities have a total population about 20 million inhabitants. Based on the waste generation rates published by the DEA (2012) the Category A municipalities generate a total of about 10 million tonnes of waste per annum and most of it is landfilled. When landfilling at an average density of 1 tonne/m<sup>3</sup>, the municipalities require an annual landfill space of about 10 million m<sup>3</sup>. eThekweni Municipality has a useful landfill life of 120 years. Some municipalities such as the City of Johannesburg, City of Cape Town and City of Tshwane have operating landfills which have a very limited useful landfill life of less than 10 years. There is a need to investigate the implementation of alternative waste treatment technologies that shall divert waste from the landfill particularly in municipalities that have very limited landfill life. According to (GIFA, 2015) the City of Johannesburg and Sedibeng District Municipality have completed some feasibility studies of alternative waste treatment technologies (AWTT). The City of Cape Town and eThekweni Municipality have also completed AWTT feasibility studies. The Drakenstein Municipality, in the Western Cape, has finalized a waste-to-energy feasibility study. Some AWTT feasibility studies are underway in the City of Tshwane and Ekurhuleni Metropolitan Municipality. This comparative study investigates the lessons that can be learnt from the European Union (EU) in order to successfully implement appropriate alternative waste treatment technologies in South Africa. The EU and South African waste management styles are, however, not the same. The EU has successfully established some technologies that have been effective in diverting waste from the landfill. Implementation of sound policies such as segregation of waste at the source of generation, setting targets for waste recycling and diversion of biodegradable waste fractions from the landfill has led to the EU's success.

## BACKGROUND INFORMATION

The City of Tshwane has five (5) closed landfills and five (5) operational landfills (City of Tshwane IWMP, 2014). The closure of the five (5) landfills has led to an increased rate of disposal and rapid diminishing of available landfill airspace in the operational landfill sites. The waste transportation vehicles from the southern and the western parts of the City have been diverted to dispose of their waste in the northern region. The diversion of waste trucks has led to increased costs of waste transportation. According to the City of Tshwane's Environmental Management Department, Waste Management Division, the monthly tariffs for waste removal for the year 2014/15 was R221.96 per cubic meter for areas within the jurisdiction of the City. Waste from domestic areas is still landfilled without any form of treatment or segregation at source. Although there are initiatives of recovering recyclables in some waste disposal sites and facilities, the recovery rate is low and recyclables may be contaminated. The population of the City of Tshwane is 2 921 488 (STATSSA, 2011).

The City of Johannesburg has six (6) closed landfills and four (4) operational landfills (CoJ IWMP, 2011). The remaining life of the landfills, if there is no intervention to divert waste from the landfill, is less than ten (10) years. Interventions that have been proposed include development of new landfill cells, new landfill site, composting and thermal plants. The City landfills about 1.7million tons of waste per annum (Jack, 2016). Since 2009 separate waste collection at source is being piloted in 469 000 households and the response rate is less than 30 percent. A feasibility study has been completed for alternative waste treatment in the City of Johannesburg (GIFA, 2015). The household waste removal tariff varies according to property value and it ranges between R104.66 and R255.21 per household per month (Pikitup, 2015). A standard waste removal receptacle for domestic refuse is 2 x 85 litre bin and 1 x 240 litre bin. Landfill disposal of general waste costs

R180.18 per tonne. The waste collection frequency for household waste is once per week. The City of Johannesburg is the most populated municipality and has a population of 4 434 827 (STATSSA, 2011).

The City of Cape Town has eleven (11) closed landfills and three (3) operational landfills. According to the CoCT IWMP (2013/14), by the year 2014 the available landfill airspace would last for 10 to 12 years and it estimated that about 3 million tonnes of waste are generated annually. The monthly tariff for waste removal of a 240 litre lockable container in residential areas is R118.50 (City of Cape Town, 2015/16 Draft Budget). The cost per tonne for disposing general waste is R395. The City of Cape Town has some initiatives that are meant to divert waste from the landfill site. The split bag waste collection (Think Twice) is piloted in 5 areas with 99 990 formal households to give effect to the separation-at-source principle, which started in 2007. A Transaction Advisor has completed the feasibility study of waste beneficiation and AWTT. The City of Cape Town has a population of 3 740 026 (STATSSA, 2011).

eThekweni Municipality operates three (3) waste disposal sites. According to eThekweni's IWMP (2004) the annual landfilled waste is about 1.3 million tonnes. Bisasar Road landfill site has been the largest operational landfill covering a footprint area of about 44 ha and landfilling about 4000 tons per day. A notice was issued in January 2016 that the Bisasar Road landfill has reached its capacity and it shall only receive builder's rubble and soil. A 100 ha Buffelsdraai landfill site has been developed in the north of Durban with a design life of more than 75 years. The tariff for the removal of domestic waste varies according to the value of the property. It costs between R33.75 and R165.03 per month to remove domestic waste from residential properties, eThekweni Municipality Tariff Tables (2015/16). To landfill a cubic metre of solid waste costs R174.40. The gate fee for waste disposal depends greatly on the compaction rate / density of the waste. The population of eThekweni Municipality is 3 442 361 (STATSSA, 2011).

Ekurhuleni Metropolitan Municipality landfills about 1.2 million tonnes of waste a year in five (5) operational landfill sites which have a useful landfilling life of about 25 years (IWDMP, 2015). There are nine (9) closed landfill site and three (3) privately owned operational landfills. The monthly tariff for domestic waste removal at Ekurhuleni varies according to the property value and the tariff ranges between R89.56 and R225.15. The disposal of general waste costs R224.29 per ton. Although the Ekurhuleni Metropolitan Municipality does not have a very limited landfilling airspace, a transaction advisor has been appointed to conduct a feasibility study on AWTT. The Ekurhuleni Metropolitan Municipality has a population of 3 178 470 (STATSSA, 2011).

The EU has observed some improvements in the diversion of waste from the landfill. The improvements can be attributed to sound waste management policies. The Landfill Directive 1999/31/EC sets reduction targets for recyclables and biodegradable waste that goes to the landfill as stated by the Official Journal of European Communities (1999). Between 1995 and 2010, the landfilling rate reduced from 62 percent to 37 percent. By 2006, seven (7) EU Member States and Switzerland had reached the target of landfilling 35 percent of the 1995 biodegradable waste (EEA, 2012). EU members introduced elevated landfill taxes. For example the UK landfill tax increased from £7 per tonne in 1996 to £80 per tonne by April 2014 (HM Revenue & Customs, 2015). The landfill tax helps to enforce the use of alternative technologies and discourages landfilling of residual waste. Most residual waste is incinerated in the EU. Incineration is an established technology and operates at a better commercial scale when compared to advanced thermal treatment (ATT) technologies such as pyrolysis and gasification (Defra, 2014). **Table 1** below presents a comparison of landfill space, waste tariffs for municipal solid waste (MSW) and the use of AWTT in selected South African municipalities and Europe.

Table 1: Comparison of landfill space, waste tariffs and alternative waste treatment technologies

Municipality / Country	Population	Available landfill airspace	Tariffs for general waste		Alternative waste treatment technology
			Monthly household waste collection	Waste disposal / landfill tax	
City of Tshwane	2 921 488	< 10 years	R221.96 per m <sup>3</sup>		An AWTT feasibility study is underway
City of Johannesburg	4 434 827	< 10 years	R104.66 to R255.21	R180.18 per tonne	An AWTT feasibility study has been completed
City of Cape Town	3 740 026	< 10 years	R118.50	R395.00 per tonne	An AWTT feasibility study has been completed
eThekweni Municipality	3 442 361	120 years	R33.75 to R165.03	R174.40 per m <sup>3</sup>	An AWTT feasibility study has been completed
Ekurhuleni Metropolitan Municipality	3 178 470	25 years	R89.56 to R225.15	R224.29 per tonne	An AWTT feasibility study is underway
United Kingdom	64 559 135 (World DataBank, 2016)			R1 633.48 per tonne	In 2012, 24 energy from waste plants operating in England treated 4million tonnes of residual MSW (Defra 2014)
EU27	508 million (Europa <sup>a</sup> , 2016)_			R1 289.35 per tonne, average (CEWEP 2015)	A total of 316 waste to energy plants in Europe (Medarac <i>et al</i> , 2014)

## WASTE MANAGEMENT SCENARIOS

Waste management is least prioritised for service delivery in most South African municipalities. The priorities, as can be seen in the capital expenditure of most South African municipalities, are housing, water, electricity and road infrastructure. Job creation is a priority for the South African government. In the EU there is more emphasis on stimulating transition towards a circular economy (Europa, 2016). The EU's proposals on waste are geared towards diverting waste from the landfill by setting recycling target, reduction in landfilling, discouraging landfilling and incentivizing of green products. In South Africa most of the municipal solid waste is still landfilled without any form of treatment or resource recovery (Trois and Simelane, 2010).

The Polokwane Declaration of 2001 sets a target of zero waste by 2020 for South Africa. Progress towards the zero waste target is minimal because most South African household waste is still collected without any form of separation and it ends in the landfill. Estimates state that about 90 percent of all collected waste in South Africa ends in the landfill. Material recovery facilities (MRF) have been established in some municipalities to recover recyclables. Some of the facilities have stopped operating. The main cause of the MRF failure is the low rate of recovery of recyclables. The absence of separating waste at source makes the facilities to be operated as "dirty MRF" with lower recovery rates than "clean MRF". Some South African municipalities are piloting separation of waste at source but the response rate is very low. In the EU, separation of waste at source has been key in enabling the diversion of waste from the landfill by recycling, composting and incineration.

In South Africa, incineration of waste is at small scale and it is primarily used for the thermal treatment of healthcare waste and some hazardous waste. There are some small scale initiatives that are meant to divert waste from the landfill. For example, Interwaste has launched a plant that produces 12 000 tons of refuse derived fuels annually (Resource, 2016). The refuse derived fuels are used as fuel in the cement kilns.

According to Rama (2016) the cement industry offers an opportunity for the use of refuse derived, however, the South African cement industries are remotely located from the metropolitan municipalities. A composting plant has been piloted at the Tshwane Fresh Produce Market to produce compost from food waste and cardboard (Resource<sup>a</sup>, 2016). The pilot composting plant has a capacity of 1 tonne/day. In the Kraaifontein material recovery facility in the City of Cape Town, the Japan International Cooperation Agency is piloting a plant that converts about 500kg of plastics to 500 litres of oil per day (JICA, 2015).

In the European countries, incineration of waste is used at a commercial scale. Since 1995, the amount of municipal solid waste that has been incinerated in the EU-27 has increase by 19.6 million tonnes or 63.1 percent; and recycling and composting was used to treat about 42 percent of solid waste by 2009 (Blumenthal, 2011). There are some established companies that recycle the mainline recyclables such as paper, cardboard and plastic in South Africa. It is estimated that South Africa recycles about 10 percent of its solid waste and the rest is landfilled. Recyclables are collected mainly by informal recyclers from the generators. The informal recyclers sell the recyclables to middlemen and the middlemen sell the recyclables to the company that makes the final product, see **Figure 1** for the South African waste recycling hierarchy. Some South African municipalities established cooperatives that are meant to recycle waste. However, the rate of failure of the cooperatives is high.

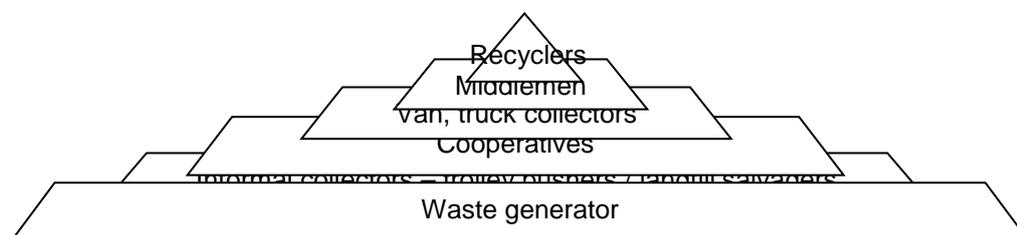


Figure 1 Waste recycling hierarchy, South Africa

There has been reduction in the landfilling rate in the EU. The reduction in the landfilling rates has been caused by the combined implementation of recycling, composting and incineration technologies. It can be observed in the EU countries that landfill taxes play an important role in incentivising a shift up the waste hierarchy. By 2012, twenty (20) European countries had introduced the landfill tax and it ranged between € 50 and € 70 per tonne of waste (EEA, 2013). In South Africa landfills charge a gate fee that ranges between R180 and R395 per tonne of waste in the metropolitan municipalities and there is no landfill tax. It is still looks cheaper to landfill waste than to implement the AWTT in South Africa.

There is a ceiling for the availability of feedstock for recycling, composting and incineration. In Canada, the Metro of Vancouver has decided to put on hold proposed waste to energy developments (Appleyard, 2016). The Metro's decision is due to the uncertainty of the availability of feedstock and dwindling residual waste. The dwindling supplies of residual waste may be due to the increased recycling rates in Vancouver. Recycling, however, compliments incineration and does not compete with it. The capital expenditure for establishing a waste to energy plant can be substantial. In the UK the capital costs for establishing an incineration plant costs between £145m to £200m for a capacity of 150 000 tonnes per year to 350 000 tonnes per year (Defra, 2013). The costs of maintenance and upgrades of incineration plants are soaring. The costs may be recovered from the sale of electricity, gate fee and sale of recyclables. An incineration plant may pay itself off in fifteen (15) years (Appleyard, 2016).

#### CHALLENGES OF IMPLEMENTING ALTERNATIVE WASTE TREATMENT TECHNOLOGIES (AWTT)

Environmental authorizations, permitting, licencing and social issues are the primary challenges for the establishment of any AWTT or a landfill site. For instance, once land has been identified it would take about 10 years to establish a landfill in South Africa.

The capital expenditure and maintenance costs of technologies for treating waste are substantial. Landfilling still appears to be less expensive than AWTT. However, the cost of landfilling may be more than it appears to be when considering the cost of managing the landfill aftercare period. The landfill aftercare period may stretch to about 50 years after landfill closure. The absence of the landfill and carbon taxes makes landfilling to be attractive over AWTT in South Africa.

Separation of waste at source is a prerequisite for implementing sustainable composting, recycling and incineration projects. The response rate in the South African metros that pilot separation of waste at source is low. Separation of waste at source may be promoted with some economic incentives.

There are about 37000 waste pickers in South African landfills and about 5000 trolley pushers (Ringwood, 2015). The waste pickers and trolley pushers are regarded as informal recyclers. Formalizing informal recyclers is a challenge. Some informal recyclers tend to salvage waste that has been separated at source in some piloting households hence affecting the performance of formal recycling initiatives.

Providing a constant feedstock quality and quantity for the AWTT may not be guaranteed. The ATT actually need a more consistent quality of the feedstock than incineration. Seasonal variation of waste composition and the absence of waste separation at source are the main causes of the variation in the quality of the feedstock. There is also a limit for the availability of waste for AWTT.

Securing a BBBEE partner to implement a waste to energy plant in South Africa is a challenge.

## CONCLUSION

Implementation of separate collection of waste at source is key for the use of any technology that is meant to divert waste from the landfill. Separation of waste at source in South Africa is still at pilot stage and it has a low response rate. There is a need to have cost saving incentives in order to encourage the public to separate waste at source.

Combined recycling, composting and incineration can effectively divert waste from landfill. Informal recyclers play a major role in the recovery of recyclables in South Africa. However, there is a need to incentivise the formalization of the informal recyclers. Apparently, informal recyclers are not keen to be formalized.

Some South African municipalities have established cooperatives that recycle waste. The failure rate of the cooperatives is very high. There is a necessity to investigate how the private sector can be involved with the municipalities for the successful implementation of recycling and composting initiatives.

Introducing landfill and carbon taxes can help to discourage landfilling and make the cost of using AWTT to be comparative with landfilling. In the EU the introduction landfill taxes can be correlated to the lowering rate of landfilling. The short-term and long-term costs of landfilling waste in South Africa should be evaluated.

Incineration is an established technology and it is used at the commercial scale in the EU. Some advanced treatment technologies, like pyrolysis and gasification, are still not used extensively like incineration. Compared to incineration, the ATT tend to require a consistent feedstock and are more expensive to establish and maintain.

Most of South African waste is still collected without any form of separation at source. Technologies that promote job creation and can handle both mixed and separated waste can work in the South African context. However, the South African AWTT must be mechanical and automated in order to promote resource recovery from mixed waste streams. The mixed South African waste suits the use of incineration than pyrolysis or gasification.

The City of Johannesburg, City of Tshwane and the City of Cape Town have less than 10 years of useful landfill life and have a need to imminently implement AWTT that shall divert waste from the landfill.

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