

European advances in waste management and current trends. What this is doing for Europe and its relevance for South Africa

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ABSTRACT

The current status of the waste management industry, legislation and practice in Europe and the governing policies are presented, including tendencies and policy developments. This is supplemented by a review of the achievements and the challenges in the European Union. The historical development, achievements and the challenges ahead are discussed. Also, the current status of solid waste management and achievements in South Africa are discussed as well as the current challenges and shortcomings. Finally, the actions and improvements required for South Africa to improve solid waste management and achieve the already set standards and goals are discussed and contextualised in relation to the global need to deliver on sustainability, resource efficiency and climate change policies, thus requiring a significant improvement in the ability to organise waste management well.

1. INTRODUCTION

1.1 Where we come from, and where we are at?

Globally, waste management's starting point was the horrors of the plagues of the Middle Ages resulting in massive deaths due to unsanitary conditions in crowded cities resulting in pollution of water sources, rats and vectors carrying diseases as well as open waste and littering in the streets and urban areas affecting health and well-being. The massive sanitation challenges of the Middle Ages as well as during the Industrial Age resulted in political pressure to ensure waste removal, which in the first instance was a simple process of throwing waste in large dumps immediately outside the city walls. For example, the first Danish waste management ordinance was issued in the City of Copenhagen in the year 1661, which provided the regulatory and institutional framework for enforcing waste removal tariffs from house owners and from traders bringing goods into the city for the purpose of sale, thus financing the costs of waste management (staff, carts & horses).

For an equally long time, poor and marginalised people have been struggling to create a living out of the waste from affluent citizens and businesses. This very much remains an important source of income for many marginalised people of South Africa, where practically each medium to large sized landfill constitutes the workplace and source of income for 50-250 people. Similarly, even small rural dumpsites and landfills often provide informal income for 5-50 waste pickers. In addition to the picking at landfills there is widespread curb-side waste picking as well as waste picking at commercial facilities' waste skips and dumps in the waste pickers' search for dry recyclables such as metals, cardboard, paper and plastic, as well as wood waste e.g. for heating/cooking or firewood purposes.

Hence, one could argue that we have not really come much further today, as one of the key challenges for cities today still is to put in place manageable and affordable waste removal systems and secure suitable dumpsite or sanitary landfill capacity near the cities. For example, in South Africa, and much of the developing world, the majority of rural and peri-urban citizens still do not receive reliable waste collection services and a large portion of the waste stream is still dumped indiscriminately in the countryside or in sub-standard dumps. Furthermore, the vast majority of developed countries such as USA, Australia, Singapore, Hong Kong, former Soviet Union, South-East Europe etc. are still landfilling 40-80% of the waste generated.

In some Northern European countries and selected cities in North America significant achievements have been made in terms of waste management, as all waste is actually collected and accounted for. Only 2-10% of the waste generation is landfilled, with the balance being utilised for material, nutrient or energy recovery (Table 1). This is, however, still far from the global norm yet.

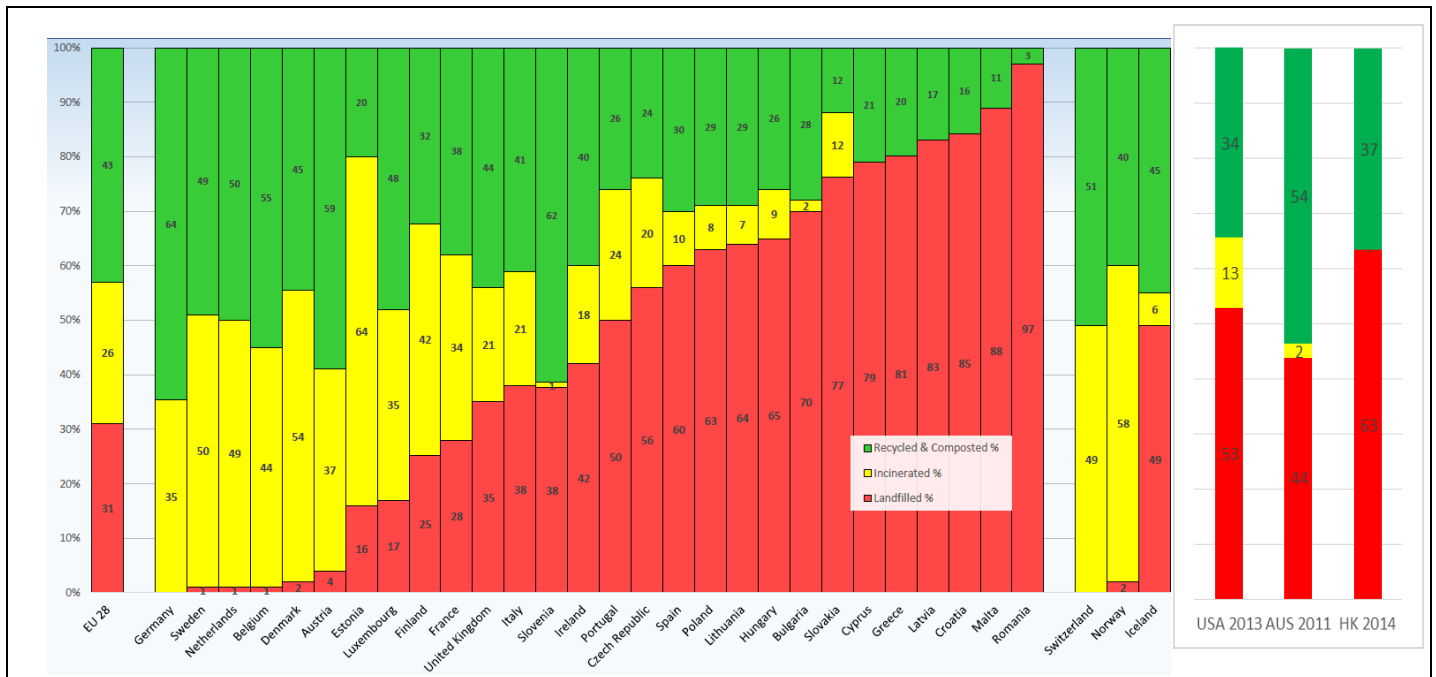


Figure 1. Percentage of waste recycled, incinerated or landfilled in selected countries of the Europe (2013), US (2013), Australia (2011) and Hong Kong (2014) (US EPA 2013 /1/, CEWEP 2014 /2/, Australian Dept of Environment 2014 /3/ & Environmental protection Agency of Hong Kong 2013 /4/)

Figure 1 shows the percentages of waste recycled, incinerated or landfilled in a number of countries. It should be noted that there are significant differences in the way these waste statistics are generated. For example, in Germany the percentage going to landfill is 0%. This is due to the definition applied in Germany where 0% untreated waste is landfilled, whereas large quantities of pre-treated waste is landfilled, such as reject and bio-stabilised waste from mechanical biological treatment facilities. In other countries, bio-stabilised residual waste can be classified as "compost", even though it would not meet the compost quality criteria of several countries.

As humankind, we are now at a crossroad where the number of people and the volume of material and goods that we consume is problematic in terms of emission of climate change gasses, rate of depletion of natural resources, minerals and nutrients as well as the increasing loss of land use opportunities. Even now, the consumption of raw materials is not sustainable (OECD 2015 /5/). With the expected addition of 2½ billion more affluent consumers on the planet in the year 2050 (UN 2015 /6/), this situation will only be further exacerbated.

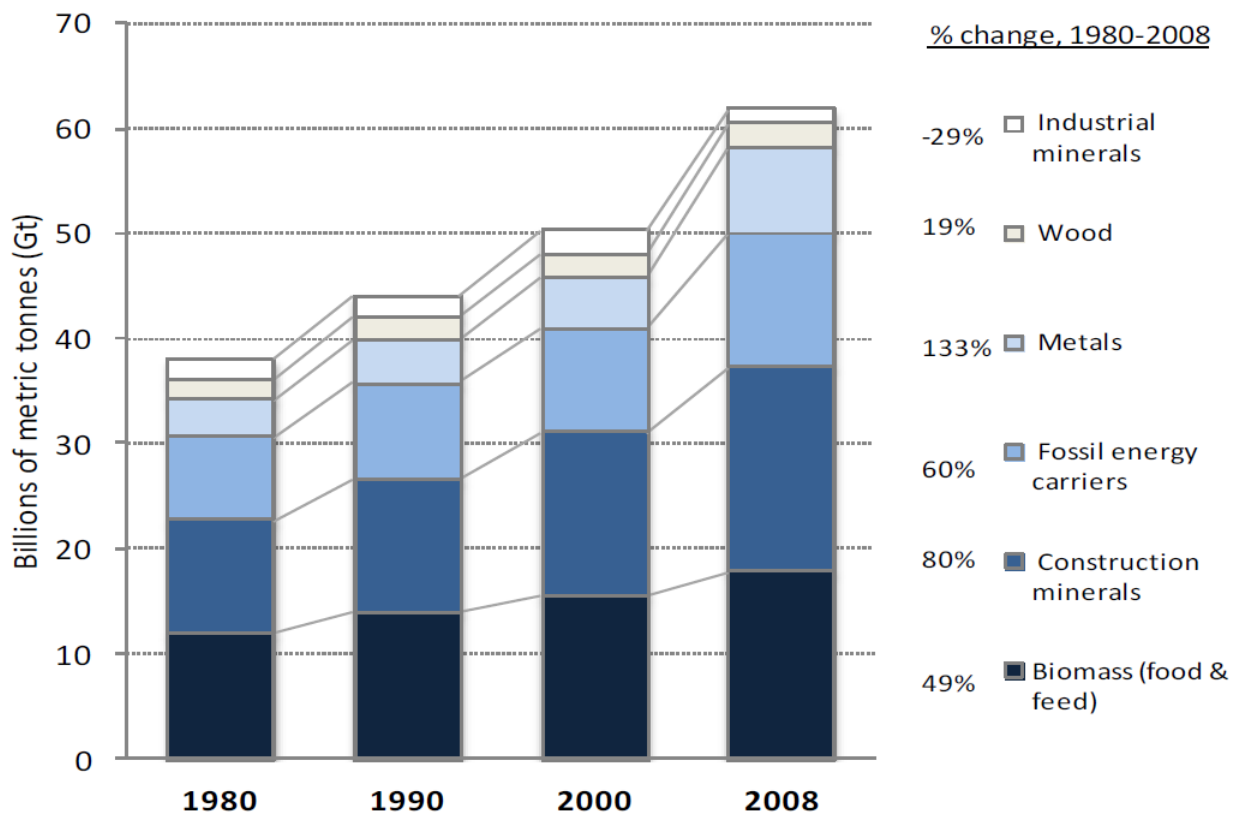


Figure 2. Global Material Resource Extraction (OECD 2013 /7/)

Because of these global challenges, we now see major shifts in policies, albeit yet limited action and achievement on a global scale:

1. Climate change policies focussing on phasing out fossil fuel consumption
2. Resource efficiency policies focussing on avoiding loss of resources and converting towards circular material and nutrient flows and bringing the mining of virgin materials to an end or absolute minimum
3. Development and sustaining of circular economy business models
4. Phasing out/reducing harmful chemicals and substances that inhibit circular material flows

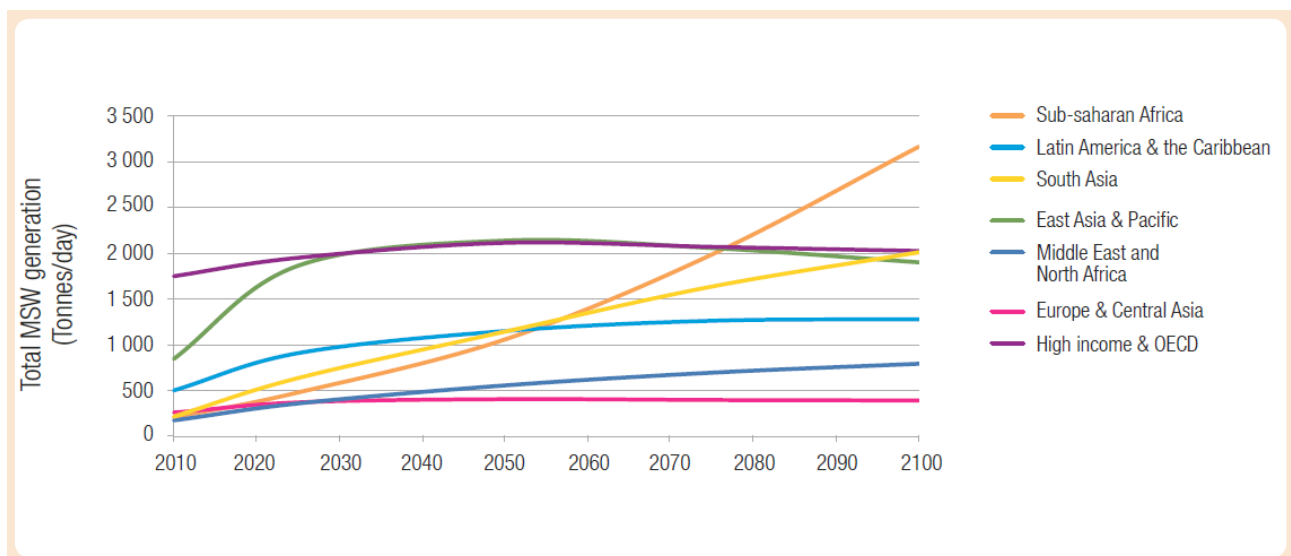


Figure 3. Projected Global Waste Generation (UNEP 2015 /8/)

The cost of waste management in Europe is relative high compared to other countries. Figure 4 and 5 below shows the typical landfill and incineration gate fees in Europe in 2011. The figures 4 and 5 show that taxes on waste in many European countries have a significant impact on the total gate fee. Typically, the final

waste tariffs payable by residents would include i) cost of receptacles and collection, ii) cost of treatment and iii) cost of administration and additional recycling and hazardous waste initiatives (such as drop off centres and community containers for e.g. glass, paper etc.. For example, in Denmark a household would typically pay between 450 and 650 Euro/year for a freestanding house.

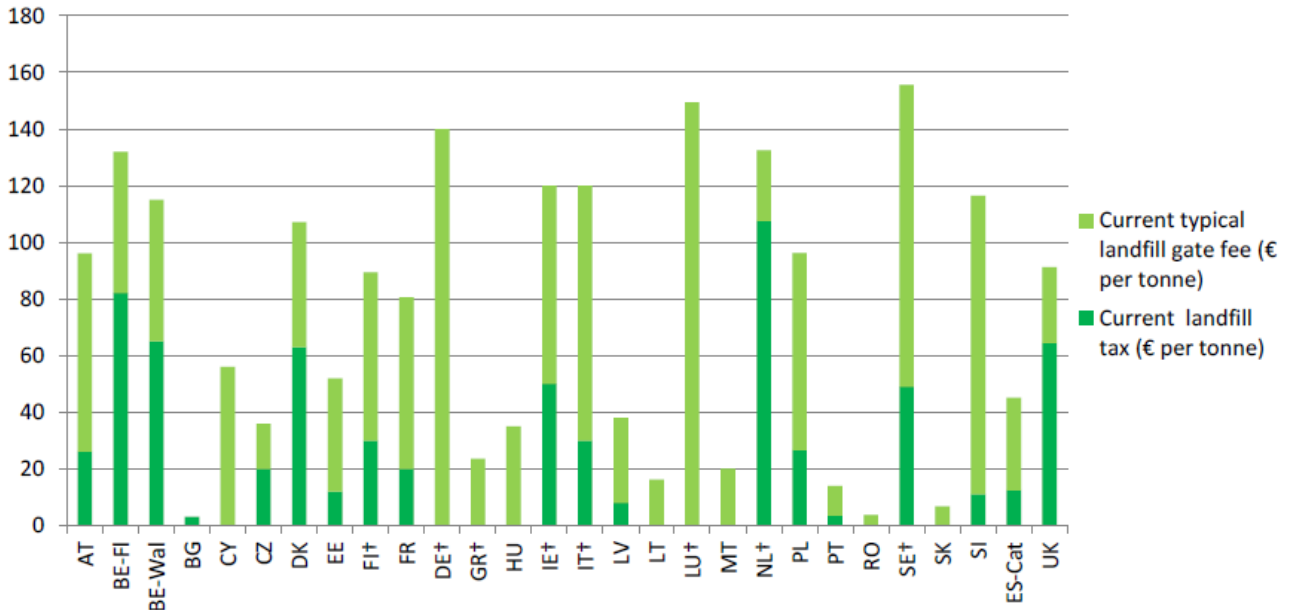


Figure 4: Overview of total typical cost of landfill (non-hazardous municipal waste, legal landfills), 2011 (European Commission 2012 /23/)

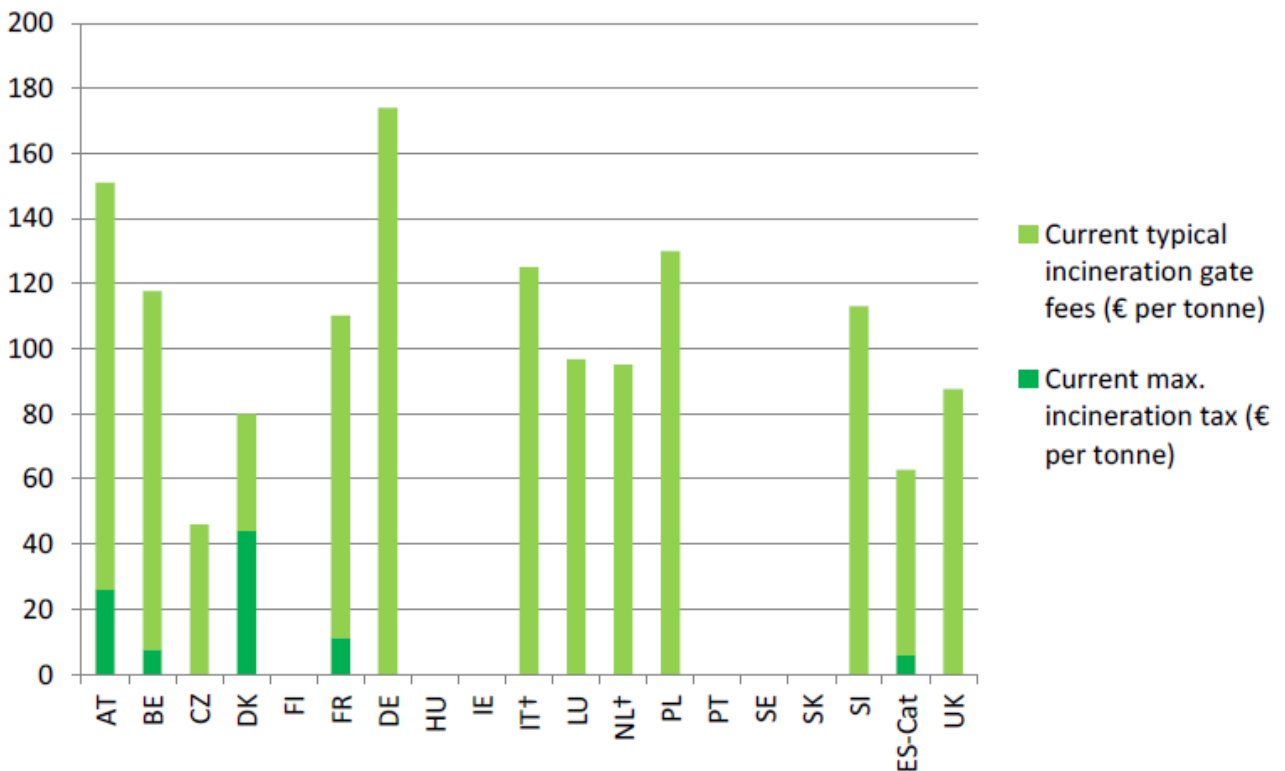


Figure 5. Overview of total typical cost of incineration (municipal waste) (European Commission 2012 /23/)

1.2 Where do we want to go? – And why?

The path is set by the imperatives of the following overall needs and policies:

1. **Climate change policies**, requiring reduced release of Climate Change Gases (CGC), including avoiding methane gas emissions from landfills, loss of energy intensive resources (polymers, metals

etc.) and reducing the need for chemical fertilisers and making efficient use of nutrients and biogas from bio-waste.

2. **Resource efficiency policies**, requiring the collection and efficient reuse of resources from the waste stream as well as avoiding the generation of waste in the first place, thus improving the supply and availability of recovered resources in a more circular economy
3. **Landfill diversion policies**, requiring avoidance of residual waste and recovery of material, nutrient and fuel resources otherwise destined for landfill, thus avoiding loss of future land use opportunities and preserving land for sustainable urban development
4. **Occupational and public health and safety**, requiring the avoidance of littering and indiscriminate dumping of waste as well as ensuring that waste pickers, formal employees of waste management activities are not exposed to excessive climatic, respiratory, noise or physical exposure associated with waste and waste management operations. As well as protection of the public from adverse health impacts
5. **Waste ordinances / By-laws** specifying how different types of waste must be managed including payment for services and prescribed use of facilities for different types of waste

Hence, there is really only one path to follow:

1. **Expand waste collection services** to include all residents and businesses whether rural or urban
2. **Avoid non-compliant health exposure** of formal and informal workers involved in waste management activities as well as the general public
3. **Avoid unnecessary generation of waste**
4. **Recover materials and nutrients** from residual waste in an effort to move towards a circular economy
5. **Recover energy** from residual waste after recovery of materials and nutrients in an effort to ensure best possible utilisation of resources; reduce the use of fossil fuels; and minimise landfilling
6. **Minimise landfilling** and only landfill in well-engineered landfills that control leachate and landfill-gas generation as well as manage windblown litter and vectors

To actually be successful on this path, it is imperative to ensure financial viability, which means that there must be:

1. A legal basis for requiring and collecting waste collection and disposal fees that are fully reflective of the actual capital costs and cost of operation and maintenance (unless government wishes to provide this service free of charge)
2. An efficient monitoring and tracking system for waste generation and movement that can support payment of tariffs and combat illicit waste management practices. It is furthermore critically important to monitor the effect of any waste management policies and to make well informed waste management decisions
3. Full funding for all operational and maintenance costs of SWM services as well as capital costs
4. Access to capital investment funds, as well as mechanisms for planning for future investments and repayment of capital costs, e.g. via loans, PPP partners or similar arrangements

1.3 How are we failing?

Globally, solid waste management is improving and we tend to be making progress in regulating waste activities as well as enforcing and give credence to the policies mentioned above. Hence, an increasing part of the world population is receiving waste management services, and basic waste collection and disposal services are functioning in more and more cities and countries.

However, there are still many examples of failure to manage solid waste well and efficiently, including:

1. **Giving preference to established waste practices**, pressure groups and technologies, thus resulting in barriers or delays in bringing on board better technologies and better waste management practices. This includes perhaps providing capital subsidies, and operational or maintenance grants to maintain status quo
2. Waste **tariffs are often not fully reflective of the true costs**, because of capital grants, tax rebates, cross-subsidisation from other sectors, and deferring to pressure from industrial/commercial waste producers etc.

3. **Political inability to make necessary but unpleasant decisions** timeously to secure adequate and high quality waste treatment and disposal capacity, thus avoiding e.g. landfill capacity crisis, use of sub-standard facilities, insufficient treatment capacity etc.
4. **Inability to align and coordinate policies** on e.g. waste, energy, industry, agriculture and mining, resulting in inefficiencies, unfair preferences and making sub-optimised decisions
5. **Inability to regulate and enforce** efficiently, leading to non-compliant businesses winning the competitive race.
6. **Excesses, corruption and inefficiencies** in the operation and maintenance of waste collection and management facilities

To truly improve waste management, governments and municipalities must be willing and able to work towards addressing the above failures and challenges.

2. THE EUROPEAN EXPERIENCE

2.1 Historical development in policies and regulation

The Central and Northern European countries started in the 1970s and 1980s developing advanced waste management systems consisting of well-engineered sanitary landfills, waste-to-energy facilities and simple recycling systems based on source separation and, in some cases, central sorting of waste including compost production. This was done as a response to the pollution effects of industrialisation and urbanisation and the sudden increase in prosperity that led to increased consumerism and waste generation.

This necessitated new control measures that consisted of waste by-laws, national waste management and environmental protection regulations. It became important to introduce flow control to support investment in treatment capacity and recover these investments via gate fees that could not be avoided as a consequence of flow control, targetted waste taxes and enforcement.

2.2 Current policy and regulatory focus

The list below /9/ highlights selected key pieces of EU legislation, however, there are several additional detailed decisions and pieces of EU regulation including reporting requirements etc. that apply. This EU legislation is adopted in the member states' national legislation in slightly varying ways according to national legislative tradition and interpretations, and a number of member states have implemented supplementary and complementary waste management and environment legislation.

1. Waste Framework Directive, or Directive 2008/98/EC of the European Parliament and of the Council of 19 November 2008 on waste and repealing certain Directives. It provides for a general framework of waste management requirements and sets the basic waste management definitions for the EU.
2. Regulation (EC) No 1013/2006 of the European Parliament and of the Council of 14 June 2006 on shipments of waste.
3. Decision 2000/532/EC establishing a list of wastes. This Decision establishes the classification system for wastes, including a distinction between hazardous and non-hazardous wastes. It is closely linked to the list of the main characteristics which render waste hazardous contained in Annex III to the Waste Framework Directive above.
4. Directive 2000/76/EC of the European Parliament and of the Council of 4 December 2000 on the incineration of waste
5. Directive 2000/59/EC of the European Parliament and of the Council of 27 November 2000 on port reception facilities for ship-generated waste and cargo residues - Commission declaration
6. Council Directive 1999/31/EC of 26 April 1999 on the landfill of waste
7. Directive 2000/53/EC of the European Parliament and of the Council of 18 September 2000 on end-of life vehicles
8. Directive 2002/95/EC of the European Parliament and of the Council of 27 January 2003 on the restriction of the use of certain hazardous substances in electrical and electronic equipment
9. Directive 2002/96/EC of the European Parliament and of the Council of 27 January 2003 on waste electrical and electronic equipment (WEEE)
10. Council Directive 96/59/EC of 16 September 1996 on the disposal of polychlorinated biphenyls and polychlorinated terphenyls (PCB/PCT)
11. Council Directive 91/157/EEC of 18 March 1991 on batteries and accumulators containing certain dangerous substances, and repealing Directive 91/157/EEC
12. European Parliament and Council Directive 94/62/EC of 20 December 1994 on packaging and packaging waste

13. Council Directive 86/278/EEC of 12 June 1986 on the protection of the environment, and in particular of the soil, when sewage sludge is used in agriculture
14. Council Directive 75/439/EEC of 16 June 1975 on the disposal of waste oils, as amended

In addition to the Regulations, Directives and Decisions of the EU, which constitutes the three types of legally binding acts, the EU issues a number of supporting documents, including:

1. Green and white papers;
2. Action Programmes;
3. Guidelines;
4. Strategies and Strategy papers;
5. Communications;
6. Conclusions;
7. Recommendations and Opinions;
8. Resolutions and
9. Declarations

A number of such documents have been issued in terms of resource efficiency, circular economy, climate change, rare earth minerals etc. as, e.g., expressed in the 7th EU Environment Action Programme (EAP) (EU Webpage 2016 /10/) and (EU 2014 /11/).

Because of the European policies and the development in the market place, the following effects are expected in Europe:

1. *Significant reduced need for landfilling:* Large scale landfilling is unsustainable. Northern European practice of only 2-8% to landfill sets the trend (need better and more comparable waste statistics)
2. *Move towards circular economy* where materials to a higher degree exit in "closed material loops": Increased pressure from resource, carbon and energy policies result in push for closed loops for materials and nutrients. Energy recovery from remaining residual waste only
3. *Less need for WtE capacity* in Northern Europe. Need to define "recycling quality". Also, as energy supply becomes fossil-free (wind, solar, hydro etc.), energy from waste will be less desirable as it changes classification from "clean" to "dirty" energy depending on whether coal or renewable energy sources are being supplanted
4. *Continued liberalization of the waste market*, less direct waste flow control and more indirect control via regulation, tenders and fiscal tools. More emphases on truly integrated waste management: We must be even better organized and regulation will be more complex! Benchmarking and push for lower waste tariffs to balance profits in liberalized market
5. *More cross-sectoral approach:* waste – energy – agriculture – resources (e.g. both the energy and the waste sector wants access to the same biomass)

2.3 Waste Management Results Achieved in Europe

The key achievement of e.g. European waste management has been the move towards integrated waste management, which is critically important for the success of any multi-streamed waste management system for the purpose of meeting particular environmental, economic, resource or carbon policies.

Integrated waste management is the art of being well-organised and successful in waste management and is supported by a number of enabling mechanisms such as:

1. Regulation and enforcement (permitting, licensing, reporting, audits, waste data reporting systems, access to district heating networks, access to power supply etc.)
2. Fiscal incentives (waste tax, tax on natural resources, tax on carbon emissions, incentives for green energy, taxes on fossil fuels etc.)
3. Standards supporting markets for recovered materials (compost, recycled aggregates, end-of-waste products etc.)
4. Good organisational structure (public/private) and clear roles and responsibilities for all stakeholders (waste generators, authorities, transporters, recyclers/treatment plants etc.)
5. Integration of relevant sector policies: Waste – energy – environment – resources

As shown in Figure 6 and Figure 7 significant achievements have been made in Europe. This is also the case in many cities of North America and South East Asia first of all in terms of ensure practically 100%

waste collection efficiency and secondly in terms of diverting waste away from landfills resulting in increasing rates of recycling and recovery for material, nutrient and energy recovery and utilisation.

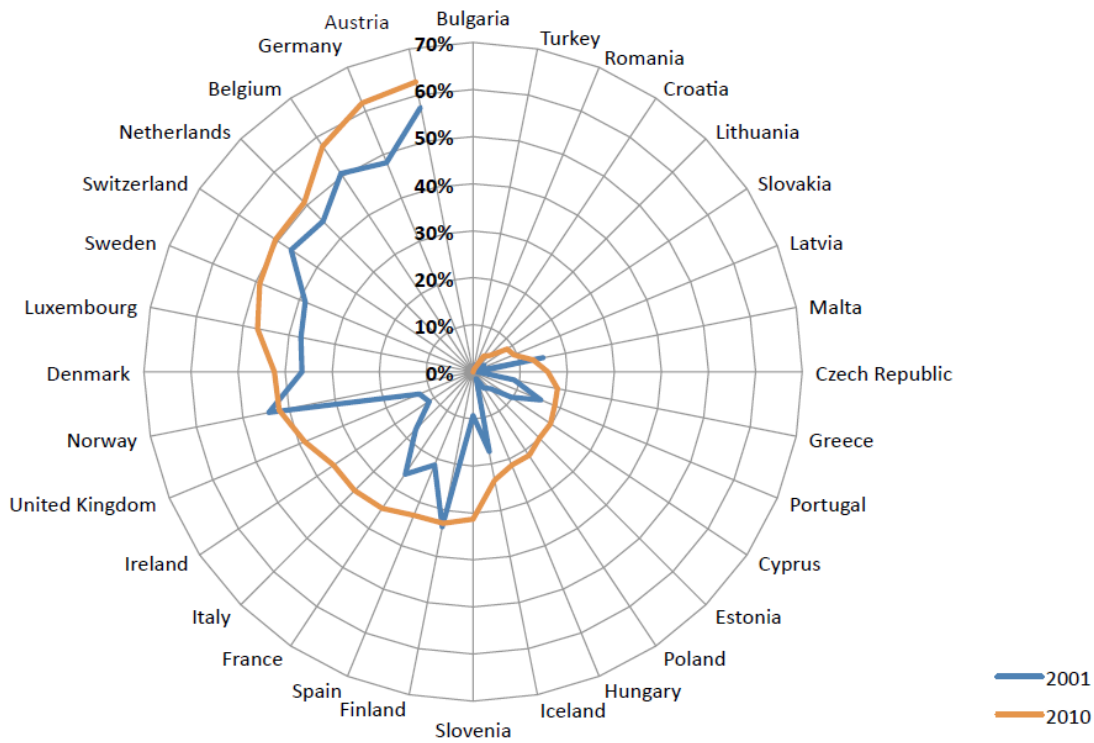


Figure 6. Development in European Recycling Rates (UNEP 2015 /12/)

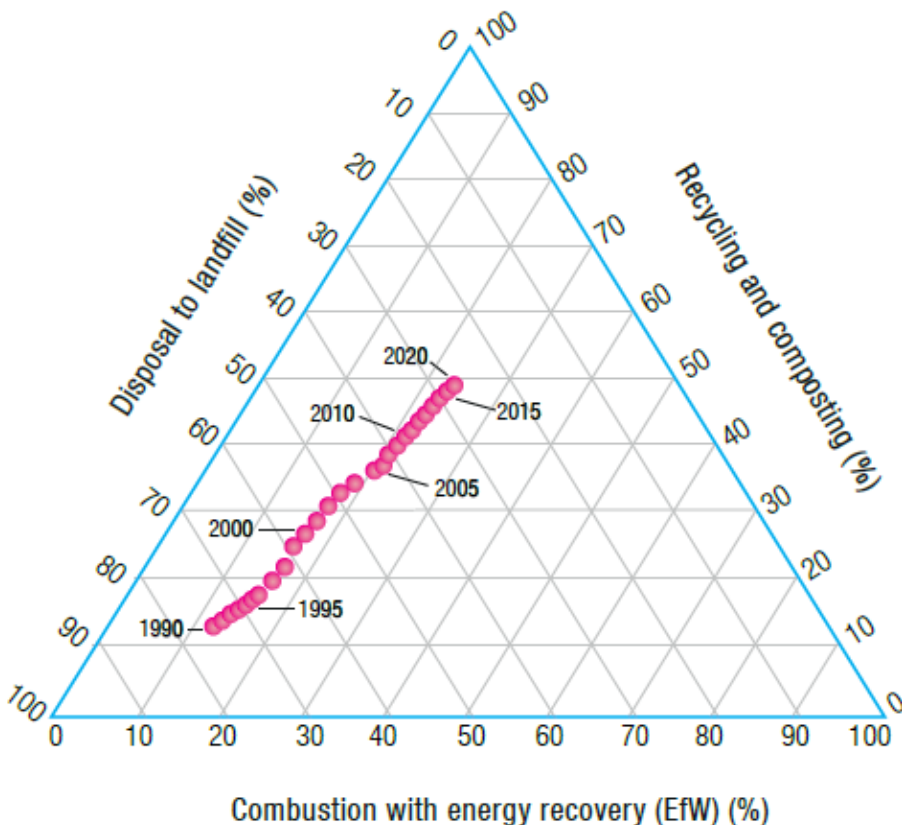


Figure 7. EU-27 development in fate of collected waste: Less landfilling, more recycling and more energy recovery (UNEP 2015 /12/)

The Figures 6 and 7 above show the remarkable waste statistics of, especially, the Northern and Central-Western European countries, where the percentage of waste being landfilled is less than 10% in many countries and where much waste is recovered for material and energy recovery. Apart from setting ambitious standards and policies that are enforced by legislation, the key to these results are the willingness and ability

to organise waste management in detail and well via a balanced mix of municipal and privately owned or operated infrastructure, where roles and responsibilities are clearly defined and the financial framework is restructured to support the desired waste flow.

2.4 Current European Challenges in Waste Management

In the EU the roles and responsibilities of the public and private stakeholders is constantly being discussed and there is a strong tendency towards exposing more and more activities to the market forces. Hence, there are a number of battlefields in European solid waste management at the moment, including:

1. Municipal/public waste utilities vs. private contractors/PPP operators (control and access to waste)
2. National/regional government vs. local government/municipalities (Who sets the goals and pays the costs of implementation?)
3. Established technologies (WtE/MBT) vs. emerging technologies such as AD, enzymatic treatment, single stream recovery technologies etc. (preference and access to market)
4. Waste sector vs. energy sector (access to market, cost of recovered energy)
5. Waste/energy sector vs. agricultural sector (quality of bi-products to farmland, access to bio-waste, alternative fuel markets etc.)
6. Municipality vs. small commercial/retail (freedom of choice, waste flow control)
7. Global solutions and transboundary movement of waste vs. local solutions, self-reliance and avoidance of transboundary movement of waste (self-reliance or global trust and distribution of work)

Depending on political opinions, the opportunities and interests of each stakeholder may push the above agendas in particular directions.

For example, the application of energy recovery from waste in conventional mass-burning facilities is either an excellent idea or a bad idea, depending on the point of view. This is because today waste-to-energy is beneficial to the environment as the produced energy supplants fossil derived energy and methane emissions from landfill is avoided, whilst in 2050, such waste-derived energy would be supplanting renewable energy sources such as solar and hydropower.

Hence, based on the current tendencies and discussions in Europe, there appear to be some winners and losers in the coming years, as presented in Table 1.

Table 1. Winners and losers in the European waste management industry (MIIECF Conference 2016 /13/).

Winners	Losers
Private waste contractors get more market access	(Some) Municipal loss of waste flow control
Waste producers enjoy lower tariffs for some services or more service at the same price	Municipality stuck with non-profitable services
Investors can buy/build waste infrastructure for profit	Public loss of control of waste infrastructure incl. treatment capacity
Increased market for waste collection contractors (multiple waste streams, longer haulage)	Higher entry barrier for new technologies/solutions for special waste streams due to loss of flow control
Lowest gate-fee facilities (incl. haulage) increase volume	Higher gate-fee facilities (including haulage) lose volume due to "waste tourism"
Big (economies of scale) and global distribution of work	Small / local solutions

3. THE SOUTH AFRICAN EXPERIENCE

3.1 Historical development in policies and regulation

Historically there have been significant differences in the service levels provided in affluent or urban areas and in less affluent or rural areas. This remains the case in South Africa, where there are still large proportions of rural municipalities that provide practically no waste collection services. The services provided in affluent or urban areas remain mostly restricted to a simple collection and landfilling service, and the recycling services available are mostly selective and operated informally by individuals, cooperatives of waste recyclers, NGOs or selected industries (e.g. paper and beverage can recyclers).

South Africa's constitution is globally unique insofar as it includes a constitutional right to a good and clean environment for all, including access to waste services. The constitution also allocates roles and responsibilities to the different spheres of government in terms of delivering this constitutional right.

After 1994 the first national waste management policy was developed and a set of minimum requirements and guidelines were developed for waste activities, which provided the basis for improving the national waste management services. Subsequently, the IWMPs were introduced providing a planning and monitoring instrument for municipalities and, furthermore, the National Waste Management Act of 2008, with subsequent adjustments was enacted.

3.2 Current policy and regulatory focus

Waste management is well-regulated in South Africa by a number of national pieces of legislation as well as many cases of provincial legislation and municipal waste bylaws, including (DEA website 2016 /14/):

1. The South African Constitution (Act 108 of 1996)
2. Hazardous Substances Act (Act 5 of 1973)
3. National Health Act (Act 61 of 2003)
4. Environment Conservation Act (Act 73 of 1989)
5. Occupational Health and Safety Act (Act 85 of 1993)
6. National Water Act (Act 36 of 1998)
7. The National Environmental Management Act (Act 107 of 1998)
8. Municipal Structures Act (Act 117 of 1998)
9. Municipal Systems Act (Act 32 of 2000)
10. Mineral and Petroleum Resources Development Act (Act 28 of 2002)
11. Air Quality Act (Act 39 of 2004)
12. National Environmental Management: Waste Act, 2008 (Act 59 of 2008)
13. National Environmental Management: Waste Amendment Act, 2014 (Act 26 of 2014)

The above national legislation is most critical for setting the framework for waste management in South Africa, supplemented by provincial legislation as well as municipal waste by-laws, where applicable.

3.3 Waste Management Results Achieved in South Africa

A number of waste management results have been achieved in South Africa including:

1. Waste collection services are provided in all metros, cities and major urban centres
2. Environmentally sound and well engineer landfills are available in all metros and larger municipalities
3. There is a vibrant and significant waste management industry that can provide a large range of services including waste collection, treatment and disposal. Also, specialised facilities for the treatment of hazardous waste, infectious waste, destruction of chemicals, thermal treatment and physical/chemical treatment are available
4. Cooperatives and NGOs are supported and provided opportunities to assist in extending solid waste management and recycling services to more residents
5. There is a vibrant and active waste management institute (IWMSA) where all interested parties can share and seek knowledge and experience from other industry partners, government agencies and academic and research institutions.
6. A number of businesses, NGOs and branch organisations are very active in the recovery of particular materials from the waste stream such as beverage cans, batteries, tyres, plastic, metals, cardboard/paper etc.
7. There are active environmental and green NGOs that focus on environmental protection and justice

8. There are dedicated waste management staff in national and provincial Departments for Environment and there are dedicated waste management staff in all municipalities
9. There is a modern regulatory framework for management of waste in South Africa, including the Waste Act of 2008
10. Waste Management Officers have been defined and must be appointed in e.g. all municipalities, thus, supporting strengthened focus and coordination for improving solid waste management, including building qualified solid waste management capacity at the municipal level

There is therefore a significant basis for further development and improvement of the solid waste management services in South Africa.

Waste management tariffs in South Africa vary significantly. For example: In the City of Johannesburg the waste collection tariff (as of 2012) per household is between 0 (property value < ZAR 150,000) and 203 ZAR/month (property value > ZAR 1.5 million) (City of Johannesburg 2016 /24/). In Cape Town the tariff per household varies between 0 and 119 ZAR/month depending on property value (City of Cape Town 2016 /25/) and in Tshwane the typical tariff varies between 0 and 187 ZAR/month depending on property value and level of service (City of Tshwane 2016 /26/).

Landfill gate fees also vary significantly from 0 at some landfills where weighbridge and record keeping is absent to typically 200 - 450 ZAR/tonne.

3.4 Current South African Challenges in Waste Management

Based on personal experience from several solid waste management projects on the ground in South Africa, and substantiated by discussions with waste management specialists in South Africa (contractors, municipal employees and consultants) and experience from municipalities, provinces and national agencies in South Africa, there appear to be significant solid waste management challenges in South Africa today. These include:

1. Planning, compliance and data management:
 - a. *No reliable waste data exist* at national level, provincial and often also not at municipal level. The existing SAWIS is not operational due to lack of reporting, even though reporting is required by law. For this reason, it is very difficult to monitor impact of policy changes or define most urgent interventions. Also, it would be very difficult to introduce waste taxes, if desirable, as there is no workable mechanism to capture data required to enforce accurate payment of taxes or even local waste management tariffs.
 - b. The *IWMPs, if updated, are sometimes lacking ambitions* in terms of expanding service delivery to all residents and providing licensed and environmentally acceptable landfill capacity as well as diverting more waste towards resource recovery. In many cases the plans and deadlines set in the IWMPs are not met or achievable, amongst others, due to lack of political decision making, lack of funding, and inability to implement decisions made.
2. Service level:
 - a. A very large part of South Africa, in particular in rural and informal areas, is *not receiving any reliable waste collection service*, if at all. There is often a lack of waste receptacles, waste collection vehicles and affordable disposal options
 - b. There is a *significant difference in the service levels provided in rural, urban and affluent areas*, including stability of service, quality and availability of receptacles, and opportunity to participate in recycling activities
 - c. Practically all collected waste is landfilled, little is utilised for material recovery or nutrient recovery compared to e.g. EU standards.
3. Environmental performance:
 - a. Many unlicensed or *non-compliant landfills/dumpsites* are in operation
 - b. *Significant fly-dumping* of building rubble, garden waste etc. in public open space
 - c. Significant environmental impact from *release of leachate and landfill gases* at many non-compliant or poorly operated dumps and landfills
 - d. *Lack of control* of disposal of hazardous chemicals, solvents, oils from residents, commercial, industrial and agricultural wastes etc.
 - e. Significant impact from e.g. *sub-standard metal scrap and chemical recovery operations*
 - f. Relatively frequent *uncontrolled landfill events* such as fires, overflowing leachate ponds and leachate systems, temporarily unpassable internal roads due to adverse weather and substandard internal road quality
4. Lack of financial sustainability:

- a. Current waste management services (collection, landfilling, sorting & recycling and special treatment) are mostly underfunded. *Municipal services are, largely, completely dependent on grants* and unable to plan for capital and operational costs or to ring-fence budget for operation and maintenance activities. This means that many municipalities are struggling to keep their fleet of collection vehicles going, and they are unable to make any major investments without significant outside funding and grants.
 - b. Many municipalities are *unable to collect waste tipping fees* at landfills nor effectively collect a waste management levy that is reflective of the true costs of capital and operation
 - c. Inability of *inefficiency in dealing with non-payment*
 - d. Large numbers of residents, especially in rural or informal settlements, are *unable or unwilling to pay* a reflective waste management tariff mostly due to limited disposable income
5. Inefficiency in the use of current infrastructure
- a. Due to *absence of planning*, regulation and infrastructure for e.g. garden waste and building rubble significant, and costly, landfill space is taken up by e.g. garden waste or building rubble that could have been recycled or turned into compost etc.
 - b. Landfill operation and compaction is often inefficient due to the prevalence of *numerous waste pickers on site* and the absence of, or break-down of, landfill compactors
 - c. *Costs are incurred for the periodical cleaning up of fly dumping* of building rubble, garden waste and general waste due to lack of control and enforcement
6. Shortage of treatment and disposal capacity
- a. Landfill capacity is in many municipalities limited due to the rapid filling-up of existing landfills and the *inability to timeously locate or fund new landfill sites* or expand existing landfills
 - b. Due to extensive grant funding of existing landfills and the absence of fiscal measures in favour of more *elaborate recycling and treatment technologies it are rarely financially viable* to invest in e.g. mechanical-biological treatment facilities, biological or thermal energy recovery facilities or recycling facilities, as capital investments and operation and maintenance costs are relative high compared to grant funded landfills.
 - c. In the absence of fiscal measures in favour of recycling, NGOs and private companies can invest in, and operate, recycling systems for high-value materials. Hence, *recycling capacity and recycling rates remain low*.
7. Enforcement of standards and regulations:
- a. There are significant reporting, licensing and permitting requirements and sometimes limited capacity to process such applications timeously. Limited enforcement capacity results in *business advantages and opportunities for sub-standard operators* at the expense of those seeking to be compliant. Hence businesses' motivation for being compliant and transparent is often low
 - b. *Waste Management Officers are in some cases poorly equipped* (DEA 2016 /15/) in terms of time and training to fully function as intended, due to many other commitments, thus, making the post a position shared between several functions

The above challenges represent critical barriers for effectively improve solid waste management in South Africa, and constitute a major obstacle for achieving a waste management standard similar to e.g. European standards. Table 2 presents some of the conundrums experienced in some areas of South Africa where there are significant discrepancies between the formal standards and policies and the actual situation on the ground.

Table 2. Solid Waste Management conundrums concerning formal standards and actual situation on the ground.

Conundrums concerning:	Formal status	Problems experienced on the ground
Legal issues	Very modern and comprehensive national waste management regulation	Frequent failures to meet acceptable environmental standards
Financial issues	Significant funds made available through national, provincial and municipal budgets as well as through various grant and support programmes exist for waste management and there are legal provisions for collection of municipal waste management tariffs	Waste management services are often underfunded and there are widespread difficulties financing new waste management investments in receptacles, vehicles, treatment and recycling facilities as well as landfill construction, operation and maintenance
Skills and capacity issues	Waste management officers are appointed and available according to the Waste Management Act 2008	Lack of skills and capacity to carry out waste management planning, monitoring and enforcement
Environmental issues	Environmental standards are comparable to	Significant environmental impact from

Conundrums concerning:	Formal status	Problems experienced on the ground
	best international standards	releases of leachate and landfill gases as well as landfill fires and illegal dumping of waste. Also negative impact from sub-standard recycling operations such as scrap dealing, oil and solvent recovery etc.
Institutional issues	The roles and functions for solid waste management are well described in the Constitution as well as in relevant solid waste regulation.	In some instances inter-municipal cooperation to enjoy benefits of economies of scale and share the use of waste management infrastructure may be problematic, resulting in sub-optimisation due to the need for self-reliance in many councils. E.g. resulting in many smaller relatively expensive landfills as opposed to fewer larger relatively cheaper landfills. Cooperation is difficult.
Organisational issues	There are clear descriptions of functions and organisational structures in provincial departments, district councils and local government	In some cases posts in local governments, districts and provincial departments are vacant for long periods due to lack of budget or suitable candidates. Retaining and developing required skills can be problematic.

In short, South African solid waste management is in many instances poorly organised, in-efficient, underfunded and under-capacitated, however, significant funds are being spent via various grant, investment and support programmes such as COGTA (COGTA 2016 /17/), Youth for Waste (DEA 2016 /18/), Indigent Rates and Tax Rebates (DEA Notice 413, 2011 /19/), MIG (DPLG 2014 /20/) etc. Also, significant funds are spent on maintenance and operation of the existing waste management services and infrastructure. Furthermore, in the absence of reliable waste data or efficient waste flow control mechanisms, it is very difficult to become well-organised or make well-informed decisions on future waste management investments at national, provincial or municipal level.

3.5 What's next in South Africa?

It is imperative that the significant barriers for improving waste management in South Africa are overcome. There is a need to work towards, among others:

1. Securing reliable waste statistics and waste data to allow for proper planning, enforcement and to establish the basis for waste tariffs and possibly taxes on waste to ensure that the most desirable waste treatment and disposal options are also the most economical ones available
2. Establish firm waste flow control measures that are enforceable and that are enforced
3. Establish firm framework for issuing, and efficient collection of, waste management tariffs that are fully reflective of the full whole-life costs
4. Secure, through the existing planning frameworks, sufficient and timeous waste processing, treatment and disposal capacity of compliant standards
5. Expand waste collection efficiency to include practically all residents and businesses, including rural and informal areas
6. Implement measures to increase resource recovery to minimise landfilling, even though with the expansion of waste collection efficiency and the expected general increase in prosperity for all South Africans the total waste generation is expected to increase significantly in the coming years in South Africa
7. When affordable to supplement the existing recycling and material recovery capacity with advanced waste treatment capacity, especially in metros, such as Mechanical Biological Treatment, Waste-to-Energy and Anaerobic Digestion.

And most importantly, this requires a significant improvement in the way that the sector is organised, to ensure that the available resources are used efficiently and that skills and resources are available and can be applied efficiently to achieve the required service delivery and comply with the intentions of the existing regulatory framework.

4. CONCLUSIONS

Globally, solid waste management has come a very long way from a simple linear process of take, use and throw, to the current focus on building a circular economy, where finite material and nutrient resources continue to be part of valuable resource loops, thus ensure that there will be sufficient materials (metals, polymers, biomass, nutrients etc.) and opportunities for tomorrow's society and our grandchildren's grandchildren. However, we have only just embarked on the journey towards a circular economy, and there is still a long way to go in e.g. Europe as well as in South Africa.

Today households pay in the range of 450-650 Euro/year for their waste services in Northern Europe. This is in sharp contrast to the current waste tariffs in typical South African Metropolitan areas of 85-150 Euro/year. It is clearly not possible to achieve a standard similar to that of the European Union at one third of the price. Similarly, the typical tipping fee at a South African landfill (if any) is 10 – 20 times less than that of a typical landfill in Northern Europe (including taxes), which would make it very difficult to recover the actual costs of planning, construction, operation, closure and 50 years of after-care for South African engineered landfills. Furthermore, such low landfill tipping fees, that are not reflective of the full actual costs, present a significant barrier to introducing any other form of capital-intensive waste treatment facility in South Africa, such as mechanical sorting, anaerobic digestion, enzymatic digestion, thermal treatment and energy recovery etc. Therefore, unless significant policy and regulatory changes are made it will be difficult for South Africa to evolve from the current practically 100% dependency on landfilling.

Building a circular economy will in many ways require a paradigm shift in the ownership and stewardship of materials and products as well as require significant improvements to our ability to be well-organised and efficient. However, a circular economy approach would also afford new employment opportunities in the management of products and materials e.g. as opposed to the extraction and distribution of raw materials.

With continued growth in the global population as well as the continued growth in prosperity, which is expected to be of particular significance in South Africa, material use, consumption and waste generation is expected to grow enormously in South Africa.

Therefore, if we consider waste management a challenge today, it will be more so in the coming years. Unless also South Africa can make significant progress in material recovery, landfill diversion and even establishing simple material loops that will prepare us for a circular economy the waste generation will increase significantly and the often looming landfill capacity problems will be exacerbated.

The EU plans to further focus on resource efficiency and the establishment of viable circular economy business models. It is therefore possible that the current gap between waste management practices in the South Africa and the EU may widen and that this may have an impact on South African products marketability on the European and similar markets.

Therefore, there is really only one way to go: We need to be much better organised and prepare for the paradigm shift needed to allow us to cope with the current shortcomings and to future-proof our economy in terms of access to resources and new opportunities for a more resource-efficient economy.

We better start now.

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