The Challenge of Multiple Policy Objectives for the Transformation of Solid Waste Management: Analysis of the Situation in South Africa and Experience from Abroad in Handling the Barriers

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ABSTRACT

Management of waste is increasingly a complicated task, among others because multiple policy objectives are developed and the solid waste management system is expected to meet all of these often conflicting objectives. These policy objectives include: i) improved service delivery, ii) diversion of waste from landfill, iii) improved resource efficiency, iv) growth of a green economy and green jobs, v) improvement of health and safety, vi) development of private sector opportunities, vii) sustainable management and treatment of hazardous and chemicals waste.

The paper present a brief analysis of how these multiple policy objectives affect and impact the transformation of the management of wastes, and presents examples of how these barriers and constraints have been addressed and been at play internationally, as an indication the number of issues and stakeholders that needs to be acknowledge when moving solid waste management forward in South Africa.

1. INTRODUCTION

1.1 The complexity of meeting all stakeholders' expectations with multiple policy objectives

Typically, any waste management interventions needs to take cognisance of several policy objectives (Figure 1).

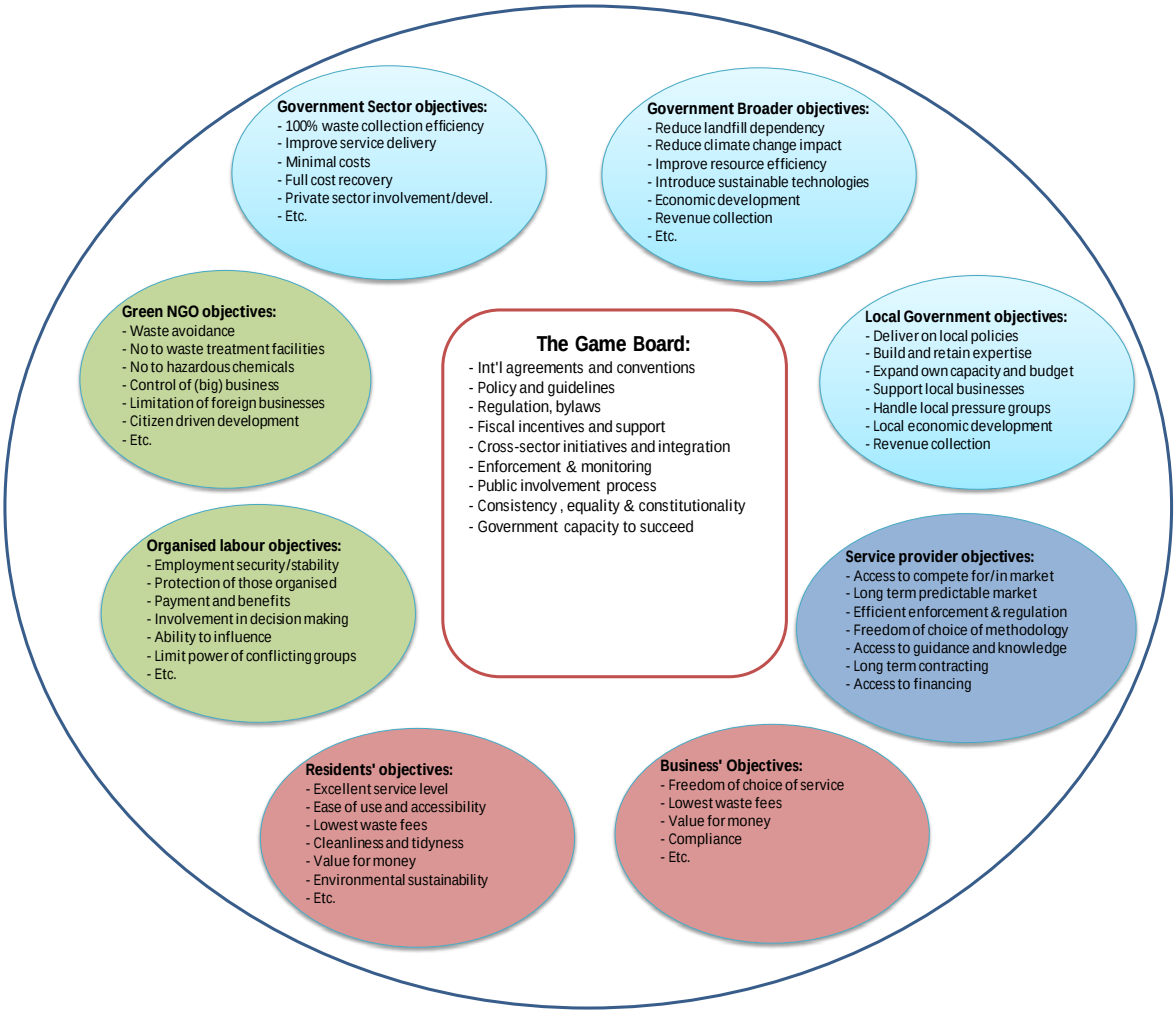

Figure 1. Typical policy objects relevant to any waste management intervention (Kristiansen, 2014)

Therefore, any solid waste management intervention, whether it is initiated at national, provincial or local level of government, by a private contractor or a public utility, will run into the challenge of meeting not only ones own expectations but also those of multiple stakeholders. Each of the stakeholders have their own prioritising of each of the several overall policy objectives of the community in terms of waste management. Typically, the battle field contains the following key objectives (Table 1):

Table 1. Overview of Typical Key Objectives, Stakeholders and Typical Conflict Areas

Key policy objective	Typical stakeholders prioritising this	Typical choice of supporting analytical tool or qualitative/quantitative argumentation	Typical conflict areas
· Environmental protection	· Environmental departments at all tiers of government · Environmental NGOs	· Air dispersion models, dispersion models for fluids and substances, life cycle assessment models, etc.	· Businesses expecting higher costs · Employees working for industries who will be regulated stricter · Community leaders concerned with employment and earnings in industries facing regulation
· Landfill diversion (minimising need for landfill volume)	· Departments of waste management at all tiers of government · Environmental NGOs · Businesses offering waste treatment and recovery solutions	· Waste characterisation studies, waste management scenario analysis with waste stream analysis, waste stream forecasting, technology assessments	· Owners of landfills wishing a return on investment · Informal reclaimers active on landfills · Community leaders concerned with employment and earnings in industries facing regulation
· Resource efficiency	· Environmental departments at all tiers of government · Environmental NGOs · Recovery and reprocessing industry offering capacity and services for secondary materials	· Life cycle assessment models · Material supply horizon assessments	· Owners of landfills wishing a return on investment · Informal reclaimers active on landfills
· Protection of current employees interests	· Organised labour / unions · Informal reclaimers · Waste collectors · Landfill employees	· Protection of current employment	· Municipalities, operators and businesses wanting to introduce new technologies, plants and solutions
· Creation of new employment opportunities	· Community leaders · Government on all tiers	· Socio-economic models	· Current municipal and private facilities loosing volume or turnover
· Private sector business interests	· Economic development departments in all tiers of government · Business associations	· Financial models · Public procurement procedures · PPP regulations and procedures	· Environmental NGOs wary of “big business” and environmental controls · Competing private businesses wary of possible advantages to competitors
· Informal sector business interests	· Waste Pickers Association · Waste traders association	· Political and interest group influencing methods	· Formal businesses offering or operating in the same business field · Municipal waste operations affected by informal businesses activities

Key policy objective	Typical stakeholders prioritising this	Typical choice of supporting analytical tool or qualitative/quantitative argumentation	Typical conflict areas
· Cost efficiency (reduced costs to waste generators)	· Residents/rate payers associations · Business associations · Departments of economic development	· Accountability for spend of resources · Auditing and benchmarking of activities · Price control mechanisms · Organisational reviews · Competitive procurement of goods and services	· Those affected by efficiency gains
· Socio-economic costs optimisation	· Economic departments at all tiers of government	· Socio-economic models	· Disagreement on the assumptions and reference conditions suitable for socio-economic models · Proponents of other policy objectives may not feel represented by economic models alone · Environmental NGOs may argue higher pricing of environmental issues · Organised labour may argue higher pricing/estimates on job loss/creation
· Energy generation	· Dept of energy in all tiers of government · Independent power producers · Operators/investors in energy producing waste infrastructure	· Life cycle assessment to determine optimum scenarios ·	· Interests of competing generators of energy · Dominant/protected energy producers or distributors · Energy supply safety/risks
· Transparency	· NGOs · Investors ·	· Transparent and consultative decision processes	· Vested interests · Sensitive decisions and activities
· Generation of revenue (tax base)	· Government, treasury, payers of levies and taxes, businesses impacted by fiscal incentives	· Socio-economic tools	· Once an activity has become a significant source of tax or revenue, any change that is not tax/revenue neutral would have to include compensations to secure the tax base/revenue collection

1.2 Examples of challenges that the use of analytical models presents

When motivating new policies and investments various analytical models are normally used to motivate the desired change of policy or investment. However, these models typically result in a number of challenges, such as:

1. Disagreement concerning the priority of objectives (e.g. environment, costs, current employment, new business and employment opportunities)
2. Disagreement concerning the choice of framework conditions/assumptions applied for the analytical model (e.g. shall local, national or global impacts be used for a life cycle assessment? Shall atmospheric, aquatic or land impacts be prioritised, or shall current or accumulated future impacts be prioritised?)
3. Disagreement concerning the appropriateness of the analytical model (e.g. can the outcome of a socio-economic analysis be used to determine if more resources should be recovered into the economy as secondary resources, or should predicted future resource scarcity and loss of land to landfill space and hence lost opportunities also play a role?

Apart from these principal types of disagreement there are frequently significant conflicts that are routed in the vested interests of particular stakeholders, as indicated in Table 1 above.

2. SUFFICIENCY OF CURRENTLY AVAILABLE ANALYTICAL TOOLS AND MODELS

2.1 Economic Tools and Models

There are a number of economic tools and models that typically are applied when making investment decisions for solid waste management solutions. Among these are:

- Net Present value (NPV): A methodology that discounts future costs and income to today's prices, thus, calculating one single NPV monetary value for a number of alternative scenarios. This methodology assigns a value to actual tangible costs and incomes and does not include other benefits or disadvantages.
- Socio-economic assessment is a method that in addition to the actual tangible costs assigns a value or cost of impacts that are not directly tangible to the individual or industry but to society as a whole. I.e. a value is assigned to health, use of time, loss of land, species etc.
- Business planning / bankable feasibility study: Conventional business planning and studies to assess the bankability and motivate commercial or balance-sheet financing for business activities. I.e. calculating the Internal Rate of Return (IRR), Net Present Value (NPV) as well as calculating cash flows, capital expenditures, operational costs and revenues, including taxes, levies etc.
- Stated preference/Contingent valuation method seeks to determine the value/compensation that a population will accept to maintain a certain functionality that cannot directly be priced based on commercial terms. It is based on a particular survey technology.
- Willingness to pay/willingness to accept methods are based surveys to determine the population's willingness to pay for a positive service/quality or the willingness to accept compensation for loss of a service/quality.

Each of these tools make use of certain assumptions, including determining a monetary value to impacts such as traffic accidents/deaths, air pollution, habitat quality etc. Also the NPV methods can generate very different results when comparing alternatives depending on the assumed discount rate. Hence, there are a number of assumptions that can be the cause of disagreement during peer review of results.

2.2 Environmental Tools and Models

Similarly there are a number of tools that can be applied to determine the environmental impacts, including:

- Life Cycle Assessment (LCA), where a number of commercially/scientifically available tools exists, such as EaseTech, GaBi, SigmaPro, etc. These LCA tools can calculate, within a set frame of reference the total impact in terms of a number of particular pollutants or composite environmental indicators for e.g. EcoToxicity, acid gases, CO_2-equivalents, etc.
- Environmental Risk Assessment (ERA), where the actual environmental impact of activities is estimated based on a scientific approach. Typically, different methods and approaches are used depending on the key focus, i.e. aquatic environment, atmospheric impact, public health, impact on crops etc. Tools can include air dispersion modelling, groundwater plume modelling etc.

It is often experienced that LCA and ERA provide different or even contradicting results (Naturvårdsverket, June 2004) because of the difference in perspective in time and the lack of a functional unit[i] in ERA.

2.3 Service Assessment Tools and Models

Service assessment tools can focus both on the actual and perceived serviced provided as well as the efficiency and transparency of services delivered. Such tools include among others:

- Focal group interviews can be conducted to gauge the perception of residents, businesses and other stakeholders in relation to the quality and efficiency of services
- Transportation Studies where the location of e.g. garden centres, drop off centres, paper and glass cubes etc. are mapped and analysed with regard to the location of residents and the average driving and transport distance is optimised for fair and efficient location for the entire population serviced
- Public Expenditure Tracking Surveys (PETS) and Quantitative Service Delivery Surveys (QSDS) have become important tools for analysing service delivery and public expenditures. Typically, PETS seek to trace the flows and uses of resources through the various layers of government to service facilities in order to identify differences between the official and actual allocations and to determine

the extent to which resources reach service providers. QSDS seek to assess quality and performance in resource usage at the frontline facility level. They have both proved to be important tools for diagnosing various efficiency, effectiveness and equity problems in public expenditures, in particular governance and incentive problems, bottlenecks, rent capture and leakage of public resources.

- Public integrity assessments tools usually aim at assessing the institutional framework for promoting integrity and combating corruption across the public sector, and/or at identifying corruption or corruption risks within specific government agencies and/or among public officials. The focus of such assessments is on the broad rea of public administration rather than on the delivery of public services (Martini, Maira August 2012).

There are many variants of the above assessment tools that in various ways assess the quality and efficiency of service delivery as well as the integrity of utilities and officials responsible for waste management services.

2.4 Public Awareness, Knowledge and Acceptance Models

Typically any solid waste management intervention will take a point of departure in the current level of awareness, knowledge and acceptance of not just residents and businesses but also among public officials and relevant private sector service providers. Among the tools typically used are:

- Public Participation and Acceptance Assessment is typically carried out through interviews and polling via representative sampling of the serviced residents and businesses as well as through recording and assessing the degree of involvement and participation of stakeholders in e.g. public hearings, environmental days, voluntary recycling and awareness initiatives etc.
- Public Awareness and Knowledge Assessment is typically carried out via focal group interviews as well as compliance with and use of the waste management systems provided. This is a way to identify the degree of buy-in and acceptance as well as knowledge gaps that need to be addressed, e.g. in public awareness campaigns, to improve the overall performance, efficiency and service delivery

Normally, a tailor made approach to assessment of public awareness, knowledge and acceptance is developed to suit the particular purpose, demographics and socio-economic settings as well as the purpose of the assessment.

2.5 Integrated Assessment Models

A literature review and practical experience show that there are no fully integrated assessment models that can handle the complexity and multitude of parameters of the above mentioned individual assessment models for solid waste management scenarios. However, some integrated assessment models have been developed for other types of environmental issues, in particular there are several global integrated climate change assessment models that can integrate several contributing factors into one combined model.
For solid waste management scenarios, in the absence of proper integrated assessment models, qualitative scoring and weighting models are typically developed, where the relevant parameters are assessed individually and the several evaluation results for different parameters are weighed and added together, thus, producing one qualitative weighed score for all parameters for several scenarios

2.6 The Clash of Tools and Models

There are several examples of clashing results when applying different models. Some of the typical clashes when assessing solid waste management scenarios are:

1. If *discounting of future emissions* is applied, as e.g. has been the case for some LCA studies that argue against waste-to-energy technologies, there is a tendency to defer future emission, and this, ignore environmental impacts that will influence future generations. E.g. emissions from landfills that are emitted over a period of perhaps 100 years will not be considered, whereas impacts caused by the immediate conversion of waste to energy will. Thus, posing a significant risk for skewing the results and the subsequent political decision making based on expert model results (Hellweg, 2002).
2. Models that assess technologies that *supplant fossil fuel energy*, and thus fossil fuel environmental impacts, tend to underestimate the expected future change in energy-mix, which in most countries should be expected as a consequence of policies to move towards fossil-free energy systems. Hence, when assessing e.g. biogas, landfill gas and waste-to-energy systems one may over-estimate the positive effects of supplanting e.g. coal-based energy, as such coal based energy sources are likely over time to be at least partially replaced by renewable energy sources such as solar, wind and geothermal systems (Marriott, Joe, 2010)

3. LCA models may underestimate the *critical consequences in cases where the current environment is already challenged*. Here, Environmental Risk Assessment (ERA) may be a better way to e.g. handle situations where for example a limited drinking water resource is already compromised, where the land availability for e.g. landfills is extremely limited, where a technology requires a significant water use in an area of extreme water deficit etc.
4. Focal Group Interviews may render particular outcomes in terms of the survey groups' preferences depending in recent pressure group activities, community leaders known preferences, negative experiences from the past, and similar *assumption of guilt by association* based on recent public outcries etc.
5. Socio-economic assessments may e.g. put a *price to citizens' and businesses' time* used for recycling and sorting waste compared to simply disposing all waste mixed in one receptacle. There are very few stated preference studies done that can balance the experienced positive benefit of pre-recycling residents use of time for recycling against the experienced negative cost of other residents not willing to engage in recycling activities. Depending on the assumptions made by the socio-economist, the socio-economic assessment may show a positive or a negative socio-economic impact from increased recycling (Czajkowski, Mikołaj 2012).

The above examples are but a few of the many clashes of models and assumptions that are experienced when advisors apply scientific models to produce an objective decision-making basis for politicians before large investments are made in new integrated solid waste management systems that impact thousands of residents and businesses.

2.7 Sufficiency of tools and models for assessing solid waste management scenarios

As presented above, several individual assessment models and tools exist but in the absence of one integrated assessment model, the final decision on the preferred integrated solid waste management system will have to be a political decision-making process, where civil servants with the support of technical advisors prepare a decision-making basis for final political discussion and decision, where a final decision can be made based on a political weighting of the many and often conflicting policy objectives.

The strength of this political decision-making is, that elected politicians are representative of the values and priorities of the electorate with an obligation to also protect the interests and well-being of future generations.

However, due to the complexities it can be difficult for politicians to make well informed decisions as there are several interest-groups and businesses that make representation and highlight particular concerns and risks over others. To this end, sector policies (i.e. climate change policies, waste management policies, environmental protection policies, air quality management policies, land use policies, agricultural policies, urban development policies, energy policies etc.), geographical develop policies as well as international conventions and agreements can guide politicians in the decision-making process.

3. EXAMPLES OF PROJECTS AND THE USE OF ASSESSMENT MODELS

3.1 Overview of project examples

In this section selected examples of the use of assessment models and play of other deciding factors are presented in an anonymous way based on actual projects in Europe that COWI has been involved in. These project examples comprise:

1. Establishment of a new Waste-to-Energy facility by an inter-municipal waste management utility owned and operated by an association of municipalities. The concept was to establish a new WtE facility in an area where the district heating system currently is not supplied by energy from waste and assuming an increase in waste generation or import of waste from another European country.
2. Increased recycling rates in municipalities by introducing more efficient source separation based on multiple compartment containers and mechanical sorting of collected resources

3.2 Establishment of new waste-to-energy (WtE) facility

3.2.1 The battlefield

One regional inter-municipal waste management company wished to establish a WtE facility at a new location where there is an excellent opportunity to supply district heating to a district heating network that currently is being supplied by fossil fuel derived energy sources. Hence, the project would result in a significant saving in the consumption of fossil fuel.

There is shortage of waste suitable for WtE due to significant existing capacity in the regional area and due to decreasing waste quantities because of economic, demographic and industrial changes and increased recycling rates. For this reason competing WtE facilities are concerned about the impact of providing additional WtE capacity and some municipalities are concerned about the long-term financial viability of the plant.

Several municipalities are owners of the inter-municipal waste management company, and each municipality must provide a financial guarantee for the considerable loans that are required to finance the capital intensive investment. Each municipality is considering the risks that such a loan guarantee entails, in the event that e.g. insufficient residual waste can be provided from owner municipalities or imported from other municipalities or that the revenue from sale of energy is less than planned.

Environmental NGOs are opposed to the plans.

3.2.2 Key stakeholders

The key stakeholders are:

1. Management of the inter-municipal waste management company wanting to build the plant
2. The mayors and politicians of each owner municipality
3. Civil servants of each owner municipality
4. Politicians and civil servants of non-owner municipalities
5. Voters/residents of the municipalities
6. Management and board of affected district heating companies
7. Management and board other waste-to-energy facilities competing for the same residual waste
8. Environmental NGOs
9. Potential suppliers of the plant

3.2.3 The application of assessment tools

Several of the stakeholders individually applied environmental, socio-economic and financial assessment models to determine their interests and potential losses and gains from the proposed project, and the outcome of these studies where largely contradicting each other, as different assumptions, models and approaches were applied. Financial models were used with very different baseline assumptions and from different perspectives. For example, the outcome differed if the proposed plant was viewed from a WtE company perspective or from the perspective of one of the owner-municipalities providing the loan guarantees and carrying the financial risk. Also, the view on future waste quantities had a profound impact on the outcome of the independent assessments. A key issue was possible need to import waste from e.g. the UK, to ensure sufficient waste supply. Here, all LCA models showed that import of UK waste was environmentally advantageous due to the supplanting of coal based energy and that only power and not heat can be utilized in the UK, as opposed to the proposed plant.

3.2.4 The resulting decision

In the end, it was decided first to defer and later to abandon the establishment of the new facility, mostly due to the waste supply risk and differences in views on the desirability of dependence on import of waste from abroad. This was because a decline in waste quantities being experienced caused by a combination of increased recycling initiatives and economic slowdown as well as due to an indicated change in national waste management and resource policies.

3.3 Increased recycling of dry recyclables

3.3.1 The battlefield

The national government issued a resource and waste management strategy (DEPA 2013). Implementation of the strategy would result in significant change to the municipal waste management infrastructure over a 1-2 decades.

The key changes would be introduction of expanded multi-stringed or co-mingled collection of dry recyclables as well as bio-waste for separate recycling as material or nutrient/bio-energy resources, which in turn, would result in less waste requiring waste-to-energy treatment, over-capacity at exiting waste-to-energy facilities or increased export of waste from primarily the United Kingdom for energy utilisation.

Some changes to status quo were required due to changes in EU policy in terms of recycling targets and resource efficiency that member states must meet within deadlines.

Some of the arguments voiced include:

1. Waste collection will become much more expensive due to the need for more receptacles and more transportation
2. Co-mingled collection of dry recyclables for mechanical sorting can be achieved at same price as today with higher quality of outputs
3. The focus on higher recycling rates is a false goal, as much of the recycled waste is down cycled or used as fuel in WtE facility, cement kilns or similar and not re-entering a circular flow of materials
4. Merely achieving recycling targets is counterproductive for improving environmental performance, as this does not support achieving high quality in recycling.
5. The country and municipalities will lose money due to creation of over-capacity at existing WtE facilities resulting in higher treatment fees or losses to be covered by rate payers.
6. Energy produced by bio-energy facilities is more expensive and unaffordable resulting in increased energy prices
7. Residents cannot or will not effectively segregate recyclables
8. Import of UK residual waste for WtE treatment in Denmark is environmentally and financially a significant benefit, as the waste would be landfilled or utilised for power generation in the UK only whereas there is a much higher energy efficiency in Denmark due to the extensive use of district heating, these benefits significantly outweigh the emissions and costs cause by transporting the waste from the UK

3.3.2 Key stakeholders

The key stakeholders were:

1. Management and board of existing waste-to-energy facilities
2. Municipalities that must implement the policy
3. Political parties in opposition to the Government
4. Pressure groups of the opinion that WtE is the most efficient and environmentally friendly residual waste choice
5. Pressure groups of the opinion that material and nutrient/bio-energy recovery from residual waste is the most efficient and environmentally friendly choice
6. Environmental NGOs
7. Residents/voters
8. Business organizations

3.3.3 The application of assessment tools

A state think tank on economic development (det Økonomiske Råd, 2014) argued that the policy was economically unjustifiable, as the economic benefits from the recovered materials did not outweigh primarily the economic cost of the time that all residents would have to spend sorting their waste, based on a usually applied value of residents time equal to the cost applied in economic assessments to people stuck in traffic.
Various LCA models were applied using different assumptions documenting that either the net energy efficiency would drop as a consequence of the policy or would increase depending on e.g. assumptions made for the quality of recycling.

LCA models have also been applied documenting that import of residual waste from the UK for treatment in Danish WtE facilities would have significant environmental benefits, apart from the financial benefits, due to the much higher energy efficiency of WtE facilities in Denmark producing both heat and power as opposed to UK plants producing power only, if landfill is not the only option in the UK due to limited WtE capacity there.

3.3.4 The resulting decision

The Governments Resource Strategy (DEPA 2013) has been approved and implementation of the strategy will be regulated through a mixture of voluntary agreements and legislation brought in place in the coming years. The targets set by the Resource Strategy includes:

- 50% recycling of all solid waste from households
- Collection of 75% of electronic waste (WEEE) from households
- 70% recycling of paper, cardboard, glass, metal and plastic packaging and 60% og biowaste from the commerce/service sector
- 70 recovery of shredder waste (from end-of-life-vehicles)

Actually, these national targets may have to be further tightened if the July 2014 legislative proposal of the EU (EU, 2014) will become law. The July 2, 2014, EU legislative proposal sets the following targets:

- Recycling and preparing for re-use of municipal waste to be increased to 70 % by 2030;
- Recycling and preparing for re-use of packaging waste to be increased to 80 % by 2030, with material-specific targets set to gradually increase between 2020 and 2030 (to reach 90 % for paper by 2025 and 60% for plastics, 80% for wood, 90% of ferrous metal, aluminium and glass by the end of 2030);
- Phasing out landfilling by 2025 for recyclable (including plastics, paper, metals, glass and bio-waste) waste in non hazardous waste landfills – corresponding to a maximum landfilling rate of 25%;
- Measures aimed at reducing food waste generation by 30 % by 2025;

4. SUMMARY AND CONCLUSIONS

There is a number of Integrated Assessment Models (IAM) developed for e.g. climate change, the energy sector etc. However, there is not a well-developed IAM for the waste sector in general and it does not seem likely, that a universally acceptable IAM can be developed for waste management systems, due to the complexities and political agendas associated with waste management.

The paper has presented some of the key challenges and the conundrums of carrying out sound and solid assessment of investments and changes to any solid waste management system.

It is clear that it is important that assumptions made when applying the many assessment models and tools need to be transparent and justifiable to avoid the generation of biased results.

Because solid waste management touches on numerous activities in any society, including households, businesses and industry, agriculture and the energy sector, as well as it is a base for significant government revenue in the form of taxes and levies, it would seem inevitable that any major decisions will have to be political rather than based on the outcome of scientific integrated assessment models that can make a balanced assessment based on the numerous models and tools available.

Waste management decisions will most likely always be informed by policies and marked conditions for among others:

- Resource efficiency
- Climate change and CO_2 emissions
- Employment and economic development
- Environmental protection
- Landuse
- Energy supply and safety
- Biomass availability and utilisation
- Residues from extracting industries (minerals, hydro-carbons, aggregates/sediments etc.)

And obviously be informed by residents and businesses expectations of fair, equitable, efficient, affordable and environmentally sustainable waste management delivered with a high services level.

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