OPERATOR MODELS AND BUSINESS OPPORTUNITIES IN ADVANCED WASTE TREATMENT FOR SOUTH AFRICA

Government of the Republic of South Africa Department of Environmental Affairs

environmental affairs
Department:
Environmental Affairs
REPUBLIC OF SOUTH AFRICA

NATIONAL GREENING

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DEUTSCHE ZUSAMMENARBEIT

Acknowledgements

The Department of Environmental Affairs would like to thank the following partners and/or individuals who have contributed and supported the development of this document on Operator Models in Advanced Waste Treatment for South Africa.

- Mr Bertie Lourens, Waste Plan, Pretoria
- Mr Jason Gifford, WEC, Pretoria
- Mr Roelf de Beer, Pickitup, Johannesburg
- Mr Ushan Naidoo, Mpact, Johannesburg
- Ms Gracia Munganga, Anaergia, Cape Town
- Mr Bruce Thorndike, Anaergia, Cape Town
- Mr Detlev Meyer, Reliance Compost, Cape Town
- Mr Theo van der Walt, Bloem Organic Compost, Bloemfontein
- Dr Jenitha Badul, Ms Leanne Richards and Ms Elizabeth Ntoyi, Greening Programmes and Fund, Department of Environmental Affairs, for review and finalisation of document
- Mr Brian Chapole, Department of Environmental Affairs, layout and design elements

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Table of Contents

List of Tables

List of Figures

Acronyms and Abbreviations

AD	Anaerobic Digestion
AISWM	Advanced Integrated Solid Waste Management
AWT	Advanced/Alternative Waste Treatment
BAU	Business as Usual
BFOT	Build Finance Operate Transfer
C&D	Construction and Demolition Waste
CAPEX	Capital Expenditure
CBO	Community-based Organisation
CCT	City of Cape Town
CFC	Chloroflurocarbon
CH4	Methane
CMIP	Consolidated Municipal Infrastructure Programme
CO2	Carbon Dioxide
CPI	Consumer Price Index
CV	Calorific Value
DBFO	Design Build Finance Operate
DBOFT	Design Build Operate Finance Transfer
DBOT	Design Build Operate Transfer
DEA	Department of Environmental Affairs
EHS	Environmental and Health and Safety
EIA	Environmental Impact Assessment
EM	Environmental Managers
EPR	Extended Producer Responsibility
ESLA	Extended Service Level Agreement
FX	Foreign Exchange
GCF	Green Climate Fund
GHG	Greenhouse Gas
GIB	Green Investment Bank
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit
GN	Government Notice
HCFC	Hydrochloroflourocarbon
HDPE	High Density Polyethylene
HFC	Hydrofluorocarbon
HM	Her Majesty's
HSE	Health, Safety, and Environment
IDP	Integrated Development Plan
IRS	Informal Recycling Sector
ISWM	Integrated Solid Waste Management
IWB	Itinerant Waste Buyer
IWMP	Integrated Waste Management Plan
IWS	Informal Waste Sector
KfW	KfW Development Bank
KP	Knowledge Product

LFG	Landfill Gas
LPG	Liquefied Petroleum Gas
MBT	Mechanical Biological Treatment
MFMA	Municipal Finance Management Act
MHT	Mechanical Heat Treatment
MIG	Municipal Infrastructure Grant
MRF	Material Recovery Facility
MSA	Municipal Systems Act
MSP	Micro Service Provider
MSW	Municipal Solid Waste
MSWM	Municipal Solid Waste Management
NEMA	National Environmental Management Act (Act 107 of 1998)
NGO	Non-Governmental Organization
NPV	Net Present Value
NO2	Nitrogen Dioxide
NWMS	National Waste Management Strategy
O&M	Operation and Maintenance
O3	Ozone
ODA	Official Development Aid
OPEX	Operating Expenditure
PDI	Previously Disadvantaged Individual
PET	Polyethylene terephthalate
PFC	Perfluorocarbons
PFI	Private Finance Initiative
PFMA	Public Finance Management Act
PPP	Public Private Partnership
PPPFA	Preferential Procurement Policy Framework Act
PRC	Private Recycling Cooperatives
PSP	Private Sector Participation/Private Service Provider
RDF	Refuse Derived Fuel
RLM	Rustenburg Local Municipality
RSA	Republic of South Africa
S@S	Separation at source
SAWIS	South African Waste Information System
SCM	Supply Chain Management
SF6	Sulphur hexafluoride
SHEQ	Safety Heath Environment and Quality
SLA	Service Level Agreement
SMME	Small Medium Micro Enterprise
SWM	Solid Waste Management
UEL	Useful Economic Life
UMDM	uMgungundlovu District Municipality
WC	Windrow Composting
WtE	Waste to Energy

Glossary

Advanced Integrated Solid Waste Management (AISWM). AISWM describes the next natural developmental step for waste management in South Africa. Implementing the concept will present significant challenges, and solutions will need to be found that work in many different socio-economic contexts.

Advanced Waste Treatment (AWT). A specific technology or facility that alters the characteristics of waste through physical, thermal, chemical, and/or biological processes either prior to, or in place of, landfill. AWT broadly includes the recycling and/or recovery elements of the waste hierarchy.

AWT Maximum Co-Benefit. The ideal of maximising the shared benefit of diverting waste from landfill using AWT technologies by integrating the strengths and goals of national government, municipal authorities, and private entities.

Domestic Waste. Waste arising from households.

Energy from waste. The recovery of energy from waste typically by direct combustion and mass incineration. More energy recovery technologies are mentioned in the "waste to energy" definition.

Food Waste. Food losses occurring at the end of the food chain (retail and final consumption) are rather called "food waste", which relates to retailers' and consumers' behaviour. There are different food waste streams and therefore different approaches in terms of management may need to be considered.

Formal Sector. An economic sector, which encompasses all jobs with regular, structured, working hours and regular wage, and are recognised as income sources, on which income taxes must be paid. The formal waste sector is defined as including: waste handlers (private and municipalities), waste equipment providers, waste consulting/ engineering companies, waste research and development organisations, as well as waste and resources sector associations.

General Waste. Refers to waste that does not pose an immediate hazard or threat to health or to the environment, and includes (a) domestic waste; (b) building and demolition waste; (c) business waste; (d) inert waste; or (e) any waste classified as non-hazardous waste in terms of the regulations made under section 69 of the waste amendment Act (2008), and includes non-hazardous substances, materials or objects within the business, domestic, inert or building and demolition wastes.

Greenhouse Gas. Any gas that absorbs infrared radiation in the atmosphere, including gases such as: carbon dioxide (CO_2), methane (CH_4), nitrogen dioxide (NO_2), ozone (O_3), chlorofluorocarbons (CFC), hydro chlorofluorocarbons (HCFC), hydrofluorocarbons (HFC), perfluorocarbons (PFC), sulphur hexafluoride (SF_6). These gases affect the overall heat-retaining properties of the Earth's atmosphere and create a temperature increase of the Earth's atmosphere when they build-up, affecting and changing the global climate.

Greens and Garden Waste. Organic biodegradable waste material generated from a typical garden such as grass clippings, leaves, branches, etc.

Hazardous waste. Any waste that contains organic or inorganic elements or compounds that may, owing to the inherent physical, chemical or toxicological characteristics of that waste, have a detrimental impact on health and the environment.

Household. A household is a group of persons who live together and provide themselves jointly with food and/or other essentials for living, or a single person who lives alone. Note: The persons occupy a common dwelling unit (or part of it) for at least four nights in a week on average during the past four weeks prior to the survey interview, sharing resources as a unit.

Informal Sector Integration. Methods to organise and recognise the informal recycling sector as part of official waste management strategies.

Informal Sector. The nature of employment in addition to the characteristics of enterprises and includes all types of informal employment both inside and outside informal enterprises. It extends the focus from enterprises that are not legally regulated to include employment relationships that are not legally regulated or socially protected.

Integrated Solid Waste Management. Integrated Solid Waste Management (ISWM) is a comprehensive waste prevention, recycling, composting, and disposal program. An effective ISWM system considers how to prevent, recycle, and manage solid waste in ways that most effectively protect human health and the environment. ISWM involves evaluating local needs and conditions, and then selecting and combining the most appropriate waste management activities for those conditions.

Material Recovery Facility. A materials recovery facility, materials reclamation facility, materials recycling facility or Multi re-use facility (MRF - pronounced "murf") is a specialized plant that receives, separates and prepares recyclable materials for marketing to end-user manufacturers. Generally, there are two different types: clean and dirty MRFs. The former takes segregated waste streams, the latter takes unsegregated waste.

Mechanical Biological Treatment (MBT). MBT combines both mechanical and biological treatment methods, i.e. open windrow composting (WC), materials recycling facilities, anaerobic digestion, and in-vessel composting. These will be supported by a combination of pre-treatment and sorting techniques at the front-end of the process, and a selection of emissions control and quality control techniques at the end of the process.

Organic Waste. Waste of a biological nature which can be broken down, in a reasonable amount of time, into its base compounds, by micro-organisms and other forms of treatment, regardless of what those compounds may be. They have also been considered as "organic waste" and are referenced in this study.

Recovery. A practice whereby waste is reclaimed for further use in a process which involves the separation of waste from a waste stream for further use and the processing of that separated material as a product or raw material.

Recycle. A process where waste is reclaimed for further use, and the processing of that separated material as a product or raw material.

Re-use. To utilise components of the waste stream again for a similar or different purpose without changing the form or properties of that component.

Separation at Source (S@S). The practice of setting aside post-consumer materials and household goods so that they do not enter the mixed waste streams.

Treatment. The National Environmental Waste Management Act No. 59 (2008) defines treatment as any method, technique or process that is designed to:

a. Change the physical, biological or chemical character or composition of a waste; or
b. Remove, separate, concentrate or recover a hazardous ortoxic component of a waste; or
c. Destroy or reduce the toxicity of a waste, in order to minimise the impact of the waste on the environment prior to further use or disposal.

Waste Management Hierarchy. The waste management hierarchy provides a systematic and hierarchical approach to integrated waste management, addressing in turn waste avoidance, reduction, re-use, recycling, recovery, treatment, and disposal as a last resort.

Waste to Energy (WtE). The conversion of waste materials into useable heat, electricity, or fuel through a variety of processes, including combustion, gasification, pyrolysis, anaerobic digestion, and landfill gas (LFG) recovery.

Chapter 1
INTRODUCTION



1 Introduction

1.1 Background of the AISWM Programme

The South African Government through its Department of Environmental Affairs and in partnership with the German Development Cooperation has embarked upon the implementation of an **ADVANCED INTEGRATED SOLID WASTE MANAGEMENT** (AISWM) Programme for the Republic of South Africa (RSA).

The Programme concentrated on project preparation in municipalities and disseminated knowledge, experience and the practical application of Advanced Waste Treatment (AWT) as well as broader AISWM systems in the context of South African municipalities.

AISWM is not a universally known term but is used to describe Integrated Solid Waste Management (ISWM) utilising **ADVANCED WASTE TREATMENT** technologies, within a framework of policies, legislation and practices that reduce dependency on landfill for the disposal of waste. The Programme defines AISWM as the coherent and sustainable application of approaches and solutions that have the effect of reducing the amount of waste that needs to be landfilled.

AISWM is the process of advancing waste management practices up the hierarchy away from landfill and towards creating energy, recycling and composting, reuse and reduction. AISWM does not necessarily demand the use of sophisticated and expensive technology; rather it involves a basket of management systems and appropriate technologies that succeed in sustainably diverting waste away from landfill.

The National Department of Environmental Affairs (DEA) coordinates the programme at national level, with Rustenburg Local Municipality (RLM) and uMgungundlovu District Municipality (UMDM) partnering at a local level. Each of the partner municipalities receives tailored consultancy support for the preparation of **AISWM** projects that may be integrated into, and be sustainable within, their local situation.

The objectives of the Programme were to demonstrate **AISWM** systems in municipalities and undertake **KNOWLEDGE DISSEMINATION AND TRAINING ON BEST PRACTICES, EXAMPLES, AND LESSONS LEARNED** from the projects to decision makers in other South African municipalities.

A series of five Knowledge Products (KPs) were prepared to support capacity building on the subject of AISWM across South Africa. The aim of the KPs is to provide clear, concise, and factual information to support decision-making on AISWM and AWT, so that municipalities and their partners can plan and implement the next generation of facilities.

1.2 Relationship to Knowledge Products in this Series

This Knowledge Product 5 (KP5), ***OPERATOR MODELS TO FACILITATE ADVANCED WASTE TREATMENT***, is the fifth KP in the series. It builds on KP1: *Introductory Guide to Advanced Waste Treatment,* KP2: *Appropriate Technology for Advanced Waste Treatment,* KP3: *Recognising the Informal Waste Sector (IWS) in Advanced Waste Treatment*, and KP4: *Financial Implications of Advanced Waste Treatment.*

KP5 provides guidance on the management and contracting arrangements for AWT facilities and services. It identifies and classifies the different contractual approaches relevant to the AWT technologies, identified in KP2 and KP4 as being the most appropriate and applicable to South Africa. This knowledge product presents lessons learnt from elsewhere in the world on introducing sustainable operator models for AISWM, a methodology by which bespoke optimum operator model(s) can be selected and, finall y, how municipalities can establish AISWM systems to sustainably support AWT technologies. The full suite of KPs is illustrated in Figure 1.1.

Figure 1.1. Relationship among Knowledge Products in this Series

1.3 Scope of Knowledge Product 5

This series of Knowledge Products has demonstrated that AWT is unlikely to be directly financially competitive with landfill disposal of waste, except for cases, where the availability and/or proximity of available landfill capacities are limited.

Municipalities, pursuing AWT, therefore, need to frame their projects in terms of the strategic, environmental, and social benefits that they bring, in developing the local economy, business opportunities, and livelihoods.

It has been demonstrated globally that the strongest AWT projects are those that are founded on a thorough grasp of the availability of feedstock material for the particular facility, and those that are well connected to the markets for process outputs.

The main objective of KP5 is to provide clear, concise, and factual information to support decision-making by municipalities and their relevant stakeholders on introducing advanced waste treatment technologies.

South Africa, is committed to moving waste management practices up the so-called waste management hierarchy by reducing, and diverting, waste materials disposed of to landfill so that their value is not lost. South Africa's National Waste Management Strategy enshrines this approach towards reducing the amount of waste that needs to be landfilled, and to gradually shift waste management practices up the hierarchy of options from "disposal" to "create energy", "recycle and compost", "reuse", and "reduce".

Within an **AISWM** context, it is the middle band of the hierarchy (i.e. recycling and composting, and the creation of energy) as shown in Figure 1.2. AISWM, Waste Management Hierarchy, which is the focus of this KP.

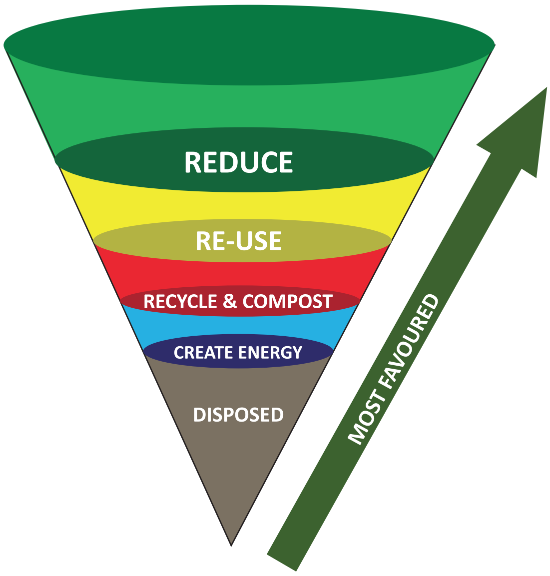

Figure 1.2. AISWM, Waste Management Hierarchy

The **AWT** technologies are defined as a specific technology or facility that alters the characteristics of waste through physical, thermal, chemical and/or biological processes either prior to, or in place of, landfill. This definition effectively means that any technology or facility that meets environmental standards, and leads to a sustainable reduction in demand for landfill, can be considered to be advanced waste treatment.

In practice, most "waste treatment" facilities being developed internationally include a component of recycling/composting and energy recovery in the same facility. Treatment therefore often relates to both the "recycling and composting" and "create energy" strata of the waste hierarchy.

The technologies that are covered by the operator models represent both mainstream, and emerging, technologies that can be applied for the treatment of **municipal solid waste** (MSW). Moreover, this KP will only present those operator models identified for the short- and medium-term, i.e. proven technologies with the greatest potential for uptake across South Africa rather than those which, due to cost, are unlikely to be considered except for the largest municipalities and, even then, specific circumstances or where exceptional factors apply.

Table 1. Short, Medium, and Long-Term Delineation of AWT Technologies

Technology Grouping	Classification	Example Technologies
Promising Technologies - short term	Technology options that are being practiced and/or under developed in South Africa and those which have a strong potential for contributing to advanced Integrated solid waste management in South Africa.	**Open Windrow Composting.** **Clean materials recycling facility.** **Dirty materials recycling facility.**
Potential Technologies – Medium Term	Technology options that have scope for successful applications in South Africa where appropriate conditions are in place. These conditions would require a technology well suited to the waste streams, one which is affordable, competitive, and represents a considered component of an advanced integrated solid waste management system.	**Mechanical Biological Treatment.** **Anaerobic Digestion.** **Energy from Waste (incineration).** **In-Vessel Composting.**
Potential Technologies – Long Term	Technologies that are unlikely to have applications in South Africa in the short to medium term, except under specific circumstances (e.g. for processing a "difficult" waste stream) or where exceptional factors are in place (e.g. grant funding for a demonstration unit).	**Gasification.** **Pyrolysis.** **Plasma Gasification.** **Mechanical Heat Treatment.**

The objective of KP5 is to provide guidance on the management and contracting arrangements for appropriate AWT facilities within a South African AISWM context. Operator models which are applied internationally, will be presented in this KP, depending on the AWT facilities. A comparison between public and private models will be undertaken and the eligible suggested models for being the South African context.

KP5 is divided into five main sections, as follows:

- **Section One** presents an introductory overview of the background to this study. It briefly introduces the waste management hierarchy, the position of AWT technologies within the hierarchy, and identifies the most appropriate examples of AWT technologies, for which operator models will need to be developed to facilitate their short to medium-term implementation in South Africa.

- **Section Two** defines an "operator model", and its position within the wider institutional framework for supporting ISWM systems. It presents the basis for identifying, and subsequently developing, the most promising arrangements operator models for South Africa by presenting the main lessons learnt from other developing countries in the development of such operator models to facilitate AISWM systems. It also presents the main generic management arrangements under which service delivery is organised, controlled, and financed. It further links context and conditions for selecting an operator model, and puts forward a number of objectives, one or a combination of which will shape decision making on operator models.

- **Section Three** transposes the theory at global context in Section Two into a South African context, through the development of bespoke operator models for each of the main "quick win"/ "special case", short/medium-term technology types hitherto identified. As a prelude, it presents the main elements of the country's prevailing policy/planning and legislative frameworks. It also presents a screening of the potential "generic" models to identify those which will work best in South Africa – the screening being undertaken against a set of sustainability criteria based on a desk-based review of policy/legislative drivers augmented by stakeholder interviews with a number of representatives from the waste management industry in Cape Town, Johannesburg, and Pretoria.

- **Section Four** outlines the selected business opportunities for the use of AWT technologies in South Africa, which are implementable and scalable given the local solid waste management (SWM) context.

- **Section Five** presents the key conclusions and recommendations.

Chapter 2

OPERATOR MODELS: GLOBAL BEST PRACTICE



2 Operator Models: Global Best Practice

2.1 South African Context

The main purpose of this section is to briefly outline the main components of the planning/policy and legislative frameworks in South Africa, which could influence the bespoke operator model to be developed for each technology type. The majority of the information in this section is taken from the "Alternative Waste Treatment Guide" (DEA, 2015).

2.2 Legislative Framework

The implementation of AWT Technologies by municipalities and by the private sector triggers a large number of complex legislative and regulatory requirements. The sector itself is currently governed by a number of pieces of legislation, including:

- The South African Constitution (Act 108 of 1996);
- Hazardous Substances Act (Act 5 of 1973);
- Health Act (Act 63 of 1977);
- Environment Conservation Act (Act 73 of 1989);
- Occupational Health and Safety Act (Act 85 of 1993);
- National Water Act (Act 36 of 1998);
- The National Environmental Management Act (Act 107 of 1998);
- Municipal Structures Act (Act 117 of 1998);
- Municipal Systems Act (Act 32 of 2000);
- Municipal Waste Sector Plan, GN 270 of 2012;
- National Domestic Waste Collection Standards, GN 21 of 2011;
- Municipal Finance Management Act, 56 of 2003;
- Mineral and Petroleum Resources Development Act (Act 28 of 2002);
- Air Quality Act (Act 39 of 2004);
- National Environmental Management: Waste Act, 2008 (Act 59 of 2008); and
- National Environmental Management: Waste Amendment Act, 2014 (Act 26 of 2014).

The most relevant of these are briefly outlined below:

2.2.1 Constitution of South Africa

The Constitution of South Africa, 1996 (the Constitution) provides the foundation for environmental regulation and policy in South Africa. The right to environmental protection and to live in an environment that is not harmful to health or well-being is set out in the Bill of Rights (Section 24). This fundamental right underpins environmental policy and law, in particular the framework environmental legislation established by the National Environmental Management Act, 1998 (Act No. 107 of 1998).

The Constitution assigns concurrent legislative competence to national and provincial government with respect to the environment and pollution control (Section 146). It assigns exclusive provincial legislative competence to local government for matters of cleansing and refuse removal, refuse dumps, and solid waste disposal. The Constitution allows national legislation to set national norms and standards relating to these matters in cases where national uniformity is required to deal effectively with waste management.

2.2.2 The National Environmental Management Act (Act 107 of 1998)

The National Environmental Management Act (NEMA) introduces a number of additional guiding principles into South African environmental legislation, including the life-cycle approach to waste management, producer responsibility, the precautionary principle, and the polluter pays principle. Chapter 5 of NEMA provides instruments for integrated waste management. NEMA further places a duty of care on any persons who may cause pollution or degradation of the environment, requiring them to institute measures to either prevent pollution from occurring, or to minimise and rectify the pollution or degradation where it cannot reasonably be avoided.

2.2.3 The National Environmental Management: Waste Act 2008 (Act 59 of 2008)

The Waste Act fundamentally reformed waste management and, for the first time, provided a coherent and integrated legislative framework addressing all the steps in the waste management hierarchy. The waste management hierarchy provides a systematic and hierarchical approach to integrated waste management, addressing in turn waste avoidance, reduction, re-use, recycling, recovery, treatment, and safe disposal as a last resort. The Waste Act echoes the duty of care provision by obliging holders of waste to take reasonable measures to implement the waste management hierarchy.

Norms and standards are therefore the foundation of the regulatory system established by the Waste Act. The Waste Act obliges national government to develop norms and standards on key regulatory matters, while it may develop additional norms and standards on certain ancillary matters. Provinces and municipalities may also develop standards provided they do not conflict with national standards.

The Waste Act needs to be read in conjunction with the body of legislation that regulates local government, including the Municipal Finance Management Act (MFMA), 2003 and the Municipal Systems Act, 2000, which create the overall framework for planning, budgeting, service delivery, and reporting at local government level. For example, Section 3 of the Act requires the state, including local authorities, to put in place uniform measures to ensure this is achieved, i.e.

- Local standards for the separation, compacting and storage of solid waste that is collected as part of the municipal service or that is disposed of at a municipal waste disposal facility;
- Local standards for the management of solid waste that is disposed of by the municipality or at a waste disposal facility owned by the municipality, including requirements in respect of the avoidance and minimisation of the generation of waste and the reuse, recycling and recovery of solid waste; and
- Local standards in respect of the directing of solid waste that is collected as part of the municipal service or that is disposed of by the municipality or at a municipal waste disposal facility to specific waste treatment and disposal facilities.

While waste reduction, reuse, recycling and recovery are encouraged, this must be done in a manner which utilizes a minimal amount of natural resources with minimal environmental impact when compared to disposal.

The Waste Act establishes cooperative governance mechanisms for dealing with matters such as waste planning, the designation of waste management officers, and performance reporting. National and provincial government departments are also constitutionally obliged to support municipalities in the execution of their functions. The Waste Act does not apply to areas that are regulated by their sectoral legislation including: radioactive waste, residue deposits and residue stockpiles, the disposal of explosives, and the disposal of animal carcasses. A key aspect of the Waste Act is the requirement to develop a National Waste Management Strategy.

2.2.4 Municipal Structures Act (Act 117 of 1998)

Metropolitan, district, and local municipalities are established in terms of Municipal Structures Act (read together with the Constitution), and their powers and duties are set out therein. The division of powers between district and local municipalities is also governed by the Act.

These two categories of municipalities are required to designate associated powers, but it is up to a district municipality to seek the achievement of integrated, sustainable, and equitable social and economic development of its area as a whole. These municipalities must co-operate by assisting and supporting each other. In this regard, each entity may request the other to render financial, technical, and administrative support services but only to the extent of its ability to do so.

2.2.5 Municipal Waste Sector Plan, GN 270 of 2012

The Plan has several objectives aside from improving performance and professionalism in municipalities and better service delivery. One objective is to reduce the amount of general and hazardous waste going to landfills. This is to be achieved through source separation (which is seen as long term goal for all municipalities). This intervention, in collaboration with the recycling industry, could include the establishment of one, or a combination of: buy-back and drop-off centres, kerb-side collection of recyclable material, and/or materials recovery facilities.

2.2.6 National Domestic Waste Collection Standards, GN 21 of 2011

These Standards state that source separation should be encouraged and supported in line with relevant industry waste management plans. In addition:

- All domestic waste must be sorted at source (i.e. at household level) in all metropolitan and secondary cities;
- The service provider/municipality must provide clear guidelines to households regarding types of waste, the sorting of waste, appropriate containers, and removal schedules for each type of waste; and
- Community involvement in recycling must be encouraged.

The municipality must provide an enabling environment for households to recycle domestic waste. An enabling environment could include kerbside collection and/or well-kept drop-off centres within easy reach. Where the municipality does not provide for kerbside collection of the recyclable component of source separated waste, it must co-operate with the recycling sector to ensure the provision of facilities where recyclables can be dropped off for collection by service providers. Mainstream recyclables (i.e. paper, cardboard, newspapers, magazines, plastic, glass, cans and tins) must therefore, according to the level of service provided, be either collected at households or from communal collection points by the municipality or service providers. Non-mainstream recyclables (electronic waste, scrap metal, batteries, fluorescent lights, used oil, etc.) must be routed to clearly marked drop-off centres at well-advertised locations for collection by service providers in the relevant recycling sector.

2.2.7 Municipal Systems Act (Act 32 of 2000)

Various environmental obligations and principles are prescribed by this Act. For example, municipal services must be equitable and accessible, as well as environmentally and financially sustainable. Services can be provided either through an internal or external mechanism (i.e. with own resources or through a service provider, such as a private contractor, community based organisation, Non-Governmental Organisation (NGO) or even another sphere of government). The Act sets out various circumstances when a municipality must review and decide upon a mechanism to provide services. Sections 78 to 81 state in detail the procedure and requirements to be followed when deciding on whether to opt for an internal or external service delivery mechanism. Prior to deciding on an external mechanism a municipality must assess the direct and indirect costs and benefits associated with such a move, including amongst others, the expected effect on the environment, human health, well-being and safety, and job creation.

2.2.8 Municipal Finance Management Act (Act 56 of 2003)

Municipalities may enter into a public-private partnership agreement, but only if the municipality can demonstrate that the agreement will:

- Provide value for money to the municipality;
- Be affordable for the municipality; and
- Transfer appropriate technical, operational and financial risk to the private party.

The agreement must comply with the Municipal Public-Private Partnership (PPP) Regulations, GN R 309 of 2005. Furthermore, if it involves the provision of a municipal service then Chapter 8 of the Municipal Systems Act must also be complied with. Before a PPP is concluded, the municipality must conduct a feasibility study which, among others:

- Explains the strategic and operational benefits of the PPP for the municipality in terms of its objectives;
- Describes in specific terms the nature of the private party's role in the PPP, the extent to which this role, both legally and by nature, can be performed by a private party;
- Takes into account all relevant information; and
- Explains the capacity of the municipality to effectively monitor, manage and enforce the agreement.

Prior to the initiation of the feasibility study the municipality must notify the National Treasury and the relevant provincial treasury of the municipality's intention, together with information on the expertise within the municipality to comply with the provisions of section 120 of the Act. In addition, if requested to do so by the National Treasury or the relevant provincial treasury, the municipality must appoint a person with appropriate skills and experience, either from within or outside the municipality, as the transaction advisor to assist and advise the municipality on the preparation and procurement of the PPP agreement.

Regulation 5 sets out the basic requirements a PPP agreement must comply with, namely that it must provide value for money to the municipality, be affordable for the municipality, describe in specific terms the nature of the private party's role in the PPP, and confer effective powers on the municipality to monitor implementation of, and to assess the private party's performance under, the agreement, and to manage and enforce it, etc. No municipal entity may initiate, procure, or enter into a PPP agreement on its own or on behalf of its parent municipality, but it may be a party to such an agreement initiated, procured, and entered into by its parent municipality.[1]

[1] Regulation 10

2.3. Policy and Planning Framework

2.3.1 Policy

The main policy document which sets the principle directions for waste management in the country is the "National Waste Management Strategy" (2011) which, in turn, is a legislative requirement of the National Environmental Management: Waste Act, 2008 (Act No. 59 of 2008), hereafter referred to as the "Waste Act".

The purpose of the National Waste Management Strategy (NWMS) is to achieve the objectives of the Waste Act, which defines its scope and specifies its contents. Organs of state and affected persons are obliged to give effect to the NWMS. The Waste Act indicates that the Minister must review the strategy at intervals of not more than five years. Whilst the period that the strategy covers is not specified, the bulk of its provisions will relate to the five-year period prior to the next strategy review.

The NWMS is structured on a framework of the following eight goals and their associated targets which should have been met by 2016 (Table 2).

Table 2. Main Goals and Targets of the National Waste Management Strategy

Goal	Target
1. Promote waste minimisation, re-use, recycling, and the recovery of waste.	• 25% of recyclables diverted from landfill. • All metropolitan municipalities, secondary cities, and large towns have initiated separation at source (S@S) programmes. • Achievement of waste reduction and recycling targets set in Waste Management Plans (WMPs) for paper and packaging, pesticides, lighting, and tyre industries.
2. Ensure the effective and efficient delivery of waste services.	• 95% of urban households and 75% of rural households have access to adequate levels of waste collection services. • 80% of waste disposal sites have permits.
3. Grow the contribution of the waste sector to the green sector economy.	• 69 000 new jobs created in the waste sector. • 2 600 additional SMEs and cooperatives participating in waste service delivery and recycling.
4. Ensure that people are aware of the impact of waste on their health, well-being, and the environment.	• 80% of municipalities running local awareness campaigns. • 80% of schools implementing waste awareness programmes.
5. Achieve integrated waste management planning.	• All municipalities have integrated their management planning. Integrated Waste Management Plans (IWMPs) have met the targets set in IWMPs. • All waste management facilities required to report to South African Waste Information System (SAWIS) have waste quantification systems that report information to WIS.
6. Ensure sound budgeting and financial management for waste management services.	• All municipalities that provide waste services have conducted full-cost accounting for waste services and have implemented cost reflective tariffs.
7. Provide measures to remediate contaminated land.	• Assessment complete for 80% of sites reported to the contaminated land register. • Remediation plans approved for 50% of confirmed contaminated sites.
8. Establish effective compliance with, and enforcement of, the Waste Act.	• 50% increase in the number of successful enforcement actions against non-compliant activities. • 800 Environmental Managers (EM) are appointed in the three spheres of government to enforce the Waste Act.

Source: DEA 2011

In order to achieve these eight goals, the Waste Act encourages the following measures to be undertaken:

- Waste classification and management system, i.e. a methodology for the classification of waste and provision of standards for the assessment and disposal of waste for landfill disposal;
- Norms and standards, i.e. establishing the baseline regulatory standards for managing waste at each stage of the waste management hierarchy;
- Licensing, i.e. lists of activities that require licences (with conditions), and those that do not if undertaken according to conditions or guidelines;
- Industry waste management plans, i.e. enables collective planning by industry to manage their products once they become waste, and to collectively set targets for waste reduction, recycling, and re-use;
- Extended Producer Responsibility (EPR), i.e. which regulates industry to be responsible beyond the point of sale for particular products that have toxic constituents or pose waste management challenges, particularly where voluntary waste measures have failed;
- Priority wastes – identifies categories of waste that, due their risks to human health and the environment, require special waste management measures, particularly where a solution requires the involvement of multiple role-players; and
- Economic instruments – encourages or discourages particular behaviour and augments other regulatory instruments.

The NWMS places a number of obligations on government, the private sector, and civil society for the implementation of the above measures.

2.3.2 Planning

On the basis of the various policy and legal framework (e.g. MSA and MFMA), a systematic planning process can be elaborated for establishing an AWT solution, i.e.

- Municipal needs analysis;
- Options assessment;
- Feasibility; and
- Implementation.

These are further elaborated as follows:

2.3.2.1 Municipal Needs Analysis

A status quo assessment of the MSW generation, collection and treatment will provide the municipality with a better understanding of waste management in their area, not least the adequacy of the current systems and processes in place for handling an AWT project. This assessment includes the current status with regard to the delivery of services, number of residents, demographic profile and socio-economic composition of a municipality; the quantity of material available for recovery; and the characterisation/classification of waste, etc. The collected data should then identify priority waste streams to be addressed. The assessment will form the basis for analysing what AWT technologies (if any) will be viable to treat the identified priority waste stream(s).

This assessment will form the basis for the municipalities to compile an IWMP for long term and holistic planning, and to integrate the IWMP into Integrated Development Plans (IDPs) to ensure that the waste project's needs, as identified in the IWMP, are integrated into municipal planning and that a budget is allocated.

2.3.2.2 Options Assessment

The options screening process essentially comprises a waste characterisation study (including thermal, chemical, physical properties, composition, and quantities.), with particular reference to the waste volumes needed to pursue a specific technology option. As part of the assessment process, the municipality should consider the financial implications on municipal budgets, site issues (i.e. any complications arising with the physical location of the site), legislation/regulations, and market potential for technology outputs. One of the key aspects of the options assessment is to establish whether it will be a municipal service or a municipal function. This is important as it will determine, whether the project will be delivered through an internal or an external mechanism (i.e. requiring a contract). The former is a service that a municipality (in terms of its powers and functions) provides and levies fees, charges, or tariffs with respect to such a service, e.g. waste collection, whereas a municipal function is an activity that the municipality is mandated to provide, e.g. recycling.

A PPP is significant if technical, financial, and operational risks are to be transferred.

2.3.2.3 Feasibility Study

Once the most appropriate option has been identified, the next stage is to assess its feasibility from a number of perspectives, not least technical, financial, value assessment, environmental and delivery model/contracting. For example, the former will encompass aspects such as the composition and quantity of waste and the suitability of a technology and, furthermore, whether there is a market for the product or not. The financial assessment will consider aspects such as project cost, financing options, and financial modelling (tariffs, payback period, etc.). The value assessment will determine the relative costs, benefits, and value added from the identified option, with the delivery model/contracting assessment determining how the contracting should be done.

The assessment of environmental feasibility should comprise the location, the environmental processes to follow, and whether an environmental impact assessment (EIA) is required. Throughout the entire feasibility assessment process, the relevant stakeholders should be consulted regularly, to be fully involved in any decision-making that could impact upon the project's implementation. The feasibility study itself should conclude with the development of an implementation and procurement plan. The entire study should then be presented to the Municipal Council for approval.

2.3.2.4 Implementation

The implementation and procurement plan will give guidance to the procurement process leading to the compilation of a contract. The plan must follow supply chain management (SCM) regulations in terms of the procurement process, not least in terms of any competitive procurement (including PPP), which must comply with Section 120 of the MFMA. It is important to note that once a contract is finalised, it may trigger Section 33 of the MFMA if the municipality has a financial obligation beyond three years.

The contract management includes a number of procurement stages (signing of contract), development stage (signing a commitment to service delivery), delivery stage (period during which services are provided and used), and exit stage (end of project).

Table 3 presents the types of contracts that are potentially possible and their expected/typical duration.

Figure 2.1 Extruded plastic pellets from Source Separated plastic waste

Table 3. Types of service delivery contracts between private and public entities.

Type	Description	Duration
Service	Service provider being paid a fee by the municipality to provide operational services.	1-3 years
Management	Municipality pays service fees to service provider assuming all responsibility for operation and maintenance of delivery service.	5 years
Lease	The service provider rents facilities from municipality for operations and maintenance.	10 years
Concession	The concessionaire will lease assets owned by the municipality for period of concession. The focus will be on operating, maintenance and financing of existing fixed assets.	15+ years
Build-operate-transfer (BOT)	This is a standalone capital project for which a concession is granted and where the municipality may or may not receive profits or fees.	15+ years

Source: DEA 2015

The implementation of AWT technologies can necessitate both capital and operational costs. Examples of the former include use of the Municipal Infrastructure Grant (MIG), the Equitable Share Programme/ Consolidated Municipal Infrastructure Programme (CMIP), Expanded Public Works Programme (EPWP), donor funding, financial institutions, and public-private partnerships, etc. Examples of operational costs include tariffs, rates, equitable share, donor funding, and product revenue.

2.4 Informal Sector

The waste sector, like many other commercial sectors in South Africa and other Middle Income Countries around the world, has a very active informal waste sector (IWS) that has been reclaiming and recognising 'waste' as a resource for decades.

The IWS does function with a surprising degree of internal co-operation. On the working front of a landfill site, for example, there is often some form of order within the apparent chaos. For example, the division of access rights to materials is commonplace. This reflects the status, which the reclaimer has within the social group, and the business relationships each individual has within the recycling value chain. On the streets, different informal reclaimers often concentrate on different materials – once again based on their commercial relationships within the supply chain networks that they serve.

The IWS can be categorised according to the four types of activities which it performs:

- Waste Collection and Transport: occurs in low-income areas not served by municipal waste collection services. Entrepreneurs provide this service and might charge a pick-up fee to residents. Long distances and the lack of transport are key stumbling blocks and tend to prevent the IWS from growing organically and financially;

- Cleaning Services: sometimes informal workers perform other waste-related services such as street sweeping and cleaning of public facilities;

- Recovery of Recyclables: the most common activity in South Africa in which itinerant waste buyers (IWB) go "door-to-door", collecting, buying, or bartering for valuable materials prior to formal collection or "cherry picking" of materials (i.e. extracting the most highly-valued materials) from landfills or bins and bags placed out on streets prior to municipal collection for re-use or recycling; and

- Manufacturing Activities: individuals or informal enterprises sometimes make use of unprocessed recovered material as raw materials (e.g. aluminium and textile waste). This can include those formal enterprises which have contracts with businesses. Businesses now regard the waste hierarchy as a means of improving their bottom line.

Informal waste collection and transport, and the provision of other waste-related services, are referred to as the informal service sector. These activities are mostly found in un-serviced areas (including rural, urban and informal settlements) in South Africa. The recovery of recyclables is the largest informal waste activity in the country, whilst manufacturing activities (item 4) occurs sporadically. Although the IWS is involved with all of the earlier-mentioned activities, the most relevant activity for many municipalities is the recovery of recyclables, and this is also the focus of Knowledge Products 3 ("*Recognising the Informal Waste Sector in Advanced Waste Treatment*") in this series of publications.

Approximately 150 000 reclaimers are estimated to be active in the South African IWS[2] working within, and parallel to, the formal waste management system. This is a significant workforce and one that is not officially recognised in national statistics. Very little research has been carried out on the IWS, and data on the quantities of materials extracted and valorised by this sector of the economy is completely lacking.

Significant funds will continue to be spent on modernising waste management infrastructure and services across the country. Part of the challenge in implementing new, more advanced, waste management systems, is how to work with the IWS in a 'fair deal' where materials are directed away from landfill at the same time as preserving livelihood opportunities, improving health and safety conditions, and ensuring the dignity of work.

It is anticipated that some resistance to formalisation from the IWS will be inevitable. Therefore, trust needs to be built by using a bottom-up approach, and this will take significant time and effort. However, there seems to be no pragmatic alternative.

2.5 What is an "Operator Model"?

An "operator model", in generic terms, is the contractual relationship between the public authority and an operator.

Within the context of an AISWM system, the relationship is more complex and is a function of the six institutional functions inherent within an ISWM (Figure 2.2. after Wilson et al., 2001). These include, amongst others, the following:

- Client, who is responsible for ensuring the provision of a reliable ISWM system meeting the required standards;

[2] The global benchmark estimate for low and middle income countries (UN Habitat 2010: 1), is that 1% of the urban population in developing countries survives by reclaiming recycled material from waste. The IWS in South Africa is conservatively estimated at approximately 150 000 people (approx. 0.4% of the total urban population, or 6% of the total informal sector).

- Operator, who is responsible for the delivery of the MSWM service on the ground;
- Revenue collector, who is responsible for collection of revenue for ISWM;
- Policy, which is the framework set at National level and implemented at Regional and Local levels within which ISWM are delivered;
- Planning, which describes the responsibility for strategic and operational planning and general programing and control.

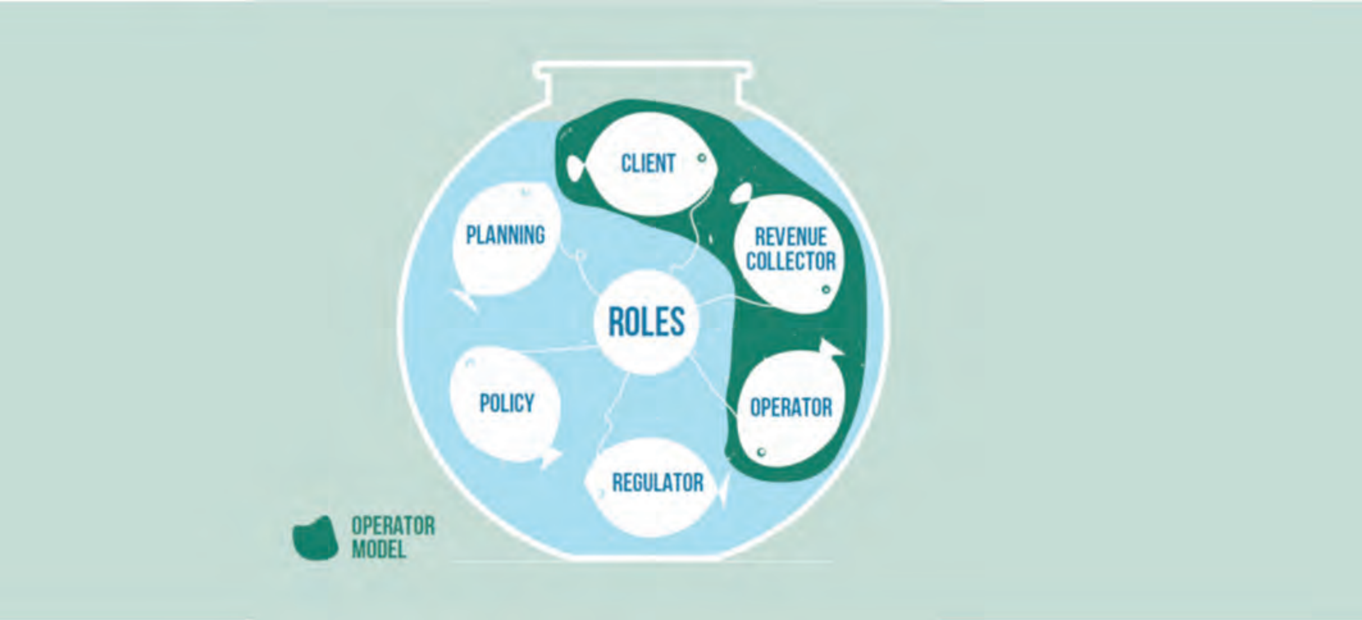

Figure 2.2. Essential Functions in providing Solid Waste Management Services (Source: Wilson et al., 2001)

With respect to the earlier-mentioned functions, the planning, policy maker, and regulator roles are defined within a national framework of sectorial policy, regulations, and planning.

An "operator model" is a local expression at project level of this national sectorial framework in terms of the relationship between ownership, decision-making, responsibility, contracts and agreements, human resources management and money flows between the operator, client, and revenue collector (Figure 2.3)

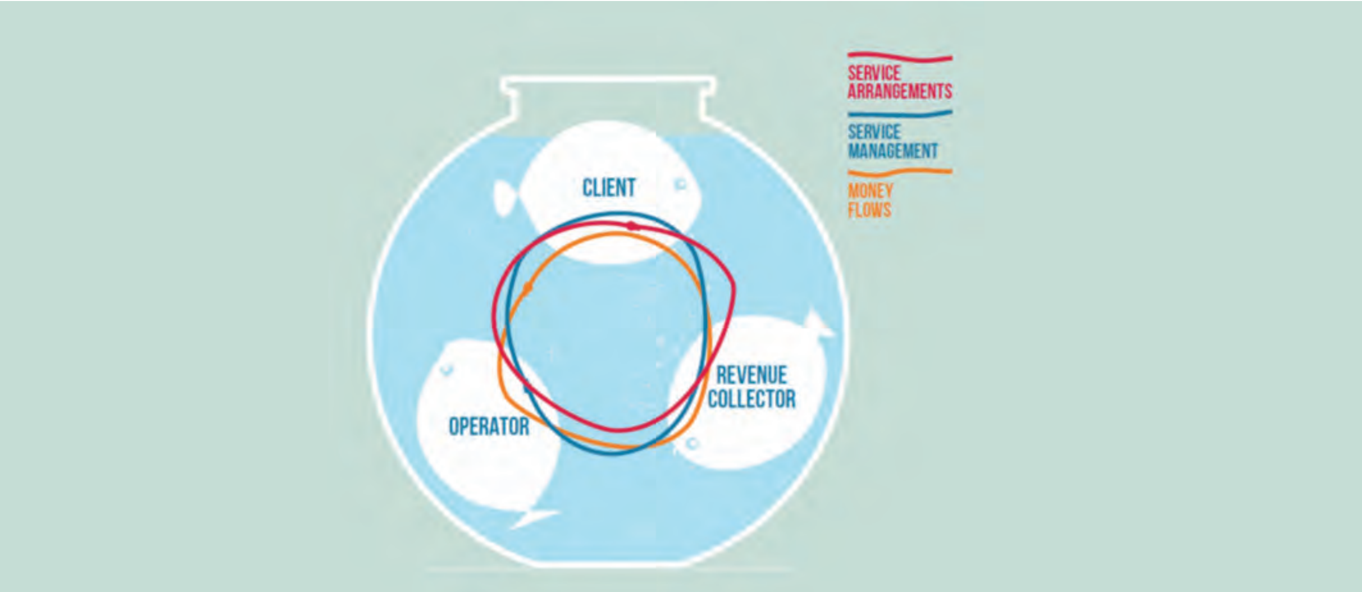

Figure 2.3. Components of an Operator Model (Source: GIZ, 2013)

The roles of client, revenue collector, and operator are distinct. They may be located in different institutions or, even, in different departments of the same organisation. For example, in an operator model, where collection is undertaken by the private sector, then the private sector company is the "operator", the public authority is the "client" (responsible for ensuring the provision of a reliable waste management service), and also the "revenue collector" responsible for collecting the fees to operate the service. On the contrary, in a 100% public operator model, the municipality can simultaneously be the "operator", "client", and "revenue collector", albeit the three functions are performed by different departments. In practice, few operator models are purely public or purely private – rather there is a continuum of options between these two extremes.

Within any given operator model, the "client" function invariably rests with the municipality in order to ensure that public health and environmental conditions are protected, that services are undertaken at a level of quality required, and that costs are affordable. However, the "revenue collector" function may actually be provided by a range of different organisations (e.g. the service provider, the municipality, or another third party) and, similarly, the "operator" function can be undertaken by a range of different organisations.

Within this basic framework, there are various operator models which can arise due to a multitude of possible client, operator, and revenue collector arrangements and, depending on the location of these functions, a variety of ways to contract, organise, manage, and finance a municipality's waste management services.

In addition to a municipality "internalising" its waste management system (e.g. when treatment and disposal facilities are located within the same administrative territory as the waste generators), there are cases when the operator model needs to reflect inter-municipal co-operation, i.e. a partnership between two or more municipalities in order to expand a waste management system's geographical boundaries, thereby facilitating the planning and physical location of waste management facilities as well as benefiting from economies of scale (i.e. making public services cheaper for everyone) and upgrades of performance indicators, i.e. improving public services. Figure 2.4 below (GIZ, *op.cit.*) presents the continuum between self-reliant municipalities and nationally administered services.

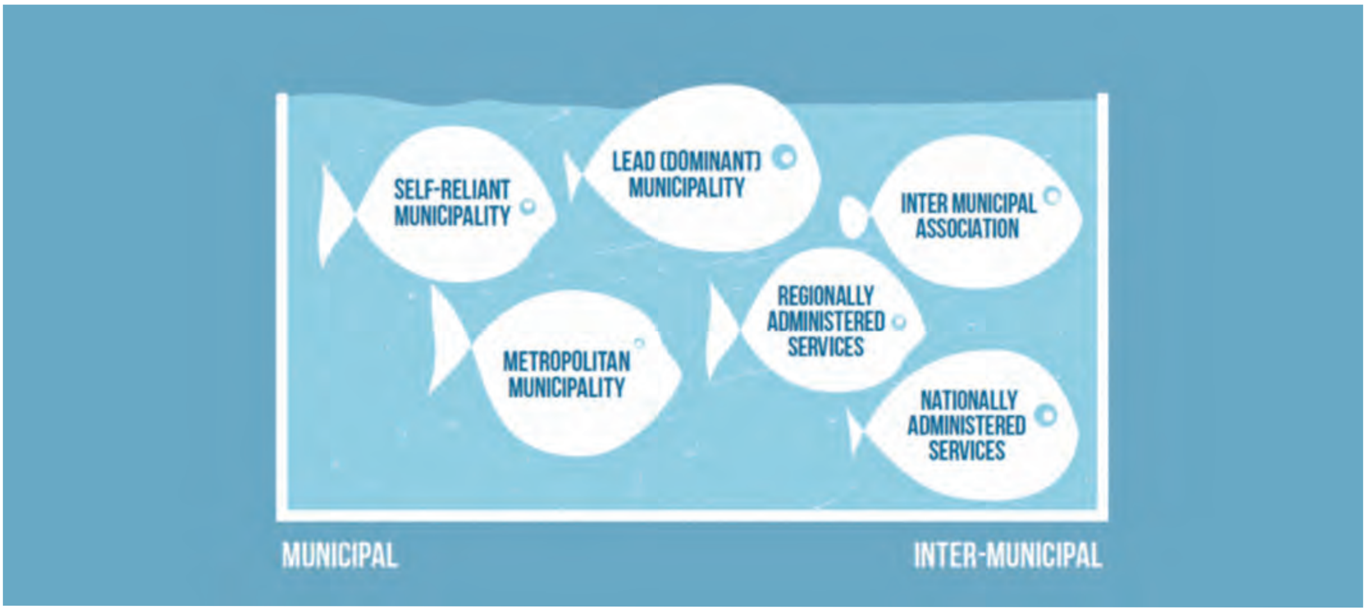

Figure 2.4. The Continuum between Operator Models for Self-Reliant Municipalities and Nationally Administered Services.

In inter-municipal, regional, or nationally organised models, the "client function" within the operator model is located at that respective institutional level, whether being one or more municipalities or at regional/national government.

2.6 Getting the Project Concept Right

Municipalities can attract investment into their waste management system, but only when the framework conditions outlined earlier are optimal. The material and energy value of the waste is rarely sufficient for AWT projects to be financially self-sustaining. Therefore, a gate fee is usually required for an AWT facility to function effectively.

This series of Knowledge Products has demonstrated that AWT is unlikely to be directly financially competitive with the landfill disposal of waste (albeit there are a number of indirect benefits), except in cases where the availability and/or proximity of available landfill capacity is limited. Municipalities that are actively pursuing AWT therefore need to frame their project concepts in strategic, environmental, and social benefits that they bring in terms of developing the local economy, business opportunities, and livelihoods.

All this rests on a sound selection of technical options, and the existence of a competitive market for investment and business entrepreneurship.

2.7 Institutional Capability of the Client

There are two key considerations to take into account in terms of the client's capability to participate in, and form part of, a robust operator model.

Pivotal Role of the Client

The client, the authority responsible for ensuring the provision of a reliable municipal solid waste management (MSWM) system, has a pivotal role. A strong client and local political will to change things makes a very big difference.

Technical & Financial Capability of the Client

The technical and financial capacity of the client (and indeed the operator as well) is important, particularly in understanding any prevailing strengths and weaknesses in capacities, and in managing the respective elements of the prevailing SWM system.

2.7.1 Management

The institutional roles of client, operator, and revenue collector have to be recognised regardless of whether a model is municipal, inter-municipal, or has private sector participation. Each of these roles has a different function in providing waste management services, and they require a different set of capacities and skills. The key management criteria in this context comprises, amongst others:

- High User Inclusivity – the extent to which stakeholders have access to, and influence on, how the system works – is relevant to the management of services under all model types;
- Appropriate, affordable, and applicable technical solutions – ensures investments into systems that are suitable, affordable, and interface well with already functioning systems, infrastructure, and technologies;
- Transparency in decision making and procurement helps to ensure that the available resources are going where they are supposed to;
- The importance of piloting new initiatives prior to full roll-out will help reduce the risks that are associated with any change made to the existing system;

- The existence of reliable and consistent data will facilitate better decision-making when choosing technical solutions;
- A focus on household waste will help to concentrate scarce resources/efforts, and therefore lead to optimal results in municipal ISWM; and
- Institutionalising good management practices is beneficial to any operator model.

2.7.2 Financial Management

Some operator models have inherently weak financial management practices (in particular public operator models) as, in some countries, the authority is not always being checked by an external party, and there is less threat of penalties for poor performance whilst other operator models, e.g. private sector participation (PSP) models, have inherently strong practices. Irrespective, there are three financial management practices that are equally important to any model's successful implementation:

- Cost accounting – this is good management practice, and is more regularly and robustly done when the private sector is involved;
- Awareness of costs and revenues, and thus working towards balancing the budget, will increase the reliability of the service; and
- Approaching full-cost recovery, i.e. working towards paying for operational costs and refinancing from local budgets will help the service running at a reliable quality.

2.8 Private or Public Operators?

The most successfully operating AWT facilities are those that are:

- Well integrated into the overall ISWM system;
- Founded on a thorough grasp of the availability of feedstock material; and
- Closely connected to the markets for process outputs.

Research on global experience has shown that there is no particular 'right or wrong' between public and private operated waste management services *per se* (GIZ, 2013); there are many examples of well-functioning AWT systems for both public and private operator models. In this respect, it is important to note that there is a diversity of Public Private Partnerships (PPP) arrangements, ranging from franchising primary collection, to contracting out parts of the collection and transport system, to privately operated MRFs, green waste composting working under short term contracts, and through to more complex municipal Public Private Partnership (PPP) projects for more capital intensive mechanical, biological, and thermal treatment facilities. The essential ingredients of a functional waste management system are a sound concept, a technically competent client, a well-articulated service specification, and a financially stable operator.

2.8.1 Public Models for Advanced Waste Treatment

International experience has shown that a public operator model is used at various governance levels, most commonly at municipal or inter-municipal level, when one or more of the following conditions are present:

- International experience suggests that there is often an embedded belief that the public model will be more cost efficient compared to a Private Sector Participation (PSP) (Chapter 2.8.2) model, often due to previous poor experiences of the PSP process;

- There is a focus on social objectives (such as increasing employment and protecting livelihoods), the public sector thereby being perceived as an opportunity to achieve a social objective;

- Interested operators may be hard to find, particularly if the private sector perceives that there is insufficient profit-making potential (e.g. either the market is not big enough, and/or user charges are very low, etc.);

- There are national/local policies, which favour public models, e.g. where legislation favours public models through subsidies, making financing more readily available, or by providing incentives such as tax cuts; and

- Unfair market practices, such as a monopoly, can induce a switch-back from private sector to public sector provision.

2.8.1.1 Advantages & Disadvantages of Public Models

The advan tages and disadvantages of choosing a public operator model are summarised in Table 4.

Table 4. Advantages and Disadvantages of Public Sector Operator Models

Public Models	
Advantages	• Municipalities have an immense amount of experience in providing waste collection and disposal services in the specific local context; • Municipalities have full control over assets and services; and • Municipalities may be exempt from paying VAT or equivalent taxes.
Disadvantages	• Municipalities tend to pay less attention to feasibility studies when modernising, since there is no tendering involved; • Municipalities tend to pay less attention to cost accounting and cost recovery, or maximising revenues, since there is no pressure to make a profit or immediate threat of bankruptcy; and • Municipalities tend to have less experience in the operation of modern resource recovery facilities or other AWT (therefore a significant need to build capacity) when compared to their private counterparts who do this as their core business and are more market oriented.

2.8.2. Private/Private Sector Participation Models for Advanced Waste Treatment

International case studies have shown that there is a wide diversity of PSP operator models currently being used to facilitate the delivery of municipal waste management services. The following section summarises the main operator model approaches, including insights into models for building sustainable collection systems as, although the focus of this document is on operator models to facilitate sustainable AWT technologies, collection systems need to be put in place to ensure that the waste “feedstock” for such facilities is effectively captured and transported to the facility.

2.8.2.1 Collection

The waste collection service is often divided into “primary” and “secondary” services, i.e. it reflects the fact that waste often undergoes a two-stage process of primary collection from dwellings, and is subsequently placed at a transfer point or station and collected for onward transport to the transfer station or disposal point. Primary collection of waste is required where large collection vehicles are unable to gain access to areas of service, and is often typified by small vehicles which can serve densely arranged houses, or heavily trafficked streets, etc. Primary collection services thus lend themselves to small-scale service providers, because providing the service is non capital intensive.

2.8.2.2 Primary Collection

Primary collection is an extension of the regular waste collection service into suburban, peri-urban, or low income areas with poor infrastructure. If a "one step" collection system is unable to reach all customers, then manual collection is needed to remove the waste. International experience suggests that the optimum PSP operator model can include multiple micro-providers, through short-term area based contracts and decentralised management.

Table 5. Advantages and Disadvantages of the Optimum PSP Model

Optimum PSP Operator Model	
Benefits	• Job creation and micro-enterprises development, involving community members into service provision in their own area or district; and • Flexibility, making it easy to start small and progressively roll out the service step-by-step.
Drawbacks	• The monitoring and management effort is significant, and can only happen at the local level through regular meetings and constant monitoring; and • Micro-scale providers have very limited financial capacity and may need financing schemes for the service to be provided at the required standards.

2.8.2.3 Secondary or "One Step" Collection

Secondary collection is the collection of solid waste for the second time, e.g. from community collection points, prior to its transport to a transfer station, treatment facility, or disposal site. The secondary collection service begins where the primary service ends, i.e. at the communal containers, collection points, or transfer stations.

International best practice suggests that the optimum PSP operator model for secondary collection services is a medium to long-term service contract, with medium to large-scale companies, and is particularly suitable for door-to-door collection systems in relatively high income and good infrastructure neighbourhoods. Conditions and capacities that favour this choice include:

- Decision makers are of a good opinion that the private sector is more cost effective;
- There is interest from suitable private companies, because they believe the contract to be profitable due, in part, to the amount of waste handled and the user charge/fee per tonne that can be obtained;
- The municipality is able to manage a transparent selective bidding process for selecting the operator; and
- The municipality is aware of the risks and benefits, and is able to negotiate beneficial contract terms for the entire contract duration from the point of view of quality and affordability of the service. The main benefits and drawbacks from such an operator model can be summarised as follows:-

Table 6. Benefits and Drawbacks of the Optimum PSP Model for Secondary Collection

Optimum PSP Model for Secondary Collection	
Benefits	• Involving the private sector allows the municipality to facilitate investment into vehicles and containers through use of a private company; and • The service providers acting on the national and international markets are usually experienced companies with proven track records that are able to ensure an efficient/modern service.
Drawbacks	• An increased reliance from the municipality on investment from a private company will result in limited scope for negotiation on terms and conditions such as the level of user charges. • Another drawback could be where a municipality already possesses human and capital assets (perhaps in part) for delivery of these services. Labour unions strongly oppose the outsourcing of services historically undertaken by the public sector, e.g. waste collection.

2.8.2.4 Waste Recycle/Recovery/and Treatment

2.8.2.4 (a) Recycling

International best practice suggests that the integration of the informal recycling system (IRS) into an ISWM system will increase current recycling rates (thereby reducing costs to the authorities) and also professionalise it by moving away from the commonly practiced “dirty and illegal” recycling to one that protects workers’ livelihoods, health, and safety. This approach will work provided that the following conditions are met:

- Protecting livelihoods is on the agenda of the local authorities, and there should be an openness to recognise its added value;
- Awareness at the decision-making level needs to be transferred to the public through awareness campaigns; and
- Provision of capacity building and assistance to the sector to eliminate child labour.

The PSP operator model that works best in these circumstance is a Design, Build, Finance, and Operate (DBFO) Agreement/Joint Venture (with the local authority) for a long-term concession contract including a wide range of resource recovery activities - with or without the participation of the informal sector. The contracts are usually long term – 30 years or more – to allow for investment recovery, with the private company usually charging the local authority a gate fee.

The private sector will be interested in investing in a resource recovery plant that includes recycling, if:

- The waste quantities are large enough and the waste streams contain enough recyclable materials to make the business attractive;
- There is a market for recyclables; and
- Environmental legislation is in place which, in line with the polluter pays principle, mandates the payment of at least a gate fee and/or tax on landfilling and user charges.

The benefits and drawbacks of this PSP operator model are stated in Table 7.

Table 7. Benefits and Drawbacks of the Optimum PSP Model for Recycling

Optimum PSP Recycling Model	
Benefits	• Implementation of state of the art technologies; and • Large capital investments from the private sector.
Drawbacks	• High operational costs that are charged partially or completely to the municipality and thereby the citizens; and • Lack of flexibility in some of the facilities operated, thereby potentially locking waste streams into one solution for a long time.

2.8.2.4 (b) Resource Recovery

The optimum PSP operator model for resource recovery at a commercial scale is through a large company in a long term Build Finance Operate Transfer (BFOT) type of concession contract. These types of treatment facilities usually include a sorting stage (either mechanical or manual), and then various treatment and recycling options for the sorted waste streams. These facilities are particularly attractive for investment if, in an ideal situation, they are financed through a combination of a gate fee and the sale of recyclables, compost, Refuse Derived Fuel (RDF), energy, or greenhouse gas (GHG) reduction units or credits granted under the Kyoto Protocol mechanism.

International experience suggests that the conditions and capacities that need to be in place for choosing this model are:

- Existing market for the products of the Material Recovery Facility (MRF) plant;
- Sufficient waste quantities to make economies of scale possible;
- Incentives from the local authority to attract investors such as offering land or other assets or other favourable conditions that increase the profitability of the investment; and
- Capacity of the municipality to assess the proposed technology's reliability and applicability to developing countries as well as the cost implications of such projects to the public.

If the enabling conditions and capacities need to be met. The benefits and drawbacks of this particular operator model are listed in Table 8.

Table 8. Benefits and Drawbacks of the Optimum PSP Model for Resource Recovery

Optimum PSP Operator Model for Resource Recovery	
Benefits	• Attracting private investment capital to waste management; • High capability and know-how of the private sector in the building and operation of the treatment facility; and • Opportunity to divert waste from landfilling to resource recovery and treatment.
Drawbacks	• Such facilities tend to be financially feasible only on a large scale; • There is a risk of excluding informal recyclers from the market if project development and contracting is not done properly; and • The facilities may function without environmental permits, or that any "products" produced by the facility are not used in an environmentally sound way. • Inputs such as energy/electricity and potable water and outputs such as residues, sludges and contaminants, and the management thereof, may also be negative aspects

In contrast to the "commercial scale" scenario described earlier, a PSP operator model for facilitating resource recovery on a non-profit sharing, or profit sharing, basis is most commonly done for small or community scale facilities. When treatment is implemented at the community level, its members often form cooperatives and share the treatment revenues attained through common efforts.

Some technologies such as biogas production, charcoal production, and composting, may be done at varying scales. Composting has the highest chance of success and capacity as a sustainable option due to the high organic fraction of waste in low and middle-income countries and favourable weather conditions for biodegradation.

The conditions that favour this option include:

- Capacity and knowledge to operate the facility; and
- Existing demand for the output of the facility.

Source separation increases the quality of the end product and is likely to increase the product's marketing potential. However, this applies only if a Mechanical Biological Treatment (MBT) Plant is implemented, whilst simultaneously impeding the activities of the informal recycling sector (IRS). However, should this not be possible, then MBT could be combined with the informal sector or waste picker associations, focusing on both the recovery of recyclables and bio-stabilisation of the residual waste.

2.8.2.4 (c) Disposal & Treatment

The basic operator model options for improving disposal and treatment are similar to those for resource recovery. The main difference is that there is no economic incentive in the intrinsic value of the materials, and thus this is traditionally a public service provided by the municipalities.

The main PSP operator model for disposal and/or treatment is via a large company for the operation of a sanitary landfill, regardless of whether it is publicly or privately financed. The typical contract is a long-term concession contract, either Design, Build, Operate, and Transfer (DBOT) or a variation that includes financing (DBOFT). In case of DBOT, ownership and control is retained by the local authority. In the case of DBOFT, the company operating the landfill has a higher negotiating power and may be able to obtain high gate fees due to its almost monopoly position that may prove unaffordable over time. The feasibility of taking on the task of operating a landfill depends on the quantity of waste entering the landfill, because operators are usually paid via a gate fee.

2.8.3 Inter-municipal Models to Facilitate Advanced Waste Treatment

Inter-municipal models may be either public or private implemented via the co-operation of municipalities. Usually, this requires a waste management system to be organised through the co-operation of local authorities within a municipality, region, province, or country depending on country size and the administrative units into which it is organised.

Inter-municipal models are usually chosen to facilitate economies of scale, i.e. recycling, treatment, incinerating, and landfill facilities, which cost less per tonne at higher capacities. There is a number of enabling conditions which facilitate the choice of an inter-municipal operator model, namely:

- A tradition of good cooperation between municipalities in waste management (or other sectors) and a consensus on the solidarity principle, i.e. all municipalities "coming together" under a common goal or vision;
- A focus on sound management and operation through professional structures, economic efficiency, and cost recovery as governance strategies;

- The availability of fiscal facilities for inter-municipal models;
- Availability of a legal framework for establishing and running inter-municipal organisations; and
- Feasibility studies, which show that an inter-municipal model will result in savings due to economies of scale.

Inter-municipal operator models yield a number of positive aspects, for example cost efficiency in investment and operation that allows smaller municipalities to enjoy benefits from waste management services that they would not have had the capacity to achieve on their own and, no less important, the possibility for municipalities to learn from each other and build on each other's experiences. The key disadvantage is that smaller municipalities may lose decision-making power over their waste management activities in the long-term to larger municipalities or the metropolitan city in the area.

2.9 Common Operator Models for AWT Facilities

2.9.1 Introduction

This section is divided into two sub-sections:

- To present the common operator model for each of the main technologies judged to be the most appropriate, applicable, and affordable for South Africa, in the short to medium-term, based on international best practice (see Table 13); and
- To present common operator model options for the additional supporting elements within the MSW management value chain (e.g. primary and secondary collection) for supporting AWT operator models.

Choosing an AWT technology has implications both downstream, in the collection system through quality and quantity requirements, and upstream in the market development for the recovered resources. With respect to the former, and as already alluded to in this study, attention needs to be placed on ensuring that the potential feedstock for the respective AWT technologies is not just fully captured at source but efficiently/effectively transported to the facilities.

Waste collection includes all physical and mechanical activities undertaken to transfer waste from the point of waste generation, and move it to the place of transfer resource recovery, treatment, or disposal.

The interface between the primary and secondary collection service is a vital point of intervention in the design of a waste management system. Without a fully functioning interface, the collection/transfer points can often become urban dumpsites.

Therefore, a municipality will require a robust operator model for supporting primary collection irrespective of the AWT technology, whereas the need for secondary collection will depend upon the selected or available collection vehicles and upon the transfer system and AWT facilities in place.

The following section presents the optimum generic operator models based on international best practice for supporting primary and secondary waste collection systems, and its subsequent transfer to the AWT facilities.

2.9.2. Primary Collection

Primary collection is a service that is generally financed through user fees – users are willing to pay at the very least, for primary collection, regardless of income level. The revenue collector for this service is most commonly either the operator or the public authority. Table 9 presents the various options for public and private sector operator models for institutionalising primary collection based on international best practice.

Table 9. Private and Public Sector Operator Models for Primary Waste Collection

Type	Description	Advantage(s)	Drawback(s)
Public model: primary and secondary collection. *Primary collection by the public authority together with secondary collection.*	The public authority provides primary collection/door to door services, as an integral part of the overall waste collection service.	Experienced operator. Direct control over service provision.	Workers may be demotivated by the lack of a reward structure. Inherently weak monitoring and control if inspection and operation functions are not clearly separated. More likely to depend on national or local budget for financing.
Micro franchise PSP: primary collection. *Primary collection by micro-service providers (MSPs) as a singular service item, with revenue collected by MSP.*	Micro-scale service providers are franchised to provide primary collection/door to door services, and collect a small fee from the door. Predominately short-term (2-5 years) area-based contracts based on invitation.	Friendly and familiar system. Can be flexible and cost efficient. May facilitate rapid rollout to unserviced area.	Increased monitoring is needed; otherwise waste collected may not end up in the designated sites. Risk of waste accumulation in case of non-payment as the operators will only collect waste if they are paid for the service.
Micro contracted PSP: primary collection. *Primary collection by MSPs as a singular service item, with revenue collected by MSP.*	MSPs are franchised to provide primary collection/door to door services, and are paid for the service by the public authority. Predominately short-term (2-5 years) area-based contracts based on invitation.	Friendly and familiar system. Can be flexible and cost efficient. Control over non-payers is possible.	Micro-management and increased monitoring is needed, otherwise waste collected may not end up in the designated sites, and the risk of waste accumulation is increased.
PSP: primary and secondary collection. *Primary collection by medium-large private service providers together with secondary collection.*	Medium-large scale private operators provide primary collection/door to door services, as an integral part of the overall waste collection service. Medium-longer term (5 to 15 years) and larger area contracts attributed through a bidding process. The service needs to be adjusted in areas with more difficult infrastructure; in these areas sub-contractors or additional employees may be used.	Can be a flexible and cost-efficient solution. Less management and monitoring effort is needed from the public authority as the contractors take on part of these tasks in the areas where primary collection is needed.	Less responsive to local demand for primary collection service. Public authority has less direct control over extent and quality of the primary collection service.

Source: Soos et al., 2012

2.9.3 "One Step"/Secondary Collection

Secondary collection is capital intensive and, in order to function effectively, needs a well-managed and well-resourced operator. Indeed, the more capital intensive the secondary collection service, then the more commonly the service is provided by fewer/larger companies. Moreover, there are cases that support the view that private sector participation makes the service more cost-effective, especially if there are good contracts in place and bidding conditions that foster competition. On the other hand, keeping the service public (or provided by municipal companies) may bring advantages as profit is not factored into the costs, and services may be exempt from VAT.

Table 10 presents the main operator models that have been used to institutionalise secondary collection services.

Table 10. Private and Public Sector Operator Models for Secondary Collection

Type	Description	Advantage(s)	Drawback(s)
Public model: secondary/one-step collection. *Secondary/one step collection by the public authority*	The public authority provides either a one-step or the secondary collection service. The service costs come out of the public authority budget, and revenue is collected via taxation systems and/or government subsidy.	Experienced operator, no dependence of private operator's equipment.	Inherently weak monitoring, control, and financial management. Services may be run as a cost centre with less attention to efficiency.
Public enterprise: secondary/one step collection. *One-step or secondary collection service by a public enterprise.*	The public authority establishes a public company or enterprise to provide the services. Revenue is collected via taxation systems and/ or government subsidy with billing either managed by the enterprise or via the public authority.	Experienced operator. Good management, monitoring, and control.	Inherently weak financial management because there is no real pressure to control costs, and make a sustainable profit in the public sector. More likely to run as a cost entre, with less attention to efficiency. May rely more on public funds.
PSP service contract: secondary/one step collection. *Secondary/one-step collection with medium-large companies under service contracts with, and paid for, by the public authority.*	The public authority contracts out the provision of either one-step services or the secondary collection to a PSP, and pays for this service. The public authority owns part or the whole of the assets, and leases these for the use of the PSP contractor. The service contracts are usually medium term (5-15 years) contracts based on serviced areas and attributed through a bidding procedure.	Cost efficiency; Good monitoring and control. In case companies underperform they get penalties or payment reductions. Efficient financial management.	No private investment. Attention can be placed on maximising revenue rather than service coverage and performance. Requires strong client competence.
PSP concession contract: secondary/ one-step collection. *Secondary/one step collection with medium to large companies under concession contracts with, and paid for by, the public authority.*	The public authority grants a PSP the exclusive right to operate, maintain, and carry out investment for one-step services or secondary collection service, and pays for this service. The private operator is required to make and sustain the necessary investments in collection vehicles and other equipment. The concession contracts are longer term (8-25 years) to allow recovery on investments. Contracts are based on serviced areas and attributed through a bidding procedure.	Cost efficiency; Good monitoring and control. Efficient financial management. Access to private investment. Knowledgeable and capitalised operators.	Risk of loss of direct control of the municipality to negotiate contract terms or loss of power to intervene in case of emergency situation. Increased risk of corruption, since the economic interests can be relatively high.
PSP franchise: secondary/one-step collection. *One-step or secondary collection service carried out by private sector providers under a franchise or open competition model.*	Private service provider is licensed/ franchised to provide services, and granted the responsibility and right to collect their own revenue from municipal waste generators. The franchise contracts are longer term (8 – 25 years) to allow recovery on investments. Contracts attributed through a bidding procedure.	Low management efforts for securing financing of operations. Performance based contracts allow control of service quality.	Low payment rates and no legal mechanism at the operator to constrain the non-payers. This may cause accumulation of waste or illegal dumping. Areas may be serviced by more than one operator leading to structural inefficiencies.
PSP joint venture: secondary/one-step collection. *One-step or secondary collection service carried out by joint venture public/private companies.*	Joint venture companies are established between the public authority and a PSP to provide collection service.	Access of municipality to operational decision-making. Access to private investment and expertise.	Inflexible solution, as it involves a long-term commitment to a single service provider/partner. Requires a strong client to specify and negotiate terms of partnership. Governance procedures can be difficult to set and change.

Source: Soos et al., 2012

2.9.4 Transfer Stations

Introducing or improving transfer stations is driven by the need to improve the cost efficiency of the logistics when waste is transported over long distances to the point of disposal. Transfer station operation may be integrated at the back-end of the collection services contract, or at the front end of the treatment disposal contract, or simply exist as a singular service. Therefore, the revenue collector and source of financing may be similar to those in collection, i.e. part of a user charge, or the payment based on quality of service from the public authority to the operator. Alternatively, it may be similar to the arrangements in a treatment plant or disposal facility, i.e. based on a gate-fee collected either from the public authority or the operator delivering waste at the gate.

Table 11. Public and Private Operator Models for Facilitating Waste Transfer

Type	Description	Advantage (s)	Drawback (s)
Public model: transfer. *Transfer by public authority or enterprise*	The public authority finances, owns, builds, and operates the transfer station(s) either directly or through a public company. Financing of operations is through the public authority budget.	The public authorities have some experience in operation. There is no incentive for double counting of waste to gain unfair advantage.	Inherently weak monitoring, control, and financial management due to the lack of profit motivation when compared to the private sector. Lower environmental performance.
PSP service: transfer. *Transfer services provided by PSP under service contract and paid by the public authority.*	Public authority finances the design, construction, and operation of the transfer station, tendering the operations to the private sector, either linked to the collection or disposal service contracts, or contracted independently of these services. The public authority pays for this service based on the tonnes handled and owns all the assets.	Experienced operator. Good management, monitoring, control. Environmental performance can be easily enforced.	Less control over the waste management system interfaces. No private investment funds attracted.
PSP concession: transfer *Transfer investment and services by PSP under concession contract with and paid by the public authority.*	The public authority grants a PSP the exclusive right to operate, maintain, and carry out the investment for transfer service, and pays for this service based on the tonnes handled. The private operator is required to make and sustain the necessary investments in fixed and mobile assets.	Private investment funds attracted. Cost efficiency; Good monitoring and control. Efficient financial management. Environmental performance can be easily enforced.	Less control over the waste management system interfaces. Risk of double counting waste handled to increase the payments received from the public authority.

Source: Soos, Whiteman, Wilson, Briciu, & Schwehn, 2012

2.9.5 Integrated Waste Management Services

The financing of an integrated waste management service is through local taxes, user charges, or a combination of the two. Other revenues may come from the sale of either recyclables, compost, or energy depending on the activities foreseen in the integrated model. The revenue collector may be the public authority, operator, or a third party such as a utility company.

Table 12. Public and Private Operator models for integrated solid waste management

Type	Description	Advantage (s)	Drawback (s)
Integrated public service. *All service elements combined into one, provided by the public authority or enterprise.*	Full integration of the collection and treatment/ disposal service elements with the public authority or enterprise performing the entire service	Experienced operator in street sweeping, collection and disposal. Single source accountability for service performance. Interfaces between different parts of the service chain are clear.	The public operator may lack expertise in recycling, composting, and treatment activities. Inherently inadequate monitoring, control, and financial management due to poor profit motivation. The time from project concept to allocating investment financing may be lengthy.
Integrated PSP concession: *All service elements combined into one, with investment financing, construction, and operation by the PSP.*	Full integration of the collection and treatment/ disposal service elements, contracting out to the private sector. The contractor is required to finance, construct, and operate facilities/ services and is paid a price per tonne of municipal waste.	Allows for an integrated management of the service. Less management effort on the one side of the public authority, as it needs to deal with only bidding process, one operator.	Heavy reliance on one operator. The operator may lack expertise in one or the other aspect of waste management. May not be sufficiently demand responsive to citizens' needs. Long-term engagement that may not fulfil changing requirements in the long-run.
Integrated PSP. *Integrated waste management combining all service elements into one, provided through joint venture PSP.*	Full integration of the collection and treatment/ disposal service elements through a joint venture with a private company. The public authority provides financial guarantees, and often also staff, and the private partner manages the service and brings in investment for the construction/upgrading of service and facilities.	Allows for an integrated management of the service. More control over operations from the public authority.	Heavy reliance on one operator. The operator may lack expertise in one or the other aspect of waste management. More involvement in the day-to-day operations, delivery, and management is needed from the side of the public authority. Long-term engagement that may not fulfil changing requirements in the long-run.

Source: Soos et al., 2012

2.9.6 Conclusions

The AWT technology chosen has implications both downstream, in the collection system through quality and quantity requirements, and upstream, in the market development for the recovered resources. The interface between the primary and secondary collection service is a crucial point of intervention in the design of a waste management system. Robust operator models will be required for supporting primary collection, irrespective of the AWT technology, whereas the need for secondary collection will depend upon the selected, or available, collection vehicles and upon the transfer system and AWT facilities in place.
In terms of institutionally supporting primary collection, there are four main operator models typically used. These comprise a public model (i.e. primary collection by the public authority together with secondary collection), a micro-franchise PSP primary collection model (i.e. primary collection by micro-service providers (MSPs) as a singular service item, with revenue collected by MSP), a micro-contracted PSP primary collection model (i.e. primary collection by MSPs as a singular service item, with revenue collected by MSP), and a PSP primary and secondary collection model, i.e. primary collection by medium-large private service providers together with secondary collection. Each model contains distinct advantages and disadvantages.

From a secondary collection perspective, there are five operator models commonly used throughout the world. These comprise of two solely public models (i.e. public model: secondary one step collection by either a public authority or private enterprise respectively), and three private sector participation models comprising concession contract secondary collection (i.e. secondary collection with medium/large enterprises under concession contracts with, and paid for by, the public authority), franchise secondary collection (i.e. secondary collection service carried out by private sector providers under a franchise or open competition model), and joint venture secondary collection, i.e. a secondary collection service carried out by joint venture public/private enterprises.

In terms of supporting secondary collection, transfer stations are often used to improve cost efficiency when waste needs to travel long distances to the point of either treatment or disposal. Three operator models are commonly used to support this process: i) Transfer by a public authority or enterprise; ii) Transfer services provided by PSP under service contract and paid by the public authority; and iii) Transfer investment and services by PSP under concession contract with, and paid by, the public authority. As stated earlier, each of these models has advantages and disadvantages.

2.9.7 Promising "Quick Win" Technologies

2.9.7.1 Open Windrow Composting

Composting is the simplest form of biological treatment and is suitable for the treatment of some source-segregated biological or organic / putrescible waste streams. In its simplest form, composting takes place in the open air in large elongated uniform prism shaped 'piles' of waste, known as windrows.

Figure 2.5 A Typical Windrows Composting Operation

Historically, this has been the standard form for commercial green garden waste and on-farm composting operations, and is suitable for grass cuttings, prunings, and leaves. It is not suitable for composting food or catering waste, because the process is open to the air and cannot be controlled to demonstrate the achievement of the sustained high temperatures required for sanitisation.

The waste feedstock is mechanically shredded and placed into long windrows on a solid, non-permeable surface. Water may be added, depending on the moisture content of the waste. The windrows are turned regularly, either with a wheeled loader for small-scale operations or by a specialist windrow turner machine (pulled along by a tractor / a dedicated vehicle) for larger sites. The windrows are turned several times during the composting process, which takes in the region of twelve to sixteen weeks, depending on product quality and maturity requirements. The compost may be suitable for use as a soil improver for horticultural and agricultural purposes, or for large scale remediation/landscaping works. Open windrow composting (WC) is a relatively low capital waste treatment process which, in developing countries, can have a high success rate (when compared to incineration or MBT because it is less sensitive to economies of scale and conditions are favourable to composting due to the high organic fraction of waste and favourable weather conditions for bio-degradation.

Table 13. Presents the typical operator models which have been used to support open windrow composting.

Table 13. Public and PSP Operator Model Options for Supporting Open Windrow Composting

Type	Description	Advantage (s)	Drawback (s)
Public Model composting *Composting established and managed by the public authority*	The public authority develops and operates the composting plant.	Potential to generate revenues to offset the net costs of composting.	Inexperienced operator; inherently weak monitoring and control of the process. Possibility of a lack of attention to product quality may lead to costly system.
PSP service: composting *Composting facilities leased for operation to PSP*	Composting facilities are established by public authorities but operated under service contract by PSP.	Access to expertise. Market based flexible solution. Good control over Environmental and Health and Safety (EHS) standards.	May not be feasible without payment of an avoided landfill gate fee. Needs market development.
PSP concession: composting *Composting facilities established and managed by PSP*	The private sector finances and operates composting plant independently, and secures contracts from the public authority for the input material. These types of arrangement are more frequent for commercial scale composting.	Access to investment and expertise. Market based flexible solution.	May not be feasible without payment of an avoided landfill gate fee. Needs market development. Municipality has limited involvement and control.
Micro PSP: composting *Small-scale community composting by micro-service providers*	Micro-service providers establish and operate small scale decentralised composting facilities. All costs and revenues accrue to the PSP, but may be supplemented by payment of avoided costs of collection and disposal.	Access to private financing. Market based flexible solution. Reduces collection as well as disposal costs. End products may be used locally.	Typical operators are Community based Organisations (CBOs) and Non-Governmental Organisations (NGOs). Therefore, capacity building, awareness raising, and market development are necessary. The municipality has no involvement and control.

Source: Soos, Whiteman, Wilson, Briciu, & Schwehn, 2012

2.9.7.2 Clean Materials Recycling Facility

A clean MRF utilises mechanical separation techniques to further sort a partially pre-segregated waste stream into fractions suitable for sale onto re-processors. A clean MRF is suitable for the processing of dry mixed recyclables, which can be sourced from a number of suitable collections; namely, a domestic household recycling collection, a commercial dry recycling collection, or recycling collected by authorities at “bring sites”/civic amenity sites/drop off points. A clean MRF will segregate a mixed recycling stream into its component constituents, typically by materials and then by grade. The main outputs from a clean MRF will be separated recyclate such as paper/card, cardboard, mixed glass cullet, PET plastics, High Density Polyethylene (HDPE) plastics, plastic film, mixed aluminium, and mixed steel.

Clean MRFs will only operate on dry recyclables that have already been segregated from the remaining waste, therefore they are a component alongside a dedicated collection system. They can be low technology, i.e. with a substantial amount of manual picking, or high technology with more capital intense equipment (such as high speed imaging cameras, optical sorters, and pneumatic actuator separators). The most likely applications in South Africa would be to utilise manual pickers to help sort the recyclables in conjunction with some mechanical segregation (e.g. magnets). This would have the mutual benefit of reducing capital costs and maximising employment, with the strategic aim of transferring employment from landfill pickers to recyclate sorters, with the associated environmental, and health and safety improvements.

2.9.7.3 Dirty Materials Recycling Facility

A dirty MRF differs from a clean MRF in that it segregates valuable materials from a mixed 'dirty' waste stream rather than from the components of an already part segregated 'clean' waste stream. A dirty MRF typically recycles less than a quarter of input material and, in South Africa, experience to-date shows that the actual number is much lower than this. A dirty MRF may accept mixed solid waste, mixed commercial waste, or construction and demolition (C&D) waste and recover products suitable for a number of different outlets. For example, high quality recyclate may be extracted suitable for the reprocessing market, whereas lower quality recyclables will produce a high calorific value (CV) fuel (RDF) suitable for energy recovery facilities, and cement kilns. Fines and other rejects from the process will usually be of a low quality and sent to landfill.

Dirty MRFs consist of relatively simple technology and systems, and may be applied to a wide range of waste streams from C&D wastes through to commercial and household wastes. The technology presents an opportunity in South Africa as a method of deriving RDF for co-combustion in cement kiln. Dirty MRFs may provide significant employment through hand sorting and operation of the plant.

Table 14 presents the main operator models used to facilitate the sustainable introduction of both clean and dirty MRFs elsewhere in the world.

Table 14. Public and PSP Operator Models for Supporting Clean and Dirty MRFs

Type	Description	Advantage (s)	Drawback (s)
Public Model recycling *Collection and sorting of recyclables by the public authority or enterprises*	Separate collection and sorting of dry recyclables, or facilities, for sorting mixed municipal waste with or without RDF production are financed and operated by the public authority.	Potential to generate revenues for the public authority (client).	Inexperienced operator; inherently weak monitoring and control, costly system, displacing informal sector. Expensive solutions with little consideration to economies of scale in logistics.
PSP service: recycling *Collection of recyclables by the private sector under contract with the public authority*	PSP provide separate collection service for recyclables under a service contract, with net costs paid for by the public authority.	Experienced operator. Adaptable to new/updated service specifications. Potential to generate revenues to offset net service costs.	System can be costly; Potential to displace informal sector. May not have economy of scale, depending on the location of the client function.
PSP franchise: recycling *Collection and sorting of recyclables by the private sector under franchise contract with the public authority.*	Recycling systems are financed and operated by the private sector under a franchise arrangement with the public authority, potentially requiring payment of an "avoided landfill gate fee" to the franchise.	Highly attuned to market demand, business-oriented and facilitates access to investment. Relatively efficient system.	Driven solely by market demand. Limited control over service specifications. Operators will act in their business interest.
PSP open competition: recycling *Collection and sorting of recyclables by the private sector (informal/formal) in open competition.*	PSP recyclers (informal or formal) access and extract recyclable materials of value at various points in the waste management chain including door-to-door collection, from containers, transfer stations, and disposal sites.	Efficient service provided free of charge. Protection and creation of green jobs and livelihoods.	Limited investment. Difficulty increasing health, safety, and environment (HSE) practise and eliminating child labour in the informal sector due to ingrained work practices.

Source: Soos, Whiteman, Wilson, Briciu, & Schwehn, 2012

In addition to the above, Table 15 presents an additional operator model option for a dirty MRF at a landfill site.

Table 15. A Public Operator Model Option for a Combined Dirty MRF/Landfill Site

Type	Description	Advantage	Drawback
Public recycling co-operative: landfill *Landfill constructed and operated by the public authority; cooperative carries out recycling under franchise agreement.*	The public authority constructs and operates the landfill, allowing participation of recycling cooperatives to continue to extract and sort recyclables at the site under franchise type agreement.	Experienced operator; Improved control over informal recycling activities. Can charge socially affordable gate fee.	Actual standards may be less than acceptable. Difficulties in raising technical standards of disposal operations. Health and safety issues and conflict of interests between the municipality and IRS – especially on the working disposal cell.

Source: Soos et al., 2012

2.9.7.4 Conclusions

Promising "quick win" AWT technologies in a South African context comprise composting, and clean and dirty material recycling (MRF). Composting is suitable for the treatment of some source-segregated biological or organic/putrescible waste streams which, in its simplest form, takes place in the open air in large elongated uniform prism shaped piles of waste known as windrows. A clean MRF utilises mechanical separation techniques to further sort a partially pre-segregated waste stream into fractions suitable for sae onto re-processors. A dirty MRF differs from a clean MRF in that it segregates valuable materials from a mixed "dirty" waste stream rather than from the components of an already part-segregated "clean" waste stream.

There are a number of operator models used to support both of these technologies. With respect to composting, there are four operator models practised throughout the world, namely a "public" model (i.e. where composting is established and managed by the public authority), PSP concession model (i.e. where composting facilities are established and managed by PSP), a PSP service model (i.e. where composting facilities are leased for operation to PSP), and micro-PSP composting whereby small-scale community composting is undertaken by micro-service providers. All of these potential operator models have advantages and disadvantages.

There are four main operator models used throughout the world for institutionally supporting MRFs. These include a public model for recycling (i.e. where the collection and sorting of recyclables is undertaken by the public authority or enterprises), PSP service recycling (i.e. where the collection of recyclables by the private sector occurs under contract with the public authority), PSP franchise recycling (i.e. where the collection and sorting of recyclables by the private sector occurs under franchise contract with the public authority), and PSP open competition recycling – where the collection and sorting of recyclables by the private sector occurs under conditions of open condition. As per the composting operator models, all models have their advantages and disadvantages.

2.9.8 Potential "Special Case" / Medium-Term Technologies

2.9.8.1 Mechanical Biological Treatment

Mechanical biological treatment combines both mechanical and biological treatment methods supported by a combination of pre-treatment and sorting techniques at the front-end, and emissions control and quality control techniques at the back-end, of the process. It represents a suite of technologies, from low technology to high technology, using anaerobic or aerobic biological treatment stages. The treatment may be used to derive recyclables or fuel (in a similar manner to MRF), but also to digest or compost the biodegradable elements for: i) refinement and application to certain land uses; ii) as a pre-treatment to landfill, or; iii) to dry the organics to include within the fuel fraction of the waste. Certain configurations of MBT facility also use Anaerobic Digestion technologies to derive biogas from the organic element of the waste stream.

The mechanical and biological processes can be arranged in either order, with mechanical treatment preceding biological treatment or vice versa. Typical mechanical treatments will include a range of sorting technologies. Biological treatment will be in the form of either anaerobic digestion or aerobic composting (bio stabilisation or bio drying), and will produce a compost like output or digestate, which can be used for landfill capping, energy recovery, or remediation works. Stabilised bio-waste is generally a low value output from the treatment of mixed residual wastes that is likely to be unsuitable for uses other than as a soil improver or soil conditioner.

A MBT process will produce relatively low-quality mixed or separated recyclable materials (depending on the amount of separation activities undertaken to refine outputs). These materials are likely to be glass (as an aggregate), metals, and plastics. However, they can also include paper and other recyclate if extensive separation techniques are employed. MBT is a treatment concept that is gaining in popularity as different countries grapple with the challenge of conserving resources and reducing greenhouse gas emissions.

2.9.8.2 Anaerobic Digestion

Anaerobic digestion (AD) is an established treatment technology for source segregated organic wastes, in particular those including food waste, agricultural wastes and sewage sludge. Anaerobic digestion of organic waste entails the biological degradation of biodegradable wastes by microbes under strict controlled conditions - most facilities accepting food waste tend to blend the food waste with other waste streams including garden waste, and organic agricultural waste, including both animal and plant waste material.

During the process, biodegradable material is converted into methane (CH_4) and carbon dioxide (which together comprise a combustible energy source known as biogas), leaving a partially stabilised digestate consisting of a wet solid or liquid suspension of non-biodegradable materials, undigested organics, microbes, and decomposition by-products. Anaerobic digestion produces biogas which can be used to generate renewable heat and/or electricity. Matured digestate can generally be used directly at a nearby location, or dewatered, with the liquid being used further afield as a natural fertiliser with the further matured solid digestate used as renewable compost for soil improvement. The application of digestate in the field must be governed by a set of norms and standards. Anaerobic digestion has potential for application in treating a range of organic waste streams in South Africa, and it is a growing technology internationally. Careful consideration is required for correctly matching the waste stream with an AD technology type and choice of outlet for both digestate and biogas products.

Table 16 presents operator model options for both MBT and AD, particularly as part of an integrated facility, based on experience elsewhere in the world.

Table 16. A Public and Private Operator Model for MBT/AD as Part of an Integrated Facility

Type	Description	Advantage(s)	Drawback(s)
Public model: integrated resource recovery. *Public authority develops and operates an integrated resource recovery facility.*	The public authority develops and operates an integrated resource recovery facility combining different mechanical, biological, and thermal treatment processes.	Potential to generate revenues to partly offset the net costs of treatment.	Inexperienced operator; inherently weak monitoring and control. Lack of attention to product/output quality may lead to costly system. The time from project concept to allocating investment financing may be lengthy.

Type	Description	Advantage(s)	Drawback(s)
PSP: integrated resource recovery. *Integrated resource recovery facility provided by PSP under concession or service contract.*	The private service provider develops and operates an integrated resources recovery facility combining different mechanical, biological, and thermal treatment processes. The public authority usually pays a gate fee.	Technical efficiency. Access to investment and expertise. Market oriented operation. Ability to mobilise investment funds quickly and efficiently.	May be costly. EHS performance needs strict monitoring. Increased risk of economic influence.

Source: Soos et al., 2012.

2.9.8.3 Energy from Waste (Incineration)

Incineration (e.g. waste to energy (WtE)) is a thermal waste treatment technology which combusts waste in the presence of oxygen to produce heat which, in turn, can be used to generate electricity. It is usually applied in countries that are very densely populated and/or where land is scarce/ expensive, or there are specific policy drivers in place that make it an attractive option. It is the direct combustion of materials, with the release of energy recovered as heat, heat and electricity, or electricity only. Incineration combustion temperatures are typically in excess of 850^{0}C, and the waste is converted into carbon dioxide and water along with a wide variety of trace gases and ash residue. Any non-combustible materials (e.g. metals, glass) remain as a solid residue, known as Bottom Ash, which contains a small amount of residual carbon.

Incineration is a common waste treatment process in numerous countries across the world. It is an established technology that can be used to treat a variety of waste streams. It is capital intensive, although revenues from both gate fees and energy generation has made the technology competitive, particularly in those countries where there is a lack of an alternative fuel source or a high price is paid for traditional fuel sources (e.g. coal or natural gas). This treatment option is only suitable for high calorific, relatively dry, waste, which does not tend to be the case in developing countries, where waste is usually wet and needs to be pre-treated before being suitable for incineration. Incineration (for developing countries) will also compete against the IRS regarding the higher-value materials.

Table 17. Optimum Operator Models for Energy from Waste Facilities based on Global Experience

Type	Description	Advantage(s)	Drawback(s)
DBOT PSP: incineration *Incineration financed by the public authority designed constructed and operated by the private sector*	Public sector finances construction of the incinerator, contracting the design, construction and operation to the private sector. Combination of gate fees and feed in tariffs for electricity (or heat) finance the operation and maintenance of the facility.	Good control of gate fees and costs to the users. Technical efficiency; control of EHS elements.	Systems can be very expensive. No access to private investment funds. EHS standards need to be strictly monitored and controlled.
DBFO PSP: incineration *Incineration financed, constructed, and operated by PSP under concession contract with the public authority.*	Private sector design, build and finance the construction of incinerators, with guaranteed minimum quantity of municipal waste input and feed in tariffs for electricity (or heat).	Access to investment and expertise. Optimisation of technical design.	Systems can be very expensive. EHS standards need to be strictly monitored and controlled. Little control of gate-fees and costs to the users.

Source: Soos et al., 2012.

2.10 Conclusions

Medium-term technologies comprise mechanical biological treatment (MBT), anaerobic digestion (AD), and energy from waste. The former technology combines both mechanical and biological treatment methods, and is used to derive recyclables (or fuel) as well as digest or compost the biodegradable elements. Anaerobic digestion is an established treatment technology for source segregated organic wastes, one that entails the biological degradation of biodegradable wastes by microbes under strictly controlled condition. Incineration is a thermal waste treatment technology which combusts waste in an oxygen environment to produce heat and energy.

Globally, there are a number of operator models for institutionally supporting the sustainable implementation of such technologies. For both MBT and AD, there are both public and PSP integrated resource recovery models. The former is where the public authority develops and operates an integrated resource recovery facility whereas, for the latter, an integrated resource facility provided by PSP under a concession or service contract. Both models have advantages and disadvantages. For incineration, global experience attests to two PSP models. These are either DBOT PSP (i.e. where incineration is financed by the public authority but designed, constructed, and operated by the private sector) or DBFO PSP where incineration is financed, constructed, and operated by PSP under concession contract with the public authority. Both models, will have their advantages and disadvantages, respectively.

Chapter 3

OPERATOR MODELS FOR SOUTH AFRICA

3. Operator Models: For South Africa

The main objective of section 3 is to take the operator models, which have been identified as best global practice in the support of sustainable AWTs (i.e. Tables 2 to 10), and to present bespoke operator models (i.e. those likely to work best in a South African context) for each of the main technological types which outlined in the previous section, amongst other factors, suggest how the informal sector can be formally integrated into the proposed operator models.

The approach essentially involves the screening of these generic models against the requirements of South Africa's main policy, planning, and legislative frameworks (augmented with the insights gained via a number of interviews with representatives from the county's waste management sector) in order to identify an optimum model for each AWT option.

3.1 Short-Term "Quick Win" Technologies

3.1.1 Composting

Section 2.5.2 outlines the technical specifics of the composting process. Instead this section takes into consideration the available and most appropriate operator models for composting in South Africa.

3.1.1.1 Model Changes for the SA Context

For the purpose of determining the most appropriate operator models for composting in South Africa, Table 18 presents the likely model types that are applicable. The global model types presented in Section 2 were assessed and either maintained or amended to represent appropriate local operator models. Five local operator models are presented in Table 18.

Table 18. Changes to the composting global model types based on the South African SWM context

Global Model Type	Global Model	*Change(s) or Adaption(s)*	SA Model Type	Description
Public Model: composting *Composting established and managed by the public authority*	The public authority develops and operates the composting plant.	***None.***	**Public Model: composting** *Composting established and managed by the public authority.*	The national, provincial or local authority develops and operates the composting plant, without private intervention.
PSP concession: composting *Composting facilities established and managed by PSP*	The private sector finances and operates composting plant independently, and secures contracts from the public authority for the input material. These types of arrangement are more frequent for commercial scale composting.	***This model type is known as a PPP, and is subject to the local PPP legislation.***	**Public Private Partnership (PPP): composting** *Composting facilities established and operated by private entity.*	The private sector finances and operates the composting plant independently, and secures contracts from the public authority for the input material. These models are only likely to be feasible for large scale commercial composting.
PSP service: composting *Composting facilities leased for operation to PSP*	Composting facilities are established by public authorities but operated under service contract by PSP.	***Two distinct model types exist in South Africa, based on the level of service required by the public authority and sale of output material.*** ***Both models are subject to the tender processes stipulated in the Preferential Procurement Policy Framework Act (PPPFA) and Public Finance Management Act (PFMA).***	***Operating* Service Level Agreement (SLA): composting** *Composting facilities leased for operation only to private entity.*	Composting facilities are established by public authorities but operated under a defined Service Level Agreement (SLA) contract by the private entity. The public authority is responsible for collection and chipping of greens, and sale and revenue collection for compost.
			***Extensive* Service Level Agreement (SLA): composting** *Collection and chipping of greens, operation of composting facilities and sale of compost by private entity.*	Composting facilities are established by public authorities, but the collection and chipping of greens, and operation of composting facilities is by a private entity subject to a defined SLA contract. The sale of and revenue collection is for the private entity.
Micro PSP: composting *Small-scale community composting by micro-service providers*	Micro-service providers establish and operate small scale decentralised composting facilities. All costs and revenues accrue to the PSP, but may be supplemented by payment of avoided costs of collection and disposal.	***Essentially a small-scale, community-based SLA, requiring the tender processes stipulated by the PPPFA and PFMA. The tender would have a requirement for the tenderer to be a community based Small Medium Micro Enterprise (SMME).***	***Community-based* Service Level Agreement (SLA): composting** *Collection of greens, and operation of small-scale composting facilities by SMMEs.*	SMMEs establish and operate small-scale decentralised composting facilities. All costs and revenues accrue to the SMMEs, but may be supplemented by payment of avoided costs of collection and disposal by the public authority.

3.1.1.2 Qualitative Assessment of Composting Model Types

Table 19 presents a qualitative assessment of five local operator model types. The assessment focuses on four key factors, namely: financial, legal and institutional, technical, and social factors. The performance of each of the model types relative to these factors, amongst other socio-economic considerations, is then used to determine the most appropriate composting operator model type.
The following operator models are assessed:

- **Public Model**: The national, provincial or local (public) authority establishes, develops and operates the composting plant, without private intervention. The advantage of this operator model is that there is a potential of generating revenues to offset the net costs, while an inexperienced operator may lead to inherently weak monitoring and control systems. Lack of attention to product quality may lead to costly systems. Furthermore, these systems are characterized by slow procurement of parts and items for maintenance activities.

- **Public Private Partnership (PPP):** The private sector finances and operates the composting plant independently, and secures contracts from the public authority for the input material. The municipality has limited involvement and control. This model is only likely to be feasible for large scale commercial composting. The advantages of such a system are: good access to investment and expertise and market based flexible solution. On the other hand, it may not be feasible for the composting plant to be financially viable without payment of an avoided landfill gate fee. Market development is also necessary.

- ***Operating* Service Level Agreement (SLA):** Composting facilities are established by public authorities but operated under a defined SLA contract by the private entity. The public authority is responsible for collection and chipping of greens, and sale and revenue collection for compost. There is access to expertise for the operations and a relatively good control over Safety Heath Environment and Quality (SHEQ) standards. Significant municipal intervention for collection and chipping of greens, and sale of compost is required.

- ***Extensive* Service Level Agreement (SLA):** Composting facilities are established by public authorities, but the collection and chipping of greens, and operation of composting facilities is by a private entity subject to a defined SLA contract with low municipal intervention. The sale of and revenue collection is for the private entity. Through extensive SLA systems there is access to expertise for the collection, chipping and operations, very good control over SHEQ standards and efficient sale of compost. The frequency of procurement process is high.

- ***Community-based* Service Level Agreement (SLA):** SMMEs establish and operate small-scale decentralised composting facilities. All costs and revenues accrue to the SMMEs, but may be supplemented by payment of avoided costs of collection and disposal by the public authority. There is access to private financing and market based flexible solution. This operator model reduces collection as well as disposal costs, while the end products can be used locally. Typical operators are CBOs and NGOs, therefore they need capacity building, awareness-raising, and market development as it may be possible that existing knowledge of this technology is limited. The municipality has little involvement and control.

Table 19. Comparative assessment of composting operator models, using selected financial, legal and institutional, technical and social factors (highlighted in green, purple, blue, and red respectively. The selected option is highlighted in green.

SA model type	Safeguard financial sustainability of municipality	Provide value-for-money in terms of cost and benefits	Safeguard rights and interests of municipal employees	Ensure model is established within existing legal framework	The model is implementable, practical and feasible	Technical competence in planning, management and operation	Degree of integration of informal sector	Safeguard rights and interests of rate-payers
Public Model: composting *Composting established and managed by the public authority*	Less safeguarded	Lowest value for money	Equally safeguarded	Equally compliant	Lowest feasibility	Lowest competence	Low degree of integration	Less safeguarded
Public Private Partnership (PPP): composting *Composting facilities established and operated by private entity.*	Most safeguarded	Highest value for money	Equally safeguarded	Equally compliant	Low feasibility	Highest competence	High degree of integration	Most safeguarded
***Operating* Service Level Agreement (SLA): composting** *Composting facilities leased for operation only to private entity.*	More safeguarded	Moderate value for money	Equally safeguarded	Equally compliant	Moderate feasibility	Moderate competence	Moderate degree of integration	More safeguarded
***Extensive* Service Level Agreement (SLA): composting** *Collection and chipping of greens, operation of composting facilities and sale of compost by private entity.*	More safeguarded	High value for money	Equally safeguarded	Equally compliant	High feasibility	High competence	Moderate degree of integration	More safeguarded
***Community-based* Service Level Agreement (SLA): composting** *Collection greens, and operation of small-scale composting facilities by SMMEs.*	Less safeguarded	Low value for money	Equally safeguarded	Equally compliant	Low feasibility	Moderate competence	Highest degree of integration	Less safeguarded

3.1.1.3 Preferred Operator Model for Composting

Two particular model types can be delineated from the analysis undertaken in Table 14 as having the greatest promise for sustainable replicability within the South African context, namely: Public Private Participation (PPP) and Extensive Service Level Agreement (SLA).

Given that composting in the country is typically a small to medium volume operation (c. 5,000 – 15,000 tons/annum), particularly in the vast majority of local municipalities (and therefore requires significantly less capital investment than either mechanical or thermal SWM processes) then, by comparison, the PPP model is less favourable than the SLA model (highlighted in green).

Furthermore, PPPs have an extensive and lengthy procurement processes which can stretch as long as eight years, and which would require the signing of a 10-20 year contract to take garden refuse and "greens" from the municipality. The SLA is likely to be a more appropriate model type as it would incorporates the collection and chipping of garden refuse and "greens" (usually at designated drop-off facilities), and then open windrow composting at a licensed facility made available by the municipality. Thereafter, all compost produced, will be sold by the private entity as their product with revenue collected as such. There would be no claim on the revenue of compost sales by the public authority.

CASE STUDY 1: Experience in South Africa: Composting in the City of Cape Town (CCT)

The CCT Metropolitan Municipality is one of only a handful of municipalities which have attempted medium- to large-scale composting. Cape Town is one of the three largest cities in South Africa, with a population of almost 4 million. The agricultural sector on the outskirts of CCT Metro is well developed with an ever increasing international demand for organic products. This has given rise to the use of compost and the proper means of producing it specifically for the agricultural sector.

The Cape Peninsula has a Mediterranean climate with mild winters, and hot and dry summers. This warm climate is favourable for composting all year round, but the hot and windy summer weather places a high demand on moisture supply for the compost.

The CCT, under contracts with Reliance Compost (Pty) Ltd and other smaller private service providers, has diverted in excess of 13 000 000 m^3 of garden refuse and greens from Cape Town landfills since 2001 (Mr Detlev Meyer, pers. comm.). The current composting contract operates as follows:

- Garden refuse and greens that are generated in the City are taken to one of the public drop-off facilities by residents and businesses;
- The private entity sorts and chips the waste at the drop-off facility and loads its own vehicles for transportation to the composting facility, which is on their premises;
- The organic waste is composted using open windrows, and tested and bagged on-site by the private entity; and
- The private entity markets and sells the compost to market, and takes the risk of any market fluctuations or natural disasters that may affect the compost quantity or quality.

This current operator model is subject to a three-year SLA with the CCT. At the end of the prevailing 3-year period, the private entity(ies) is required to re-tender for the work. This, however, is a disruptive contract approach given that the private entity is required to provide all the necessary land, equipment, and transport fleet to carry out this work. It is envisaged that a 5-year SLA would provide more private sector stability, and ultimately enable a more efficient and cost effective service.

3.1.2 Recycling

There are good opportunities for recycling in South Africa, particularly amongst the informal sector, which can lead to the creation of a significant number of sustainable jobs if properly supported by the public authorities. Recycling opportunities exist as soon as the waste is generated. The facilities and equipment required to recycle materials are site specific, and depend largely on the character and volume of the input waste and materials. In municipalities that have some form of source separated recyclables a larger mechanised, clean MRF can be established which can typically process significant volumes of recyclables. In municipalities where no source separation exists, or is being planned, many micro-scale dirty MRFs can be established within communities as drop-off facilities. The separated materials from these micro-MRFs can then be fed into larger clean MRFs and/or directly to end-users and manufacturers.

Municipalities play a pivotal role in enabling and supporting recycling, but may not be most suited to operate such facilities or, indeed, to facilitate the sale of recycled materials and goods, they are required to facilitate comprehensive, timely, planning and procurement. This section considers the available and most appropriate operator models for recycling in South Africa.

3.1.2.1 Model Changes for the SA Context

Table 20 presents the most likely applicable operator model types for recycling in South Africa. There are six local operator models presented in Table 20, one of which is solely carried out by the public authority, and the other five represent variable degrees of involvement and ownership by the private sector.

Table 20. Changes to the recycling global model types based on the South African SWM context

Global Model Type	Global Model	Change(s) or Adaption(s)	SA Model Type	SA Model Description
Public Model recycling *Collection and sorting of recyclables by the public authority or enterprises.*	Separate collection and sorting of dry recyclables, or facilities, for sorting mixed municipal waste with or without RDF production are financed and operated by the public authority.	***None.***	**Public Model: recycling** *Collection and sorting of recyclables by the public authority or enterprises.*	Public authority finances and operates separate collection and sorting of dry recyclables, for sorting mixed/clean municipal waste.
			Public Private Partnership (PPP): recycling *Recycling facilities established and operated by private entity.*	The private sector finances and operates the recycling facility independently of the public authority, and secures contracts from the public authority for the input material. These models are only likely to be feasible for large scale recycling.
PSP service: recycling *Collection of recyclables by the private sector under contract with the public authority.*	PSP provides separate collection service for recyclables under a service contract, with net costs paid for by the public authority.	***Two distinct model types exist in South Africa, based on the level of service required by the public authority and sale of output material.*** ***Both models are subject to the tender processes stipulated in the PPPFA and PFMA.***	***Operating* Service Level Agreement (SLA): recycling** *Recycling facilities leased for operation only to private entity.*	Recycling facilities are established by public authorities but operated under a defined SLA contract by the private entity. The public authority is responsible for collection of recyclable materials, and sale and revenue collection for sorted materials.

Global Model Type	Global Model	Change(s) or Adaption(s)	SA Model Type	SA Model Description
			***Extensive* Service Level Agreement (SLA): recycling** *Collection of recyclables, operation of recycling facilities and sale of processed materials by private entity.*	Recycling facilities are established by public authorities, but the collection and operation activities of the composting facilities are subject to a defined SLA contract by a private entity. The sale of recyclables and revenue collection is for the private entity.
PSP franchise: recycling *Collection and sorting of recyclables by the private sector under franchise contract with the public authority.*	Recycling systems are financed and operated by the private sector under a franchise arrangement with the public authority, potentially requiring payment of an "avoided landfill gate fee" to the franchise.	***This model is considered the EPR model in South Africa, which has slight differences.***	**Extended Producer Responsibility (EPR): recycling** *Collection and sorting of recyclables by the private sector under EPR contract with the public authority.*	A tax/fee payment is levied to producers of certain materials (i.e. tyres, packaging, etc.), which in turn is used to fund the re-use and recycling of these materials via the private sector, particularly by stimulating entrepreneurship in PDI communities.
PSP open competition: recycling *Collection and sorting of recyclables by the private sector (informal/formal) in open competition.*	PSP recyclers (informal or formal) access and extract recyclable materials of value at various points in the waste management chain including door-to-door collection, from containers, transfer stations, and disposal sites.	***Unlikely in South Africa, seeing as the waste is "owned" by the municipality.***	No SA Model Type.	No SA Model Type.
Public recycling co-operative: landfill *Landfill constructed and operated by the public authority; cooperative carries out recycling under franchise agreement.*	The public authority constructs and operates the landfill, allowing participation of recycling cooperatives to continue to extract and sort recyclables at the site under franchise type agreement.	***Similar in SA, but no formal agreement exists between the public authority and the established cooperatives.*** ***Model type changed from Public to Private.***	**Private recycling co-operative: landfill** *Landfill constructed and operated by the public authority; private cooperatives carry out recycling under an informal understanding.*	The public authority constructs and operates the landfill, allowing participation of recycling cooperatives to continue to extract and sort recyclables at the site under and informal understanding between the public authority and private cooperative.

3.1.2.2 Qualitative Assessment of Recycling Model Types

Table 21 presents a qualitative assessment of the five local operator model types. The following types of operator models are assessed:

- **Public Model**: The public authority finances and operates separate collection and sorting of dry recyclables, for sorting of mixed/clean municipal waste. The advantage of this operator model is that there is a potential to generate revenues for the public authority, although this is not considered appropriate in SA due to the displacement of the informal sector and expensive solutions with little consideration to economies of scale in logistics and the procurement which might be chosen.

- **Public Private Partnership (PPP):** The private sector finances and operates the recycling facility independent of the public authority, and secures contracts from the public authority for the input material. The model is only likely to be feasible for large scale recycling. The advantages of such systems are good access to investment and expertise, and a market based flexible solution. On the other hand, it may not be feasible for the composting plant to be financially feasible without payment of an avoided landfill gate fee.

- ***Operating* Service Level Agreement (SLA):** Recycling facilities are established by public authorities but operated under a defined SLA contract by the private entity. The public authority is responsible for the collection of recyclable materials, and sale and revenue collection for sorted materials. There is access to expertise for the operations and a relatively good control over Safety Heath Environment and Quality (SHEQ) standards.

- ***Extensive* Service Level Agreement (SLA):** Recycling facilities are established by public authorities, but the collection and operation of composting facilities is conducted by a private entity subject to a defined SLA contract. The sale of recyclables, and revenue collection, is done by the private entity. Through extensive SLA systems there is access to expertise for the collection, chipping and operations, very good control over SHEQ standards and efficient sale of end products. The frequency of the procurement process is high.

- **Extended Producer Responsibility (EPR):** A tax/fee payment is levied to producers of certain materials (i.e. tyres, packaging, etc.), which in turn is used to fund the re-use and recycling of these materials via the private sector, particularly by stimulating entrepreneurship in Previously Disadvantaged Individual (PDI) communities. These models are highly attuned to market demand, business-oriented and facilitate access to investment into informal economy and support entrepreneurship. Typical operators are CBOs and NGOs, therefore, they need capacity building, awareness raising, and market development. The public authorities have little involvement and control.

- **Private recycling co-operative: landfill:** The public authority constructs and operates the landfill, allowing participation of recycling cooperatives to continue to extract and sort recyclables at the site under and informal understanding between the public authority and private cooperative. It allows stimulation of informal sector, under the guise of an experienced landfill operator, and increases the available landfill airspace. The actual standards of operation in practice may be less than acceptable. There are also difficulties in raising technical standards of disposal operations.

The assessment focuses on four key factors namely financial, legal and institutional, technical, and social factors. The performance of each of the model types relative to these factors, amongst other socio-economic considerations, are then used to determine the most appropriate recycling model type.

Table 21. Comparative assessment of recycling operator models, using selected financial, legal and institutional, technical and social factors (highlighted in green, purple, blue, and red respectively. The selected options are highlighted in green.

SA Model Type	Safeguard Financial Sustainability of Municipality	Provide Value-for-Money in terms of Cost and Benefits	Safeguard Rights and Interests of Municipal Employees	Ensure Model is Established within Existing Legal Framework	The Model is Implementable, Practical and Feasible	Technical Competence in Planning, Management and Operation	Degree of Integration of Informal Sector	Safeguard Rights and Interests of Ratepayers
Public Model: recycling *Collection and sorting of recyclables by the public authority or enterprises*	Less safeguarded	Lowest value for money	Equally safeguarded	Equally compliant	Lowest feasibility	Lowest competence	Low degree of integration	Less safeguarded
Public Private Partnership (PPP): recycling *Recycling facilities established and operated by private entity.*	Most safeguarded	Highest value for money	Equally safeguarded	Equally compliant	Low feasibility	Highest competence	High degree of integration	Most safeguarded
***Operating* Service Level Agreement (SLA): recycling** *Recycling facilities leased for operation only to private entity.*	More safeguarded	Moderate value for money	Equally safeguarded	Equally compliant	Moderate feasibility	Moderate competence	Moderate degree of integration	More safeguarded
***Extensive* Service Level Agreement (SLA): recycling** *Collection of recyclables, and operation of recycling facilities and sale of processed materials by private entity.*	More safeguarded	High value for money	Equally safeguarded	Equally compliant	High feasibility	High competence	Moderate degree of integration	More safeguarded
Extended Producer Responsibility (EPR): recycling *Collection and sorting of recyclables by the private sector under EPR contract with the public authority.*	More safeguarded	High value for money	Equally safeguarded	Equally compliant	High feasibility	High competence	High degree of integration	More safeguarded
Private recycling co-operative: landfill *Landfill constructed and operated by the public authority; private cooperatives carries out recycling under an informal understanding.*	More safeguarded	High value for money	Equally safeguarded	Generally none compliant	High feasibility	Low competence	Highest degree of integration	More safeguarded

[7] For the purpose of this study, incineration refers to the closed combustion of municipal solid waste, general waste and/or domestic waste for the purposes of energy recovery. This section does not look at the incineration as a destruction method for health care risk waste or any other hazardous wastes.

3.1.2.3 Preferred Operator Model for Recycling

The analysis presented in Table 21 suggests that there is no single preferred recycling operator model. Recycling is area and site-specific, and unique approaches can be used where suited. Therefore, the three operator models are likely to be the most effective and allow for the greatest flexibility and enable the most commercial opportunities are namely an Extended SLA, Extended Producer Responsibility (EPR), and Private Recycling Cooperatives (PRC). These preferred options are highlighted in green in the table.

An Extended SLA (ELSA) provides private entities with the licensed land, facilities, and equipment to conduct recycling and bailing of materials. In this instance, the private entity is also responsible for collecting source separated recyclable materials from households and businesses, per their agreement with the municipality. This is likely to be the most efficient solution to recycling on a large-scale. In comparison, EPR has the potential to have the greatest impact on material flows in the country. The producers of specific goods (such as tyres, packaging, metals, glass, batteries and lighting) will be levied a charge to enable the recycling of these materials by entrepreneurs. Instead of disposing of these materials, this enables significant job creation opportunities and minimises the use of virgin materials in the manufacturing of goods. Lastly, RPCs are the better known commercial vehicle for recycling in the country. PRCs establish themselves at landfills and dumpsites with associated waste pickers and other labour. The waste pickers separate materials on-site, which are then collected (compacted) and transported to buy-back centres for weighing and payment. This type of recycling stimulates the informal sector and increases landfill airspace after waste is dumped.

CASE STUDY 2: Robinson Deep MRF, Johannesburg

A previous dirty MRF facility operating at Robinson Deep Landfill Site (Gauteng) closed when found to be not economically viable. The Robinson Deep MRF will now be retrofitted and operated as a clean MRF. The MRF will be operated by EnviroServ which has a joint venture with Vumo Waste in the name of "Robinson Recycling". Robinson Recycling reports that, at full capacity, this MRF can handle approximately 500 tons of recyclable waste per day. A number of entrepreneurs currently operate materials recovery and recycling businesses within the city of Johannesburg, focusing mainly on commercial/business sector recyclable wastes. Pikitup initiated a "Separation at Source" Pilot Programme in the Waterval Depot area in 2009, which was expanded to other areas (Zondi, Diepsloot and Orange Farm), currently servicing more than 265,000 targeted households with a total quantity of 4,970 tons/annum being separated and diverted from landfill disposal. Pikitup intended to extend this service to cover the entire City by June 2014, i.e. 958,000 households (Jeffares & Green, 2014) (however this was not ever achieved). Pikitup acknowledges, in its latest Separation at Source Strategy (Pikitup, 2015), lessons learnt to date and anticipates that new initiatives such as Jozi@Work, construction of new sorting facilities and ongoing communication and awareness campaigns will improve

3.2 Medium-Term Potential Technologies

3.2.1 Integrated Resource Recovery: MBT and AD

Both AD and MBT are complex technologies that require an integrated approach to waste management in order to be most effective and to readily form part of an integrated resource recovery facility. For the purpose of defining South African model types for these technologies, this section looks at the operator models for an integrated resource recovery facility in SA, which would include MBT and/or AD. Technically, AD is a more scalable technology than MBT, the latter requiring greater quantities of municipal solid waste to ensure the viability of mechanical processing equipment. MBT has a higher resilience for variations in feedstock than AD. The biological system that underpins the AD is complex and requires a high level of monitoring and testing by adequately trained operators. Both technologies are considered either medium- or long-term, and must be well operated and maintained over a period of 10 years to provide maximum benefit.

3.2.1.1 Model Changes for the SA Context

Table 22 looks at the likely operator models for integrated resource recovery in South Africa, the global model types presented in Section 2 assessed and then either kept the same, amended and/or changed to represent appropriate local operator models. There are three local operator models presented in Table 22, one of which is solely carried out by the public authority with the other two representing different degrees of involvement and ownership by the private sector.

Table 22. Changes to the MBT & AD global model types based on the South African SWM context

Global Model Type	Global Model	*Change(s) or Adaption(s)*	SA Model Type	Description
Public model: integrated resource recovery. *Public authority develops and operates an integrated resource recovery facility.*	The public authority develops and operates an integrated resource recovery facility combining different mechanical, biological, and thermal treatment processes.	***No thermal treatment processes, apart from the on-site combustion of biomass and/or biogas.***	**Public model: integrated resource recovery.** *Public authority develops and operates an integrated resource recovery facility.*	The public authority develops and operates an integrated resource recovery facility combining different mechanical and biological treatment processes.
PSP: integrated resource recovery *Integrated resource recovery facility provided by PSP under concession or service contract.*	The private service provider develops and operates an integrated resources recovery facility combining different mechanical, biological, and thermal treatment processes. The public authority usually pays a gate fee.	***There are two distinct model types here, namely: a PPP (concession) and a SLA (service contract.***	**Public Private Partnership (PPP): integrated resource recovery** *Integrated resource recovery facility established and operated by a Private entity.*	The private sector finances and operates an integrated resource recovery facility independent of the public authority, and secures contracts from the public authority for the input waste. These models are only likely to be feasible at large scale.
PSP: integrated resource recovery *Integrated resource recovery facility provided by PSP under concession or service contract.*	The private service provider develops and operates an integrated resources recovery facility combining different mechanical, biological, and thermal treatment processes. The public authority usually pays a gate fee.		**Service Level Agreement (SLA): integrated resource recovery** *Collection of waste, operation of resource recovery facilities and sale of outputs by private entity.*	Resource recovery facilities are established by public authorities, but the collection and operation of the facilities is by a private entity subject to a defined SLA contract. The sale of the output from these facilities, and revenue collection is likely to be for the private entity.

3.2.1.2 Qualitative Assessment of MBT & AD Model Types

Table 23 presents a qualitative assessment of the three local operator model types highlighted earlier.[3] As with the preceding qualitative assessments, this analysis focuses on four key factors, namely financial, legal and institutional, technical and social. The performance of each of the model types relative to these factors, amongst other socio-economic considerations, is then used to determine the most appropriate model type(s).

[3] *For a description of the operator models, refer to Section 3.2.2.2.*

Table 23. Comparative assessment of resource recovery operator models, using selected financial, legal and institutional, technical and social factors (highlighted in green, purple, blue, and red respectively. The selected options are highlighted in green.

SA Model Type	Safeguard Financial Sustainability of Municipality	Provide Value-for-Money in terms of Cost and Benefits	Safeguard Rights and Interests of Municipal Employees	Ensure Model is Established within Existing Legal Framework	The Model is Implementable, Practical and Feasible	Technical Competence in Planning, Management and Operation	Degree of Integration of Informal Sector	Safeguard Rights and Interests of Ratepayers
Public model: integrated resource recovery. *Public authority develops and operates an integrated resource recovery facility.*	Less safeguarded	Lowest value for money	Equally safeguarded	Equally compliant	Lowest feasibility	Lowest competence	Low degree of integration	Less safeguarded
Public Private Partnership (PPP): integrated resource recovery *Integrated resource recovery facility established and operated by a Private entity.*	Most safeguarded	Highest value for money	Equally safeguarded	Equally compliant	Low feasibility	Highest competence	High degree of integration	Most safeguarded
Service Level Agreement (SLA): integrated resource recovery *Collection of waste, operation of resource recovery facilities and sale of outputs by private entity.*	More safeguarded	Moderate value for money	Equally safeguarded	Equally compliant	Moderate feasibility	High competence	Moderate degree of integration	More safeguarded

3.2.1.3 Preferred Operator Model for AD & MBT

The higher level of complexity and commitment, required for the ongoing operation of an integrated resource recovery facility or process would rules out the first of the operator models in Table 23, i.e. the Public Model. It would not be in the best interest of rate payers for a municipality to solely take on such a facility, because it would not adequately safeguard the financial sustainability of the municipality and may result in tariff hikes to sustain operations. In many similar respects, the SLA is not the preferred model either. Under the SLA, the municipality would first and foremost be required to establish the relevant facilities, such as highly complex mechanical separation equipment as well as an entire AD process, including organic matter sorting, digesters, heat exchangers, biogas extraction and upgrading processes, and biogas combustion and energy use components. The private sector is well suited to operate this kind of plant as well as plan, design, construct, and finance it. Therefore, PPP is the preferred operator model in this context and is highlighted in green in Table 18.

The PPP model type affords good, readily accessible, access to capital financing, and any output energy, products, and/or materials can be taken to market more efficiently. However, private investors will be looking for returns on equity in excess of 10 year bond yields, adjusted for inflation. Therefore, the PPP model type may only be feasible if the public authority is willing to commit to paying an avoided landfill gate fee. The public authority is also required to sign a contract for the supply of waste (feedstock) to the facility for an extended period, i.e. in the order of 10-20 years. This poses a further risk, given that the character and quantity of waste could vary considerably over this period.

CASE STUDY 3: Bronkhorstspruit Biogas Plant (Pty) Ltd, Tshwane

Whilst waste to energy (WtE) is an up-and-coming technology in South Africa, there are currently no municipal WtE facilities for solid waste organics operated under contract with the private sector[4]. Therefore, a good example of a viable WtE plant is an AD plant established and operated solely by a private entity, apart from developing the first wheeling agreement[5] with the Tshwane Metropolitan Municipality. The project is called the Bronkhorstspruit Biogas Project (Pty) Ltd (BBP) and is part of the Renewable Energy Independent Power Producer Programme (REIPPPP).

This project aims to meet the national target of 10 000 GWh of renewable energy in South Africa. The Project is a Design Build Finance Operate (DBFO) by Bio2Watt with an initial life cycle of 20 years. The project is located in Bronkhorstspruit in the Tshwane Metropolitan Municipality close to an agricultural stronghold in the Gauteng province. Situated on the premises of one of South Africa's largest feedlots (Beefcorp), the location provides proximity to key fuel supplies, grid access, and sufficient water supplied by Beefcorp's storm water collection dams.

The plant's targeted electricity generation capacity is 4 MW, which will create long-term direct and indirect employment. About 40 000 tonnes a year of cattle manure, and a further 20 000 tonnes of mixed organic waste, will be fed into two anaerobic digesters to produce the biogas feedstock for a combined heat and power application using an internal combustion gas generator sets. Two key challenges of the project have been the complexity of the contractual arrangements and the absence of a clear agreement between small Independent Power Producers, such as BBP, and National Government.

[4] Note that at the time of compiling this document, the formal opening of the New Horizons energy-from-waste biodigestion plant took place in January 2017 – the information is now in the public domain and is one of the first largescale working WtE plants in South Africa using municipal organic waste as the primary feedstock.
[5] In electric power transmission, wheeling is the transportation of electric energy (megawatt-hours) from within an electrical grid to an electrical load outside the grid boundaries (Wikipedia, 2016).

3.2.2 Energy from Waste: Incineration

During the latter part of the 20th century, energy from waste (EfW) was seen by many European countries and other advanced nations as a "silver bullet" for diverting waste from landfill. However, EfW by means of direct combustion and incineration[6] is nowadays becoming less and less attractive, both as an investment and as an attempt to mitigate climate change. Solid waste incineration is considered to be an AWT technology which is low in priority and importance on the South African National Waste Management Hierarchy (2011). It typically undermines more important waste management approaches, such as waste minimisation and avoidance, the re-use of waste and materials, and composting and recycling.

Once an incinerator is built, it requires solid waste feedstock for a minimum of 20 years, and therefore diverts waste streams from possible recycling initiatives. Waste incineration plants are some of the most capital intensive AWT technologies available today with payback periods typically in excess of 15 years, particularly if heavily debt financed. Incineration is also a very complex thermal technology which requires highly skilled operators and 24-hour monitoring. Harmful emissions from waste incineration plants have been the subject of debate for decades. Proponents of incineration have argued that harmful dioxin levels have dramatically decreased with more modern incinerator technologies, whilst others argue that emissions are not limited to dioxins but also include harmful nanoparticles and toxic air, water, and ground discharges and by-products. Ideally, waste incineration should only be used for residual solid waste fractions, i.e. the waste stream that is treated after appropriate integrated processing source separation, recycling, composting, and AD. In this example, because the residual fraction of municipal solid waste would be small, it would probably not be economically justified to establish a waste incinerator.

Within the South African context, the sentiments shared earlier are no different. There is very little likelihood of a public authority (such as a local or district municipality) solely taking on such a technology. Furthermore, because the process is highly mechanised and functions in a controlled thermal environment, the number of jobs created per tonne of waste treated is relatively small, when compared to the likes of composting, recycling, and resource recovery via MBT and/or AD. Should the unlikely event that a South African municipality does decide to construct and operate a waste incineration plant, it will be required to partner with the private sector, especially for the design, build, and operation of the plant, and possibly for the financing of the plant as well. This section (Section 3.2.2) looks at the available and most appropriate operator models for solid waste incineration in South Africa. An incineration plant has been planned for the Drakenstein Municipality in Wellington in the Western Cape and is currently at the stage of Authorities' approvals and environmental assessment.

3.2.2.1 Model Changes for the SA Context

For the purpose of determining the most appropriate operator models for waste incineration in South Africa, Table 24 looks at the likely model types that are applicable. The global model types presented in Section 2 were assessed and either maintained and/or changed to represent appropriate local operator models. There are three local operator models presented in Table 24, one of which is solely carried out by the public authority, and the other two represent a different degree of involvement and ownership by the private sector.

[6] For the purpose of this study, incineration refers to the closed combustion of municipal solid waste, general waste and/or domestic waste for the purposes of energy recovery. This section does not look at the incineration as a destruction method for health care risk waste or any other hazardous wastes.

Table 24. Changes to the global incineration model types based on the South African SWM context

Global Model Type	Global Model	*Change(s) or Adaption(s)*	SA Model Type	Description
		A solely public model could exist in SA, but the direct sale of energy is not something that would be undertaken by the municipality.	**Public model: incineration.** *Public authority develops and operates an incineration plant, and sells the energy.*	The public authority develops and operates an incineration plant, and facilitates the sale of energy to the public or private sector.
DBO PSP: incineration. *Incineration financed by the public authority designed constructed and operated by the private sector*	Public sector finances construction of the incinerator, contracting the design, construction and operation to the private sector. Combination of gate fees and feed in tariffs for electricity (or heat) finance the operation and maintenance of the facility.	***Typical of an SLA. Private entity likely to oversee sale of energy in SA.***	**Service Level Agreement (SLA): incineration.** *Collection of waste, operation of incineration plant and sale of energy by private entity.*	Incineration plant is established by public authority, but the collection and operation of the plant is by a private entity subject to a SLA. The sale of energy and revenue collection is likely to be carried out by the private entity.
DBFO PSP: incineration *Incineration financed, constructed, and operated by PSP under concession contract with the public authority.*	Private sector design, build and finance the construction of incinerators, with guaranteed minimum quantity of municipal waste input and feed in tariffs for electricity (or heat).	***Typical of a PPP. Private entity likely to undertake project in its entirety.***	**Public Private Partnership (PPP): incineration** *Incineration plant established and operated by a Private entity, including sale of energy.*	The private sector finances and operates an incineration plant independent of the public authority, and secures contracts from the public authority for the input waste. These models are only likely to be feasible at large scale.

3.2.2.2 Qualitative Assessment of EfW Model Types

Table 25 presents a qualitative assessment of the three local operator model types highlighted above. As with the preceding qualitative assessments, this assessment focuses on four key factors, namely financial, legal and institutional, technical, and social. The performance of each of the model types relative to these factors, amongst other socio-economic considerations, is then used to determine the most appropriate waste incineration model type(s).

3.2.2.3 Preferred Operator Model for EfW (Incineration)

The only foreseeable, appropriate, operator model for waste incineration is a Public Private Partnership (PPP) – highlighted in blue in Table 20. Both the solely Public model and the SLA contract are far less likely due to the involvement by the public authority, and the risk inherent in the ownership of such a plant. The design, build, and operation of a waste incineration plant requires highly qualified and knowledgeable expertise, which the private sector is well suited to provide. Due to high capital cost of such a plant, the private sector is also well capable of sourcing adequate financing for the plant, and more likely to service debt repayments in a timely manner. The private sector is particularly better suited to operate a waste incineration plant than a public authority during circumstances such as an urgent service/maintenance requirement and/or an emergency. In these instances, a PPP places penalties on the private entity to ensure the plant is kept running, and waste is being incinerated as planned. The private entity therefore has a strong financial incentive to operate the plant as effectively as possible. Notwithstanding, it is currently unclear whether a public authority can guarantee waste feedstock, which places additional risk on the private party.

Table 25. Comparative assessment of incineration plant operator models, using selected financial, legal and institutional, technical and social factors (highlighted in green, purple, blue, and red respectively). The selected option is highlighted in blue.

SA Model Type	Safeguard Financial Sustainability of Municipality	Provide Value-for-Money in terms of Cost and Benefits		Safeguard Rights and Interests of Municipal Employees	Ensure Model is Established within Existing Legal Framework	The Model is Implementable, Practical and Feasible	Technical Competence in Planning, Management and Operation	Degree of Integration of Informal Sector	Safeguard Rights and Interests of Ratepayers
Public model: incineration. *Public authority develops and operates an incineration plant, and sells the energy.*	Less safeguarded	Lowest value for money		Equally safeguarded	Equally compliant	Lowest feasibility	Lowest competence	Low degree of integration	Less safeguarded
Service Level Agreement (SLA): incineration. *Collection of waste, operation of incineration plant and sale of energy by private entity.*	Less safeguarded	Moderate value for money		Equally safeguarded	Equally compliant	Moderate feasibility	Moderate competence	Low degree of integration	Less safeguarded
Public Private Partnership (PPP): incineration. *Incineration plant established and operated by a Private entity, including sale of energy.*	Most safeguarded	Highest value for money		Equally safeguarded	Equally compliant	Low feasibility	Highest competence	Low degree of integration	Most safeguarded

CASE STUDY 4: South African EfW

There are currently two local municipalities (in the Gauteng and Western Cape Provinces) considering waste incineration - having already received and approved proposals, and undertaking a series of feasibility studies, land-use planning, and associated environmental authorisations. However, as is the case for integrated resource recovery (MBT and/or AD), there are currently no operational incineration plants for MSW in South Africa.

The recent online Alternative Waste Treatment Guide[7], owned and supported by the DEA, has posted a summary of six case studies for Fluidized Bed Combustors as MSW incinerators (Granatstein, Technoeconomic Assessment of Fluidized Bed Combustors as Municipal Solid Waste Incinerators: A Summary of Six Case Studies, 2004). Another well-known case study is that of the Toshima Incineration Plant in Tokyo, recorded by the same author (Granatstein, 2000).

3.3 Conclusions

There are a number of potential operator models to facilitate the introduction of both short-term "quick win" technologies and medium-term potential technologies. All of these models have advantages and disadvantages. For the purposes of introducing composting, the two particular models with the greatest promise are those involving public-private participation (PPP) and via the use of an Extended Service Level Agreement. Of these two options, the latter is the most favourable not least because it incorporates the collection and chipping of garden refuse and "greens", and the open windrow composting at a licensed facility made available by the municipality.

By way of facilitating recycling, there is no single preferred recycling operator model – primarily because recycling is area and site specific, and unique approaches can be used when suited. That said, three operator models are likely to be the most effective, allow for the greatest flexibility, and enable the most commercial opportunities, i.e. an Extended SLA, Extended Producer Responsibility (EPR), and Private Recycling Cooperatives (PRC).

In terms of medium-potential technologies, both AD and MBT are complex technologies that require an integrated approach to waste management in order to be most effective. The higher level of complexity and commitment required for the ongoing operation of an integrated resource recovery facility, coupled to the fact that the private sector is well suited to operate such technologies (as well as plan, design, and construct it) suggests that PPP is the optimum operator model. This is because it offers good access to readily available capital financing, and any output energy, products, or materials can be taken to market more efficiently.

Waste incineration plants are some of the most capital intensive technologies available, with payback periods typically in excess of 15 years. If a South African municipality wishes to develop a waste incineration plant, then it will have to partner with the private sector – specially for the design, build, and operation of the plant and, possibly, financing the plant itself. In such circumstances the only credible operator model is a Public Private Partnership.

[7] The online Alternative Waste treatment Guide can be accessed using this link: http://awtguide.environment.gov.za/

Chapter 4
OPPORTUNITIES TO SUSTAINABLY FINANCE AWT PROJECTS



4. Opportunities to Sustainably Finance AWT Projects

4.1 Introduction

This section outlines selected business opportunities for the use of AWT technologies in South Africa,which are implementable and scalable given the local SWM context. The end goal is to see these opportunities catalyse an enabling environment for the increased diversion of solid waste from disposal sites, resulting in inter alia improved public health, the creation of sustainable jobs and lowered net carbon emissions.

***AWT Business Opportunities*[8]**

An outlook on the future exchange of monies for the rendering of goods and/or services, or transfer of equity, for the alternative treatment of solid waste.

4.2. Key Leverage Points for AWT Technologies

Currently the economic benefits of solid waste in South Africa are not being realised, with the greater proportion of municipal solid wastes being generated, collected and disposed of at numerous licensed and unlicensed landfills sites and unregulated sites. Solid waste is largely perceived to have negligible economic value, and perhaps the greatest indication of this is widespread illegal dumping, costing the National Government billions of rands each year (CSIR, 2011).

From an Investment perspective, existing private sector appetite is confined to a handful of private, multi--national waste companies which typically derive economic benefit from waste by transporting it between service points or directly to landfill. Existing efforts to separate waste at source are hindered by a lack of public engagement, largely due to the inequitable transfer of benefits to those who chose to recycle their waste. Despite the prevailing situation, there exists a robust business case for the implementation of AWT technologies and the corresponding diversion of waste from landfill. This is outlined in the business rationale provided in Section 4.3. Underpinning this business case are five key leverage points that have been identified for the South African context.

- Waste is not a waste. Practically all biomass, materials and items that are discarded and intended for dumping or disposal have value, albeit small or insignificant in some cases. This value is either unknown or undiscovered, or processes are required to extract the inherent value. The costs of these processes are greater than the tradable value of the processed output(s);

- Municipalities own the waste. Municipalities are legally responsible for the collection and disposal of MSW. Therefore, it is crucial to engage with municipalities and develop a co-benefit approach to AWT, which is likely to include at a multi-faceted funding approach to AWT;

- Function not service. Local municipalities are legally mandated to carry out solid waste management services such as collection, disposal, and area cleaning. These services are well known and already well established in South African local municipalities. The implementation and operation of AWT technologies are, however, for the large part, classified as municipal functions, which have less MFMA/MSA requirements than a municipal service and are therefore more flexible in terms of contracting private sector participation. The private sector is likely to be better suited to both construct and operate AWT technologies, along with enabling facilitation and support by the respective public authority. Contracting private sector expertise is a crucial risk mitigation measure for municipalities;

[8] *This generic definition has been constructed specifically for the purpose of this knowledge product.*

- Recovering full costs. It is evident in most low- and middle-income countries that the fees to cover SWM costs do not exist or cannot be levied effectively by the governing authorities. This results in total SWM costs rarely being covered. At the heart of this conundrum is often the lack of knowledge of some authorities as to what their full SWM services costs are due to poor financial management. Continuously assessing and tracking these full services costs provides a basis upon which the financial viability and municipal affordability of future AWT projects can be determined. These costs should include all capital and operating costs, such as upfront and back-end costs as well as the socio-economic and environmental costs of unsustainable SWM (GIZ, 2015).

Cost sharing is pivotal. Landfilling solid waste is an inexpensive process in the short-term, but a very poor long-term investment. Conversely, AWT technologies are expensive to implement but can be prudent long-term investment options as they extract part of the inherent value in waste materials and divert waste from landfill (US EPA, 1997). As such, the cost to implement and operate AWT technologies should be borne by both the respective public authority and contracted private entity(ies) in order to enable holistic affordability and to maximise investment, growth, and job creation opportunities. In this respect, municipalities are better suited to provide annual operating expenditure (OPEX) subsidies to enable project sustainability, as opposed to on-going capital expenditure (CAPEX). Also, operational expenditure (OPEX) typically constitutes 60-85% of total SWM costs in present day terms and are arguably key to enabling the day to day sustainability of SWM (GIZ, 2015).

The predominant business-as-usual (BAU) approach to SWM in South Africa is presented in Figure 4.1. In addition to the resultant business opportunities that exist for the diversion of solid waste from landfill using AWT technologies

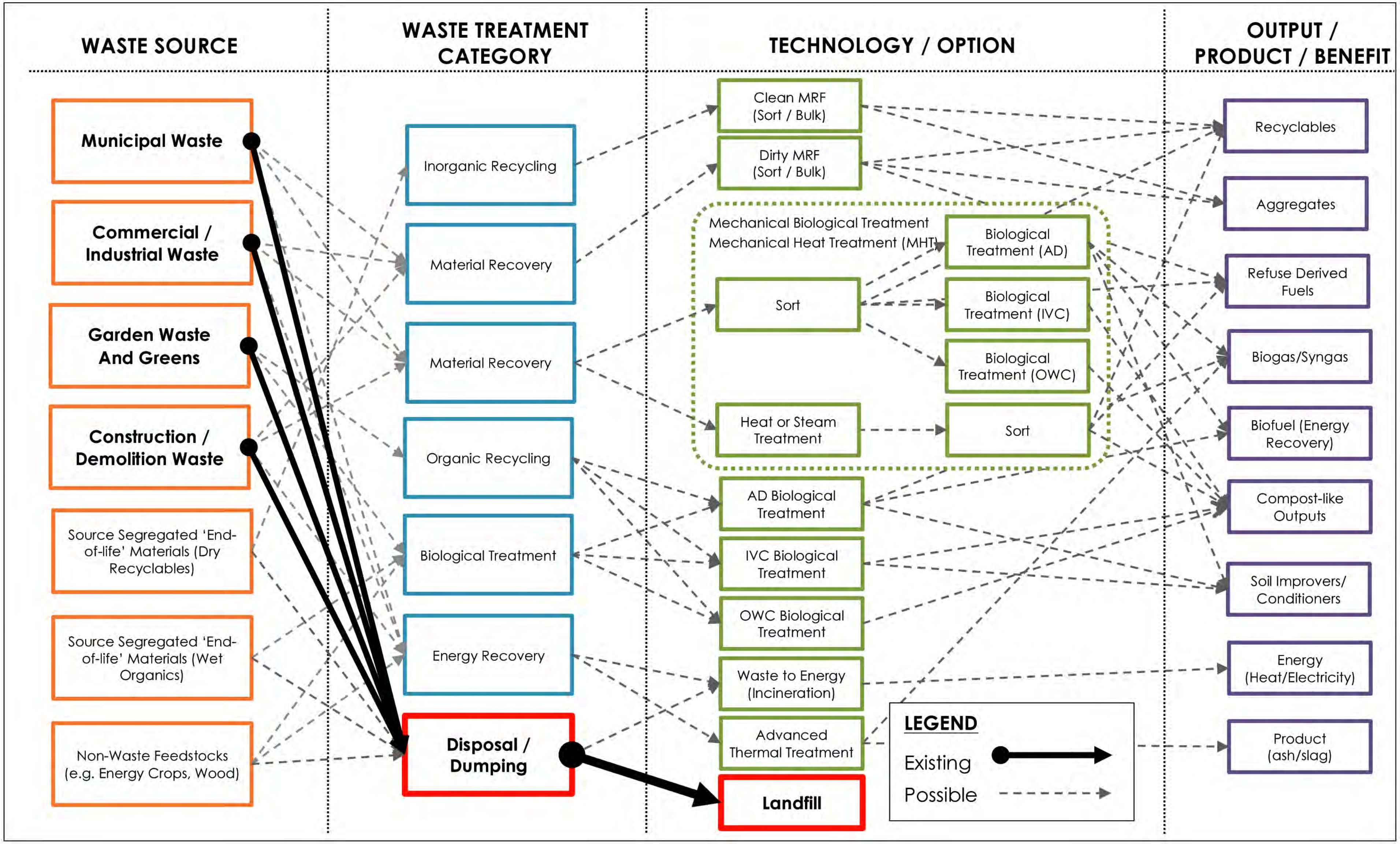

Figure 4.1. Business-as-Usual approach to SWM in South Africa, reflecting possible AWT business opportunities

Notes for flow diagram:

1. All treatment options will typically also have a reject for **disposal**, usually items that are inappropriate for treatment because of their size or other characteristics. This is not shown on the diagram to avoid over complicating the illustration, but is an important aspect to bear in mind, and overall mass balances should be considered in the context of the technology, its performance limitations & track record and the waste stream in question.

2. Whilst there are a range of outputs indicated on the diagram (**purple** boxes), these are reliant on the respective market for that output. Where markets are not available the output may have to be disposed of. For example, if the quality of compost produced is insufficient for the available market it may end up in landfill. Or, if the quality of a gas generated is insufficient to meet energy recovery system requirements it may be flared off. In such circumstances the environmental merit of the system and its business case may be jeopardised.

3. The diagram is focussed on the **waste sources** from municipal, commercial & industrial and construction and demolition sectors. There will be individual components within each of these categories that may require specialist treatment, such as asbestos in construction waste for example, which are not covered within this publication.

4. The diagram is a generic illustration of the main technology types and is not intended to be exhaustive in terms of all technology combinations and configurations. For example, there are technologies which may be used for specific waste streams (e.g. tyre crumbing or Waste electrical goods treatment systems).

5. Some outputs in the diagram may be used as feedstock of other treatment options within the diagram, for example refuse derived fuel could be used as a feedstock for some incineration processes or an advanced thermal treatment (e.g. gasification or pyrolysis) process.

6. Some technologies will also generate residues from the clean-up of emissions from the treatment process which may require specialist disposal. These are not shown on the diagram, but are referred to in the text of this document as each technology is described. An example is the flue gas treatment residue produced during the clean-up of incineration emissions, this typically comprises around 3-5% of the throughput of the facility and would require specialist **disposal**

4.3. Co-Benefit Business Rationale

4.3.1 General context

As described in the introduction, the AWT technologies that are covered in this KP represent mainstream, or emerging, technologies that can be applied for the treatment of MSW. Furthermore, this KP only presents operator models identified for the short- and medium-term, i.e. proven technologies with the greatest potential for uptake across South Africa rather than those which, due to cost, are unlikely to be considered except for the largest municipalities and, even then, under specific circumstances or where exceptional factors are in place. The larger, long-term AWT projects are likely to be implemented in the form of PPPs, which, historically, have high transaction advisory costs, extended timelines and require significant capital outlay. These long-term projects have not been considered in this section.

External, developmental funding for AWT, in the form of 'green funds' or 'climate funds', is available for certain projects in municipalities. The pre-conditions for these funds often prioritise maximum carbon emissions reductions, which tends to favour the smaller, organic-oriented technologies that intervene in the food waste and garden waste streams.

In light of such considerations, and on the basis of the key leverage points, the following business rationale is presented for obtaining the maximum "co-benefit" from AWT technology implementation and operation.

***AWT Maximum Co-Benefit*[9]**

The ideal of maximising the shared benefit of diverting waste from landfill using AWT technologies by integrating the strengths and goals of national government, municipal authorities, and private entities.

[9] *This generic definition has been constructed specifically for the purpose of this knowledge product.*

Hypothetically, if the private sector were to intervene in a particular MSW stream resulting in the diversion of MSW from landfill, then there would be a direct financial benefit to the municipality in question in the form of operational cost savings and delayed capital expenditure (CAPEX) requirements in respect of both fleet and the landfills.

Financing AWT Infrastructure

There are, traditionally, two important aspects to be considered in the financing of AWT infrastructure, namely:

1. **How capital investment expenditures (capex) are to be financed; and**

2. **How recurrent costs (opex) are to be financed.**

The financing of capital investment usually attracts most focus internationally because a shortage of capital funds is commonly viewed as a principal impediment to development. However, the financing of recurrent costs is probably a more critical issue, it is typically upon the source upon which the financial sustainability of AWT technologies depend.

In the context of municipalities being the custodians of MSW collection and disposal within their respective jurisdictions, any possible waste stream interventions by the private sector would need to be contracted through a suitable, legislated procurement process.

Municipalities carry out municipal services which, in the case of solid waste, broadly includes collection and disposal. Municipalities are also responsible for solid waste management, meaning that they "own" the waste (DEA, 2011). Intervening in a solid waste stream using AWT technologies, however, is likely to be categorised as a municipal function which would be readily undertaken by private entities. Therefore, in order to maximise shared benefits, the implementation and operation of AWT technology should be a fully collaborative effort between municipal authorities and private solid waste management entities – therein lie business opportunities for AWT in South Africa.

4.3.2 Costing Basis: AWT vs Landfill

A critical determination of the viability of any AWT business opportunity is to determine a cost-reflective proxy for the diversion of waste from landfill. This is particularly important from a National Government perspective, it is essentially the financial custodian of waste infrastructure investment. Therefore, when comparing the status quo or base case of landfilling to the AWT technology case, the collection and transportation of waste is assumed to be net neutral[10]. Solid waste needs to be transported from the existing service points to either landfill or an AWT facility. Thus, the cost reflective proxy emerges as the tangible financial cost of landfilling solid waste, which will be saved, in part, if waste is diverted away from disposal facilities and to AWT technologies instead.

One such method of representing this cost-reflective proxy is through a simplified visual illustration of evaluating the financial costs and benefits of a particular AWT technology, as depicted in Figure 4.2. This illustration uses 'net present value' (NPV) for comparative purposes to take into account the time value of money. Since landfill capex is generally funded by National Government through grants whilst operational spend is funded by municipalities, financial cost benefit assessment must be done at a country-level rather than at a municipal level.

[10] *For the purpose of this KP, the investigation of alternative transportation modes has been excluded. However, it is acknowledged that the alternative transportation of waste presents multiple business opportunities, particularly for SMMEs via non-motorised modes; notwithstanding, too few case studies exist in South Africa to draw definitive cost-oriented conclusions on alternative transportation modes.*

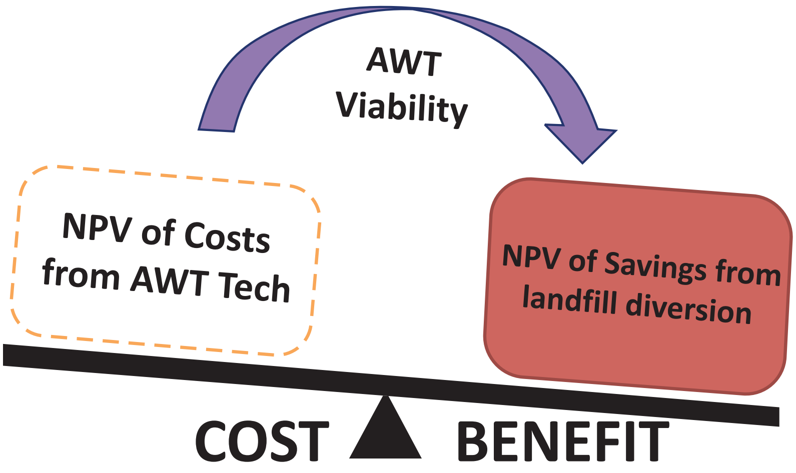

Figure 4.2. Financial cost-benefit assessment for AWT technologies[11]

The true financial cost of sanitary landfilling solid waste must incorporate the net present value of all operational costs (inclusive of preventative and periodic maintenance) and future capital expenditure. This cost represents the diversion benefit to National Government for every unit of solid waste that is diverted from landfill. For comparative purposes, the true financial cost needs to be expressed on a Rand per tonne (R/t) landfilled basis.

AWT has two distinct post-feasibility costs, namely (in chronological order): i) CAPEX for construction, installation and commissioning; and (ii) OPEX for on-going operation and maintenance. Within a South African context, and from a CAPEX perspective, five typical CAPEX funding concepts should be costed in respect of the CAPEX to both National Government and a development bank or commercial lender in the form of official development aid (ODA), as well as the annual cost to a municipality servicing the loan repayments, if necessary.

The municipality's annual costs would therefore include both subsidy payments and loan repayments, which can be expressed as a percentage of their collection fees serve as an 'acid-test' to gauge affordability. A combination of grant funding, concessionary loans or commercial loans can be considered to fund the CAPEX associated with the AWT project, whilst the municipality is responsible for any annual OPEX payments to ensure the project viability. Five possible funding concepts for CAPEX are presented in Figure 4.3. CAPEX funding options available to municipal authorities..

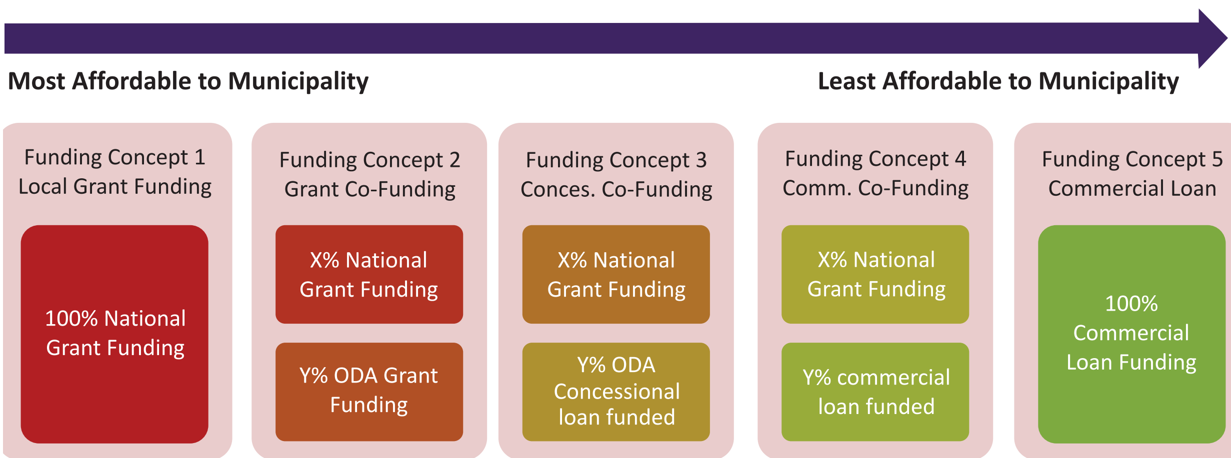

Figure 4.3. CAPEX funding options available to municipal authorities

[11] *NPV = Net Present Value; AWT Tech = Advanced Waste Treatment Technology*

An International Perspective on Financing Capital Costs:

There are five potential sources for financing the capital investment costs for AWT technologies, namely:

- Accumulated internal reserves held by the operating agency;
- Central, state, and municipal government grant contributions;
- Domestic or international commercial loans raised by the state or municipal governments;
- International funding agency grant and loans; and
- Private sector finance.

With respect to the first option, MSW municipal departments rarely have the accumulated funds necessary to finance new infrastructure. A more traditional source of investment financing is through transfers from central government although, not only do such funds tend be made available on only an ad-hoc basis, but decentralisation and institutional reform is reducing the role of central government in financing waste management infrastructure in South Africa.

Although commercial loans raised on domestic or international markets are a potential source of investment capital, they are rarely used for a number of reasons, e.g. central governments commonly maintain tight controls over foreign borrowings, and high commercial rates and short repayment periods often make loan service obligations difficult to meet etc.

Grants and loans from international development finance agencies are an important source of finance. Grants are immediately attractive because neither interest nor capital has to be repaid, and loans from such agencies are potentially attractive because interest rates are often much lower than commercial rates and, moreover, repayment terms tend to be much longer than for commercial loans.

Lastly, the private sector is commonly used to finance such technologies because not only can the need for up-front investment costs be sometimes avoided in such cases, a principal benefit in using the private sector is that it can lead to a reduction in unit costs through efficiency improvements, etc.

For the purpose of recovering the recurrent operational costs, a cost 'sharing' mechanism between private contracting parties and municipal authorities should be instituted. Whilst it is relatively straightforward to find donors or private equity to fund the capital requirements for infrastructure, it is difficult to find donors who are willing to pay for these recurrent, operational costs. Failure to service the operational costs for AWT technologies jeopardises the quality of the service and increases the risk of rapid equipment deterioration (GIZ, 2015). Assuming the private sector are best suited to operate the AWT, then Figure 4.4. Simplified calculation of revenue required by private sector to operate AWT technologies. illustrates the likely costs of engagement with the private sector as being the sum of the OPEX incurred by the private contracting party and the market related returns, i.e. profit, that would attract private sector participation. In other words, the contracting public authority would need to ensure that the revenue that could be generated by the AWT technology (whether in the form of gate fees, or output product sales) must be equal to or exceed the full operating cost of the AWT technology <u>PLUS</u> the (profit) margin that is attractive to the private sector (i.e. Market Related Return), in order to make it attractive to private sector investment.

Figure 4.4. Simplified calculation of revenue required by private sector to operate AWT technologies

The surplus or gap in OPEX can then be calculated by subtracting the likely 'Third Party Sales' the private sector are able to achieve (if output is generated) from the 'Required Revenue' as determined beforehand. Figure 4.5. A simplified approach to determine the appropriate OPEX surplus or gap. sets out two possible scenarios, whereby either a surplus is achieved (highly unlikely based on global experience), or a gap in recovery of OPEX is prevalent. The recovery of all OPEX is often the single biggest threat to the sustainability of AWT technologies in the long-term, and therefore any envisaged gap in OPEX recovery must be suitably covered via a municipal economic instrument (GIZ, 2015; US EPA, 1997).

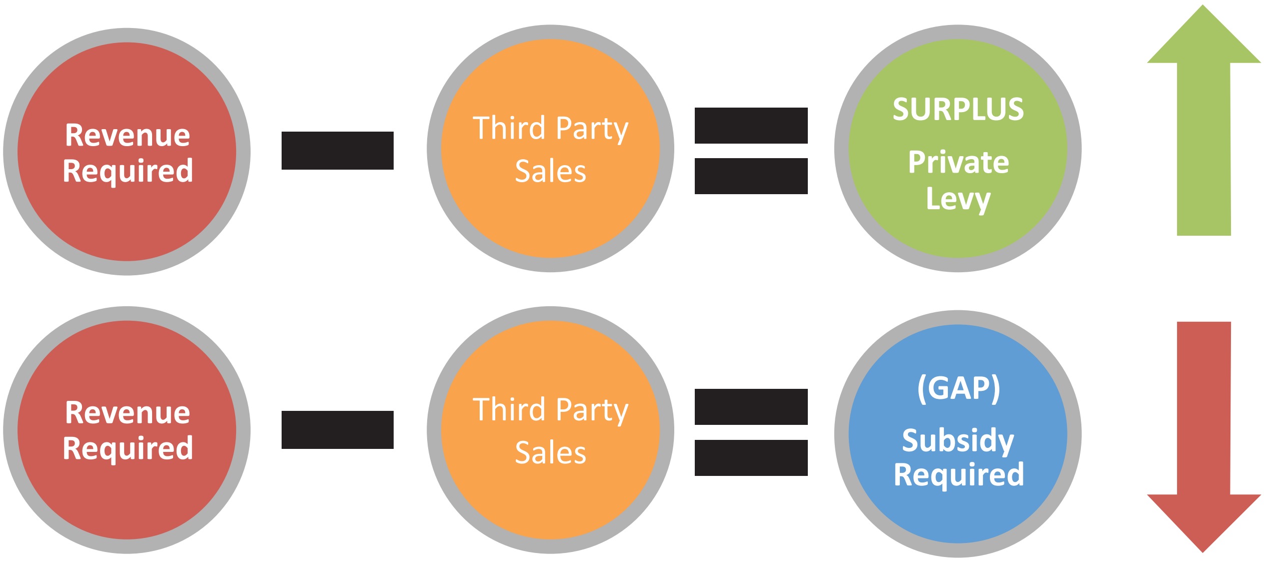

Figure 4.5. A simplified approach to determine the appropriate OPEX surplus or gap

In the event an OPEX surplus is achieved, the municipal authority has two generic options: (1) to offer this surplus to the private sector as an incentive to boost their profitability in the medium- to long-term, or (2) raise a levy against the private sector, via a service level agreement type contract, as a fee to lease and operate the AWT technology, or rights to sell any outputs to market. The second option would be the most likely to ensure maximum near-term economic benefit to the municipal authority in question (US EPA, 1997). However, in the event the calculated OPEX is relatively small, it would be worthwhile offering this to the private sector as an OPEX recovery contingency, which in addition to incentivising their long-term profitability could be accompanied by an improved service offering. This being said, existing case studies in South Africa show that an OPEX surplus is a rarity. The most probable outcome is likely to be an OPEX gap, which will need to be borne annually by the municipal authority, as owners of the AWT technology/plant and custodians of the waste, to ensure the viability of the AWT technology going forward.

It is critical to consider the affordability of an AWT project at the municipal level, primarily because in the likely OPEX gap scenario municipalities will have to allocate a portion of their operational budget towards paying a subsidy to their contracted private sector operator(s). Also, in the event the project CAPEX is funded by concessionary or commercial loan agreements, municipalities will need to make annual loan repayments, which must form part of the their OPEX budgets. By way of example, the graph in Figure 4.7 illustrates NPV of costs to Government in three separate, hypothetical funding scenarios (using the likes of Green Climate Fund (GCF) funding), with seven modelled sensitivities.

An International Perspective on Financing Recurrent, Operational Costs:

Based from global trends the funds available for supporting recurrent expenditures (OPEX) typically come from three sources:

- Transfer funds assigned by a central, state, or provincial government usually in the form of non-specific grants;
- A municipality's own general revenue sources, consisting mainly of taxes and charges; and
- Specific charges levied by the municipality on the users of specific services, such as waste management, water services and electricity supply etc.

The first of these alternatives usually contributes a significant proportion of total municipal recurrent funds, but there is often little scope for this amount being increased. In terms of a municipality's own resources, contributions are usually paid directly into consolidated revenue, and are not earmarked for specific uses. With respect to the latter of the three sources, such charges are intended to recover the costs of providing these services to individual users.

To fund the sustainable introduction of AWT infrastructure, additional funds will need to be generated to cover OPEX requirements through either expanding the use of current sources, releasing funds from current sources by operating existing services more efficiently, by maximising the revenue available from existing taxes or charges, and by introducing new direct or indirect user charges.

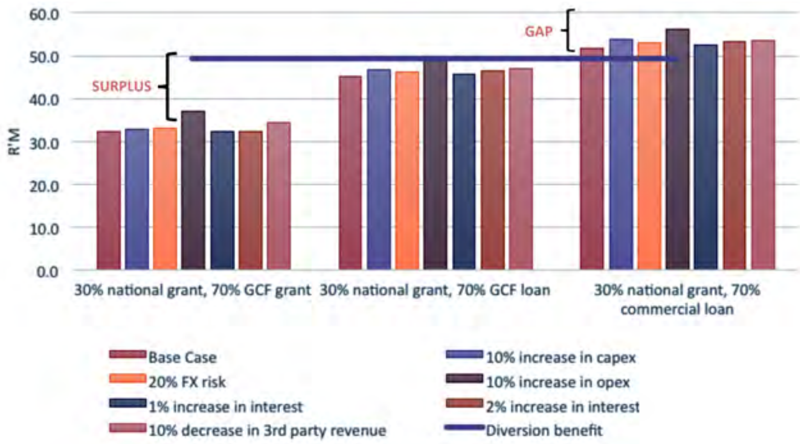

Figure 4.6. Example of OPEX surplus/(gap) as an expression of Government's net benefit/(cost)

This particular AWT technology example shows that Government will be most impacted upon by a 10% increase in OPEX and a 10% decrease in third party revenue. These two risks are likely to be transferred to the operation and maintenance (O&M) contractor for a fixed period of time, but will ultimately remain with Government in the event that the contracted private sector operator fails in their duties. Figure 4.6 also illustrates the risk adjusted NPV costs being quantified for three specific funding scenarios, and highlights that at least one of the CAPEX funding scenarios (commercial loan) results in the cost to government exceeding the diversion benefit that will arise over the 15 year selected operational period.

By way of further illustrating the overall net benefit/(cost) to Government to implement AWT technologies, Figure 4.7 represents all the costs to Government on an annual basis. This example a two-year debt drawn period for capital outplay during construction and a subsequent fifteen-year operation period, during which the municipality is liable for subsidy payments. Two other important indicators are the annual landfill diversion benefits, and the cumulative NPV for the project, which becomes positive between years 5 and 6, i.e. between 1/Jan/23 and 1/Jan/24.

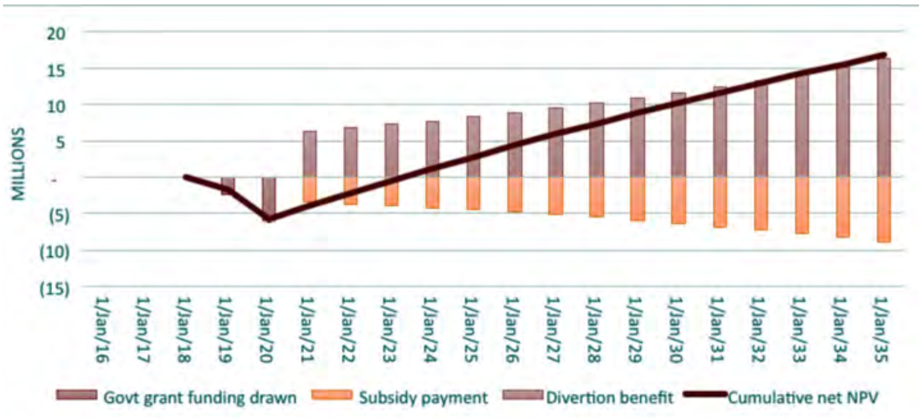

Figure 4.7. Annual costs and cumulative NPV benefit to Government.

A Perspective on Municipal Affordability

Municipal affordability relates to the ability of municipalities to:

- Raise and service debt needed to finance the AWT project; and
- Level and collect charges from service users.

The ability to raise debt finance is usually governed by three things: i) the lack of guarantees from the Treasury should municipality default on payment therefore risk assessment and ability to service a loan by a municipality must be established ii) The portfolio of loans already held by a municipality; and iii) Competing demands on municipal financing sources. The municipal affordability of AWT investments therefore relates to three issues:

- The legal capacity and constraints on municipalities raising debt finance;
- The extent to which debt finance is already committed to or needed by other services; and
- Municipalities' ability to raise the recurrent financing needed to cover – at a minimum – debt service and O&M costs.

The implication of such constraints is that the level of borrowing a municipality can undertake is governed by its existing loan portfolio, by any other loans that it may wish to take to finance other municipal priorities, and its annual income. It is this combination of loan requirements that will determine whether or not municipal borrowing capacity has been reached, and the need to establish priorities between competing demands. Constraints such as these are also a reason why the private sector is often involved in the provision of AWT technologies/affordable waste management services.

4.4 Infrastructure Funding – The UK Approach

Investing in AWT technologies is a relatively new area for South Africa and, as already alluded throughout this series of KP publications, there are a number of inter-related factors that need to be taken into account if such infrastructure is to be sustainably implemented. This section presents a brief summary of the UK's approach towards financing such infrastructure and the possible lessons that could be learnt. The UK's approach towards financing infrastructure (including AWT technologies) is set out in its National Infrastructure Plan which was first published in 2010 and has been updated on an annual basis thereafter. This infrastructure plan is complemented with a national infrastructure pipeline which is updated on a six-monthly basis. The government support for infrastructure investment is manifested through two main instruments, namely:

- UK Guarantees Scheme; and
- UK Green Investment Bank.

4.4.1 UK Guarantees Scheme

The UK Government has committed to providing up to £40 billion in guarantees to UK infrastructure projects in order to progress development. The scheme seeks to ensure that where major infrastructure projects may struggle to access private finance due to adverse credit conditions, these projects can still proceed. The Government has wide discretion over how a guarantee is structured in terms of scale, timing, risk exposure and relationship, subject to the terms and dynamics of each individual project. The guarantees could cover key project risks such as construction, performance, or revenue risk. Applications are made via Infrastructure UK[12], and are subject to due diligence, commercial fees, and necessary approvals.

Eligibility Criteria of UK Guarantees Scheme:

1. Nationally significant – as identified in the National Infrastructure Plan;
2. Ready to start construction within 12 months – from guarantee being awarded and having obtained (or about to obtain) necessary planning and other required consents;
3. Financially credible – with equity finance committed and project sponsors willing to accept appropriate restructuring of the project to limit any risks to the tax payer;
4. Dependent on the guarantee to proceed – and not otherwise financeable within reasonable timeframe; and
5. Good value to the taxpayer – assessed by Her Majesty's (HM) Treasury to have acceptable credit quality, no unacceptable fiscal or economic risks present, and to make a positive impact on economic growth.

4.4.2. UK Green Investment Bank (GIB)

GIB's purpose is to accelerate the UK's transition to a greener economy. GIB was created by the UK Government in November 2012, its sole shareholder, and capitalised with an initial £3.8 billion of public funds. GIB uses this finance to green projects, on commercial terms, across the UK and to mobilise other private sector capital into the UK's green economy.

GIB primarily invests in the offshore wind, waste and bioenergy, and energy efficiency markets. GIB has backed 26 projects and set up five funds committing £1.3 billion. For every pound of investment by GIB, three additional pounds of private investment have been mobilised.

4.4.3. UK Waste Infrastructure Funding Models

The following table (Table 26) summarises the main funding models used in the UK for waste infrastructure – including AWT:

[12] *Infrastructure UK (IUK) was a division of HM Treasury that advised government on the long-term infrastructure needs of the UK and provided commercial expertise to support major projects and programmes. It has recently been amalgamated into the Infrastructure and Projects Authority.*

Table 26. Main funding models employed in UK for solid waste treatment infrastructure

Financing	Financing Types	Waste	Financing Source
Upfront investment made by public capital	Public Industry	Commercial waste operations by local authorities	Paid for by taxpayer
	Conventional capital procurement	Municipal waste facilities	Paid for by taxpayer
Upfront investment made by private finance	PPP/ Private Finance Initiatives (PFI)	Municipal waste treatment	Paid for by taxpayer
	Economically regulated private industry		Paid for by user
	Other private industry	Commercial waste disposal	

Private finance in the form of design, build, finance, and operate (DBFO) projects is the most common form of public private partnerships (PPP) used in the UK, and the country currently has over 700 operational projects with a capital value of over £50 billion covering a wide range of public sector services. The main characteristics of the UK's PPP model/market are:

- Private capital at risk;
- Strong incentive to deliver on time and to budget, i.e. no payment until the asset is operational etc.;
- Incentives to maintain asset and service level over the contract period, i.e. the public sector only pays for an acceptable service;
- Fixed price;
- Certainty of whole-life costs; and
- Output based, i.e. the private sector decides how to deliver the service to meet the output requirements.

Recent reforms to the UK's PPP model have introduced aspects such as public sector equity to enable greater transparency, faster and less expensive procurement, flexible service provision focussing on services directly related to the asset, and the structuring of projects to facilitate access to capital markets or other sources of long-term debt finance, etc.

4.5. Modelling Criteria & Sensitivities

In light of the business rational presented in Section 4.3 and the UK lessons presented in Section 4.4, this sub-section provides a modelling approach and associated sensitivities to help municipal authorities quantify the business opportunities that exist with AWT technologies in South Africa.

In order to quantity the costs and benefits of AWT in the South African context, a forecast cash flow should be generated over the construction period and useful economic life (UEL) of the selected AWT technology. The following list presents the general modelling assumptions and criteria that would typically be applied to forecast the costs to municipal authorities:

- Cost inflation: prevailing Consumer Price Index (CPI);
- Taxes: statutory Value Added Tax (VAT);
- Years of operation: UEL of asset(s);
- Waste volume growth: national census growth in population; and
- Government's cost of funding: long dated bond yield.

In terms of funding for the CAPEX portion of AWT technologies, the following general funding assumptions can be used to quantify the cost to the municipality of either a concessionary loan or commercial funding. However, in the event the assets are fully grant funded (see Figure 4.3.), these funding assumption will not apply.

- Concessionary interest rate: Prime less 2% (general consultation with DBSA);
- Commercial interest rate: Prime plus 1.5% - 6.5% (FY17 commercial debt issued to a sample set of RSA municipalities, and could therefore be higher);
- Repayment period: based on UEL of assets; and
- Repayment date: 2-year debt tail (consultation with DBSA, and considered industry norm).

To test the resilience of the selected model in the event of different financial risks, a number of key sensitivities can be run, which should seek to quantify the impact on both municipal authorities and National Government. The aim of financial sensitivity analysis is to assess the implications for financial stability of plausible changes to the major assumptions upon which the AWT financing arrangements are based.

Table 27 captures the key sensitivities and their likely impacts on municipal authorities and National Government.

Table 27. Key sensitivities and their likely impacts on municipal authorities and National Government

Sensitivity	Impact on municipality	Impact on National Government
Adverse change in Foreign Exchange Rates (FX)	Increased subsidy and loan repayments	Additional grant funding required from government, municipality's operational costs increase
Capex overspend	Increased loan repayments	Additional grant funding required from government, municipality's operational costs increase
Higher than forecast OPEX	Increased subsidy	Municipality's operational costs increase
Decrease in third party revenues	Increased subsidy	Municipality's operational costs increase
Increase in interest rates	Increased loan repayments	Municipality's operational costs increase

Sensitivities that should be modelled could include, but are not limited to:

- % Increase in CAPEX;
- % Foreign Exchange (FX) Risk;
- % Increase in OPEX;
- % Increase in Interest;
- % Increase in Interest; and
- % Decrease in third Party Revenue.

By way of conclusion to this section, i.e. in order to quantify the cost-benefit of AWT, a forecast cash flow should be developed for the technology's lifetime based on a number of robust assumptions pertaining to the cost to the municipality of either a concessionary loan or commercial funding. It is also important that the model is resilient to a number of potential financial risks, e.g. percentage increase in CAPEX etc.

4.6. Business Risks Identified

Whilst there are good business opportunities for the establishment of AWT technologies in South Africa, one must be mindful of the associated risks of engagement. As already discussed above, if the introduction of AWT in a South African context is to be successful/sustainable, private sector entities must be integrally involved as operators.

For example, likely concerns may include political and regulatory risk as AWT infrastructure typically has a lifetime much longer than political cycles, and the potential investor's revenues and cost base depend heavily on regulation. Such risks in this particular context are likely to include delayed construction permits and community opposition (i.e. during the planning and construction phase), changes to various asset-specific regulations and outright expropriation (i.e. during the operating phase) and, towards the end of a contract, the non-renewal of licenses and tightened decommissioning requirements.

Table 28 highlights these likely risks listed in order of severity. These risks have been drafted in light of the key leverage points and business rationale presented in Sub-sections 4.1 and 4.2.

Table 28 Likely business risks associated with AWT technologies

Risk(s) Identified	Possible Cause(s)	Possible Mitigation Measure(s)
Municipal Liquidity Risk Private sector may require higher than forecast returns to compensate for perceived liquidity risk.	• Private sector perception of the municipality's ability to pay its suppliers, subsidies or loan repayments on time.	• Municipality to communicate its payment statistics to the private sector over lifetime of project to alleviate concerns.
Delayed Financial Close Increasingly lowered private sector appetite for project due to on-going project signing delays.	• Inception of AWT project implementation is delayed, and thereby delayed operation.	• Ensure reliable and efficient administration is in place, e.g. clear agency set-up and efficient procurement and permit processes, strict implementation of anti-corruption and transparency standards, etc.
Operation Phase Risks Risks of expropriation, risks of breach of contract, and risks of asset-specific regulation.	• A fundamental risk faced by a private AWT owner is the risk of outright confiscation or nationalization of their asset. • Any small change to operating regulations pertaining to AWT technologies could have a large detrimental effect on revenues or cost.	• Robust infrastructure regulation and contracts, i.e. rules that are adaptive in a predicable way, "stress tested" regulation that will function under unfavorable conditions etc. • Effective interaction with the public sector, e.g., constructive communication with public agencies etc. • Culture of open dialogue, i.e., management of risk and return expectation, multi-stakeholder dialogue beyond specific projects.
Overstated Sales Assumptions Third party revenue assumptions are significantly overstated, skewing modelled return expectations.	• Market pricing at feasibility stage does not materialize. • Demand for products may be overstated.	• Contracts can be structured to transfer this risk in respect of third party revenue to the private sector, or vice versa.
Adverse FOREX Changes Adverse foreign exchange movements result in higher than forecast capital expenditure costs. (assuming imported equipment)	• Local political instability. • Down grading of sovereign debt to non--investment grade status. • Deteriorating macro-economic conditions.	• Hedging instruments for private sector party(ies). • Risk is likely to remain with the municipality until financial close. • AWT technologies will have increasingly less exposure to Foreign Exchange movements post-construction.
Interest Rate Risk Interest rate risk will be borne by the municipality until financial closure.	• Deteriorating macro-economic conditions. • Down grading to non-investment grade status.	• Bidders may opt to hedge against interest rate risk once financial close has been reached, if not prohibitively expensive.

Risk(s) Identified	Possible Cause(s)	Possible Mitigation Measure(s)
Planning, Design and Construction Phase Risks Risks of cancellation or change of scope, risks concerning environmental and other permits, and risks of community opposition.	• Any potential AWT project is vulnerable to cancellation if a new government sets different priorities from those set by the previous government. • Construction permit delays can have a severe impact on an AWT project's profitability, because cash flows start later than expected. • Local communities can affect AWT projects in ways that don't just influence permit procedures.	• Ensure that there is a general stability of laws and regulations, i.e. there is a legal architecture in place conducive to preserving established principles, and that there is a non-partisan alignment on infrastructure vision and strategic decisions. • Inclusive community engagement, i.e. participatory planning and low burden construction, ongoing community involvement during operation etc.
High-Tech Risk Premiums Funders may require higher risk premiums as the technologies on offer may be viewed as untested.	• New or untested technology that has not been funded previously	• Bidders may opt to use their own balance sheet to fund the interventions as the capital expenditure values are not prohibitively high. • Capital grants could reduce the project's funding requirements and allow the private sector to fund the remaining capital expenditure with their own balance sheets.
Municipal Solvency Risk The inability of municipalities to furnish annual payment agreements to private sector due to bankruptcy.	• Municipal bankruptcy.	• Undertake a creditworthiness assessment of the municipality to ascertain its: i) Financial profile; ii) Major creditworthiness constraints; iii) Supporting creditworthiness factors; and iv) Debt carrying capacity.

Whilst there will be good business opportunities from the introduction of AWT technologies, this process will not be without risk. These risks range from municipal liquidity, delays in financial closure, overstated sales assumptions, interest rate risks, and municipal solvency risks etc. However, whilst these risks do create a challenge for the sustainable development of the sector, they can be successfully mitigated against through a combination of pro-active management and appropriate due diligence on the potential AWT investment opportunity.

Chapter 5
CLOSING REMARKS

5. Concluding Remarks

The implementation of appropriate operator models to facilitate the sustainable implementation of AWT technologies in South Africa will clearly need to overcome a number of constraints. Nevertheless, one of the key messages that has arisen from the numerous stakeholder interviews held during the preparation of this KP is that the desire is there to overcome these constraints – however the enabling institutional conditions have to be created at both the levels of the "operator model" and, indeed, at the wider municipal, provincial, and national levels.

An analysis of the strengths and weaknesses of the definitive operator models in the South African context cannot be separated from an analysis of the wider institutional framework itself. Deficiencies in the latter also need to be addressed as a pre-requisite for supporting the introduction of sustainable operator models. The conclusions listed below are therefore relevant to both the wider strengthening of the institutional framework, as well as those relevant to facilitating the sustainability of the "conventional institutional components" of an operator model *per se*.

1. Arguably, the "Client", typically being the public authority (e.g. local municipality), has the *most* pivotal role to play in creating the conditions for supporting the introduction of sustainable AWT's - being the entity legally responsible for service delivery with respect to municipal solid wastes. Typically, the interest and involvement of the Client will make-or-break an AWT project. In the South African context, however, one can conclude that the Client function of the typical operator model (i.e. client-revenue collector-operator) is relatively weak (first and foremost due to a lack of capacity), with the possible exception of a few metropolitan cities and local municipalities.

2. The national policy framework should encourage the introduction of sustainable AWTs is in place, namely the National Waste Management Strategy (2011). It is consistent with international best practice, and comprises a number of goals and targets to facilitate the diversion of waste away from landfill and up the so-called "waste management hierarchy". Similarly, the regulatory framework also provides similarly appropriate legislative drivers to support this process.

3. Whilst the regulatory framework is appropriate, enforcement needs to be improved at all tiers of government. There are real constraints arising from Sections 33 and 120 of the MFMA. For example, the three year contractual agreements for service contracts are not really attractive from the perspective of business planning, longer agreements for 5 years require a board decision, and longer-term agreements (together with any PPP) require approval from National Treasury. The approval process for the latter two options is both complex and lengthy, and not well understood. This is a significant barrier to implementing AWT.

4. A major constraint to the effective implementation of national policy lies at the level of the municipality, i.e. through a lack of both capacity and a horizontal/integrated approach taken to the waste management sector. The municipalities are under-staffed and lack of training/knowledge in aspects such as PPP. Focus needs to be placed on developing capacity of the municipalities as the future 'Clients' of AISWM systems.

5. There are few, if any, integrated waste management plans at municipal level, i.e. there is very little horizontal integration between the various departments, and coherent decision-making is lacking when it comes to supporting and developing municipal infrastructure as a whole. Efforts need to be placed on providing streamlined and strengthened organisational structures, with a single point source of contact and expertise in waste management within the municipalities.

6. The lengthy and complex public procurement processes in South Africa create a situation, driving alternative service delivery mechanisms for involving the private sector to be considered, where these can add value and capacity to the public sector – e.g. PPP's. The upshot of this is that the private sector will be the key driver for diverting waste from the landfill. Although the PPP process works in theory, in practice the process is hampered by a lack of capacity within the municipalities with the result that, to-date, no PPP projects for waste management have been approved in the country.

7. There is a mix of private and public sector operators for the collection and transport of general waste. Primary and secondary collection of solid waste are municipal services, and therefore municipalities are required to go through the MSA Section 78 process in order to qualify their use of external, private operators. However, most private operators have a reluctance to work with municipalities due to a number of perceived difficulties such as: slow payment, no payment, poor internal communication, and a lack of timely correspondence. Most private operators prefer to work with larger private clients instead.

8. The promising AWT technologies for the short-term identified within KP2 have been confirmed during this study as being the most appropriate, applicable and affordable solutions. The greatest business opportunities lay in composting and recycling through clean MRFs.

9. Securing access to the relevant waste stream via local government will be an important pre-requisite for the sustainable introduction of AWTs. In this context, and with respect to recycling, moving away from the concept of centralised mechanical MRFs to decentralised micro-MRFs (which are community driven and involve the use of mainly labour) will be the optimum "win-win" solution - one that meets both the government's requirement for local job creation, and the diversion of solid waste away from landfill.

10. In terms of the most appropriate operator models for South African AWT technologies, the Public operator model for all of the short- and medium-term AWTs is considered the least appropriate and the least likely to be successful. The converse is, in the most part true, whereby the private sector has the know-how and resources to *solely* carry out AWT in a timely and profitable manner. Therefore, operator models that support the use of the private sector are favoured and are likely to be the most beneficial to the municipality, informal sector, and South African rate payers alike.

11. In terms of the operation of short-term "quick win" technologies, the most appropriate contract types are *Extensive* SLAs and PPPs. In both instances, the private sector is contracted to *operate* the AWT technology. With the SLA, the private entity would normally provide the land, licensed facilities, and have equipment already available and, in the case of the *Extensive* SLA, would be required to collect a particular waste stream for treatment.

12. Notwithstanding the lengthy procurement system, the 3 year SLA is one of the quickest South African operator models to enact, and is likely to be well contested amongst the private sector - thereby providing a more efficient market price. Most entrepreneurs, nevertheless, emphasise the importance of extending agreements beyond a 3 year period to a minimum of 5 years, to allow for increased business security. There appears to be a false perception that the procurement process for a 5 year "management" SLA contract is more cumbersome and lengthy than for the 3 year "service" SLA contract. The difference here is that the 5 year contract simply requires board approval at the municipal level, and does not require the "lengthy" approval from National Treasury.

13. For the operation of medium-term potential AWT technologies, the maximum involvement of the private sector is required and thus the PPP operator model is favoured. There are currently no solid waste management PPPs in South Africa (as of June 2016), and no local yardstick to judge the efficacy of this operator model for such AWT. However, the private sector is best suited to take on the DBFO of an AWT technology, process and/or facility and, importantly, has a greater risk appetite over the long-term than public authorities.

14. There is unquestionably a robust business case for the implementation of AWT technologies, and the corresponding diversion of waste from landfill in a South African context, based on five key leverage points: i) Waste is *not* a waste; ii) Municipalities *own* the waste; iii) Function *not* service; iv) Recovering *full* costs; and v) Cost *sharing* is pivotal. In this respect the underlying business rationale is one of maximum co-benefit, i.e. the implementation and operation of AWT technology should be a fully collaborative effort between municipal authorities and private solid waste management entities.

15. The relevant costs associated with AWT are CAPEX for construction, installation, and commissioning, and OPEX for on-going operation and maintenance. The former can be sourced from a combination of grant funding, concessionary loans, or commercial loans, whereas a municipality is responsible for OPEX payments. It is the latter which is fundamental to the sustainability of AWT technologies, because failure to service the operational costs jeopardises the quality of the service and increases the risk of equipment deterioration. It is therefore critical to consider the affordability of an AWT project at the municipal level, not least because in the likely OPEX gap scenario, municipalities will have to allocate a portion of their operational budget towards paying a subsidy to their contracted private sector operator.

16. EPR will play a vital role in developing and stabilising markets for packaging waste recycling. Implementation of EPR for packaging waste will transform the sector, and open up significant new opportunities for investment, business and employment in the waste management sector.

17. The "operator" component is working well in South Africa – the weaknesses and lack of confidence which many have in their agreements with the municipalities (i.e. clients) notwithstanding – and conditions/opportunities should be created for encouraging more private sector participation within the sector. The three-year service agreement is arguably a real constraint here, and needs to be revised particularly if one wishes operators to invest in more modern trucks and collection bins etc.

18. It is envisaged that the optimum operator model for facilitating the introduction of **sustainable composting** is an extensive SLA. One example of which is the drop-off, sorting, chipping, collection, transportation, and composting of greens and garden refuse in the City of Cape Town. A competitive private entity should be contracted to sort and chip greens and garden refuse at a drop-off facility and then transport it to a composting site, where a nationally acceptable standard of composting is carried out by the private entity. The private entity then "owns" the compost and should carry the risk and reward of offering it to the market. The public authority will be involved in the planning and licensing for an acceptable composting site, and will provide institutional and administrative support such as the revenue collection for greens (if any), contract management and payments, environmental monitoring, and any re-licensing requirements and correspondence with national authorities.

19. The optimum operator model for facilitating **recycling** is to move towards decentralised micro-MRFs (organised through some form of local community co-operative) which feed into a centralised, mechanical, clean MRF. Experience in South Africa has shown that the productivity of the people in the manual system will be the same as the productivity of those in the mechanical MRF system, albeit with significant cost savings. Every town should have a basic "micro-MRF" sorting facility which serves the local community – in such circumstances, the local authorities will grant access to the general waste stream - and which can be funded using an urban settlement grant to cover CAPEX. The only proviso is that, if it is to be grant funded, then it will have to be constructed on council land because government funds cannot be used to construct buildings on private land.

20. The best operator models for **AWT** in South Africa are those that involve the private sector. It is clear from those interviewed during the course of preparing this KP5 that municipalities lack both the capacity and desire to operate AWT facilities. In order to encourage investment into AWT technologies in South Africa, there needs to be a considerable lengthening of contracting periods between municipalities and the private sector, in the order of 10 to 20 years depending on the nature of investment concerned. This is will help mitigate for high interest rates and facilitate increased local investment.

21. Cost "sharing" should be instituted between the private contracting parties and the municipality. The recovery of all OPEX is the single biggest threat to the sustainability of AWT technologies in the long-term and, in this respect, it is recommended that any envisaged gap in OPEX recovery must be suitably covered by some form of public sector guarantee.

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