

# **A NATIONAL WASTE RESEARCH, DEVELOPMENT (R&D) AND INNOVATION ROADMAP FOR SOUTH AFRICA: PHASE 1 STATUS QUO ASSESSMENT**



## **Current and Required Institutional Mechanisms to Support Waste Innovation**



**science  
& technology**

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## DOCUMENT INDEX

Reports as part of this project include:

REPORT NUMBER	REPORT TITLE	AUTHORS
CSIR/NRE/SUSET/ER/2012/0045/A	Phase 1 - HCD: Skills for an Innovative Waste Sector: Workshop Report (11-12 July 2012)	Lombard, R.K., Lombard, J., Godfrey, L. and Roman, H.
CSIR/NRE/PW/ER/2012/0052/A	Phase 1 - HCD: Current waste HCD initiatives in South Africa	Lombard, J., Lombard, R.K. Godfrey, L. and Roman, H.
CSIR/NRE/SUSET/ER/2012/0053/A	Phase 1 - HCD: Core waste management skills and implementation modalities	Lombard, J., Lombard, R.K., Godfrey, L. and Roman, H.
CSIR/NRE/SUSET/ER/2012/0063/A	Phase 1 - Institutional framework: Current and required institutional mechanisms to support waste innovation	Schoeman, C., Mapako, M., Kalan, S., Godfrey, L. and Roman, H.

## EXECUTIVE SUMMARY

Over the past five years in South Africa, progressive science and environmental policies have been developed to drive waste management practices up the waste hierarchy away from landfilling towards reduction, reuse and recycling. It is recognised that innovation, including the development and deployment of new technologies is required to enable such improved waste management practices. Government recognises the contribution of the South African waste sector towards growing a green economy, moreover, it sees opportunities for innovation, enterprise development and job creation in this sector.

The Department of Science and Technology (DST) has recognised the need for a roadmap to guide waste R&D and innovation in support of a green economy and the national system of innovation (NSI). The Department has therefore initiated a process to develop a 10-year Waste R&D and Innovation Roadmap for South Africa (2012-2022).

### *Aims and Methodology*

Phase 1 of the roadmap development entails assessing the status quo of waste R&D and innovation in South Africa and has two sub-tasks: a Human Capital Development analysis (separate reports<sup>1</sup>) and exploring *sector opportunities and constraints to waste innovation* in South Africa (this report). The aim of this sub-component of the project is *to identify current and required institutional, legislative and financial mechanisms that will support a national waste innovation programme*. This was achieved by means of a two-pronged-approach which consisted of a desktop study of relevant waste- and innovation-related strategies, reviews and reports, as well as interviews with key role players in relevant public and private institutions, in order to assess:

- Relevant institutions, i.e. key role-players and responsibilities
- Existing support mechanisms, e.g. funding, technology evaluation, commercialisation
- Economic and legislative constraints, gaps, opportunities for technology development and innovation

### *Brief summary of waste innovation and the National System of Innovation*

The primary law regulating waste management in South Africa is the National Environmental Management, Waste Act, 2008 with the Department of Environmental Affairs (DEA) as the national custodian of waste management in South Africa. The *role of DST* is to support government and industry through directing investment in scientific knowledge and technology development which, in this case, will lead to an improvement in the way waste is managed. Current science and technology development support mechanisms that DST can employ towards this aim includes research programmes (grant funding, research chairs, centres of excellence), human capital development (studentships, internships) and technology investment through agencies such as NRF, TIA.

*Innovation* is seen as one of the key drivers of South Africa's intended transition from a resource- and commodity-based economy to a value-adding knowledge-based economy and can be the

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<sup>1</sup> All reports are available on the project website – [http://www.csir.co.za/nre/pollution\\_and\\_waste/waste\\_innovation.html](http://www.csir.co.za/nre/pollution_and_waste/waste_innovation.html)

vehicle to achieving government's goals of service delivery, national development and improved global competitiveness.

Waste innovation requires a complete reform of the whole waste generation, collection and disposal process, with a move away from disposal of waste to landfill. There is currently a small national investment in waste R&D in South Africa. While no national figures exist, it is estimated that current waste R&D investment in South Africa is <0.5% of the total waste sector turnover of R10 billion. While the waste sector is recognised as being able to make an important contribution to South Africa's economic growth and new job potential, the NSI appears to have not yet responded, with no focused waste innovation programmes or incentives in place to stimulate technological and non-technological innovation. The lack of information on the effectiveness of NSI institutions' innovation funding initiatives, and their particular application within the waste sector, highlights that there is no way through which to measure the performance or impact of different financial incentives on the NSI, which makes policy development and corrective action in the system difficult.

### *Constraints, gaps and opportunities to waste innovation*

The main constraints, gaps and opportunities to waste innovation that were identified based on interviews with key waste management- and/or innovation role players in the sector centred around seven themes. These include:

- legislative
- economic and financial
- institutional
- behaviour and perceptions
- infrastructural
- information sharing and collaboration, and
- human capital development

Cutting across these issues, are seven prominent cross-cutting themes, which challenge waste innovation in South Africa. These include:

- a need for communication coherence and inclusion
- enhanced policing and enforcement
- skills and capacity development
- streamlining and harmonising of cumbersome processes between and within government departments
- improved support for innovation, and
- more accessible and fitting poverty reduction support

Many of these challenges to waste innovation are not unique to South Africa, as discovered through a review of similar waste innovation strategies and roadmaps for Europe and Australia.

### *Concluding Thoughts*

Key to the development of new models for sustainable waste management is the creation of infrastructure, preconditions, instruments, and an institutional context in which all actors can perform their partnership functions in an optimal manner.

Through the establishment of a waste RDI roadmap, DST can contribute to addressing some of the identified shortcomings in the context of the waste sector, particularly:

- including the private sector meaningfully in the innovation system
- identifying sectoral priorities for innovation, with directed investment and support
- strengthening governance systems by putting mechanisms in place to overcome current governance challenges to waste innovation
- strengthening human capital in the waste innovation sector through formal human capacity development programmes, and
- supporting small enterprises and the informal sector through the NSI as a crucial part of a national waste innovation programme.

In order to develop waste innovation in South Africa, waste needs to be purposefully targeted by government as a national priority by providing strategic direction, a collaborative context and focused funding/incentives, all of which are currently underdeveloped.

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## GLOSSARY OF TERMS

Abbreviation	Full terminology
ARC	Agricultural Research Council
AWT	alternative waste technologies
BERD	Business expenditure on R&D
BRICS	Biotechnology Regional Innovation Centres
CATNAP	Cheapest Available Technology Narrowly Avoiding Prosecution
CBO	Community Based Organisations
CDM	Cleaner Development Mechanisms
CEC	Commission of the European Communities
CIC	Climate Innovation Centre
COGTA	Cooperative Governance and Traditional Affairs
DBSA	Development Bank of Southern Africa
DEA	Department of Environmental Affairs
<i>(previously DEAT)</i>	<i>(Department of Environmental Affairs and Tourism)</i>
DEFRA	Department for Environment, Food and Rural Affairs
DEWHA	Department of Environment, Water, Heritage and the Arts
DHET	Department of Higher Education and Training
DMR	Department of Mineral Resources
DOE	Department of Energy
DoH	Department of Health
DST	Department of Science and Technology
the dti	Department of Trade and Industry
DWA	Department of Water Affairs
<i>(previously DWAF)</i>	<i>(Department of Water Affairs and Forestry)</i>
EAP	Environmental Assessment Practitioners
EDD	Economic Development Department
EEP-S&EA	Energy and Environmental Partnership with Southern and Eastern Africa
EIA	Environmental Impact Assessments
EPWP	Expanded Public Works Programme
ETAP	Environmental Technologies Action Plan
EU	European Union
FET	Further Education and Training
GCGC	Global Change Grand Challenge
GCRP	Global Change Research Plan
GDP	Gross Domestic Product
GERD	Gross domestic expenditure on R&D
HCD	Human Capital Development
HEI	Higher Education Institutions
HSRC	Human Science Research Council
IDC	Industrial Development Corporation
IDP	Integrated development plans
IP&WM	Integrated Pollution and Waste Management
IPAP	Industrial Policy Action Plan
IPP	Independent Power Producer
IPR	Intellectual Property Rights
IWMP	Integrated Waste Management Plan
IWMSA	Institute of Waste Management of Southern Africa
MFMA	Municipal Finance Management Act
MIG	Municipal Infrastructure Grants

Abbreviation	Full terminology
MR&PDA	Mineral Resources and Petroleum Development Act
MRC	Medical Research Council
MRF	Material Recovery Facility
MW	Megawatt
NATSURV	National survey
NCPC	National Cleaner Production Centre
NEM:WA	National Environmental Management: Waste Act (Act 59 of 2008)
NGO	Non-governmental organisation
NIPMO	National Intellectual Property Management Office
NRF	National Research Foundation
NSI	National System of Innovation
NWMS	National Waste Management Strategy
OECD	Organisation for Economic Co-operation and Development
PIC	Public Investment Corporation
PPP	Public-private partnerships
R&D	Research and Development
RDI	Research and Development and Innovation
S&T	Science and Technology
SAEO	South Africa Environment Outlook
SALGA	South African Local Government Association
SARChI	South African Research Chairs Initiative
SAWIC	South African Waste Information Centre
SAWIS	South African Waste Information System
SEDA	Small Enterprise Development Agency
SETI	Science, Engineering and Technology Institutions
SME	Small and Medium Enterprises
SMME	Small, Medium and Micro Enterprises
SPII	The Support Programme for Industrial Innovation
THRIP	Technology and Human Resources for Industry Programme
TIA	Technology Innovation Agency
TISA	Trade and Investment South Africa
TYIP	Ten Year Innovation Plan
US	United States
VC	Venture Capital
WRC	Water Research Commission

## 1 INTRODUCTION AND BACKGROUND

The recent enactment of science and environmental policy, such as the Department of Science and Technology's (DST) 10-year plan (DST, 2007); the Global Change Grand Challenge Research Plan (DST, 2011) and the National Environmental Management: Waste Act (Act 59 of 2008) (RSA, 2009) has led to a number of requirements for both the public and private sector in terms of the management of waste in South Africa. The need to move waste management up the waste hierarchy away from landfilling towards minimisation, reuse and recycling calls for new ways of doing things, for new technologies, for innovation.

### 1.1 Strategic alignment

The planned 10-year Waste Research Development and Innovation (RDI) Roadmap is strategically aligned with a number of national government policies. However, two very relevant policy documents that the DST aims to support through the roadmap are the:

- Global Change Grand Challenge
- National Waste Management Strategy

#### 1.1.1 Global Change Grand Challenge

The Global Change Research Plan (GCRP) (DST, 2011) identifies four major cross-cutting knowledge challenges which need to be addressed in order to achieve the goal of the Global Change Grand Challenge (GCGC), of enhancing scientific understanding of global change, developing innovations and technologies to respond to global change, and understanding the social context within which solutions will have to be implemented.

These four challenges include: *Understanding a changing planet; Reducing the human footprint; Adapting the way we live; and Innovation for sustainability*. Within each of these four challenges, eighteen (18) key research themes are identified. This waste RDI programme directly addresses three of these research themes, namely B1: Waste-minimisation methods and technologies; B4: Doing more with less; and D4: Technological innovation for sustainable social-ecological systems; but also indirectly addresses a number of the other research themes. The Waste RDI Roadmap therefore builds upon what has already been endorsed through the GCGC process.

#### 1.1.2 National Waste Management Strategy

The National Waste Management Strategy (DEA, 2011) outlines eight (8) specific goals to be achieved by 2016. The DST recognises the contribution it can make in achieving these goals, in particular:

- Goals 1 & 3<sup>2</sup> – waste minimisation, reuse and recycling provides considerable opportunities for research, innovation and technology development and implementation; especially technologies appropriate for South African conditions. By developing innovations to address waste

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<sup>2</sup> Goal 1 - Promote waste minimisation, re-use, recycling and recovery of waste.  
Goal 3 - Grow the contribution of the waste sector to the green economy.

minimisation, re-use and recovery the DST can contribute to growing the waste sector's contribution to the Green Economy. Waste minimisation is also recognised as an area for job creation in South Africa, given labour intensive technology options.

- Goal 5<sup>3</sup> – scientific methods to integrate waste management is also aligned to goal 1. The Integrated Waste Management Plan (IWMP) if based on sound scientific principles is the only way to achieve sustainable development in the long-run.
- Goal 7 – bioremediation is an important aspect of contaminated land rehabilitation. The DST can use this to stimulate the bioeconomy as microbes and enzymes make good catalysts for the breakdown of pollutants (*aligned with a national bioeconomy strategy*).

It is in the above context that this report on the “*Current and required institutional mechanisms to support waste innovation*” is prepared. It is Output 2.1 of Phase 1 Status Quo Assessment of the DST project titled “*A National Waste Research and Development and Innovation (RDI) Roadmap for South Africa: In support of a Green Economy and the National System of Innovation*”.

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<sup>3</sup> Goal 5 - Achieve integrated waste management planning.  
Goal 7 - Provide measures to remediate contaminated land.

## 2 METHODOLOGY

The DST has initiated a process to develop a 10-year waste R&D and innovation (RDI) roadmap for South Africa. Phase 1 of this process entails assessing the status quo of waste R&D and innovation in South Africa and has two sub-tasks: a Human Capital Development (HCD) analysis (DST 2012a, b, c) and exploring **sector opportunities and constraints to waste innovation** in South Africa (this report)<sup>4</sup>. The aim of this sub-component of the project is **to identify current and required institutional, legislative and financial mechanisms that will support a national waste innovation programme**. This was achieved by means of:

- An institutional assessment, i.e. key role-players and responsibilities
- Review of existing support mechanisms, e.g. funding, technology evaluation, commercialisation
- Review of economic and legislative constraints, gaps, opportunities for technology development and innovation

A two-pronged-approach was adopted to ascertain the opportunities and constraints to waste innovation in South Africa. This consisted of a desktop study of relevant waste- and innovation-related strategies, reviews and reports, as well as interviews with key role players in relevant public and private institutions.

This report commences with a brief situational analysis of the South African **waste management sector (Section 3)** which overviews the sector's legal framework; local waste generation volumes; waste sector institutions and their roles; the employment potential, capacity and skills gaps; as well as the current situation on waste innovation technologies/processes and patents.

**Section 4** explores the **National System of Innovation (NSI)**. It assesses the various institutions in the NSI framework and their responsibilities, as well as existing support mechanisms to innovation. It presents findings of reviews of the NSI: key challenges are highlighted, which include constraints and gaps regarding governance and coherency between government departments (spanning legislative, policy and institutional issues); the private sector's role and behaviour regarding innovation (including adaptation to policy, issues around partnering and patenting implications); and from the reviewers' recommendations, opportunities are outlined to enable innovation.

**Section 5** presents the **constraints, gaps and opportunities to waste innovation** based on the views of key role players in the waste sector. From the interviews, seven main themes crystallised around challenges and opportunities for the sector, namely:

- legislative,
- economic and financial,
- institutional,
- behaviour and perceptions,
- infrastructural,
- information sharing and collaboration, and
- human capital development.

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<sup>4</sup> All reports are available on the project website – [http://www.csir.co.za/nre/pollution\\_and\\_waste/waste\\_innovation.html](http://www.csir.co.za/nre/pollution_and_waste/waste_innovation.html)

These themes are used to structure the discussion on current constraints, gaps and opportunities to waste innovation in South Africa.

**Section 6** provides recommendations for addressing the challenges within the NSI and for addressing the cross-cutting issues identified through engagement with key stakeholders.

## 2.1 Definitions

### 2.1.1 Waste

For the purposes of this programme, the definition of ‘waste’ as per the National Environmental Management: Waste Act (RSA, 2009) is adopted -

**“waste”** means any substance, whether or not that substance can be reduced, re-used, recycled and recovered—

- a) that is surplus, unwanted, rejected, discarded, abandoned or disposed of;
- b) which the generator has no further use of for the purposes of production;
- c) that must be treated or disposed of; or
- d) that is identified as a waste by the Minister by notice in the *Gazette*, and includes waste generated by the mining, medical or other sector, but—
  - i. a by-product is not considered waste; and
  - ii. any portion of waste, once re-used, recycled and recovered, ceases to be waste;

This definition is however qualified for the purposes of the waste RDI roadmap, to include mining waste and power generation waste (where significant opportunities for beneficiation exist), but exclude municipal wastewater, which is being addressed through a separate DST initiative.

a **“by-product”** means a substance that is produced as part of a process that is primarily intended to produce another substance or product and that has the characteristics of an equivalent virgin product or material.

**‘general waste’** means waste that does not pose an immediate hazard or threat to health or to the environment, and includes domestic waste; building and demolition waste; business waste; and inert waste.

**‘hazardous waste’** means 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

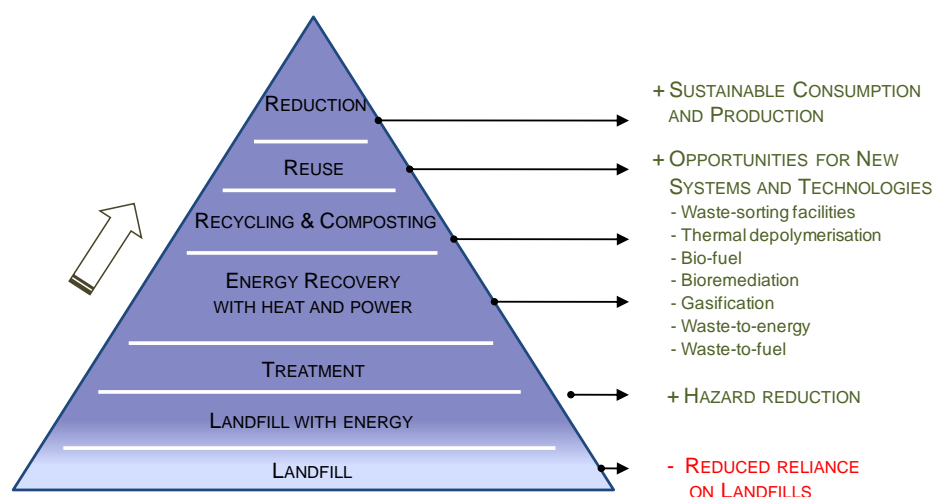
### 2.1.2 Innovation

Innovation may be defined as the capacity to generate, acquire and apply knowledge to advance economic and social purposes. It includes both the search for frontier technologies driven by research and development (R&D), as well as the forms of learning and adaptation that might be market led or socially driven (DST, 2012). For the purposes of the waste RDI roadmap, innovation includes both technological and non-technological innovation, as defined in the South African Innovation Survey of 2008 (HSRC, 2011). It includes varying degrees of novelty from world first, new

to South Africa, new to the sector, and new to the firm. While there are institutions and systems to support innovation in South Africa, it is recognised that there is room for improvement in comprehensively covering the whole innovation chain, and coordination among the support institutions (DST, 2009). With an emphasis on moving South Africa towards a *Green Economy*<sup>5</sup>, the South African waste sector has been recognised as one which provides opportunities for innovation, enterprise development and job creation.

### 2.1.3 Waste Innovation

Waste innovation requires a complete reform of the whole waste generation, collection and disposal process, with a move away from disposal of waste to landfill. It requires thinking differently about waste and recognising its potential as a renewable resource that provides opportunities for beneficiation, rather than as an unwanted product that requires treatment and disposal. Waste innovation must start with minimising waste (and minimising the hazardousness of waste) through cleaner production mechanisms (**Figure 1**).



**Figure 1: Opportunities for waste innovation (adapted from Enviroserv, 2012)**

<sup>5</sup> A green economy is defined by the United Nations Environment Program (UNEP) as “...one that results in improved human well-being and social equity, while significantly reducing environmental risks and ecological scarcities”. In South Africa, the first green economy summit took place in May 2010, and there the President made the statement that South Africa has ‘no choice’ but to develop a green economy.

### 3 SITUATIONAL ANALYSIS: SOUTH AFRICAN WASTE SECTOR

#### 3.1 Key Legislation

The Constitution (RSA, 1996) accords all South Africans the right to an environment that is not harmful to health or well-being. This provision is the basis for the country's environmental laws and regulations. The South African waste sector has seen a significant change in the policy landscape over the past 10 years (Figure 2). Waste management in South Africa is guided by the White Paper on Integrated Pollution and Waste Management (IP&WM) (RSA, 2000), the National Environmental Management: Waste Act, 2008 (RSA, 2009) (NEM:WA) and the National Waste Management Strategy (NWMS) (DEA, 2011).

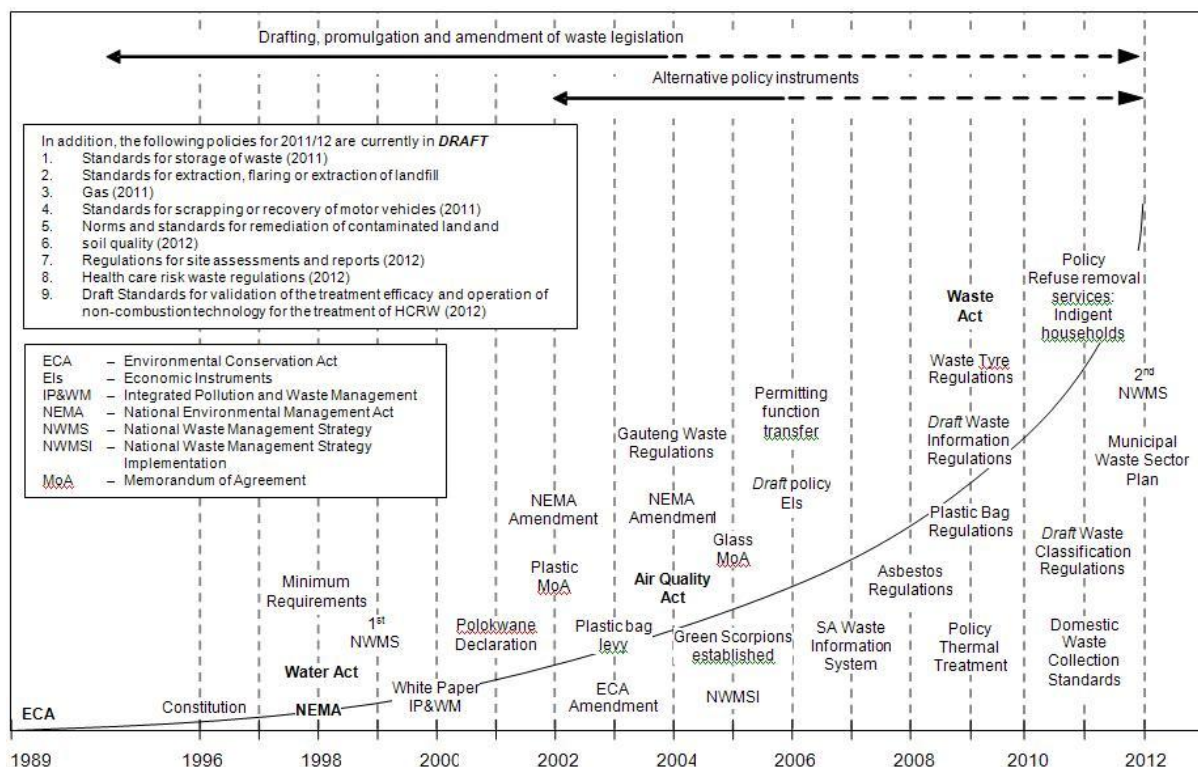


Figure 2: Changing waste policy landscape in SA (adapted from Godfrey & Nahman, 2008)

The primary law regulating waste management in South Africa is NEM:WA. Among the objectives of this Act are:

- Minimising the consumption of natural resources
- Avoiding and minimising the generation of waste and reducing, re-using, recycling and recovering of waste
- Promoting and ensuring the effective delivery of waste services

The successful implementation of these goals largely depends on their translation into policy, strategy and legislation (including municipal by-laws).

In addition to the NEM:WA, a number of additional national laws and international agreements also govern the waste sector, including:

- 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)
- The South African Constitution (Act 108 of 1996)
- 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)
- Mineral and Petroleum Resources Development Act (Act 28 of 2002)
- Municipal Finance Management Act (Act 56 of 2003)
- Air Quality Act (Act 39 of 2004)

Relevant international agreements which South Africa has signed/ratified<sup>6</sup>, include -

- Convention on the Prevention of Marine Pollution by Dumping Wastes and Other Matter, 29 December 1972 (London, Mexico City, Moscow)
- Multilateral Agreement on the Control of Pollution of Water Resources in the South African Region, 21 November 1985
- Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal, 22 March 1989 (Basel)
- United Nations Framework Convention on Climate Change, 9 May 1992 (New York): Convention On Biological Diversity, Opened For Signature At Rio De Janeiro On 5 June 1992

### 3.2 Waste generation in South Africa

A number of studies have been undertaken to quantify the tonnages of general and hazardous waste generated in South Africa<sup>7</sup>. According to the 2<sup>nd</sup> and 3<sup>rd</sup> national waste baseline studies, the total amount of waste generated in South Africa (excluding mining waste<sup>8</sup>) rose from about 65.4 million tonnes in 1997 (DWAF, 2001) to about 108 million tonnes in 2011 (DEA, 2012). This waste may be classified as general and hazardous.

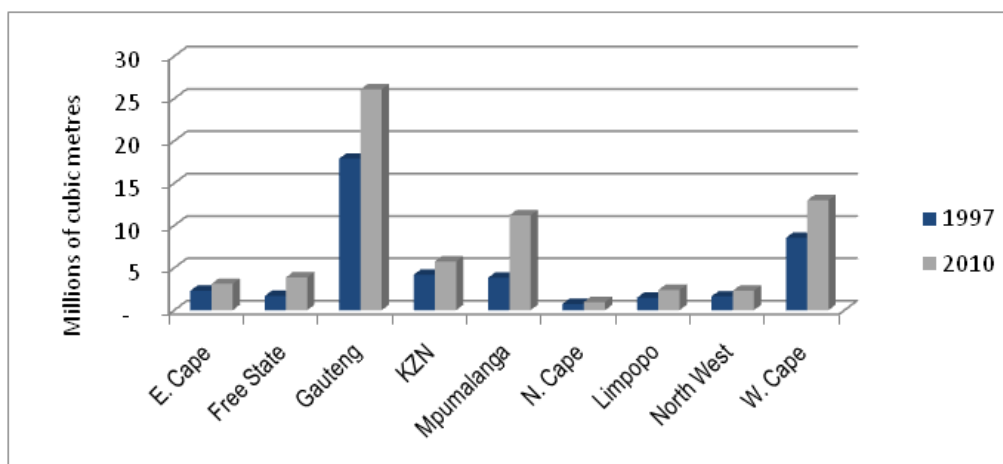
Most of the general waste is generated in the two urban hubs of Gauteng and Western Cape. Data for 2011 shows that 45% of the general waste was generated in Gauteng, which is significantly higher than the next highest producer, the Western Cape at 20% of the total (DEA, 2012).

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<sup>6</sup> All treaties and conventions searchable at <http://www.dfa.gov.za/chiefstatelawadviser/treatysection.html>

<sup>7</sup> These include the official 1991, 1997 and 2011 baseline studies (DEAT, 1991, DWAF, 2001, DEA, 2012), the Purnell research paper for the NWMS (DEAT, 2009) and the National Environmental Outlook Reports (The 2012 South Africa Environment Outlook (SAEO) project, is underway and due for completion around March 2013).

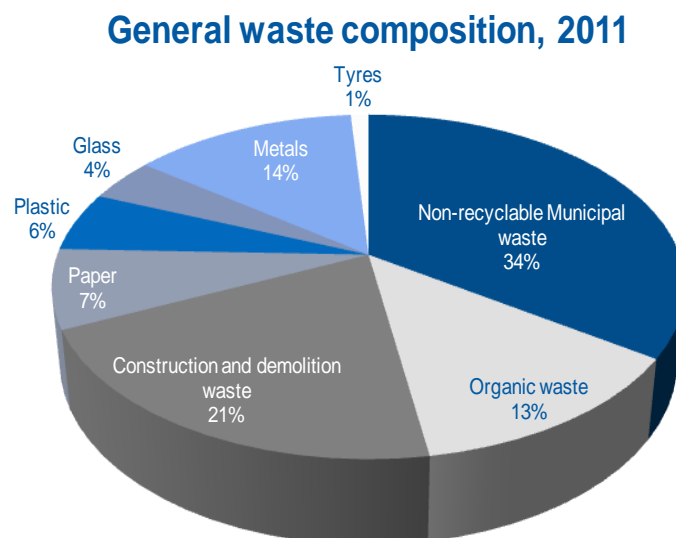
<sup>8</sup> Due to a change in the classification of waste, the 2012 National waste baseline study did not include mining waste. To allow for comparison with the 1997 baseline figures, these tonnages are removed when reporting total waste generated in 1997.



**Figure 3. Estimates of general waste generation in cubic metres by province 1997 and 2010 (National Treasury, 2011)**

In 1997 South Africa's per capita production of waste stood at 0.7kg per day (DEA, 2012a) which was comparable to typical figures for developed countries (DWAF, 1997)<sup>9</sup>. The 3<sup>rd</sup> National Waste Baseline (DEA, 2012) shows that this has increased to an average per capita production of 0.96 kg per day, with generation rates ranging between 0.19 kg per day in North West and 2.08kg per day in Gauteng (DEA, 2012). Figure 3 compares the quantities of general waste generated by province for 1997 and 2010.

The 3<sup>rd</sup> national waste baseline study indicates that the majority (66%) of general waste is potentially recyclable (Figure 4). This provides significant opportunities for reduction of waste to landfill and associated innovation opportunities.



**Figure 4: Preliminary waste composition for general waste, 2011 (percentage by mass), (excluding GW99 – Other, which is mainly biomass waste from industrial sources) (DEA, 2012)**

<sup>9</sup> According to the World Bank, the global MSW average *per capita* is 1.2 - 1.4 kg/day. Developed countries generate well above this average, for example the USA with 2.1kg/day and Australia with 1.9kg/day. The continental average for Africa is 0.65kg/day.

There is also an additional 5 million cubic metres of hazardous waste generated annually, most of it in Mpumalanga and KwaZulu Natal provinces where the mining and fertiliser production industries are concentrated. In 2011 hazardous waste disposal quantities for Mpumalanga province alone was nearly 2.25 million tonnes, nearly half of which was slag (ferrous metal and other slag). Mining waste constitutes the largest proportion of solid waste (over 70%) followed by pulverised fuel ash (nearly 7%). In comparison the other wastes are far less, being 6.1%, 4.2% and 3.6% respectively for agricultural, urban waste and sewage sludge (DEA, 2012a).

### 3.3 Waste sector institutions and roles

The Department of Environmental Affairs (DEA) is the national custodian of waste management in South Africa. However, other government departments also have specific waste responsibilities as dictated by their mandates. These departments are supported by a number of parastatals and non-government stakeholders. **Table 1** provides an overview of the waste sector stakeholders and their roles, and these are further described in **Sections 3.3.1 to 3.3.5**.

#### 3.3.1 National government

As national custodians of waste, the functions of the DEA include development of policy, strategy and legislation, coordination, enforcement, dissemination of information, participation in appeals, authorisations, monitoring, auditing and review, and capacity building (DEA, 2012b).

The waste-sector related responsibilities of other national departments include:

- **Department of Cooperative Governance and Traditional Affairs (CoGTA)** – responsible for municipal service delivery, encompassing waste services planning, delivery and infrastructure.
- **Department of Trade and Industry (dti)** – broadly responsible for industry regulation and development of norms and standards, applying relevant legislation, development of markets for recycled products and supporting SME development.
- **National Treasury** – financial regulation and overseeing budgetary allocation for waste management at national level.
- **Department of Water Affairs (DWA)** – protection of water resources, and the effects of waste management practices. Collaborates with DEA in waste disposal licensing.
- **Department of Mineral Resources (DMR)** – mining sector waste that may not be covered by the Waste Act.
- **Department of Health (DoH)** – regulating health care risk waste and treatment facilities and providing relevant advice to DEA.
- **Department of Agriculture, Forestry and Fisheries (DAFF)** – guidelines for agricultural waste.
- **Department of Energy** – energy from waste and related emissions trading.

**Table 1: Stakeholders and their roles<sup>10</sup>**

	Government			Associations/ organisations	NGOs	Industrial and professional services				Academia
	National	Provincial	Local			Waste contractors	Industry	Consultants	Suppliers	
Policy development										
Setting standards & targets										
Advisory, regulation										
Inspection										
Authorisations										
Waste service delivery/disposal										
Planning										
Information sharing										
Capacity building										
Awareness raising										
Clean up campaigns										
Watchdogs										
Reclaimers, collection										
Recycling										
Treatment/safe disposal										
Design, construction										
Monitoring, auditing										
Suppliers: equipment/materials										
Research and Development										

<sup>10</sup> Based on DEAT 2012a: *Table 2: Main players in the South African Waste Sector*.

As custodian of the national waste RDI programme, the role of DST is to provide government and industry with the appropriate scientific evidence base that will lead to an improvement in the way waste is managed. This can be achieved by supporting science and technology development through available DST and supporting agency (National Research Foundation (NRF), Technology Innovation Agency (TIA)) mechanisms e.g. research programmes (grant funding, research chairs); human capital development (studentships, internships); and technology investment.

### **3.3.2 Provincial government**

Specific waste-related functions carried out by Provincial Government include (DEA, 2012b):

- Development of provincial environmental implementation plans.
- Assisting where necessary, with drafting and reviewing of the first-generation municipal integrated waste management plans.
- Monitor compliance with provincial implementation plans and intervene if necessary.
- Develop provincial guidelines and standards.
- Develop and enforce provincial regulations for general waste collection, and support local government in the implementation of waste collection services.
- Act on environmental hazards as required.
- Ensure that all industries have access to appropriate waste disposal facilities.
- Quality assurance of the Waste Information System.
- Ensure waste minimisation and recycling, and promote voluntary partnerships with industry.
- Regulation of hazardous waste transporters, and hazardous waste collection facilities; and
- Supporting DEA in planning centralised waste treatment facilities.

### **3.3.3 Local Government**

The Constitution assigns waste management services to local government i.e. refuse removal, refuse dumps and solid waste disposal (RSA, 1996). Section 84(1) of the Municipal Structures Act specifies the functions and powers of *district municipalities* regarding solid waste disposal as: determination of a waste disposal strategy, regulation of waste disposal, disposal sites and facilities for more than one local municipality in the district

*Local municipalities and Metropolitan municipalities* are responsible for providing waste management services including collection and disposal facilities, specifically:

- Compilation and implementation of general waste management plans;
- Public awareness campaigns;
- Collection of data for the Waste Information System;
- Waste collection services and management of waste disposal facilities, and
- Ensuring waste minimisation and recycling initiatives.

### **3.3.4 Private sector**

The private waste sector is a diverse one, ranging from industry (as generators and re-processors), to private waste companies (specialising in collection, transportation, storage, separation, treatment, reprocessing, and landfilling), to waste consultants, and equipment suppliers. These functions are performed under various contractual arrangements. Stakeholders mentioned options ranging from purely commercial to exclusive arrangements to deliver specific municipal services. Private sector

companies generally belong to numerous associations and organisations representing their interests. Some of these groupings are listed in **Section 3.3.5**.

### **3.3.5 Waste associations, NGOs and research organisations**

Both the private and public sector are supported by many sector associations and organisations performing networking, information sharing and capacity building functions (DEA 2012b). These include:

- Institute of Waste Management of Southern Africa (IWMSA);
- National Recycling Forum;
- Recycling Action Group;
- Recycling Industry Board;
- PET Plastic Recycling South Africa;
- Packaging Council of South Africa;
- Paper Recycling Association of South Africa;
- Plastic Federation;
- Electronic Waste Association of South Africa.

Additional support is provided by academia and science councils (CSIR, HSRC). Non-governmental organisations (NGOs) and community based organisations (CBOs) play an important role in the sector in awareness raising, as watch-dogs, implementers and trainers.

## **3.4 Value of the South African waste sector**

While no waste sector audit has ever been undertaken in South Africa, the sector is estimated to have an annual turnover of R10 billion (\$1.2b) (DEA, 2009a), with the two largest private waste companies having a combined total revenue for 2009/2010 financial year of R1.6 billion<sup>11</sup>. South Africa's Gross Domestic Product (GDP) as at the 4<sup>th</sup> Quarter of 2009 was R1,782 billion (StatSA, 2010), suggesting that the South African waste sector contributes approximately 0.56% to South Africa's GDP. The proportion of the public and private waste sector (in terms of revenue) is unknown, however figures would suggest that the majority of the revenue is within local government, responsible for domestic waste collection services. There is no information available on the capital value of waste collection, reuse, recycling, treatment and disposal infrastructure in South Africa.

To date, no comprehensive sector analysis has been undertaken on the size, skill base, value and employment opportunities within the South African waste sector. It is recommended that this be undertaken as part of the Phase 1 Waste RDI Roadmap.

It appears that the South African private sector is very innovative, with the South African business expenditure on R&D (BERD) being close to 60% of the gross domestic expenditure on R&D (GERD) (DST, 2012). This is one of the highest proportions in developing countries (DST, 2012). However, when it comes to waste R&D and innovation, there is currently a very small investment. While no

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<sup>11</sup> Company Annual Reports

national figures exist, it is estimated that current waste R&D investment in South Africa is <0.5%<sup>12</sup> of the total waste sector turnover. There is no information available on the split in private and public sector investments in waste R&D in South Africa.

### 3.5 Employment potential, capacity and skills gaps

Waste management legislation, while having an environmental protection based philosophy, is also driven by Government's priority of job creation. With a policy directive of moving up the waste hierarchy, job opportunities are recognised in areas of waste collection, transfer, separation, reuse and recycling. Government intends to implement measures to strengthen and expand the waste economy, generate and sustain jobs, and formalise existing jobs in the waste economy. The National Waste Management Strategy has set the target of 69 000 new jobs in the waste sector and 2600 additional SMEs and cooperatives delivering waste services and recycling by 2016 (DEA, 2011).

### 3.6 Innovation in the waste sector

The innovation potential in the waste sector is influenced by many factors including the national system of innovation, enforcement of legislation, and availability of funding support. While there is much being done in South Africa around non-technological or social innovation<sup>13</sup>, e.g. informal collectors, or indigenous knowledge of waste management practices within communities, the following sections focus specifically on technological innovation in the waste sector.

#### 3.6.1 South African waste patents

A patent search was undertaken to obtain insight in the waste technology sector in South Africa. The keywords 'waste', 'refuse' and 'wastewater' were used to search patents that were registered in South Africa over the last five years, that is since July 2007. The total number of hits for granted patents was 174 for South Africa, with none pending. Comparable numbers using the same search criteria are listed in **Table 2**. Taking the total number of granted and pending patents, SA is comparable to Brazil but lags behind India and Australia. However on a per capita basis SA does much better, coming second to Australia, which with its small population does much better. However, a similar search of waste and wastewater patents granted in South Africa over the period 2006-2010, showed that only 14% of the registered patents were South African. The majority of the waste and wastewater patents registered in South Africa were lodged by international patent holders, including Europe (23%), USA (27%), Australia/New Zealand (10%), UK (6%), India (6%). This highlights the competitive international R&D space in waste and wastewater technology development.

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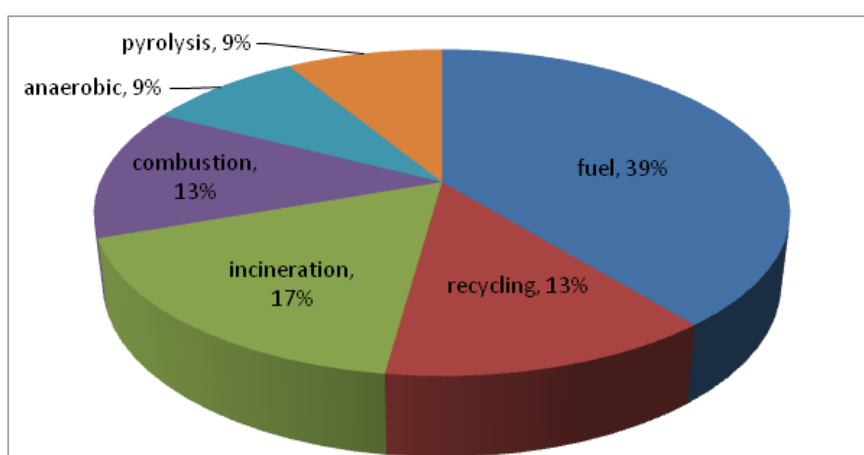
<sup>12</sup> Estimated current allocations to science councils and universities in support of waste research. In addition, the majority of investment in waste R&D appears to be self-funded (DST, 2012c).

<sup>13</sup> Non-technological innovation is poorly documented in the South African waste sector.

**Table 2: Waste related patent data for selected countries**

Country	Patents granted	Patents pending	Population <sup>14</sup> (millions)	Per million population
South Africa	174	0	50.59	3.52
India	187	581	1 240	0.62
Brazil	37	209	196.7	1.25
Australia	320	241	22.6	24.82

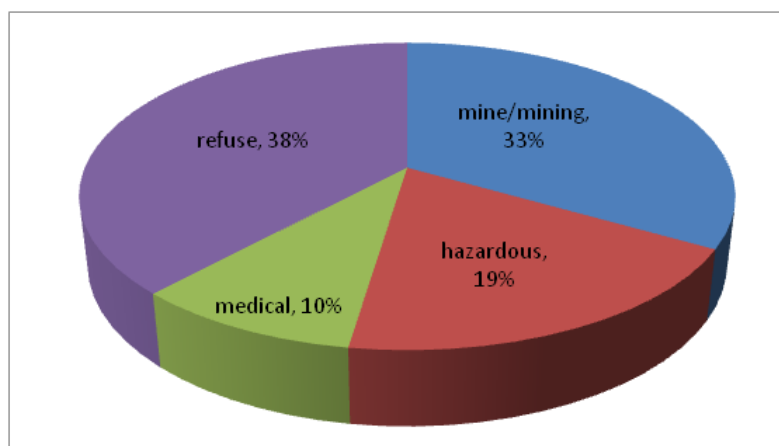
Of the 174 SA granted patents, 46% are related to wastewater and other issues including nuclear waste and air pollution and are not considered further, given the focus of the Waste RDI Roadmap. The remaining 54% were examined further in terms of the keywords used in their titles. A plot of frequently used title keywords (**Figure 5**) shows that ‘fuel’ was most often mentioned (39% of registered waste patents), followed by ‘incineration’ and ‘combustion’, ‘recycling’, ‘anaerobic digestion’ and ‘pyrolysis’. Without examining the abstracts of each patent it would be misleading to attach too much value to this indicative classification, other than to highlight an apparent emphasis on thermal treatment technologies with energy recovery (78% of registered waste patents).

**Figure 5. Technology types mentioned in waste patent titles**

**Figure 6** provides an indication of the split according to category of waste based on the patent title keywords. *Refuse* (typically used to refer to municipal waste) appears most frequently at 38%, with *mining/mine* next at 33%. The *hazardous* category is obviously ambiguous as it can encompass the other categories, and *medical* was the least frequently mentioned keyword at 10%.

Information such as the above can assist in assessing whether waste innovation is in tune with the magnitude and priority of the respective waste streams. For example while mining and power generation wastes are by far the largest quantity of waste generated in South Africa, the proportion of patents, although respectable at 33%, does not reflect this trend. However, the South African patent search results do reflect the current global trends in technology development, with a move towards energy recovery from municipal waste streams and thermal treatment of general and hazardous waste (with energy recovery).

<sup>14</sup> World Bank (2011)



**Figure 6. Categories of keywords describing wastes in the patent titles**

Again the analysis of the keywords is only indicative as there are no rules for use of keywords in patent application and applicants may use very different words to describe the same process of technology.

### 3.6.2 Emerging technologies in South Africa

A rudimentary assessment of emerging waste technologies replacing landfilling in South Africa, based on those mentioned during the interviews with stakeholders, are given in **Table 3**.

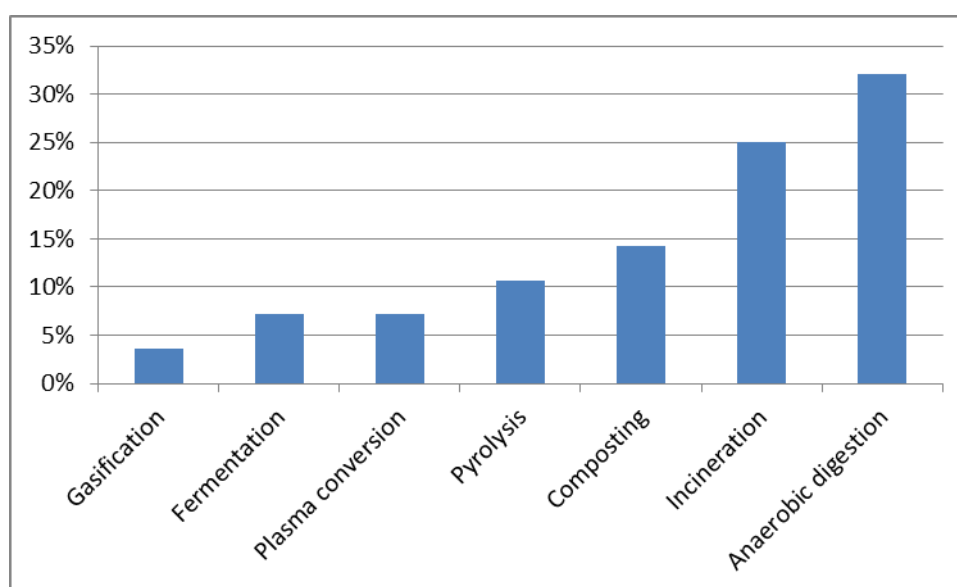
**Table 3: Waste treatment technologies mentioned by stakeholders in interviews**

Technology mentioned	Brief description of waste treatment application
<b>Biological processes</b>	
Anaerobic digestion	Fermentation of organic waste in the absence of oxygen to produce biogas, a mixture of methane and carbon dioxide in the ratio approximately 2:1. Leaves a stable sludge that can be used as manure. Biogas can be used direct for process heat or in engines for transport or power generation. Can handle a limited range of biomass materials.
Fermentation	Aerobic biological process typically utilizing yeasts used to produce for example ethanol or methanol from organic wastes. Releases carbon dioxide and leaves sludge. Can handle a limited range of biomass materials.
Composting	Composting is the biological decomposition of biodegradable solid waste under controlled predominantly aerobic conditions to a state that is sufficiently stable for nuisance-free storage and handling and is satisfactorily matured for safe use in agriculture. <sup>15</sup>
<b>Thermal processes</b>	
Plasma converters	Very high temperature (6 000°C to 10 000°C) decomposition of waste to its elemental constituents, able to handle a wide variety of wastes, organic and inorganic. Uses plasma torches, produces syngas (mixture of mainly carbon monoxide and hydrogen), exhaust heat and slag. Syngas and heat can be used to generate power, and slag can be converted to useful by products, typically construction materials.
Incineration	Burning of combustible waste in air to produce energy and ash, releasing

<sup>15</sup> <http://www.unep.org/ietc/informationresources/solidwastemanagementpublication/tabid/79356/default.aspx>

Technology mentioned	Brief description of waste treatment application
	carbon dioxide. The heat energy released may be used for power generation. Will not handle inorganic components such as metal and glass.
Gasification	Breakdown of solid organic waste in a controlled supply of oxygen to make syngas. The gas can be used in engines, process heat, or as an industrial chemical feedstock. The process can handle any biomass material. <sup>16</sup>
Pyrolysis	Thermal decomposition of solid organic waste in the absence of oxygen to produce char, pyrolysis oil and syngas. <sup>4</sup>

The number of interviewed stakeholders who mentioned each of the technologies is shown in **Figure 7**. Anaerobic digestion (also referred to as biogas, landfill gas by stakeholders) and incineration (also termed combustion by stakeholders) were the most widely mentioned, followed by composting and pyrolysis.



**Figure 7. Stakeholder mention of specific technologies**

Most of the processes cited in **Table 3** and **Figure 7** are waste-to-energy technologies, a popular topic internationally (as reflected in the patent search). While the results of **Figure 7** do not necessarily reflect the uptake and implementation of technologies in South Africa, they do reflect the current level of awareness and discussion around technology options and opportunities in SA.

<sup>16</sup> [http://www.biomassinnovation.ca/pdf/factsheet\\_Juniper\\_Pyrolysis&Gasification.pdf](http://www.biomassinnovation.ca/pdf/factsheet_Juniper_Pyrolysis&Gasification.pdf),  
[http://www.foe.co.uk/resource/briefings/gasification\\_pyrolysis.pdf](http://www.foe.co.uk/resource/briefings/gasification_pyrolysis.pdf)

## 4 THE INSTITUTIONAL FRAMEWORK AND SUPPORT MECHANISMS THAT SUPPORT WASTE INNOVATION

### 4.1 National System of Innovation

Innovation is seen as one of the key drivers of South Africa's intended transition from a resource- and commodity-driven economy to a knowledge economy (DST, 2012).

The 1996 White Paper on Science and Technology conceptualised a National System of Innovation (NSI) as a “set of functioning institutions, organisations and policies which interact constructively in the pursuit of a common set of social and economic goals and objectives” (DST, 2012). It was thought that this would be a mechanism by which to integrate and induce coherence among national activities in the science and technology (S&T) space, identify priorities, and to focus attention on innovation rather than the production of knowledge. It was envisioned that innovation would be used to achieve government's goals of service delivery, national development and improved global competitiveness (DST, 2007).

As illustrated in Figure 8, the NSI includes science councils, universities, business R&D units, research agencies, current funding agencies and the government, at all levels of governance, as well as communities, NGO's, etc. As discussed below, the way in which these institutions currently work together in the NSI is unfortunately not as effective as it should be (DST, 2012).

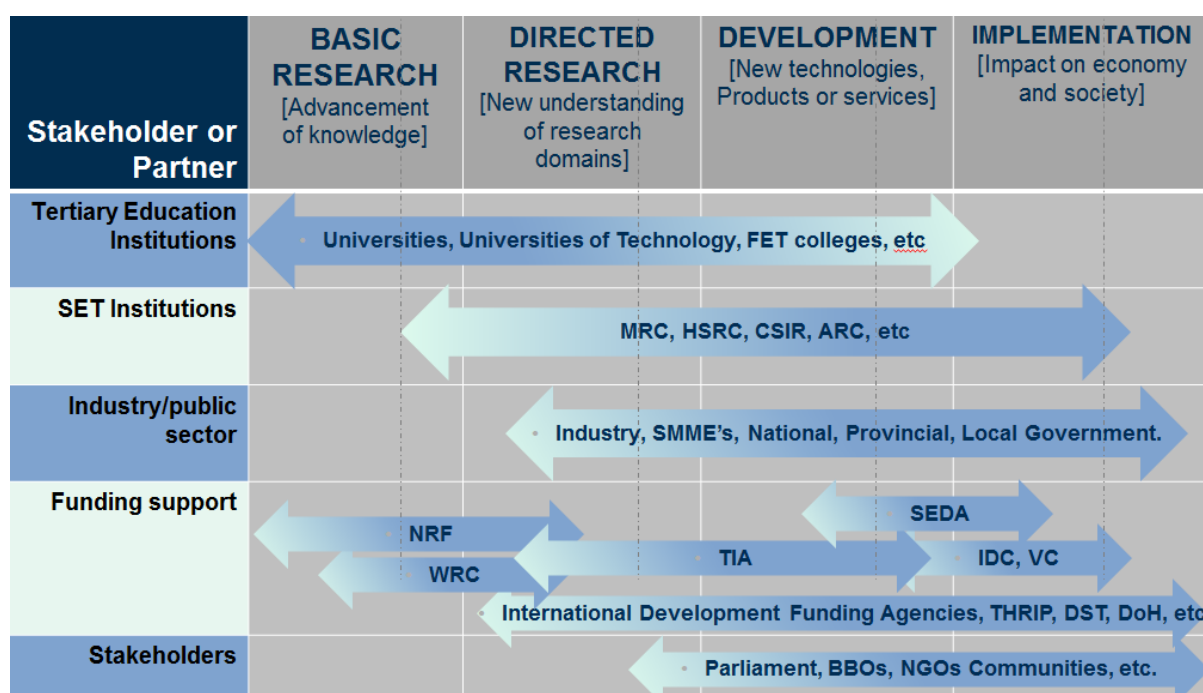


Figure 8: South Africa's National System of Innovation (adapted from CSIR, 2012)

### 4.2 Reviews of the NSI

The NSI has undergone various reviews in the last sixteen years, with the two most recent (and relevant) ones being the 2007 Organisation for Economic Co-operation and Development (OECD)

Reviews of Innovation Policy: South Africa (OECD, 2007 cited in DST, 2012) and the DST Ministerial Committee Review on the Science, Technology and Innovation Landscape in South Africa (DST, 2012), both commissioned by DST. The Ministerial Review Committee found that many of the findings of the OECD 2007 review of the NSI are still relevant today and that while progress has been made in restructuring the system to meet the current needs of the country, the NSI is still perceived to be inadequate to meet the country's challenges, especially with respect to the transition from a resource- and commodity-based economy to a value-adding knowledge-based economy. The NSI also seems to be underperforming in its contributions to the alleviation of poverty and job creation, with the OECD noting that *"there may be little understanding of the role that the NSI should play in addressing social imperatives"* (DST, 2012:5). What follows is a synthesis of the findings of both these reviews.

It appears that the notion of an NSI has found little traction in government departments other than DST, and possibly **the dti**, or in the strategies of key role players in the system. Research and development (R&D) seems to be well-understood and generally regarded as important by the players in the system, but the notion of innovation is generally not.

The relevant findings of the OECD can be summarised as follows:

1. Initiatives in the NSI seem to have little effect in practice due probably to a shortage of skills in the system, uneven levels of commitment to the notion of an NSI, or to the different players in the system operating in the silos created by their (perceived) organisational boundaries;
2. Investment in the system is too little and spread too thinly, into many disparate projects and purposes. Priorities are insufficiently identified, and resources from the various players in the sector are not marshalled to achieve critical mass in addressing any of these priorities;
3. The agencies in the NSI (e.g., science councils, universities, etc.), are insufficiently differentiated resulting in scope creep, competition, duplication and contradictory research efforts;
4. There is very little coherence and integration between the various agencies and no co-ordinating body that devises and monitors innovation policies and strategies nationally or is able to marshal the resources required for implementing these effectively;
5. There is also very little integration between the national, provincial and local levels of government.

Some of the recommendations that came out of particularly the OECD review included:

1. The need to include business and the private sector meaningfully in the NSI;
2. Recognize a broader range of activities (in addition to traditional R&D) that contribute to the NSI, or could do so;
3. Greater integration between all the agencies, government departments at all levels of governance, and with the international systems of innovation, including reciprocal flows of skills, knowledge, equipment and facilities, policies and strategies;
4. The need to understand the demand (pull) for innovation and its linkages to the supply (push) side of science, and hence create a NSI that is more responsive to the innovation needs of the country;
5. Identify and define sectoral priorities for innovation, rather than prioritising in terms of particular technologies;

6. Strengthen the governance systems to enable better identification of these priorities;
7. Establish a national (cabinet) level coordinating body that is able to analyse, coordinate, measure and oversee activities, resources, and policies in the NSI;
8. Create a more enabling environment for the creation and strengthening of the human resource base and pipeline in the NSI, by reviewing immigration, recruitment and promotion policies in this regard;
9. Provide better mechanisms of support for innovation in small and medium enterprises (SME's), including better access to funding (government loans with favourable terms, venture capital<sup>17</sup>, angel funding<sup>18</sup>), and improved means of accessing these by SME's;
10. Provide improved mechanisms of SME access to the support that research and innovation organisations can provide.

Many of these issues highlighted by the OECD in 2007 are still relevant, and constrain waste innovation, as discussed in more detail in **Section 5**.

### 4.3 NSI Institutions and support mechanisms

The following sections provide a brief overview of the NSI as background to the discussion on current constraints, gaps and opportunities for waste innovation in SA. **Figure 9** illustrates the innovation chain along with key stakeholder roles, with input and support from policy and investment.

Looking at the innovation chain (**Figure 8 and 9**), there are very specific roles for each organisation to play. The NRF provides support for basic science and knowledge generation. The intention of demonstration and commercialisation stages is to scale up findings from proof of concept at laboratory scale in order to apply this new knowledge to real problems. This often entails considerable risk – both scientific and financial. While venture capitalists focus mainly on technologies that have been proven at demonstration scale, up until recently there has been little organisational support within what has been referred to as the 'innovation chasm'. The Technology Innovation Agency (TIA) has been established with the specific mandate to help bridge the gap between lab scale and full scale technology development (DST, 2012), since it is here that most technologies face financial or technical failure. Until recently there has also been little interest from venture capitalists within the environmental technology arena; however this is slowly changing, as opportunities are realised for alternative energy technologies, waste-to-energy technologies and product recovery technologies. The last phase, market uptake sees proven products embodying the new knowledge going to market, which is where stakeholders such as IDC would be involved along with investment partners<sup>19</sup>.

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<sup>17</sup> Venture capital funding is provided by an individual, or group of individuals, to a company, and usually takes the form of an investment, rather than a loan. Such investments usually require a high rate of return and are secured by a substantial ownership position in the business.

<sup>18</sup> Angel funding is usually provided by individuals that invest their own money (as opposed to venture capitalists who invest other people's money) in small start-ups or entrepreneurial companies. Such investments are usually characterised by a high level of risk, and potentially large returns on investment.

<sup>19</sup> Although, given the poor translation of pilot scale to full scale technologies in South Africa, the IDC is also moving into the space of supporting technology upscaling from laboratory scale to demonstration scale.

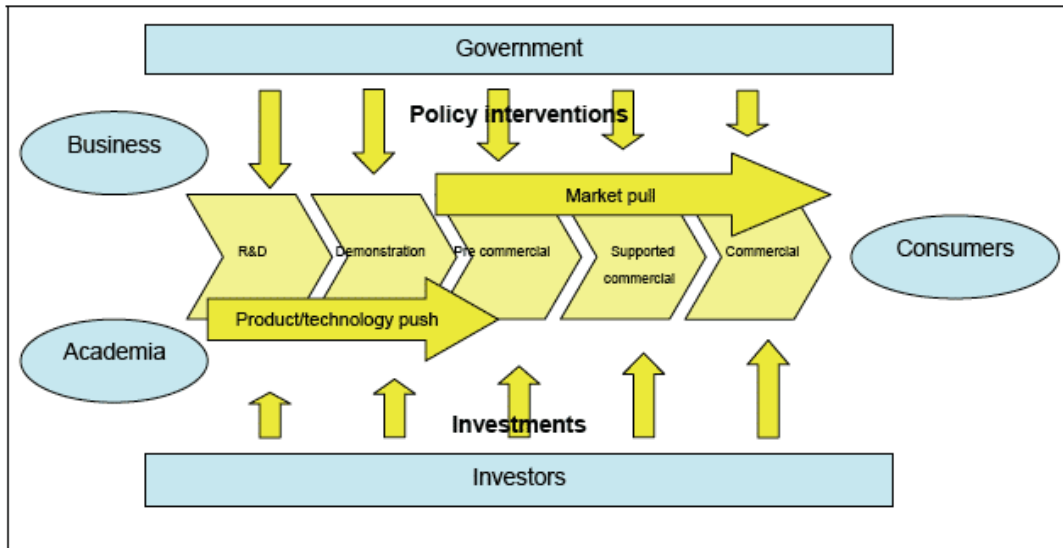


Figure 9: The innovation chain and key stakeholder roles (from Scottish Government, 2009)

The following section provides a brief context to some of the government initiatives aimed at supporting waste innovation in South Africa.

#### 4.3.1 Department of Science and Technology (DST)

The DST encourages patent protection through its Patent Incentive Scheme, which reimburses a percentage of costs associated with said protection. It also has a parallel scheme that awards grants directly to inventors of granted South African patents (with corresponding granted patents in examining countries). These are currently administered through National Intellectual Property Management Office (NIPMO).

#### *The Technology Innovation Agency (TIA)*

TIA absorbed The Innovation Fund and the Biotechnology Regional Innovation Centres (BRICS) amongst other entities. The mandate of the Innovation Fund was to invest in late-stage R&D projects, intellectual property protection, and commercialisation of new and inventive South African technologies. The BRICS were created to act as centres for the development of biotechnology platforms, from which new businesses offering a range of services and products would grow (DST, 2012). These latter two agencies invested more than R2 billion, but the impact of this funding is not known. TIA's stated objectives are to support the development and commercialisation of competitive technology-based services and products, in projects that are beyond basic research but not yet at the production expansion phases. TIA was established in terms of the TIA Act 26 of 2008, and became operational on 1 April 2010. TIA appears to still be finding its feet and has not yet established a track record of waste innovation support. It is considered by some to be too new to assess its effectiveness yet.

#### 4.3.2 Department of Trade and Industry (the dti)

The Technology and Human Resources for Industry Programme (THRIP) is a grant from **the dti**.

### ***Technology and Human Resources for Industry Programme (THRIP)***

THRIP is managed by the NRF, an agency of the DST. THRIP promotes partnerships in pre-commercial research between business and the public-funded research base including universities and research institutions. It aims to foster collaboration between the parties, with respect to skills development, technology transfer and implementation and investment in research. It thus providing opportunities for academic and research institutions to promote science, patents, student qualification, etc. together with close industrial involvement to support relevant R&D and technology uptake, while enabling South African industry to access innovative responses to technological needs and to produce a flow of highly skilled researchers and technology managers. The funding programme requires co-investment from an industrial partner at a 1:1 to 1:3 relationships for large companies. THRIP funds have been used successfully to address technology and process issues in the mining wastewater and waste beneficiation fields, but little to no information exists on the application of THRIP funding into other waste innovation activities.

### ***4.3.3 Economic Development Department (EDD)***

#### ***Industrial Development Corporation (IDC)***

The Industrial Development Corporation (IDC) is a self-financing, state-owned national development finance institution that provides financing to entrepreneurs and businesses engaged in competitive industries (EDD, 2012)

#### ***The Support Programme for Industrial Innovation (SPII)***

SPII is administered by the Industrial Development Corporation (IDC), and comprises two streams; one which targets SME's (maximum grant of R1.5million) and the other which is open to all companies (grant of more than R1.5 million). Both of these are regarded as important by their beneficiaries, but again, the impact of these grants is unknown (and there is in fact anecdotal evidence that the latter has high transaction costs, and up to 30% of the grants going to middlemen). SPII provides financial assistance for projects that develop innovative products and/or processes and focuses on the stage of development between proof of concept and the production of a pre-production prototype. The fact that SPII only 'refunds' claimable expenses means that beneficiaries need to secure upfront funding to spend on their projects, which they then claim back from SPII. This has implications in terms of cash flow and may make SPII a less accessible option for especially SME's.

### ***4.3.4 DEA/DBSA Green Fund***

The Department of Environmental Affairs (DEA) has set up a Green Fund (of R800m initially) and appointed the Development Bank of Southern Africa (DBSA) as the implementing agent. The aim of the fund is to support the transition to a low carbon, resource efficient and climate resilient development path delivering high impact economic, environmental and social benefits. The Green Fund will provide catalytic finance to facilitate investment in green initiatives that will support poverty reduction and job creation. The Green Fund will respond to market weaknesses currently hampering South Africa's transition to a green economy. One of the intended ways of achieving this – very relevant to the Waste RDI Roadmap – is through promoting innovative and high impact green programmes and projects. The Green Fund has three thematic funding windows: Low Carbon

Economy, Environmental and Natural Resource Management, and Green Cities and Towns (GCT), with a specific focus area for sustainable waste management and recycling. Eligible projects are required to be new and unique in the green economy space and innovative regarding any of the following aspects: technology, business model, institutional arrangements, or financing. The Green Fund will provide the following financial instruments: project development grants (recoverable and non-recoverable), capital grants (recoverable and non-recoverable) and concessional project development loans.

#### **4.3.5 *The Public Investment Corporation and the Industrial Development Corporation***

The Public Investment Corporation (PIC) and the IDC facilitate the introduction of new technology and innovations to the market by providing funding to support early stage development and industrial expansion in state-owned enterprises. However, again there is little understanding of the impact of these funding mechanisms. Initiatives like the Industrial Policy Action Plan (IPAP) are laudable, but it is too early to assess its impact on innovation.

#### **4.3.6 *The Plastic Bag Levy***

Some years ago, government instituted a plastic bag levy (currently 4c/bag). Some of the objectives of the initiative, as agreed between government and the private sector, were to promote efficiency in the use, re-use, collection, recycling and disposal of plastic bags; investigate and make recommendations in respect of the development of new markets for recycled material; stimulate participation in recycling by small-scale and micro entrepreneurs; ensure best-practice in recycling through educational work and technical support. The revenue from the plastic bag levy, estimated to be R258 million for the 2010/11 financial year (National Treasury, 2012), is currently not being used to stimulate waste innovation, but it certainly has the potential to do so.

The revenue from the plastic bag levy is currently not being used to stimulate waste innovation, but it certainly has the potential to do so.

#### **4.3.7 *International support mechanisms***

In addition to a number of local NSI support mechanisms, as discussed above, there are also international mechanisms being introduced to drive innovation in South Africa. Examples of this include the European Union FP programmes, the Innovation Prize for Africa<sup>20</sup> (an initiative of the United Nations Economic Commission for Africa (ECA) and the African Innovation Foundation (AIF).

#### **4.3.8 *Monitoring and evaluation***

The lack of information on the effectiveness of these innovation funding initiatives, and their particular application within the waste sector, highlights that there is currently no way in which to measure the performance or impact of these

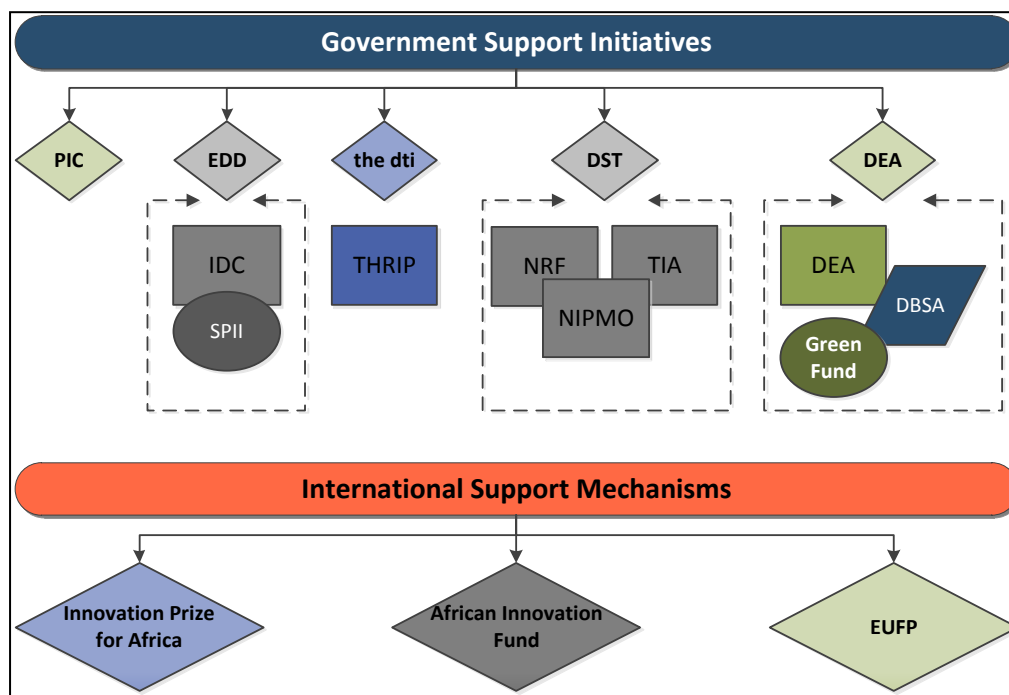
Comprehensive and meaningful indicators need to be developed to assess the performance of the waste sector.

<sup>20</sup> <http://innovationprizeforafrica.org/>

different financial incentives on the NSI, which makes policy development and corrective action in the system difficult. It is recommended that indicators be developed to assess the performance of the sector, based on the objectives of the different initiatives.

#### 4.3.9 Summation

**Figure 10** provides a summary of the public sector institutions making up the NSI and their respective support institutions.



**Figure 10: Public Sector Support Initiatives**

Government has introduced the concept of the Green Economy as an important area for stimulating the economy and providing job opportunities. Except for NRF's THRIP, IDC's Green Economy funds and the DBSA/DEA Green Fund that invest directly or indirectly in waste initiatives, the processes, support mechanisms and organisational structures etc., necessary to enable or support innovation in this area appear to be lacking:

- **The dti** has established a Chief Directorate dealing with the Green Economy, but there are very little, if any, funding instruments, available to the Directorate to encourage waste innovation.
- Environmental and waste related issues are currently embedded within the Energy, Advanced Manufacturing, and Mining & Minerals technology sectors of TIA, but TIA does not have a sector focused solely on developing innovation in the green economy space<sup>21</sup>.
- The DST has recently established the Directorate: Environmental Services and Technologies to support science, technology and innovation in the environmental sector.

In addition, while some funding is being directed towards waste from existing organisations, none of the institutions or entities in the NSI have focused solely on waste innovation as a priority.

<sup>21</sup> Technology Innovation Agency Strategic Plan 2012/13-2016/17

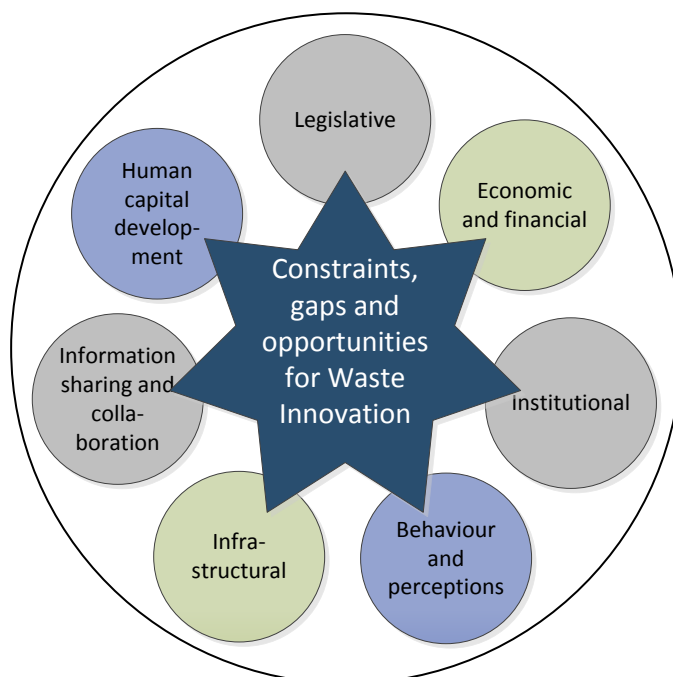
## 5 CONSTRAINTS, GAPS AND OPPORTUNITIES FOR WASTE INNOVATION

In addition to understanding the key waste innovation support mechanisms available in South Africa (Section 4), it was important to also understand the constraints to waste technology development and innovation. The following section provides a summary of interviews held with stakeholders from academia, research institutions, and public and private waste management organisations. As such, this should be seen as the *perceptions* of key stakeholders, regarding current **challenges and prospects for waste innovation** in South Africa. A total of 21 interviews were held during the period May-August 2012 (for a full List of interviewees consulted see ANNEXURE A).

The interviewees were probed for –

- shortcomings/obstacles that constrain innovation in the waste sector and how to address these;
- opportunities for waste innovation (especially entrepreneurial potential); and
- support required (funding, technology evaluation, commercialisation, etc.) that would enable capitalizing on waste innovation.

From the interviews, seven broad themes of constraints to waste innovation emerged. These are illustrated in **Figure 11** and further discussed in the following sections.



**Figure 11: Constraints, gaps and opportunities for waste innovation - seven themes**

**Figure 12** depicts the percentage of respondents (blue: public sector, and red: private sector) that highlighted a specific theme during the interviews. From the results, it is evident that issues with regards to legislation, behaviour and perceptions, were raised the most, followed by economic and financial issues.

Although human capital development is ranked low in **Figure 12**, this could be misleading. Interviews were steered to address only HCD matters that were relevant to this task on sector opportunities

and constraints to waste innovation, since a separate task on HCD–relevant matters to DSTs Waste Innovation Programme was conducted in parallel.

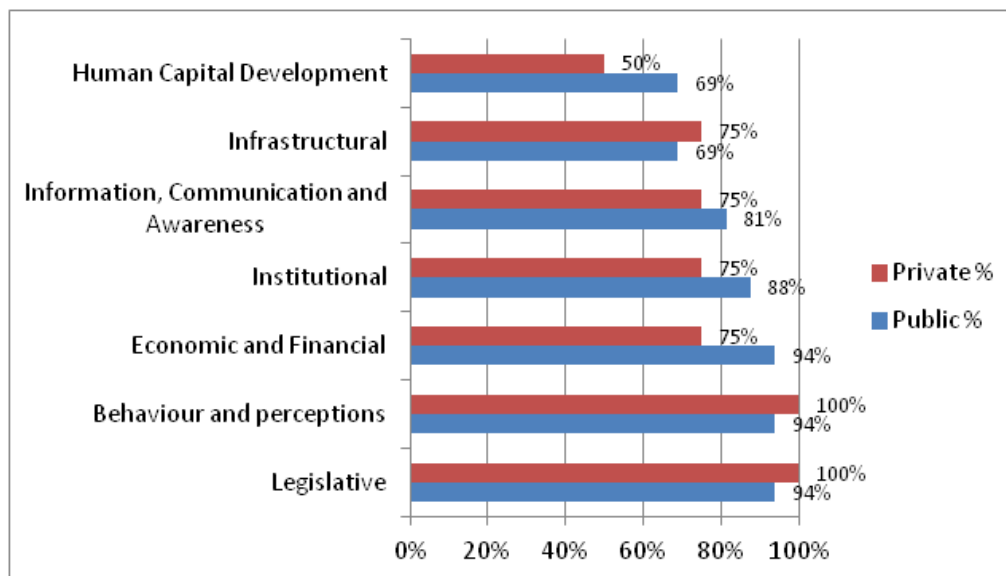


Figure 12: Topic occurrence during interviews<sup>22</sup>

These challenges to waste innovation are not unique to South Africa, as is evident from the review of similar waste innovation strategies and roadmaps for Europe and Australia (**Annexure B**).

## 5.1 Legislative issues

**Figure 13** summarises the seven main legislative issues that came to the forefront during interviews with stakeholders. These are discussed below.

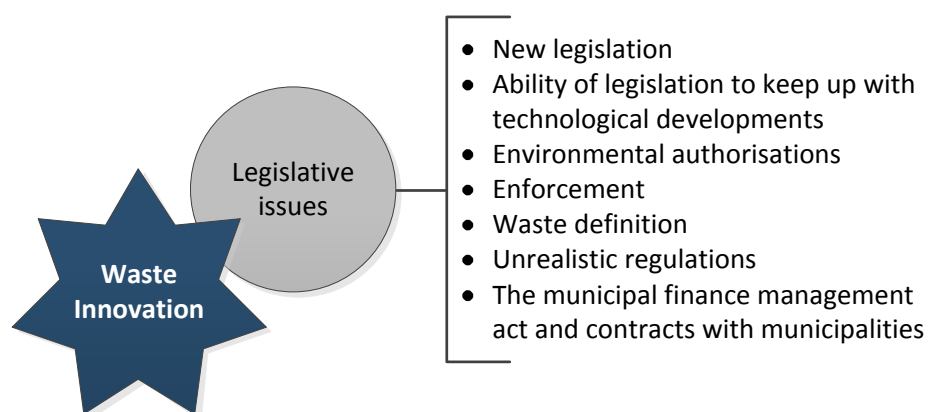


Figure 13: Legislative constraints, gaps and opportunities for waste innovation

<sup>22</sup> Human Capital Development may have scored lower than is the case, since the topic was not actively pursued here, given that a parallel HCD project was being undertaken. The results for HCD presented here should be interpreted with caution.

### 5.1.1 *New legislation*

The recently promulgated National Environmental Management: Waste Act (NEM:WA) (RSA, 2009) as well as new waste regulations currently being developed in support of the Waste Act, are expected to provide many waste innovation opportunities, as they require the sector to move up the waste hierarchy, away from landfilling. An example is the draft Waste Classification Regulations (RSA, 2012) which will require waste generators to classify their wastes, and in so doing lead generators to a better understanding of their waste streams, their value, and alternative waste management options to landfilling. The NEM:WA requires the use of accredited laboratories for the classification of wastes and ultimately the end disposal method.<sup>23</sup> This protocol may add a considerable cost component to disposal and thus make landfilling less attractive – which respondents felt would in turn boost interest in alternative waste technologies (AWT).

While the objective of certain regulations may be to stimulate innovation, the response to such regulations is not always innovation. Companies may simply import technologies and thereby comply with the regulatory requirements. Local innovations will need to be competitive with these alternative off-the-shelf solutions.

It is generally acknowledged by stakeholders that there are many good pieces of waste legislation that have been recently enacted. However, private sector stakeholders were divided on the draft Waste Classification regulations. Some welcomed the regulations while others felt the added requirements of these new regulations posed a challenge to enforcement and implementation. The added costs of waste stream analysis as well as the need for correspondingly well-trained specialist staff were cause for concern. The impression was that the education and training pipeline was not producing this skilled manpower in the required numbers and quality level (*more on this in Section 5.7 around human capital development*).

### 5.1.2 *Ability of legislation to keep up with technological developments*

Stakeholders perceived limited capacity at policymaking level for the development of innovative policies, regulations, and monitoring mechanisms. This was seen as resulting in legislative development generally lagging behind technological innovation. Consequently, the policy and legislative framework was perceived as failing to provide an appropriate and responsive regulatory environment for innovative ideas to flourish. This may be partly due to a lack of in-depth understanding of waste technologies, particularly emerging technologies, within DEA, the

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<sup>23</sup> According to a presentation on SAWIC (<http://www.sawic.org.za/documents/983.pdf>) the need for use of accredited laboratories for classification of waste will be phased in over 2 years. The draft Waste Classification Regulations (Section 8) stipulate that “waste generators must ensure that their waste is assessed in accordance with the Standard for Assessment of Waste for Landfill Disposal set in terms of Section 7(1) of the NEM:WA prior to the disposal of waste to landfill. Subject to subregulation (2), all waste generators must ensure that the wastes they generate are classified in accordance with SANS 10234 within 90 days of generation.” Annexure 1 of these regulations however, excludes most general waste streams, with the result that the focus of these regulations will be on hazardous waste. While classification of hazardous waste may increase costs and associated disposal/treatment options, this new policy requirement may not deter disposal of general waste to landfill, and often to inappropriately designed and operated landfill sites (dump sites). However, since waste needs to be classified not only if it is to be landfilled (classification determines the end use), these additional costs would equally apply to other hazardous waste management options, unless there is waste reduction and internal reuse, prior to the need for disposal/destruction.

department responsible for waste policy development, and within municipalities, responsible for local government by-law development (*more on this in **Section 5.7.3** around public sector skills*).

### 5.1.3 Environmental authorisations

Waste management licences (issued under the NEM:WA) and the previous waste permits (issued under Section 20 of the Environmental Conservation Act) have been criticised for stifling innovation for the way they restrict even constructive improvements in waste handling and utilisation at waste facilities because of the need to amend permits. The situation is made worse by the lengthy periods of time it takes to amend these permits (see **Section 5.4** Behaviour and perception issues), on average 3-4 years, but as long as 8 years. It was in one case stated that environment authorisations remain the biggest constraint to company growth, despite streamlining of the EIA process. Environmental Impact Assessments (EIAs), for example, can easily take a year and cost in excess of R500 000 according to one private sector stakeholder. There were also fears expressed of possible corruption in the approvals process.

Streamlining the processes for application of licenses and amendment of permits presents an opportunity to effect faster processing thus relieving a legislative constraint to innovation.

### 5.1.4 Enforcement

The perceived lack of enforcement of environmental legislation has a number of shortcomings that negatively impact on innovation in the waste sector. Failure to prosecute clear offenders in a timeous manner is blamed by stakeholders for producing an atmosphere of general impunity, with prosecution of offenders seen as half-hearted for reasons that are not clear. The conviction rate was seen as particularly low, a situation that encouraged waste companies to take chances especially in instances where improved waste management would cost them money. Lack of enforcement of legislation means that companies often don't have to find solutions to their waste management problems, perpetuating the CATNAP philosophy of many industries – Cheapest Available Technology Narrowly Avoiding Prosecution. This lack of a push to devise solutions to waste problems stifles innovation and investments in finding alternative technology solutions.

Enforcement of legislation requires that alternative solutions to waste management be found, which stimulates both technological and social innovations.

### 5.1.5 Waste definition

The current protection-based definition of waste remains problematic in that it can stifle waste beneficiation, reuse and recycling and hence innovation<sup>24</sup>. Some specific concerns raised were around cement classification and whether waste tyres were really a hazardous waste. With the new definition of waste not yet having been tested in court, there are organisations who feel that certain

<sup>24</sup> Yolandi Booyens.2012. *Regulatory environment killing small businesses*.  
<http://www.engineeringnews.co.za/article/regulatory-environment-killing-small-businesses-2012-09-07>

beneficiated products may remain waste under the current definition, which poses a risk to the organisation, e.g. reuse of certain mining and power generation waste streams. Mining waste, although included in the definition of waste, is considered as 'residue deposits' and 'residue stockpiles' under the Mineral Resources and Petroleum Development Act (MR&PDA) (RSA, 2002) and is often 'overlooked' in terms of environmental legislation. It is unclear as to whether the 'lenient' control of these deposits encourages or discourages innovation, however, to date there is arguably very little beneficiation of these significant (in terms of size) deposits.

There were also some perceptions particularly from the informal sector that the policy development processes were overly top-down and failed to engage sufficiently with the relatively less organised stakeholder groups such as the informal sector.

Suggestions were made to engage with industry on the definition of waste and the exemption of certain wastes to allow for more innovative approaches to dealing with them.

#### **5.1.6 *Unrealistic regulations***

The development of waste regulations was criticized for not sufficiently recognizing the differences between rural and urban contexts – in terms of waste issues as well as available resources. There was a perception that legislation was primarily developed around the large urban metros and rolled out to the rest of the country. One stakeholder felt that the less-urban municipalities were not in a position to implement the legislation due to their limited financial resources and that in instances the legislation was 'over-kill' given the typical waste streams and tonnages generated in these more rural areas. An approach for addressing this could be the phased implementation of waste legislation – starting with metropolitan municipalities and working out to rural local municipalities.

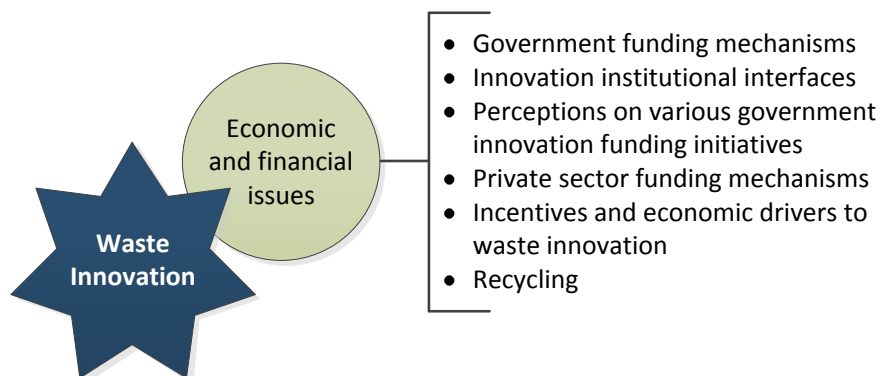
Local indigenous knowledge and the needs of more rural municipalities provides opportunities for technological and social innovations.

#### **5.1.7 *The Municipal Finance Management Act and long term contracts with municipalities***

Various respondents mentioned that an obstacle to waste innovation was the Municipal Finance Management Act's (MFMA's) maximum contracting period of five years for public-private partnerships (PPP's). The result is that the perception exists that industry cannot venture large (innovative) waste management projects (such as material recovery, waste treatment, or waste disposal facilities), with municipalities, since they would be unable to recover their capital investment over a five year period. However, there are ways to work within the MFMA to support longer-term capital investment projects. For instance IDC mentioned a 20-year waste-to-energy project with the City of Joburg where the municipality guaranteed 500 000 tons of waste per annum for 20-years. However if waste innovation is to be promoted, clear guidance needs to be provided by Treasury on how longer-term public-private partnerships can be established within the waste sector, particularly in areas of waste beneficiation, recycling and waste-to-energy. Other municipal involvement risks that were high-lighted included payment delays and striking workers.

## 5.2 Economic and Financial issues

**Figure 14** summarises the six main economic and financial issues raised by stakeholders. These issues are discussed below.



**Figure 14: Economic and financial constraints, gaps and opportunities for waste innovation**

Respondents felt that South Africa's investment in the development of new waste technologies was inadequate, especially for developing an innovation from idea to market. There is a perception that both government and the private sector have a low risk appetite and a tendency to import proven off-the-shelf technologies (more cheaply) rather than investing in South African innovations; in early-stage technology R&D; and in chancing unproven local solutions to waste challenges.

### 5.2.1 Government funding mechanisms

Perspectives from the interviews were that nowhere in government or the NSI was 'waste innovation' clearly targeted as a sector for development and funding. There are instances of individual projects receiving funding from e.g. THRIP and IDC's green economy fund, but a focused waste innovation budget and strategy is currently lacking.

A dedicated and directed waste innovation strategy with budget, implemented by appropriate organisations across the NSI, is required.

To complicate matters, innovation development cycles tend to be long-term, whereas political decision and impact cycles typically tend to have a three to five year span. It is therefore challenging to motivate innovation funding to treasury – for non-prioritised initiatives – if results are only to be realised in the medium to longer-term (5+ years) (related to this see the MFMA **Section 5.1.7** under legislative issues).

There were varying views on industry's awareness of innovation funding mechanisms. Some felt financial support for innovation was not well marketed and potential beneficiaries were unaware of – and thus not applying for – the variety of funding assistance programmes available. Others were of the opinion that financial aid for innovation was well advertised but that the supporting institutions' requirements were too strict or cumbersome (bureaucratic processes). Suggestions were made to review funding accessibility by studying the funding application criteria and processes across the NSI

which may deter promising innovations from receiving deserved funding. Case studies and collaboration with business in this regard was proposed.

It was acknowledged that different types of funding and funding requirements should be applied over the various stages of the innovation development lifecycle – for example, initially high-risk funding (R&D in support of proof of concept) could be required for developing and demonstrating innovative ideas – however as the innovation nears the market, risks should be abated by market intelligence (proof of concept at demonstration/pilot scale).

### **5.2.2 Innovation institutional interfaces**

Both business and innovators thought that the interfaces across the stages of innovation development, between the various institutions in the NSI, were not functioning well. The NSI institutions were accused of a silo-mentality, resulting in entrepreneurs running the risk of either requesting support prematurely or too late to qualify for support criteria. Coordinated guidance at one central point could alleviate this problem. It was proposed to map out and publicise the institutional support available over the entire innovation development lifecycle and to facilitate smoother interfaces between the various NSI supporting institutions to ensure that promising waste innovations are seamlessly transferred and don't fall through the cracks.

The notion of an innovation funding chasm, between proof of concept at laboratory-scale and at demonstration-scale (pilot), was still widely held. Perceptions were that TIA was established to close this gap, however several respondents questioned TIA's effectiveness regarding this. Some even complained of a dearth of early-stage funding options in developing a promising idea up to proof of concept stage, and requested a risk funding pool to enable initial development (**See Section 4.3.1 and 6.1.1**).

In concurrence with the above, the Innovation Hub's Climate Innovation Centre (CIC) – following an assessment of the country's innovation landscape – identified early-stage activities in clear need of support. Amongst them were: support required for promising pre-revenue companies with no track record, and working prototypes to entrepreneurs to attract additional investment. These findings are also relevant to the South African waste sector.

Related to this, the Governments of Finland, Australia and the UK have perceived a gap in innovation support in the energy and environment sector and are funding the Energy and Environmental Partnership with Southern and Eastern Africa (EEP-S&EA) in South Africa and the region (ten countries in total) (EEP-S&EA, 2012). The EEP-S&EA is housed at DBSA and solicits funding proposals from across the region for pre-feasibility up to demonstration level projects. Furthermore, the incubator programme that started off as the Cleantech Competition within the National Cleaner Production Centre of South Africa (NCPC-SA) is similarly aimed at supporting entrepreneurs with clean technology ideas to progress towards commercialisation.

In order to tap into the private sector for additional risk-funding support for promising innovations, it was suggested to investigate ways to incentivise private business to invest in (early) R&D and innovation development, with the expectation of securing return-on-investment down the line.

Linking innovations up with (private sector) funding should also be approached from the other side of the coin – by assisting innovators to identify and get ‘off-take’ agreements from potential (private sector) users of the technologies.

### 5.2.3 *Perceptions on various government innovation funding initiatives:*

#### *DST*

The DST tax incentive for investing in innovation (which according to respondents entails getting up to 150% of company R&D funding deducted off taxes) (see **Section 6.1.1**), is perceived as being too cumbersome a process to apply for. With the result that many private waste companies have instead utilized internal line budgets, or traditional financing such as bank loans, to support R&D and technology development, instead of the DST tax incentive<sup>25</sup>.

There is also a widely held opinion that other government departments see DST as a ‘supporting department’. If this is so, the DST might benefit from exploring a strategy of engaging the departments it supports to co-fund initiatives, e.g. **the dti**, Economic Development Department (EDD), DEA. For example, many respondents believe that DEA’s waste legislation embodies the right policy and strategy for the local context, however the effective enforcement of the regulations are lacking. This could present an opportunity for DST in working with the affected departments and co-funding appropriate technology solutions, including possible monitoring and enforcement technologies (DST Information & Communications Technologies RDI Roadmap).

#### **TIA**

As noted by respondents from TIA, South African industries are prone to search overseas for ‘off-the-shelf’ solutions (inbound technologies) that can be plugged in locally. This is not viewed by TIA as innovation and therefore they do not fund such imports (even though the technology may be new to the country or new to the company) (See **Section 2.1.2**). For TIA to recognise an opportunity there has to be a local value add to the technology, and/or new know-how developed to customise it to local conditions. TIA can provide initial investments, but not on a continuous basis.

In essence, TIA funded projects need to be commercially viable and self-sustainable in the long-run. This is somewhat misaligned with the perceptions of technology developers, who see TIA as a funding agent for pre-commercial, high risk stages of technology development (demonstration scale).

There is a misalignment between the expectations and practice of TIA, with technology developers requiring TIA to act as funder of pre-commercial, high risk stages of technology development

#### *the dti*

**The dti**’s Green Industries Unit mentioned that up to now they have not funded many recycling projects. They were mostly approached with existing collection/sorting ideas being rehased (funding for a truck or a forklift) without much innovation or downstream beneficiation (value-add). Although **the dti** does have incentive schemes for cleaner production and energy efficiency it does

<sup>25</sup> It is noted that changes to the DST Research and Development Tax Incentives are being made from the 1 October 2012 (pers comm., Mr W. Mabogoane, Deputy Director: Research and Development Tax Incentives).

not have a specific scheme directly related to waste recycling. In support of SMMEs there are cooperative grants, whereby successful applicants can receive R350 000 start-up funding, while contributing 10% themselves in terms of capital or skills.

## EDD

### IDC

South Africa's State-owned Industrial Development Corporation (IDC) has been allocated R22.4 billion to stimulate 'Green Industries'<sup>26</sup> – which includes waste management. According to the IDC, their support is aimed at getting market-ready technologies to the market – often investing in equity. However, their search for new promising projects can warrant investing in earlier stages and for strategic high-impact projects even at the beginning of the project. Its venture capital unit can invest in technology development and where relevant, partners can be brought on board. Nevertheless it does not have a pure innovation focus. The IDC reviews technologies from a funding point of view to see if it is suitable for adoption and therefore does not discriminate against proven technologies. A return on investment is expected by the IDC. As such, new start-up ventures often present too high a risk as there is no security or holding guarantee obtainable. *“The IDC is also not pursuing any Cleaner Development Mechanisms (CDM) initiatives, as there does not seem to be revenue in that”* (pers comm., 2012).

Some respondents mentioned that the IDC's funding criteria and cumbersome application process were a major obstacle to industry. An example was mentioned of an e-waste initiative that, for three years, unsuccessfully pursued funding from both the IDC and the Development Bank of Southern Africa (DBSA) – upon which it eventually turned to conventional banking institutions which secured the funding.

## DBSA

Whereas the IDC predominantly works on an equity basis, mostly funding industry, DBSA provides loans which require capital and interest to be repaid. According to DBSA's respondent, although the DBSA has developed a strategy on how to invest in waste management<sup>27</sup> it has to date invested in very few waste management projects. While DBSA mostly funds municipalities, e.g. its development fund supports the preparation of municipal integrated development plans (IDPs) – in theory it could also support industry waste management solutions. It has concessionary loans at its disposal. *“It is hard to find profitable/bankable waste innovation projects in SA – there do not seem to be many large ones out there. South African municipalities have a budget for waste management – so this should not necessarily be an issue. However, at 3-5% of the municipal budget, the waste management function seems to be under-funded (it is 10% in other countries)”* (pers comm.). The respondent also mentioned that though not strictly *financially* viable, many waste projects might be economically viable if indirect/intangible benefits (the triple bottom-line or opportunity costs down the line) are taken into account.

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<sup>26</sup> Business Report, Thursday 17<sup>th</sup> November 2011, The Star. <http://www.greenbusinessguide.co.za/idc-a-green-trailblazer-with-a-green-fund/>

<sup>27</sup> Waste Management Investment Strategy, pers comm., Marler, M. 2009. DBSA

## DEA

The DEA has some influence in municipal budgets for the environmental sector through its financial planning inputs to national treasury. However with budget constraints, the environmental sector is underfunded – receiving on average less than 3% of the municipal budget (pers comm. 2012). According to respondents, the municipal waste budget is often insufficient to replace aged waste collection and disposal equipment, let alone fund comprehensive waste collection or recycling services. DEA has infrastructural and funding support mechanisms available for municipal waste management through the Expanded Public Works Programme (EPWPs). For example Mafikeng’s Working for Waste, an EPWP based model pilot<sup>28</sup> – is aimed at increasing waste collection coverage, while creating jobs and promoting SMMEs. The Mafikeng pilot entails a number of SMMEs being funded and mentored to provide the extended waste collection service, and they in turn employ additional workers to do the job. It has been running for around three years, with the department funding the additional capacity and infrastructure wholly during the first year and then gradually withdrawing while the municipality in turn gradually takes over up to full payment by year four. By then the SMMEs will own their own trucks and capital equipment and be capable and competent of continuing the service. The outcome of the Mafikeng pilot will determine if a national roll-out of this initiative is desirable. This provides an example of how innovation can also be applied to funding and roll out of municipal services.

## Municipalities

In general, respondents felt that only the large metros still have municipal capacity, but even these are struggling. Perceptions are that budgets are holding municipalities back from doing more than the absolute basics and that many municipalities survive on the Municipal Infrastructure Grants (MIGs) and Indigent Grants. This is believed to be partly due to the population growth rate and the rate of urbanisation (for certain cities) being greater than the municipal income growth rate. *“In the past, 20% of the population financially supported service delivery for 20% of the country – now 20% of the population financially supports service delivery for the whole country”* – the budget hasn’t grown in proportion to increased service demand – according to a respondent. While MIGs are intended for new infrastructure development (capital budget) some respondents hinted that perhaps funding for maintenance (operational budget) or modification of existing infrastructure should also receive attention to avoid white elephants down the line. Issues around available capex and opex budgets for waste management in municipalities has resulted in a growth in outsourced waste services to private companies as a way of operationalising capital expenditure. Officials from municipalities have indicated that private waste companies can render waste services at a lower cost and a higher level of compliance than that of municipalities (Godfrey *et al.*, in press).

### 5.2.4 Private sector funding mechanisms

Given that technology development (from idea to market readiness) is an expensive and time-consuming process, the science council/consultant business model was not seen as being conducive to optimal technology development. Respondents from research institutions noted that the private sector – in search of innovative waste solutions – was more prone to invest in universities which often had better infrastructure and *“student labour costs are cheaper and together with the human*

<sup>28</sup> <http://www.8linkd.com/projects/domesticwaste>

*capital development (HCD) tax benefits they get more bang for their bucks*". Some academic and research staff expressed a need for guidance and support in the process of commercialising their innovations, such as: understanding the market, developing business plans, costing and financial modelling.

### **5.2.5 Incentives and economic drivers to waste innovation**

According to respondents, there are no immediate economic drivers (other than perceived loss of revenue due to social perceptions) encouraging waste management expenditure. While implementing waste reduction (cleaner production) measures in organisations often results in significant costs savings, a perception still exists that leaving the implementation of appropriate waste practices to market mechanisms will fail. Responsible waste practices are not a concern to many industries – in the words of a respondent: *"Waste management is a grudge purchase for business, always has been, always will be. Very few clients have a first-world waste influence"* – thus company investment in waste management is normally motivated by compliance to legislation, pressure by an international parent company, some waste accreditation system (e.g. ISO14000) or for social recognition. Worthy waste initiatives that incur costs are often not approved by management unless there are tangible benefits (e.g. direct cost savings, increased productivity, improved public perceptions). Implementing progressive waste management solutions will always be a business decision. Waste companies indicated that waste innovation is driven by legislation and associated costs. Industry weighs up compliance/non-compliance costs and risks to determine a course of action. Thus in the absence of incentives, if the penalties are not too severe and the probability of being apprehended is remote, adoption of prescribed waste practices that require resource investment, are unlikely. This highlights the importance of not only creating fitting legislation but also the capacity to regulate and enforce it with appropriate penalties – which serves as incentive for waste generators to invest in progressive waste management. (Refer back to the legislative **Section 5.1.4** on Enforcement – in this regard.) As soon as there is a demand for improved waste management, service providers will respond with innovative solutions.

Drivers of progressive waste practices in, for example, Europe include the lack of space for landfill development, implementation (and enforcement) of engineered sanitary landfills, enforcement of progressive EU waste and environmental legislation, and the corresponding high cost of waste disposal. Furthermore, the high cost of electricity and the need for heating, in Europe makes waste-to-energy initiatives attractive. South Africa does not have a space scarcity (although available land close to urban areas is becoming problematic); many municipal landfills are dumpsites and are not engineered and so do not carry expensive design and operating costs. With the result that municipal tipping fees are under-priced and do not take cubic airspace values into account, let alone externality costs (environmental and social costs). What's more, electricity is still relatively inexpensive in South Africa and waste-to-energy projects that need to feed into the grid are at the mercy of Eskom, who dictates the rules of engagement as they have the monopoly on power supply. Private sector waste-to-energy players were frustrated by the uneven playing field and mentioned that in South Africa's energy planning waste-to-energy only comes into play by 2020. *"Eskom has requested another 15% tariff increase over the next four years, while the private sector can already produce electricity cheaper than Eskom"*. None of the above conditions promote advanced waste management practices in South Africa.

Most waste treatment/processing technologies require dependable bulk waste input to be economically viable (see the MFMA **Section 5.1.7** under legislative issues). A growing obstacle to these waste management methods is the emerging 'greedy' perception that waste now has value and that the generators of waste should therefore be paid for it. This is in stark contrast with landfilling, where waste generators pay for disposal. Competing waste management methods such as waste beneficiation, waste-to-energy or thermal destruction require substantial investments, and costs will be even higher if customers are to be remunerated for their waste. The result is that when competing waste management methods' costs are compared to tipping fees, landfilling invariably seems the most attractive option – thus perpetuating landfilling.

As proper treatment and disposal of waste directly affects the 'common good' government involvement is warranted – and due to the extent and legacy aspects of the waste problem, innovative thinking is required to fix it. Respondents suggested that funding from the taxation system (or penalties for non-compliance) be ring-fenced for tackling problematic waste and that it be driven as a national priority – much like the American Super-fund System utilises tax money to achieve national objectives too big for company undertakings. Respondents felt that there was a lobbying-role for DST and **the dti** to obtain support from the likes of the Department of Energy (DOE), Department of Mineral Resources (DMR), Department of Water Affairs (DWA) and others. An example of this is the R400m set aside by the inter-ministerial committee to deal with the acid mine drainage problem<sup>29</sup> and which will require innovative technology solutions. Suggestions were made for escalating landfilling fees to be more market-related and creating a mind-set where waste generators are required to pay for waste management – irrespective of the waste management solution.

Alternatively a waste landfill tax (or -carbon tax) was suggested whereby waste disposed to landfill be taxed, which in turn could support a rebate for waste diverted from landfill and alternatively processed. Such a rebate could encourage recycling even when recovery prices are not favourable. A deposit system was also proposed whereby each category of waste would be loaded – thus creating an economic value for waste, which could be recovered through, amongst others recycling. For example e-waste could have traces of metals with recovery value, however the logistics of recovery often tend to outweigh its worth. Extended producer responsibility (as provided for under the Waste Act) could subsidise industry recycling programmes. Another respondent mentioned: *“In Brazil there are projects with 100% waste collection, because waste has a value and can be subsidised with the sale of electricity and fuel generated from it – but both sides (supply and demand) need to be integrated for the system to work”*.

Respondents advised that incentives to encourage desirable waste management practices have to be pragmatically evaluated to ascertain if they have unintended consequences such as business profiting from it without contributing to achieving the required outcomes.

Respondents believed that there is a research/innovation interest bias towards waste that has potential value (for e.g. due to possible recovery of metals/minerals from waste). According to a major waste service provider South Africa's hazardous waste does not hold much value. Large

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<sup>29</sup> Mail and Guardian, 8 July 2011. <http://mg.co.za/article/2011-07-08-acid-mine-report-is-a-ruse>

manufacturing industries tended to abstract all value from the waste stream up-front, or easy pickings are removed. What remained was low quality or difficult to handle, thus requiring sophisticated equipment and often not being financially viable. Mining 'waste', for example, is often stockpiled until the price of metals increases (to warrant extraction), or until technologies improve to allow for cost-effective recovery and are then 're-mined', e.g. vanadium or silicone carbide.

### **5.2.6 Recycling**

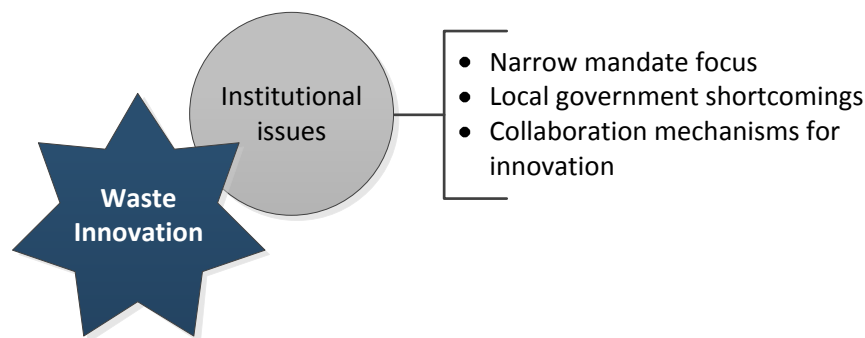
The general perspective from the bigger private waste management companies was that operating a recycling business is not financially sustainable without some means of subsidisation. However government seems to view it as an important sector for SMME engagement and job creation. At company level, successful recycling is dependent on large volumes and efficient logistics, which requires innovative ways of reclaiming and optimising. In spite of this, many recycling initiatives are not viable on their own and need to integrate/link with related up-/downstream money making opportunities, and/or rely on subsidies/incentives. At an industry level, this calls for recycling market development. The drive should be to meet manufacturers' requirements for accepting recycled materials as inputs to production – for example constant supply needs to be guaranteed. There are some limitations however, for example the maximum recycled content of plastic packaging that will be acceptable to the market. A green incentive scheme was suggested for manufacturers willing to add recycled materials to their input mix (i.e. % recycled content). Formalisation of a green procurement drive was also advocated, whereby preferential buying policies (for e.g. rebates) could be applied to 'green' products (such as those that incorporated recycled materials).

Perceived challenges to government's recycling approach of increased informal sector involvement was summarised as: *"Informal reclaimers are often stuck/happy in a survivalist mode – only working when they need money. They like the flexibility of not having to work 8:00 to 17:00. Very few have the basic skills to put a proper business plan together or run a business. Many are also illegal immigrants. Thus migration to the formal sector will be fraught with challenges"*. In line with government's drive, examples were given of municipalities contracting and subsidising cooperatives to provide these services in a manual/labour-intensive fashion to informal settlements – sometimes at a lower cost than formal waste collection/recycling. For small enterprises intending to start waste management related businesses, insecurity around the supply chain where waste is the process input erodes the SME's confidence to embark on such a business. Facilities for recycling activities, such as conveyors for waste pickers to access waste before landfilling were suggested as one way to support small enterprise recycling. A stakeholder cited integrated waste management projects around Cape Town where municipalities have contracts with small-scale collectors to collect waste in the informal settlement areas. This was said to be working well, and probably costs municipalities less to collect in informal settlements than in formal settlements. Additionally, community-based recycling opportunities could allow greater participation of rural communities in waste recycling and waste minimisation. However, there were concerns that recycling, where communities were mere collectors, did not empower these communities and did not teach them about business. They remained powerless to negotiate prices and were bound to accept the prices dictated by buyers. It is important that small scale operators add value to the waste streams, such as granulation so that they could fetch better prices. An instance was also mentioned where as part of an EPWP initiative, people were partly paid with food for collecting waste.

Institutional linkages may be complicated where middlemen impose themselves. An example was given of Soshanguve where it is apparently not possible to get waste metal out without going through middlemen. Such cartels obviously escalate prices.

### 5.3 Institutional issues

The three main institutional issues that surfaced from the interviews are captured in **Figure 15**. These are expanded on below.



**Figure 15: Institutional constraints, gaps and opportunities for waste innovation**

#### 5.3.1 *Narrow mandate focus*

Respondents pointed out the 'silo' mode of operation of government departments and other bodies. Often this narrow mandate focus is used to exclude initiatives that could ensure better integration and support innovation. In addition to DEA which regulates the waste sector there are numerous other government departments with waste management-related mandates, including the Departments of Health, Cooperative Governance and Traditional Affairs (COGTA), Mineral Resources, Energy, Transport, and Trade and Industry. Each department has worked on waste on the basis of its own strategy, without an effective, agreed overarching vision guiding them. A possible way to tackle this problem would be a dedicated integrative inter-ministerial coordinating mechanism.

There was also the perception of a narrow view of science & technology, which was seen by stakeholders as a political perception that tended to separate S&T away from the immediate service delivery challenges that policymakers grapple with. Science councils tended to be viewed as service providers, not partners to government departments and this was seen as a flawed stance.

Several stakeholders felt that science innovation in South Africa is driven more by the pet research topics and interests of academics rather than some kind of overarching forum that identifies priority research needs. (Also see **Section 5.7.1** under *human capital development*) This tends to produce a mismatch between what scientists want to do and what is required for coordinated national development. Perceptions were that there was insufficient coordination at national level to identify what needs to be done, and who should do it and to ensure focus on issues that are particularly unique to SA, and to find SA solutions to these. The DEA has recognised this short-coming which is why they are developing a Waste R&D strategy for South Africa (in conjunction with DST).

### 5.3.2 Local government shortcomings

The limited skilled technical and managerial capacity at municipality level was seen by respondents as being responsible for several shortcomings (*more on this in Section 5.7.3 around public sector skills*). Without specialist waste staff at the majority of municipalities, officers are unable to engage meaningfully in discussion fora with the private waste sector. As a result innovation is not prioritised as it was not well understood by such staff.

The wide discrepancy in experience and knowledge between consultants and council officials often leads to consultants recommending the latest technologies that are not necessarily the most appropriate for the context of the municipality. The lack of appropriate technical capacity means that municipalities are often unable to evaluate proposals and are thus open to manipulation and wasteful expenditure. The capacity to correctly operate and maintain such new technologies once acquired is also usually lacking (*more on this in Section 5.7.3 around public sector skills*).

### 5.3.3 Collaboration mechanisms for innovation

Suggestions were made by respondents for stakeholder interactions/platforms with a focus on timely linking waste innovations to market needs. For example:

- A waste innovation support map – indicating the kind of support offered by various organisations (including contact details, eligibility criteria and application guidelines) at each stage of the waste innovation life cycle (See **Section 5.2.2**).
- A competition/olympiad where ideas can be vetted (through the relevant technology evaluation expertise), finalists selected to present their concepts and winners provided with opportunities for take-to-market support. (There is a potential role for TIA here).
- An open-innovation platform for linking demand (the waste management market) with supply (waste technologies/innovations), i.e. entrepreneurs/industry – who understand business and the waste environment, with scientists – developing waste solutions (Eskom is taking this ‘open innovation’ approach in seeking ocean energy opportunities<sup>30</sup>). Key to the success of this is:
  - A top-down combined with bottom-up approach, i.e. opportunities for industry to air problems and for innovators to respond with potential solutions, and vice-versa opportunities to promote innovative ideas and test market reaction – with an eye on off-take agreements.
  - Connecting the innovator and entrepreneur early in the development cycle to allow solutions to be tailored to market requirements and thus facilitate user-acceptance, uptake and commercialisation.
  - Addressing IP issues and models for partnership up-front and creating a collaboration culture to solve problems, e.g. the entrepreneur-in-residence initiative capitalises on the fact that mature and experienced entrepreneurs who have already achieved their career goals are inclined to collaborate and share expertise.
  - Presenting opportunities for financial support and exposure to investment/venture capital institutions.

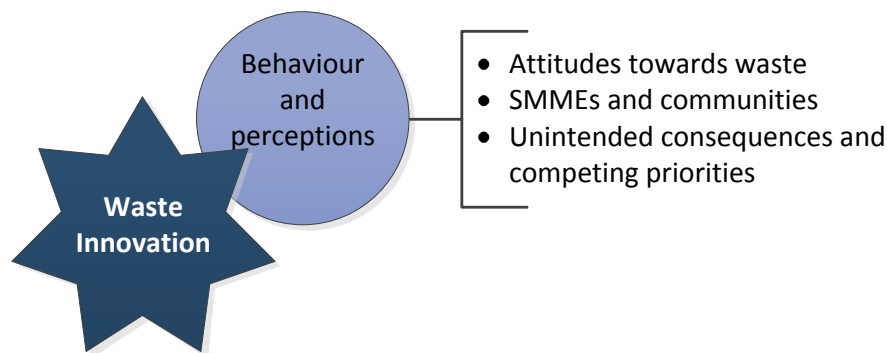
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<sup>30</sup> <http://www.openinnovation.eskom.co.za>

- Marketing, promotion and commercialisation support – including exposure to well-connected individuals/organisations with networks that can unlock not just national but also international market potential (there is possibly a role for Trade and Investment South Africa (TISA) here)
- In its simplest form this solution could also link existing technologies to solution seekers.
- This concept could be extended to expose academic/research endeavours to business interest by allowing industries to vet the market relevance of academia's science/technology outputs.
- Waste innovation scouters – i.e. foot-soldiers that can infiltrate venture capital markets and academic/research institutions to find opportunities and to act as honest-brokers with an understanding of technology and markets.
- A recurring waste indaba allowing key players with experience in the sector to debate waste related issues, technologies and government strategies, for e.g. recycling – the pro's and con's and its suitability to meet governments job creation expectations. This would be more than what is currently offered by the Waste Khoro, which is only a forum for government officials.

## 5.4 Behaviour and perception issues

The three most salient behaviour and perception issues impacting waste innovation are listed in **Figure 16** below, and explained in the section below.



**Figure 16: Behaviour and perception constraints, gaps and opportunities for waste innovation**

### 5.4.1 Attitudes towards waste

According to some industry and academic stakeholders, there has been limited acceptance of cleaner production (waste minimisation) approaches in industry, leading to continued reliance on inefficient production systems. Some of the factors contributing to this attitude in industry are:

- insufficient focus on waste minimisation in industry
- perception that the costs of waste minimisation outweigh the benefits (see **Section 5.2.5**)
- narrow profit focus (see **Section 5.2.5**)
- insecurity in the supply of waste where waste is the input into a manufacturing process

Stakeholders felt that society (government, industry and the public) generally do not see waste as a renewable resource. This way of looking at waste influences the perceived options available for

dealing with waste, and encourages innovation. A change in mindset is necessary, moving away from the prevailing cradle-to-grave mentality towards a cradle-to-cradle approach to waste and resources management.

In numerous instances respondents cited public perceptions as an obstacle to waste innovation. Examples include:

- public opposition to waste-to-energy (including mass-burn incineration) on environmental and health grounds, as well as cultural perceptions and norms – even though research has shown it in many instances superior to other methods and in compliance with strict environmental legislation in Europe, where it has consequently been implemented; and
- refusal to accept methane gas – converted from human/animal sewage – to power cooking, on sanitary/health grounds – even though research has proven these fears unfounded.
- minimal community participation in recycling initiatives where there has been inadequate public buy-in, which informal sector stakeholders felt was due to overly top-down design and implementation of these initiatives.

#### **5.4.2 SMMEs and communities**

In developing innovative waste management solutions for South Africa it is very important to understand the country's socio-economics, and varying resources between urban and rural environments. Communities in rural areas have a perception that anything less than 'first world technologies' is a violation of their rights. This perception needs to be managed as successful innovations in rural and urban environments do not have the same 'recipes'. It has often resulted in fancy imported designs being installed where they are not appropriate and could not be sustained, either due to lack of budget or available skills (*more on this in Section 5.7.3 around public sector skills*). Innovation needs to be adapted to

It is generally felt that the South African science and technology fraternity is not sufficiently linked to municipalities or the market – as a solution provider. Local research outputs (especially in the policy/public good space) are in need of transferral mechanisms to shift innovation into the market place and reach stakeholders/end-users.

suit the context and its people. Innovative solutions do come out of communities, the knack is to tap into these, shared and exploit the learning for wider application. Socio-ecological innovation and co-creation between municipalities and rural or peri-urban communities allows for the development of technologies suited to the local context. Community involvement in the development and implementation of approaches to local waste management incorporating indigenous knowledge and approaches will enhance buy-in and greater participation. Foreign investors and development agencies, such as the German Development Bank and the Swiss, have recognised that in order to understand the SA waste sector they need to work in partnership with the local municipalities.

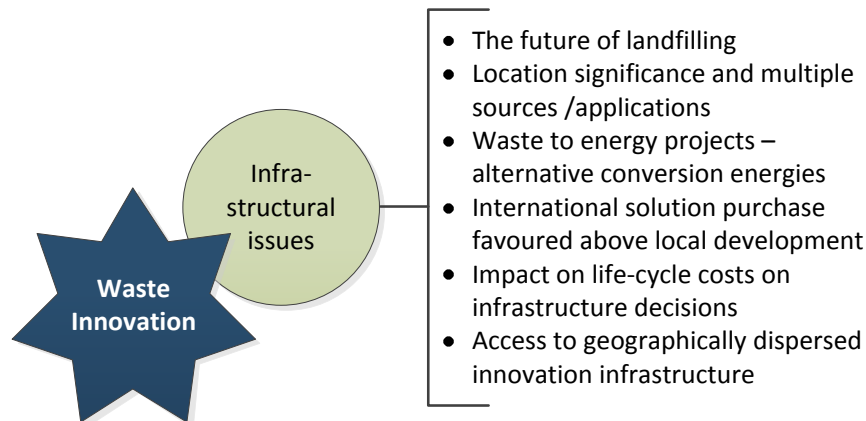
#### **5.4.3 Unintended consequences and competing priorities**

The need for rapid economic development often undermines waste minimisation and beneficiation priorities. For example, the pressing need to generate power in the face of national power shortages is seen to compromise waste minimisation and beneficiation of power generation waste, with the company focussing on its key business. ESKOM currently only recycles about 2% of the fly

ash it produces, however one academic stakeholder estimated the current fly ash production to be approximately 40Mt per annum from the coal-fired power stations. In such cases, opportunities exist for start-up companies or entrepreneurs to take on these waste streams that are not the core business of the industry.

## 5.5 Infrastructural issues

The six main infrastructural issues raised during the interviews appear in **Figure 17** and are discussed below.



**Figure 17: Infrastructure constraints, gaps and opportunities for waste innovation**

Industries and municipalities make long-term infrastructure decisions due to the substantial investment costs involved. The price of buying into an infrastructure-intensive process or technology is a loss of agility. So when an alternative (even improved) innovation presents itself, there is an inherent inertia to change direction. Similarly, concerns were raised around vested interests in some sections of industry driving behaviour. Where alternative innovations or technologies were seen as potential competition, these could be stifled by companies already promoting their own technologies.

### 5.5.1 The future of landfilling

While a number of alternative waste technologies (AWT) are appearing in South Africa (**Section 3.6.2**), landfilling remains the most prevalent waste disposal method. Innovation opportunities still exist with regards to landfilling. For example, regionalisation of landfills, which was first proposed in the 1999 NWMS (DEAT, 1999), provides for different ways of managing waste. The opportunity for mono-disposal sites was also mentioned. With current concerns over the non-compliance of municipal landfills, public-private partnerships as part of a regionalization strategy allows for a few capable service providers to take responsibility for managing waste streams correctly. This was seen by stakeholders as being preferable to tasking municipalities with a specialist responsibility that was not a core activity. A move was advocated towards more – especially clean – Material Recovery Facilities (MRFs) as in Europe, facilitated by separation at source initiatives.

### **5.5.2 Locational significance and multiple sources/applications**

For waste processing plants to function efficiently they require a reliable supply of large volumes of waste. Waste, by nature is a low value commodity and in general is widely dispersed. With ever increasing transport costs, drawing on waste from a large area can make inbound logistics costs exorbitantly high for these items of little worth, and the resultant technologies and innovations financially unviable. In the absence of subsidies or incentives, the viability of many waste initiatives is therefore dependent on integrating/linking activities with related up-/downstream money-making opportunities. Thus, waste processing facilities, have to be strategically placed to avoid exorbitant inbound logistics costs and to tap into as many revenue streams as possible. An example was given of a company that planned a plant at a big metropolitan trade port, thus receiving waste from the adjacent air- and trade port. It intended to set up a green park with a digester to deal with processing the organic waste. The surrounding agricultural greenhouses would in turn be prime customers for taking up the heat and electricity generated as a result of the waste treatment processes, a good example of industrial ecology. In addition, it would also deal with e-waste components. A type of industrial-symbiosis concept which to date has not evolved in South Africa.

### **5.5.3 Waste to energy projects – alternative conversion energies**

As discussed in **Section 5.2.5**, a South African complication of waste-to-energy projects centres on supplying and tapping into the national electricity grid. According to Independent Power Producers (IPPs), they are struggling to engage with ESKOM, who has the monopoly on energy production. Because of the frustrations experienced around this issue, companies are investigating alternative conversion energies, such as vehicle fuel or heat (steam), which do not require access to the national power grid. However, these alternative initiatives also come with their own challenges – not many industries demand steam, or where steam is required, the industries are often not clustered together spatially to allow for a single supply and off-take (an example is the canning and food industry, which in general is not clustered together). This again highlights some of the challenges experienced around successfully implementing industrial ecology initiatives in South Africa. As for vehicle fuel, performance losses are indicated for taking up this alternative, moreover the costs of converting from existing diesel refuelling infrastructure would dampen enthusiasm. There are international examples of instances where these obstacles have been overcome and successful initiatives implemented, however in studying these for South African applicability the inherent conditions and subsidies need to be taken into account.

### **5.5.4 International solution purchase favoured above local development**

According to private waste companies', often the expertise to developing a solution cannot be found in South Africa. A major company mentioned that it was recently in the market for developing an incineration technology. It could not find the required capacity locally and had to import a solution from the East. In fact, the companies interviewed did not seem in favour of South African technologies. Instead they had a shopping list approach where they searched the global market for the most suited and cost-effective solution. Overseas technology solutions are purchased

R&D and innovation opportunities associated with inbound technologies must be explored, e.g. support for local adaptation R&D or sector sharing/learning from pilot facilities.

in a plug and play fashion – sometimes a local technology partner provides support. For large investments, waste companies might invest in buying a pilot plant to see if the technology is suitable for South Africa.

#### **5.5.5 Impact of life-cycle costs on infrastructure decisions**

Respondents from research institutions voiced a need for laboratories and equipment to build prototypes and test functionality. Setting up and maintaining specialized world-class facilities are expensive. Moreover the laboratory use is often so specific that it limits wide usage or clientele. Costs of facilities for developing and on-going testing of waste solutions and other downstream requirements need to be factored into business plans in order to reflect the life-cycle cost and accurately assess the revenue implications of a waste opportunity. For example when South African companies adopted non-thermal treatment methods for health care waste (as alternative to incineration which had come under attack by NGOs), regular biological (validation) testing became a legal prerequisite. The two facilities employing this method had to send samples to an accredited laboratory twice a year, to ensure conformance. The testing process, equipment and maintenance of required organisms were expensive and it could not be justified for half-yearly use for only two clients by the laboratories. As a result there are no accredited laboratories in South Africa for biological testing of non-thermal treatment facilities, and samples are now sent overseas.

#### **5.5.6 Access to geographically dispersed innovation infrastructure**

A complication of the Research Infrastructure Support Programme (a NRF grant)<sup>31</sup> that was mentioned is the fact that applications are made by individual universities and science councils, which are dispersed across the country. The research fraternity wanting to make use of the infrastructure obtained through these grants, is often debilitated by the logistics of accessing it at disparate locations. Respondents felt that a hub model /centre of excellence would be preferable, where facilities and research around specific disciplines are located together, providing economies of scale and avoiding scenarios where investment in R&D infrastructure is diluted, as is the effective use of the infrastructure.

### **5.6 Information sharing and innovation collaboration issues**

The four main issues pertaining to information sharing and collaboration are depicted in **Figure 18**. These are further explored below.

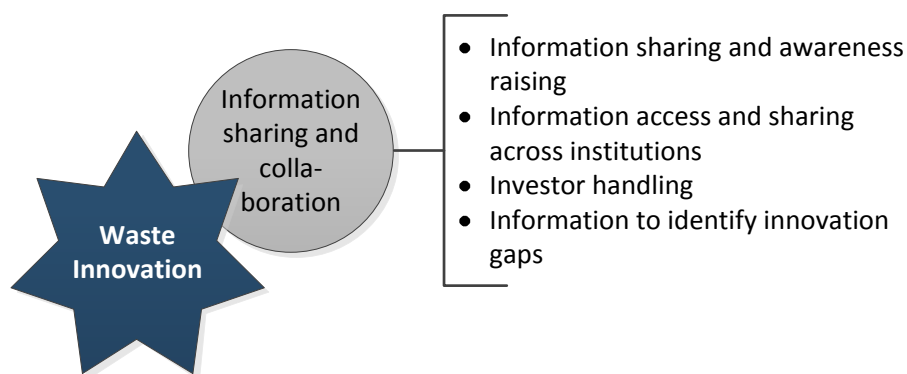
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<sup>31</sup> **Strategic Platforms Grants (Contract grants)**

The Strategic Platforms Support (SPP) Grants are geared towards the strengthening of research infrastructure and specific research platforms in the country in order to develop highly skilled people and generate new knowledge and technologies that are a prerequisite for progress in science and technology as well as economic growth.

- A number of different programmes are included:
- Research Infrastructure Support Programme
- National Equipment Programme (NEP)
- National Nanotechnology Equipment Programme (NNEP)
- Strategic Research Infrastructure Programme (SRIG)

<http://www.nrf.ac.za/risa.php?fdid=3>



**Figure 18: Information sharing and collaboration constraints, gaps and opportunities for waste innovation**

### **5.6.1 Information sharing and awareness raising**

In South Africa, waste management has only recently begun to receive the kind of attention and progressive thinking that have been prevalent in developed economies for decades. Consequently the general public needs to be educated on forward-thinking waste management behaviour and practices, including alternative approaches such as minimisation, re-use, and recycling procedures for the various waste streams. Examples were cited in the interviews of public ignorance around the inadmissibility of e-waste (e.g. TV or microwaves) disposal to normal landfill sites. Both urban and rural populations would greatly benefit from waste education customised to their context (including the benefits of recycling and reuse). To overcome many of the perceptions to waste already discussed under **Section 5.4.1**, popular scientific communication is required. Perceptions need to be adjusted to view waste as a resource instead of useless, unwanted remains. A mind shift is required from ‘cradle-to-grave’ philosophies and policies to close the ‘cradle-to-cradle’ cycle – whereby-products or leftovers from one production cycle becomes the input to another (possibly unrelated) use.

An approach to sensitising consumers towards environment-friendly behaviour (and promoting green products), is eco-labelling. Organisations such as Indalo Yethu (a DEA initiative) and National Cleaner Production Centre (NCPC) (a dti initiative), aim to create an eco-conscious society through awareness raising, including promoting eco-labelling and voluntary eco-endorsement programmes.

### **5.6.2 Information access and sharing across institutions**

According to interviewees, there is a lack of mechanisms in SA through which to transfer research outputs to stakeholders (end-users), especially in the policy/public-good space. Both government and industry noted at a waste HCD workshop held on the 11-12 July 2012 that they found it difficult to access particularly research outputs from academia and science councils (DST, 2012a). In some cases the information is available for sharing but accessing and adapting it for practical implementation proves to be a challenge. This is in part because the dissemination of such R&D is not the mandate of key departments such as DEA, SALGA and COGTA, which is further aggravated by the fact that DST does not have a presence in all the 273 municipalities. Another issue is that the information is often not in a format accessible to non-specialists and needs to be interpreted, or re-packaged into a format more suited for lay audiences. The Knowledge-Brokering waste function

within UK Department for Environment, Food and Rural Affairs (DEFRA) is an example of how policy questions are converted into research questions, and how research and ‘evidence’ from academia is translated back for policy-makers (DEFRA, 2007).

An illustrative example of knowledge transfer in support of innovation is the CSIR Toolkit of Good Waste Management Practices at selected rural, local and urban municipalities (CSIR, 2010). The value of such accessible information is underlined by the fact that, in 2007 the then Department of Environmental Affairs and Tourism (DEAT) found that 87% of South Africa’s municipalities lacked the capacity and infrastructure to pursue waste minimisation activities. This toolkit packaged often complex or technical waste information into a format that was easy to read and was simply communicated, to serve as examples to other municipalities struggling with service delivery (CSIR, 2010). The toolkit highlights those initiatives which have resulted in real improvements to the way waste is managed in communities. This could be expanded to a simple, yet practical guide regarding waste technologies, to inform municipal waste management. An objective framework describing the various waste management technologies, their potential use, pro’s and con’s, as well as implementation and maintenance cost implications. This could be augmented with a list of technology providers and their contact details. As a start, a waste technology audit is suggested to establish which waste technologies are currently being employed where in South Africa and to address what issues and which waste streams.

Respondents with interactions at municipal level felt that there have been waste management innovations at different municipalities, but these remain largely unknown. There is no suitable forum for the sharing of such interesting developments. WASTECON, a largely industry-focussed bi-annual waste conference is not well attended by municipalities. Furthermore, the participating companies are mindful of the competition present and will not share important ideas, innovations and information openly. The other large forum is the Waste Management Officers’ Khoro, an annual conference which the DEA launched in September 2010. The event has a pronounced policy focus, aiming to bring together all waste management officers nationally in an effort to deal with the implementation of the National Environmental Management Waste Act, waste Regulations and related legislation<sup>32</sup>. The Waste Khoro is well attended by representatives of municipalities, but is not open to non-government stakeholders. As such, existing fora do not easily allow for transfer of information between public and private waste sectors.

There are numerous private sector stakeholders with each waste company having their own data. These waste companies are often reluctant to share their detailed waste information (for competitive reasons). Where data is made available, it is often contradictory or incomplete.

### **5.6.3 Investor handling**

The lack of a one-stop-shop through which investors would make initial contact to obtain information on procedures, key contacts and access necessary documentation and forms was seen as a major obstacle to waste sector innovation by private sector stakeholders. This frustrating experience on the part of intending investors was contrasted with the experience in some African

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<sup>32</sup> [http://www.environment.gov.za/?q=content/mabudafhasi\\_adressed\\_waste\\_officers\\_khoro](http://www.environment.gov.za/?q=content/mabudafhasi_adressed_waste_officers_khoro)

countries such as Tanzania where responses, information and guidance could be obtained in relatively shorter times from dedicated national investment centres.

#### **5.6.4 Information to identify innovation gaps**

In the late 1980s and early 1990s the Water Research Commission's (WRC) undertook a national survey initiative (NATSURV). NATSURV's objectives were: to establish a database which can be used to determine targets for water intake and pollution loadings reasonably achievable by industry; and to establish areas where research is needed to assist industry in improving its water and waste-water management. Numerous industries were surveyed and an extensive database of industry-related information was compiled. Various potential research projects were identified, the details of which were circulated to all the universities and technikons in South Africa. To assist further with the dissemination of this information, industry-specific guides on water and wastewater management was produced for industries such as: soft drink and carbonated waters, dairy, red meat, laundry, textiles, pulp and paper, sugar, etc. These guides were aimed at the industries, and to other interested parties such as municipalities, administrators, researchers and consultants in the water and waste-water fields. Targets proposed in the NATSURV industry guides for water intake and pollution load per unit of product provided a basis both for legislation and for action within industries, by providing like industries with a valid basis for comparison. A WRC respondent confirmed that the organisation was in the process of updating the now out-dated industry guides over a four to five year period. A number of respondents referred to the NATSURV industry guides and suggested that similar guides be developed for solid waste as outputs to the DST Waste R&D and Innovation Programme, as it will identify important research and innovation opportunities and gaps for technology development.

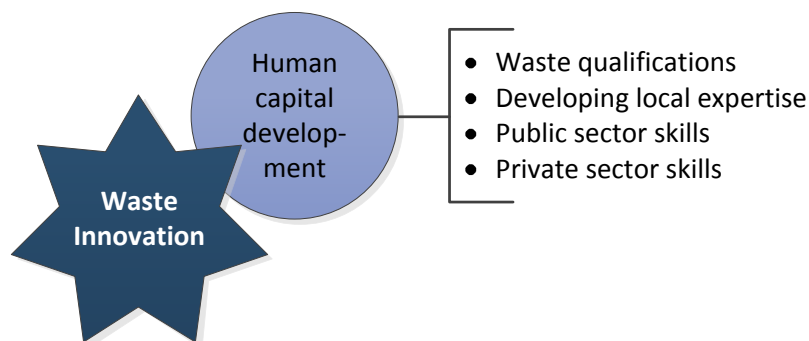
R&D and innovation opportunities and gaps need to be identified through the collection of information, which must guide strategic RDI programmes and associated investment

Alternatively, information from Industry Waste Management Plans, required under the new NEM:WA may be a source of such industry waste information. As a starting point, the waste baseline study, currently being undertaken by the CSIR on behalf of the DEA, that collects readily available information of waste quantities per waste type, might provide initial indications of key areas to target further which can be built upon through future reporting of waste information to the South African Waste Information System (SAWIS) managed by DEA.

The map of South African landfill sites needs to be updated and enhanced with various information layers, such as waste composition, quantities and site qualities (legal compliance, engineering design details and lifespan). Existing waste information portals such as the South African Waste Information Centre (SAWIC), could be augmented by a waste atlas database/geographic information system. This could provide details on where waste hotspots are; which wastes to prioritise; and model how waste spreads geographically using a few key determinants. This could enable capacity to be centrally planned and coordinated so that geographically similar areas could be targeted with similar policies and strategies.

## 5.7 Human Capital Development issues

While separate detailed HCD reports have been prepared as part of Phase 1 of the Waste RDI Roadmap (DST, 2012a), **Figure 19** highlights the four HCD challenges raised by stakeholders as obstacles to waste innovation. The section below provides more insight into these issues.



**Figure 19: Human capital development constraints, gaps and opportunities for waste innovation**

In order for South Africa to solve domestic issues such as unemployment and poverty, as well as grow and transform as a global economy, there needs to be an improvement in the utilisation of the country's inherent innovation resource. Considering entrepreneurship as a driver of innovation and a tool for addressing South Africa's social and economic needs, the focus must be on nurturing skilled and resourceful individuals that create and sustain high-growth ventures through the consistent use of innovation. HCD is therefore critical to enhancing the abilities of all current and potential actors, to allow them to take on new partnership roles in sustainable waste management (pers. comm., 2012).

### 5.7.1 Waste qualifications

Waste management is a complex system and is becoming more technologically advance. Future waste management will require specialist training, however no formal waste-specific degree (or equivalent) currently exists in South Africa's tertiary institutions (although some related topics are embedded in other degrees). Waste practitioners generally have engineering or environmental science backgrounds and it is typically only at a masters- or PhD-degree stage that they begin to specialise in waste management. Respondents felt that universities in general do not seem to have a specific interest in waste *"only if it forms part of a researcher's pet interest"*.

Thus, scarce skills are head hunted and poached from competition and come at a price. *"Competence and capable skills can be found – in older professionals. However, science and chemistry standards seem to be dropping and recently qualified technically-oriented individuals are no longer plug-and-play. For example in lab environments a year's practical on-the-job training is required before their workmanship is up to standard"* according to the above respondent.

The general gist from the interviews was that tertiary institutions' programmes and qualifications don't seem to meet industry's needs and a critical analysis and redirection is required to produce

relevant and appropriate graduates and post-graduates to be employable locally. *“Government must be deliberate in developing local competencies in line with its technological strategy.”*

### 5.7.2 Developing local expertise

Historically, due to South Africa’s international isolation, specialist skills and technologies had to be developed locally, as they could not be sourced from foreign markets. Since South Africa’s re-entry into the international economy the market conditions have changed dramatically, amplified by the effects of globalisation. South African companies that now seek these specialist skills have access to a more competitive, broader and deeper international skills pool. Furthermore, South Africa does not have a large domestic market or favourable labour policies to attract international technology companies to establish locally and to employ and develop local technical expertise. *“There is no longer sufficient demand/facilities in South Africa to attract students to high end scientific/technical skills in for e.g. analytical chemistry that could feed waste innovation”* (pers comm., 2012 Technical director of a waste management company). Those who do specialise in these fields have an international job market for employment opportunities. Another major waste company’s technical director declared: *“Finding manpower is the biggest frustration. We recruit scientific and environmentally qualified interns to train and gain experience in the waste management field, and have up to now absorbed all of them into the team after internship completion. We could really make use of an annual publication with contact details for recently qualified BSc post-graduates in SA.”*

Link to mechanisms put forward in the HCD programme to provide information on available waste sector expertise, e.g. dedicated post-graduate diploma or honours in waste management (publication of recent graduates), community of practice for specialists and students, etc.

### 5.7.3 Public sector skills

The view on public sector skills almost unanimously singled out a lack of waste innovation competence and capacity in municipalities, especially regarding technology evaluation expertise (See **Section 5.3.2**). The respondents observed that municipal staff turn-over remained abnormally high and the inexperienced young engineers that were often in charge, lacked practical real-world exposure to enable them to make sound technology investment decisions. Instead they often relied on their ‘comfort-consultants’, who are prone to push for technologies that have income potential for their companies and not necessarily the most fitting and cost effective solution. Suggestions were made that experiential learning and on-the-job training/shadowing of seasoned professional (PR) engineers be reintroduced, e.g. young municipal engineers could be mentored by retired professional engineers.

Opinions were voiced that a hurdle to addressing this municipal skills problem is that the smaller municipalities often don’t know what they don’t know, or where to turn to for help. Municipal-oriented waste training/development programmes by the Institute of Waste Management South Africa (IWMSA) and the North West University (in the past) were mentioned. However, these were mostly aimed at interpreting the legislation, strategies, and service delivery aspects, etc., intended mostly for councillors and senior management officials, and were not accredited.

In order to assist and capacitate municipalities the DEA also runs a programme whereby community environmental workers are deployed to local municipalities and in many instances these people get absorbed into the municipal structure. Suggestions were made that in order to improve municipal waste management and planning expertise the practice of getting consultants to develop integrated waste management plans (IWMP) for municipalities should be stopped, or at least changed to one of joint-development. In order to enable knowledge transfer, municipalities could solicit these planning experts to facilitate the IWMP development with them, but municipalities need to take ownership of the planning process and its outcomes.

Training is also required on how to operate and maintain technologies within municipalities to avoid white elephant situations. As such, 'recipes' or guidelines were suggested – detailing standard practices to be followed for waste-related processes. This could also be developed to support engineers, accountants and enforcement practitioners who work in this field. However respondents felt that inspectors or enforcement officers were often not technically competent to vet waste compliance and just blindly tick-off legal requirements without understanding conformance complexities.

#### **5.7.4 Private sector skills**

In support of SMMEs and developing entrepreneurs, respondents felt that there was a skills development gap in terms of operating cooperatives after establishment and that an initiative is required to educate and guide these SMMEs in terms of processes and running a business. According to the Innovation Hub's Climate Innovation Centre (CIC) in an assessment of the country's innovation landscape, skills training is required to provide the initial capabilities for companies to enter or scale-up their innovations.

In the same line as the 'mentoring by experienced engineers', the entrepreneur-in-residence programme was suggested. Such a programme would capitalise on the fact that mature and experienced entrepreneurs who have already achieved their career goals are inclined to collaborate and share expertise. Scientists/technology creators are often not business-minded and could be out of touch with the market-opportunity presented by their invention and what is required to commercialise. Having a multi-disciplinary team with an entrepreneurial expert in house would allow the innovation to be transformed to meet market needs timeously in the innovation development cycle. Key to enable this is resolving IP and partnership issues.

## 6 RECOMMENDATIONS

### 6.1 Addressing the challenges within the NSI

DST's responses to the recommendations of the OECD 2007 review of the NSI included the Ten Year Innovation Plan (TYIP) (DST, 2007), the establishment of the Innovation Fund and the BRICs, the establishment of the Knowledge Economy Forum, Centres of Excellence<sup>33</sup>, and the South African Research Chairs Initiative (SARChI) (DST, 2012). Initiatives like SARChI, Centres of Excellence, , the establishment of the Innovation Fund and the BRIC's have all been positive, as is the intention behind the tax incentive scheme for company R&D (DST, 2012). DST has also been successful in fostering international cooperation through research exchanges and South African participation and collaboration in the European Union Framework Programme projects.

However, a number of other key recommendations have not been addressed, such as the need to bring business into the NSI, and resolving the difficulties arising from the governance and institutional architecture of the NSI (DST, 2012).

#### 6.1.1 Business sector involvement

The business sector in South Africa acknowledges that there are a number of well-intentioned initiatives and policies implemented by DST and government departments more broadly, but these have some significant limitations that act more as disincentives to business to engage meaningfully in the NSI. The tax rebate on R&D investments by companies, for example, has exclusions and reporting requirements that limit its accessibility and usefulness, especially to SME's. The business sector shares the view that innovation and technology are fundamental to achieving the country's goals with respect to economic growth, competitiveness and job creation, with the NSI. It also believes that the state has a role to play as a national coordinating body to marshal national resources in the science and technology (S&T) space towards a common beneficial goal, but that state intervention needs to take the private sector's needs and interests in the space into account. The sector believes that DST has a science focus rather than a technology focus (e.g., the SKA project), the latter of which would offer better support to industry and business, and that the Department suffers from a lack of business-experienced personnel. The Ministerial Review Committee suggests that one of TIA's roles should be in facilitating multi-party and cross-sectoral partnerships to facilitate a culture and practice of innovation towards a common shared purpose, as is the case with similar government agencies in, e.g., Finland.

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<sup>33</sup> Centres of Excellence are centres or nodes of research, based mostly at universities, which serve to concentrate resources and capacity to facilitate collaboration between researchers on long-term, multi-disciplinary projects in areas that are strategically important to South Africa. The primary aim of Centres of Excellence is the generation of new scientific knowledge that would benefit our national and regional development objectives.

Furthermore, it should also focus on investing strongly in SME's operating in the technology sector, to amongst other things, advance black-owned businesses in the sector. Innovation and growth in this particular sector is hindered by the lack of venture capital and angel funding, with the result that skilled individuals and entrepreneurs tend to migrate to countries with more favourable conditions. Financiers need to have an increased risk appetite, and processes through which funding can be accessed must be simplified to make these more accessible to especially SME's. It is hoped that with time, TIA funding will become more accessible and play a role in this regard. It seems that venture capital is in fact readily available, but the investments are on a relatively small scale with certain tax and exchange control regulations making it difficult for fund managers to create value.

Another suggestion from the business sector is that cooperative programmes be introduced, through which the state could partner with groups of small businesses that are unable to fund their own R&D programmes, but which need access to a particular technology to enhance their global competitiveness. Every participating organisation has access to the outputs of the research, and is entitled to exploit the same.

Business is of the view that some of the skills shortages in the human resource base may be addressed by prioritised state funding for engineering and technology training and research (DST, 2012). Universities (and science councils) should also be incentivised to include support for the economy as one of their (research) priorities, by introducing special funding arrangements to address such issues in their research.

Triple helix partnerships between government, business, and higher education and science councils are essential to addressing the national priorities and developmental challenges, and government must play a stronger catalytic role in bringing the various players together and in creating conditions for the required cooperation and innovation. For example, in order to reverse the decline in business and industry funding in the public sector, the former needs to be more closely involved in the design of the necessary funding instruments and arrangements. In certain sectors, it may be necessary to include society as well to create quadruple helix partnerships.

The business sector has identified a number of challenges that need to be addressed by government to improve the effectiveness of the NSI:

1. The tax rebate on R&D investments by companies needs to be revised to be more accessible and useful
2. DST has a co-ordinating role to play in marshalling S&T resources and facilitating cross-sectoral partnerships towards a common innovation purpose
3. There should be prioritised state funding for engineering and technology training and research
4. The State needs to –
  - a) focus on investing strongly in SME's operating in the technology sector
  - b) facilitate and incentivise more accessible funding support mechanisms for SME's
  - c) play a catalytic role in creating triple and quadruple helix partnerships to address national developmental priorities and challenges
  - d) take the private sector needs into account to encourage the latter's meaningful participation in the NSI
  - e) encourage a wider view of innovation to meet its globally competitive goals

In addition, the system needs to be agile, and priority must be given, immediately, or at least in the short-term, to getting agencies such as TIA functioning effectively. Much more attention also needs to be paid to the needs of the private sector so as to encourage its meaningful and full participation in the NSI. As noted by participants in this project, innovation is typically driven by business, not by government. So the question is; how does government create an environment that stimulates innovation in the private sector, thereby creating opportunities for business to draw on capabilities of an NSI?

There is a concern within the agencies of the NSI, like the NRF, that the private sector directs some of its R&D investment overseas even when it can be performed locally (DST, 2012), and the NRF believes that conditions must be created to make local R&D the best option to such firms. A wider view of innovation (in addition to the traditional technological-driven view) is also necessary if the country is going to be internationally competitive within a global economy.

### **6.1.2 Governance issues and coherence between government departments**

It is imperative that at least the government departments that should be creating an enabling environment for innovation (DST, the dti, DEA, EDD, Department of Higher Education and Training (DHET)) work together more closely. Similarly a waste (or green technologies) inter-departmental committee would be important to setting, and implementing, cross-Department RDI priorities for the waste sector. An open system of

An inter-departmental working group on green technologies will ensure successful collaboration on initiatives identified under the Waste RDI Roadmap.

innovation that allows for a free flow of ideas and people between the various players in the system, globally and internationally, is also key to enabling innovation. Immigration and intellectual property policies and legislation need to allow for this. International collaboration is also a fundamental building block in this regard, and this is an area in which the state has done very well, especially with regard to the European Union Framework Programme, of which South Africa is a key beneficiary.

State-owned enterprises may be key to energising innovation through their procurement activity, international linkages, their R&D needs, and their involvement in technology transfer. The IDC and PIC are also potential levers for innovation.

### **6.1.3 Economy**

One of the paradoxes is of course that while South African industry is highly innovative, the economy is fairly stagnant (DST, 2012). This is largely due to structural reasons, such as the lack of transferable skills from one sector to another which constrains the country's ability to create employment (DST, 2012). This points to the need for social innovations that will lead to social change, through for example government enacting legislation and regulation that would create an enabling environment to, for example, address the human resource capacity constraints in the system (by changing immigration policies for instance, and revitalising, and increasing the number of, technical colleges); actively involving civil society groups and communities in development initiatives rather than only seeing communities "*as recipients of service delivery*" (DST, 2012:25).

Internationally, it appears that national growth increasingly depends on creating small and medium enterprises. This appears to be true in South Africa as well, with SME's contributing to 40% of our GDP and accounting for 60% of all employment<sup>34</sup>. The growth and vitality of the SME sector is crucial if the NSI, and the country, are to achieve its job creation and economic goals. As indicated in paragraph 6.1.1, government should invest more in SME's in the technology sector, especially if it wants to promote black-owned technology based SME's.

#### **6.1.4 Patent activity**

Another paradox with respect to private sector innovation in South Africa is that the high rate of innovation has not translated into increased patenting levels. This is probably mainly due to the innovation that is introduced being more incremental and adaptive. Patent activity is not common in areas in which South Africa is at the technology frontier. The country is generally an original equipment manufacturer in the medium-technology space, which again, generally excludes local patents.

One of the key constraints to creating a national culture of innovation is the regulatory framework for intellectual property rights. Although it is generally well-intentioned, it has proven to be burdensome for its users (DST, 2012), and counter-productive, particularly when it comes to co-innovation between the private sector and academia or science councils. It is still too early to determine the impact of the Intellectual Property from Publicly Financed Research and Development Act 51 of 2008 (IPR Act), but the delays already experienced at the new NIPMO indicate that this too may be problematic. There are also early indications that, as happened with the Bayh-Doyle Act<sup>35</sup>, companies will limit research collaboration with universities and science councils, and may outsource their R&D needs to other private providers rather than to these institutions so as to avoid the onerous intellectual property ownership conditions and reporting requirements inherent in the IPR Act.

Except in the agriculture and health fields, South African universities and public research organisations are much more in the research business than in the innovation business (DST, 2012). Companies generally do not look to these organisations for information on innovation but these do provide the high skills levels that bring new ideas to business. It is worth noting that the proportion of local private sector funding of research in universities is at 10% and amongst the highest in the world, with about half of the investment flowing through THRIP (DST, 2012).

## **6.2 Cross-cutting waste issues**

Enhancing waste innovation in South Africa, which can support a transition to a green economy, requires that government and the private sector address seven broad themes of issues, currently inhibiting waste innovation. These issues, which have been extensively covered in **Section 5**.

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<sup>34</sup> Address by Naledi Pandor MP, Minister of Science and Technology, at the launch of the Southern Gauteng Regional Innovation Forum and Science Park, VUT, 4 June 2012

<sup>35</sup> P.L 96-517, Patent and Trademark Amendments Act of 1980, 35 U.S.C s200-212

The following section highlights some of the cross-cutting issues arising from the views of stakeholders, along with recommendations that were suggested to address these issues –

- Innovation in the waste sector
- Communication coherence and inclusion
- Policing and enforcement
- Skills and capacity
- Cumbersome processes and the need for harmonisation between departments
- Small sector support and poverty reduction
- Information on the waste sector

It must be emphasised that the issues presented in **Section 5** as well as these cross-cutting themes, may not include all of the challenges facing waste innovation in South Africa. It is therefore important that the DST, as well as other tasked organisations, continue to monitor the state of waste innovation, and where appropriate, respond to these issues through appropriate mechanisms.

### **6.2.1 Innovation in the waste sector**

Many stakeholders bemoaned the lack of funding at the prefeasibility/proof of concept phases. This lack of funding is not unusual at what is a high risk stage of the innovation chain where not many funders are willing to take this risk.

*Recommendation:* There is a need for inclusive dialogue to better understand the gaps and interface issues in the innovation support structures and find ways to address these taking into account broad stakeholder inputs.

The private sector could play a greater role in R&D and innovation.

*Recommendation:* The waste RDI roadmap needs to promote a greater role for the private sector in R&D and innovation beyond just increased R&D expenditure/ spending.

There are several shortcomings identified in the NSI as it currently stands. A national waste RDI programme is one way to address these as follows

*Recommendations:*

- The private sector meaningfully included in the NSI
- identifying sectoral priorities for innovation
- putting mechanisms in place to overcome current governance challenges to waste innovation particularly improved coordination
- strengthening human capital in the waste innovation sector through formal HCD programmes supporting SMMEs through the NSI as a crucial part of a national waste innovation programme

Innovation is typically driven by business, not by government, but government can provide the required enabling environment.

*Recommendation:* An inclusive approach is critical in the creation of a conducive environment by government for business to draw on the capabilities of an NSI.

Local factors create specific barriers that require adaptation of foreign best practice, or original local solutions. These factors include lower land and power costs that make landfilling more attractive and discourage alternative innovations, including waste-to-energy projects.

*Recommendation:* Escalating landfilling fees to be more market-related, and carefully crafted incentives and penalties, to ensure waste generators pay for waste management, and recyclers are rewarded. These are government roles at both national and local level.

There were concerns around the role of TIA, if it supports only commercially viable projects, since this places it further up the innovation chain, away from the high risk stage where assistance is most needed (support to bridging the innovation chasm).

*Recommendation:* Coordination within the NSI is required to streamline responses to the needs of entrepreneurs.

### **6.2.2 Policing and enforcement**

Weak enforcement often means that waste organisations implement the cheapest available technology which does not drive innovation (or support for national policy).

*Recommendation:* Competent investigation and gathering of evidence that will stand up in court is essential, as is punishment of all convicted offenders.

Some regulations and guidelines have the unintended effect of stifling innovation or providing perverse incentives for undesired behaviours. As an example, waste minimisation could stifle waste recycling innovation by causing insecurity around the supply of waste where waste is the input into a manufacturing process.

*Recommendation:* Dialogue would identify conflicting regulations and guidelines, and explore ways to harmonise these.

### **6.2.3 Communication coherence and inclusion**

Many non-government stakeholders feel they are not always consulted as much as they would like in order for them to make inputs into policy and/or decisions. A possible source of difficulty is that a single waste forum or mode of communication is not available to dissimilar stakeholders. Thus an online call for public input, or a stakeholder consultation suited for industry associations and academic groups will not allow meaningful engagement with small local councils, rural communities, and the informal sector.

There are also local level waste management innovations as well as data within waste companies that are not shared. If communicated this would facilitate more evidence based policy and improved waste management.

*Recommendations:*

- Complex technical and legal documents need to be translated into formats suited to the target audience, for example research findings to policy briefs and simplified flyers, local language articles in the popular press and community radio.
- The current methods of interacting with stakeholders within the NSI need to be interrogated in consultation with all stakeholders with a view to enhancing interaction and trust. This may entail parallel processes designed to reach the different types of stakeholder.

- A transparent, inter-Departmental committee on waste innovation (or green technologies) is needed to ensure alignment of policies and policy objectives.
- Government departments need to better harmonize their separate interactions with stakeholders to ensure coherent messages are conveyed.

#### **6.2.4 Skills and capacity**

The skills shortage that is prevalent across the waste sector points to several possible causes, among them the lack of a dedicated post-graduate waste management degree/diploma; inappropriate curricula not tailored to the needs of the economy, and insufficient through-put of required skills.

The skills and experience gap between external consultants and experts, and local government officials exposes local government officers to manipulative practices because they do not have sufficient knowledge and experience to effectively engage with and supervise the consultants. This gap also constrains municipalities from meaningful engagement with the private sector towards prioritised innovation opportunities.

##### *Recommendations:*

- Skilling at local government level is critical, and not just in the waste sector. This could involve both on the job training and monitoring the hiring of staff to ensure quality staff are in place.
- For the waste sector, a dedicated post-graduate honours degree or diploma in waste management could provide critical skills.

#### **6.2.5 Cumbersome processes and the need for harmonisation between government departments**

Stakeholders in the waste sector are experiencing similar obstacles or limitations as noted by the Ministerial Committee in the review of the NSI and alluded to in both **Sections 4 and 6**. The tendency for government departments to work in silos in pursuing their respective mandates allows certain issues, some crucial, to 'fall between the cracks' where such issues are not aligned with any one of the departmental mandates.

*Recommendation: A mechanism to provide a cross-departmental vision is necessary.*

Investors and entrepreneurs are frustrated by not having a single point of entry where all necessary support and guidance is available.

*Recommendation: A national investment centre, or similar facility as found in some African countries, is one solution to this problem.*

The Department of Energy Renewable Energy IPP Bidding Programme could be used to stimulate waste to energy projects, and the income from such projects could subsidize waste management costs

*Recommendation: Synchronising the objectives of Departments, e.g. DoE & DEA can improve support for waste to energy in DoE programmes.*

### **6.2.6 SMME support and poverty reduction**

SMEs and the informal sector are not able to meaningfully contribute in future planning for the waste sector.

*Recommendation:* In the waste RDI roadmap it is important to devise a variety of mechanisms to grow SME involvement in waste innovation as these are crucial to the success of waste innovation and job creation.

The status quo in the waste sector provides little support to enable microenterprises and SMEs to organise, add value to the waste they collect, and negotiate terms of trade.

*Recommendations:*

- Initiatives to assist the informal sector to be more organised around the needs of this sector.
- There is need to identify and incorporate indigenous knowledge into the mainstream body of knowledge.
- Innovative Industry/SME/microenterprise partnerships that nurture development and growth of waste sector microenterprises are needed.

### **6.2.7 Information on the waste sector**

To date, no comprehensive sector analysis has been undertaken for South Africa to fully understand the size of the waste sector. Information also remains within waste companies, and indigenous knowledge that is not shared.

*Recommendations:*

- It is necessary for mechanisms to facilitate sharing of information that are already available, to be developed and implemented, or where already in place, to be more widely rolled-out.
- It is recommended that a waste sector analysis be undertaken as part of the Waste RDI Roadmap to establish the magnitude and contribution of the sector to South Africa's economy.

## 7 CONCLUSIONS

One of the core principles of the NSI is the notion that innovation can be a prime driver of development in a country. A number of issues were raised in **Section 5** which pose a threat to that notion, and if not addressed decisively and with a determined effort and concerted political will and determination, will continue to hinder the performance and effectiveness of the NSI. These issues included:

- legislative,
- economic and financial,
- institutional,
- behaviour and perceptions,
- infrastructural,
- information sharing and collaboration, and
- human capital development.

While the waste sector is recognised as being able to make an important contribution to South Africa's economic growth and new job potential, the NSI has not yet responded, with there being no focused waste innovation mechanisms (financial or institutional) in place to stimulate technological and non-technological innovation. Limited

information available on current innovation activities in the waste sector, suggest that innovation is currently taking place through private sector investment to primarily import solutions to meet its innovation needs.

It is hoped that the establishment of a national Waste RDI Roadmap will address some of the current shortcomings in the NSI, with respect to the waste sector, identified in the OECD and Ministerial reviews, as well as in this review of key challenges, gaps and opportunities to waste innovation.

The aim of establishing a waste RDI roadmap is to address some of the identified shortcomings within the NSI. The roadmap should at least:

- view innovation as more than just traditional R&D and must include both technological and social innovations
- ensure that the private sector is meaningfully involved in designing and implementing the roadmap;
- identify sectoral priorities for waste innovation and incentivise Higher Education Institutions (HEI's), Science Engineering and Technology Institutions (SETI's) and private sector R&D organisations to work on those priorities;
- strengthening governance systems, and putting in place mechanisms to overcome current governance challenges to waste innovation (including inter-Departmental working groups);
- strengthening human capital in the waste innovation sector through formal Human Capital Development (HCD) programmes;
- ensure that SME's are appropriately supported by the mechanisms in the NSI and regarded as crucial to achieving the objectives of a waste innovation programme (especially with respect to job creation); and
- include an internationally open system, with reciprocal flows of inputs (skills, knowledge, equipment, etc)
- that R&D expenditure by the private sector be increased, and that this increase be felt locally (as opposed to overseas R&D spend).

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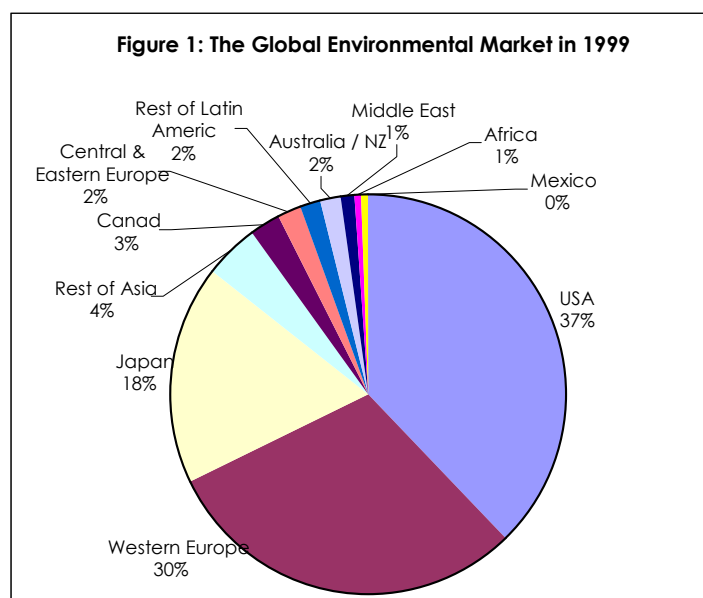
A national waste innovation programme for South Africa: Phase 1 Status Quo Assessment

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## ANNEXURE B. INTERNATIONAL STATE AND BEST PRACTICE

### 1. Europe

In 2000, estimates were that the global market for environmental technologies was worth around ZAR 3 195 billion (CEC, 2002). As seen in **Figure 20**, the USA, European Union (EU) and Japan account for about 85% of this market. At the time, the EU appeared to have a competitive exports sector in this area, especially in developing water and wastewater treatment infrastructures, waste management infrastructures and operations, air pollution control technologies and renewable energy goods and services (CEC, 2002).

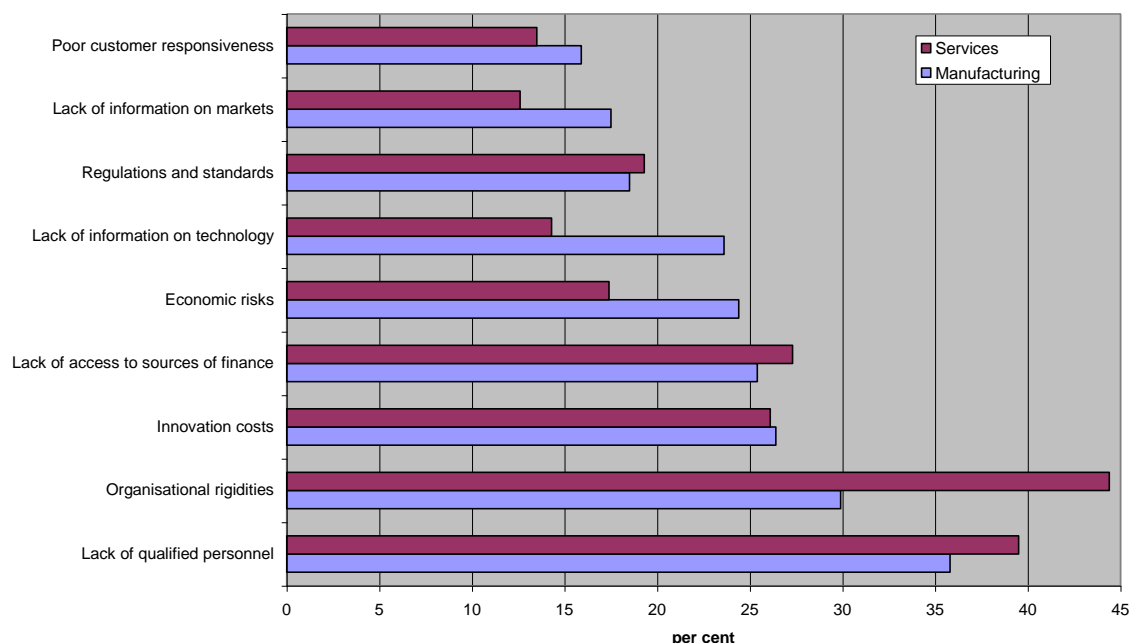


**Figure 20: The Global Environmental Market in 1999 (CEC, 2002)**

The EU sustainable development strategy is based on the principle that “*economic growth, environmental protection and social inclusion should go hand in hand*” (CEC, 2002:4). The strategy adopts a broad definition of environmental technologies to include “*all technologies whose use is less environmentally harmful than relevant alternatives*” (CEC, 2002:5). The Commission of the European Communities (CEC) recognizes both integrated technologies that prevent pollutants from being generated in the production process as well as end-of-pipe technologies that reduce the amount of pollutants that are produced and that are released into the environment.

The strategy recognizes that the EU has a role to play in contributing to sustainable development globally, by sharing EU-developed environmental technologies. At the same time, it cautioned against disadvantaging developing countries by, for example, dumping obsolete technologies in such countries which may have less stringent environmental regulations than the EU, or other developed regions. In other words technologies that are disseminated should be appropriate, and suited, to local needs.

The strategy also recognizes that even though environmental technologies have significant potential, there are obstacles to their development and market penetration (see **Figure 21**).



**Figure 21: Factors seriously delaying innovating projects (CEC, 2002)**

Clean air, water, natural resources, stable climate etc. are all common environmental goods, and as such have insufficient or missing markets. This means that returns from investments in environmental technologies would be lower than “*if prices reflected the full value of environmental goods or services*” (CEC, 2002:16). There is therefore systemic under-investment in innovative environmental technologies resulting in their not being taken up, and there being little incentive to research and develop such technologies.

The EU recognized that mechanisms like the use of economic instruments could help to address these obstacles. The costs of environmental technologies are critical to facilitating their adoption, as expensive technologies are unlikely to be adopted. Bearing natural investment cycles in mind would also go a long way to reducing the (perceived) cost of adopting new technologies, and introducing a technology at the right time will help ensure that it has the most favourable impact. The EU has also introduced taxation mechanisms to incentivize the adoption of, e.g. energy saving technologies. The EU employment guidelines include encouraging Member States to explore alternative options of tax revenue, such as taxing energy or pollution emissions, which would allow, e.g. tax on labour to be reduced.

Setting policy priorities and a coherent and predictable legislative framework are important in facilitating long-term planning, which helps reduce costs for researchers and investors. The 6th Environmental Action Programme identified four environmental priority areas for a period of ten years, and, as with the OECD, 2007 and 2012 Ministerial Review of the South African National System of Innovation (see **Section 4.1**), also recognized the need to use the business sector to develop innovative solutions and to better incentivize the market itself – a global trend in RDI. It also recognized that consumers have an important influential role in the environmental technology

market, and businesses and households could be encouraged to identify opportunities through voluntary measures.

The EU has structured its research programmes and set its research priorities through its Research Framework Programmes. This has allowed industry and associated research organisations to share the costs of the research, through a system-orientated, multidisciplinary approach. The EU recognized that the key to getting the biggest bang for your research buck so to speak is the proper exploitation of research outputs, and public research programmes should “*help make new products and services commercially viable*” (CEC, 2002:20).

The EU’s Environmental Technologies Action Plan (ETAP) proposed actions in three main areas: getting from research to markets; improving market conditions; and acting globally (CEC, 2004). Each of which are discussed briefly below.

### **1.1. Getting from research to the markets**

Even though there were existing funding mechanisms in the environmental technology space, ETAP recognized the need to improve their effectiveness and efficiency in key technology areas. In particular, there was a need to enable small and medium enterprises to participate more effectively in these mechanisms, as well to strengthen the mechanisms with respect to support for dissemination, exploitation of research results, and for accelerated technology transfer. Funding for the piloting, demonstration and dissemination of promising environmental technologies should be increased.

One of the more innovative mechanisms proposed by ETAP was the intention to establish technology platforms that would bring all the stakeholders together to create a shared long-term vision for the development and promotion of a specific technology or solution for a particular issue. These platforms would develop a strategic research agenda, link industry and financial institutions, explore public-private partnerships to commercialise research outputs, explore mechanisms for improved technology transfer to developing countries, develop strategies for regional education and training programmes and propose possible demonstration and dissemination projects. Parallel discussions with stakeholders regarding the development and deployment of technologies would also be held (CEC, 2004).

ETAP recognized that it is often difficult, especially for SME’s, to convince the market of the merits of an environmental technology they have produced. Following on the success of the US Environmental Agency’s similar ‘*Environmental Technology Verification*’ programme, ETAP planned to encourage the creation of networks of testing centres, based on technology sectors, to verify certain key technologies. Each network would develop commonly agreed assessment protocol and evaluate the technical, economic and environmental performances of technologies, taking the life-cycles of the technologies into account. The standardization of protocols within networks would also facilitate access to markets and financing schemes by environmental technology producers, whose technologies were tested by a centre in a network.

## **1.2. Improving market conditions**

In addition to greater efforts being required to bring environmental technologies to market, it is also necessary to take into account that many potentially significant environmental technologies already exist, but are underutilized. This is probably due to factors such as lock-in to existing technologies, less eco-efficient but cheaper alternative solutions, low market awareness, and lack of access to finance. ETAP put in place a number of measures in an attempt to overcome this difficulty. These include setting performance targets that are viable and realistic, but at the same time, long-term and visionary, that will encourage the development and uptake of environmental technologies by especially industry. These could include CO<sub>2</sub> emission standards for cars, or energy efficiency standards for household appliances, and would be voluntary, unless proven to be ineffective, in which case they may be made legally binding. ETAP also included various measures to leverage and incentivize investment in environmental technologies, and socially and environmentally responsible initiatives. These include mechanisms to facilitate co-investment with, for example, venture capitalists, to alleviate the risk of investing in new environmental projects or related businesses.

In addition, ETAP recognized that economic barriers to the uptake of environmental technologies could be removed by the proper application of market-based instruments such as the taxes, tax breaks, subsidies, tradable permits and deposit refund schemes. These would help reduce pollution as they would make the producers and consumers pay for their polluting behavior and change it in a cost-effective way. Market-based instruments could potentially also increase the markets and demand for environmental services and public goods (CEC, 2004). The ETAP also recognized that identifying and removing environmentally harmful subsidies would be a first step towards reducing prices and the harmful effects of such subsidies on the environment, especially where these distort prices in favour of more polluting, subsidized technologies.

ETAP recognized that public procurement can be a powerful catalyst for the uptake of environmental technologies. It encouraged the investigation of setting performance-based requirements in public procurement processes so as to promote environmental technologies, by pulling them into the market place. It would also be important to promote life-cycle costing for long term investments such as buildings and energy supply systems (CEC, 2004).

Crucially, ETAP recognized that social acceptance of environmental technologies is vital to an encouraging investment in such technologies. Raising consumer awareness about the existence and benefits of environmentally friendly goods and services is therefore important if the public is to buy these and make use of their potential benefits, and the information needs to be widely available if the *“power of consumers can be sufficiently mobilized to drive the demand”* (CEC, 2004:20), and it is the responsibility of all levels of government to do so.

## **1.3. Acting globally**

In addition to potentially increasing employment and economic growth in the EU, investment in environmental technologies has the potential to promote sustainable development globally, through the transfer of these technologies to other parts of the world, including to developing countries. By offering these countries the opportunity to leapfrog more traditional, environmentally unfriendly

technologies through the use of more environmentally friendly and eco-efficient options, they could decouple their economic growth from environmental degradation. It must however be borne in mind that the environmental technologies that are transferred must be appropriate for local conditions, and it may be necessary for these countries to ensure that the necessary training and development also occurs to empower their populations to make the best use of these technologies.

The private sector also has a role to play in diffusing the transferring environmental technologies through, e.g. foreign direct investment in developing countries. This has the effect generally of providing such countries with a suite of technologies, as well as knowledge and expertise. Lending policies of international financing institutions should also be influenced to promote investment in environmental technologies, and the liberalization of international trade could also be important in the diffusion and use of such technologies.

## **2. Australia**

Australia's Department of Environment, Water, Heritage and the Arts (DEWHA) commissioned a study into Waste Technology and Innovation, the outcome of which was intended to feed into its State of Waste Report and National Waste Policy. The study (DEWHA, 2009) focused on identifying:

- key waste related emerging innovations, trends and opportunities;
- barriers to the implementation of such innovations and technologies; and
- future funding models for financing construction and operation.

According to the report, much of the innovation in this space has occurred in relation to the development of end-of-pipe technologies to treat waste streams. However, there are growing innovative waste management practices focused on issues related to waste minimisation and prevention, source collection and separation. As in South Africa, many of these emerging waste technologies in Australia are still in early stages of development, or are piloted in countries outside Australia, and represent a commercial risk at large-scale implementation. This tends to delay their adoption in Australia at least until they are proven overseas through continuous operation for a number of years. Unlike US or European markets, Australia is said to have relatively small amounts of potential wastes to which technologies can be applied. The fact that there are more convenient and established waste technologies already available in Australia (such as landfilling, or exporting of waste) (as in the case of South Africa), also acts as a barrier to the introduction and uptake of these technologies.

It is important to note however that, especially where waste technologies are imported, factors like local markets (for the outputs), affordability and suitability of the technology as well as the associated collection and disposal systems, need to be taken into account when assessing applicability to local conditions.

### **2.1 Barriers to innovation**

The Australian study recognized that a one-size-fits-all approach will not work to increase the use of technology and level of innovation in waste management. The study identified the main barriers to waste innovation as being (DEWHA, 2009):

- the low cost of landfilling in some Australian states and territories;
- lack of co-operation between councils;
- distrust of new and unproven technologies;
- fear of incineration;
- reluctance to make long-term commitments to outdated and inappropriate technologies, especially if there is a chance that the technology may become outdated before the contract ends;
- waste management, and the implementation of new technologies in this regard, is the responsibility of local government in Australia, whose staff often lack the commercial and technical expertise required;
- local municipalities in addition, do not have the financial resources to adopt these new technologies; and
- smaller municipalities may not be able to generate the amount of waste required to make the recycling facilities financially viable (but this could be overcome by these municipalities entering into joint contracts with service providers)

Many of these issues are found to be relevant to South Africa, as discussed further in **Section 5**.

### **2.1.1 Overcoming the Barriers**

The study suggested a number of mechanisms of overcoming these barriers:

- *financial instruments*, such as
  - the UK example of establishing a ring-fenced technology grant, which would reduce the capital, and associated costs of setting up new technology plants
  - *deposit schemes* for electronic goods like televisions and computers (to catalyze the collection of these in sufficient numbers to achieve the necessary critical mass);
  - *financial incentives* to private entities who deliver waste to recycling centres instead of having to implement broad scale collection systems, which would be more and less efficient.
  - *deposits* paid at points of sale or import could encourage consumers to bring bigger quantities of waste materials to reprocessing facilities to achieve the necessary critical mass
- *policy instruments*, such as
  - national product stewardship and *extended product responsibility schemes*;
  - *banning* landfilling of particular wastes, which could lead to the introduction of smaller scale plants for processing of the waste material
  - *enforceable waste targets* and green manufacturing and product design standards
- development of easy *assessment tools* for municipalities to use to assess the viability of new technologies

Traditionally, Australia has exported its recovered plastic waste material to China, with little local beneficiation and value add – similar to that experienced in South Africa. However, the global financial crisis has seen a drop in demand for such material. There may therefore be an opportunity for local companies to invest in new products and processes and facilities to deal with the increasing

amount of the material recovered from various recycling mechanisms in the country, but these investments would be vulnerable, especially if the demand and price for the material increases again. The study recommends that financial incentives be put in place to ensure a secure supply of feedstock to local facilities and encourage local value-adding to the recovery and sorting processes.

While innovation with respect to economic and regulatory incentives is needed, innovative thinking with respect to encouraging behavioural change (by business and individuals) to reduce the generation of waste is also necessary and would go a long way to reducing the reliance on the development and use of waste management and treatment technologies.