BRIEFING NOTE

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MAPPING SOUTH AFRICA'S WASTE ELECTRICAL AND ELECTRONIC EQUIPMENT (WEEE) DISMANTLING, PRE-PROCESSING AND PROCESSING TECHNOLOGY LANDSCAPE

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KEY FINDINGS

A summary of the main findings and recommendations arising from the study entitled "*Mapping South Africa's waste electrical and electronic dismantling, pre-processing and processing technology landscape*" are presented here.

INTRODUCTION

This project provides an assessment of waste electrical and electronic equipment (WEEE) recycling technology, in operation in South Africa, in 2016. The project, undertaken by Mintek on behalf of the Department of Science and Technology (DST), aims to –

- Assess local technology solutions and treatment capacity for the dismantling, pre-processing and processing of WEEE; gaps in local technology solutions that could support increased local processing of WEEE; and opportunities for new areas of technological innovation;
- Support future WEEE research, development and innovation in South Africa to ensure that opportunity areas, and key gaps are addressed;
- Capacitate the sector through public access to information, in order to improve the understanding of the potential business opportunities in recycling of WEEE;
- Support the diversion of WEEE away from landfill towards reuse and recycling; and
- Support the development of a local, regional, secondary resources economy that provides maximum local social and economic benefit.

The study, undertaken between May 2016 and March 2017, involved a strong research component. Primary data was collected by means of a structured questionnaire (comprising 20 questions) distributed to WEEE recycling firms and followed by face-to-face interviews with 27 firms. These firms are engaged in the dismantling, pre-processing and processing stages of the WEEE value chain, across the three prioritised waste streams – ICT & consumer electronics; lamps; and large and small household goods (including temperature exchange equipment). In sampling these firms, a balance between type, size of firm, position on the value chain, and geographical location was made. Given the constraints in the project budget and timeframes, the study areas were limited to Gauteng, KwaZulu-Natal (KZN), Western Cape, Eastern Cape and Mpumalanga. In this way, data collection activities were optimised to ensure coverage of the bulk of WEEE flows in South Africa.

Notable sector dynamics and trends:

- The South African WEEE industry has become more integrated, formalised and diversified over the past decade[1].
- Over 100 formerly registered companies operate across the WEEE recycling value chain (from collection to processing) in South Africa.
- The WEEE recycling sector remains dominated by a few well-established 'consolidator' companies (85% of volumes handled in 2015).
- Most small- to medium-sized firms concentrate in earlier stages of the value chain (i.e. dismantling). The number of firms offering location-specific[2] collection, dismantling and refurbishment activities have increased over the past five years.
- Gauteng remains the central 'hub' for the

[1] "Integrated" – refers to the fact that firms are no longer just restricting their activities to one stage in the value chain, but are increasingly straddling two or more. "Diversification" – refers to the fact that firms are increasingly broadening their product focus (focusing on more than one waste stream), service offering (engaging in complementary activities such as refurbishment) and geographic footprint (within South Africa and neighbouring countries) in response to increased competition and variable flows of WEEE.

[2] For example, companies focusing on specific geographical markets include *inter alia* Bolunga Enterprise (Pty) Ltd (Eastern Cape), Electronic Cemetery e-Waste Management Ltd (KZN), Sibanye Recycling Ltd (KZN) and Virgin Earth Ltd (Western Cape).

collection, consolidation, pre-processing and processing of WEEE in South Africa (±55% of volumes handled in 2015). The Western Cape, KZN and Eastern Cape are important provincial aggregation and sourcing nodes.

- The SADC region is emerging as an important supplementary source of WEEE inputs to the South African recycling sector and is expected to increase in importance as competition for local inputs intensifies.
- Barriers to entry are high at the pre-processing and processing stages and in specialised waste streams (e.g. lamps), but comparatively lower at the dismantling stage. Skills and technology are not the determining factors, rather access to WEEE volumes is.
- WEEE recycling is not profitable as a standalone business for small firms, with 58% regarding it as a secondary activity. Most small dismantlers complement WEEE recycling with refurbishment, which is regarded as being more profitable (making up to 60% of revenues).
- In 2015, approximately 17,733t of WEEE was handled by the 27 firms[3], with the largest source of inputs being from government departments (45%). ICT & consumer electronics made up the largest contributing waste stream (79%).
- The WEEE recycling sector is currently not a significant employer, with approximately 677 people employed across 18 firms in 2015. However, at 25 jobs/1,000t handled, the sector has the potential to increase this number as more WEEE is unlocked into the value chain.
- The main output fractions produced by firms in 2015 were ferrous (47%) and non-ferrous (16%) metals, and printed circuit boards (PCBs) (16%). PCBs remain the most valuable fraction.
- Firms are committed to process locally as far as possible, but complex fractions are exported – 90% PCBs, 60% phosphor powders, and some ferrous and non-ferrous metals are exported to Asia and Europe.
- The local re-manufacturing of WEEE plastics and glass fractions is still limited in South Africa. Approximately 80% of the 7,500t of electronic plastic fraction produced in South Africa in 2015 was exported, while the remaining 20% was beneficiated locally. In the case of glass, 90% (mostly from lamps) of the 800t produced in 2015 was beneficiated locally, while the other 10%, composed of mainly cathode ray tube (CRT) glass, was landfilled.
- The co-treatment of WEEE by pyrometallurgical processes is an established means of deriving value from precious and other metals contained in dismantled WEEE, specifically PCBs. However, the high levels of capital investment required, volumes of WEEE needed to ensure sufficient economies of scale, and associated environmental impacts, suggest that it is currently an unviable business opportunity in South Africa.

Overall, it is evident that the current growth and dynamism of the WEEE recycling sector in South Africa is not determined by the availability, sourcing and operation of technology per se, but by the availability and volumes of WEEE released into the system to process and recycle. Access to sufficient volumes of WEEE appears to be the most significant constraint to growing the South African WEEE recycling industry and in moving firms from their current manual dismantling and limited pre-processing, to greater processing and local value recovery. The result is that firms are starting to tap into easily accessible WEEE from the SADC region to utilise available, local treatment capacity. Yet recycling of WEEE generated in South Africa remains low at only 11% (DEA, 2012a).

For South Africa to strengthen its local and regional WEEE dismantling, pre-processing and processing capacity, and invest in additional technology, will require greater efforts by the public and private sectors to access WEEE out of the waste stream. Advancing the environmental, socio-economic and technological objectives of reducing the volumes of WEEE landfilled annually, expanding the base of recyclers and employees engaged across all stages of the value chain, and enhancing R&D and innovation in managing complex fractions will require a collaborative, committed and focused approach by all stakeholders to address this challenge going forward.

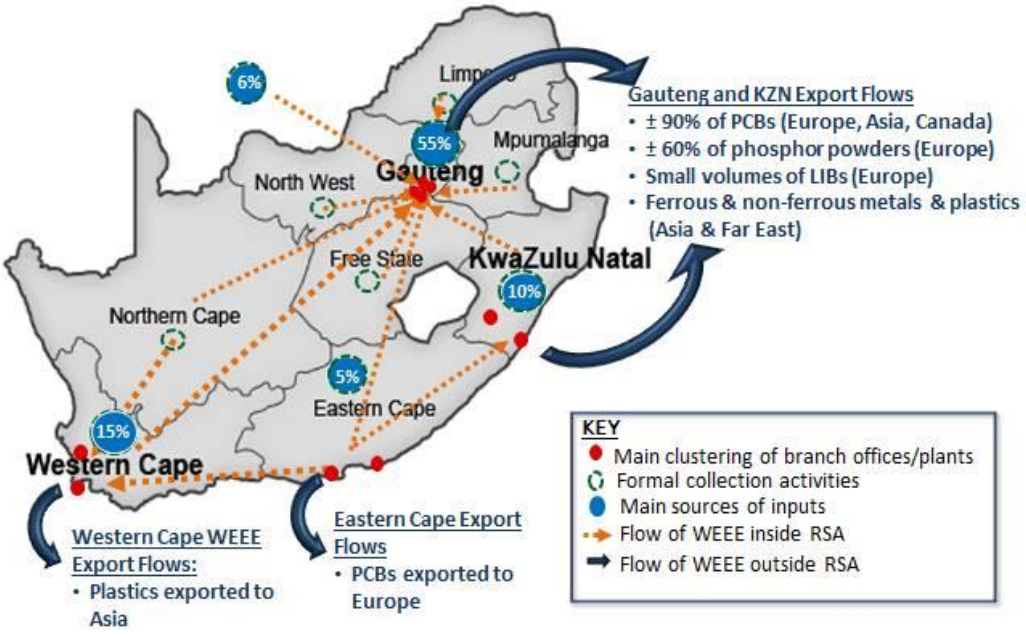
The key findings are presented schematically in the following Figures and Tables. Key recommendations and interventions, based on the findings of this research as well as recommendations put forward by the firms interviewed, are presented in the last Table.

[3] This is equivalent to 23.6% of the estimated 74,923 t of WEEE produced in 2015 (see Section 2.2).

SOUTH AFRICA WEEE TECHNOLOGY ANALYSIS: MAIN FINDINGS

Geographic Scope of WEEE Activities: Inputs & Outputs

(94% of WEEE inputs sourced nationally, 6% from sub-Saharan Africa)



Study sample – 27 firms

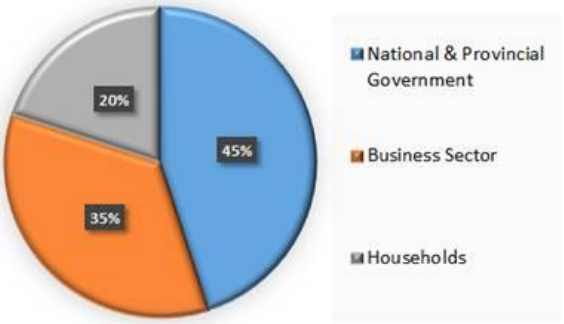
The four stages comprising the South African WEEE value chain

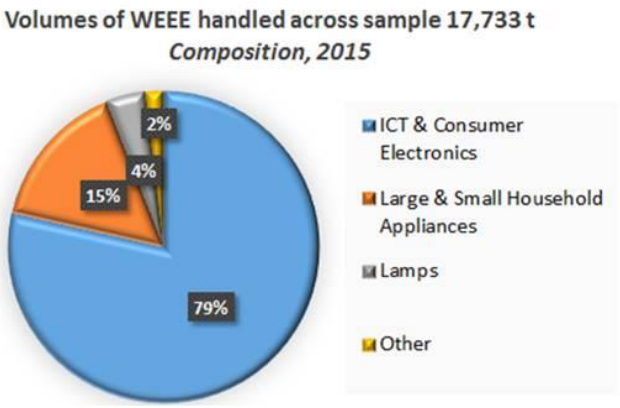
677 people employed in WEEE activities (across 18 firms)
- Dismantling firms = typically 5-25 people employed
- Pre-processing firms = >100 people
- ± 25 jobs/1,000t handled

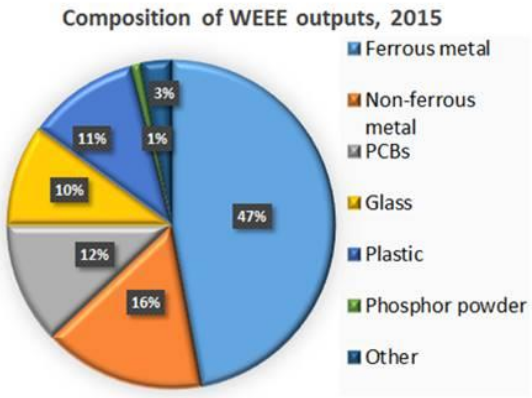
Firm participation across the WEEE value chain

Company	Collection	Dismantling	Pre-processing	Processing
Africa E-Waste	●	◐		
Bolunga Electronic Waste	●	◐		
Cape E-Waste	●	◐		
Computer Scrap Recycling	●	◐		
Desco Electronic Recyclers	●	◐	◐	
Effortless Computer Recycling	●	◐		
Electronic Cemetery	●	◐		
eWaste Africa	●		◐	
E-waste Technologies	●	◐		
Inca Metals	●	◐		
Indalo Resources	●	◐		
Just PC	●	◐		
Javco			◐	
Metrex	●	◐		
Rand Refinery				◐
Reclam	●	◐		
RecLite	●		◐	
SA Metals Group	●	◐	◐	
SA Precious Metals				◐
Sibanye Recycling	●	◐	◐	
Sims Recycling	●	◐	◐	
Sindawonye	●	◐	◐	
SmartMatta (Re-Ethical)	●			
Tshwane Electronic Waste	●	◐		
Universal Recycling Company	●		◐	
Virgin Earth	●	◐		
Waste Plan	●			

Sectoral sources of WEEE in South Africa, 2015







Local and foreign end-user market split for outputs

Company	PCBs	Ferrous Metals	Non-ferrous Metals	Glass	Phosphor Powders	Plastic	Other
Africa E-Waste	PP	PP	PP	▲		PP	
Bolunga Electronic Waste	PP	PP	PP			PP	
Cape E-Waste	PP	PP		PP		PP	
Computer Scrap Recycling	FP	FP	FP			FP	
Desco Electronic Recyclers	FP	PP	PP	PP		FP	▲ FP
Effortless Computer Recycling	PP	PP	PP			PP	
Electronic Cemetery	PP	PP		▲ PP		PP	▲
eWaste Africa	PP	PP	PP	PP	▲	▲	▲
E-waste Technologies Africa	FP	PP	PP			PP	
Inca Metals		PP	PP				
Indalo Resources	PP	PP	PP	▲		PP	
Javco						PP	
Metrex	PP	PP	PP			PP	
New Reclamation Group	FP	PP FP	PP FP	PP		PP	▲ FP
RecLite	PP	PP	PP	PP	FP	PP	FP
SA Metals Group	PP	PP	PP			PP	PP
Sibanye Recycling	PP	PP	PP	▲		PP	FP
Sims Recycling	FP	PP	PP FP	▲		PP FP	
Sindawonye	FP	PP FP	PP FP			PP	▲
SmartMatta (Re-Ethical)	PP	PP	PP			PP	
Tshwane Electronic Waste	PP	PP	PP	PP		PP	
Universal Recycling Company	FP	PP FP	PP FP			▲	
Virgin Earth	PP	PP	PP	▲		FP	▲

Key: PP = Local pre-processor/Processor FP = Foreign Processor ▲ = Landfilled ▲ = Stockpiled

Note: Local Pre-Processors (LP) are predominantly intermediary companies in South Africa that consolidate WEEE fractions, particularly PCBs and plastics produced by small- and medium-sized recyclers, before pre-processing and exporting them to Europe, America and Asia.
Foreign Processors (FP) are integrated smelting, refining and plastics recycling companies in Europe, America and Asia that recover valuable secondary materials from WEEE fractions produced in South Africa.

Key findings from the technology assessment are presented in the table below.

Technology Assessment Criterion	Dismantling Stage	Pre-processing Stage	Processing Stage (Local)
	ICT & Consumer Electronics		
Technologies & equipment currently in use across stage and waste stream	• Done manually using pneumatic or electric screwdrivers, pliers, drills, chisels, hammers and grinders	• Shredders, mills, hammers, grinders and pulverisers • Dense media separators, rotatory magnets and eddy current separators • Water separation tables • Scrubbers	<u>PCBs (shredded or whole)</u> • Completely automated, modular hydrometallurgical process • Pyrometallurgical processing possible in a gold refinery
	Large & Small Household Goods (Including Temperature Exchange Equipment)		

Technology Assessment Criterion	Dismantling Stage	Pre-processing Stage	Processing Stage (Local)
	• Done manually using pneumatic or electric screwdrivers, hammers and chisels, pliers and grinders • De-gassing pumps	• Static and mobile shears, high density ferrous and non-ferrous metal balers • Briquetting machines • Shredders, croppers, grinders, gas cutting equipment, raspers and granulators • Rotatory magnets, eddy current separators, cyclones • Water separation tables • Scrubbers	Ferrous and Non-ferrous Metal • Argon-oxygen decarburisation technology used to recover ferrous metal fractions from scrap metal in foundries • Pyro- and hydrometallurgical processing for non-ferrous metal fractions in smelters and refineries
	Lamps		
	• No dismantling required	• Mechanised lamp crushing, separating and cleaning systems (MRT or Balkan)	Phosphor Powders: • No REE refinement undertaken locally
	Other (e.g. Cables)		
	• Pneumatic or electric screwdrivers, pliers, cable jacket strippers, 'Kevlar' scissors	• Super croppers, croppers, rippers, grinders, granulators and water tables to separate the metallics from the inorganics and contaminants	Plastics • Incinerated or processed further by means of pyrolysis or extrusion Glass • High temperature smelting
Adequacy of current technologies & current capacity utilisation rates	• Equipment is rudimentary but sufficient for current firm requirements • Firms consider it uneconomic to invest in mechanised dismantling or to diversify into automated pre-processing without a significant increase in WEEE volumes received	• Technologies and solutions used to pre-process input WEEE are aligned with international best-practice and considered satisfactory to manage current WEEE streams handled • Most firms operating below capacity (30-50%) due to variable and low volumes.	• Emerging technologies for complete PCB recycling and metal recovery in South Africa. Local refinery operating at current capacity, but can be scaled up if volumes increase. • Local technology solutions lacking for CRT, LIB and temperature exchange equipment recycling – local volumes do not justify the establishment of such plants • Local WEEE plastic and glass cullet market is very small and unpredictable.
Biggest challenges affecting sourcing, operating and implementing technologies	• Low and inconsistent WEEE volumes • Insufficient investment in refurbishment infrastructure and skills development • Regulatory uncertainty, high costs of compliance, and time taken to secure a hazardous waste license • High logistics, transportation and warehousing costs	• Low WEEE collection volumes in South Africa – results in the inability to achieve economies of scale, remain profitable and invest in upgrading and expanding operations • Export restrictions and duties levied on particular WEEE fractions	• Tendency by local pre-processors to export PCBs than to process them locally (due to higher prices received and presence of a captive market for shredded fractions). • Locally-available technology for the hydrometallurgical processing of whole PCBs is available, but is proprietary and will be used solely by the owner. There may be scope for the development of competitive hydrometallurgical technologies by others, but this will likely be a standalone process rather than one capable of co-processing WEEE and other feedstocks. • In the case of the possible pyrometallurgical treatment of PCBs to recover gold, the current smelter can be reconfigured provided there is a consistent supply of feedstock material and that PCBs are incinerated off-site and delivered as ash to the refinery.

Recommendations to address these challenges are presented in the table below.

Recommendation	Potential Impact/s	Responsible Department/ Organisation
Expediting the implementation of the Extended Producer Responsibility (EPR) scheme in WEEE Industry Waste Management Plan	• Regulatory certainty • Establishment of a nation-wide, properly financed WEEE collection scheme and increased WEEE collection volumes • Financing the development of WEEE collection infrastructure to reduce costs and the recycling of negative value products	• Department of Environmental Affairs
Establishment of concessionary funding windows for the mechanisation of the WEEE sector	• Given the low margin nature of the recycling business, government funding support will help to lessen the financial burden/costs associated with mechanising operations	• Department of Trade & Industry, IDC
Removal of restrictions on access to export markets	• Enable recyclers to get full value for WEEE fractions from export markets, rather than compel them to sell to domestic markets	• Department of Trade & Industry

Recommendation	Potential Impact/s	Responsible Department/ Organisation
	where the prices they receive are lower than prevailing international market price • While incentivising the establishment of local markets to attract recyclers to sell locally instead of exporting	
Promoting the use of non-hazardous WEEE plastics in plastics products designed for markets such as plumbing pipes and gutters for low cost houses	• Preferential certification of WEEE plastics products with South African Bureau Standards (SABS)	• Department of Trade & Industry
Incentivising the development of EEE refurbishment infrastructure	• Encouraging the re-use of WEEE, particularly PCs and fridges, which ranks higher than recycling in the waste hierarchy and has the potential to create more jobs than recycling • Capacitating small and medium recycling companies that currently derive 60% of their revenues from refurbishment compared to the 40% from recycling activities	• Department of Environmental Affairs • Department of Trade & Industry
Embarking on greater public awareness campaigns aimed at communicating the benefits of recycling WEEE in order to grow collection volumes	• Reduce the perception of high residual value of WEEE (R1/kg in South Africa) but is free in developed countries	• All stakeholders (government, industry, associations, academia, public) • DEA to champion the clarification of PFMA & MFMA provisions on WEEE
Business and government consider changing business model with respect to EEE ownership, e.g. moving from purchasing to leasing to support greater return of end-of-life products to the value chain	• Reduce the high storage rates of obsolete WEEE in government departments due to issues around assets, security and the PFMA and MFMA provisions	• All stakeholders (government, industry, associations, academia, public)
Creation of a 'one stop shop' for hazardous waste licensing and other compliance requirements for WEEE recyclers	• Regulatory certainty by providing support to the WEEE recycling industry (from a single department or entity) • Issuance of hazardous waste licenses, transport and WEEE export permits under one roof • Timeous finalisation of hazardous waste licenses (currently taking between 2-4 years to be concluded) • Convenience to recycling companies and investors	• Department of Environmental Affairs
Establishment of EEE data management system	• Establish the quantities of EEE put on the market per annum: ○ Imports and exports of WEEE ○ Installed capacity of EEE in government, business and household ○ Average useful lives of EEE ○ Storage & recycling rates of WEEE	• Statistics South Africa
Capacitate and strengthen collaborative R&D work on the processing of complex WEEE fractions, e.g. phosphor powders containing REE, PCBs, plastics and CRTs	• Through uptake of R&D and technologies, unlock resources (and value) back into the economy • Mintek and the universities have already done some exploratory work on the establishment of a refinery for REE in South Africa • Future R&D activities should determine the feasibility of using lamp phosphor powders as one of the alternative secondary source of REE materials in South Africa.	• Department of Science and Technology • Universities • Science Councils • Recycling companies

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