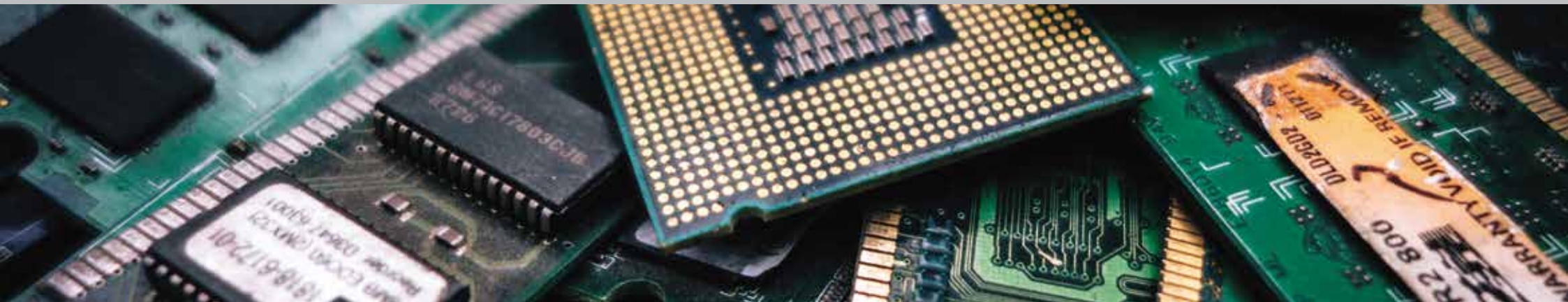


A 10-Year Waste Research Development and Innovation Roadmap for South Africa 2015-2025

2017/18 Annual Progress Report

REFLECTING ON THE THIRD YEAR OF IMPLEMENTATION



science
& technology

Department:
Science and Technology
REPUBLIC OF SOUTH AFRICA

CSIR
our future through science



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FOREWORD BY THE DEPARTMENT OF SCIENCE AND TECHNOLOGY

We have now had the third year of implementation of the Waste RDI Roadmap. The last year was impacted by fiscal constraints limiting the activities that could be carried out, particularly the research and scholarship calls. Despite this financial setback, the team has still obtained significant outputs as detailed in this Third Annual Report.

The DST launched the **Biorefinery Industry Development Facility (BIDF)** that will address the **extraction of economic value** from **organic materials**

THE LAST YEAR HAS also seen an increased interest in the concept of the Circular Economy. This is particularly encouraging for the implementation of the Roadmap, which has been advocating for the Secondary Resources Economy. This represents one aspect of the Circular Economy. Building on the initiatives of the last year the DST is looking to increase evidence through research and development in the area of city cleansing and understanding the management of waste better in the coming financial year. This has further cemented the partnership with the Department of Environmental Affairs (DEA) and a new partner has come on-board for this work, namely, the South African Local Government Association (SALGA). As so elegantly put forward by a colleague from the waste sector, one cannot recycle what hasn't been collected, thus the focus on city cleansing, together with how to improve on separation at source.

that there is potentially R17 billion of resources to be unlocked in the waste sector. The DST also launched the Biorefinery Industry Development Facility (BIDF) that will, in the long run, address the extraction of economic value from organic waste materials.

I would like to thank the Waste Roadmap Implementation Unit located within the CSIR for their continued partnership and leadership in implementing the Waste RDI Roadmap.

Henry Roman

Chief Director (Acting): Sector Innovation and Green Economy

The DST Team:

Dr Henry Roman

Director: Environmental Services and Technologies

Ms Magamase Mange

Deputy Director: Environmental Services and Technologies

An important milestone in addressing the waste economy was reached in this last year, with the DEA undertaking the Chemicals and Waste Phakisa. A central theme to developing the outcomes from the Phakisa was to ensure that what is regarded as waste be regarded as a resource that can contribute to the economy of the country and create the enabling conditions for job creation. Thus building on the findings of the Waste Roadmap Implementation Unit (WRIU)

MESSAGE FROM THE WRIU MANAGER, PROF LINDA GODFREY

2017 has been a difficult year for research and development in South Africa, with less than optimal funding within the national system of innovation. This has directly impacted on the Waste RDI Roadmap, which as a result of reduced budget, was not able to issue an open grant call or scholarship call in 2017 for the 2018 academic year. There were also limited activities due to cost-containment measures, such as no Industry-meets-Science workshop.



From left to right: Ms Magamase Mange (DST), Dr Henry Roman (DST), Prof Linda Godfrey (CSIR)

HOWEVER, in spite of these difficulties, the Roadmap continued to make impact in terms of human capital development, research and development and innovation in South Africa, as this 2017/18 Annual Report outlines.

Despite reduced direct funding to the Waste RDI Roadmap, indirect waste RDI funding within the national system of innovation increased from R28.3m in 2016/17 to R54.6m in 2017/18. This increase in funding was apparent in both public and private sector spending. The bulk of the funding (75%) came from the public sector, either directly from the DST, or via its entities, such as the NRF, TIA and the CSIR. Given the lack of a national RDI monitoring and evaluation system, it is not clear whether this increase reflects a real increase in spending in waste RDI or improved reporting for 2017/18. We suspect that it is a combination of both. Whatever the reason, it is very encouraging to see the additional investment in waste RDI in South Africa, with the Waste RDI Roadmap contributing 13% to the national investment.

To ensure ongoing excellence in waste RDI, management of the portfolio of research grants and post-graduate scholarships has been a strong focus for 2017/18. Two of the 16 grant projects were completed in 2017 and the key findings are provided later in this report.

A large number of post-graduate students (15) also successfully completed their degrees in 2017. Two new targeted grant projects were awarded in 2017/18 for projects starting in 2018. These projects will focus on food waste and the beneficiation of problematic plastic fractions.

The increased local, regional and global awareness of waste and secondary resources management, and the increasing popularity of the Circular Economy as a concept, has provided the Waste RDI Roadmap Implementation Unit the opportunity to play a much stronger science advocacy role in 2017, thus strengthening South Africa's position within the regional and global waste RDI community and supporting knowledge transfer and capacity development.

Initiatives are underway to institutionalise aspects of the Waste RDI Roadmap, through the establishment of Research Chairs in Solid Waste Management. These Chairs, which will align with the Waste & Environment and Waste & Society clusters of the Roadmap, are expected to be launched in 2018.

The work of the Waste RDI Roadmap Implementation Unit would not be possible without strong partnerships. In closing, I would like to thank our stakeholders in government, business and academia for their ongoing support in transforming the South African waste sector through research, development and innovation.

The CSIR Team:

Mr Bongani Memela

Manager: Strategic Initiatives

Prof Linda Godfrey

Manager: Waste Roadmap
Implementation Unit

Ms Marelize Ackerman

Financial Manager

Ms Lulu Makapela

Contract Manager

Mr Beeza Mtamzeli

Communications

The focus for 2017/18 has been on building South Africa's waste research, development and innovation profile in the local, regional and international waste community.



Vision

Development and deployment of performance improvements in waste management has delivered a significant contribution to the strengthening of a sustainable regional secondary resources economy in South Africa.

Mission

This has been achieved by means of a National Waste RDI Programme that supports maximisation of diversion of waste from landfill towards value-adding opportunities, including prevention of waste and the optimised extraction of value from reuse, recycling and recovery, in order to create significant economic, social and environmental benefit.

BACKGROUND AND OBJECTIVES

The Waste RDI Roadmap is an initiative of the Department of Science and Technology (DST) aimed at guiding South Africa's public and private sector investment in waste research, development and innovation (RDI) over the next 10 years (2015-2025).

Background

The DST recognised the role that RDI could play in achieving the objectives of the National Waste Management Strategy, in moving waste up the hierarchy away from landfilling, and in transforming the South African waste sector in a way that could provide environmental, social and economic benefit for the country.

In 2012, the DST, in partnership with the CSIR, embarked on a process to develop the Waste RDI Roadmap. This process, which was shaped by business, industry, government and academia, culminated in early 2015 with the publication of South Africa's first Waste RDI Roadmap.



The Waste RDI Roadmap is available to review online at www.wasteroadmap.co.za.

Objectives

With an investment ask of approximately R3.9 billion over 10 years, the successful implementation of the Roadmap is expected to assist government and industry to significantly increase the diversion of waste away from landfill towards value-adding alternatives, through more effective decision-making; faster insertion of context-appropriate technology; export of know-how and technology; and strengthened RDI capability and capacity.

The Roadmap, which is anchored in the mandate of the DST, is structured around three key pillars –

- human capital development (HCD)
- research and development (R&D)
- innovation (technological and social)

The Roadmap aims to address issues relating to five priority waste streams –

- municipal solid waste
- waste electrical and electronic equipment (WEEE)
- waste plastic
- organic waste
- waste tyres

Within six broad areas, or clusters, of activity –

- strategic planning
- modelling and analytics
- technology solutions
- waste logistics performance
- waste and the environment
- waste and society



HUMAN
CAPITAL
DEVELOPMENT

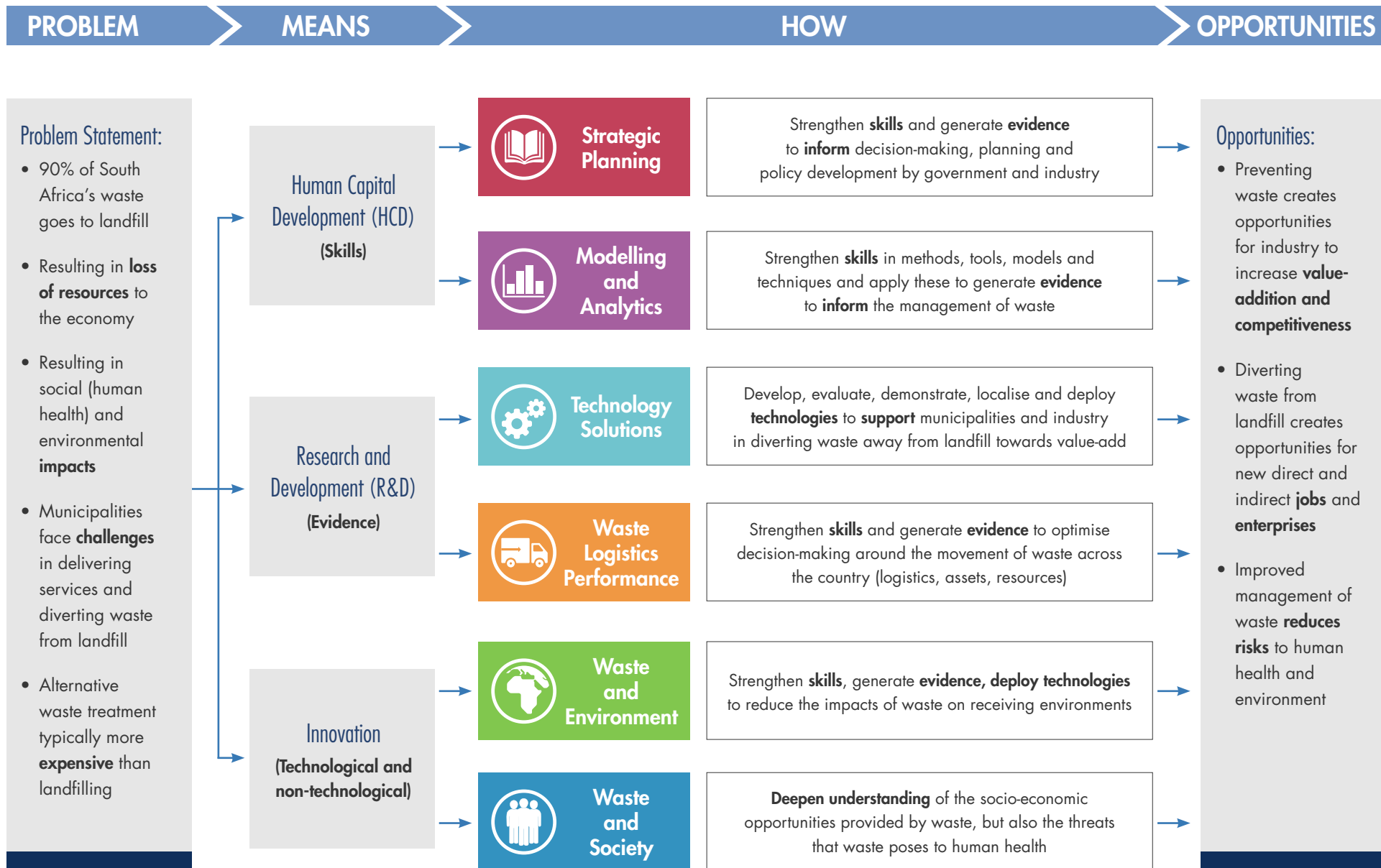


RESEARCH &
DEVELOPMENT



INNOVATION

PICTORIAL SUMMARY OF THE WASTE RDI ROADMAP



KEY FOCUS AREAS AND SERVICE OFFERINGS

Waste RDI Roadmap clusters and percentage of total investment per cluster expected (2015-2025)



Implementation

The CSIR was appointed by the DST to implement the Waste RDI Roadmap from 1 April 2015. The intention is for the CSIR, through the Waste RDI Roadmap Implementation Unit (WRIU), to drive human capital development (HCD), research and development (R&D) and innovation, in partnership with government, industry and academia; and to actively engage opportunities (local and international) for waste RDI collaboration and co-investment.

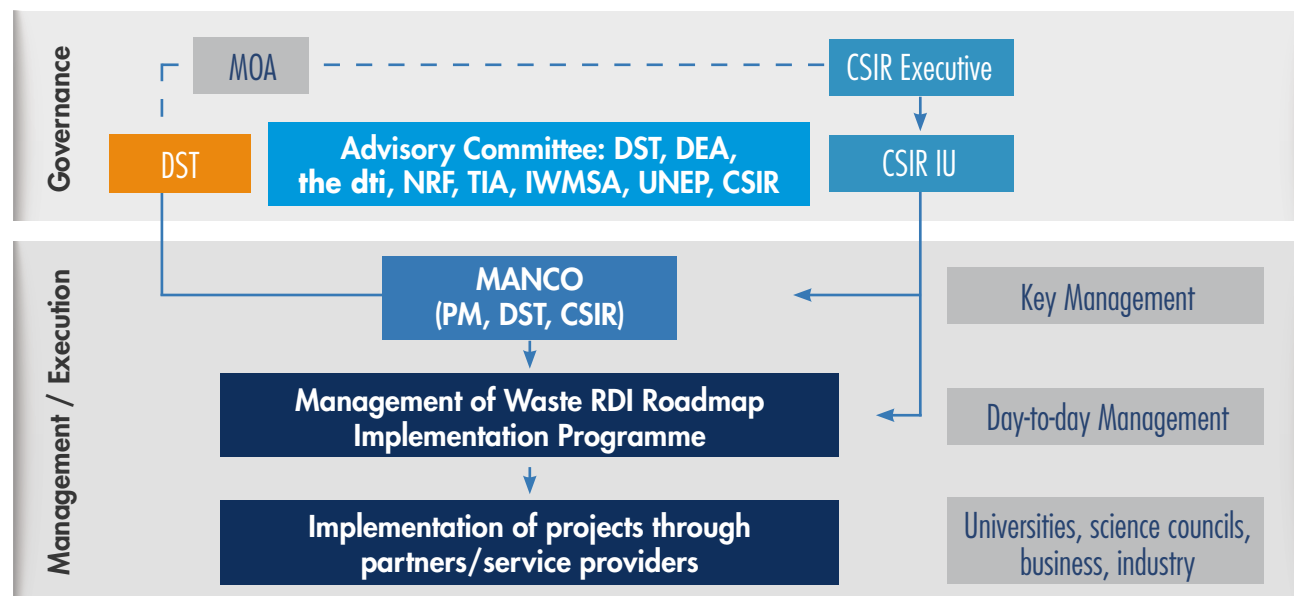
As shown here, the bulk of the Waste RDI Roadmap funding investment is planned for the “Technology Solutions” cluster, but with significant support to the other five clusters.

Human capital development, research and development and innovation continue to be funded in these key focus areas

GOVERNANCE

The Waste RDI Roadmap is implemented by the CSIR's Waste RDI Roadmap Implementation Unit (WRIU) in partnership with the DST, DST entities, other government departments, universities and science councils, business and industry. Effective governance and oversight of activities within the WRIU is fundamental to the Roadmap's implementation.

The Waste RDI Roadmap governance structure is as follows:



The first Steering Committee completed their term in 2017 and the DST would like to thank the members of the Steering Committee for their valuable input during the period 2015-2017. A new Steering Committee has been convened for the period 2018-2020 and includes representatives from:

Sector	Organisation
National Government	Department of Science and Technology, Department of Environmental Affairs, Department of Trade and Industry
R&D and Innovation Agencies	National Research Foundation (NRF), Technology Innovation Agency (TIA), Council for Scientific and Industrial Research (CSIR) (Host)
Waste Sector	Institute of Waste Management South Africa (IWMSA)
Multilateral non-governmental organisation	United Nations Environment Programme (UNEP)
Associations	South African Local Government Association (SALGA)



1 an **Operations Committee**, made up of the DST Director: Environmental Services and Technologies and the WRIU Manager, who meet monthly, or more frequently if required, to discuss operational matters



2 a **Management Committee** (MANCO), made up of senior representatives of the DST and CSIR Implementation Unit, who meet annually, or more frequently if required, to discuss management and oversight issues; and



3 an advisory **Steering Committee**, made up of representatives of government, government entities and the waste sector, who are tasked with reviewing the progress of the WRIU and giving input on the planned activities for the following year.

REFLECTING ON 2017/18

RESEARCH, DEVELOPMENT AND INNOVATION

0 Industry-meets-
Science workshops



59 researchers
supported on
Grant Projects



2
new targeted research
Grant Projects awarded



8
successful
recipient research
institutions
(new and
existing)

54.6
MILLION
RAND

invested in the
national system
of innovation

0 new applications
for RDI grants
(open)

16 research Grant
Projects funded

21.8 MILLION
RAND
of committed funding for new
and ongoing research projects

2.6 MILLION
RAND
of new R&D proposals received



www.wasteroadmap.co.za

HUMAN CAPITAL DEVELOPMENT



9 postgraduate students supported through scholarships

9 scholarships awarded in previous years (ongoing studies)

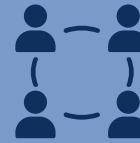
0 new scholarships awarded in 2017/18

15 students studying towards NWU higher degrees in waste management in 2017

9 Honours students enrolled for degree (4 full-time, 5 part-time)



6 Master's students enrolled for degree



4 interns supported through Grant Projects (workplace experience)

41 postgraduate students supported through Grant Projects

15 students successfully completed their degrees

5 Honours students supported through Grant Projects

4 Honours students completed NWU waste management degrees

3 Master's students supported through Grant Projects

2 Master's students supported through Scholarships

1 PhD student supported through Grant Projects

COMMUNICATION IMPACT

POPULAR ARTICLES

10 print articles highlighting the Waste RDI Roadmap

2 radio interviews

24 presentations made



TOP DOWNLOADED PUBLICATIONS

- The economic benefits of moving up the waste hierarchy
- Trends in waste management
- Skills for an Innovative Waste Sector
- South African Waste Sector Survey
- BSc Hon Brochure (North-West University)

WEBSITE



13 903 UNIQUE VISITORS

16 655 NUMBER OF VISITS

37 532 PAGES VISITED

TOP 5 COUNTRIES ACCESSING THE WASTE RDI ROADMAP WEBSITE





HUMAN CAPITAL DEVELOPMENT

Providing a pipeline of qualified post-graduate students into the waste and secondary resources sector with the skills to drive alternative waste treatment and to unlock opportunities

Increasing the supervisory capacity to mentor post-graduate students (honours, master's, doctoral) and post-doctoral researchers

STRENGTHENING SKILLS in waste management is a key priority of the Waste RDI Roadmap. A more capable public and private sector creates a strong foundation on which to transform the South African waste economy.

Building national capacity is achieved through a number of Roadmap instruments –

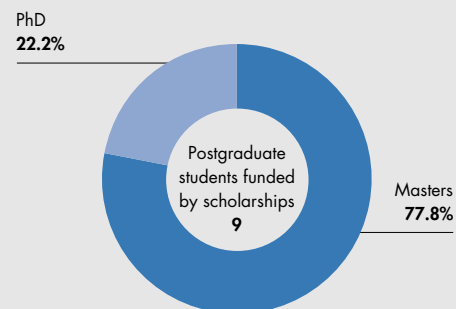
- Direct scholarships for post-graduate students
- Students supported partially or fully through research Grant Projects
- Internships with organisations supported under the Waste RDI Roadmap

Post-graduate scholarships

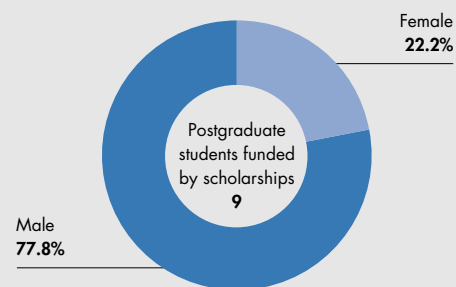
Due to funding constraints in 2017/18, no new post-graduate scholarship call was issued under the Waste RDI Roadmap for the 2018 academic year.

Nine (9) continuing post-graduate students were supported in 2017/18 through scholarships. The majority of these were Masters students distributed across six (6) public research institutions.

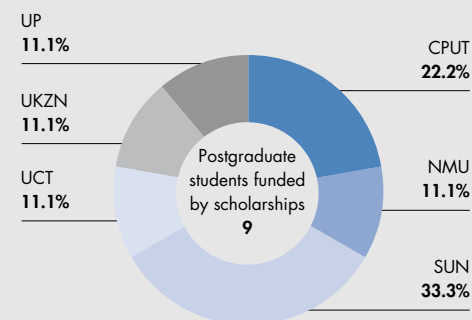
Scholarship funded students (by degree)



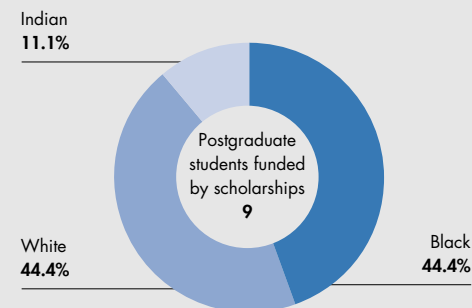
Scholarship funded students (by gender)



Scholarship funded students (by institution)



Scholarship funded students (by race)



In line with the national imperative of **equity** and **redress**, the Waste RDI Roadmap **scholarship programme** prioritised support for **appropriately qualified applicants** from designated groups viz. black and female, while ensuring that only applications that **meet the NRF merit review** and **selection criteria** are supported.

Grant funded post-graduate students

The 16 Waste RDI Roadmap Grant projects funded in 2017/18 supported 41 honours, master's and PhD students (partially or fully). The Grant projects are an important mechanism for building capacity aligned with the Waste RDI Roadmap, in South Africa.

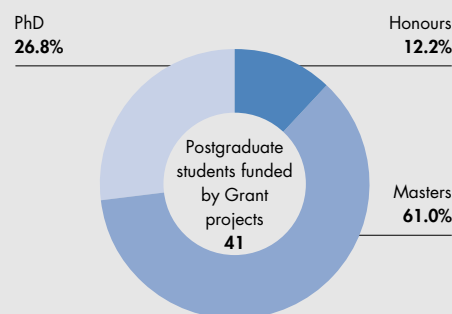
While the Waste RDI Roadmap Scholarship Call is only open to South African citizens and South African permanent residents, the Grant Projects are able to fund any student studying at an accredited public South African Higher Education Institution. In this way, the Waste RDI Roadmap is able to support the strengthening of waste skills not only of South Africans, but of candidates from across Africa and beyond.

In addition to the 26 South African post-graduate students supported on research Grant Projects, an additional 15 students from across Africa were supported financially through the Waste RDI Roadmap. This is further discussed in the section on "Partnerships".

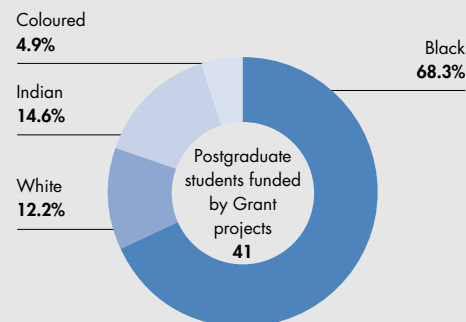
The majority of post-graduate students supported through Grants (46.3%) worked on organic waste and industrial biomass research projects, followed by municipal solid waste (29.3%).

Strengthening skills in waste management is a **key priority** of the Waste RDI Roadmap. A **more capable** public and private sector **creates a strong foundation** on which to **transform** the South African waste economy.

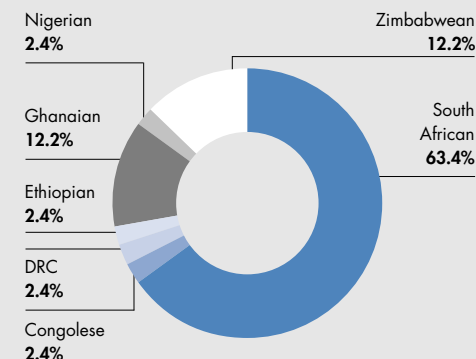
Grant funded students (by degree)



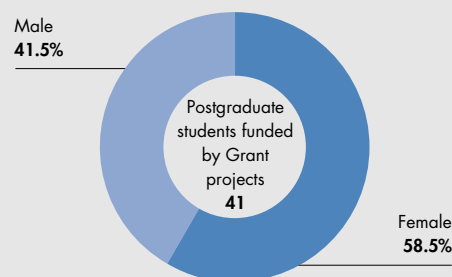
Grant funded students (by race)



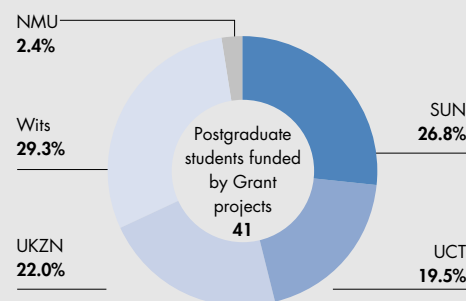
Grant funded students (by nationality)



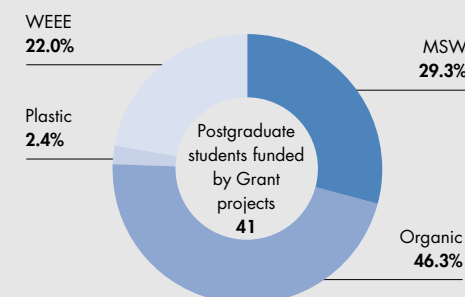
Grant funded students (by gender)



Grant funded students (by institution)



Grant funded students (by priority waste stream)





HUMAN CAPITAL DEVELOPMENT (CONTINUED)

Internships

Four (4) interns were provided with workplace experience at South African Science Councils and Universities in 2017/18. These interns were provided with opportunities to work with established researchers on Waste RDI Roadmap funded Grant projects.

Strengthening post-graduate qualifications

As at the start of the 2017 academic year, 15 students were undertaking coursework post-graduate degrees in waste management. North-West University, through the recently established BSc Honours and Master's Degrees in Environmental Sciences with specialisation in Waste Management, are hosting –

- 9 Honours students (4 full-time and 5 part-time)
- 6 Master's students

Four honours students completed their degrees in waste management and graduated from North-West University at the end of 2017.

The approval of the new Master of Science in Engineering in Waste and Resources Management, to be offered by the University of KwaZulu-Natal, is progressing, and we hope that this new degree will be offered from 2019.

Platforms for learning and knowledge exchange

South Africa has developed considerable expertise in waste and resource management in a developing country context, which is of growing interest to the local, regional and international waste community. The WRIU had the opportunity to share the South African perspective on waste management at a number of events in 2017/18. The rationale for participating in these events includes –

- Showcasing South Africa's waste R&D and Innovation locally and internationally
- Building local and international capacity based on South African learning
- Strengthening local and international partnerships

Creating and participating in platforms for knowledge exchange and learning, are important to achieving the goals of the Roadmap, in particular, strengthening human capital.

South Africa – ILO Partnership

The Department of Science and Technology and the CSIR partnered with the International Labour Organisation's training division (ILO-ITC) to develop training material which was presented at the "Opportunities for green jobs in the waste sector" training programme held in Turin, Italy, in November 2017.



ILO-Page National Green Economy Academy, Johannesburg, South Africa, 2018

The ILO-ITC training programme was attended by 18 participants from government, NGOs and universities based in Iraq, Italy, Mongolia, Nepal, Nigeria, Philippines, Senegal, South Africa, Switzerland and Uruguay.

The WRIU partnered again with the ILO-ITC and UN PAGE for the “National Academy on the Green Economy”, held in Johannesburg, South Africa from the 26 February – 2 March 2018. The Academy provided an opportunity to share the latest thinking on the South African waste sector in the context of a green economy transition, and to build national capacity by training 150 participants from all nine of South Africa’s provinces.

Waste and the Circular Economy

The Circular Economy, as a concept, has gained considerable momentum in the past year, but

there is still limited understanding of what a circular economy means for a developing country such as South Africa. The WRIU was invited to share understanding of the Circular Economy in South Africa and Africa as part of the Luiss University, MBA on the Circular Economy (Rome, Italy) and the University of Leeds “Circular South Cities” workshop (Leeds, UK).

South African Biorefinery Research Platform

The South African Biorefinery Research Platform, developed in 2016/17, remains an important tool for showcasing South Africa’s research in organic waste and industrial biomass beneficiation. The information contained on the Platform was updated in 2017 to ensure that South Africa’s biorefinery research is accurately represented to stakeholders.



Participants of the Circular South Cities Workshop, University of Leeds, UK, 2018



Participants of the DST-CSIR-ILO Green Jobs Training Programme, Turin, Italy, 2017



Key resources on the DST-CSIR-ILO Green Jobs Training Programme, Turin, Italy, 2017



Supporting the generation of new scientific evidence, relevant to South Africa, that will inform policy, planning, decision-making

Supporting the development of new technology and of adapting technology to South African conditions through R&D

RESEARCH AND DEVELOPMENT

Research, Development and Innovation Grants

Due to funding limitations, no Open RDI Grant call was issued in 2017/18.

Grant Projects

The 16 existing Waste RDI Grant Projects awarded to South African universities and science councils were closely monitored over the financial year, through quarterly reporting and annual steering committee meetings.

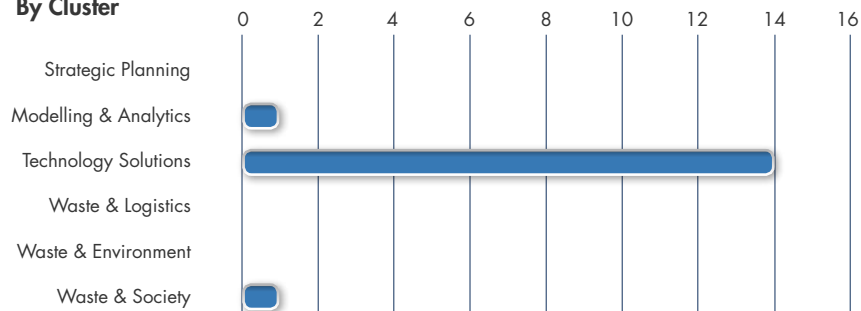
The DST and the Department of Environmental Affairs (DEA) have partnered on the Grant Project held by the University of Witwatersrand (Dr M Samson) on the "integration of the informal sector". In addition to co-funding the research, the DEA is supporting the extension of the research into a set of guidelines for practical integration of informal waste pickers in South Africa, extending the project by an extra month.

The profile of the 16 Grant Projects against the Waste RDI Roadmap clusters and priority waste streams are shown on the right.

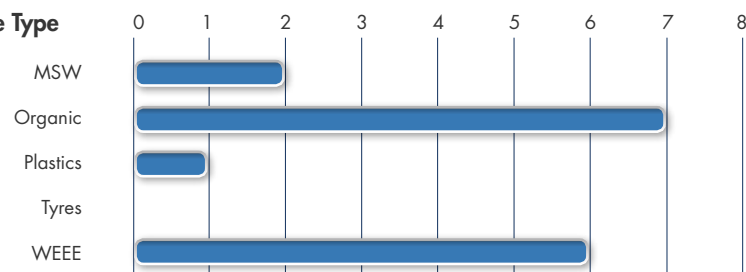
A roadshow will be undertaken during 2018 to better understand why HDI Universities are not applying, or are not successful in their applications, for the Waste RDI Roadmap research grants.

Thematic spread of R&D Grant Projects

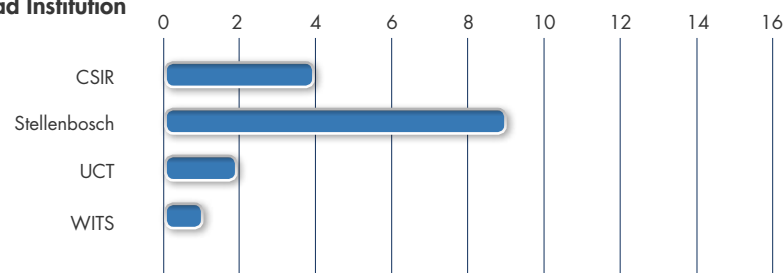
By Cluster



By Waste Type



By Lead Institution



Completed Grant Projects

Two Grant Projects were completed during the 2017/18 financial year. A summary of the outcomes of these Grant projects is provided in **Annexure 1**. The final deliverables have been made available on the Roadmap website.

Completed projects include –

- Decision Support Tool for Implementing Municipal Waste Separation at Source (A Nahman, CSIR)
- Amino acid leaching of metals from printed circuit board waste (C Dorfling, Stellenbosch University)

Grant Project deliverables

The 16 Grant Projects have produced a number of deliverables during the 2017/18 financial year, including amongst others, post-graduate dissertations, journal papers, technical reports, conference papers and briefing notes. A summary of the deliverables is provided in **Annexure 2** and summarised in the section “Waste RDI Outputs”.

“Two Grant Projects were successfully completed during the 2017/18 financial year.”



Steering Committee meeting with Grant Holder Dr M Samson, University of Witwatersrand – accompanied by post-graduate students



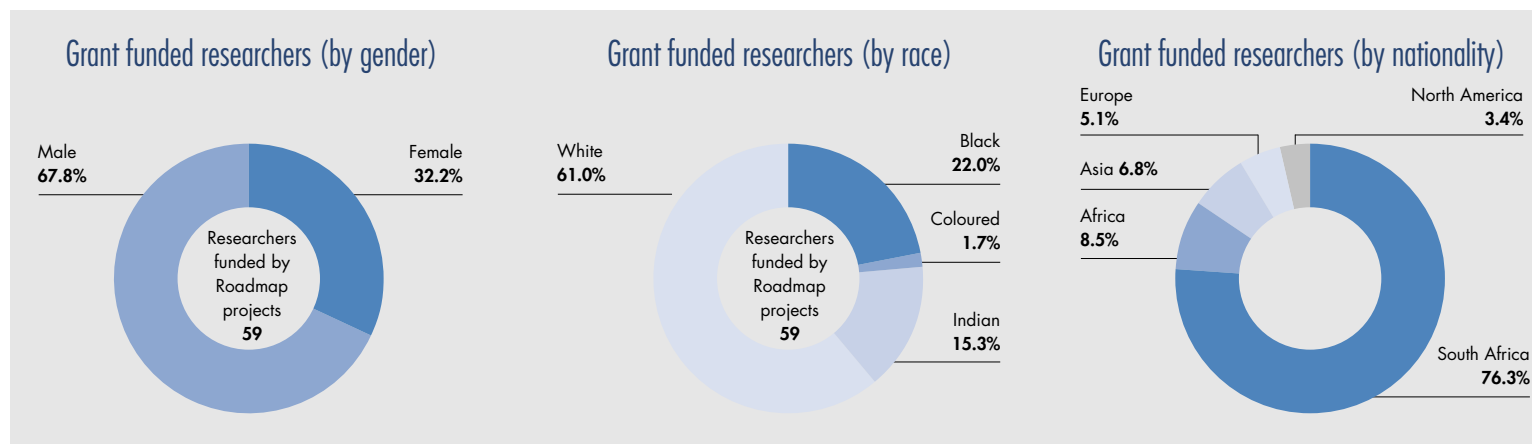
Steering Committee meeting with Grant Holder Prof. S Harrison, University of Cape Town – accompanied by post-graduate students



Steering Committee meeting with Grant Holder Prof. S Harrison, University of Cape Town – accompanied by post-graduate students



RESEARCH AND DEVELOPMENT (CONTINUED)



Profile of research teams on projects

The 16 Waste RDI Grants provided funding support to 59 researchers (non-unique) at five research institutions across South Africa in 2017/18.

As with the post-graduate students, researchers supported on the Grant Projects stem predominantly from South Africa (76%), but also from other African countries, Europe, Asia and North America. This is very encouraging for the South African waste sector. Not only is the Roadmap helping to build international capability and networks, but it is also ensuring that new ideas are introduced into the South African research community.

Targeted Grant projects

The Waste RDI Roadmap also engaged with South African researchers on two targeted research projects, approved by the DST in 2017. These projects will focus on –

- Increasing reliable scientific data and information on food losses and waste in South Africa
- Innovative solutions for dealing with problematic plastics waste fractions

The projects, which will commence in 2018/19, will vary in length from 10 months to 3 years.

SARChI Research Chairs

Institutionalising the Waste RDI Roadmap is a key part to achieving the objectives of the Roadmap.

The South African Research Chairs Initiative (SARChI) was established in 2006 by the DST as a strategic, national government intervention designed to attract and retain excellence in research and innovation at South African Universities, Science Councils and National Research Facilities. In particular, the funding

instrument is aimed at increasing scientific research capacity through the development of human capacity and stimulating the generation of new knowledge.

SARChI is designed to significantly expand the scientific research base of South Africa in a way that supports implementation of the national Research and Development policies. The funding instrument has been successful in retaining leading South African scientists in the university system and attracting leading foreign researchers and expatriate researchers to South Africa.

To this effect, the WRIU signed a Memorandum of Agreement with the National Research Foundation (NRF) in June 2017 to co-fund the establishment of the first two SARChI Research Chairs in solid waste management in South Africa.



The SARCHI Call was issued by the NRF in July 2017 for the two research chairs –

- Waste & Climate
- Waste & Society

As at the closing date of 23 August 2017, a total of 13 applications had been received. The applications were evaluated by an external panel in January 2018 and recommendations were made to the DST for consideration. Contracting with the recommended applicants is being finalised, and the two SARCHI Chairs will be announced in 2018.

The two chairs will give effect to two of the Waste RDI Roadmap clusters – Waste & Environment (Climate) and Waste & Society. In this way, the chairs will be instrumental in developing the portfolio of research and capability within these two Roadmap clusters.

The Research Chair in Waste and Climate will develop and implement a research programme that delivers evidence to support the improved understanding of the –

- Climate impacts associated with the generation and disposal of waste in South Africa;

- Measures (including technologies) to mitigate these impacts; and
- The impact of climate change on the waste sector.

The Research Chair in Waste and Society will develop and implement a research programme that delivers evidence to support the improved understanding of the –

- Opportunities to create jobs and improve livelihoods through the transition away from landfilling in South Africa;
- Business models to support a secondary resources economy, with a particular focus on SMMEs; and
- Required behaviour change to drive the transition away from landfilling, including appropriate behaviour change interventions such as awareness and communication strategies for South Africa as a developing country.

The SARCHI Chairs also play an important role in leveraging new public and private sector research funding into the South African National System of Innovation.

The **two new SARCHI chairs** will give effect to **two** of the Waste RDI Roadmap **clusters** – **Waste & Environment (Climate)** and **Waste & Society**. In this way, the chairs will be **instrumental** in **developing** the portfolio of **research** and **capability** within these two Roadmap clusters.





PARTNERSHIPS

“Waste research, development and innovation cannot, on its own, transform the waste sector. The Roadmap is one mechanism being implemented by government, through the Department of Science and Technology, to move waste away from landfilling. To ensure success, the Roadmap must be adopted as part of a suite of public and private sector responses aimed at addressing the challenges currently facing the waste sector”

Government

National government departments are key to ensuring that research outputs support decision-making, policy development and implementation.

As line department responsible for waste, the DEA is an important partner in this regard. Collaboration with DEA during 2017/18 has included –

- Partnering on the University of the Witwatersrand Grant Project on the integration of the informal waste sector. Through this partnership, the research will be taken forward into practical guidelines for integration with the intention of supporting government and industry.
- Invitation to the WRIU to serve in a review/advisory role on current national government waste projects, including policy development
- Participation in the Chemicals and Waste Phakisa, a 5-week delivery programme aimed at facilitating the implementation of the National Development Plan, with the ultimate goal of boosting economic growth and creating jobs. The alignment between the Waste RDI Roadmap and the outcomes of the Phakisa are noticeable, in particular, the identified priority waste streams and associated opportunities for valorisation.

The DEA and **the dti**, two key partner departments, both serve on the Roadmap Steering Committee.

Academia

Universities and Science Councils are at the heart of the Waste RDI Roadmap, undertaking much of the RDI necessary to successfully redirect waste away from landfill. The response of academia to the Waste RDI Roadmap Calls remains encouraging.



During 2017/18, staff from the WRIU have driven and participated in –



- Activities that have directly increased waste RDI collaboration with the private sector;
- Provided technical advisory support to government and industry; and
- Collaborated in the international waste RDI arena,
 - in support of showcasing South Africa’s waste RDI, and
 - in ensuring that intelligence is brought back in support of the Waste RDI Roadmap implementation..

This has included active engagement with, and specialist advisory support to –



South Africa –

- Department of Environmental Affairs
- Department of Trade and Industry
- Plastics and packaging sector (including PETCO, Packaging | SA, Plastics | SA, Sustainability Council)
- WEEE sector (including eWASA, SAEWA)
- Various provincial green economy, innovation and green skills forums

Regional –

- United Nations Environment Programme (UNEP) – Africa Waste Management Outlook



International –

- European Commission
- International Solid Waste Association (ISWA)
- United Nations International Labour Organization (ILO)
- United Nations Environment Programme (UNEP)

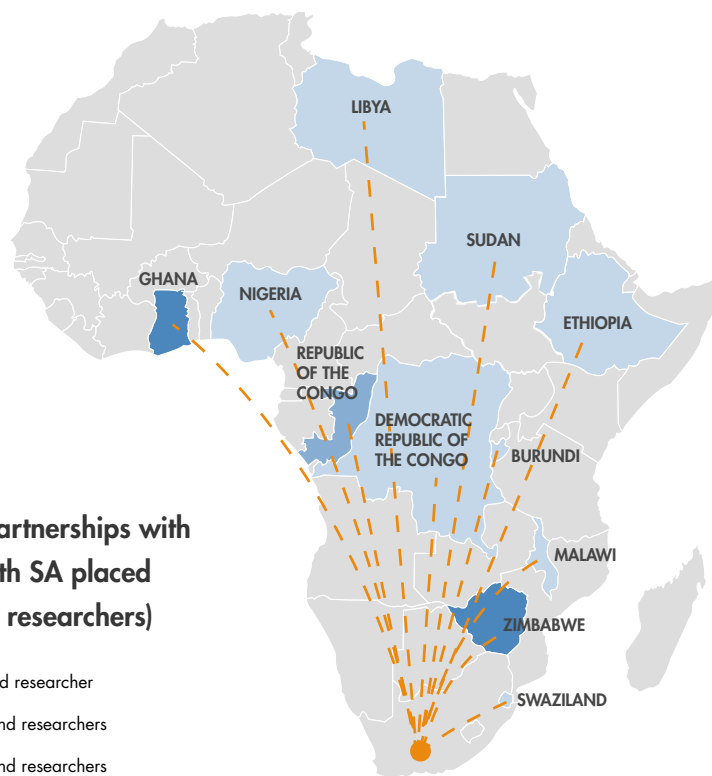
Africa

As noted in the sections on *grant funded post-graduate students* and *grant funded researchers*, a number of students (15) and researchers (5) from other African countries are being provided with the opportunity to build their capacity through Waste RDI Roadmap research projects. These students and researchers, who are currently studying and working at South African universities and

science councils, are financially supported through the South African Waste RDI Roadmap. These students and researchers provide a network of potential research partnerships with their respective countries. However, it is important to ensure that regional and international funding support is available to nurture and grow these new African research partnerships going forward (e.g. African Union, SADC, NRF, etc.).

Existing waste RDI partnerships with African countries (with SA placed African students and researchers)

- 1 post-graduate student and researcher
- 2 post-graduate students and researchers
- 5 post-graduate students and researchers



International

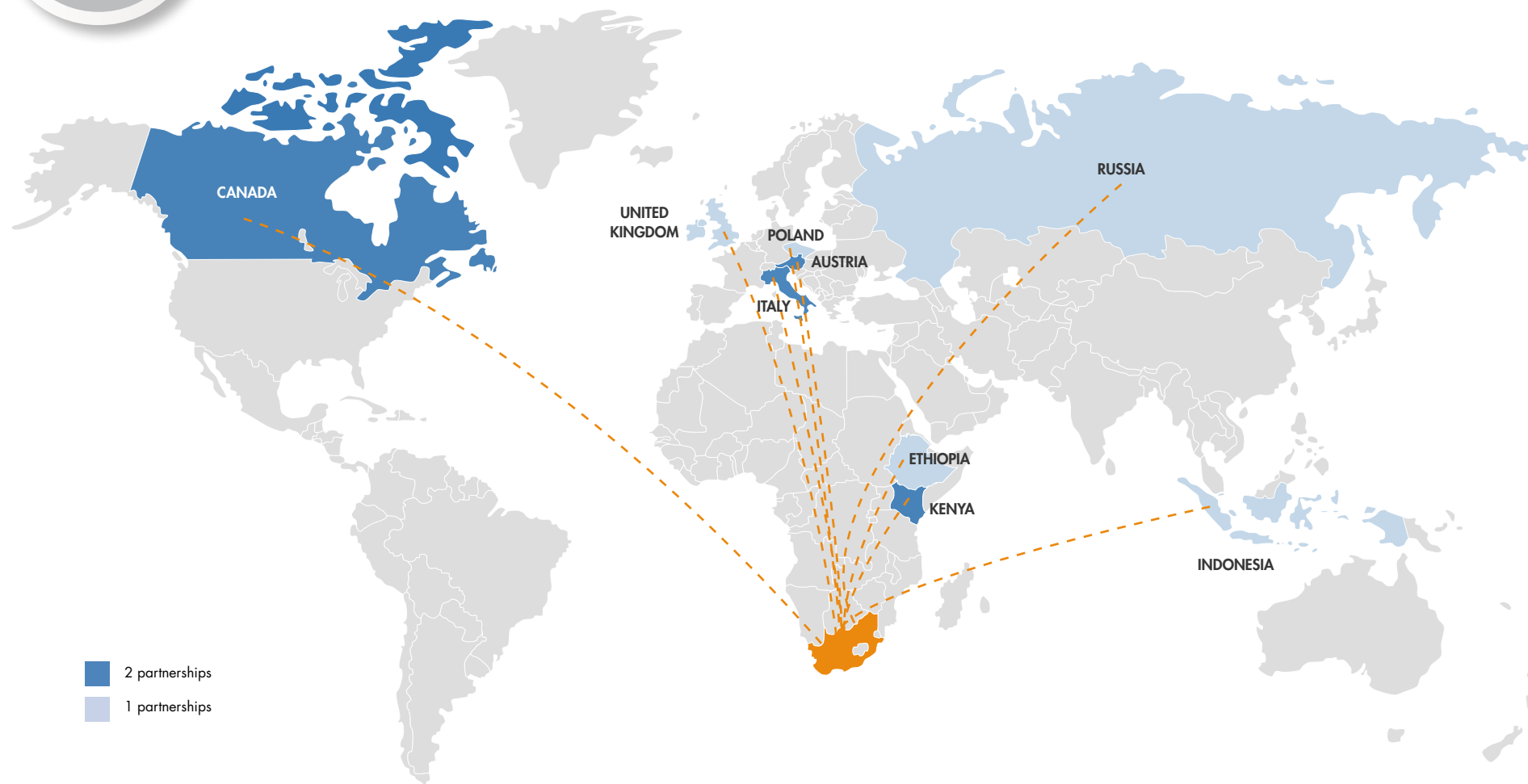
While South Africa has a young, emerging waste and secondary resources research community, the existing local pockets of scientific excellence have already developed partnerships with international research organisations in 28 countries. At least 14 research partnerships in waste management, between South African research institutions and international organisations were active in 2017/18, up from the 11 of 2016/17.

This year saw a diversity of international partnerships from Europe, North America, Africa and Asia. However, international funding to South African research institutions on waste-related research projects remains a small percentage of the current investment in waste RDI. Based on information provided by researchers (incomplete), only around R3.9m (7.1%) of the R54.6m funding support for waste RDI in 2017/18, came from international funding sources (See *Section on Investment*). The exclusion of waste and secondary resources management as a priority research area in South African bilateral research programmes remains problematic to unlocking greater international research funding to the South African research community.



PARTNERSHIPS (CONTINUED)

South Africa-international waste RDI partnerships active in 2017/18



At least **14 research partnerships** in waste management, between South African research institutions and international organisations **were active in 2017/18**.

In addition to direct research collaboration, the WRIU has also developed and strengthened international partnerships in 2017/18 in support of the Roadmap. These include –

South Africa – European Union

The European Union and member states have been an important partner for South African waste RDI for many years. Recent activities include –

- Providing technical input to the drafting of the discussion document prepared in support of the EU Delegation visit to South Africa in May 2017 on the Circular Economy.
- Invitation to Prof Godfrey to give an opening presentation on the “Circular Economy in South Africa” at the South Africa – EU Dialogue on Sustainability Transition: *The Role of Circular Economy* seminar, held in Durban on the 4 May 2017.
- Invitation to Prof Godfrey to participate in the Flanders Inspires International Visitors Programme, a five-day study tour held from the 24-28 April 2017. The group of 8 delegates from partner countries of Flanders, included representatives from South Africa (2), India (2), Germany (1), Czech Republic (1), Singapore (1) and Latvia (1)

South Africa – IETC Partnership

The WRIU was invited by the United Nations Environment Programme’s International Environmental Technology Centre (UNEP-IETC) to participate in the “Global Dialogue on Technology for Resilient Cities”, held in Osaka, Japan, in October 2017. The workshop highlighted the emphasis being placed on organic waste

beneficiation, including industrial biomass, by Asia-Pacific countries. Numerous opportunities for sharing of information between South Africa and Asia-Pacific countries exist, particularly in the valorisation of biomass.

South Africa – UNEP Partnership

The WRIU partnered with UNEP to provide support as coordinating lead author and editor of the first Waste Management Outlook for Africa (to be published in 2018). The Outlook provided an opportunity to present waste evidence for the continent, and highlight social and technological waste innovations emerging in Africa, including in South Africa. For this reason, the Africa Waste Management Outlook was partly funded by the South African Department of Science and Technology.

While developed countries are grappling with issues of zero waste, the circular economy, and the impact of the 4th Industrial Revolution on the waste sector, developing countries are still grappling with basic waste management challenges such as inadequate access to waste services, uncontrolled dumping and open burning. It was therefore important for the WRIU to actively participate in the development of the UNEP Global Environment Outlook GEO-6 in 2017/18, to ensure that the waste issues facing developing countries are not overlooked by decision-makers.

Prof Godfrey was one of a team of five scientists, who worked on the Chemicals and Waste Sections of the Geo-6 Global Environment Outlook. The team included specialists from Argentina, Chile, Italy, Jordan and South Africa.



Participants of the UN IETC, Global Dialogue on Technology for Resilient Cities, Japan, 2017



Authors meeting, Africa Waste Management Outlook, Nairobi, Kenya, 2017



Geo-6 Waste and Chemical Authors – (left to right) Mr Savino (Argentina), Prof Godfrey (South Africa), Prof Barra (Chile), Dr Armiento (Italy), Ms Halalsheh (Jordan)



PARTNERSHIPS (CONTINUED)



Participants of the South Africa – Norway Marine Waste Workshop, Pretoria, 2017

“A partnership between government departments allows us to achieve the goals set out in national policy, while addressing issues of environmental protection, economic development, and technological and social innovation in a more holistic and integrated manner”

South Africa – Norway Partnership

The WRIU hosted the “Combating Marine Waste Workshop” held in Pretoria, South Africa on the 7 December 2017, as part of the South Africa-Norway Science Week 2017. The workshop, which was initiated by Innovation Norway, was aimed at supporting local government in implementing solutions; identifying business approaches and solutions to waste management; evidence for sound decision-making; capacity building and awareness raising.

The workshop provided a platform for group discussion in the areas of –

- Data and research needs and opportunities
- Waste from sea
- Actions to support un-serviced areas (with high levels of open dumping)
- Capacity building and education



Launch of the “Women-of-Waste” global initiative at ISWA2017 Conference, Baltimore, USA, 2017

Focus area 1, data and research needs for evidencing the marine litter debate in Southern Africa, is of particular interest to the Waste RDI Roadmap, since it speaks directly to two of the priority waste streams of the Roadmap – plastic waste and municipal solid waste.

South Africa – ISWA Partnership

The WRIU is providing support to the International Solid Waste Association (ISWA) as they engage with national and provincial governments in closing the world’s 50 largest dump sites, three (3) of which are in South Africa.

The WRIU also partnered with ISWA in a panel discussion on transitioning from open dumping to sanitary landfilling, held at the IFAT Africa 2017 Trade Fair for Water, Sewage, Refuse and Recycling, Johannesburg, on 12-14 September 2017.

The WRIU participated in the ISWA 2017 World Congress, held in Baltimore, USA in September 2017 – in particular, in the UNEP regional waste management outlook session, providing key findings on the Africa Waste Management Outlook.

Transformation of the waste sector is important to the Waste RDI Roadmap, as shown in this report. The WRIU partnered with ISWA on an international research project aimed at mapping the role of women in the waste sector. This was conducted as part of the Women-of-Waste (WOW) initiative. The collaborative research project, between the CSIR and organisations in Europe and North America, has been established to provide a baseline of women working in the waste sector globally. The results will be published in 2018.

WASTE RDI OUTPUTS

THE IMPACT that the Waste RDI Roadmap aims to achieve is to support the improved management of waste and the increased diversion of waste away from landfill towards alternative waste treatment technologies, thereby maximising the potential environmental, social and economic benefits. In support of this goal, the Waste RDI Roadmap committed to the following research, development and innovation outputs over the next 10 years, if fully supported financially –

		Target	Supported ⁽¹⁾	Completed ⁽²⁾
Human Capital Development	Post Docs	65	0	
	PhDs	165	13	1
	Masters	245	32	5
Knowledge Generation	Registered patents	25	–	–
	Patent applications	70	–	–
	Publications	590	–	9
Technology Development	Products and services to market	4	–	–
	Technology packages	20	–	–
	Prototypes	60	–	–

⁽¹⁾ These students are at various stages of completion but have not graduated with their degrees

⁽²⁾ Students who successfully completed their degrees are also counted under “supported”

A total of 45 Masters and PhD students were supported in 2017/18 under the WRIU, 9 students through scholarships and 36 students through grant projects. In addition, 5 Honours students were supported.

A total of 15 students successfully completed their degrees in 2017/18. This included 5 Masters students (through grant and scholarship funding) and 1 PhD student. In addition, 9 Honours students completed their degrees. These figures exclude students funded through other funding mechanisms, such as the NRF (unavailable).

Other key indicators of impact include: increased investment in waste RDI (See Section on Investment), and increased waste RDI collaboration between the South African research community and the private waste and secondary resources sector.

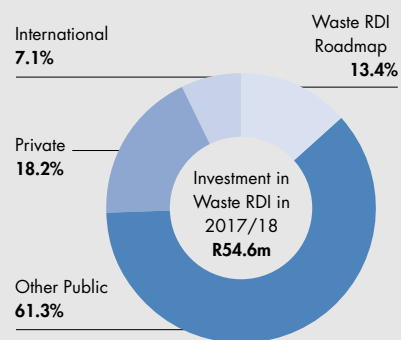
While it is too soon to measure the impact of most Roadmap outputs after only three years of implementation, the WRIU has seeded activities that will produce RDI outputs in line with the knowledge generation and technology development targets.



INVESTMENT IN WASTE RDI IN SOUTH AFRICA

Currently, there is no single mechanism (information system) to extract data on the investment being made in waste RDI in the South African national system of innovation (NSI). As such, the following information on Waste RDI Investment for 2017/18 was collected by means of a questionnaire sent to researchers working in public research institutions in South Africa. Therefore, the data reported here is susceptible to weaknesses in reporting by researchers. The financial figures presented here should be seen as a minimum spend, with a high degree of uncertainty.

Investment in Waste RDI in 2017/18



It is estimated that at least R54.6 million was invested in Waste RDI in South Africa in 2017/18, a significant increase from the R28.3m of 2016/17. This increase in waste RDI funding is likely to be a combination of new funding and improved reporting in 2017/18. Approximately 13.4% of the 2017/18 funding was directly through the Waste RDI Roadmap, while more than half (61.3%) was through other public sector funding. Of the public sector funding, approximately 47.3% was from DST and its entities, including NRF (11.6%), DST (7.2%), TIA (3.0%), and Parliamentary Grant (25.6%). An estimated 42.4% of the total waste RDI funding for 2017/18 therefore came from the DST either directly or indirectly.

Private sector RDI funding increased from 6.6% in 2016/17 to 18.2% of funding in 2017/18. This was an increase from R1.9m in 2016/17 to R9.9m in 2017/18. Approximately 33.3% of the private sector funding was from the sugar and paper and pulp sectors in support of industrial biomass beneficiation.

While the Rand-value of international funding increased slightly from 2016/17 to 2017/18, as a percentage of total funding, it decreased from 8.4% in 2016/17 to 7.1% in 2017/18. International funding to South African researchers remains a small component of waste RDI funding. Measures to support South African researchers in international research collaboration needs to be strengthened.

FINANCIAL STATEMENT

The 2017/18 financial investment in the Waste RDI Roadmap was down from the 2016/17 financial year, resulting in no new scholarship or grant calls for 2017/18. The budget also remains significantly below that outlined in the Waste RDI Roadmap. This has a direct bearing on the extent and magnitude of activities of the Roadmap.

All financial figures are exclusive of VAT.

REVENUE	2017/18	2016/17
DST seed funding	15 002 178.47	16 355 427.09
Other revenue	80 000.00	0.00
Total Revenue	15 082 178.47	16 355 427.09
EXPENSES		
Communications	23 800.00	51 586.58
Consultants	0.00	0.00
CSIR Project Management Unit	1 617 256.82	2 181 307.61
Non-recoverable innovation grants	0.00	365 442.00
Non-recoverable R&D grants	5 574 390.38	4 548 955.97
Targeted RDI projects	0.00	680 398.00
Postgraduate scholarships	0.00	930 000.00
Travelling	92 322.39	98 615.18
Workshops and general running	0.00	9 624.85
Total Expenses	7 307 769.59	8 865 930.19
Income for continuing operations ⁽¹⁾	7 774 408.88	7 489 496.90
Net Income	0.00	0.00

Notes to financial statement:

(1) Income for continuing operations is committed funding for grant projects awarded in 2015/16 and 2016/17, for which disbursements will be made in the 2018/19 and 2019/20 financial years.

THE OUTLOOK FOR 2018/19

South Africa, like most emerging economies, faces a difficult economic climate for the foreseeable future, with government and business cutting back on expenditure. This has a direct impact on the country's ability to invest in waste RDI, despite the social, economic and environmental benefits that can be realised when diverting waste away from landfill towards prevention, reuse, recycling and recovery.

The focus for the coming financial year therefore remains firmly on –

- Implementation of the two new SARCHI Research Chairs
- New Grant call on municipal solid waste (partnering with DEA and SALGA)
- Closely monitoring currently funded post-graduate studies and research projects to ensure maximum impact through this first phase of investment.
- Increasing national activity in waste RDI through industry and government partnerships
- Ensuring that investments in waste RDI are strategic, and research outputs are relevant, thereby increasing impact and supporting uptake by local and regional partners
- Raising the profile of the Waste RDI Roadmap with South African universities
- Strengthening capacity in South Africa through the sharing of information
- Increasing waste RDI collaboration between South Africa and Africa, and other key international partners
- Profiling South Africa's waste activities and waste RDI internationally
- Strengthening the investment in local waste RDI through, among others, country-to-country bilateral agreements and industry partnerships
- Supporting local government in the evaluation and demonstration of alternative waste treatment technologies through the establishment of a Waste Innovation Centre

An exciting opportunity for 2018/19 will be the launch of the first two SARCHI Research Chairs in solid waste management in South Africa. The Chairs will be part of the portfolio of Research Chairs managed by the NRF on behalf of the DST.

If the opportunity for new funding arises, the WRIU will continue to implement –

- Calls for post-graduate scholarships
- Calls for R&D and innovation grants
- Targeted requests for proposals

Our sights remain firmly on achieving the vision and mission of the 10-year Waste RDI Roadmap and the anticipated RDI outputs.



ANNEXURE 1: SUMMARY OF COMPLETED WASTE RDI ROADMAP RESEARCH PROJECTS



Decision support tool for implementing municipal waste separation at source: Incorporating socio-economic and environmental impacts

CSIR, South Africa

PROJECT INFORMATION

Waste Roadmap Instrument: Open Grant Call

Lead Institution: CSIR

Project Leader: Anton Nahman

Research budget: R697 582

Co-investment: CSIR Thematic Funding

Project timeframe: April 2016 - March 2018

Municipalities across South Africa are currently considering the implementation of separation-at-source of recyclable waste as a means of:

- increasing the diversion of waste away from landfill, and
- supporting much needed local job creation and enterprise development

However, implementing separation at source can be costly, especially if the incorrect infrastructure is adopted by a municipality or business.

The CSIR developed a model for comparing the costs and benefits of different options for implementing a separation at source recycling programme. It can be used by municipalities as a decision support tool to identify the most cost-effective option in different suburbs, based on the specific context of each suburb. Version 1 of the

model focused on financial costs and benefits.

The four collection options compared in the model for paper and packaging waste from households include:

- 1 Post-separation at a dirty MRF
- 2 Separate collection of general waste and recyclables in a truck-and-trailer
- 3 Collection of source-separated recyclables in a separate vehicle
- 4 Allowing informal sector to access 'rich bags' of recyclables

Version 2 of the model, funded by the DST under the Waste RDI Roadmap, now incorporates socio-economic and environmental impacts, valued in monetary terms so that they can be included within the economic cost-benefit framework of the model. The following socio-economic and

environmental impacts are now incorporated in the model:

- 1 Impacts of informal collectors on the viability of a separation at source programme
- 2 Impacts on employment and livelihoods
- 3 Additional/avoided emissions from collection and transport
- 4 Avoided social and environmental externalities from landfill disposal
- 5 Landfill airspace savings and increased lifespan

The model can now be used to inform decision-making regarding how best to implement source separation, from an integrated financial, socio-economic and environmental perspective, taking into account their unique circumstances and priorities. Specifically, it allows for an overall net cost or benefit to be calculated for each

collection option. This will allow for trade-offs to be assessed, and for the full range of financial, socio-economic and environmental implications of each option to be directly compared.

Preliminary results suggest that the case for separation at source improves significantly when socio-economic and environmental impacts are considered; while there is also a change in terms of which specific options are more attractive.

The full report is available for download from the Waste RDI Roadmap website
<http://wasteroadmap.co.za>

ANNEXURE 1: SUMMARY OF COMPLETED WASTE RDI ROADMAP RESEARCH PROJECTS



Amino acid leaching process for base and precious metal leaching from printed circuit board waste

Stellenbosch University, South Africa

PROJECT INFORMATION

Waste Roadmap Instrument: Open Grant Call

Lead Institution: Stellenbosch University

Project Leader: Christie Dorfling

Research budget: R349 070

Co-investment: —

Project timeframe: April 2016 - March 2018

The recovery of metals from waste printed circuit boards (PCBs), a key component in electronic equipment, is beneficial from both an environmental and economic perspective. Current hydrometallurgical processing routes utilise strong mineral acids and cyanide or halides, which pose environmental hazards. Amino acids have been proposed as alternative lixiviants with a lower environmental impact. This project aimed to evaluate the applicability of the amino acid leaching process for the dissolution of metals from PCB waste.

Bench-scale leach tests were performed to determine the rate, extent and selectivity of base and precious metal leaching at different conditions. Glycine, the simplest amino acid, was used as lixiviant. The relatively low solubility of copper in the glycine system limited the pulp density during base metal leach tests to 25 g PCBs/L.

When air was used as oxidant, copper dissolution was initially independent of both temperature and glycine concentration. It was suggested that initial copper dissolution in the air system, at 1 M glycine, was limited by oxygen diffusion through the solid-liquid boundary layer. As the reaction progressed, oxygen diffusion through the CuO intermediate was believed to be rate-limiting. Increasing the temperature and glycine concentration in the presence of air, increased the rate of CuO removal through copper-glycine complex formation, which, in turn, reduced the resistance to oxygen diffusion to the reaction surface.

When pure oxygen was used as an oxidant and the temperature was increased from 25°C to 60°C, copper dissolution increased by approximately 50% after 22 hours. Increasing the glycine concentration above 1 M, in the presence of pure oxygen,

had no effect on copper dissolution. 81% copper dissolution was achieved after 22 hours at the optimal conditions of 60°C, 1 M glycine, using pure oxygen as oxidant. At these conditions, co-extraction of gold was 1.3%.

Precious metal leach tests were performed using the residue from the base metal leach tests as feed, with H₂O₂ fed continuously as oxidant. Increasing the temperature (up to 90°C), glycine concentration (0.1 M to 0.5 M) and pH (11.5 to 12.5) had no significant effect on gold extraction, with less than 2% gold dissolution achieved after 96 hours. Further tests were performed on pure gold foils to determine whether the presence of copper in the PCBs inhibited gold dissolution. Leaching from gold foils, however, did not improve gold dissolution and it was concluded that gold leaching with glycine is not technically feasible.

A suggested flowsheet for metal extraction was validated experimentally. Small pilot-scale leach tests were performed at the optimal conditions identified from the bench-scale base metal leach tests (60°C, 1 M glycine, with pure oxygen as oxidant). Due to poor mass transfer of oxygen into solution in the small pilot-scale leach tests, two stages (each with a duration of 41-52 hours) were required to achieve 78% copper dissolution. In a subsequent leaching stage, 38% gold dissolution was achieved after 96 hours, with the addition of 0.04 M NaCN to 0.13 M glycine at 25°C, using air as oxidant. Further optimisation of process variables are required to maximise gold leaching in the glycine-cyanide system.

The full report is available for download from the Waste RDI Roadmap website
<http://wasteroadmap.co.za>

ANNEXURE 2: SUMMARY OF 2017/18 COMPLETED WASTE RDI ROADMAP DELIVERABLES

Grant Holder: M Samson (Wits)

- Chidzongu, T. (2017). *An investigation into the experiences of Zimbabwean migrant reclaimers at Marie Louise Landfill site on Dobson Ville Road, Soweto in South Africa*. Honours dissertation. Johannesburg: University of Witwatersrand.
- Kadyamadare, G. (2017). *Assessment of waste separation at source by residential households as a tool for sustainable waste practices: a case study of the City of Johannesburg*. Masters dissertation. Johannesburg: University of Witwatersrand.
- Maema, K. (2017). *Determining practices and power relations between street reclaimers with a view to how they control their spaces*. Honours dissertation. Johannesburg: University of Witwatersrand.
- Mahlodi, M. (2017). *Walking to eat in the street of Alexandra- Analysing the effects Jozi@work has on street reclaimers*. Honours dissertation. Johannesburg: University of Witwatersrand.
- Mokobane, A. (2017). *Gendered mobility: Investigating how gender influences the physical mobility of four street reclaimers in Johannesburg*. Honours dissertation. Johannesburg: University of Witwatersrand.
- Phakoe, K. (2017). *How organizing influenced reclaimers' understanding of integration and their relationship with Pikitup*. Honours dissertation. Johannesburg: University of Witwatersrand.
- Sekhwela, M. (2017). *The policy and practice of reclaimer integration in the City of Johannesburg*. Masters dissertation. Johannesburg: University of Witwatersrand.

Grant Holder: A Nahman (CSIR)

- Nahman, A., Oelofse, S., Strydom, W., Muswema, A., Matinise, S. and Stafford, W. (2018). *Decision support tool for implementing municipal waste separation at source: Incorporating socio-economic and environmental impacts*. Technical Report. Pretoria: CSIR.

- Nahman, A. (2018). SASCOST Model vs 2.1. Pretoria: CSIR.
- Nahman, A. (2018). *The SASCOST model for assessing costs and benefits of municipal waste separation at source: Version 2: Incorporating socio-economic and environmental impacts*. CSIR Briefing Note, March 2018.

Grant Holder: B Sithole (CSIR)

- Gibril, M.E., Lekha, P., Andrew, J., Sithole, B. and Ramjugernath, D. (2017). *Production of functionalized nano-crystalline cellulose from pulp and paper mill sludge*. Proceedings of the 19th International Symposium on Wood, Fibre and Pulping Chemistry, Porto Seguro, Brazil.
- Lekha, P., Chunilall, V., Andrew, J.E., Gibril, M. and Sithole, B.B. (2017). *Pulp and paper mill sludge: Characterisation of a valuable resource*. Poster presented at the 7th Forest Science Symposium, Pietermaritzburg, South Africa.

Grant Holder: B Sithole (CSIR)

- Tesfaye, T., Sithole, B., Ramjugernath, D. and Chunilall, V. (2017). Valorisation of chicken feathers: Characterisation of physical properties and morphological structure. *Journal of Cleaner Production*, 149 (2017) 349-365.
- Tesfaye, T., Sithole, B., Ramjugernath, D. and Chunilall, V. (2017). Valorisation of chicken feathers: Characterisation of chemical properties. *Waste Management*, 68 (2017): 626-635.
- Tesfaye, T., Sithole, B., Ramjugernath, D. and Chunilall, V. (2017). Valorisation of chicken feathers: Application in paper production. *Journal of Cleaner Production*, 164 (2017): 1324-1331.
- Tesfaye, T., Sithole, B. and Ramjugernath, D. (2017). Valorisation of chicken feathers: A review on recycling and recovery route – current status and future prospects. *Clean Technologies and Environmental Policy*, 19 (10): 2363-2378.
- Tesfaye, T., Sithole, B., Ramjugernath, D. and Ndlela, L.

- (2018). Optimisation of surfactant decontamination and pre-treatment of waste chicken feathers by using response surface methodology. *Waste Management*, 72 (2018): 371-388.

- Tesfaye, T., Sithole, B. and Ramjugernath, D. (2018). Valorisation of waste chicken feathers: Optimisation of decontamination and pre-treatment with bleaching agents using response surface methodology. *Sustainable Chemistry and Pharmacy*, 8 (2018): 21-37.
- Tesfaye, T., Sithole, B. and Ramjugernath, D. (2018). Valorisation of chicken feather barbs: Utilisation in yarn production and technical textile applications. *Sustainable Chemistry and Pharmacy*, 8 (2018): 38-49.
- Tesfaye, T. (2017). Valorisation of waste chicken feathers: Production of high-value materials. Doctoral dissertation. Durban: University of KwaZulu-Natal.
- Tesfaye, T., Sithole, B. and Ramjugernath, D. (2018). Valorisation of chicken feathers: Recycling and recovery routes. Proceedings of the 16th International Waste Management and Landfill Symposium, Sardinia, Italy.

Grant Holder: M John (CSIR)

- Lefatle, M.C. and John, M.J. (2018). Mechanical, Rheological and Viscoelastic Properties of Polysaccharide and Protein Based Aerogels. In: *Biobased Aerogels. Polysaccharide and Protein-based Materials*. Royal Society of Chemistry.
- Naidu, D.S., Hlangothi, S.P. and John, M.J. (2018). Bio-based products from xylan: A review. *Carbohydrate Polymers*, 179 (2018): 28-41.

Grant Holder: C Dorfling (SUN)

- Broeksma, C.P (2017). *Evaluating the applicability of an alkaline amino acid leaching process for base and precious metal leaching from printed circuit board waste*. Masters dissertation. Stellenbosch: University of Stellenbosch.

ANNEXURE 3: WASTE RDI ROADMAP SCHOLARSHIP PORTFOLIO

No	Applicant	Title	Aligned with priority waste	Aligned with cluster	University	Supervisor	Funding instrument	Year awarded
1	Mr JP du Toit	Hydrogen bioproduction from waste glycerol by <i>Rhodopseudomonas palustris</i> immobilized in a transparent PVA cryogel	Organic waste	Technology solutions	SUN	Dr R Pott	Master's scholarship	2016-2017
2	Mr R Nchabereng	The recovery of gold from waste mobile phones printed circuit boards (PCBs) using thiosulphate leaching and copper cementation process	WEEE	Technology solutions	CPUT	Mr M Aziz	Master's scholarship	2016-2017
3	Ms M Nider-Heitmann	Techno-economic analysis and comparison of biorefinery scenarios for the production of succinic acid, itaconic acid and polyhydroxyalkanoates from sugarcane waste	Organic waste	Modelling and analytics	SUN	Prof J Görgens	Master's scholarship	2016-2017
4	Mr G Potgieter	Base metal recovery from glycine leach solutions using Ion exchange and solvent extraction	WEEE	Technology solutions	SUN	Dr C Dorfling	Master's scholarship	2016-2017
5	Mr S Thakur	NGOs and household solid waste management: Assessing the project sustainability of solid waste management practices in Peri-urban areas	Municipal waste	Strategic planning	UKZN	Dr M Hansen and Dr A Nel	Master's scholarship	2016-2017
6	Ms S Candiotes	Gauteng households' definition of food waste as well as their attribution of blame along the South Africa food chain	Organic waste	Waste & Society	UP	Dr N Marx-Pienaar	Master's scholarship	2017-2018
7	Mr A Gada	Development of eco-compatible bio-composites from recycled post-consumer plastic and agricultural biomass	Organic waste	Technology solutions	NMMU	Dr S Muniyasamy	Master's scholarship	2017-2018
8	Mr D Maluleke	Bioleaching as a unit operation for the recovery of copper and other metal of value from WEEE	WEEE	Technology solutions	UCT	Prof S Harrison	Doctoral scholarship	2017-2018
9	Mr S Matebese	Assessing the integration of sustainable waste management principles in dealing with illegal dumping in informal settlements	Municipal waste	Waste & Society	CPUT	V Zungu	Master's scholarship	2017-2018

ANNEXURE 4: WASTE RDI ROADMAP PROJECT PORTFOLIO

No	Applicant	Title	Aligned with priority waste	Aligned with cluster	Principal Investigator	Funding instrument	Funding
2016_1	University of the Witwatersrand	Lessons from waste picker integration initiatives – Development of evidence based guidelines to integrate waste pickers into South African Municipal Waste Management Systems	MSW	Waste & Society	Dr M Samson	Non-recoverable open R&D grant	4/2016 - 3/2019
2016_2	CSIR (NRE)	A Decision Support Tool for Implementing Municipal Waste Separation at Source: Incorporating Socio-economic and Environmental Impacts	MSW	Modelling & Analytics	Mr A Nahman	Non-recoverable open R&D grant	4/2016 - 3/2018
2016_3	CSIR (NRE)	Beneficiation of forestry biomass waste streams	Organic	Technology solutions	Dr B Sithole	Non-recoverable open R&D grant	4/2016 - 3/2019
2016_4	CSIR (NRE)	Valorisation of chicken feathers	Organic	Technology solutions	Dr B Sithole	Non-recoverable open R&D grant	4/2016 - 3/2019
2016_5	CSIR (MSM)	Sustainable utilization and conversion of post-harvest agricultural waste residues into value added materials	Organic	Technology solutions	Dr M John	Non-recoverable open R&D grant	4/2016 - 3/2019
2016_6	University of Cape Town	Value recovery from solid confectionary waste	Organic	Technology solutions	Prof S Harrison	Non-recoverable open R&D grant	4/2016 - 3/2019
2016_7	Stellenbosch University	Reactor design for industrial furfural production from sugar cane agricultural residues	Organic	Technology solutions	Prof J Görgens	Non-recoverable open R&D grant	4/2016 - 3/2018
2017_8	Stellenbosch University	Biogas and volatile fatty acids biorefinery by co-digestion of fruit juice industry solid and liquid wastes with lignocellulosic biomass	Organic	Technology solutions	Prof J Görgens	Non-recoverable open R&D grant	4/2016 - 3/2018
2016_9	Stellenbosch University	Organic waste: a bioresource for production of novel cellulose nanocomposites	Organic	Technology solutions	Dr A Chimphango	Non-recoverable open R&D grant	4/2016 - 3/2019
2016_10	Stellenbosch University	Amino acid leaching of metals from printed circuit board waste	WEEE	Technology solutions	Prof C Dorfling	Non-recoverable open R&D grant	4/2016 - 3/2018

ANNEXURE 4: WASTE RDI ROADMAP PROJECT PORTFOLIO

No	Applicant	Title	Aligned with priority waste	Aligned with cluster	Principal Investigator	Funding instrument	Funding
2016_11	Stellenbosch University	Extraction of value from solid waste by pyrolysis conversion: Pilot scale optimisation	Plastics	Technology solutions	Prof J Görgens	Non-recoverable open innovation grant	4/2016 - 3/2018
2017_12	Stellenbosch University	Recycling rare earth elements from fluorescent lamps	WEEE	Technology solutions	Prof C Dorfling	Non-recoverable open R&D grant	1/2017 - 3/2019
2017_13	University of Cape Town	Integrated process flowsheet for the sequential extraction and recovery of valuable metals from WEEE	WEEE	Technology solutions	Prof S Harrison	Non-recoverable open R&D grant	1/2017 - 3/2020
2017_14	Stellenbosch University	Environmentally friendly lithium ion battery (LIB) recycling process	WEEE	Technology solutions	Dr G Akdogan	Non-recoverable open R&D grant	1/2017 - 3/2019
2017_15	Stellenbosch University	Thermal treatment of printed circuit board waste and its effect on downstream metal recovery processes	WEEE	Technology solutions	Prof C Dorfling	Non-recoverable open R&D grant	1/2017 - 3/2019
2017_16	Stellenbosch University	Use of PCB leach residue as reductant in pyrometallurgical operations	WEEE	Technology solutions	Dr G Akdogan	Non-recoverable open R&D grant	1/2017 - 3/2019

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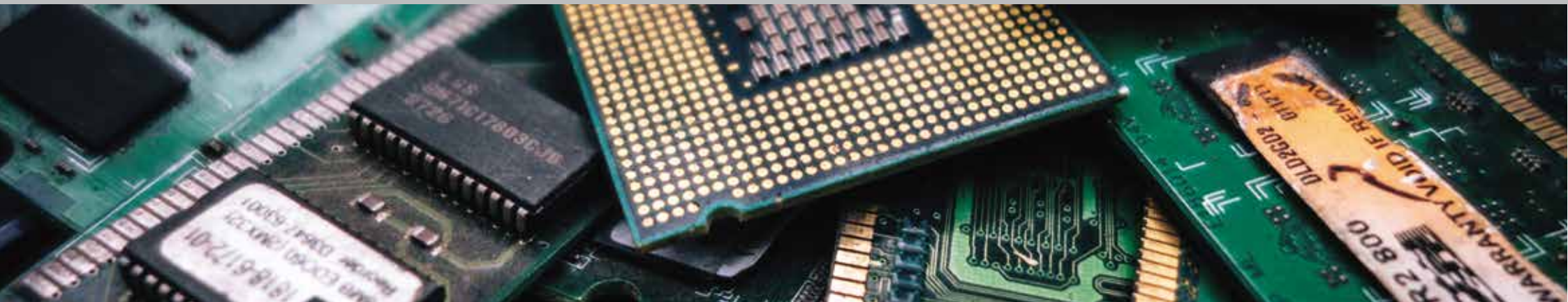
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