

# A WASTE RESEARCH, DEVELOPMENT AND INNOVATION ROADMAP FOR SOUTH AFRICA (2015-2025)

*Towards a secondary resources economy*

Summary report



**science  
& technology**

Department:  
Science and Technology  
**REPUBLIC OF SOUTH AFRICA**



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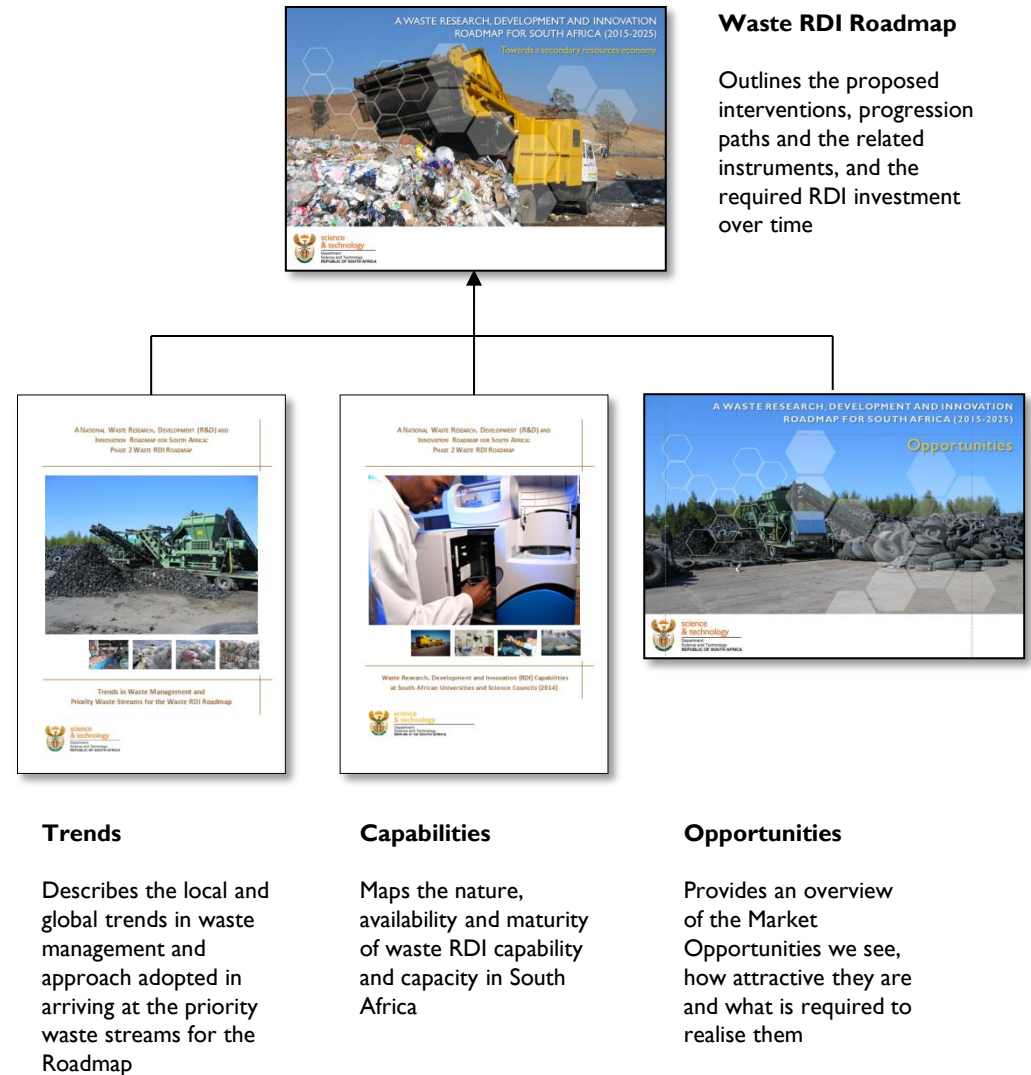
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## Executive Summary

The Waste Research Development and Innovation (RDI) Roadmap presents a structured national approach to waste RDI over the next 10 years, as a means of supporting the implementation of national policy, strategy and planning on waste and secondary resources management in South Africa.

The vision of the Roadmap is that the 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. 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 social, economic, and environmental benefit.

Driven by the potential to create local and regional benefit, the Roadmap presents a sound case for increased public and private investment in Waste RDI.

Developed through a structured process which included extensive participation and valuable input from key stakeholders in industry, government and organisations within the National System of Innovation, the Roadmap provides strategic direction, a set of action-plans and an implementation framework to guide, plan, coordinate and manage South Africa's portfolio investment for the next 10 years in six identified clusters of research, development and innovation activity.

Developing, strengthening and embedding South Africa's waste RDI capability and capacity within and between research institutions, academic institutions, industry and government, will enable the sector to make more effective decisions, insert context-appropriate technologies and create opportunities for the export of know-how and technology into the African continent and beyond.

The strategic clusters which frame the Waste RDI Roadmap (2015-2025), and which will guide RDI and investment, are –

- ▶ **Strategic Planning**

Build and strengthen the basis and application of strategic analysis and advice for the purposes of evidence-based decision-making to inform strategy formulation, planning and its execution and management

- ▶ **Modelling and Analytics**

Develop and use methods, tools, techniques, platforms, systems and frameworks for the analysis, monitoring and evaluation of technical, economic, social and environmental opportunities and impacts associated with secondary resources

- ▶ **Technology Solutions**

Design, development, evaluation, demonstration, localisation and deployment of technologies – both local and inbound - for customer-driven performance improvement

- ▶ **Waste Logistics Performance**

Optimisation of strategic, tactical and operational decision-making in respect of logistics objectives, assets and resources

- ▶ **Waste and Environment**

Strengthen the ability to identify, monitor, evaluate and report on environmental impacts of waste and its management, in order to inform better targeted and more effective responses

- ▶ **Waste and Society**

Deepen understanding of waste-related opportunities and threats, to increase the success of influencing perception and practice positively

## Aligning with National and International Priorities

The Waste Research Development and Innovation (RDI) Roadmap has been developed in support of a number of strategic, national priorities. The successful implementation of this 10-year plan can make a positive and meaningful contribution towards growing and transforming the South African waste sector, and in so doing, contribute towards the fulfilment of the following national strategic objectives. Waste management is also increasingly a shared global issue. In addition to national priorities, the Waste RDI Roadmap provides significant opportunity for international collaboration and investment on shared priorities .

### **National Development Plan (2011)**

- ▶ Creating jobs and livelihoods
- ▶ Expanding infrastructure
- ▶ Transitioning to a low-carbon economy
- ▶ Transforming urban and rural spaces
- ▶ Improving education, training and innovation

### **National Waste Management Strategy (2011)**

- ▶ Promote waste minimisation, re-use, recycling and recovery of waste
- ▶ Ensure the effective and efficient delivery of waste services
- ▶ Grow the contribution of the waste sector to the green economy
- ▶ Ensure that people are aware of the impact of waste on their health, well-being and the environment
- ▶ Achieve integrated waste management planning
- ▶ Ensure sound budgeting and financial management for waste services
- ▶ Provide measures to remediate contaminated land

### **Bio-economy Strategy (2013)**

- ▶ Strengthen solid waste research, development and innovation
- ▶ Develop integrated biorefineries from bio-based feedstocks
- ▶ Agro-processing initiatives

### **Industrial Policy Action Plan (2014/14 – 2016/17)**

- ▶ Contribute to direct and indirect creation of decent jobs
- ▶ Increase value-addition
- ▶ Improve competitiveness in both domestic and export markets

### **Global Change Grand Challenge and Research Plan (2010)**

- ▶ Reducing the human footprint
- ▶ Innovation for Sustainability

### **Green Economy Accord (2011)**

- ▶ Increasing investments in the green economy
- ▶ Procurement of renewable energy as part of the energy generation plan
- ▶ Promotion of biofuels for vehicles
- ▶ Promoting energy efficiency across the economy
- ▶ Waste recycling
- ▶ Economic development in the green economy through promotion of localisation, youth employment, cooperatives and skills development

### **National Climate Change Response Strategy (2011)**

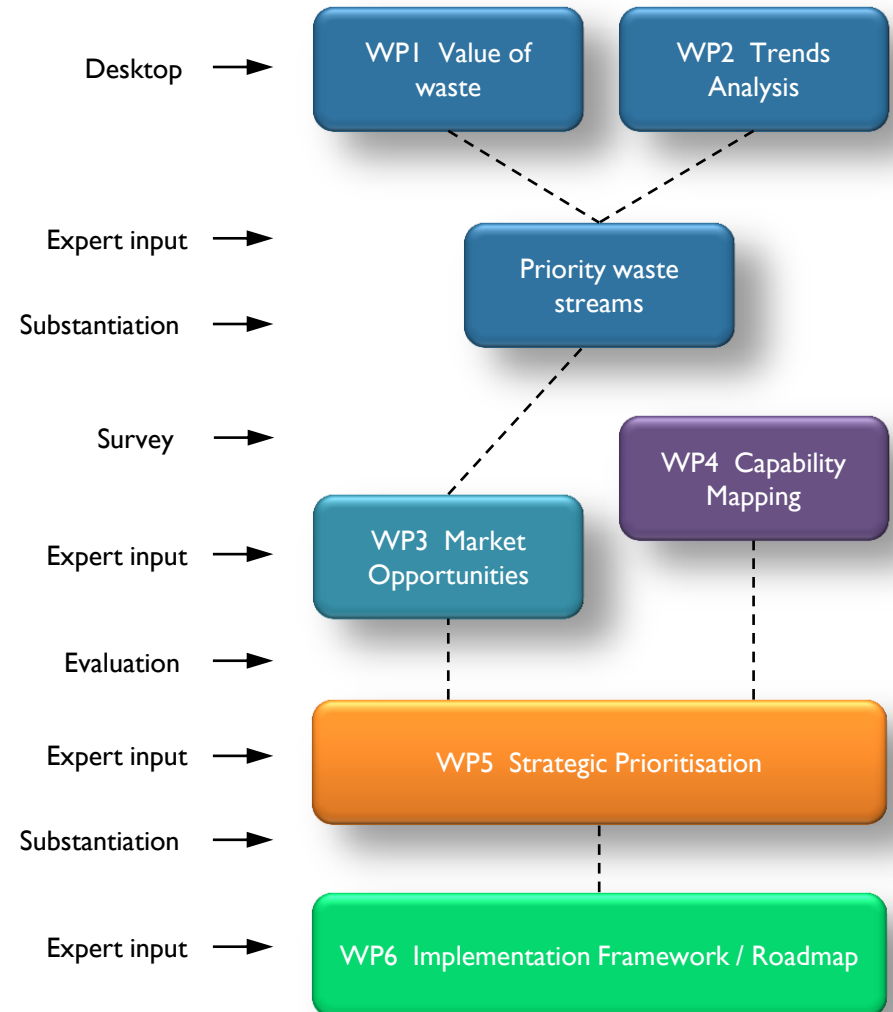
- ▶ Mitigation actions with significant outcomes
- ▶ Sectoral responses
- ▶ Informed decision-making and planning
- ▶ Technology research, development and innovation
- ▶ Facilitated behaviour change

# Introduction

## Approach

The project was divided into six Work-Packages (WP1-WP6):

1. **Value of waste** – the purpose of this desktop research was to understand the rationale behind developing the Waste RDI Roadmap and the potential social and economic benefits which could be achieved through the investment in Waste RDI in South Africa
2. **Trends** – the goal was to develop an understanding of the global and local context for Waste RDI, in terms of trends and drivers, from which to prioritise waste streams for inclusion in the Waste RDI Roadmap
3. **Market Opportunities** – the purpose was to identify and complete initial qualification of a set of Market Opportunities and RDI Potential per priority waste stream, and across the waste value chain – where interventions can respond to customer needs in order to achieve value and impact
4. **Capability mapping** – the purpose was to map the current levels of maturity of waste RDI within South African Universities and Science Councils in order to assess the country's ability to respond to current waste RDI opportunities
5. **Strategic Prioritisation** – the focus was to evaluate Market Opportunities consistently in terms of their Attractiveness and Fit, identify Clusters of priority issues, begin to outline Interventions and the associated Impact
6. **Roadmap** – The objective for each Cluster was to: articulate the proposed Intervention, identify an indicative anticipated Impact, define the appropriate Progression Path and the related Investment Instruments, in order to determine the RDI Investment required over time



# STRATEGIC INTENT

This section articulates the overall vision for a sustainable secondary resources economy for South Africa, frames the RDI mission, sets out RDI Clusters as the organising principle for the delivery of the RDI mission and defines an associated RDI Outcome as the desirable end-state that will be achieved through the successful execution of the Portfolio of planned investment and activity

## **Approach**

These pages represent the distillation of the direction and focus that has been in development during the course of the project.

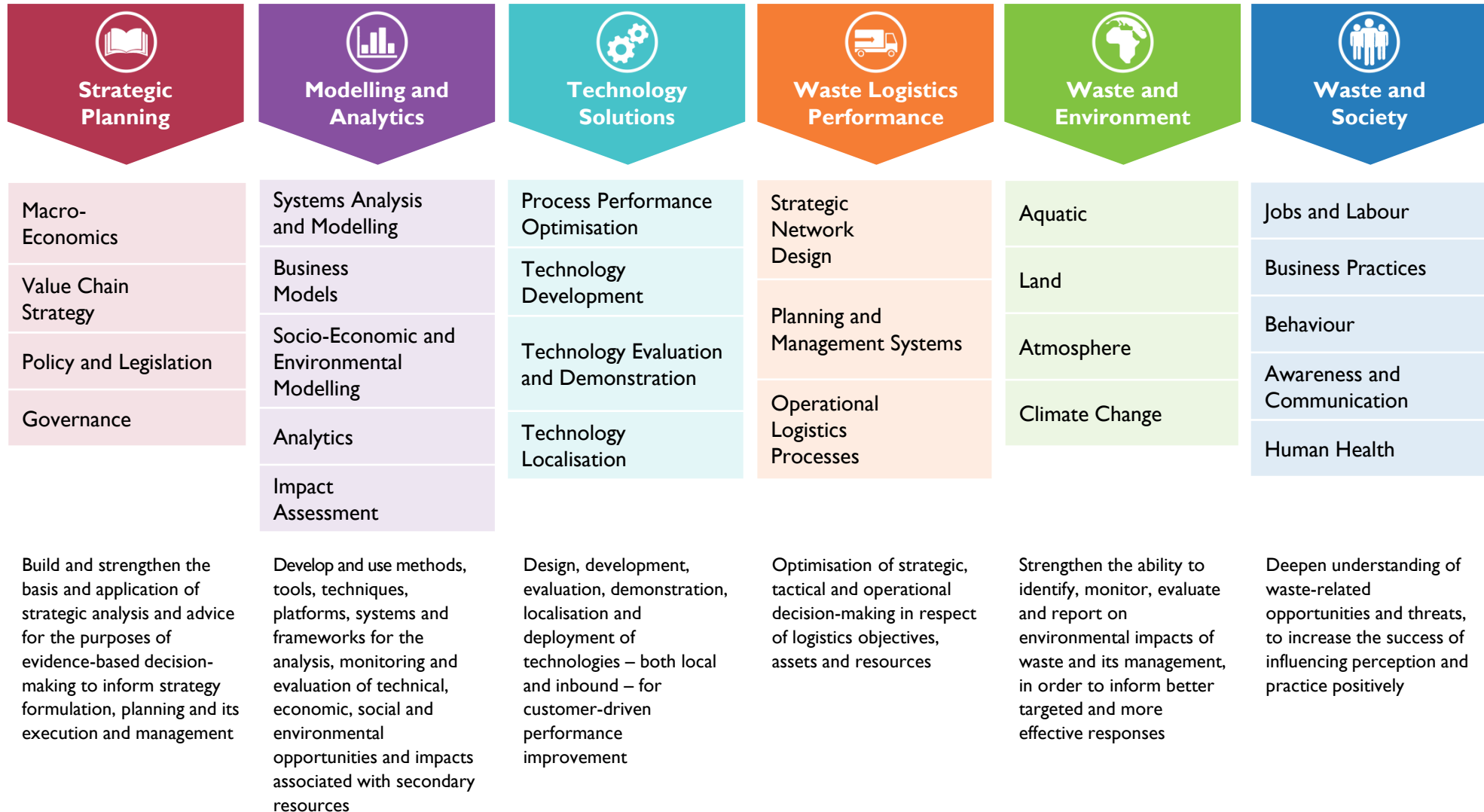
The RDI Outcomes in 2025 were developed and agreed with Experts in the course of defining strategic RDI plans for each Cluster. They articulate a desired and observable end-state that will be achieved by fulfilling the Purpose of the Cluster.

- 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.
- Means:** The underpinning contribution of RDI to strengthening South Africa's secondary resources economy is focused on four key Enablers:
1. More effective decision-making
  2. Faster insertion of context-appropriate Technology
  3. Export of Know-How and Technology
  4. Strengthened RDI capability and capacity



# Realising Waste Stream Opportunities via 6 RDI Clusters

## RDI Clusters defined



# Underpin strengthening of SA secondary resources economy

RDI Outcome for 2025	
Strategic Planning	<p><b>Evidence-based approaches are established and accepted practice in all strategic decision-making and planning for the strengthening of the secondary resources economy</b></p> <p>Source, build, synthesise, integrate and deliver evidence and practices in a manner that drives and supports effective uptake and transfer into strategic decision-making and planning processes by government, society and business</p>
Modelling and Analytics	<p><b>Driven by, and responding effectively and efficiently to the decision needs of a well-managed portfolio of internal and external customers, and able to draw on massive data resources, a broad and deep distributed modelling and analytics services capability performs and delivers a comprehensive array of analyses and evaluations</b></p>
Technology Solutions	<p><b>Technology development, localisation and exploitation driven by customer performance expectations is a key point of excellence in South African practices</b></p> <p>Focus on local technologies, with strategic consideration of leverage potential and location opportunity from the adaption of inbound technology; explicit emphasis on deployment and uptake</p>
Waste Logistics Performance	<p><b>Logistics design and operations along and across waste and secondary resource value chains is optimised and improved continually</b></p>
Waste and Environment	<p><b>Networked and inter-disciplinary RDI Programmes support the reduced impact of waste on the environment</b></p> <p>Particular emphasis on waste and climate change mitigation and adaptation</p>
Waste and Society	<p><b>Integrated and coordinated RDI Programmes inform and influence perception and practices at the organisation, community and individual level</b></p> <p>Focus on the strategic integration of social and organisational processes into the management of waste and the strengthening of a secondary resources economy</p>

# RDI CLUSTERS

The following section presents the RDI Clusters. These six clusters represent the high level areas of strategic RDI opportunities and comprise a number of research streams

## **Approach**

The clusters emerged originally from the evaluation of RDI Opportunity Areas for each of the prioritised waste streams.

In the course of the structured discussions with experts to develop a set of strategic RDI plans for each Cluster, the overall Cluster definitions, as well as the defined scope of the constituent Research Streams, was validated and refined.

## Definition and Scope

Strategic Planning			
Research Streams	SPI	Macro-Economics	Improving understanding of the dynamics of, and interactions between, global and local economic systems, with respect to production, markets and trade in virgin materials and secondary resources
	SP2	Value Chain Strategy	Development of clear and actionable strategies and plans – with a view to the regional context and opportunity - with focus on feedstock, access, market development
	SP3	Policy and Legislation	Improving the formulation and execution of national waste policy, in the context of global policy instruments and their implementation
	SP4	Governance	Improving interactions between Government, Industry and Society in the management of waste and secondary resources


## RDI Outcome for 2025

**Evidence-based approaches are established and accepted practice in all strategic decision-making and planning for the strengthening of the secondary resources economy**

## Cluster Purpose

Build and strengthen the basis and application of strategic analysis and advice for the purposes of evidence-based decision-making to inform strategy formulation, planning and its execution and management

## Definition and Scope

Research Streams	Modelling and Analytics 	
	MA1	Systems Analysis and Modelling
	MA2	Business Models
	MA3	Socio-Economic and Environmental Modelling
	MA4	Analytics
	MA5	Impact Assessment
		Methods, models, tools, techniques and data infrastructures to assess, project and evaluate costs, viability and sustainability of stocks, flows, processes and system interactions, including Value Chain Analysis (including Logistics); Life cycle Sustainability Assessment (from product design); Systems thinking with related modelling, such as systems dynamics and causal loops
		Design and development of new approaches to creating and capturing value in relation to waste management and secondary resources
		Methods, tools and techniques to assess social and economic viability and sustainability, including Resource Economics, Cost-Benefit Analysis, Life cycle Costing
		Methods, tools, techniques and data infrastructure for monitoring and evaluation, including waste classification and characterisation; environmental monitoring
		Methods, tools and techniques to assess the impact of models, and potential and actual decisions, and their implementation on receiving environments – social, environmental and economic

## RDI Outcome for 2025

**Driven by, and responding effectively and efficiently to the decision needs of a well-managed portfolio of internal and external customers, and able to draw on massive data resources, a broad and deep distributed modelling and analytics services capability performs and delivers a comprehensive array of analyses and evaluations**

## Cluster Purpose

Develop and use methods, tools, techniques, platforms, systems and frameworks for the analysis, monitoring and evaluation of technical, economic, social and environmental opportunities and impacts associated with secondary resources



## Definition and Scope

Research Streams	Technology Solutions		
	TS1	Process Performance Optimisation	Optimise operational performance with focus on efficiency and reducing processing costs of waste recycling and recovery technologies
	TS2	Technology Development	Design and development of alternative technologies for addressing South Africa's priority waste streams
	TS3	Technology Evaluation and Demonstration	Evaluation and demonstration of technologies, both locally developed and inbound
	TS4	Technology Localisation	Adaptation and localisation of inbound technologies for South African waste streams and conditions

## RDI Outcome for 2025


**Technology development, localisation and exploitation driven by customer performance expectations is a key point of excellence in South African practices**

## Cluster Purpose

Design, development, evaluation, demonstration, localisation and deployment of technologies\* – both local and inbound - for customer-driven performance improvement

\* Defined as: “Technologies across the waste value chain and across the waste hierarchy”

## Definition and Scope

Research Streams	Waste Logistics Performance		
	L1	Strategic Network Design	Designing logistics networks – transport and nodal - to move and manage waste between points of generation and end-use markets
	L2	Planning and Management Systems	Processes, platforms and technologies for optimised (KPI-driven) tactical and operational decision-making in respect of logistics objectives, assets and resources
	L3	Operational Logistics Processes	Improving operational efficiencies in order to achieve reductions in transport and nodal costs, across the waste value chain

## RDI Outcome for 2025

**Logistics design and operations along and across waste and secondary resource value chains is optimised and improved continually**


## Cluster Purpose

Optimisation of strategic, tactical and operational decision-making in respect of logistics objectives, assets and resources

\* This cluster is informed by and informs Strategic Planning – to inform and evidence Policy environment

## Definition and Scope

Research Streams

Waste and Environment 		
WE1	Aquatic	Enable more effective responses in water quality management
WE2	Land	Enable improved management of contaminated land, remediation, rehabilitation
WE3	Atmosphere	Enable better management of atmospheric emissions
WE4	Climate Change	Enable better management of climate change mitigation and adaptation

## RDI Outcome for 2025


**Networked and inter-disciplinary RDI Programmes support the reduced impact of waste on the environment**

## Cluster Purpose

Strengthen the ability to identify, monitor, evaluate and report on environmental impacts of waste and its management, in order to inform better targeted and more effective responses

Strong link with Strategic Planning and key focus is to ensure uptake of evidence by those with responsibility for Environmental management

## Definition and Scope

Research Streams	Waste and Society		
	WS1	Jobs and Labour	Evaluating, designing and developing models to maximise job creation* along waste value chains
	WS2	Business Practices	Business models, with a focus on SMEs in the waste sector
	WS3	Behaviour	Understanding human behaviour with regards to waste prevention, reuse, recycling and recovery. As a means to altering consumer behaviour
	WS4	Awareness and Communication	Awareness and communication in relation to behaviour change programmes
	WS5	Human Health	Identification and evidencing the impacts of waste on human health (environmental health)

Noting strong inter-relationship between the sub-clusters and potential tensions

\* With a focus on creating 'decent jobs'

Where SMEs are seen to include cooperatives

## RDI Outcome for 2025

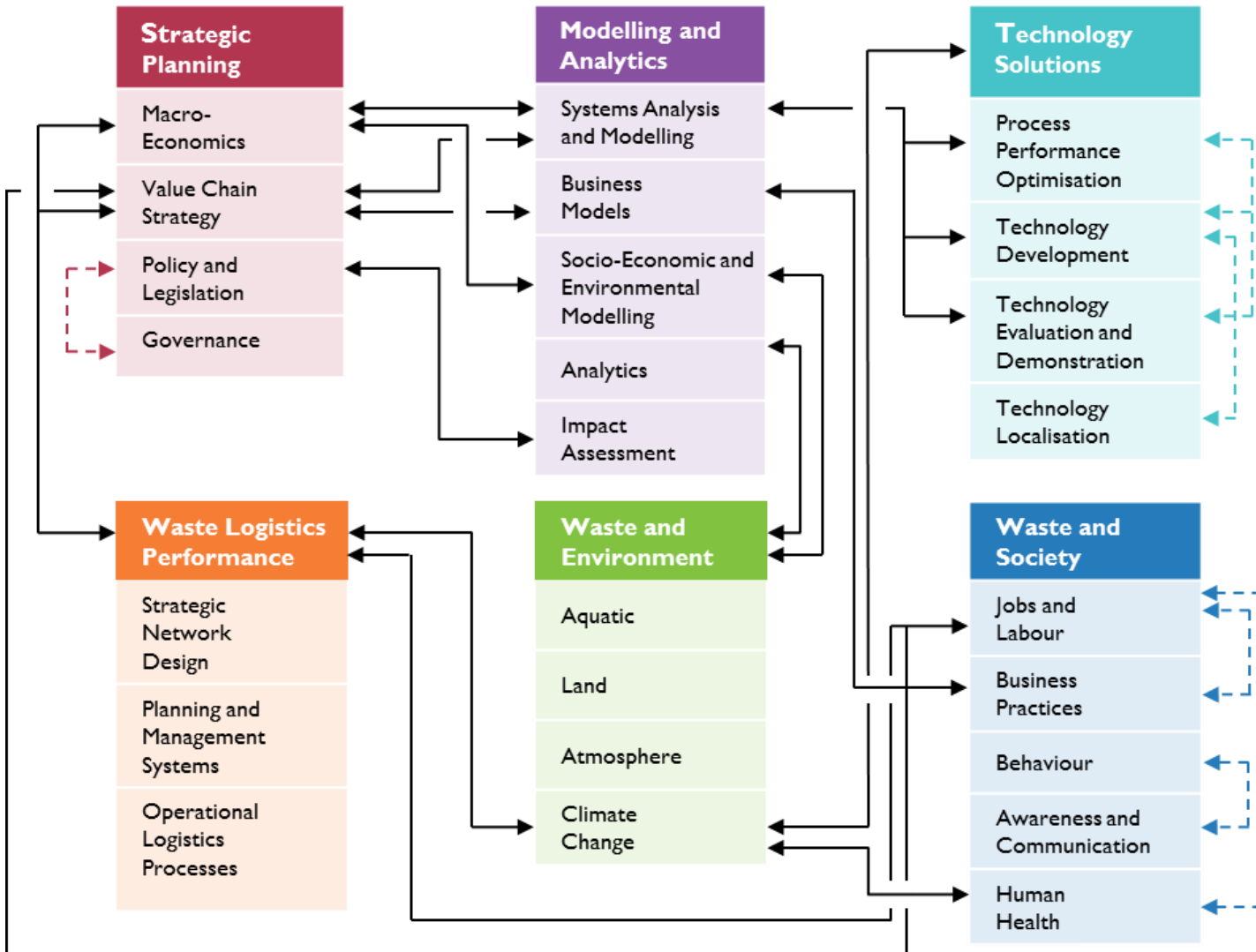
**Integrated and coordinated RDI Programmes inform and influence perception and practices at the organisation, community and individual level**

## Cluster Purpose

Deepen understanding of waste-related opportunities and threats, to increase the success of influencing perception and practice positively

# Six Waste RDI Clusters Defined

## Cluster Affinities\*



\* All Research Streams within Clusters have some level of affinity. Therefore, only particularly pertinent links within Clusters are highlighted, e.g. where one stream is likely to be addressed jointly with another.



# IMPACT AND INVESTMENT

The following section presents the Investment Requirements associated with the set of Strategic RDI Plans for the six Clusters, together with the anticipated Returns, in the form of Impact and RDI Outputs

## **Approach**

Using the Investment Assumptions developed for each Cluster as inputs (see *Appendix A*), the associated investment requirements and charts were produced.

# Impact is significant

## Anticipated Impact

<b>Waste Management</b>	<b>20% reduction (by weight) in industrial waste and a 60% reduction (by weight) in domestic waste to landfill (by 2025)*</b>	
<b>Environmental Benefit</b>	▶ Reduced environmental impacts associated with (often poor) landfilling (including e.g. greenhouse gas emissions, leachate, litter)	
<b>Economic Value</b>	▶ Potential resource value ( <i>minimum</i> ): **	R17.4 bn per annum (R8.2bn pa recovered)
	▶ Avoided financial costs of landfilling:	R4.7 bn per annum
	▶ Avoided externalities of landfilling:	R5.2 bn per annum
	▶ Avoided financial costs and externalities associated with virgin material production ( <i>not yet quantified</i> )	
<b>Socio-economic Benefit</b> ( <i>not yet fully quantified</i> )	▶ Contribution of a secondary resources economy to downstream manufacturing	
	▶ Potential for enterprise development and creation of sustainable jobs (direct, indirect and induced)	
	▶ Reduced operational costs or improved competitiveness through process performance improvements	
	▶ 'Multiplier' (knock-on) effects on the macro-economy ( <i>potentially a 1-3x multiplier</i> )	

\* DST Goal – Evaluated as Scenario 3 in the analysis of waste stream value performed as part of this project

\*\* As at 2012 values

# Investment focused on achieving system-level Outputs

## Anticipated RDI Outputs \*







	Key Performance Indicator	Outputs Ambitious**
Technology Development	Products and services to market	4
	Technology packages	20
	Prototypes	60
Knowledge Generation	Registered patents	25
	Patent applications	70
	Publications	590
Human Capital Development	Post Docs	65
	PhDs	165
	Masters	245

\* Total expected outputs over the 10 year timeframe

\*\* Assumes a) total investment indicated is made and b) RDI Productivity Assumptions (Page 39) are achieved in practice

# Investment Ambition

## Investment, in ZARm

		To Exit*	Next Stage**
	Strategic Planning	219	73
	Modelling and Analytics	403	119
	Technology Solutions	2132	641
	Waste Logistics Performance	312	128
	Waste and Environment	403	156
	Waste and Society	419	150
Total		3888 ***	1267 ***

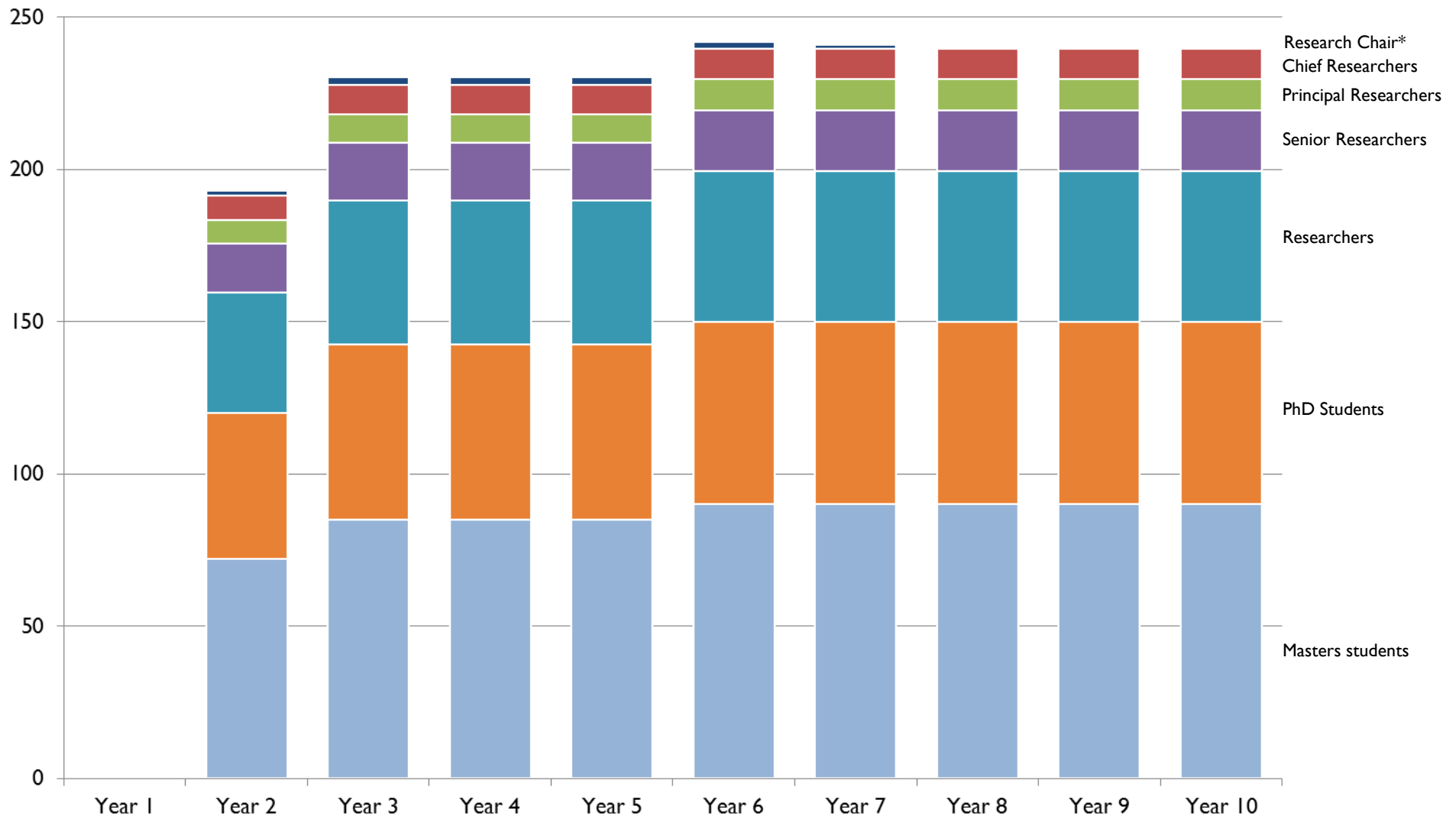
\* to the conclusion of the “Commercialise” phase

\*\* to the end of “Build Critical Mass”, including Explore

\*\*\* not including resourcing of dedicated Portfolio Management function - at 3% of total RDI investment, net of HCD component

# Significant and Productive Investment in Research Capacity

## Number of People, by research seniority

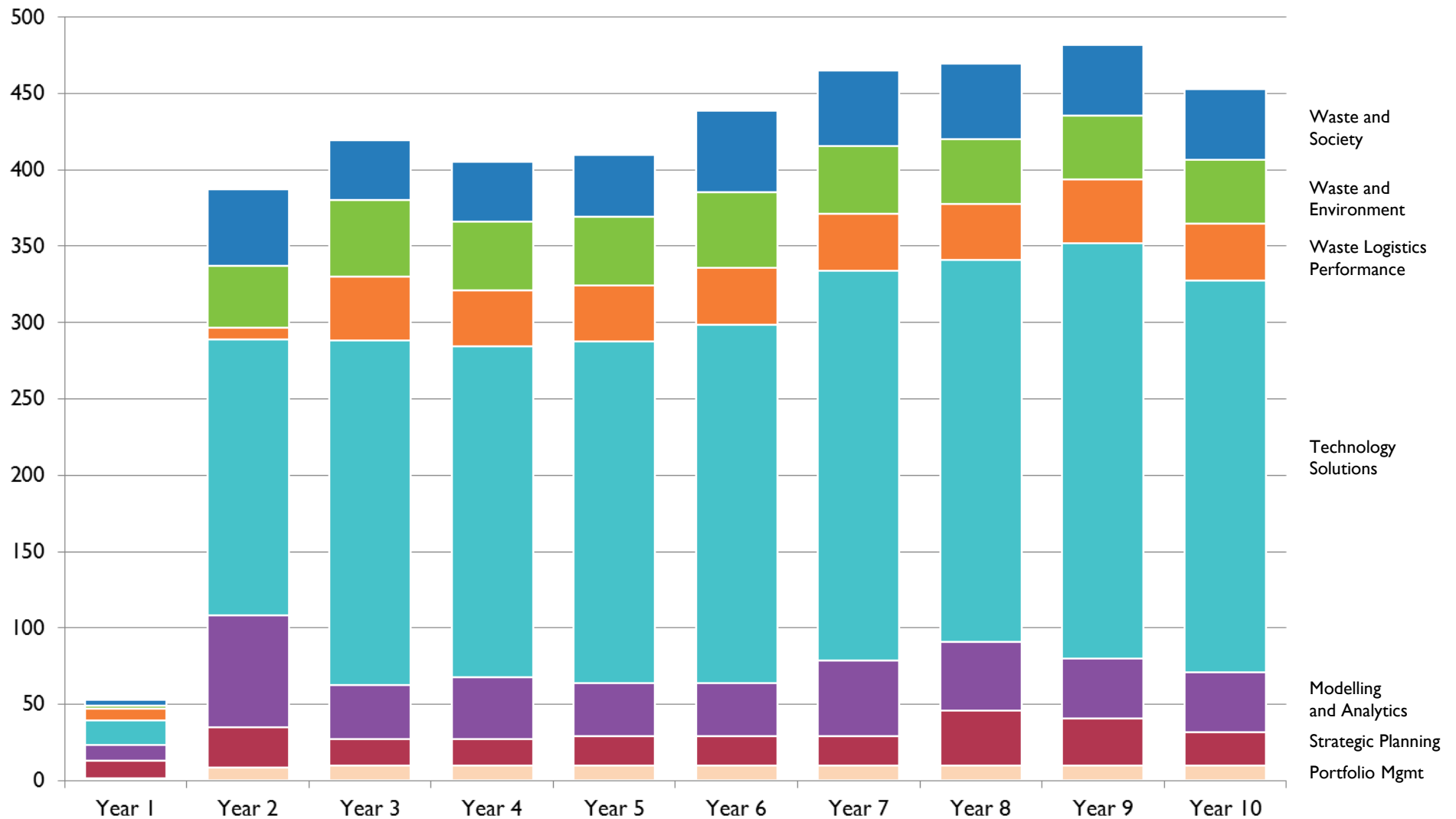


\*Only includes Professor holding the chair



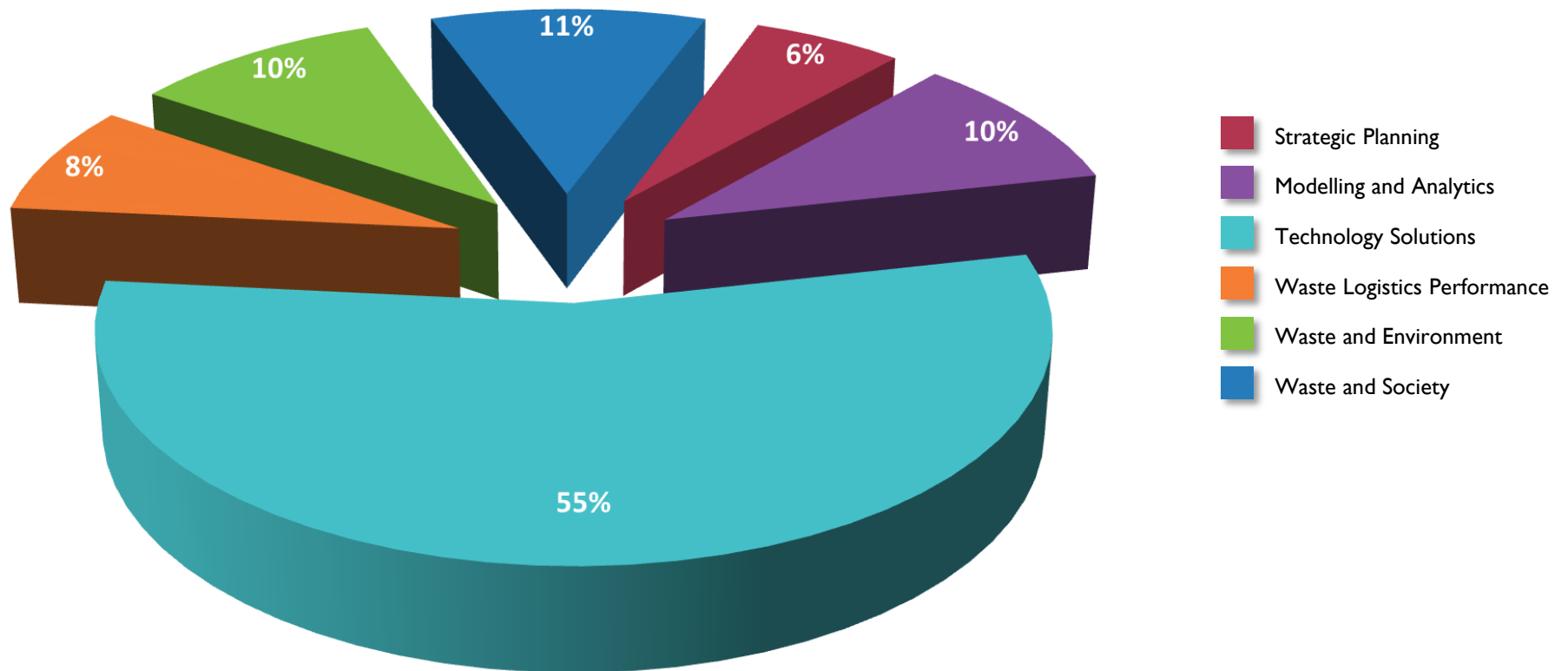
# Total Investment Requirement

Per cluster, per year, in ZARm



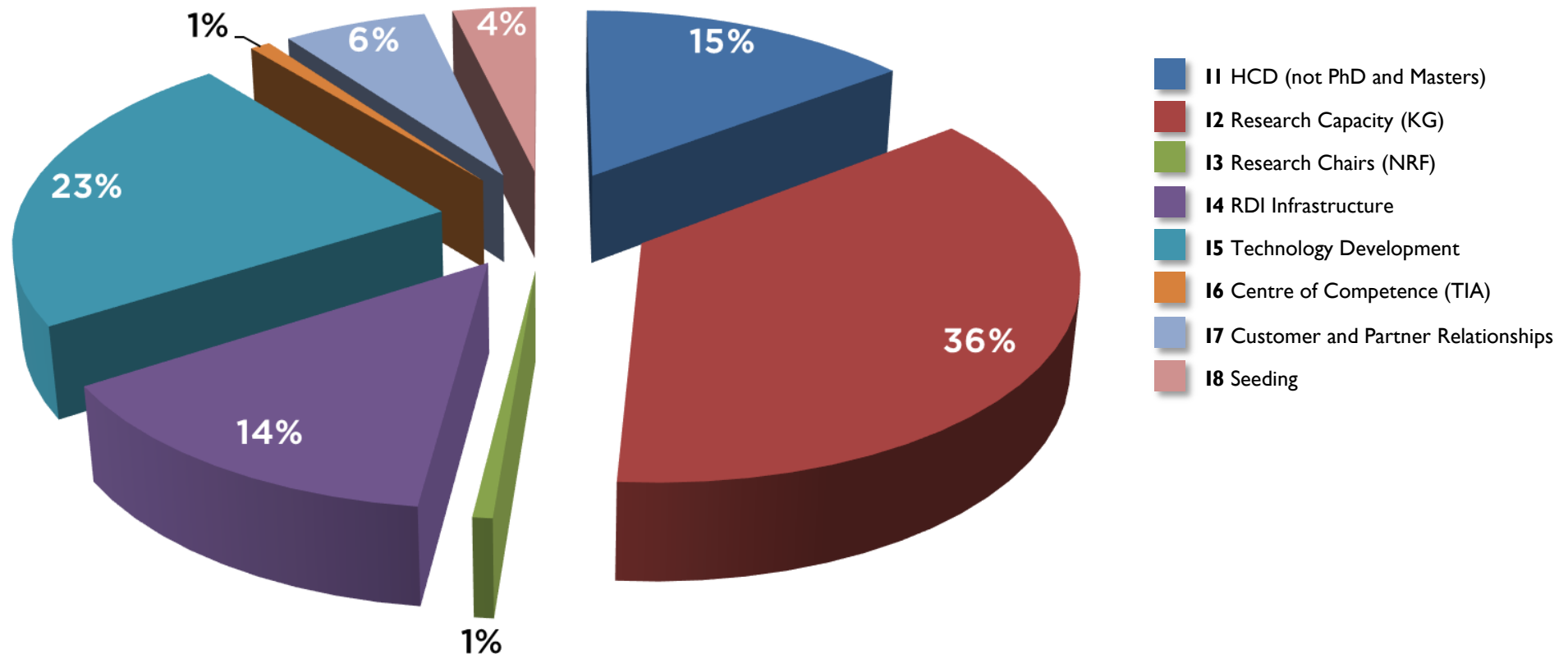
# Investment Requirement

## Total Investment, per Cluster



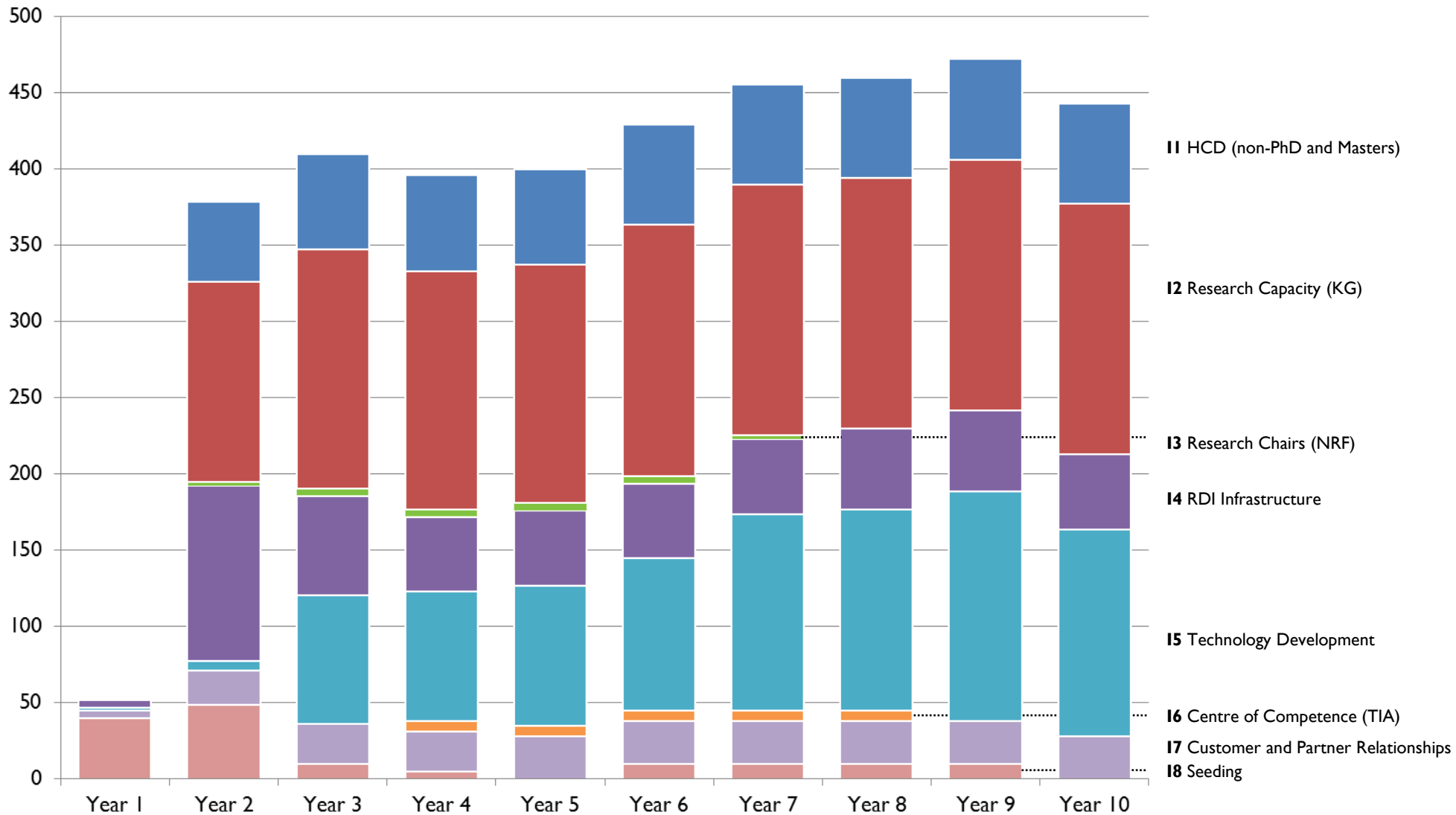
# Resourcing Strategy

## Representative proportions by Investment Instrument



# Investment Requirement

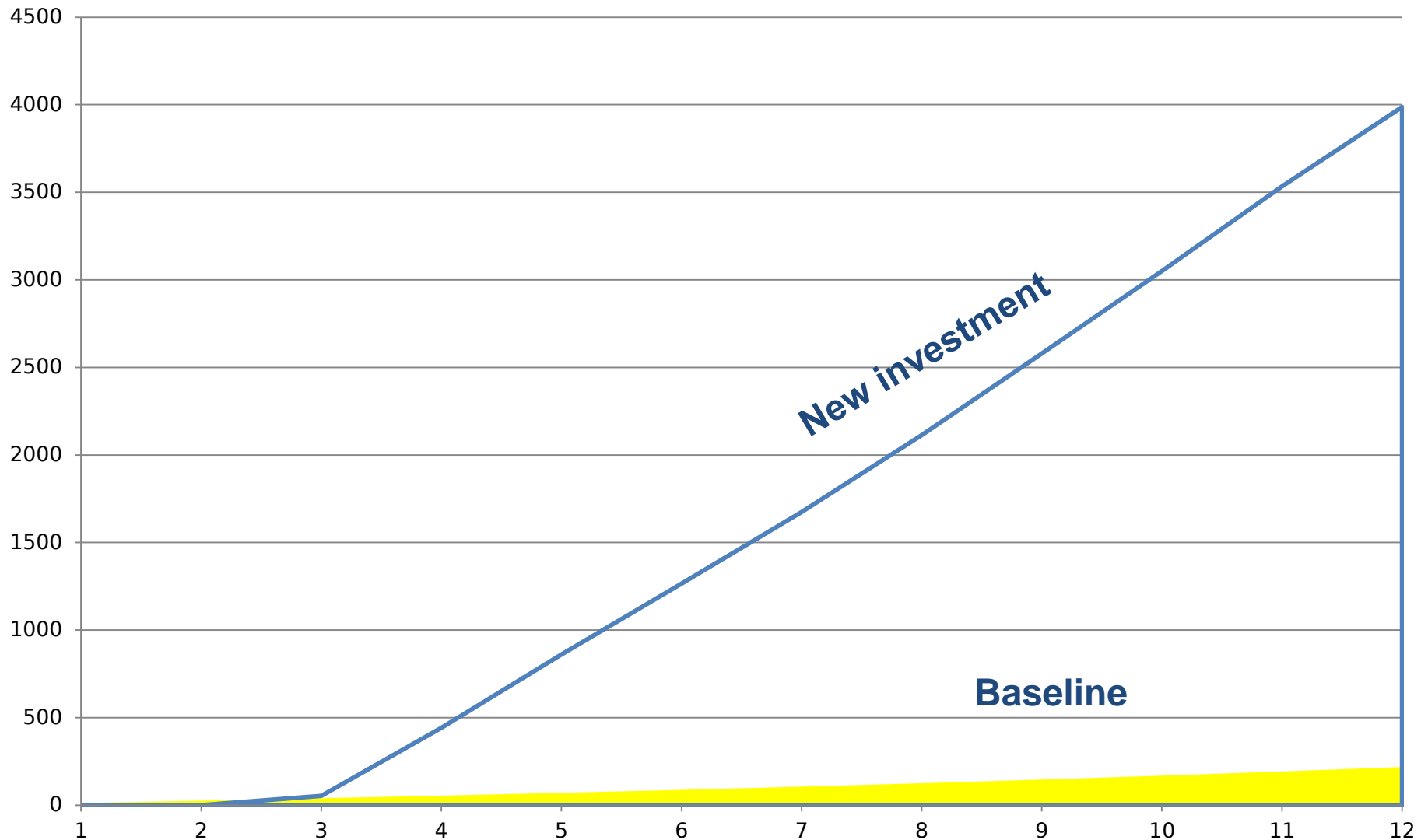
## By Investment Instrument, by year, in ZARm



# **HOW WILL THIS INVESTMENT BE FUNDED?**

# Significant gap between Baseline and Roadmap investment required

## 10-Year Investment – Cumulative, in ZARm



# Catalytic DST Investment unlocks co-funding and industry leverage

## Annual RDI Investment, by Funding Source, in ZARm

