Stellenbosch

UNIVERSITY
IYUNIVESITHI
UNIVERSITEIT

forward together
sonke siya phambili
saam vorentoe

Waste valorization - From waste to high value products

Zwonaka Mapholi | Annie Chimphango | Neill Goosen | Christie Dorfling | Robbie Pott | Johann Görgens | Eugene van Rensburg

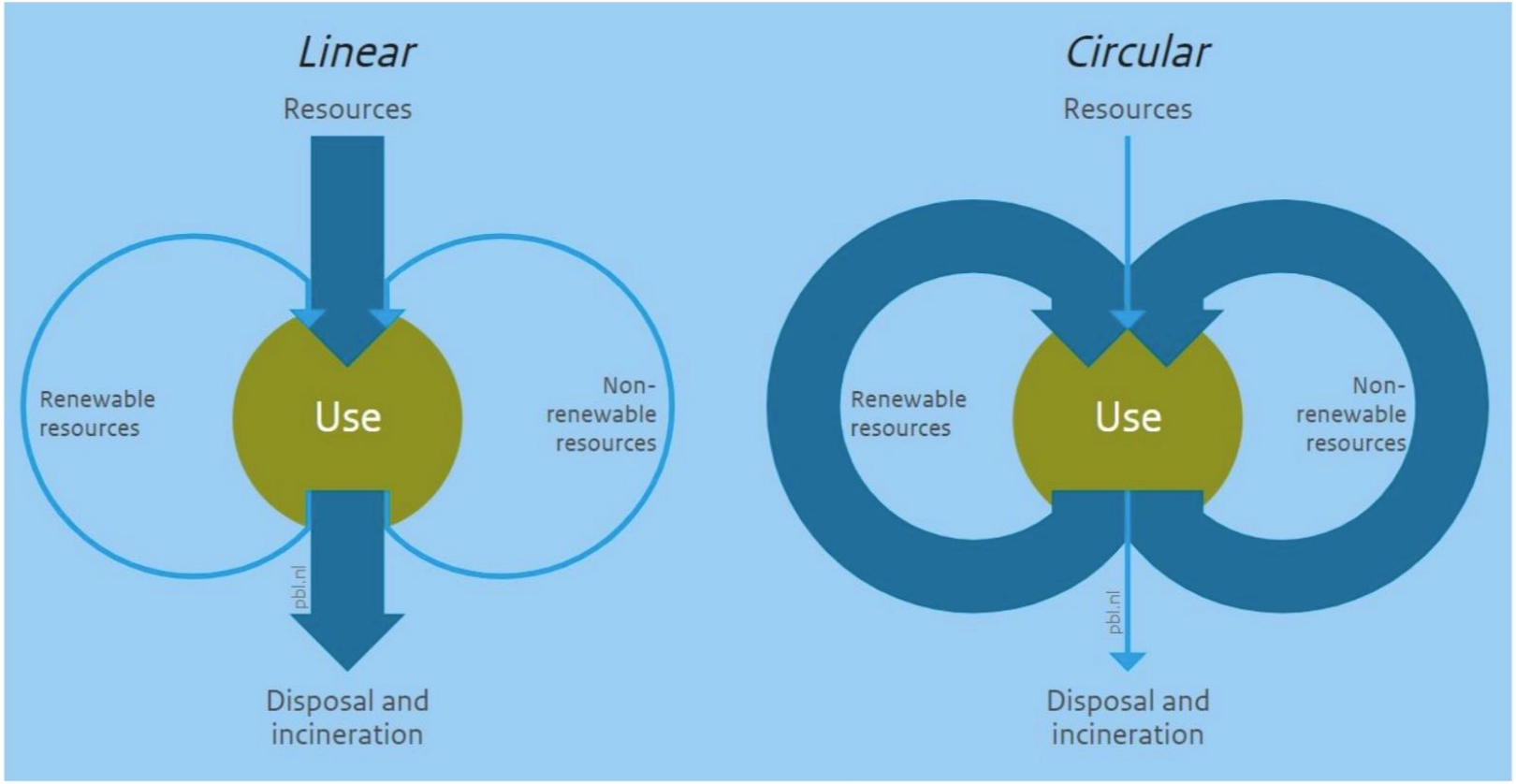
Department of Chemical Engineering

Photo by Stefan Els

Outline

- Introduction to circularity
- Types of waste ‘resources’
- Examples of waste valorization research at Chemical Engineering
- Conclusions

Waste valorization



- **Traditional take-make-dispose** (linear)
  - Emphasis on mass extraction, consumption, and disposal of resources.
  - Resource depletion, **waste generation**, environmental impact, economic inefficiency, and social impact.
- **Circular economy:**
  - 3R approach: Reduce, Reuse, and Recycle.
  - Specifically: Recycling, upcycling, energy recovery, and production of secondary raw materials.

- **Waste valorization:** process of converting waste materials into valuable products or energy.

South African economy

CSIR LAUNCHES INITIAL FINDINGS ON THE OPPORTUNITIES OF A CIRCULAR ECONOMY IN SOUTH AFRICA

Publication Date: Friday, November 26, 2021 - 00:00

The Council for Scientific and Industrial Research (CSIR) has launched early findings its 'Science, Technology and Innovation for a Circular Economy' (STI4CE) Project. The report highlights findings on what a more circular economy could mean for South Africa in terms of much-needed social, economic and environmental opportunities.

- ❑ South Africa has a **very linear economy (resource-extractive based economy)**
- High resource throughputs, predominately inland extraction, and manufacturing.
- Export of resources for further beneficiation, minimal resource investment in local stocks.
- Small resource returns into the economy.
- ❑ Country at risk of resource **depletion or overexploitation**.
- Transitioning towards a circular economy has the potential to create value across all sectors of the economy.
- Regenerative agriculture, decouples economic development from the demands placed on our energy and water systems.

Types of wastes

- The linearity of our economic model continuously leads to waste generation.
- Evident in our major economies; the **mining industry** and **agricultural** sectors.

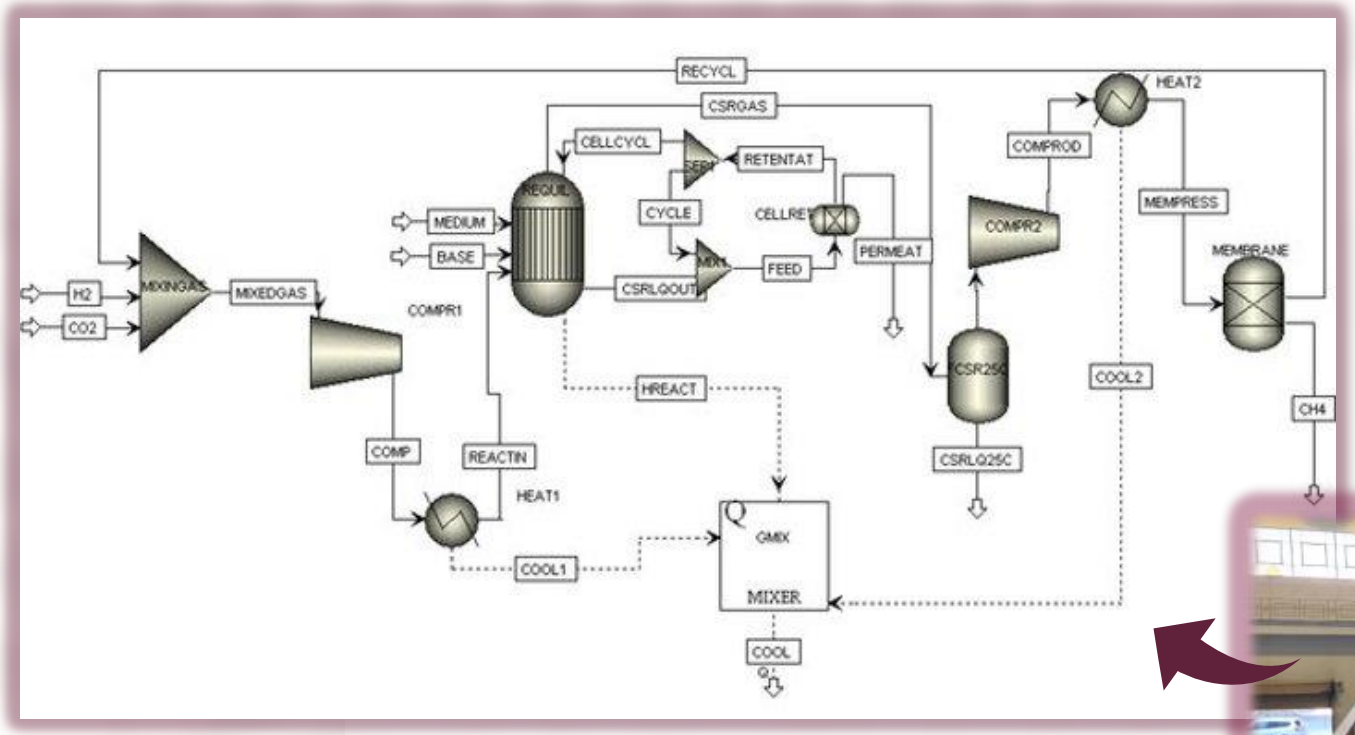
Bagasse

Mango peels

Fish wastes

Electronic wastes

Transforming waste: Innovative valorization projects



Integrating wastes processes into existing process

Extractions

Biofuels (energy)

Waste valorization research at Chemical Engineering

RESEARCH POSTGRADUATE OPPORTUNITIES UNDERGRADUATE ENGINEERING EDUCATION NEWS STAFF CONTACT US

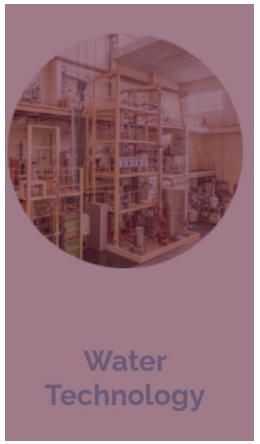
RESEARCH

HOME / RESEARCH

Overview

Chemical Engineering is an alternative description used to define a broader group of engineers who apply chemical engin… any category of chemical engineering such as petrochemical, biochemical, organic polymers, geopolymers, food and beverages, fertilisers, environmen… ring, mathematical modelling and machine learning, mineral processing and many more. Within the Department, our research foci can be grouped in to the following … earch areas:

Waste Valorisation



Water Technology

Extractive Metallurgy

Research group academics

Prof Guven Akdogan

Pyrometallurgy

Metal Recycling

Tailings Reprocessing

Plastics

Prof Steven Bradshaw

Metal Extraction

Metal Recycling

Machine Learning

Prof Christie Dorfling

Urban Mining

Metal Recycling

Process Modelling

Life Cycle Assessments

Dr Margreth Tadie

Mine Tailing Valorisation

Environmental Assessment

Biobased Chemicals

Mr Petrie van Wyk

Metal Recycling

PGM Recovery

Techno-economic Analyses

Extractive Metallurgy's waste valorization project

Research focus – Metal extraction and recycling – Urban mining

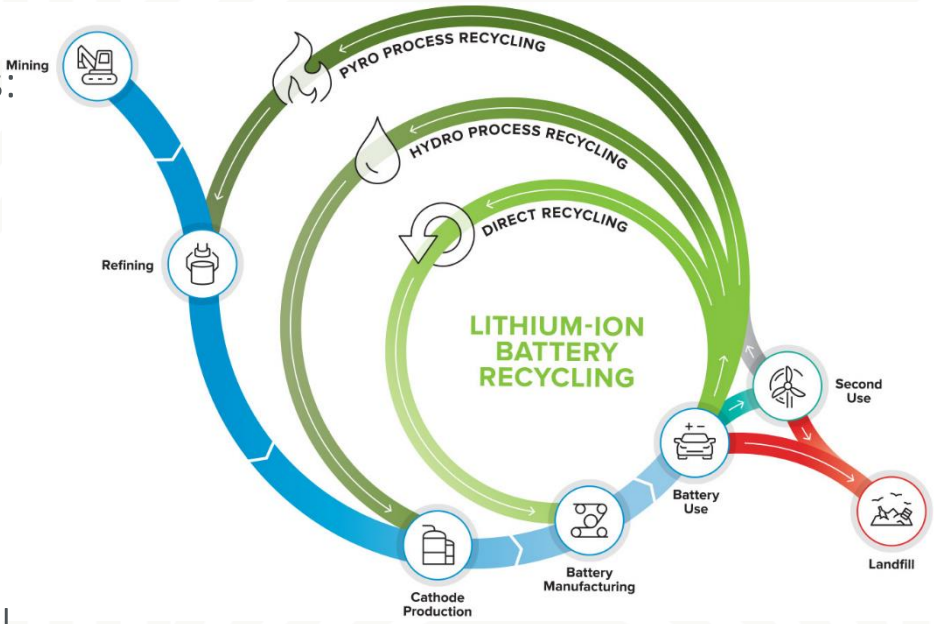
~55 million tons of electronic waste was discarded globally (2019)

Recovery of base, precious, hi-technology and critical metals, with hydrometallurgical processes:

- Printed circuit boards (copper & gold)
- Fluorescent lamps (rare earth elements)
- Lithium-ion batteries (lithium, cobalt & nickel)
- Automotive catalysts (precious metals)

Example: lithium-ion batteries (LIBs)

- Significant use of "critical metals" in LIBs, e.g. Co, Li
- 20% of Co from DRC, half of that with doubtful labour practises



Bioresource Engineering waste volarization projects

Research group academics

ZWONAKA MAPHOLI

JUNIOR LECTURER

NEILL GOOSEN

ASSOCIATE PROFESSOR

ROBBIE POTT

ASSOCIATE PROFESSOR

EUGENE VAN RENSBURG

ASSOCIATE PROFESSOR

ANNIE CHIMPHANGO

ASSOCIATE PROFESSOR

JOHANN GÖRGENS

DISTINGUISHED PROFESSOR

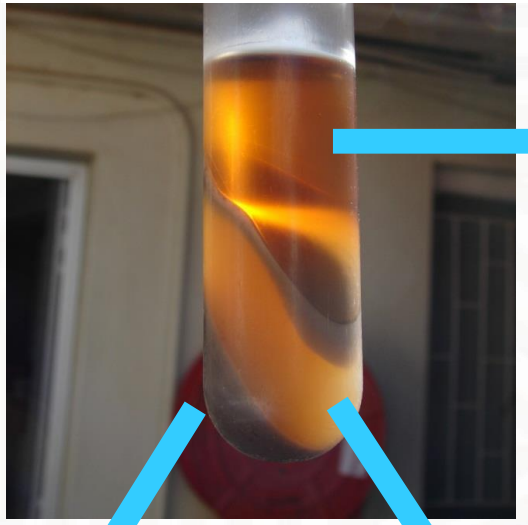
Prof Neill Goosen

Fish wastes protein hydrolysis and recovery

By-products

Protein hydrolysis

Fish protein hydrolysate



Oil

Insolubles

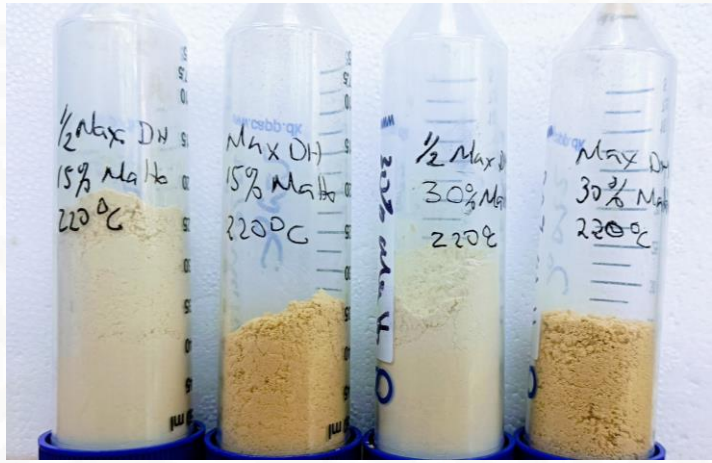
Protein

Prof Neill Goosen

Fish wastes protein hydrolysis and recovery

Hydrolysis

Spray drying



Protein powders

Prof Robbie Pott

Biohydrogen via photo-fermentation – industrial wastewater

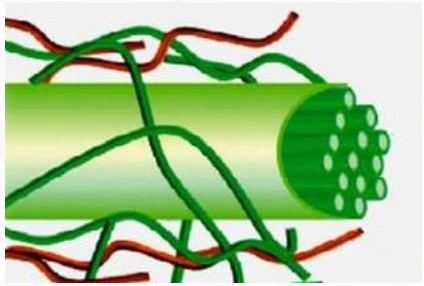
Reactor designs

Continuous conversion

Prof Annie Chimphango

Development of bioactive packaging film

Agri residue



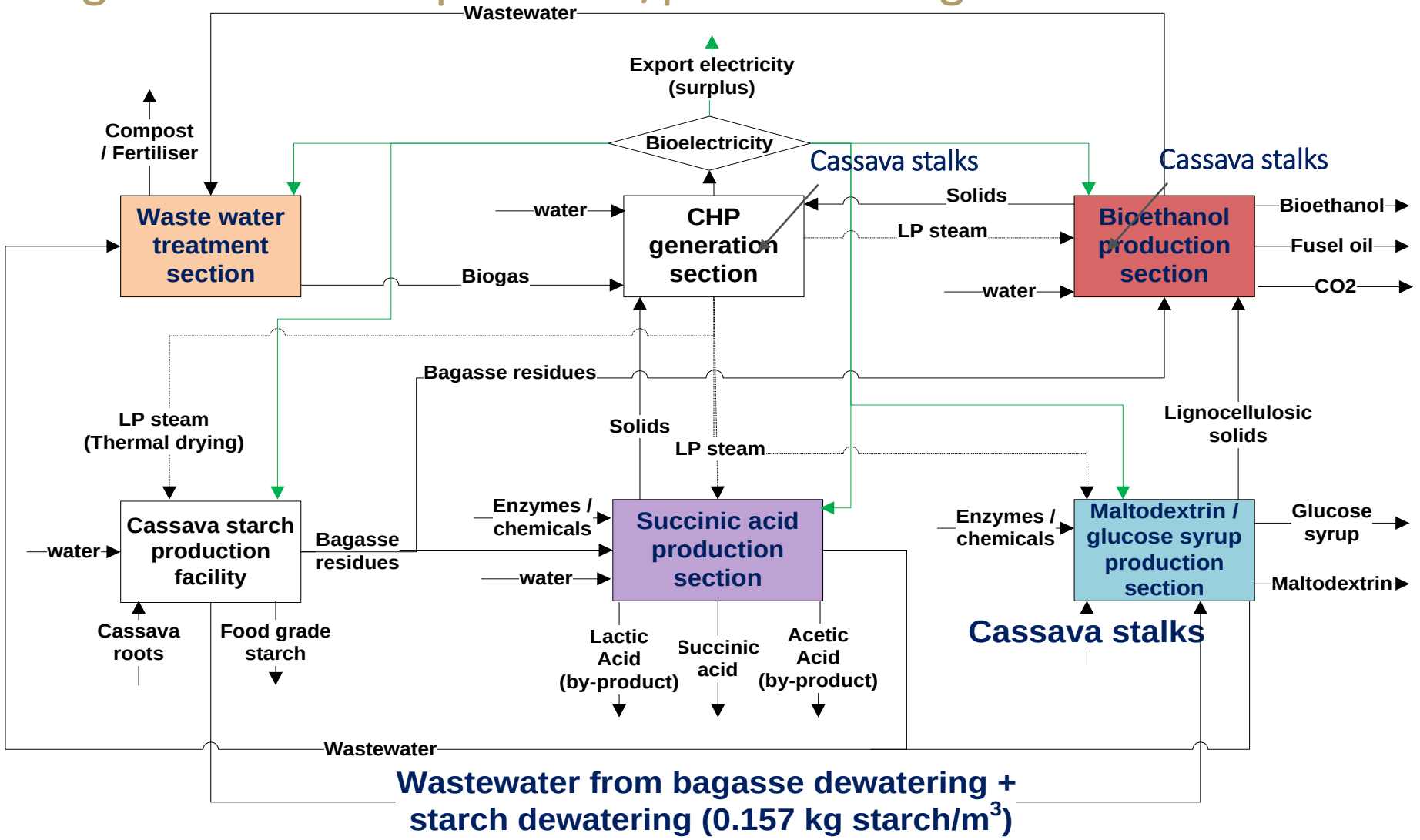
Nanocellulose

Rooibos

Bioactive Food Packaging film

Simulations, Techno-ecomonics and LCAs for Waste biorefineries

E.g. cassava waste processes/products integration:



Mr Zwonaka Mapholi

Soaps from waste cooking oil with additives from citrus peel waste

Waste cooking oils

Citrus peel waste

Anti-microbial soaps

Prof Eugene van Rensburg

Anaerobic digestion of organic and biowastes

50 L digesters

Biogas

Prof Johann Görgens

Industrial Demonstration of Bioprocess Technologies

Successful knowledge transfer from lab to demo plant for bio-ethanol from organic wastes

- Sterilisation, performance of yeasts and enzymes, feeding strategy for high solids loading
- Identified design constraints for improvement
- On-site production of yeast inoculum

Enable industrial application of new technologies

- Sufficient data on process performances, based on variabilities in waste composition
- Confirm financial models for full-scale investment
- Build industrial familiarity with technology

Mobility for Demonstration with Organic Wastes

- **Paper, pulp, packaging**
  - Pulp mill residues, label backing paper, multi-layer packaging, paper sacks, newspapers and magazines
- **Various food wastes**
  - Diary, ice cream, baby food, chicken food waste, pet food, tinned food (e.g., beans)
  - Requires diverse processing strategies
- **Clothing and textile waste**

Conclusions

- Waste valorization offers a unique opportunity to ‘close the resource loop’ in South Africa.
- Integrating waste valorization into existing bioprocesses offers alternative products, energy, and waste reduction opportunities, leading to environmental and economic benefits.
- Pursuit of waste volarization -> collaborative efforts from stakeholders.
- Industry -> Consider making products to be made again.
- Community -> Perceptions on ‘secondary products
- Government -> Policies promoting waste volarization, circularity, and sustainability.

Stellenbosch
UNIVERSITY
IYUNIVESITHI
UNIVERSITEIT

forward together
sonke siya phambili
saam vorentoe

Thank you
Enkosi
Dankie

Johann Görgens
Department of Chemical Engineering
jgorgens@sun.ac.za

Photo by Stefan Els