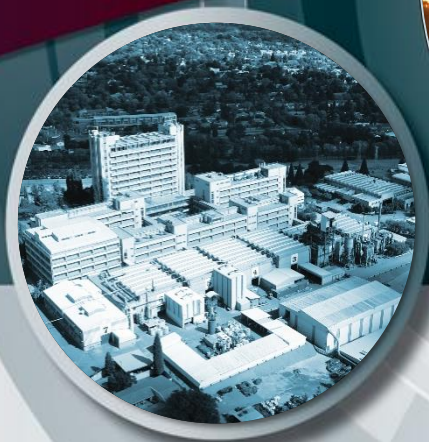


2020/21

ANNUAL INTEGRATED REPORT



Molefi Motuku, CEO | Acting Board Chair: Ms Futhi Zikalala-Mvelase

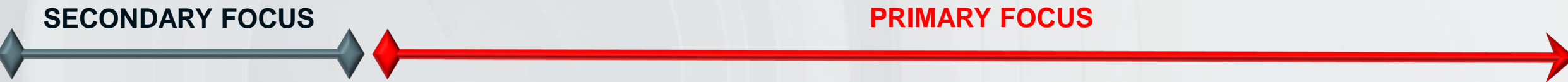
4 November 2021





- Mintek at a glance
- Mintek corporate scorecard, 2020/21
 - ✓ Learning and growth perspective
 - ✓ Research, development and innovation perspective
 - ✓ Industry development
 - ✓ Develop and maintain world-class research, development & innovation capacity
 - ✓ Financial perspective
- Concluding remarks

MINTEK: focus areas along the mining & minerals value chain



- EXPLORATION STAGE** : Geochemical sample analysis and mineral ore characterization
- CORE ACTIVITIES** : Range from **initial investigations** to **process development** and the **design, construction**, as well as **commissioning** of **industrial plants**
- OFFERINGS** : Working closely with clients, and in conjunction with engineering partners, Mintek supplies a flexible package of technology for process development and optimisation, products and services

Mintek's global operations



Gold



PGMs



Ferrous Metals



Equipment &
Technology



Base Metals



Industrial Minerals
& Diamonds



Process Control
Strategies



Uranium



Rare Earth
Elements



Economic &
Regional Studies

Mintek at a Glance: 2020/21 Performance



EMPLOYEES COVID TESTS TO DATE: 5 614 & SCREENING: 169 351

Learning and Growth



Total staff base: **507**
SET base: **243 (48%)**
SET Mid-Senior staff: **98 (40%)**



Black SET: **194 (80%)**
Female SET: **129 (53%)**
% SET Black Mid-Senior staff: **62 (63%)**



SET - PhD: **46 (19%)**
SET - MSc: **54 (22%)**
PhD Studies: **20**
MSc Studies: **38**

Financial Perspective



Products & Services: **R103 m**
Total Income: **R554 m**
Total Expenses: **R549 m**
Deficit/Profit: **R4.8 m**



Investment in R&D: **R244.9 m**
Investment in PPE: **R46.3 m**
Investment in HCD: **R9.1 m**
Staff turn-over: **5.8 %**

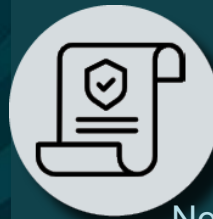


BEE Spent: **94%**
Liquidity ratio: **1.6:1**

Research, Development & Innovation



Journal papers: **36**
Conference presentations (& webinars): **24 (80)**
Books Chapters: **12**
Books : **1**



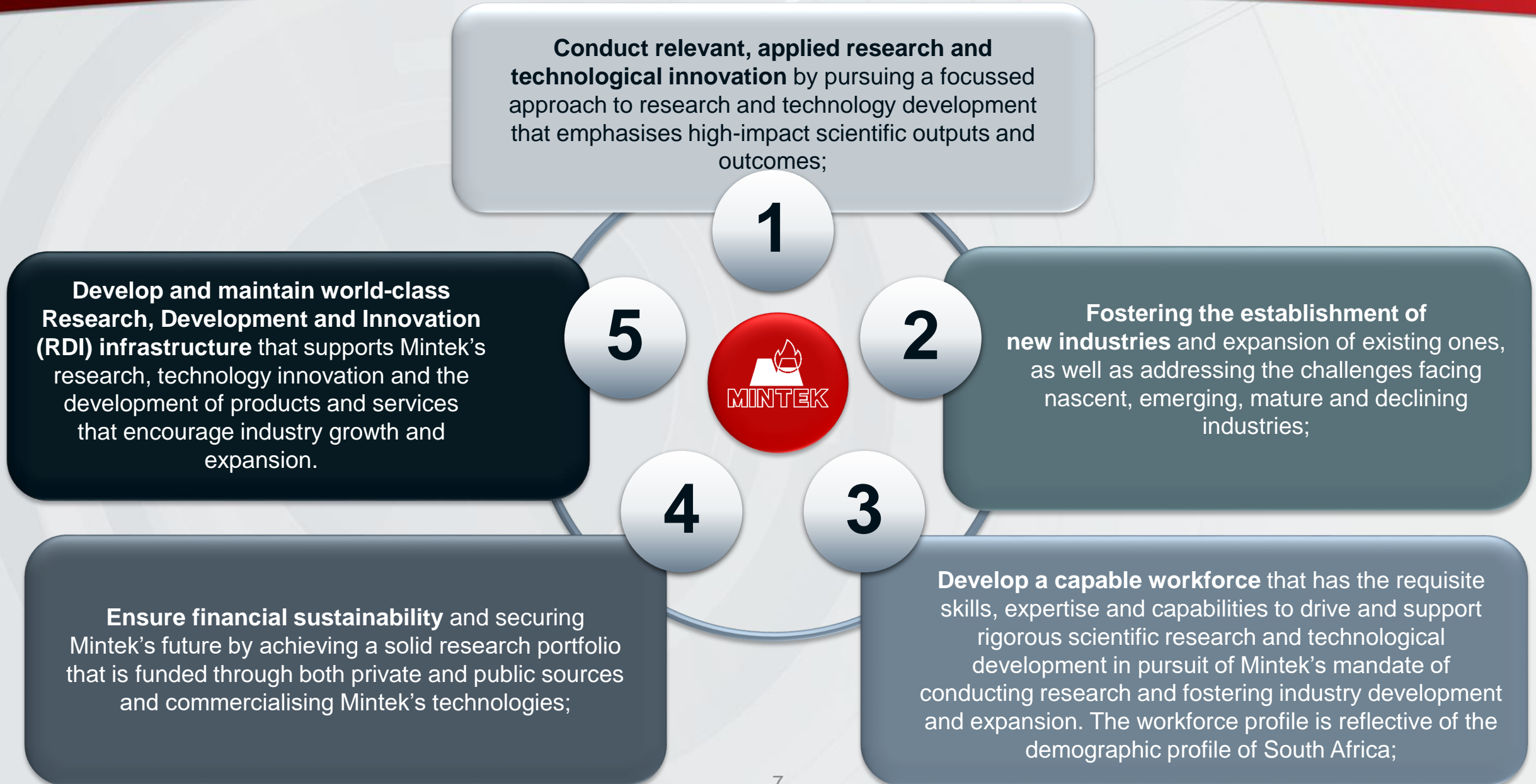
New patents: **5**
New trade marks: **5**
New technologies/prototypes: **12**



Invention disclosures: **13**
IP Licence Agreements: **0**

Mintek Corporate Scorecard, 2020/21

About Mintek – how we operate



Learning and Growth Perspective



Performance with respect to KPI's - 2020/21

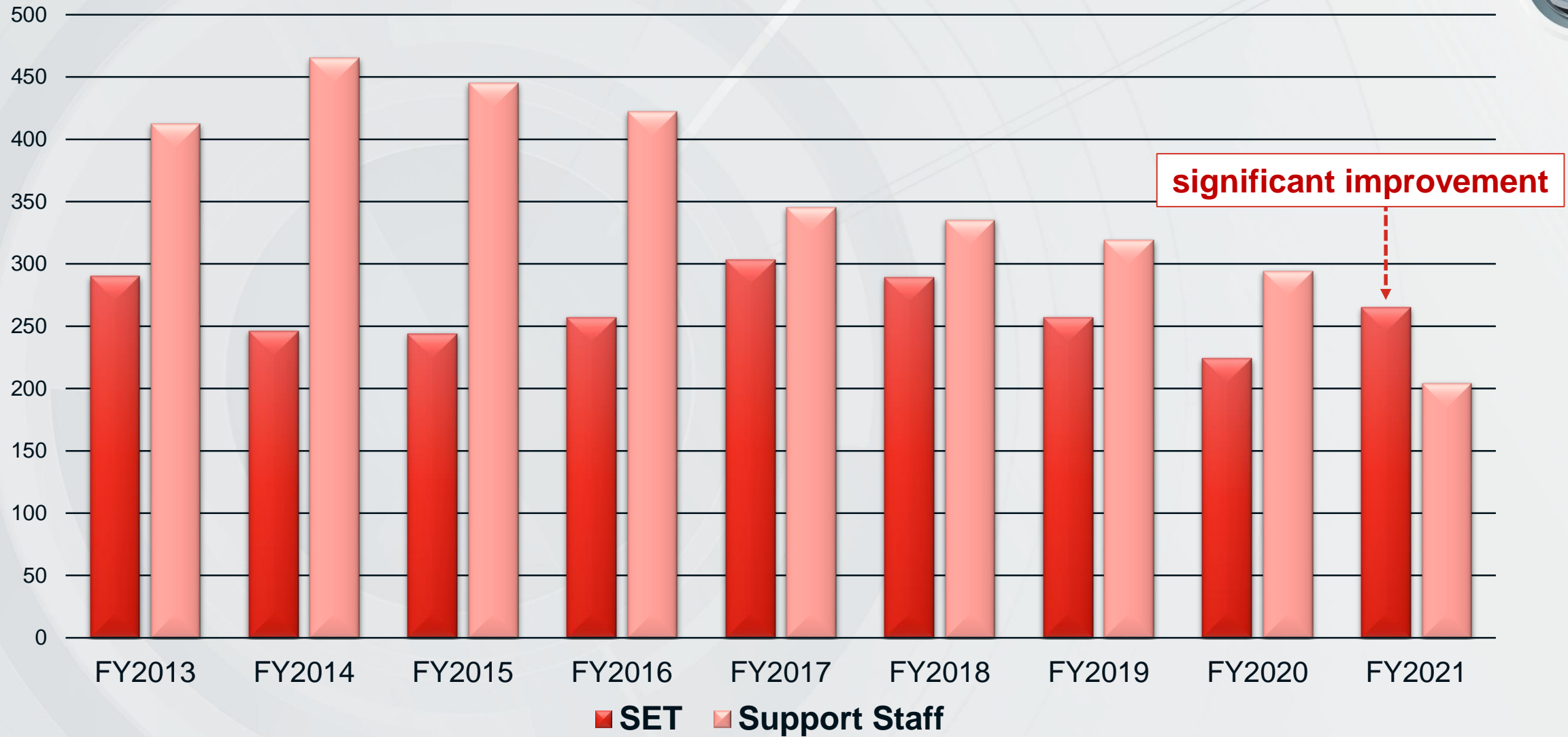
STRATEGIC OBJECTIVE #3: Develop a Capable Workforce

Key Performance Indicators	Target 2020/21	Performance 2020/21
Total number of SET employees	215	243
Percentage of Black SET staff	79%	80%
Percentage of Female SET staff	50%	53%
Total number of SET staff with doctoral degrees	33	46
Percentage of SET staff with doctoral degrees	15%	19%
Total number of SET staff with masters degrees	54	54
Percentage of SET staff with masters degrees	25%	22%
Total number of SET staff at middle and senior levels (SP, MP and SE)	111	98
Percentage of Black SET staff at middle and senior levels (SP, MP and SE)	68%	63%

Employment statistics

OCCUPATIONAL LEVELS	MALE					FEMALE					TOTAL
	A	C	I	W	NSA	A	C	I	W	NSA	
Top Management	2			1							3
Senior Management	6			3		1		1	2	1	14
Professionals, Specialists and mid-management	15	1	4	12	4	14	1	4	6	2	63
Skilled technical, academically-qualified, junior management and supervisors	85	6	3	18	5	133	5	5	18	2	280
Semi-skilled	72	5		1		20	1				99
Unskilled	46	1				1					48
Total Permanent	226	13	7	35	9	169	7	10	26	5	507
Percentage	45%	3%	1%	7%	2%	33%	1%	2%	5%	1%	100%
Gender Percentage	57%					43%					

SET vs Support staff



Developing research leaders, some new doctorates awarded



Dr Lerato Machogo-Phao, Scientist-in-Training in the Analytical Chemistry Division graduated with a PhD degree in Chemistry from the University of the Witwatersrand. Her PhD research project aimed to look at the beneficiation of one of the country's most precious minerals.

Mintek currently has **20 SET staff members** pursuing doctorate degrees in various fields of science and engineering as part of the **SET Postgraduate Qualifications Enhancement Programme**.

The topics undertaken by these candidates are aimed at **strengthening and developing new divisional competencies in core research areas**.



Dr Kirsten Youlton, Scientist in the Mineralogy Division received a PhD in Geosciences from the University of the Witwatersrand for a research project entitled "The Study of Alternative Leaching Processes on South African Gold Ores".

Developing research leaders, some new MSc's awarded



Tsholofelo Koadibane, Engineer in the Minerals Processing Division graduated with an MSc in Project Management from the University of Pretoria. Her MSc research is titled "The use of maintenance management technologies in the South African coal mining industry".

Mintek currently has **38 SET staff members pursuing Masters degrees** in various fields of science and engineering as part of the **SET Postgraduate Qualifications Enhancement Programme**. The topics undertaken by these candidates are aimed at strengthening and developing new divisional competencies in core research areas.



Martin Sitefane, Senior Engineer in the Pyrometallurgy Division was awarded a MSc. in Engineering by the University of the Witwatersrand. His dissertation addressed "The evaluation of sintering as a potential cause of dust blockage for a submerged arc furnace applied in silicomanganese production."



Patricia Maphutha, Senior Engineer in the Pyrometallurgy Division obtained an M.Eng in Metallurgical Engineering from the University of Pretoria. Her dissertation is titled "Investigation into the dephosphorization of ferromanganese alloys for production of advanced high strength steels."



Aphelele Sithole, Engineer in Pyrometallurgy Division was awarded an M.Eng degree in technology management (Cum Laude) by the Department of Industrial Engineering at the University of Stellenbosch.



Nozuko Mani graduated with an MSc (Eng) - Mining Engineering (Mineral Economics) from the University of Witwatersrand. Her research project is titled "Transfer of Social Labour Plan commitments during the sale of a mine: Rustenburg Platinum and Vedanta Zinc International (formerly Black Mountain Zinc Mining) case study".

Staff recognition by industry bodies



Dr Joalet Steenkamp, Technical Specialist in Pyrometallurgy Division was appointed a representative for the **Professional Development Committee (PDC)** of the Extraction & Processing Division Council (EPD) effective 30 March 2021 for a two-year term.



Dr Amanda Skepu, Chief Scientist who heads the Mintek Diagnostics Unit of the Health Platform in the Advanced Materials Division was appointed a member of the **UNISA Life Sciences Faculty Advisory Board Committee**. As a committee member, she will provide advice to the Life Sciences Faculty on academic curriculum, identify research opportunities and professional development of academic staff.



Dr Elias Matinde, was nominated as the incoming **Junior Vice President** and will commence his role as Junior Vice President in August 2021. Dr Elias Matinde is currently employed as the Head of Research and Development in the Pyrometallurgy Division at Mintek.



Dr Jestos Taguta, Research Engineer in the Minerals Processing Division received the **National Research Foundation (NRF) Y-rating**. The rating was awarded based on the quality of his research outputs in recent past years

Staff recognition by industry bodies



Dr Alain Mwamba, Senior Engineer in the Advanced Materials Division was appointed in dual roles as the South African National Accreditation System (**SANAS**) **Technical Assessor** and Engineering Council of South Africa (**ECSA**) **Mock Accreditation Panel member**.



Dr Quin Reynolds, Principal Engineer in the Pyrometallurgy Division was **appointed Associate Professor (extraordinary)** in the Department of Process Engineering, Stellenbosch University for a three-year period. The Associate Professorship in this category of appointment give recognition to individuals for their proven specialized expertise.



Taswald Moodley, was **awarded the First Prize (formerly known as the ECSA award)** in the main category at the University of KwaZulu-Natal (UKZN) Postgraduate Research Symposium (PRIS) which consisted of over 800 delegates from all disciplines within the College of Agriculture Engineering and Science.



Kondwani Banda, a research engineer in the Pyrometallurgy Division was **elected Treasurer for the Young Professionals Council** of the Southern African Institute of Mining and Metallurgy (SAIMMYPC) for the period 2020-2021. The appointment sets precedence towards being elected, secretary in 2021, vice chairman in 2022 and chairman of the SAIMMYPC in 2023.

Research, Development and Innovation Perspective



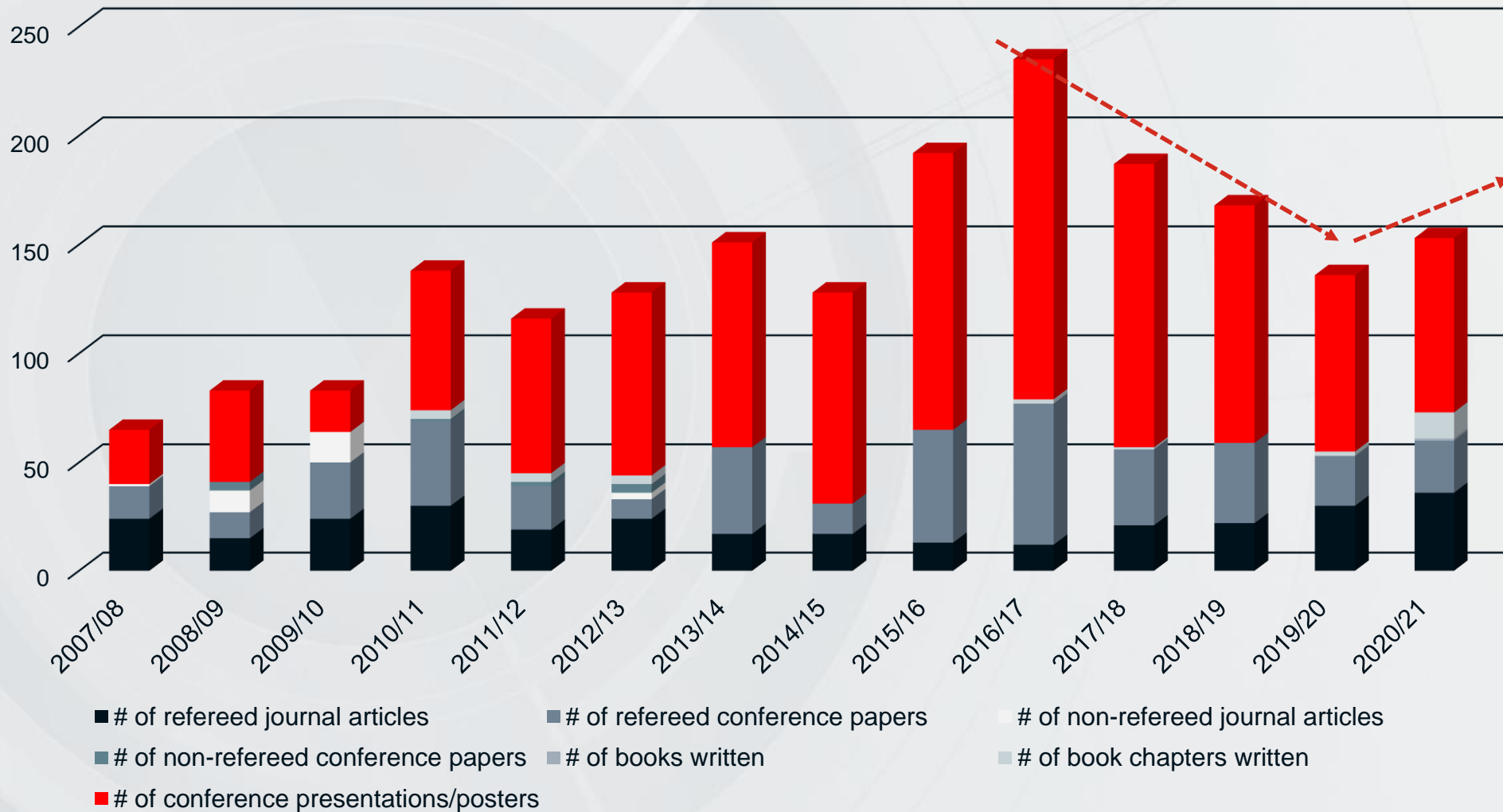
Performance with respect to KPI's - 2020/21

STRATEGIC OBJECTIVE #1: Conduct Relevant, Applied Research & Technological Innovation

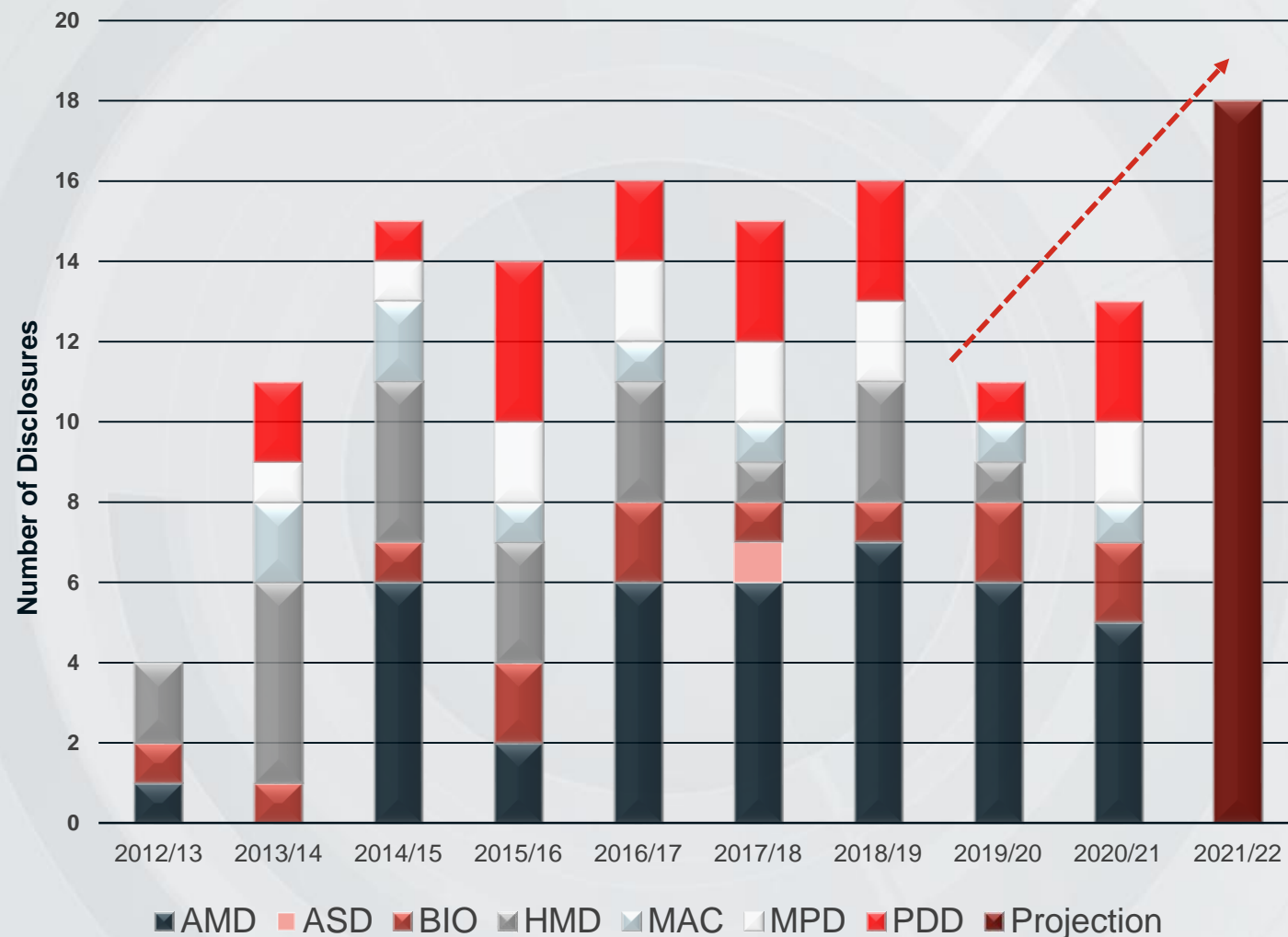
Key Performance Indicators	Target 2020/21	Performance 2020/21
Number of journal papers	30	36
Number of conference papers	70	24*
Number of book chapters	4	12
Number of books	0	1
Number of invention disclosures	18	13
Number of patents	4	5
Number of trademarks	8	5

* 80 Conference presentations & webinars

Knowledge dissemination: publications by type

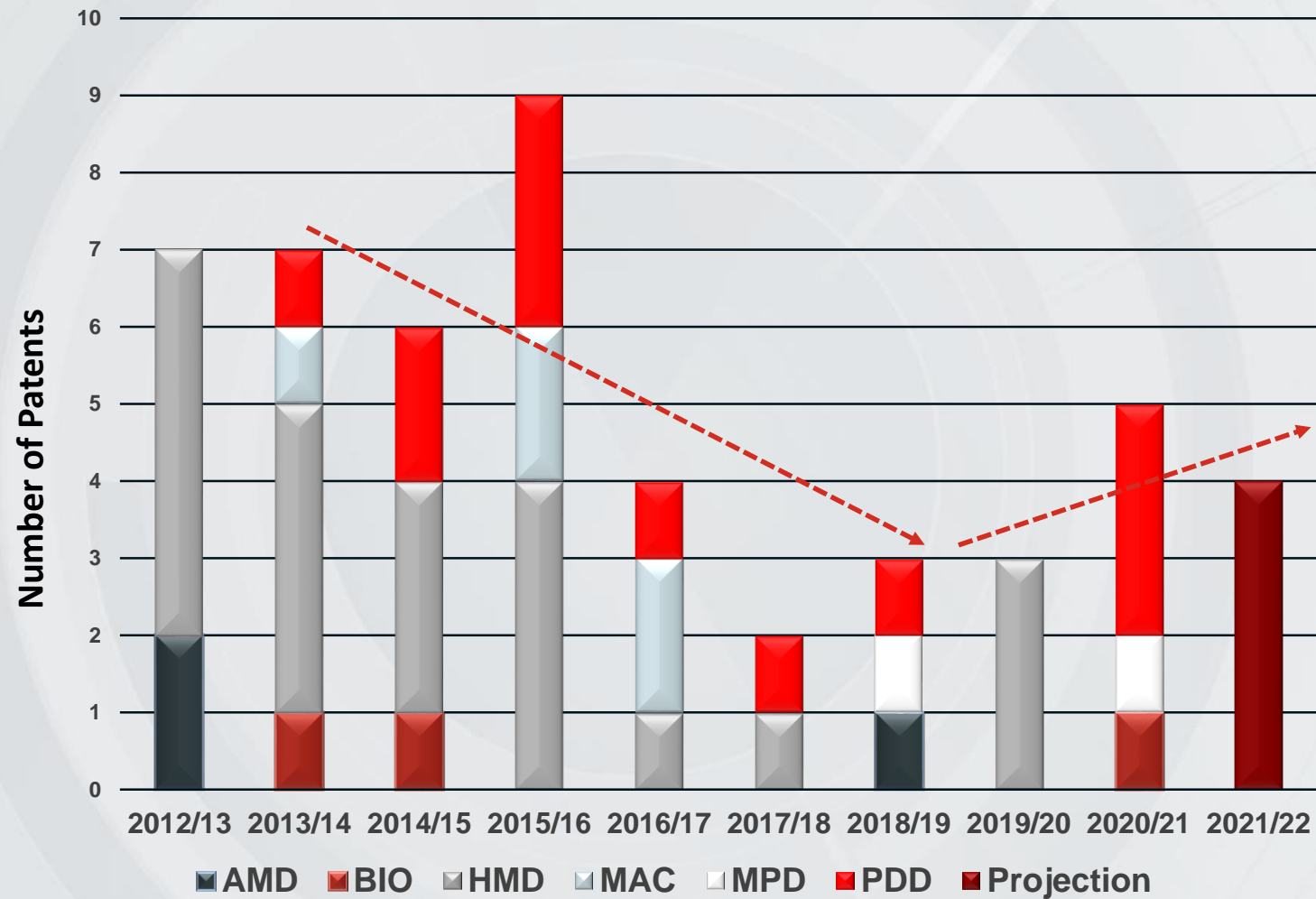


Invention disclosures



- Over the past 9 years Mintek has filed 116 invention disclosures and 45 provisional RSA patents applications.
- In 2020/21 Mintek filed 13 invention disclosures, these include:
 - An Agglomeration Binder
 - Improved Stirred Media Mill Stirrer Design
 - Magnetic Process Separator for Ferromagnetic Ores
 - Co-gasification of Urban Bio Waste
 - Solar Heap Leaching
 - DC Dual Electrode Furnace Control
 - Magnetic Slag Conditioning
 - Anti SARS-Cov-2 Spike Bivalent Nanobody
 - Single Chain Variable Fragment Based on CR3022 Monoclonal Antibody
 - Inverse Froth Factor for Flotation
 - Novel SARS-CoV-2 N501Y Gene Sequences (Covid19Variant)
 - Lateral Flow Device for Detection of HIV
 - Antibacterial CuO_PES Membrane

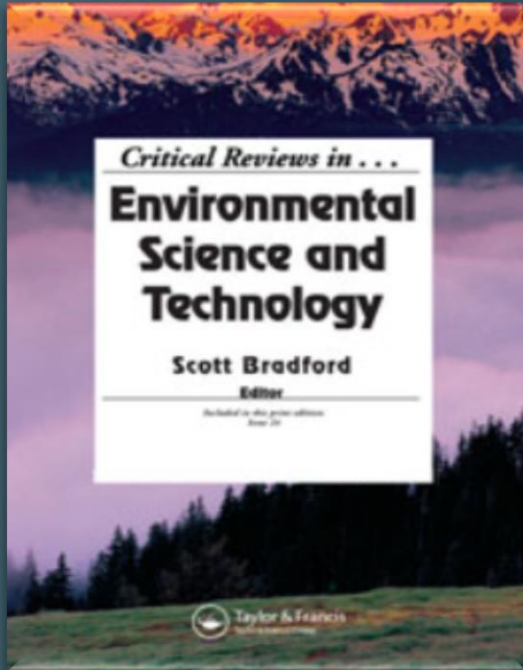
Patents



- Mintek registered 46 provisional RSA patents over the period 2012-2020
- In 2020/21 Mintek registered 5 patents:
 - Phosphorus recovery and syngas generation from biowaste (UrbanSynMetPhos)
 - Magnetic Slag Conditioning
 - Process electrical and electronic waste (eWasteSmelt)
 - Stirrer Member
 - Binder for agglomeration process

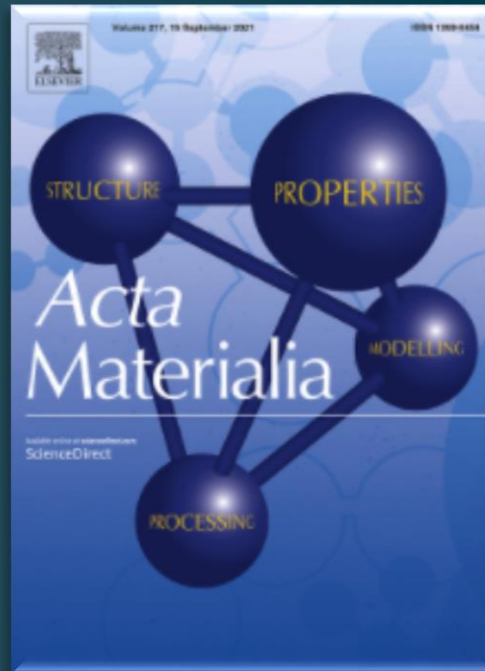
Quality: research published in top journals

- Mintek published 36 journal articles in accredited journals
- **69% had an impact factor of 2 or higher**
- Examples of high-impact factor publications:



Catalytic wet air oxidation of phenol” Review of the reaction mechanism, kinetics, and CFD modelling.

Impact factor 8.3



Efficiently Exploiting Process-Structure-Property Relationships in Material Design by Multi-Information Source Fusion.

Impact factor 8.2



Indium Phosphide Nanowires: Synthesis and integration into a Gas Sensing Device.

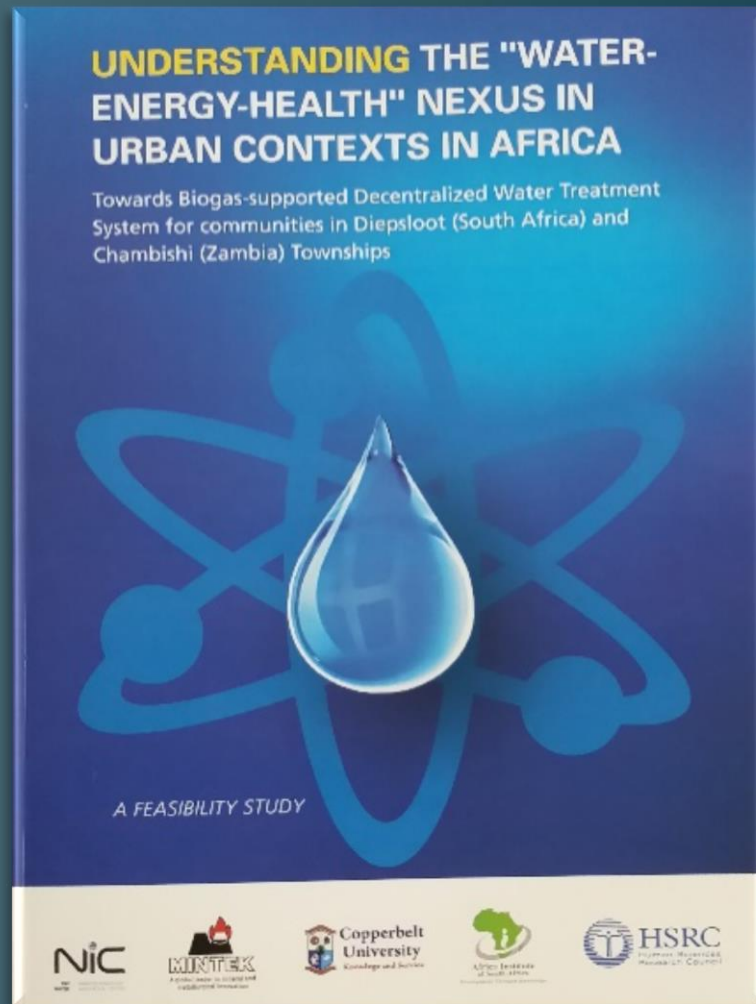
Impact factor 7.4



Green synthesis of AgMgOnHaP nanoparticles supported on chitosan matrix: defluoridation and antibacterial effects in groundwater.

Impact factor 5.9

Knowledge dissemination: book publications

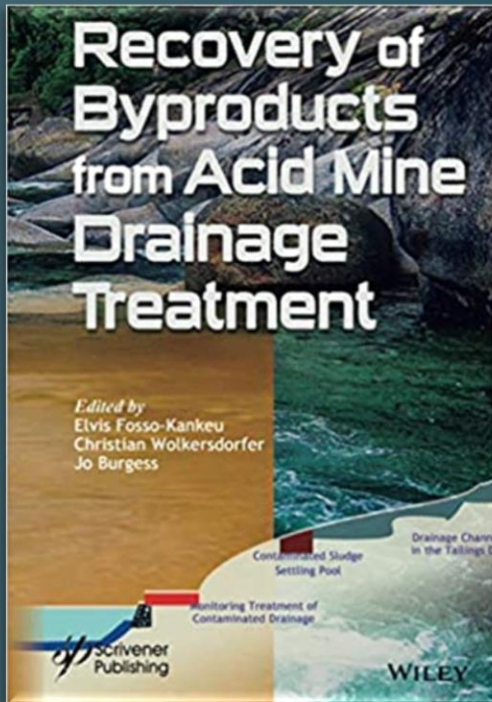


Mintek published 1 book in 2020/21 FY:

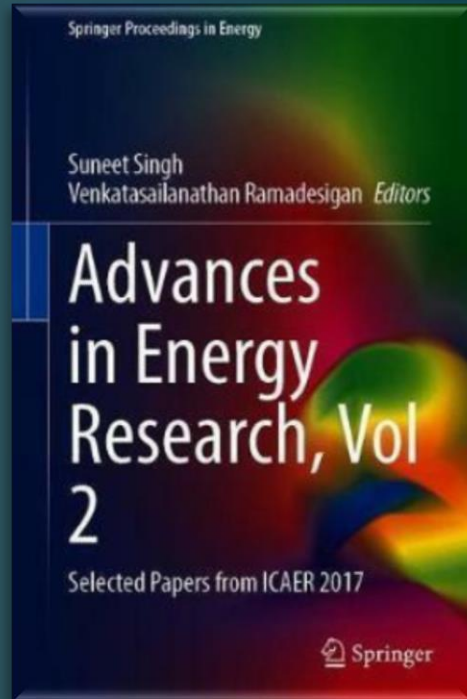
- The book explored the **potential of renewable-energy driven, decentralized water supply for the sustainable development of townships** in growing African cities.
- The study sites were Twaiteka Ward in Chambishi, Zambia, and Diepsloot Township in South Africa. Both are located on the outskirts of the two growing cities of Kitwe and Johannesburg, respectively, and they face common challenges: **They both have rapid population growth and inadequate (or in some cases, total lack of) essential services from their respective local authorities, and both experience a plethora of socio-economic challenges.**
- Findings show that a **one-size-fits-all approach cannot be applied** as each location requires context-specific solutions given the spatial variations in the nature and character of the vulnerable communities in the respective communities

Knowledge dissemination: book chapter publications

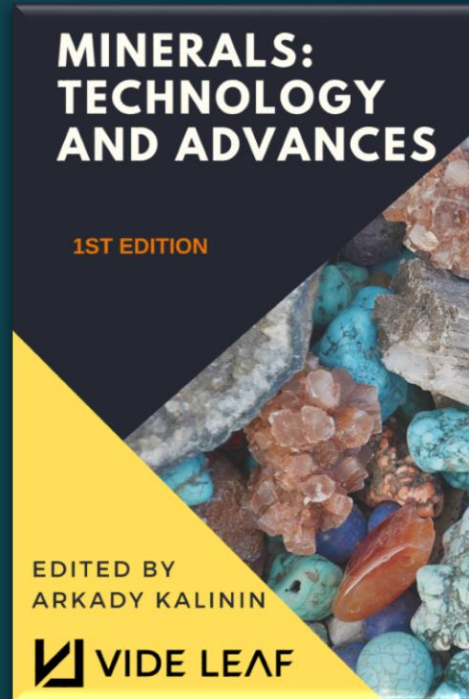
- Mintek published 12 book chapters in accredited books
- Examples of book chapters published:



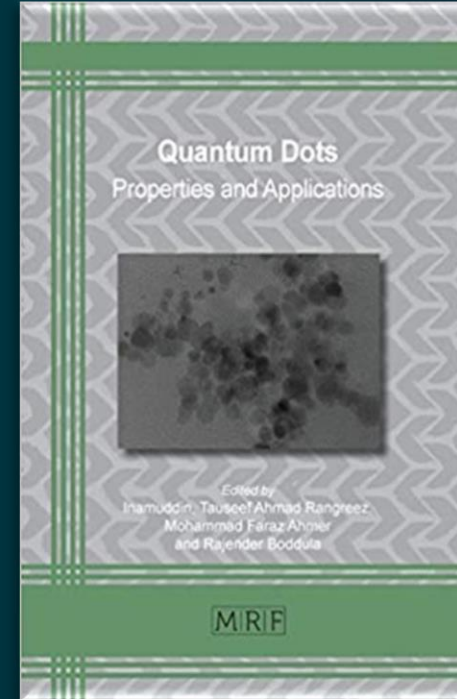
Optical and Morphological Properties of ZnO and TiO₂ derived Nanostructures Synthesized via Microwave-assisted HT method



The Prediction of Acid Mine Drainage Potential Using Mineralogy



Rare Earth Elements – A Treasure Locked in AMD

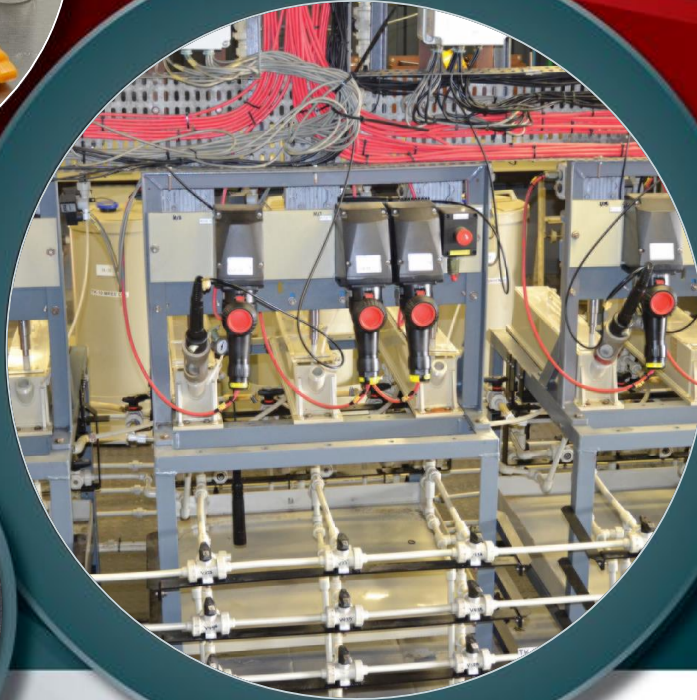


Hydrogen storage: Materials, Kinetics and Thermodynamics



Preparation and Characterization of Glass-Ceramic Composites from South African Coal Fly Ash

Industry Development Perspective



Performance with respect to KPI's - 2020/21

STRATEGIC OBJECTIVE #2: Foster Industry Establishment and Expansion

Key Performance Indicators	Target 2020/21	Performance 2020/21
Number of new prototypes, processes and/or models demonstrated/validated in a relevant environment	16	12
Income from the sale of products & services, royalties and licences, (Rm)	74.7	103.04
Number of IP Licences	2	0

Transforming mine-impacted water into a resource

Objective

Sulphate, acid and a range of metals are common contaminants of mine-impacted waters from certain sectors of the mining industry, especially coal and gold mining. **Mintek has developed a biological technology to treat the water and render it suitable for use in irrigated agriculture.**

Biological Sulphate Reduction
(the cloSURE™ process)



Achievement for 2020/21

- **Proved at pilot scale at Thungela Resources (formerly Anglo Coal) that water can be treated and is suitable for use in the agri-industry.**
- Ongoing pilot-scale programme evaluating use of liquid organic waste as substrate and inert beds to improve operability and reduce operating costs.
- **Thungela Resources has approved funding for construction of a demonstration-scale plant; detailed plant design has been completed, and construction project has commenced.**
- Mintek has secured funding from TIA for participation in design, commissioning and operation of the demonstration plant.

Next step: Construction of demonstration plant expected to be completed in March 2022, with commissioning and multi-year operation to commence thereafter. Treated water will be applied in an agricultural programme (in partnership with the University of Pretoria).

Establishing eWaste Processing Capacity in South Africa

Objective

Development of an integrated process flowsheet to **recover valuable metals such as copper, tin, lead, zinc and precious metals such as silver, gold, palladium and platinum from low grade waste electrical and electronic waste (WEEE) streams.** Processing technology specifically designed for low value cathode ray tubes (CRTs) and printed circuit boards (PCBs).

Achievement for 2020/21

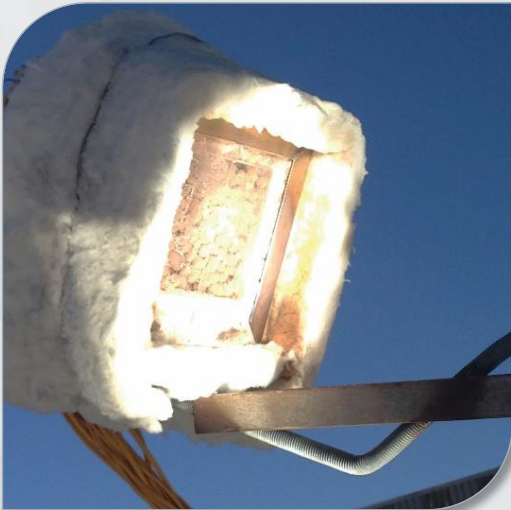
- CRTs smelting flowsheet successfully demonstrated in 4-week pilot campaign
- Discovery was made to integrate processing of CRTs with processing of PCBs by recycling of CRTs slag (as flux) to PCBs furnace, and recycling of PCBs fumes (as source of lead, zinc and tin) to CRTs furnace
- **South African provisional patent for eWasteSmelt™ process filed 16 July 2020**

Next steps

- Undertake fundamental studies on the integrated flowsheet to advance development of the process and provide experimental evidence to support claims of the IP for filing of complete patent
- Design and install second rotary furnace to develop existing facility to demonstrate the overall **eWasteSmelt™** process flowsheet by operating CRT and PCB smelting furnaces simultaneously in the same pilot campaign, to increase confidence in the integrated technology



Reviving the declining ferroalloys industry



Objective

Revival of the declining ferroalloys sector by the transfer of new technology, including the introduction of renewable energy, in the production of ferroalloys.

Achievement for 2020/21

- Significant technical progress made with H2020 PreMa programme, **confirmed proof of concept to reduce energy consumption by 25%.**
- Proof of concept completed for the pre-heating of ore prior to smelting.
- Solar dish acquired by Mintek to demonstrate technology.
- Process control equipment installed on a number of ferroalloy furnaces.
- **Participated in DMRE team addressing interventions to assist the sustainability of the ferroalloys sector.**

Next step: Installation of the Solar dish to be completed to allow demonstration of the technology developed. Continued engagement with the DMRE and sector to address sustainability issues. **Establishment of Ferro Alloys Research Association of South Africa (FARASA) with joint funding from African Rainbow Minerals and Mintek.**

Commercial Smelting Complex for the Processing of Titaniferous Magnetite

Objective

In addition to PGM and chrome rich layers, the Bushveld Complex contains vanadium bearing titaniferous magnetite layers, containing a vast proportion of the World's vanadium and titanium. **There is currently no demonstrated and proven economic process for the co-extraction of vanadium, titanium and iron as saleable products. Mintek is addressing this.**

Achievement for 2020/21

- Multi year MTEF funded programme is in its 5th year. Main progress to date:
 - Technology assessment component completed and optimal process flowsheet determined.
 - Integrated technology facility at Mintek, including detailed engineering designs.
- **Integrated technology facility currently under construction at Mintek.**
- **Civils installation was completed and the mechanical structure is 95% complete.** Upgrade of electrical and instrumentation is in progress.



Next step: Completion of integrated technology facility at Mintek and thereafter demonstrate the process at a scale large enough to prove economics and attract investment (2022).

Derelict and ownerless mine rehabilitation



SOME NOTABLE ACHIEVEMENTS IN THE ASBESTOS REHABILITATION PROGRAMME DURING THE PAST YEAR INCLUDE:

Achieving practical completion of two (2) asbestos mine rehabilitation projects; Penge Village and Asbestos Mines in Limpopo Province.

Works at the Uitkyk, Lagerdraai and Uitval asbestos mines **rehabilitation** Lepelle Nkumpi municipality were **suspended due to ongoing community protests.**



Top: Erection of a gabion toe line during the construction phase

Bottom: The finished product showing erosion control channels and blankets in Dublin Asbestos Mine in Mafefe Village, Limpopo Province.

Derelict and ownerless mine rehabilitation



SOME NOTABLE ACHIEVEMENTS IN THE HOLINGS CLOSURE PROGRAMME DURING THE PAST YEAR INCLUDE:

Sealing of 41 goldmine holings in the Gauteng Province

Continuing with construction works to seal a further 14 holings.

Finalised designs for 20 a further 20 holings in the Gauteng Province.



Top: Unsealed GOU 14 shaft in Krugersdorp, Gauteng Province.



Middle: Construction in progress for the sealing of Modderfontein 14B shaft in Brakpan, Gauteng Province



Bottom: Marker post for the GOU 13 shaft sealed in Krugersdorp, Gauteng Province.

Performance with respect to KPI's - 2020/21

STRATEGIC OBJECTIVE #4: Develop and Maintain World-Class RDI Capacity

Key Performance Indicators	Target 2020/21	Performance 2020/21
Total investment in plant, property and equipment, (Rm)	50.30	46.35
Total investment in human capital, (Rm)	13.80	9.11
Lost Time Injury Frequency Rate	<1	0
Disabling Injury Frequency Rate	<1	0
Client Satisfaction Rate	>90%	94%
Safety, Health, Environment and Quality	Maintain Accreditation	Accreditation Maintained

Financial Perspective

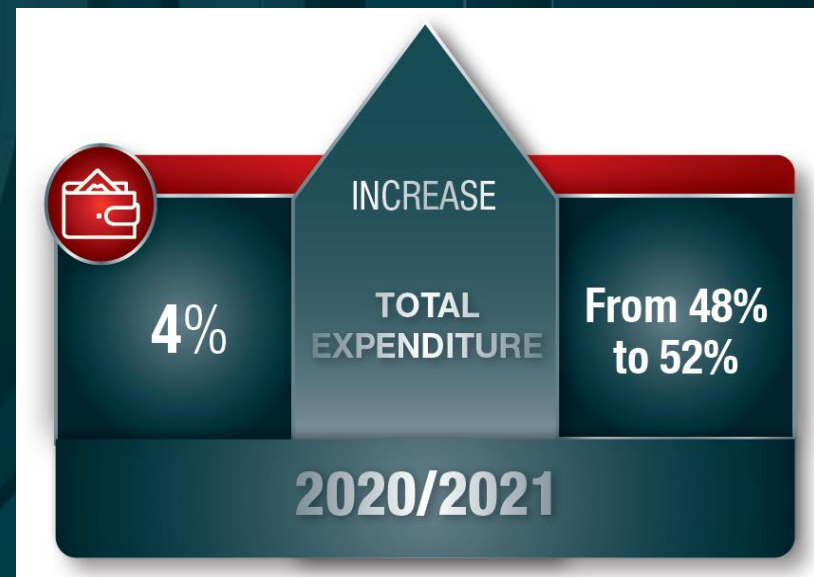
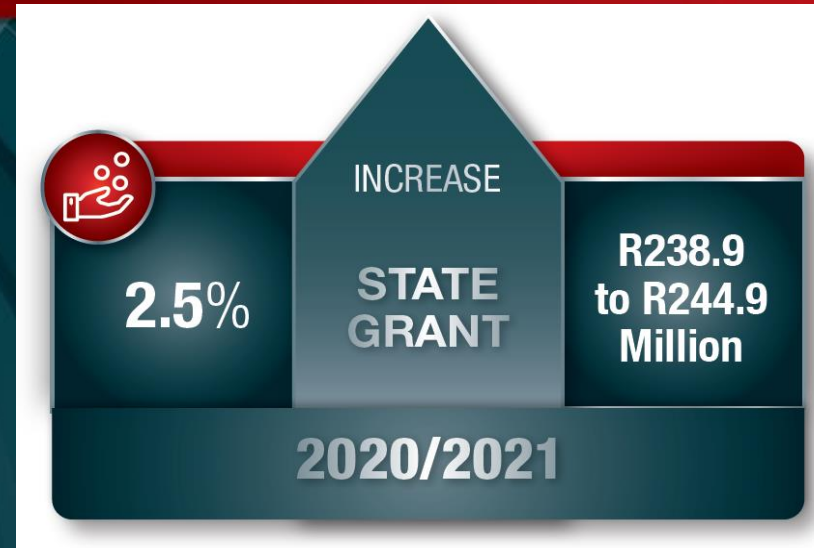


Performance with respect to KPI's - 2020/21

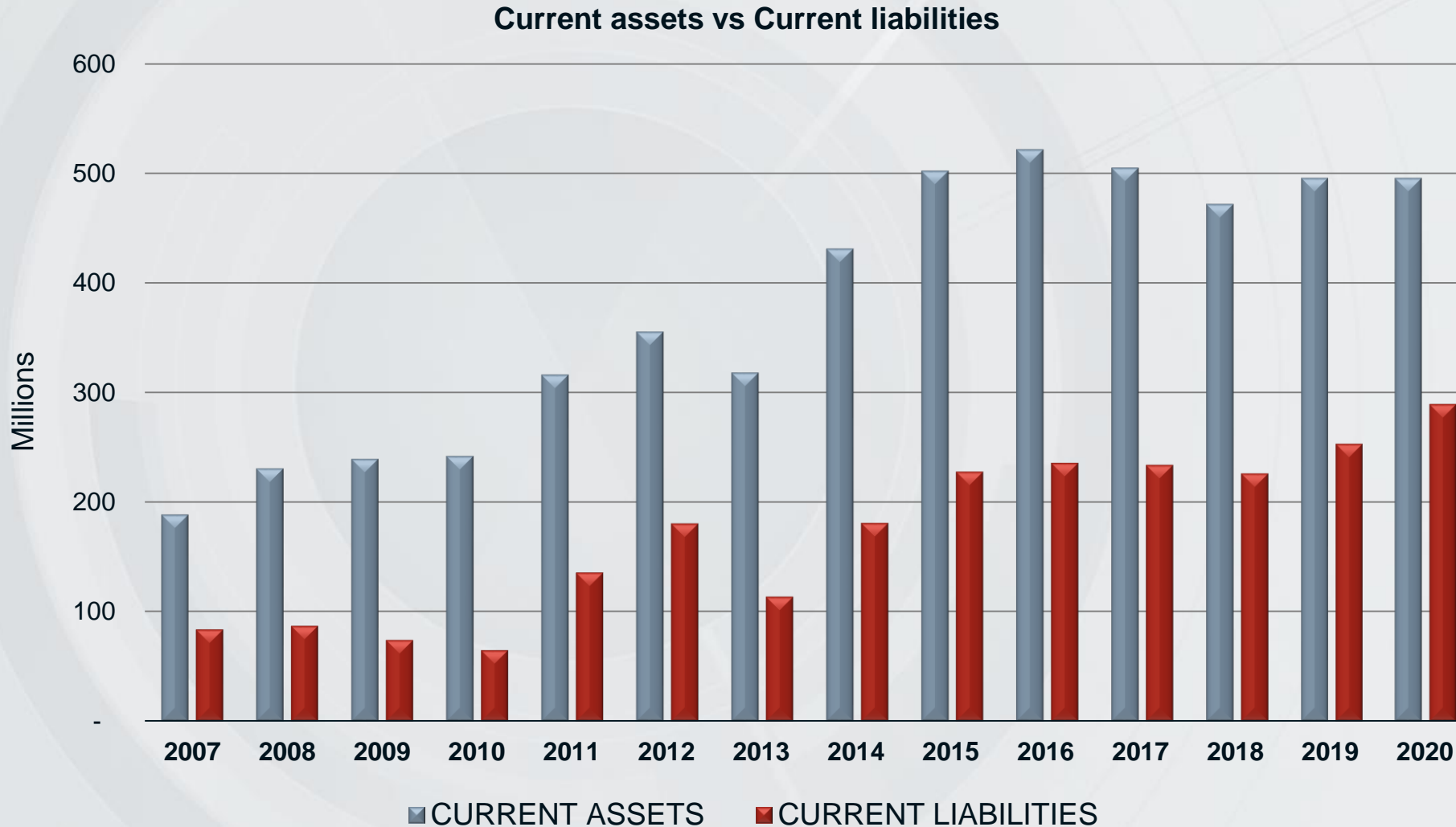
STRATEGIC OBJECTIVE #5: Financial Sustainability

Key Performance Indicators	Target 2020/21	Performance 2020/21
Total income, (Rm)	568.30	554.34
Net result, (Rm)	5.90	4.85
Contract R&D Income, (Rm)	52.90	56.92
BEE Spend as % of Procurement Spend	85%	94.01%
Audit opinion	Unqualified	Unqualified

Financial performance

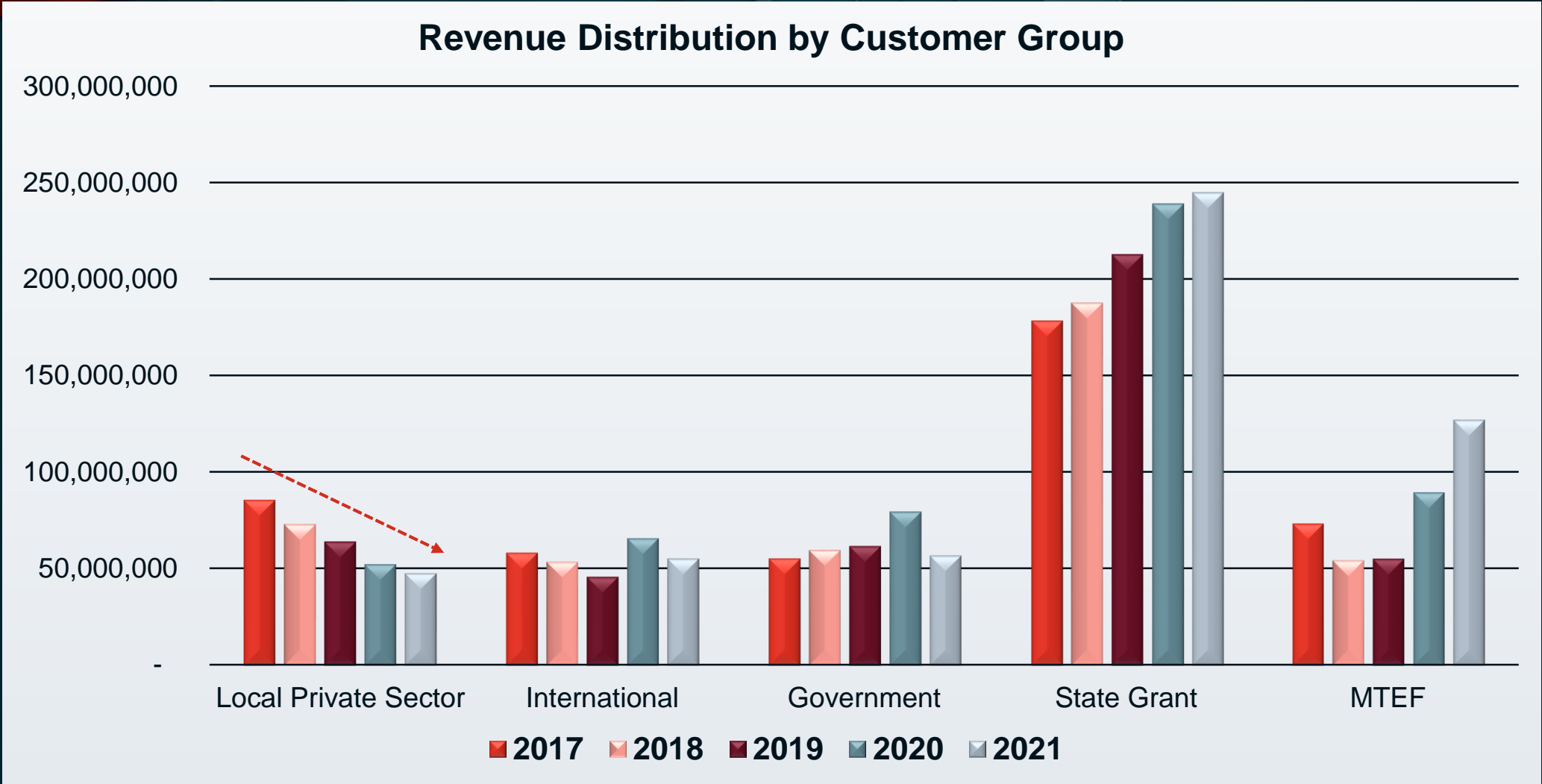


Financial position: working capital management

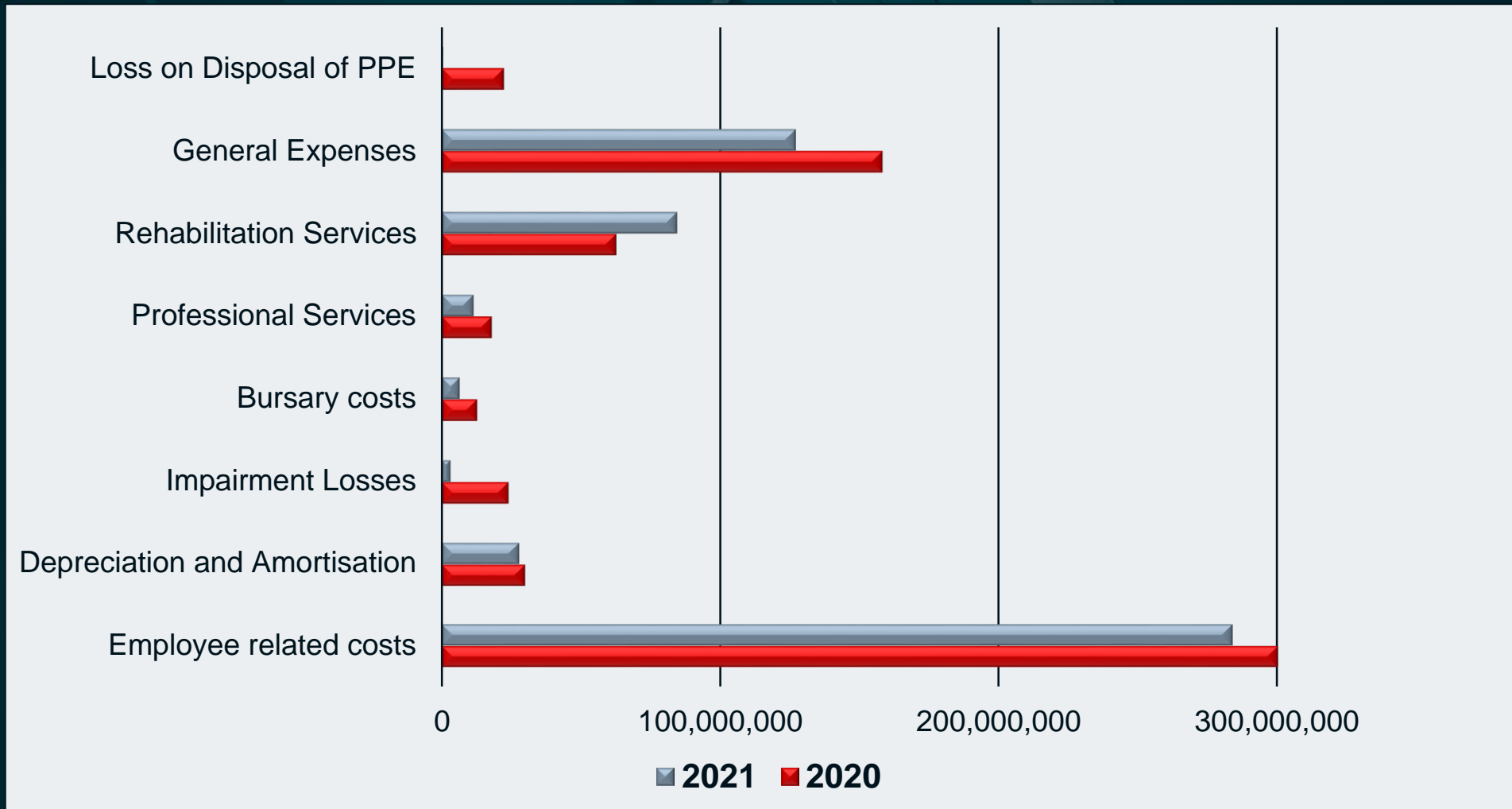


Cash locked up in working capital is a continuous focus area for Mintek. The current ratio is 1.7:1

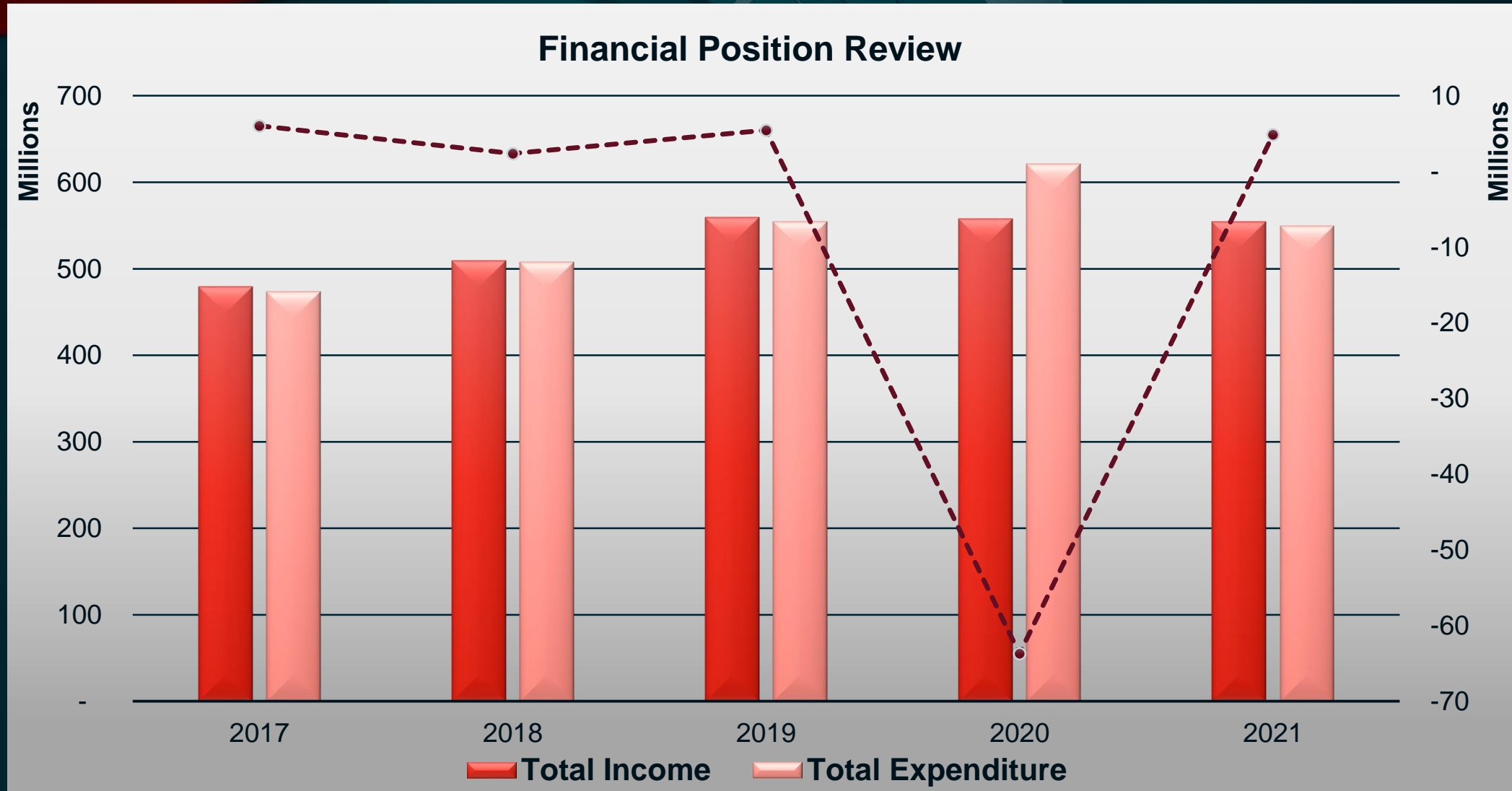
The ratio indicates that Mintek's short term obligations were adequately covered by current assets



Expenditure analysis



Net surplus / deficit



Audit opinion history



2005	Disclaimer			
2006		Qualification		
2007			Unqualified with Findings	
2008			Unqualified with Findings	
2009				Unqualified (Clean)
2010				Unqualified (Clean)
2011				Unqualified (Clean)
2012				Unqualified (Clean)
2013				Unqualified (Clean)
2014				Unqualified (Clean)
2015			Unqualified with Findings	
2016				Unqualified (Clean)
2017				Unqualified (Clean)
2018				Unqualified (Clean)
2019			Unqualified with Findings	
2020			Unqualified with Findings	
2021			Unqualified with Findings	



-
- World map showing Cynroprobe Countries FY20/21 in green. The map includes labels for major countries like Canada, United States, Mexico, Brazil, Russia, China, India, Australia, and New Zealand. A legend indicates that green countries are Cynroprobe Countries FY20/21.

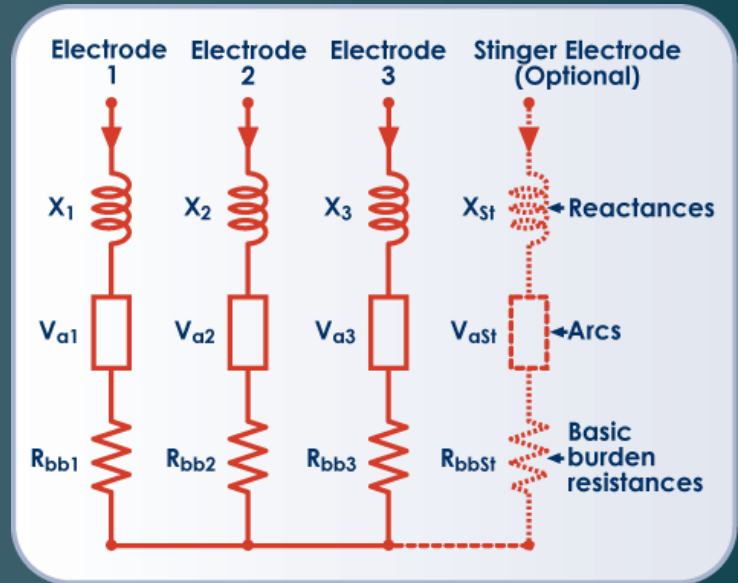
Global sale of products and services



Carbon Concentration Meter

- Online Carbon Concentration
- **Total of 28 units sold** during FY20/21
- Sustained performance in comparison to FY19/20
- **Countries:**
 - Papua New Guinea
 - Australia
 - Zimbabwe
 - Indonesia

Global sale of products and services - Ferroalloys

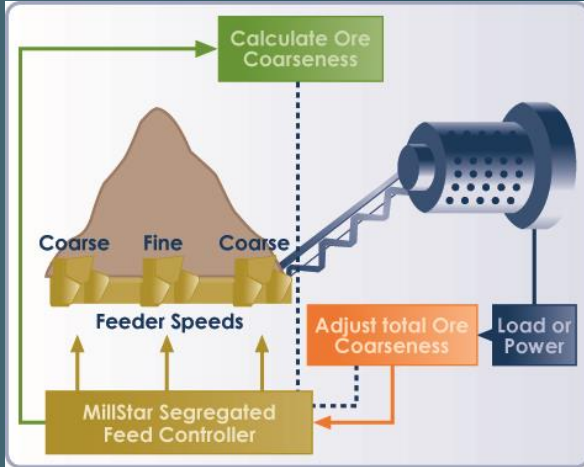


FurnStar

- Energy Management System for submerged-arc furnaces
- **3 FurnStar systems sold at a site in Brazil**
- Despite COVID-19 travel restrictions, Mintek was able to successfully **commission the systems remotely** (i.e. from their offices in Randburg while connected to a site in Brazil)



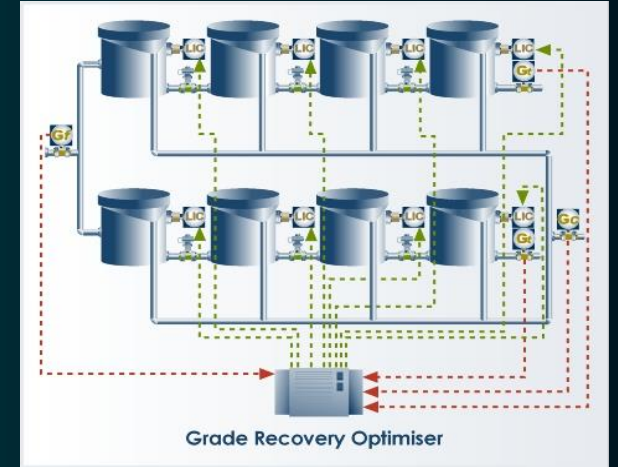
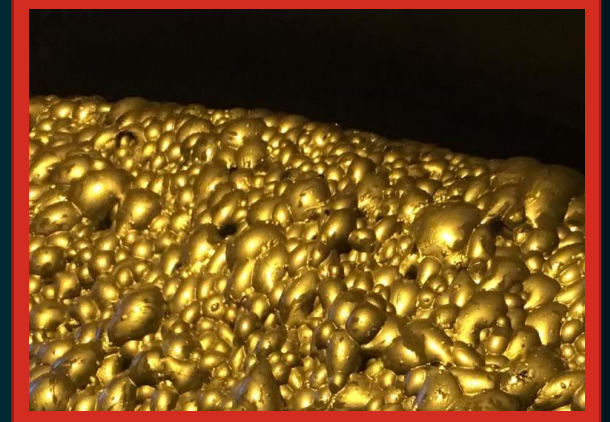
Global sale of products and services – Process Control



MillStar and FloatStar



- Control systems for milling and flotation processes on various commodities
- **First** commissioning of MillStar in **Egypt**
- **Second** commissioning of FloatStar in the **USA**
- First FloatStar installation at a **chrome mine** in **South Africa**
- **Maintenance and Support renewals:**
 - Sweden
 - Michigan, USA
 - Australia
 - Africa (RSA, Zambia, DRC, Guinea, Cote d'Ivoire)



Concluding remarks

- Mintek is in a transition phase **to fully align with our role as a research and technology organisation**, as well as an industry-focused research institution.
- We are implementing a new strategy that has already begun to deliver results with an improvement in the SET staff numbers, experience and qualification profile.
- Mintek is **building capacity in business development and commercialization** as well as **communication**.
- Rehabilitations projects were suspended due to **ongoing community protests**
- **Declining public and private sector investment in Research & Development is a major concern**
- **Mintek is 87 years old, recapitalization** is required to create Mintek RDI campus of the future
 - Mintek key capabilities are centered around **large scale pilot, testing and demonstration facilities** that are expensive to establish and maintain.
 - Buildings and research infrastructure **upgrades** have already commenced
- Overall, Mintek performed satisfactorily amidst the challenges posed by COVID 19 pandemic.



Thank You

A global leader in mineral and metallurgical innovation

MINTEK CONTACT DETAILS

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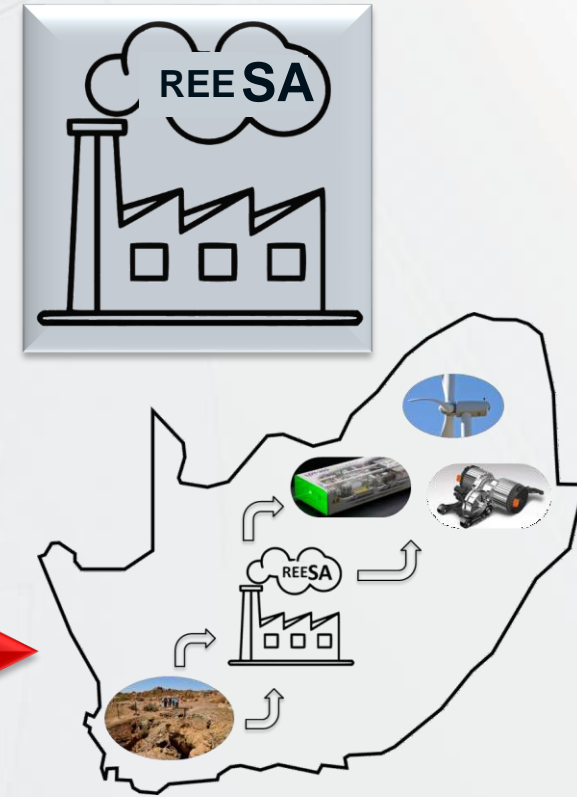
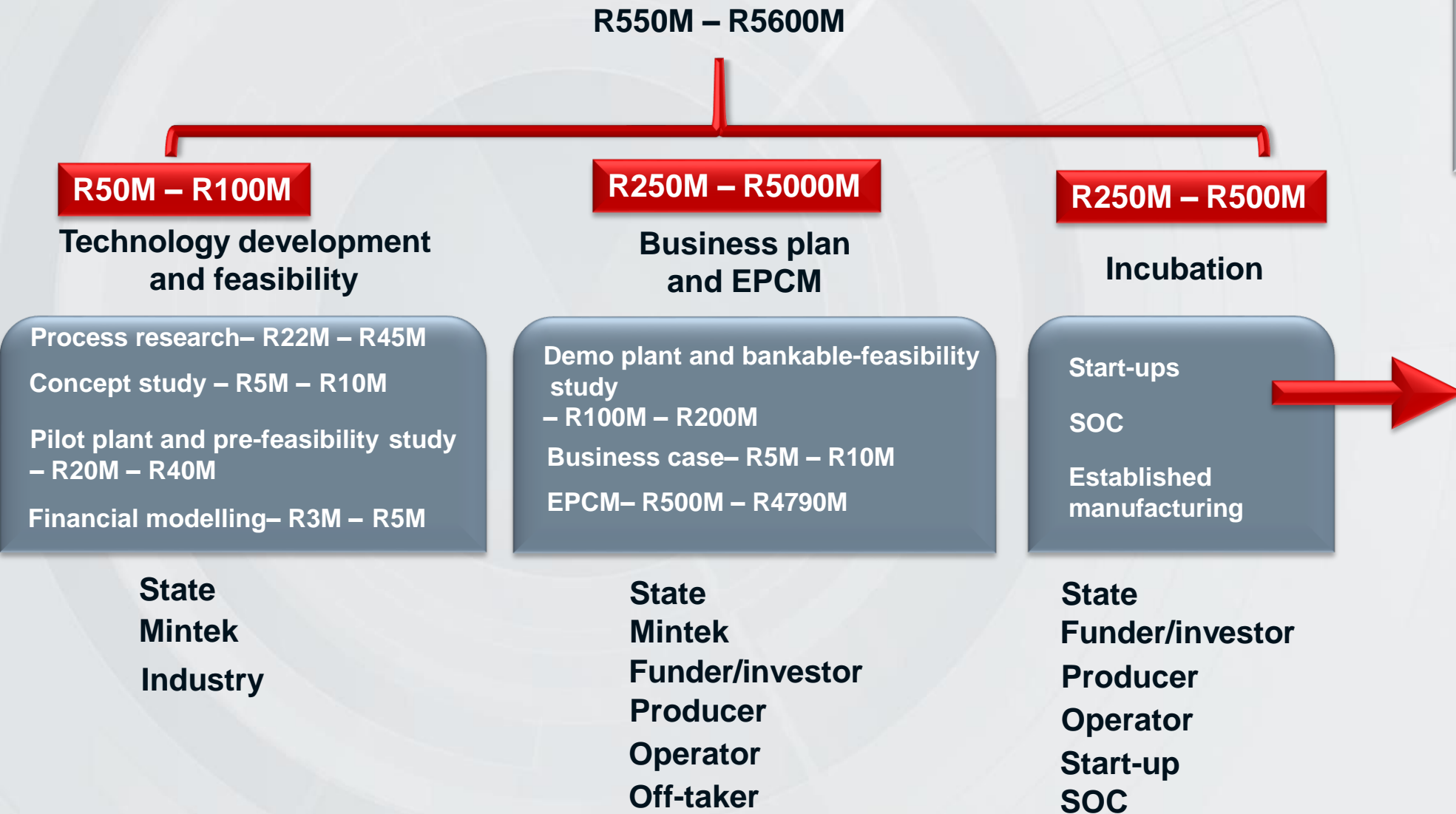
Required Support for Mintek Strategic and National Programs



- **Policy imperatives of industry revitalisation prioritised**
 - Ferro-alloy and Rare Earth Elements
- **Strategic Programmes**
 - Establishing a Local Rare Earth Element Mining and Manufacturing Industry,
 - Development of rapid diagnostic medical test kits,
 - Expanding fuel cell manufacturing infrastructure across the fuel cell value chain and
 - **e-waste recycling.**
 - **Design, procurement and construction** of a manufacturing facility for the production and establishing **ferro-alloy research program** with support from industry.
 - Revive the declining ferroalloys sector – mainly ferrochrome and ferromanganese
- **Cost pressures to launch new programmes** where research projects are expanded to the next level.

Establishing a Rare Earth Industry in South Africa

HOW? – *will all this be achieved?*



Battery precursor metals in South Africa



Electric vehicles
Smart-grid storage
Portable electronics



Electric cars, hard drives
Wind turbines
High-tech industries

Fluorspar

- Electrolyte for lithium ion batteries

1st

Manganese

- Cost-effective cathode for Li-ion batteries

1st

Vanadium

- Flow batteries

2nd

Titanium

- Advanced anodes for Li-ion batteries

4th

Nickel

- Advanced cathodes for Li-ion batteries

5th

Phosphate

- Electrolyte for Li-ion batteries

6th

Rare earth elements

- Permanent super magnets

L

SA reserve size vs global

A specific feature of these battery precursor metals is **exceptional purity.**



Technologies

Precursors

5-15 years

2-7 years

R50M – R100M

R250M – R1,250M







Technology development

Construction & commissioning

Feasibility and design studies

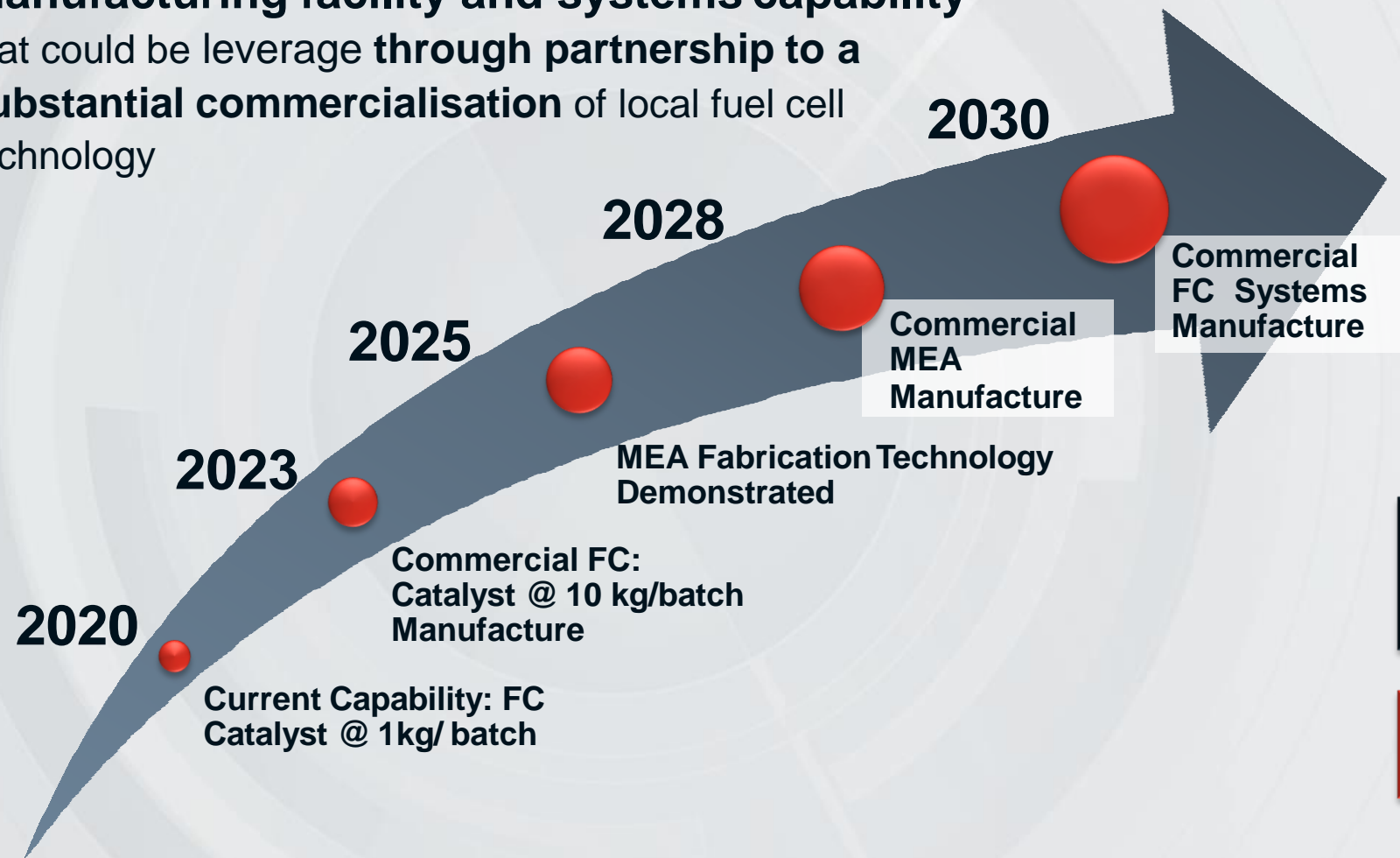
Towards production

-  Mintek
-  Partners
-  State
-  Regulators
-  Funder / investor
-  Producer
-  Implementer

Commercialisation of Mintek Fuel Cell Technologies



Establish and demonstrate a **commercial MEA manufacturing facility and systems capability** that could be leverage through partnership to a **substantial commercialisation** of local fuel cell technology



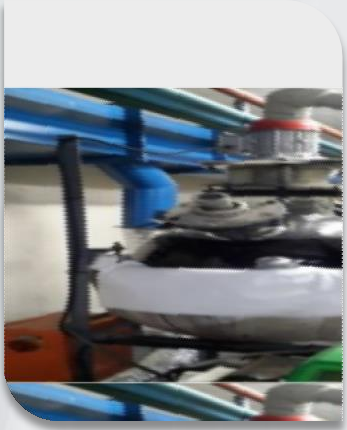
INVESTMENT SOURCE	Total 2020 – 2030, Rm
HySA	20
Mintek	200
MTEF	270
Partners (10:1 leverage)	5010
Total for 5% market penetration	5500

**HySA target of 25% for FC systems
~R29.6b revenue equivalent to
~17000 jobs in 2030**

**More realistic 5% for FC systems,
~R6b revenue & 3600 jobs**

New investment over the decade would need to approach a cumulative \$325m which could potentially represent a 10:1 gearing of the Mintek investment (~R500m by 2030 obtained from HySA, Mintek and MTEF) by collaborating partners and other commercial entities in South Africa that could use the Mintek products.

Fuel Cell catalyst scale-up for commercialisation



Bay 6.5

- 1 kg/batch scale
- 10 batches per year
- Enabled by **Impala 7kg Pt loan**

To 2023



Bay 5 (Catalyst Plant)

- 5-10 kg/batch scale
- +10 batches per year (with dedicated production staff)
- **Needs new Pt loan to do development**
- Addressable issues: filtering, milling, heat treatment (capex needed)
- Critical issues: source graphitized C or capex for large 2000°C furnace
- **High security needed**

Beyond 2023

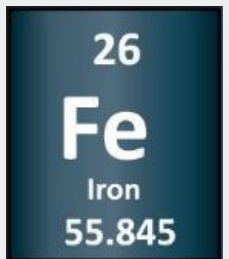
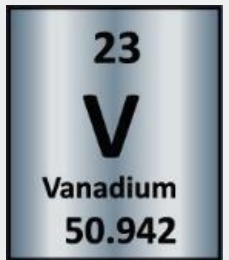
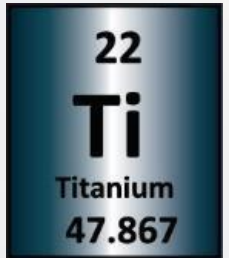
**50 kg/batch
New Plant**

- Guaranteed demand
- **New facilities**
- **Alternative site**
- **Investment**

The Bushveld Complex's VTM – background



- The Bushveld Complex: PGM and chrome rich layers, and vanadiferous magnetite layer contain vast proportions of the World's deposits of these commodities.
- VTM (vanadium-bearing titaniferous magnetite) contains **vanadium (V)**, **titanium (Ti)**, and **iron Fe** as magnetite.
- All these elements are in a complex oxide form (requires a thermo-chemical extraction process) – needs energy and chemical reactions to extract
 - Since closure of EVRAZ Highveld Steel in 2015 only small activity to extract vanadium
 - About 90% of the world's vanadium production was recovered from the titanomagnetite resources (2019) – mainly in China
 - SA has second largest vanadium reserve globally in Bushveld Complex



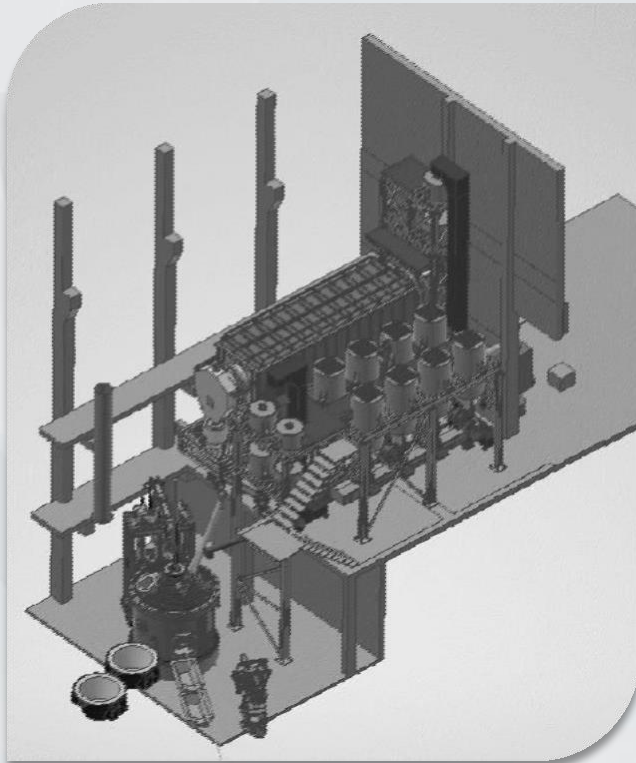
Establishing a VTM smelter in South Africa

HOW? – *will all this be achieved?*

Implementing the best available technology

R116 million MTEF

Demonstration at Mintek of economically viable smelting technology (BAT)

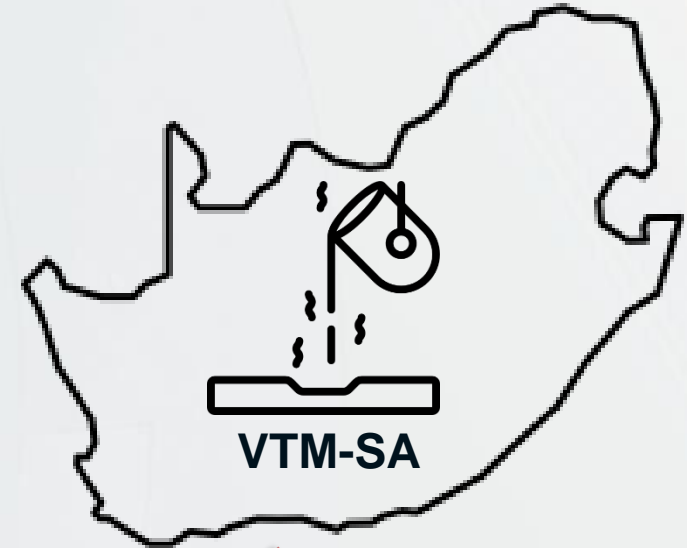


State
Mintek
Industry

R1000 to 3000M

Industry partner to develop VTM deposit for a smelting complex (2x60MW furnaces) for a detailed engineering design

Industry, Funders, IDC, PIC, Government





Problem:

- Discard coal > 60 million tonnes/year, > 2 billion tonnes
- Under utilisation of high grade coal fines
- Ageing Infrastructure



Opportunity:

- Circular economy approach
- Technology development





Technology demonstration

100M

Technology development and
demonstration

3 – 5 years

Towards Industrialisation

1000M

BFS & detailed engineering design,
Construction & commissioning

4 – 7 years