Mintek Annual Performance Plan 2021-2022

Presentation to the PPC on Minerals & Energy

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A global leader in mineral and metallurgical innovation

Outline

- Mintek at a glance
- Mintek corporate scorecard 2021/22
- Mintek's strategic framework
- Overview of key challenges and outlook
- Concluding remarks

Mintek at a Glance

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Mintek Mandate

"The objects of Mintek are through **research**, **development** and **technology transfer**, to **promote mineral technology**, and to foster the **establishment** and **expansion of industries** in the **field of minerals** and **products** derived therefrom."

(Mineral Technology Act No 30 of 1989)

Mintek is a Research and Technology Organisation (RTO)

Mintek is a Schedule 3B Entity

Mintek Mandate

***Aligning Mintek's mandate, as articulated in the Mineral Technology Act, suggests that the activities of*:**

- Research
- Development and
- Technology transfer

are pursued in order to achieve the following:

- improvement of minerals technology – particularly to enable better utilisation of minerals of the Republic
- improvement of technical processes and methods particularly improve mineral production
- promotion and expansion of existing industries in the field of minerals and products derived therefrom
- establishment of new industries in the field of minerals and products derived therefrom

It is with this lens that the priorities are assessed for applicability to Mintek and alignment with goals.

Mintek | Our focus along the mining & minerals value chain








Exploration → Mining → Concentration → Extractive Metallurgy → Refining → Manufacturing → Post mining

SECONDARY FOCUS — **PRIMARY FOCUS**

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

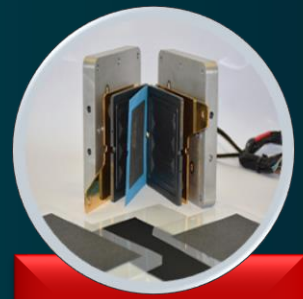
Mintek's integrated value chain

Mineralogical & Analytical Testing

Small Scale Mining & Urban Mining

Mineral Processing (Concentration)

Pyrometallurgy



Digital Platform

Value Addition / Manufacturing

Post Mining Landscape

Hydrometallurgy

Biometallurgy

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

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Mintek at a Glance: 2021 preliminary results

EMPLOYEES COVID TESTS TO DATE: 4 439 & SCREENING: 129 817

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: **63%**
- SET - PhD: **46 (19%)**
- SET - MSc: **54 (22%)**
- SET BSc/Eng.: **69 (28%)**

Financial Perspective

- Products & Services: **R102 m**
- Total Income: **R542 m**
- Total Expenses: **R551 m**
- Deficit: **R9 m**
- Investment in HCD: **R12 m**
- SET at Lower-Middle level: **145 (60%)**
- BEE Spent: **94%**
- Liquidity ratio: **1.7:1**

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: **1**
- Invention disclosures: **13**
- IP Licence Agreements: **0**

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Mintek Strategic Framework

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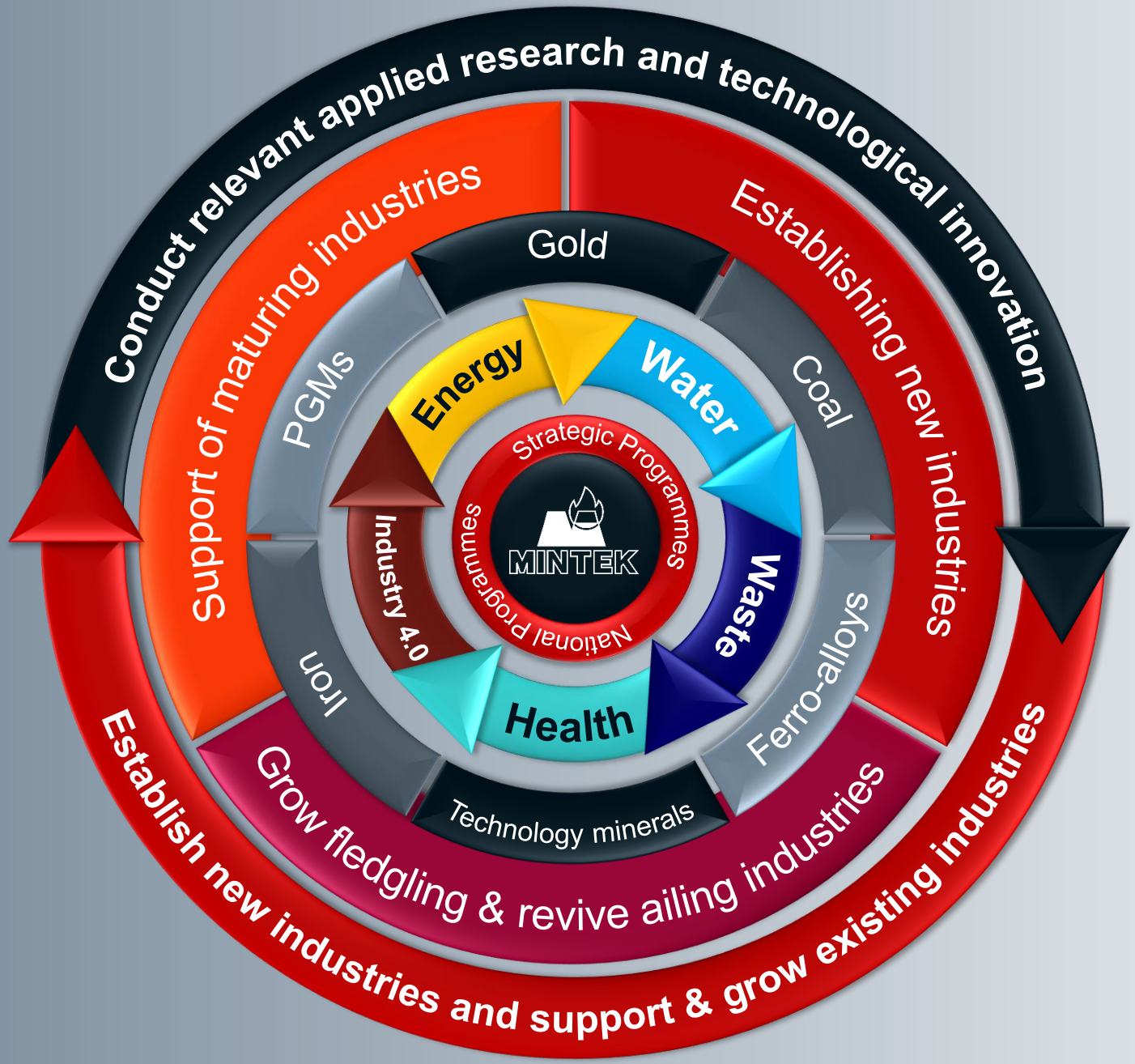
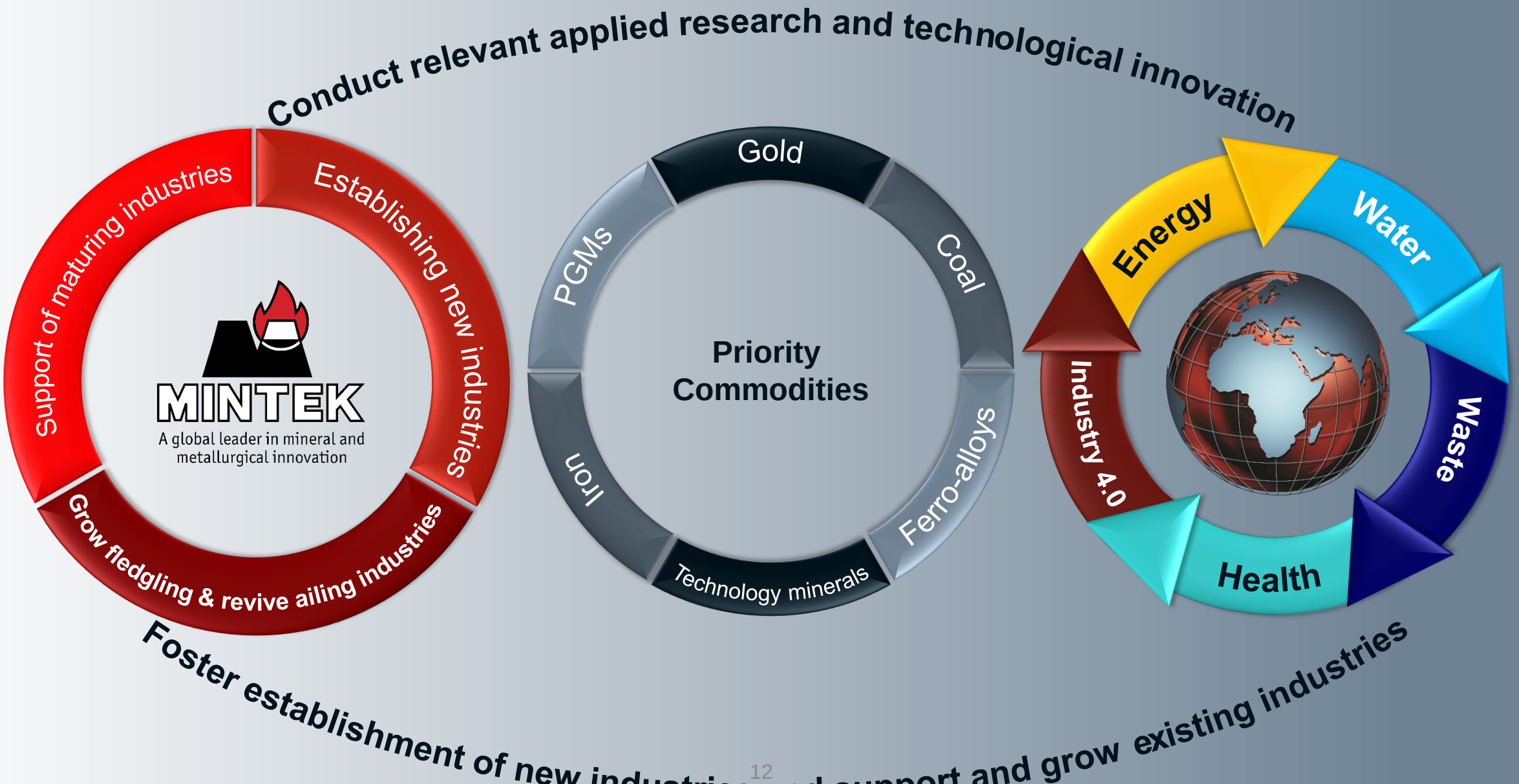
Mintek Strategic Framework – at a glance



Pillars of the RDI Strategic Framework



Priority commodities

Importance to South Africa
- 90% of global resources

Current state of the industry
- Mature, settled processing
- Changes in demand

Opportunity/problem statement
- Hydrogen economy
- Fuel cells

Importance to South Africa
- Major contributor to economy
- 4.2% of global gold production

Current state of the industry
- Declining grades
- Ageing infrastructure & technologies
- Rising costs
- Deep-level mining

Opportunity/problem statement
- Extending the life of operations
- Recovery from wastes
- Sweating assets & technical support

Importance to South Africa
- South African iron ore is globally in demand as sweetener in ironmaking
- 3rd largest exporter of iron ore

Current state of the industry
- Grades declining, sterile deposits requires unlocking

Opportunity/problem statement
- Unlocking of sterile deposits, and fines

Priority commodities

Importance to South Africa
- Major contributor to economy
- Reserves for more than >50 years

Current state of the industry
- Primary energy carrier
- Environmental pressures

Opportunity/problem statement
- Greening of coal, waste processing
- Alternative energy, gasification
- Eskom support

Importance to South Africa
- Major contributor to economy
- Dominant reserve position Cr, Mn

Current state of the industry
- Smelter closures
- Dramatic rise in exports (Cr, Mn)
- Energy intensive (electricity) users

Opportunity/problem statement
- Renewable energy
- Hydrogen reduction
- Low-grade ore
- Revival

Importance to South Africa
- 5th largest Ni reserve
- 74% of Mn global resources
- 2nd largest V reserve & high grade
- Potential to be next global REE producer

Current state of the industry
- Most minerals not primary resources, co-produced; REE deposits fragmented

Opportunity/problem statement
- Precursor metals batteries, magnets; demand for metals high; resource security a global agenda

Mintek Strategic Framework – at a glance

4 TRANSFORMATION IMPERATIVES

5 STRATEGIC GOALS

- Conduct any relevant, applied research and technological innovation
- Foster industry establishment and expansion
- Develop a capable workforce
- Ensure financial sustainability
- Develop and maintain world-class RDI infrastructure

5 CORE PROGRAMS

- Core research, development and innovation programmes
- Core industry development programmes
- Strategic and national programmes
- Priority commodities
- Enabling programmes

4 BUSINESS & OPERATING DESIGN PRINCIPLES

Agile, innovative and impact-oriented operations, and focused attention on critical capabilities

Mining and minerals value chain, clustering, quality infrastructure, industry facing programmes

Collaborative, cross-functional teaming and partnerships across technical disciplines, the organisation at large and the broader market

Commercialisation, business development, technology transfer, innovation, manufacturing capabilities, business incubation, partnerships & alliances, and joint development with industry

Key strategic focus programs, 2021-2030

- Establishing a local **rare earth element** mining and manufacturing industry
- Developing and manufacturing nanotechnology-based **diagnostic products**
- Transforming the energy mix in the energy-intensive **ferroalloys industry**
- Developing a **hydrogen** and platinum-based **fuel-cell economy** in South Africa
- **Energy storage** as an enabler of a just energy transition
- Developing **clean coal technologies**
- Revitalising South Africa's **iron ore industry**
- Unlocking the **Bushveld Complex's titaniferous magnetite**

Partnership and investment opportunities

- Point of care **diagnostic test kits** and **production of antigens** and **antibodies**
- Fuel Cell **catalyst manufacturing** – incubating the industry
- Energy storage – **The Battery Precursor Development**
- Investing in a **REE opportunity** powered by South African minerals and Mintek Technology
- Investing in a **world-class ferrochrome furnace development opportunity** enabled by Mintek's smelting technology
- Investing in an **integrated development for the production of vanadium, iron** and **titanium** from the Bushveld Complex
- Revitalizing South Africa's **iron ore industry**
- **Waste coal gasification**

Diagnostics Test Kit program: product portfolio and timelines

Short-term (2020-2022)

Qualitative Lateral Flow POC RDTs:

- Human Infectious:
  - ✓ Covid-19
  - ✓ HIV
  - ✓ TB
  - ✓ Malaria

Quantitative RDTs:

- ✓ ELISA: Covid-19

Medium-term (2023-2025)

Qualitative Lateral Flow POC RDTs:

- Zoonotic Infectious:
  - ✓ RVFV
  - ✓ Brucellosis
  - ✓ Bovine TB
- Human Infectious:
  - Syphilis
- Multiple detection:
  - ✓ HIV/ TB
  - ✓ HIV/ Syphilis
  - ✓ Brucellosis/ Bovine TB

Long-term (2026-2030)

Quantitative RDTs:

SERS assays:

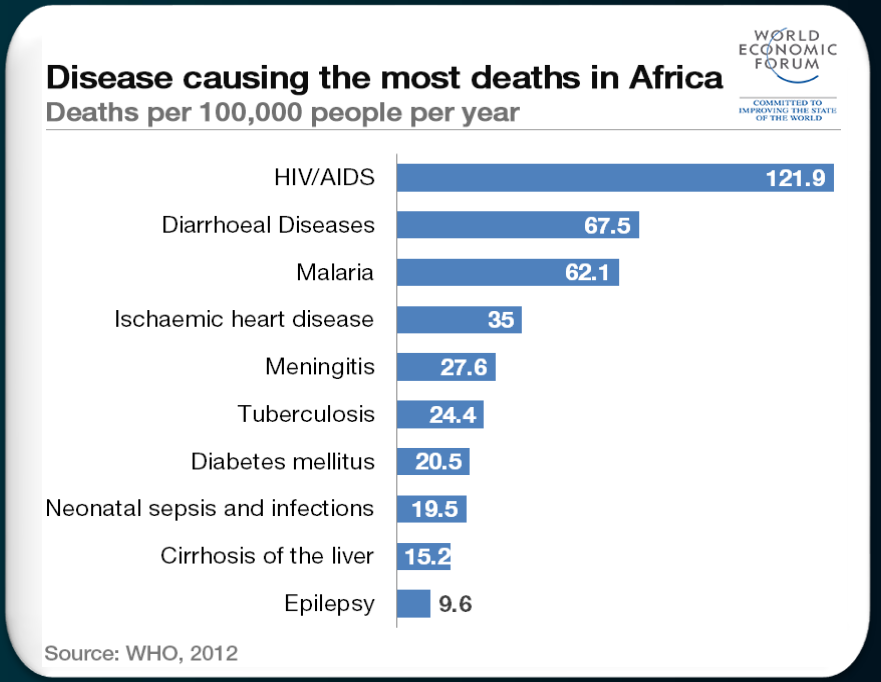
- Malaria
- TB

Fluorescent Lateral Flow assays:

- Oncology
- Diabetes

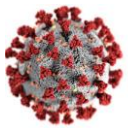
Molecular Diagnostics

- NALFIA
- Aptamer-based lateral flow assays

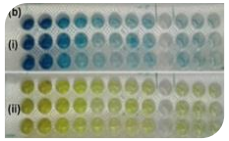


Diagnostics timelines to market

TRL 1 & 2	TRL 3	TRL 4	TRL 5	TRL 6	TRL 7	TRL 8	TRL 8	TRL 9
Biomarker &Material Development Ethics Approval	Assay Development TRL 3	Internal Evaluation	Internal Clinical Evaluation	Pilot Production	External Evaluations	Registration	Manufacturing	Sales & Distribution



- Research Ethics
- Approval & Biomarkers



- Biomarker validations
- ELISA

- Testing on Lab samples

- Testing on Clinical samples

- Small scale production
- Lab testing

- Independent Clinical evaluations

ISO 13485:2016

SAHPRA South African Health Products Regulatory Authority

- NHLS Validations
- SAHPRA Registrations
- WHO Product Evaluation

- Large scale production

- Commercialization

HIV Rapid Test

Malaria Rapid Test

COVID-19 → **Dec 2021**

TB & Brucellosis Rapid → **2 years (max) (2022)**

RVFV & Breast Cancer Rapid Tests → **3yrs (max)**

Malaria SERS Assay → **3 yrs. (max)**

Cervical & Prostate Cancer Rapid Tests → **4 yrs. (max)**

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Diagnostics reagents program: product portfolio and timelines

Pipeline Development 2020-2022

Disease Reagents Line for Diagnostics:

- Covid-19 Antibodies
- Covid-19 Antigens
- HIV Antigens
- Diagnostic Peptides

Pipeline Development 2023-2025

Disease Reagents Line:

- TB
- Malaria
- Diagnostic Peptides
- Cancer

General Reagent Line:

- Protein A/G
- Anti-mouse IgG-HRP
- Anti-rabbit IgG-HRP
- Anti-human IgG-HRP
- Cosmetic peptides
- PCR reagents
- Restriction Enzymes

Covid-19 Antigens

Peptides

Gold NPs

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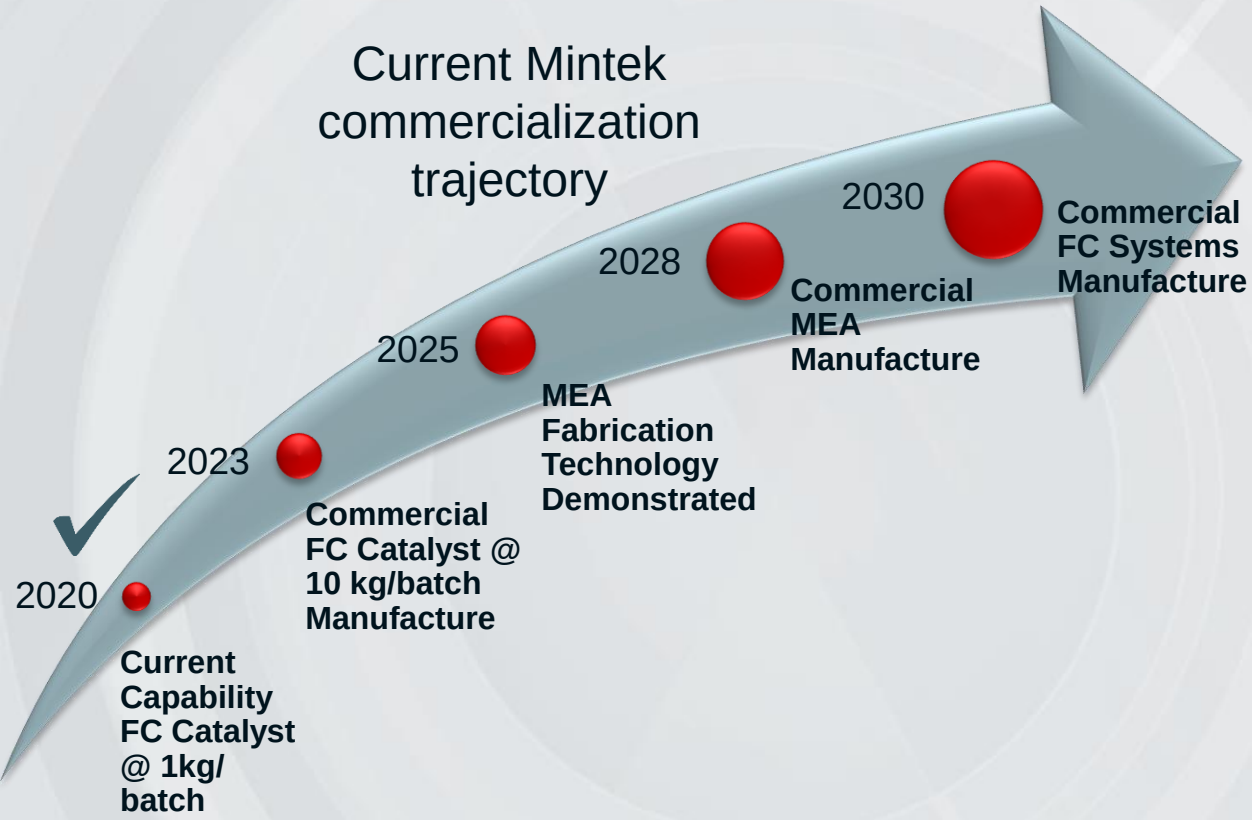
Fuel Cell program: local manufacturing



Target 5% penetration of the global PEMFC market by 2030. This would amount to:

- 840 MW FC products
- $350-660m revenue per year
- Approximately $325m cumulative local investment over 2020-2030 period
- 3600 new manufacturing sector jobs
- Local beneficiation of 200-300kg platinum to high value products

At the expected market growth SA would also provide most of the 5 - 7 tons platinum required for the global 2030 PEMFC market

Energy storage: battery precursor metals in South Africa

Electric vehicles
Smart-grid storage
Portable electronics

Electric cars, hard Drives, wind turbines
High-tech industries

Fluorspar — 1st
- Electrolyte for lithium ion batteries

Manganese — 1st
- Cost-effective cathode for Li-ion batteries

Vanadium — 2nd
- Flow batteries

Titanium — 4th
- Advanced anodes for Li-ion batteries

Nickel — 5th
- Advanced cathodes for Li-ion batteries

Phosphate — 6th
- Electrolyte for Li-ion batteries

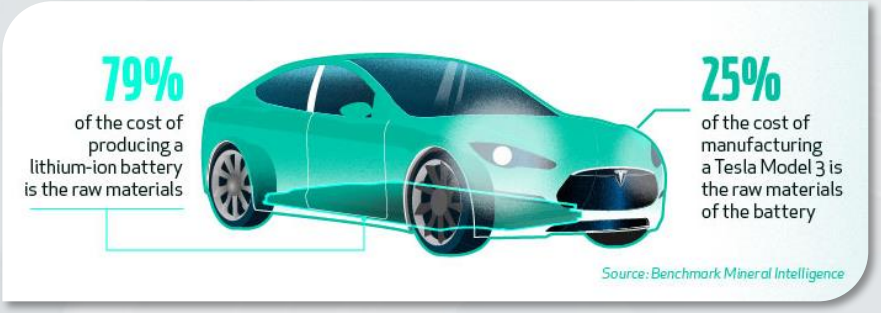
Rare earth elements — Some
- Permanent super magnets

SA reserve size vs global

As the shift to renewable energy occurs energy storage solutions are required. The most significant cost contributor to battery storage is the cost of pre-cursor chemicals.

A specific feature of these battery precursor chemicals is exceptional purity – required to ensure high performance and short charging times

Energy storage: high purity battery materials



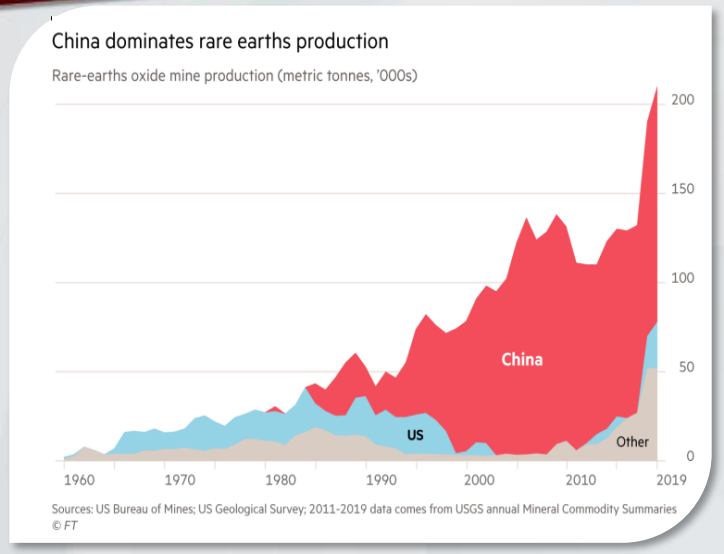
Mintek is addressing the production of these precursor battery materials – this is where most of the value lies.

Achievement for 2019 to 2021

- **Enhanced process developed**, combining iron exchange and solvent extraction technologies to improve purification to future battery grade specifications.
- First example being **Nicksyn reagent**, recommended for application in Nickel recovery and purification plant.
- Assessment of recycling and recovery of battery materials undertaken.
- First application of enhanced Digital Twinning of extraction of manganese successful. The computer modelling programme was more rapid than conventional laboratory testwork in developing the process which includes the introduction of direct solar heating.
- **Thakadu Battery Materials commissioned R 300 million nickel sulphate refinery based on Mintek technology.**

Next step 2021 - 2022: Additional market analysis. Marketing of the Nicksyn reagent and further technical development of other synergistic technology options.

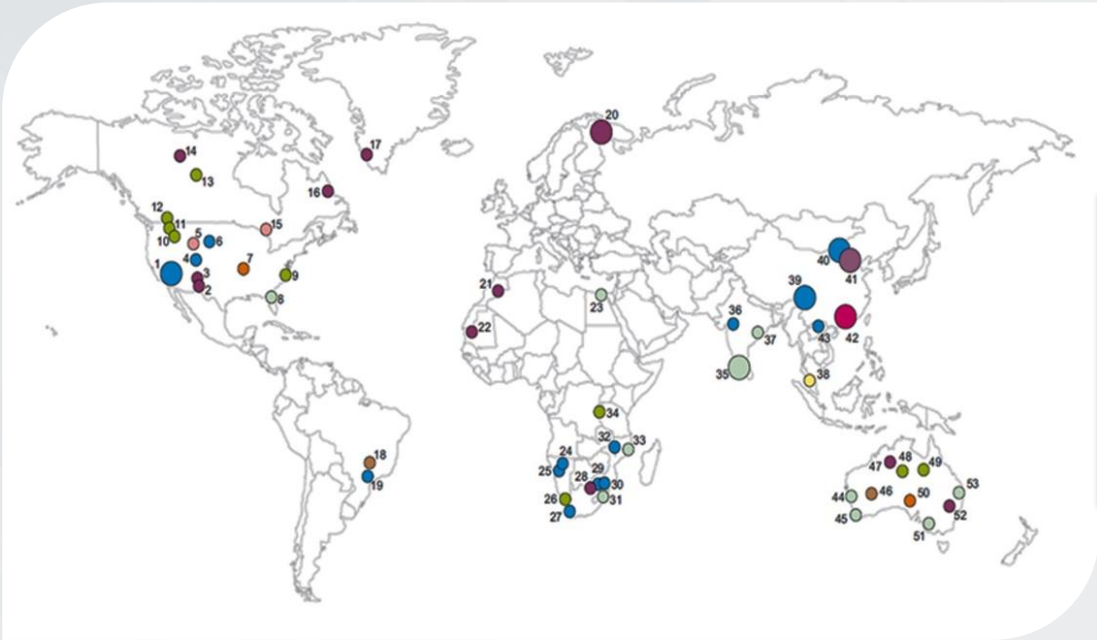
Rear Earth Elements program: China and REE supply risks



- China dominates world REE production and consumption
- More than 80% production, less than 40% of world reserves
- Bayan Obo is an enormous REE resource and set China up for world dominance
- A tight supply is expected towards 2030
- Global rare earth resources are modest in size and low grade
- REE productions is dominated by a few world class deposits

Bayan Obo, China (Inner Mongolia)

48 Mt contained REO



No single Southern African deposit can support a global competitive $500m processing and separation plant.

Rare Earth Element deposits – GSSA 2011 – Jock Harmer
China's Rare Earth Elements Industry: What can the West learn? IAGS 2010

⇒ Driver to seek alternative supply

Establishing a centralized REE refinery in South Africa

Mintek's technology suite has been shown to process all these ores in a single processing facility to produce refined REE products

1. Research & Development ✓
2. **Centralised Refining Technology demonstration** (at pilot scale) ✓
3. **Demonstration plant to be build and feasibility study carried-out (in progress but needs funding)**
4. Partners & investment
5. Construction
6. Commissioning
7. Operations

Hydrometallurgical separation

PyEarth™

High temperature concentration

Mintek's REE technologies at pilot scale

SOUTH Africa is well placed to maximise the economic value of the regional REE deposits, currently government has funded the technology development and pilot facilities – funding is being sought for the bankable feasibility study and demonstration plant.

Development of world-class Ferrochrome furnace

- ✓ **Siyanda is an established chrome producer and this project aims to build a new smelter in South Africa (**Siyanda Chrome Smelting Company ferrochrome project)
- ✓ SCSC invested in developing project and feasibility study including pilot plant demonstration test at Mintek
- ✓ Mintek pilot test processed 34% Cr grade chromite (over **110 tons**) and produced a typical charge chrome product (about **40 tons)**
- ✓ Technology successfully benchmarked at pilot scale against metallurgical chromite

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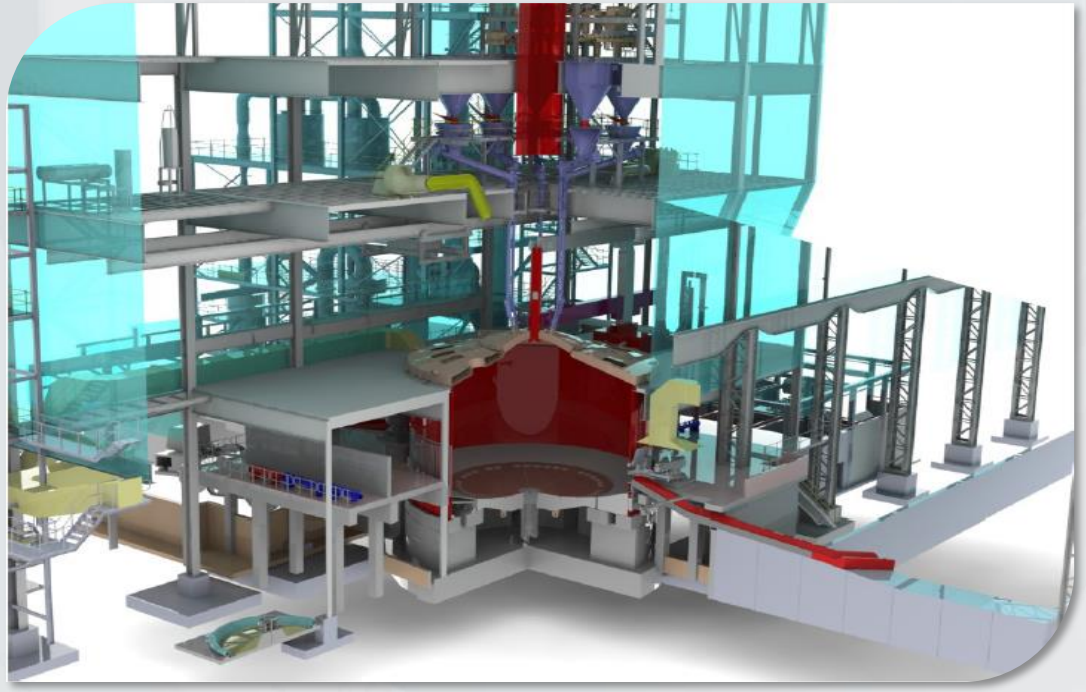
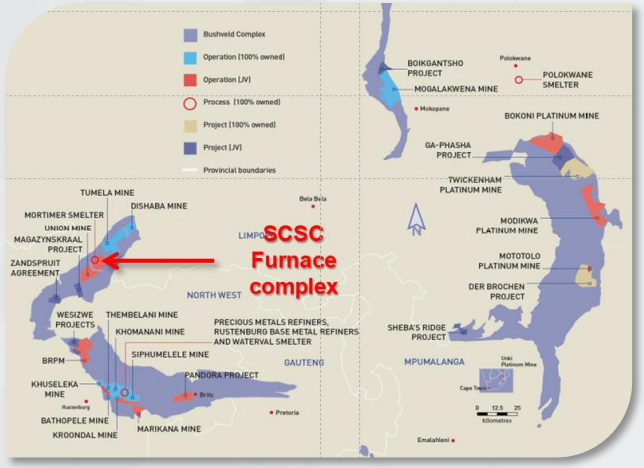
Planned SCSC 70 MW DC smelter



Bushveld Complex

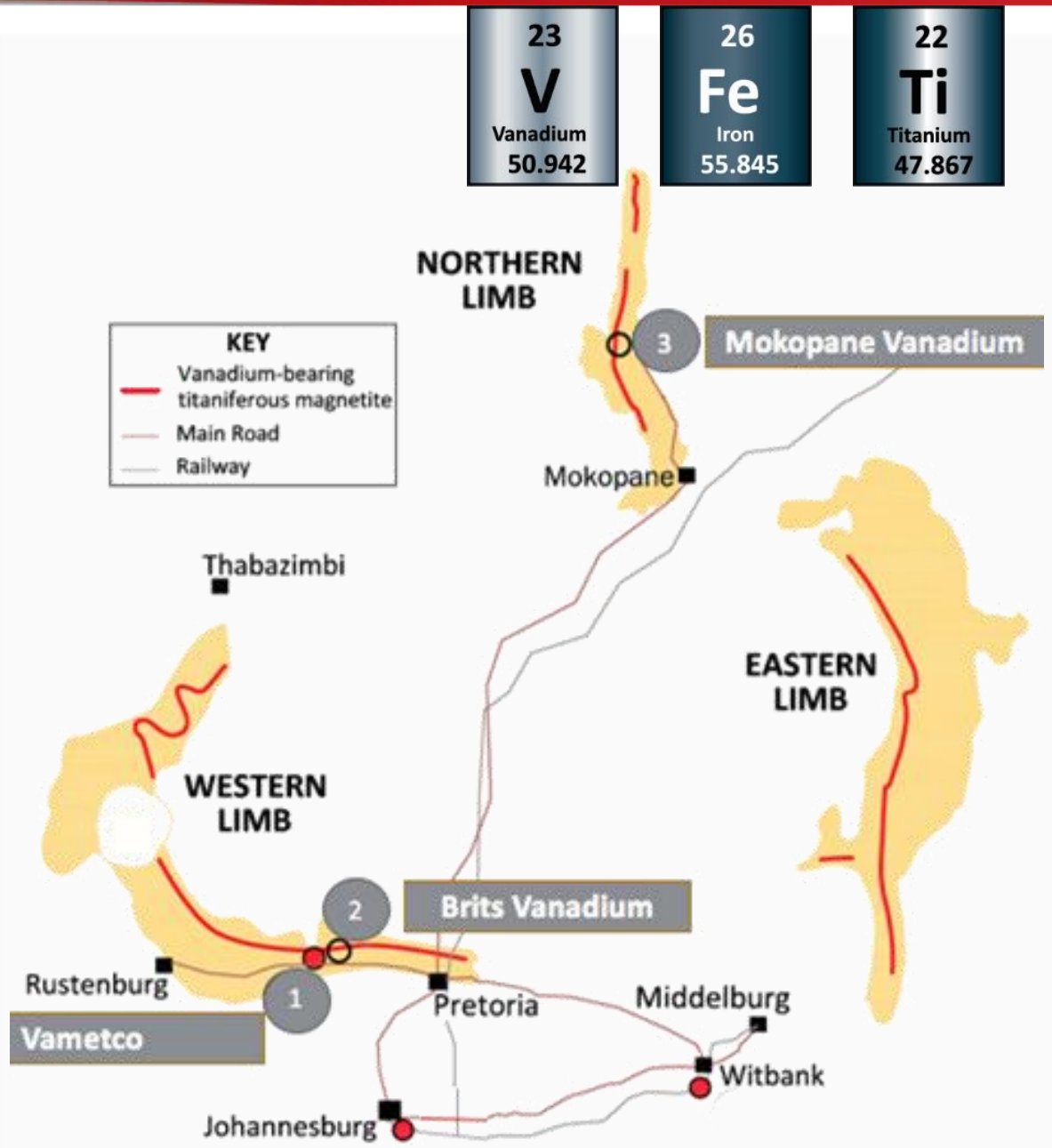


Pilot plant alloy (40 tons)

Establishing a VTM smelter in South Africa: The Bushveld Complex

- Since closure of EVRAZ Highveld Steel in 2015, we have only small activity to extract vanadium (currently only three operations)
- About **90%** of the **world's vanadium** production **from the titanoniferous magnetite resources** (2019) – mainly in **China**, **New Zealand**, and minor contribution from **SA** since Highveld Steel closure
- SA has **second largest vanadium** reserve globally as part of the famous **Bushveld Complex**
- And also **contains significant economic value as iron** and **titanium**

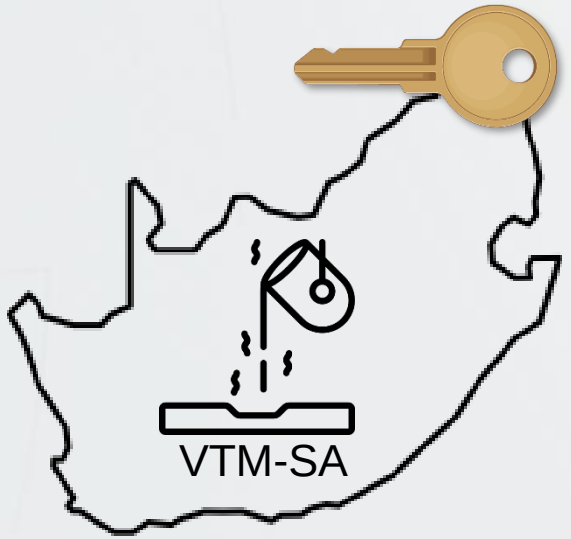
Note: VTM = Vanadium-bearing Titaniferous Magnetite



Establishing a VTM smelter in South Africa

Mintek's fluxless open-arc smelting technology demonstrated to be superior relative to existing technologies, process flowsheet also requires INTEGRATED DEMONSTRATION step

1. Research & Development ✓
2. Technology demonstration ✓ (more 1000 tons processed)
3. **Feasibility study & detailed engineering (in progress)**
4. Partners & investment
5. Construction
6. Commissioning
7. Operations



VTM demonstration facility installation commencing late 2021

South Africa is well placed to **maximise the economic value** of the **vanadium**, **iron** and **titanium** from the bushveld complex via a state-of-the-art smelting facility based on homegrown technology, currently government funded.

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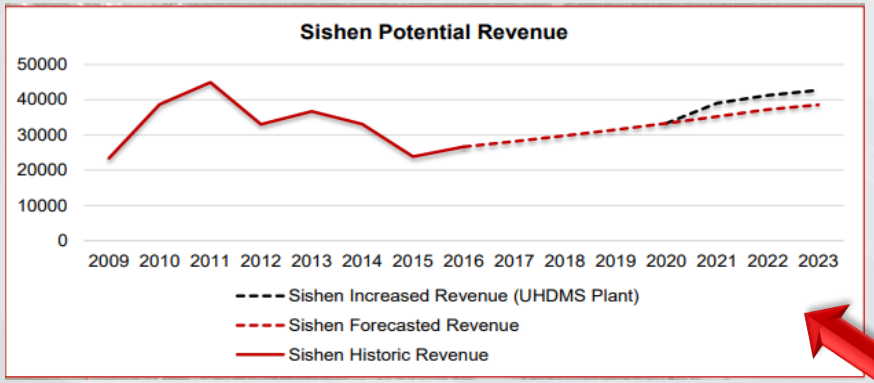
Revitalizing South Africa's iron ore industry: unlocking iron ore fines



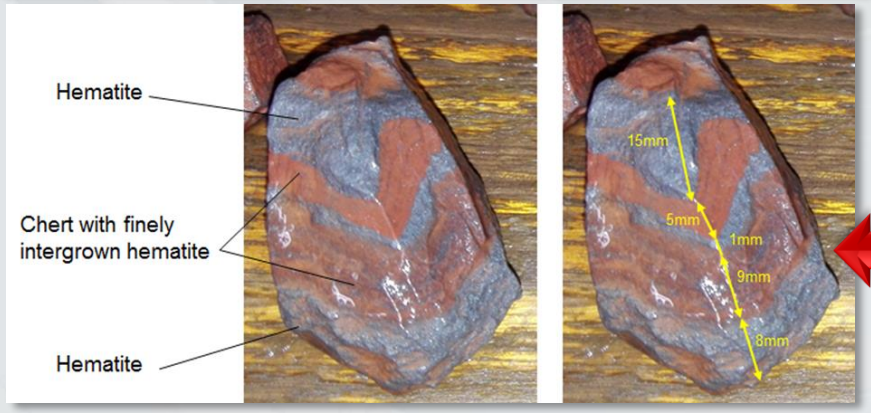
South Africa's high grade iron ore reserves are being depleted and operating costs are increasing, however there are opportunities to unlock sterile resources and low grade material extending the life of the iron ore sector.

IMPACT

Revenue	UHDDMS to yield 10.8% higher revenue than a traditional DMS
Production	Additional 3.2Mta of saleable product by May 2021 (current 41.4Mtpa)
Socio Economic	Construction: 2483 direct jobs
	Operational: 1059 jobs (644 direct)

Achievement for 2019 to 2021

- Co-developed with industry **Ultra High Density Dense Media Separation** (UHDDMS) technology for the processing of iron ore fines material.
- Currently implemented at Sishen – shows significant improvement.
- **Kumba Iron Ore announced a new R 3.6 billion investment in an additional UHDDMS plant.**
- A multi-year programme with Assmang has commenced.
- Multi year development of technology for the processing of Banded Iron Formation (BIF) ore to produce high grade iron ore commenced.



Next step for 2021 / 2022: Continuation of programme for further implementation of UHDDMS including further co-development with Kumba and Assmang. Continuation of BIF research programme as a future source of high grade iron ore.

Coal as a sustainable resource of the future

The development of coal gasification technology to recover residual energy from waste coal dumps.

Achievement for 2019 to 2021

- Proof of concept for the gasification of coal was completed. Coal can be gasified with up to 1 MW/t of net energy produced.
- Coal gasification concept patented.
- Modelling was undertaken to confirm the viability of gas generation.
- Techno-economic modelling undertaken with CSIR and Coaltech to refine opportunity and economics.

Next step 2021 - 2022: Technology comparison to confirm best available technology particularly for linking gas production and energy generation to be undertaken. Design of demonstration equipment and facility to commence. Life-cycle assessments of processes to commence. Partnerships with end users to be established.

Mintek Corporate Scorecard 2021/22

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Key Performance Indicators for 2021/22

Strategic Outcome - Oriented Goal	Key performance indicators	Prelim Results 2020/21	Target 2021/22	Target 2022/23	Target 2023/24
Conduct relevant, Applied research and technological innovation	Number of journal papers	36	**30**	33	35
	Number of conference papers	24	**35**	37	39
	Number of book chapters	12	**5**	5	6
	Number of books	1	**1**	1	1
	Number of invention disclosures	13	**16**	17	18
	Number of new patents	5	**4**	4	4
	Number of new trademarks	5	**6**	6	7
Foster industry establishment and expansion	Number of new prototypes, processes and/or models demonstrated/ validated in a relevant environment	12	**20**	21	22
	Income from the sale of products and services, royalties and licences (R million)	101.95	**108.78**	118.23	118.4
	Number of IP licences	0	**1**	1	1
	Number of certified reference materials (1)	n/a	**6**	6	7
	Number of accredited methods (1)	n/a	**19**	20	21

1. New KPI

Key Performance Indicators for 2021/22

Strategic Outcome - Oriented Goal	Key performance indicators	Prelim Results 2020/21	Target 2021/22	Target 2022/23	Target 2023/24
Develop a capable workforce	Total number of SET employees	**243**	**220**	**225**	**228**
	Percentage of SET staff	80%	**80%**	84%	88%
	Percentage of female SET staff	53%	**52%**	53%	53%
	Total number of SET staff with doctoral degrees	**46**	**55**	**58**	**61**
	Percentage of SET staff with doctoral degrees	19%	**25%**	26%	27%
	Total number of SET staff with master's degrees	**54**	**70**	**73**	**73**
	Percentage of SET staff with master's degrees	22%	**32%**	32%	33%
	Total number of SET staff at middle & senior levels (SP, MP and SE)	**98**	**115**	**119**	**123**
	% of black SET staff at the middle and senior levels (SP, MP and SE)	63%	**65%**	68%	74%

Key Performance Indicators for 2021/22

Strategic Outcome - Oriented Goal	Key performance indicators	Prelim Results 2020/21	Target 2021/22	Target 2022/23	Target 2023/24
Develop and maintain a world-class RDI capacity	Total investment in plant, property and equipment (R million)	42.14	**52.2**	52.9	52.9
	Total investment in human capital development (R million)	11.63	**14**	14.2	14.5
	Lost Time Injury Frequency Rate	0	**<1**	<1	<1
	Client Satisfaction Frequency Rate	94%	**90%**	90%	90%
	Number of accredited facilities (1)	n/a	**5**	5	5
	Safety, Health, Environment and Quality	Accreditation maintained	**Maintain accreditation**	Maintain accreditation	Maintain accreditation
Ensure financial sustainability	Total income (R million)	542.16	**568.7**	590.2	587.1
	Net result (R million)	-9.02	**0.6**	9.4	5.1
	Contract R&D income (R million)	56.21	**14.7**	15.5	16.3
	BEE spend as a percentage of procurement spend	94.01%	**85%**	90%	90%
	Audit opinion	Unqualified	**Unqualified**	Unqualified	Unqualified

1. New KPI

Overview of Key Challenges and Outlook

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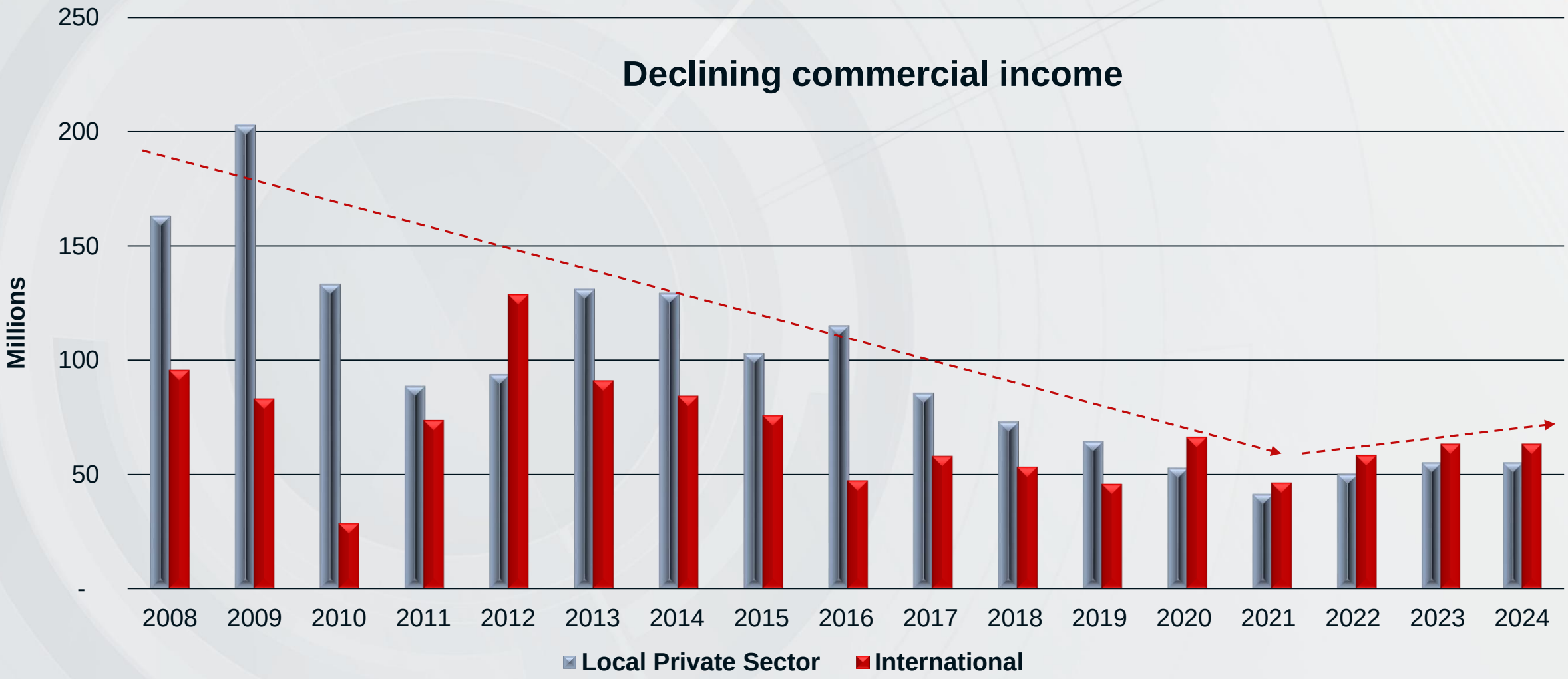
Financial sustainability



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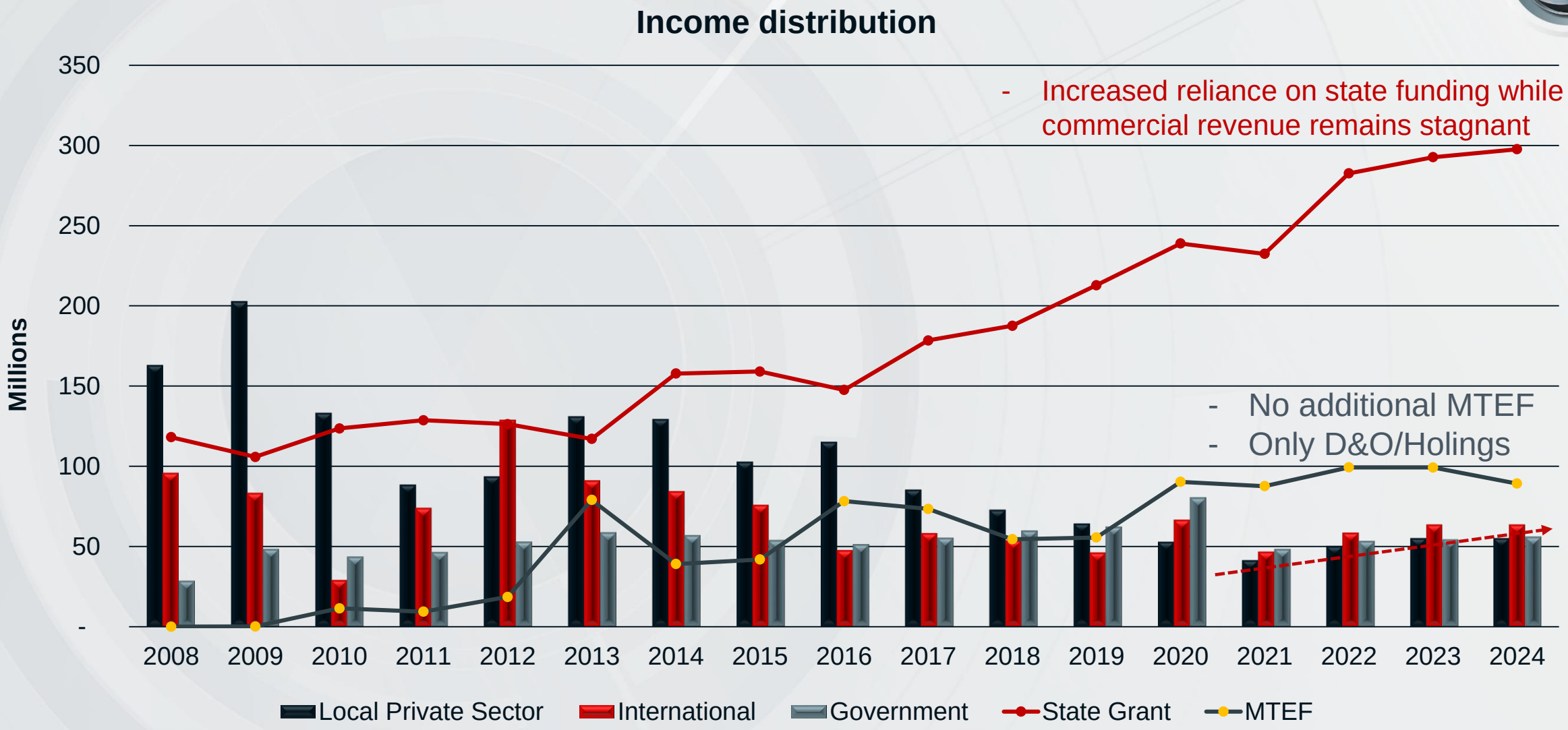
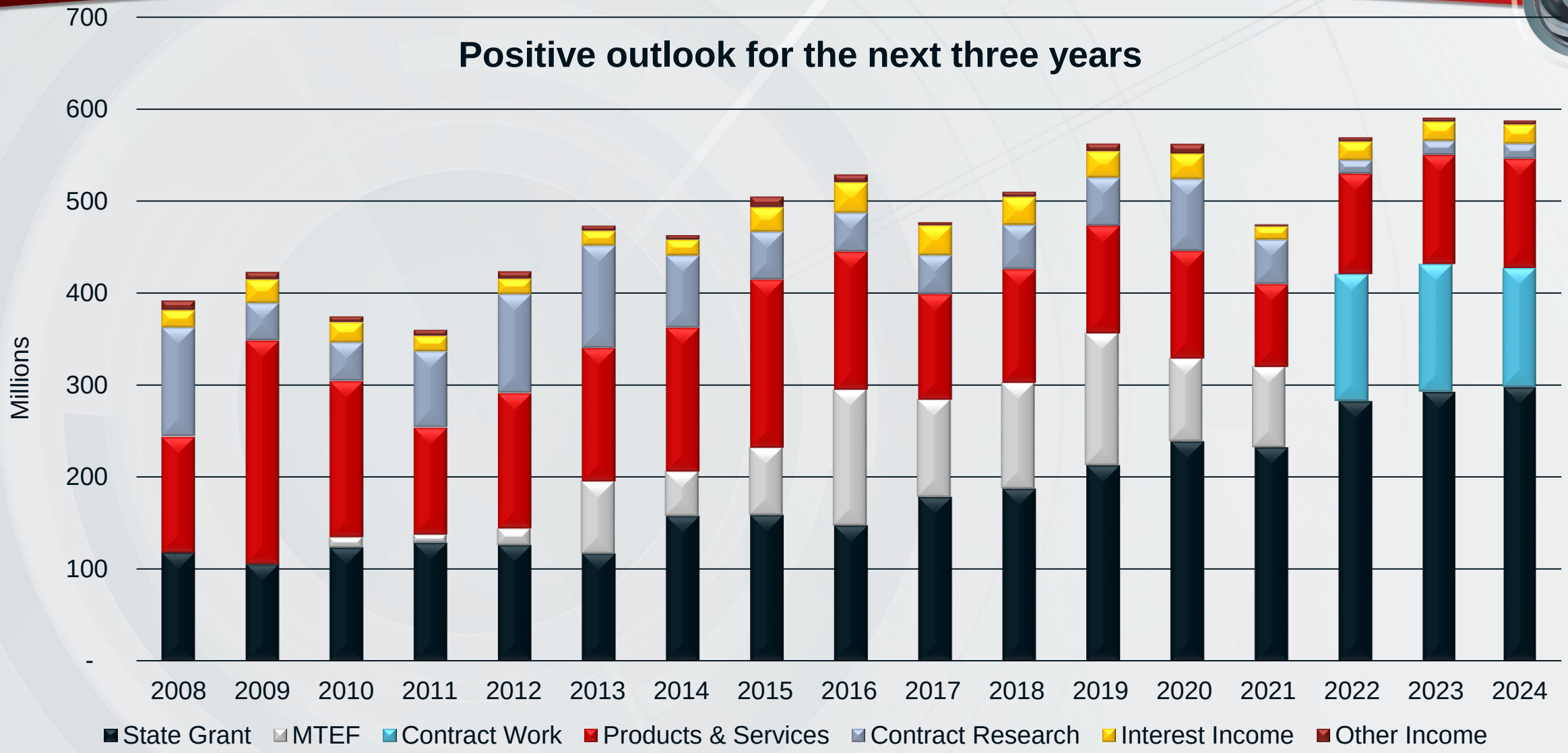
Revenue sources



Revenue sources



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Concluding remarks

- Mintek is in a transition phase to fully align with our role as a research and technology organisation.
- We are implementing a new strategy that has already begun to deliver results with an improvement in the SET staff number, experience and qualification profile.
- Mintek is building capacity in business development and commercialization.
- Notwithstanding the difficult economic climate and the Covid-19 pandemic, we will continue to manage our risks and implement mitigating measures.
- We addressing the challenge of balancing our revenue sources by diversifying our funding streams.

Thank You

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