WELCOME TO THE MITOCHONDRIA CAMPUS
THE ERA OF THE PROSUMER!

MITOCHONDRIA
Energy Systems

german cooperation
DEUTSCHE ZUSAMMENARBEIT

Implemented by:
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GREEN HYDROGEN SOUTH AFRICA

renac
renewables academy

WEBINAR SERIES – Promoting Green Hydrogen Economy in South Africa
Expert and Knowledge Exchange

01

OVERVIEW OF MITOCHONDRIA

A BRIEF HISTORY OF MITOCHONDRIA

2007: Mashudu Ramano decides to participate in the Hydrogen and Fuel Cell Sector

2008 -2010: Mashudu embarks on an extensive study of energy transitions of the last 200 years. The name Mitochondria is chosen as it represents decentralized & distributed energy solution in nature.

01

02 — 2012: Mitochondria Energy Company Founded

03 — 2014: Mitochondria installs Africa's first 100kW fuel cell system to provide energy to the Chamber of Mines building in Johannesburg

04 — 2016/17: Mitochondria Team conducts a study & recommends that we create our own Fuel Cell IP. IDC becomes a shareholder.

05 — 2018/19: Mitochondria Systems Founded. DBSA comes on board followed by DTIC. AVL appointed to do Pre-feasibility & Bankable Feasibility Studies on Project Phoenix.

06 — 2022: Mitochondria, AVL & Ceres Power Conducts tests on Project Phoenix, Gauteng & Emfuleni allocates 700 hectares Engages Architects and consultants

07 — 2025: Fuel Cell Factory opened in the Vaal SEZ & kickstarts the Hydrogen Valley Innovation Hub.

TECHNOLOGY PORTFOLIO

ENERGY AS A SERVICE (EAAS)

Mitochondria Energy Company offer Energy as a Service and Hydrogen as a Service to the market

STATIONARY FUEL CELLS

Mitochondria is developing their own fuel cell system for multi fuel and highly efficient production of power and heat. Designed according to international standards for global deployment

ELECTROLYSER

Local production of Electrolyser systems. Mitochondria is developing balance of plant and has partnered with global leading stack manufacturer

MANUFACTURING

Mitochondria is establishing local production capabilities to assemble and manufacture electrolysers, fuel cells, micro hydro, batteries and power electronics

POWER ELECTRONICS

Mitochondria is developing its own Power Electronics for Fuel Cells, Electrolysers and Batteries

BATTERIES

Mitochondria is utilizing different battery technologies together with their fuel cell system to offer complete off-grid solutions

HYDRO POWERPODS

Mitochondria has partnered with unique low head micro hydro power developer to locally manufacture and distribute hydro power

OPERATION & MAINTENANCE

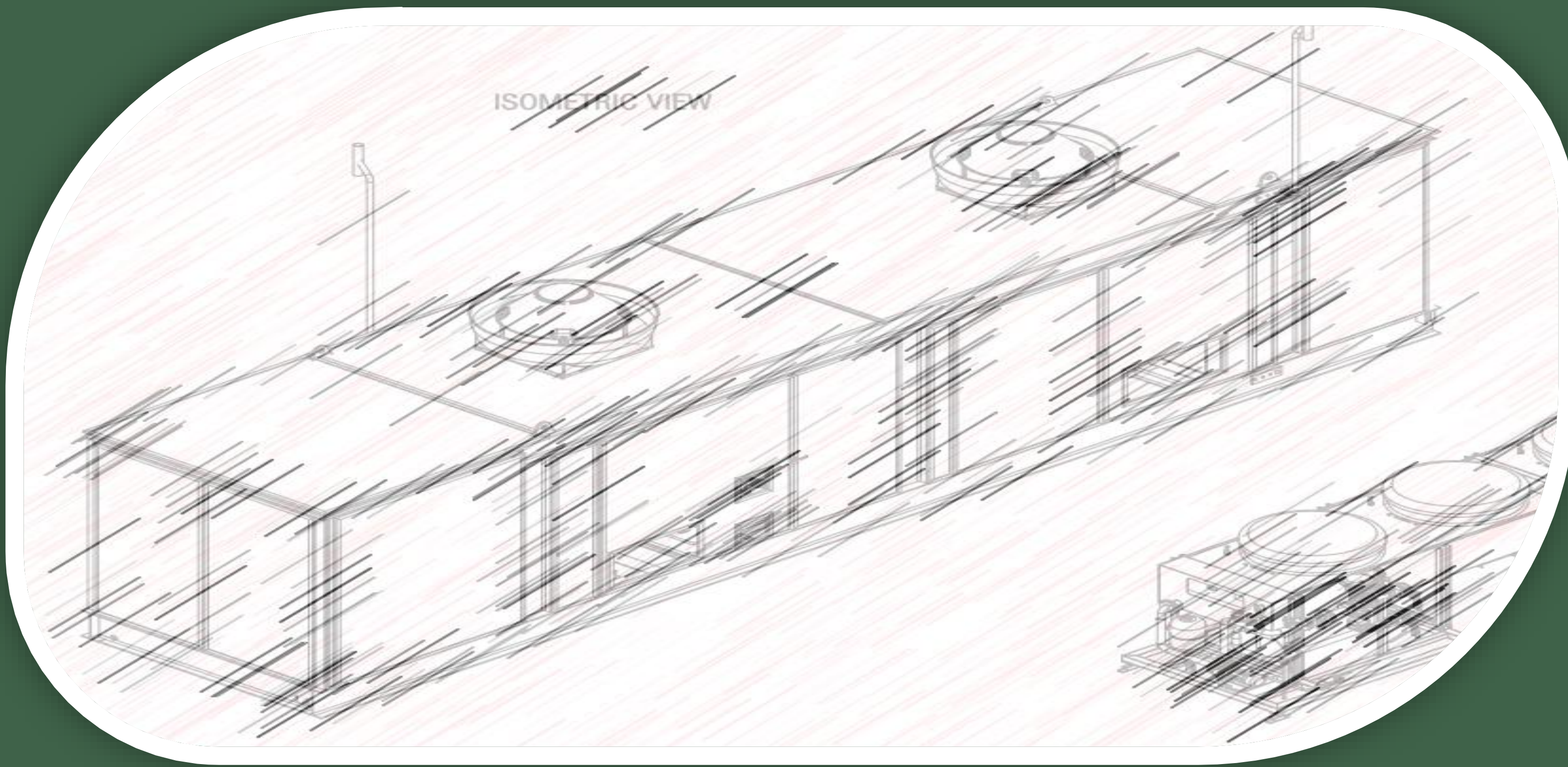
Mitochondria offer operation and maintenance services for fuel cells, electrolysers and other technologies

Project Phoenix

Video:
https://www.youtube.com/watch?v=MbbhB9maGqA&t=92s

ELECTROLYSER

Soon to be Announced!



KEY ATTRIBUTES

- Strong Partnership
- Local System Production
- Multi Megawatt Size
- First local unit 2025

Electrolyser System	
System Size	1.25 MW
Performance	~ 50 kWh/kg H_2
Hydrogen Output	23 kg/h

MITOCHONDRIA MANUFACTURING

02

ELECTROLYSER AND FUEL CELL TRENDS IN SOUTH AFRICA

COMPARISON OF FUEL CELL TECHNOLOGIES

Fuel Cell Type	Common Electrolyte	Operating Temperature	Typical Stack Size	Electrical Efficiency (LHV)	Applications	Advantages	Challenges
Polymer Electrolyte Membrane (PEM)	Perfluorosulfonic acid	<120°C	<1 kW - 100 kW	60% direct H_2;[i] 40% reformed fuel[ii]	• Backup power • Portable power • Distributed generation • Transportation • Specialty vehicles	• Solid electrolyte reduces corrosion & electrolyte management problems • Low temperature • Quick start-up and load following	• Expensive catalysts • Sensitive to fuel impurities
Alkaline (AFC)	Aqueous potassium hydroxide soaked in a porous matrix, or alkaline polymer membrane	<100°C	1 - 100 kW	60%[iii]	• Military • Space • Backup power • Transportation	• Wider range of stable materials allows lower cost components • Low temperature • Quick start-up	• Sensitive to CO_2 in fuel and air • Electrolyte management (aqueous) • Electrolyte conductivity (polymer)
Phosphoric Acid (PAFC)	Phosphoric acid soaked in a porous matrix or imbibed in a polymer membrane	150 - 200°C	5 - 400 kW, 100 kW module (liquid PAFC); <10 kW (polymer membrane)	40%[iv]	• Distributed generation	• Suitable for CHP • Increased tolerance to fuel impurities	• Expensive catalysts • Long start-up time • Sulfur sensitivity
Molten Carbonate (MCFC)	Molten lithium, sodium, and/or potassium carbonates, soaked in a porous matrix	600 - 700°C	300 kW - 3 MW, 300 kW module	50%[v]	• Electric utility • Distributed generation	• High efficiency • Fuel flexibility • Suitable for CHP • Hybrid/gas turbine cycle	• High temperature corrosion and breakdown of cell components • Long start-up time • Low power density
Solid Oxide (SOFC)	Yttria stabilized zirconia	500 - 1000°C	1 kW - 2 MW	60%[vi]	• Auxiliary power • Electric utility • Distributed generation	• High efficiency • Fuel flexibility • Solid electrolyte • Suitable for CHP • Hybrid/gas turbine cycle	• High temperature corrosion and breakdown of cell components • Long start-up time • Limited number of shutdowns

Source: https://www.energy.gov/eere/fuelcells/articles/comparison-fuel-cell-technologies-fact-sheet

OVERVIEW OF FUEL CELLS IN SOUTH AFRICA

OVERVIEW OF FUEL CELLS IN SOUTH AFRICA

- Anglo America Fuel Cell Mining Truck
- 500t truck (300t load)
- 2MW peak power (Fuel Cell + Battery)
- “Performance parity with diesel trucks”
- Anglo Invested
- First Model: “order of US$1.5 billion and includes a $200 million equity injection from Anglo American” –
- ± 400MW of fuel cells order

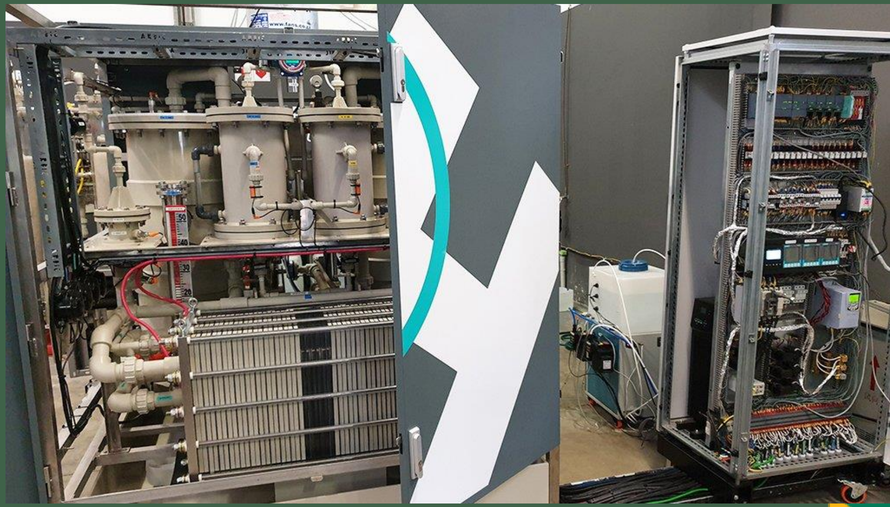
Source: https://firstmode.com/updates/first-mode-secures-200-million-in-funding-from-anglo-american-and-combines-with-nugen-team/

COMPARISON OF ELECTROLYSER TECHNOLOGIES

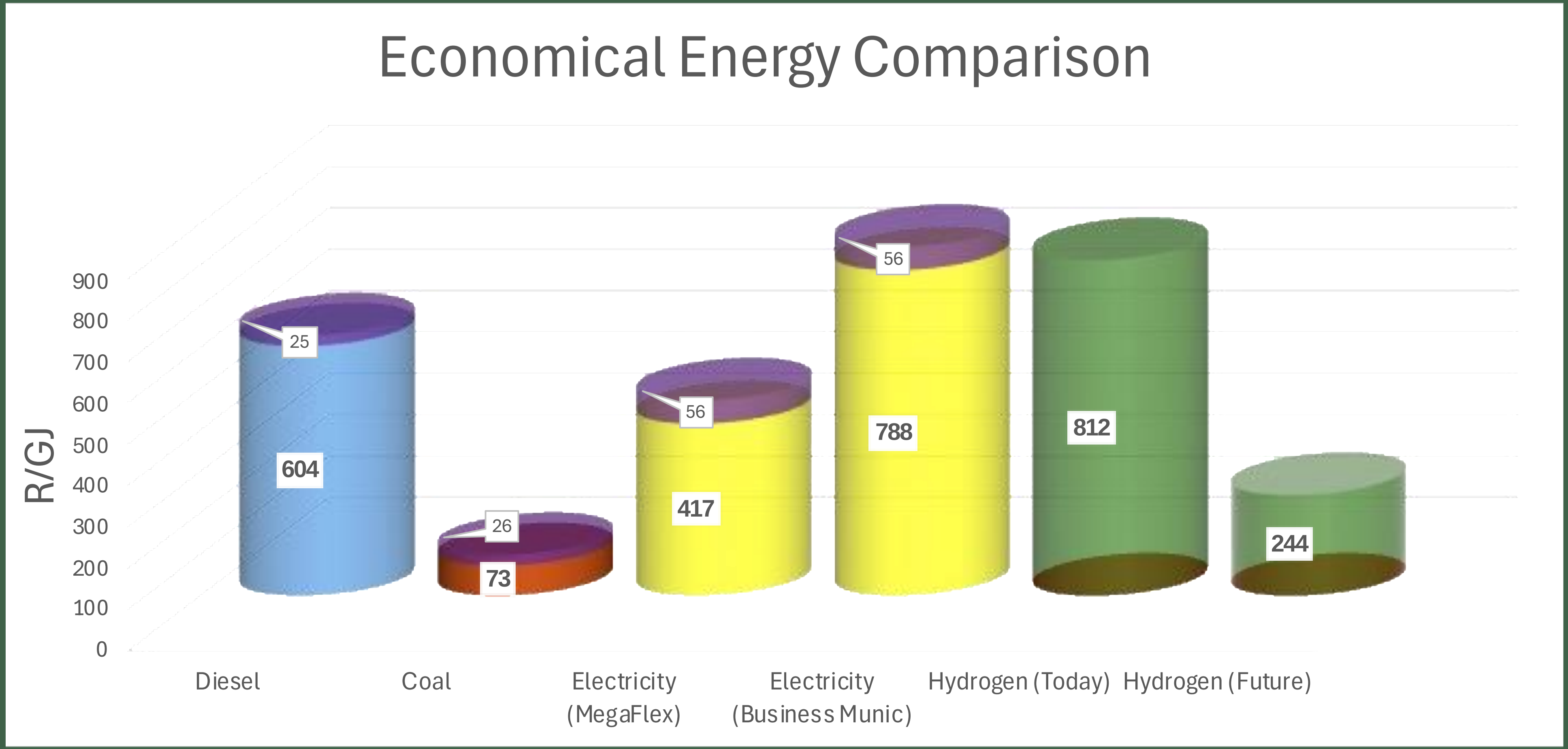
	Alkaline	PEM	SOE	AEM
Electrolyte	Aqueous potassium hydroxide	PFSA membranes (e.g., Nafion)	Yttria Stabilises Zirconia (YSZ)	Anion exchange ionomer
Cathode	Nickel, Nickel - Molybdenum alloy	Platinum, Platinum - Palladium alloy	Nickel/YSZ	Nickel and Nickel alloys
Anode	Nickel, Nickel - Cobalt alloys	Ruthenium oxide, Iridium oxide	YSZ	Nickel, Ferrous, Cobalt oxides
Operating Temperature (℃)	60-80	50-80	500-850	50-60
Operating Pressure (Bar)	30	70	1-25	1-30
Stack Lifetime (h)	60-100k	20-60k	<10k	-
Technology Readiness	Matured	Commercialised	Demonstration	Large prototype
Cost	USD 500-1400/kW	USD 1100-1800/kW	USD 2800-5600/kW	

Source: https://www.ceew.in/cef/quick-reads/explains/types-of-electrolysers

OVERVIEW OF ELECTROLYSERS IN SOUTH AFRICA



FUEL SOURCE COMPARISON



Risk Adversities

- Foreign currency denominated fuel costs ($/barrel)
- Volatility in local fuel supply
- Majority of fuel supply is based on fossil fuels – high emissions

OVERVIEW OF ELECTROLYSERS IN SOUTH AFRICA

No.	Project	Status
1	HySHiFT, sustainable aviation fuel production in Secunda	Successfully progressed to next phase of the H2 Global bidding process
2	Prieska Energy Cluster green ammonia production in the Northern Cape	Feasibility study in progress (2025 commission date)
3	Boegoebaai GH_2 Port in the Northern Cape	Master planning completed and 3 potential port developers announced
4	Ubuntu GH_2 Project in the Northern Cape	Pre-feasibility study completed
5	Atlanthia Green Hydrogen production at Saldhana Bay	Pre-feasibility conducted
6	Upilanga Solar and Green Hydrogen Park in Northern Cape	Bankable Feasibility Study in progress
7	Sasolburg Green Hydrogen Programme in the Free State	Successful production of green hydrogen
8	Hive energy Green Ammonia in Eastern Cape	Pre-feasibility study completed
9	Hydrogen Valley Programme - Limpopo, KZN and Gauteng corridors	Various stages of feasibility, Rhynbow project completed pre-feasibility study

EXAMPLE OF ELECTROLYSERS IN SOUTHERN AFRICA

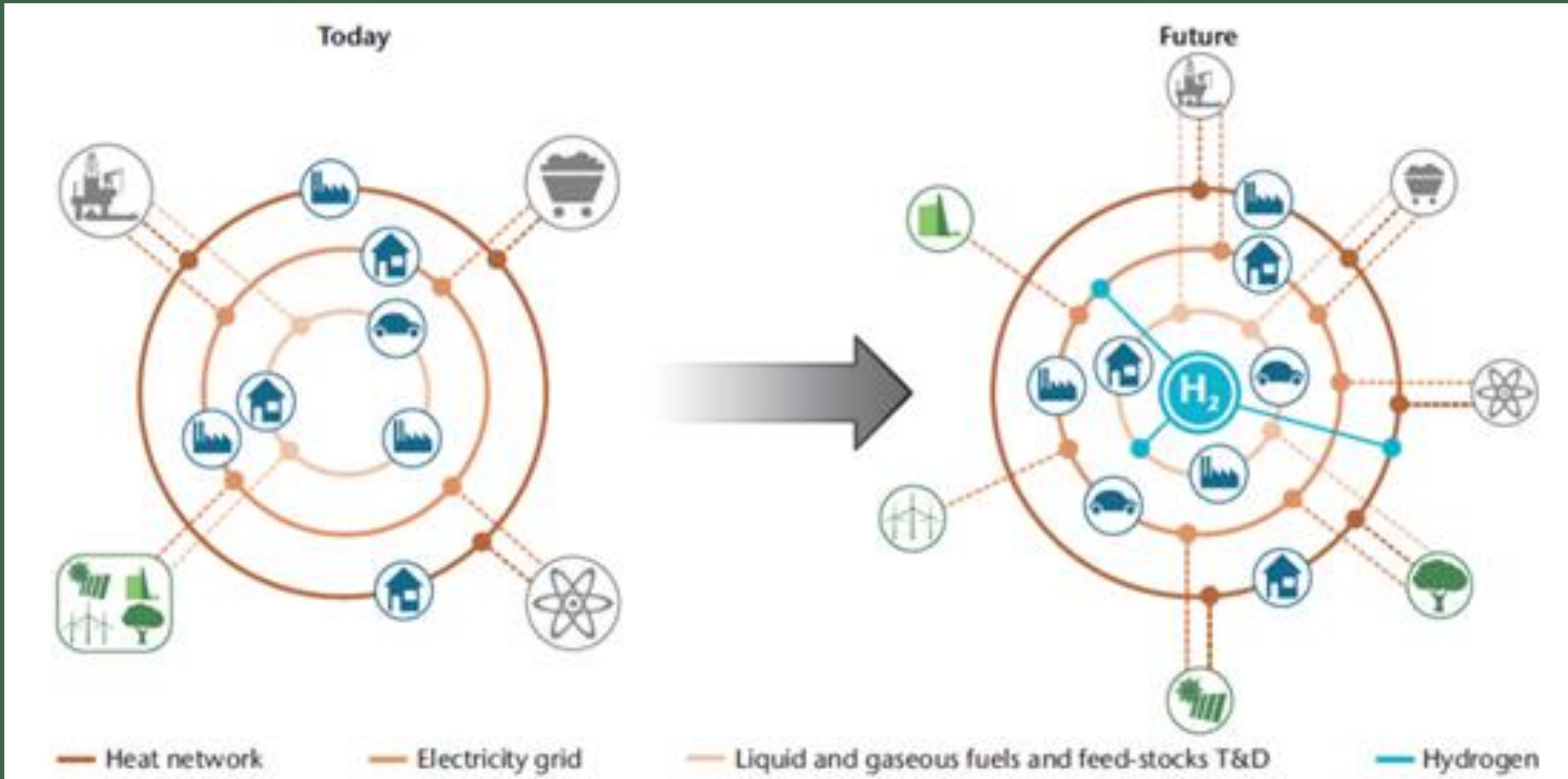
Sable Chemicals @ A Glance

- Sole Ammonium Nitrate (AN) manufacturer in Zimbabwe
- Started operations in 1969 based on 100% imported ammonia
- Added Ammonia making section in 1972, including Electrolysis
- Required 115 MW of power at full capacity
- Based on hydro power from Kariba - "Green" ammonia till 2015
- Sable plant was the largest of 10 in the world = (70% of NH_3 requirements)
- Full capacity – 240 000 tonnes of Ammonium Nitrate (AN) annually.
- Employed 480 people

More Than Just A Fertiliser Company

Source: https://ammoniaenergy.org/wp-content/uploads/2022/12/Allen-Manhanga_slide-3.png

THE POTENTIAL HYDROGEN CAN UNLOCK IN THE LOCAL MARKET



Source: https://blog.softinway.com/wp-content/uploads/2020/10/Hydrogen-present-and-future.png

THE POTENTIAL HYDROGEN CAN UNLOCK IN THE LOCAL MARKET

- Electrical Grid Constrains & Infrastructure
  - R390b for Transmission Infrastructure
  - Intermittency of solar PV and wind
  - Hydrogen pipeline costs up to **four times less** than via powerlines (when comparing like for like distance and capacity scenarios*)

- South Africa's reliance imported Oil & Gas (foreign currency denominated)
  - Hydrogen to replace imported oil
  - Local produced hydrogen instead of imported LNG

Source: https://papers.ssrn.com/sol3/papers.cfm?abstract_id=4488777

THE POTENTIAL HYDROGEN CAN UNLOCK IN THE LOCAL MARKET

- Theoretical Example 1: Municipality
  - Invest in RE
  - ENCOURAGE/COMPENSATE THEIR CUSTOMERS TOWARDS RE
  - Access RE transformed to H2
  - H2 is used for:
    - Electricity generation (peak and long term (seasonal) storage)
      - Displace electrical infrastructure constrain/upgrade
    - Heat (LPG replacement)
    - Public transport (hydrogen buses / taxis)
    - Heavy duty transport
    - Adjacent Industries (paper/cement/steel/ammonia etc.)

Source: https://papers.ssrn.com/sol3/papers.cfm?abstract_id=4488777

THE POTENTIAL HYDROGEN CAN UNLOCK IN THE LOCAL MARKET

- Theoretical Example 2: Mining House
  - Invest in large RE (over design)
  - Access RE transformed to H2
  - GREEN H2 is used for:
    - CLEAN SUSTAINABLE MINING
    - Electricity generation (peak and long term (seasonal) storage)
    - Diesel replacement
      - Transport (mining vehicles, others)
      - Back-up generation
    - Refining / Industrial Processes
      - Reduce CO2 footprint
      - Upcycle CO2 emissions

Source: https://papers.ssrn.com/sol3/papers.cfm?abstract_id=4488777

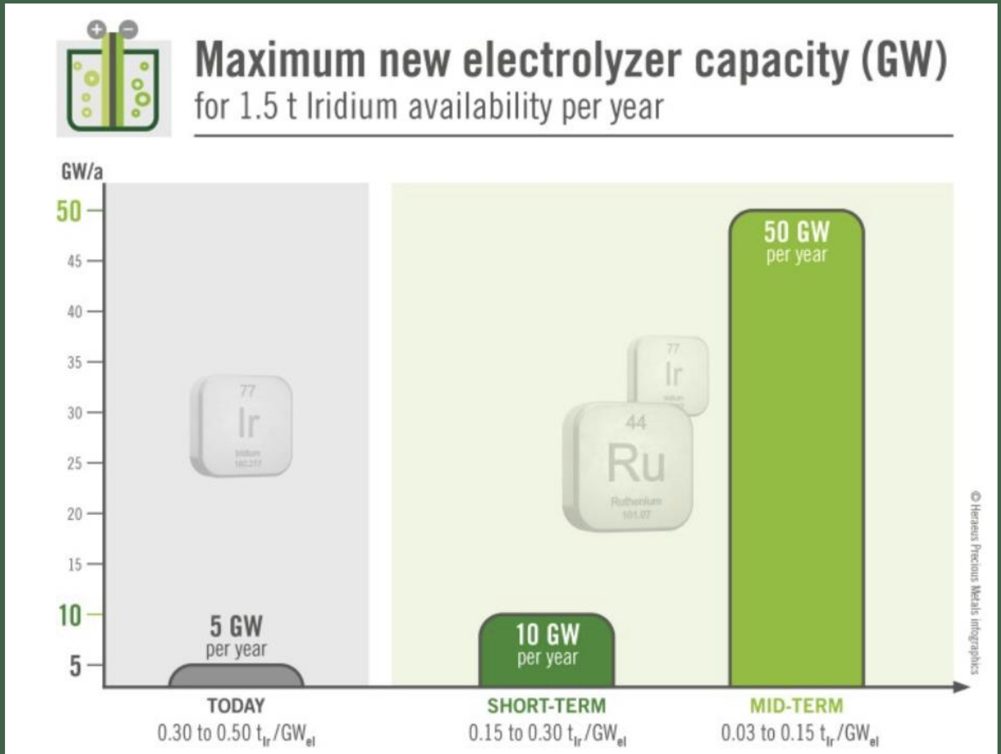
THE POTENTIAL HYDROGEN CAN UNLOCK IN THE LOCAL MARKET

- Theoretical Example 3: Agri Sector
  - Invest in RE
  - Access RE transformed to H2
  - H2 is used for:
    - CLOSE CIRCLE ECONOMY
    - Electricity generation (peak and long term (seasonal) storage)
    - Diesel replacement
      - Transport (farming vehicles, others)
      - Back-up generation
    - Fertiliser production

Source: https://papers.ssrn.com/sol3/papers.cfm?abstract_id=4488777

Thank You

THE POTENTIAL HYDROGEN CAN UNLOCK IN THE LOCAL MARKET



Iridium-thrifting is a critical factor to avoid potential material bottlenecks during the hydrogen ramp-up and has a high impact on material costs.

Table 1: Projected market potential along the PtX value chain in South Africa

NO	ITEM	2030	2040	2050
1	Total GH_2/PtX demand (million tonnes, Mt H_2 equivalent)	1.2	1.8	2.9
2	Electrolyser capacity requirements (GW)	10.9	16.2	24.9
3	RE capacity requirements (GW)	21.8	32.5	48.9
4	Iridium (tonnes)	10.9	11.4	9.8
5	Platinum (tonnes)	4.0	3.8	2.4

Source:https://www.heraeus.com/en/hpm/hmp_products_solutions/hydrogensystems/hydrogen generation/hydrogen_generation.html?websiteCriteria=0010