Seoul — Daejeon, South Korea
14-16 July 2026

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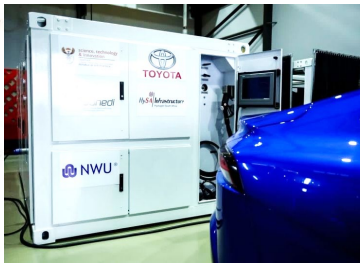

Green hydrogen mini-value chain at HySA Infrastructure NWU

Phillimon Modisha

HySA Infrastructure CoC
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http://www.hysainfrastructure.org/

HySA Infrastructure Hydrogen South Africa

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Background

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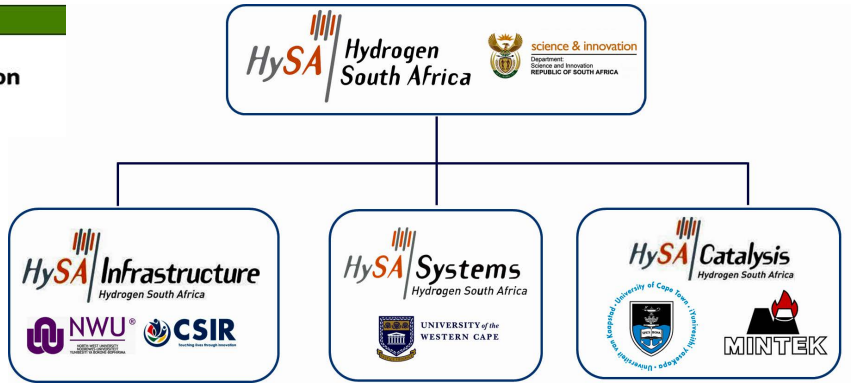
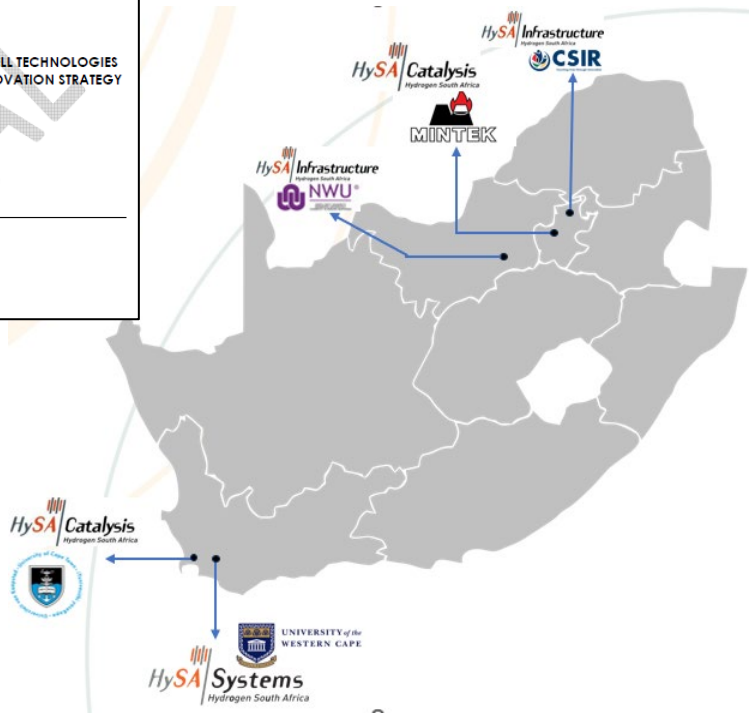
2008-2014	2014-2019	2019-2023	2023-
Technology Catch-up	Extensive Research & Development	Technology Demonstrations	Commercialization





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Policy Landscape: Various SA Government Stakeholders

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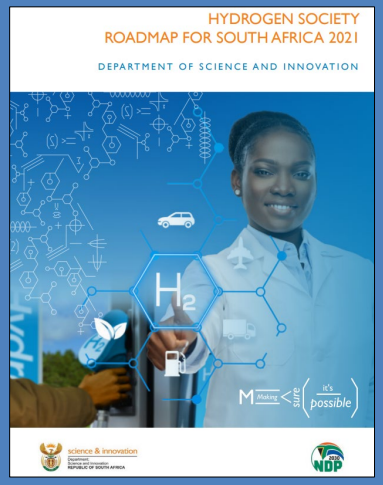

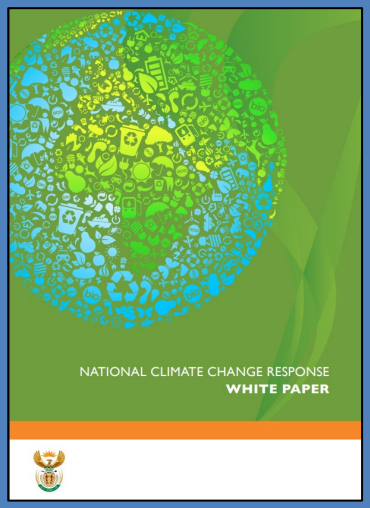

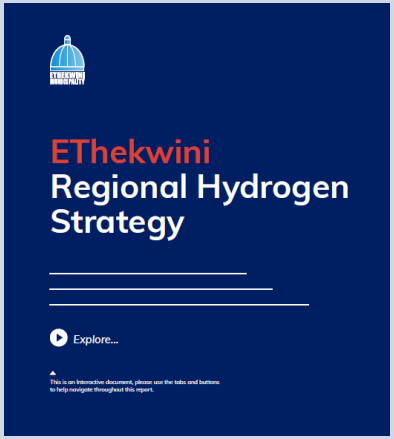

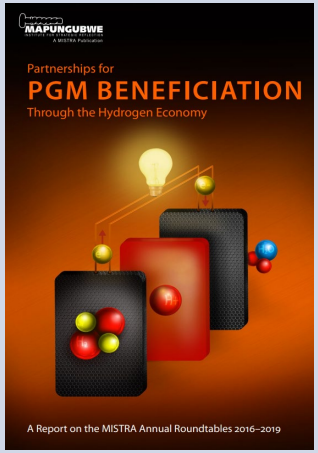

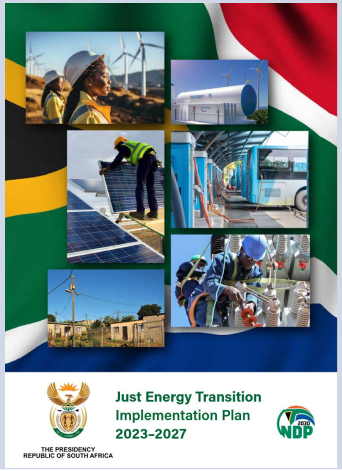

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Identified South African Hydrogen Hubs

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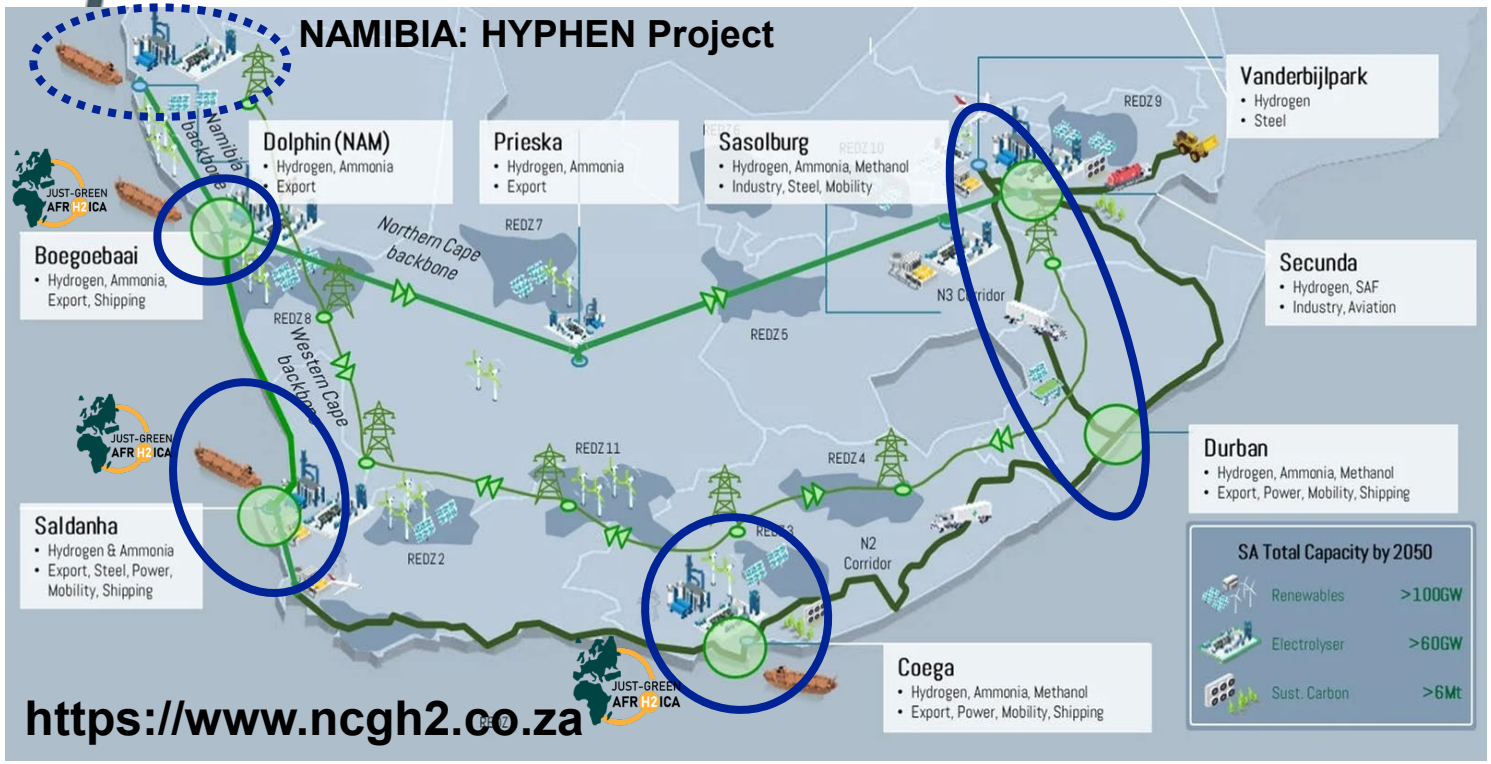
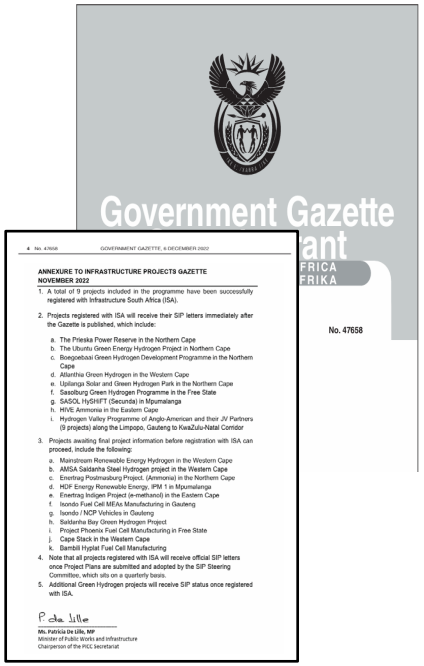
The South African Government has officially designated Green Hydrogen Hubs, which have been registered as Strategic Integrated Projects.



Ministry of Public Works and Infrastructure


Government Gazette

No. 47658

ANNEXURE TO INFRASTRUCTURE PROJECTS GAZETTE
NOVEMBER 2022

1. A total of 9 projects included in the programme have been successfully registered with Infrastructure South Africa (ISA).
2. Projects registered with ISA will receive their SIP letters immediately after the Gazette is published, which include:
   a. The Prieska Power Reserve in the Northern Cape
   b. The Ubuntu Green Energy Hydrogen Project in Northern Cape
   c. Boegoebaai Green Hydrogen Development Programme in the Northern Cape
   d. Atlanthia Green Hydrogen in the Western Cape
   e. Upilanga Solar and Green Hydrogen Park in the Northern Cape
   f. Sasolburg Green Hydrogen Programme in the Free State
   g. SASOL HySHIFT (Secunda) in Mpumalanga
   h. HIVE Ammonia in the Eastern Cape
   i. Hydrogen Valley Programme of Anglo-American and their JV Partners (9 projects) along the Limpopo, Gauteng to KwaZulu-Natal Corridor
3. Projects awaiting final project information before registration with ISA can proceed, include the following:
   a. Mainstream Renewable Energy Hydrogen in the Western Cape
   b. AMSA Saldanha Steel Hydrogen project in the Western Cape
   c. Enertrag Postmasburg Project. (Ammonia) in the Northern Cape
   d. HDF Energy Renewable Energy, IPM 1 in Mpumalanga
   e. Enertrag Indigen Project (e-methanol) in the Eastern Cape
   f. Isondo Fuel Cell MEAs Manufacturing in Gauteng
   g. Isondo / NCP Vehicles in Gauteng
   h. Saldanha Bay Green Hydrogen Project
   i. Project Phoenix Fuel Cell Manufacturing in Free State
   j. Cape Stack in the Western Cape
   k. Bambili Hyplat Fuel Cell Manufacturing
4. Note that all projects registered with ISA will receive official SIP letters once Project Plans are submitted and adopted by the SIP Steering Committee, which sits on a quarterly basis.
5. Additional Green Hydrogen projects will receive SIP status once registered with ISA.

Ms. Patricia De Lille, MP
Minister of Public Works and Infrastructure
Chairperson of the PICC Secretariat

Current Infrastructure

- ***Ports, Roads (N1, N12, N2, N3), REDZ, Northern and Southern Ele. Transmission, pipelines***

Planned infrastructure

- ***Desalination plants, Electrolysers, Ammonia plants, Refueling Stations, pipelines, CO_2 direct air capture***

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HySA Infrastructure Project Portfolio

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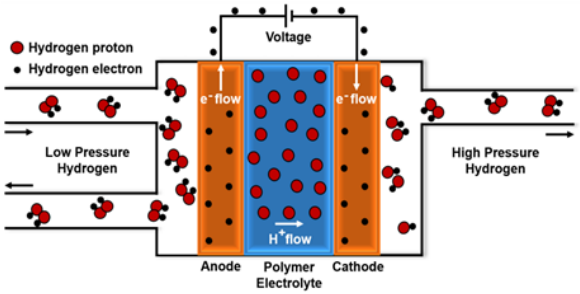
PEMWE

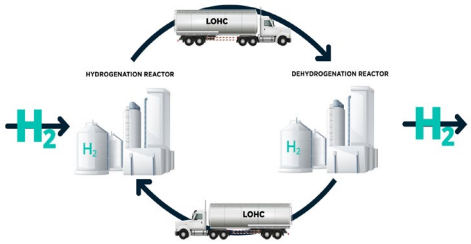
TRL 5

EHC



TRL 5

LOHC

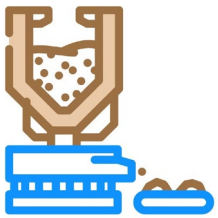


TRL 5

TRL 6

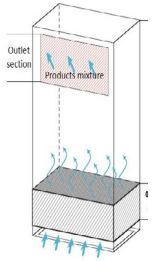
Hydrogen Refueling Stations

HPSR



Ammonia

PAR



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Integrated PEMWE Development Capabilities

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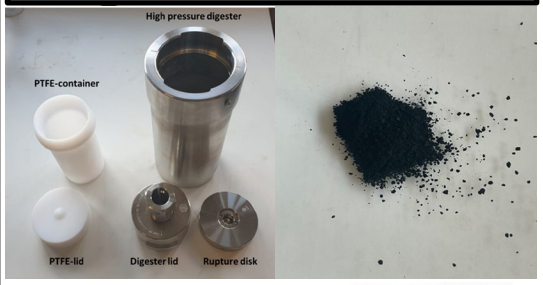
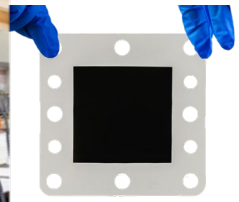
Raw material processing



Catalyst ink

CCM manufacturing

Sono-TEK Ultrasonic Spraycoater

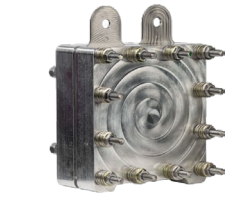


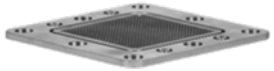
CCM

Components machining

Backplates, GDLs, PTLs, gaskets, etc

Cell/Stack assembly





Electrolyser performance testing

System Specifications

- Fully automated and programmable testing procedure
- Electrochemical Impedance Spectroscopy (EIS)
- Cell temperatures up to: 100°C
- A maximum cell current of: 250A
- Active cell area: 25 & 100cm^2
- Back-pressure control of up to 6 bar
- Ability to measure H_2 % in O_2 and O_2 % in H_2
- Water conductivity
- Mass flow rate (Oxygen + Hydrogen)

BoP assembly

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SASOL RT: System Commissioning onsite

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- Fully automated 2kW PEM electrolyser system
- Voltage monitoring in each cell
- Gas sensors
- PSA system

March 2026

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Electrolyser Test Station

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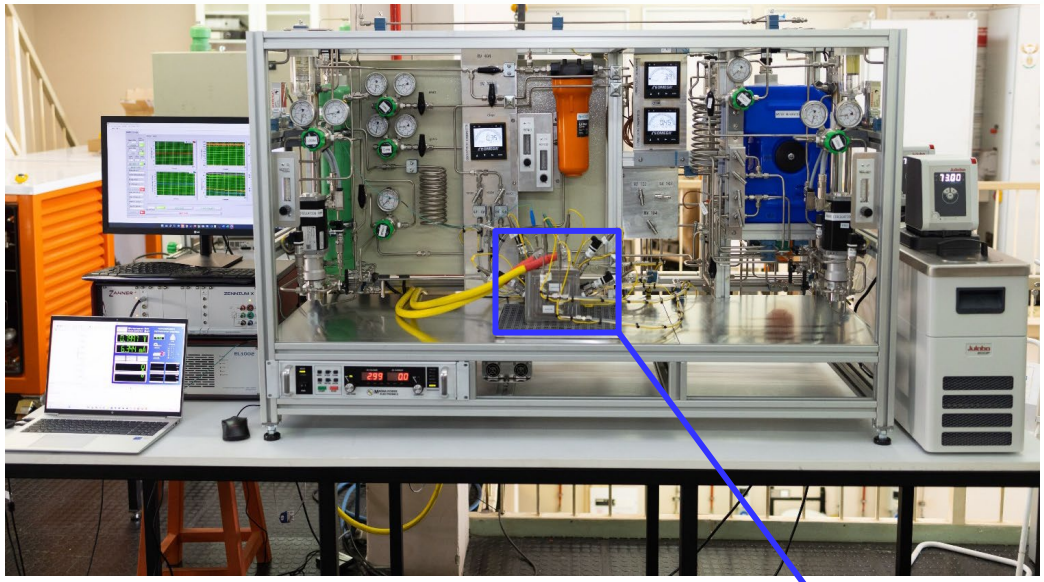
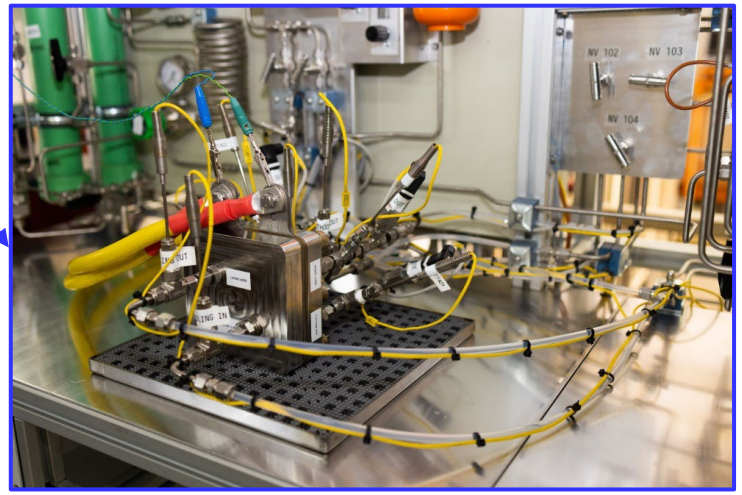


Customized Testing Hardware

- Pol curves and EIS measurements
- Voltage: 0-100V
- Temperature control: <90°C
- H_2 & O_2 pressure: 0-10 bar
- Water flow rate: 0-114 L/h
- Water conductivity: 0,06µS
- Binary analyzer: H_2/O_2 and O_2/H_2



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Electrochemical Hydrogen Compression and Separation

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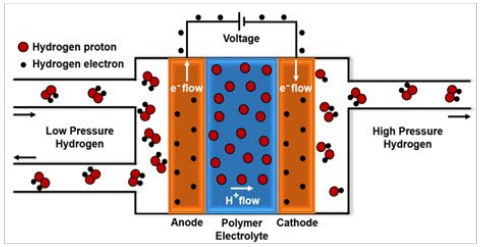
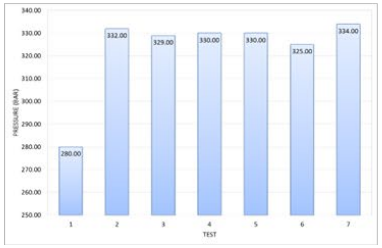


- No moving parts
- H_2 gas purification by separation
- Noise less

GEN1 EHC Compact	
Current Density	0 – 1 Amp/cm^2
Compression Rate	0 – 3 085 mL$_N$/min
Rated Pressure	300 Bar(g)



HySA's EHC Stack

- Reached 330 Bar(g)
- Currently busy with new design focusing of reaching higher pressures

LOHC: Laboratory Testing Capabilities

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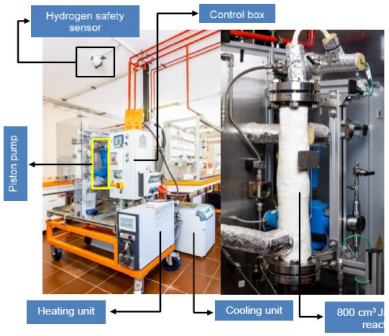
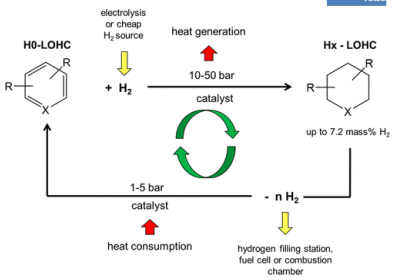
Hydrogenation

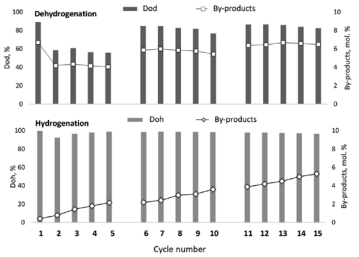


Dehydrogenation

H18-DBT

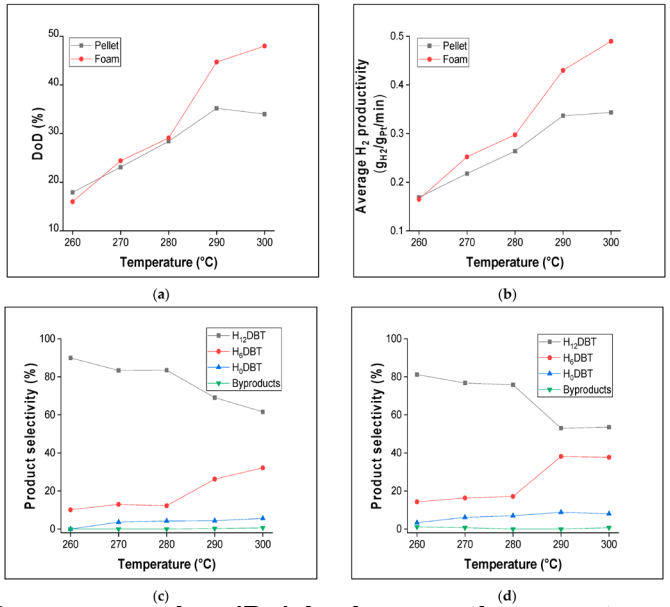
H0-DBT



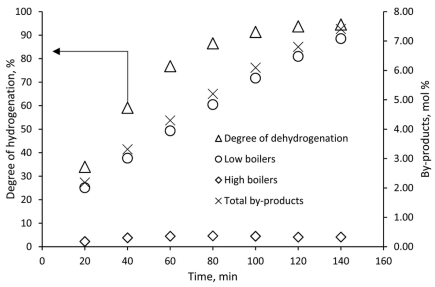


Rapid hydrogenation and dehydrogenation for cycling stability

Comparison of foam and pellet based catalysts for dehydrogenation of H18-DBT



Batch setup for catalyst screening tests



Pressure swing (De)-hydrogenation reactor

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LOHC Catalyst Preparation Capabilities

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Buchi rotary evaporator for heterogeneous catalyst preparation by wet-impregnation

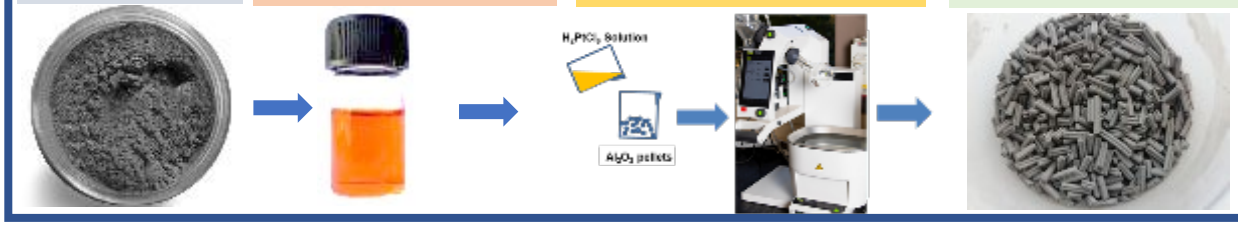
Catalyst treatment furnace

Pelletiser for catalyst preparation

Powder to pellets

PGM Beneficiation

Raw platinum → Dissolved platinum → Platinum impregnation → Pt/Alumina Catalyst



- **Pellet size: 0.85-38.1 mm**
- **Shape: Spherical**
- **Capacity: 0.006-0,02 m^3/h**

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Analytical Equipment

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LOHC Analysis

Scion GCSQMS

Agilent 5977C GC/MSD

Key Feature
- Selective Ion Mode, Peak area, Total Ion Content (TIC)

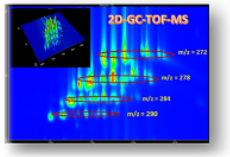
Function
- Degree of hydrogenation
- Quantify/qualify isomer fractions and by-products

Refractometer

Key feature
- Refractive index

Function
- Degree of hydrogenation

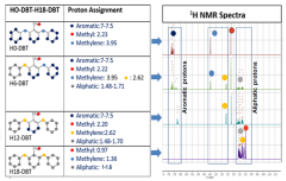
2D-GC-TOF-MS



Key feature
- 1st and 2nd dimension separation, TIC, 2D and 3D plots

Function
- Degree of hydrogenation
- Quantify/qualify isomer fractions

NMR 400 MHz



Key feature
- Chemical shift (ppm)
- Number of protons

Function
- Degree of hydrogenation

Catalyst Characterization

BELCAT II

BELSORP MINI X

SHIMADZU EDX

- Catalyst Textural Properties
- Temperature Programmed Experiments
- Elemental Composition

Gas Analysis

GC SRI-8610C

Key feature
- Peak area, retention time

Function
- H_2 gas purity, quantification of gaseous impurities

Scion 456

Hiden Analytical HPR-20 MS

Key Feature
- Detect and quantify permanent gases, NH_3, chlorine, etc. in a fast response time (300 ms)

Function
- Online gas analysis

LOHC Demonstration Units

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ENGINEERING NEWS
http://www.engineeringnews.co.za/article/chris-griffith-2018-04-12

Fuel cell dozer expected to make game-changing 2019 debut

12TH APRIL 2018 BY: MARTIN CREAMER - CREAMER MEDIA EDITOR


Anglo American Platinum CEO Chris Griffith
Photo by: Creamer Media

JOHANNESBURG (miningweekly.com) – A fuel cell dozer that runs on hydrogen carried in liquid is expected to make a game-changing debut underground next year, Anglo American Platinum (Amplats) CEO **Chris Griffith** said last night.

Speaking at the fortieth African Mining Network dinner, Griffith said third generation development had already taken place on the dozer, which was powered by a liquid carrier of hydrogen, innovated to create market demand for platinum.

"This changes the game," he said in response to *Mining Weekly Online*.

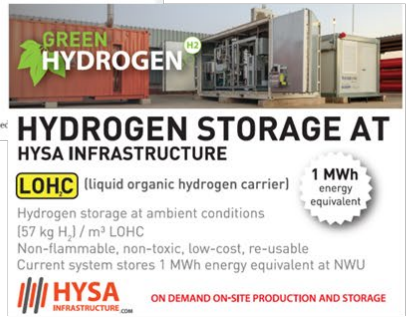
A drum of the hydrogen-carrying, baby-oil-resembling liquid can fuel the dozer for several days.

"This is some really cool technology," he added.

It is poised to be taken underground for operation at a dip that has been very difficult to crack for mechanised trackless mining.

"We're ready to put that underground in about a year's time. The equipment's all working and now we're trying to put this all together so that it works as a system," he disclosed

AngloAmerican and HySA Teams demonstrated H_2 LOHC system for low profile dozer



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LOHC Demonstration Units

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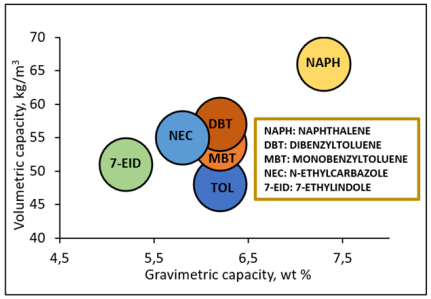
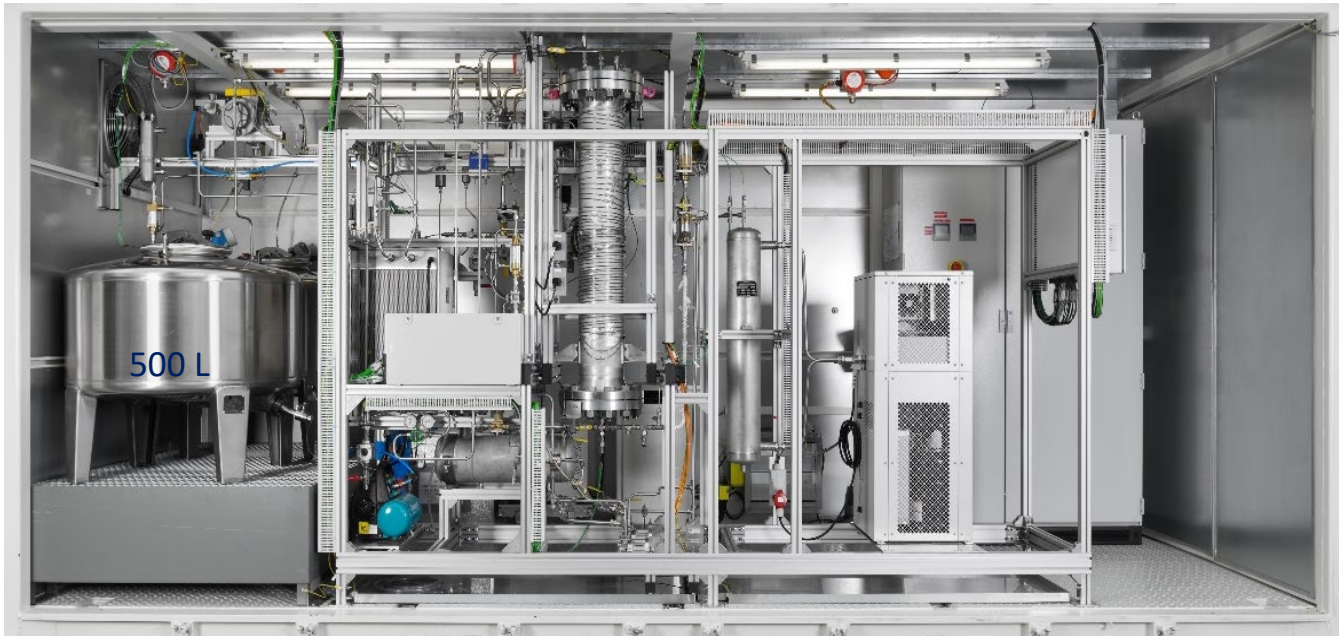
SPECIFICATIONS	HYDROGENATION PLANT
H_2 CONSUMPTION RATE	4 Nm^3/hr
HYDROGENATED LOHC PRODUCTION RATE	5 kg/hr
OPERATING PRESSURE	28 -30 bar
OPERATING TEMPERATURE	140 -180°C
REACTOR VOLUME: APPROX	50 Litres
REACTOR TYPE	Fixed-bed downflow

Hydrogenated LOHC

- High H_2 capacity: 6.2 wt% (equivalent to 57 kg-H_2/m^3 - LOHC or 2.06 kWh/kg-LOHC
- Degree of hydrogenation > 95%
- Non-flammable
- Compatible with existing infrastructure for fuels





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Refuelling Capabilities

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Specifications

- 6 Nm^3/hr PEM electrolyser with 15 bar discharge
- 500-litre potable water supply tank on the roof
- 350 bar on-board hydrogen storage
- 350 bar SEA hydrogen dispenser
- 63 A 3phase electrical connection
- Deionizer water purification system

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Toyota Mirai Refuelling

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Ambient Temperature Refuelling: SAE J2601/4

- Hydrogen Storage tanks
- Refuelling nozzle
- Power electronics
- PLC

- Water deioniser
- PEM WE system
- Compressor
- Power electronics
- PLC

RPTTF Launch and Refueller Handover

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HPSR System Commissioning

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Decarbonising Iron & Steel Industry

- 100 kVA HPSR Furnace
- Continuous smelt of 18-20 kg/h of iron ore
- Tap liquid iron in 60-80 kg batches

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Green Ammonia Synthesis

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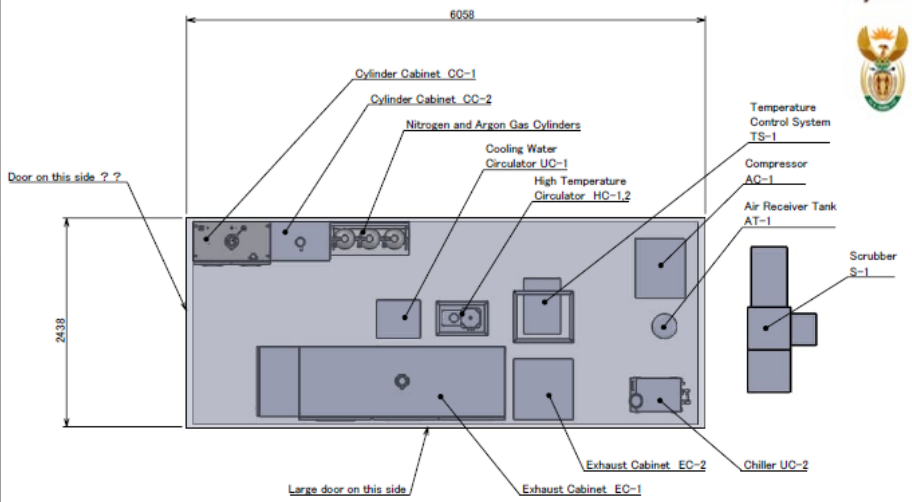
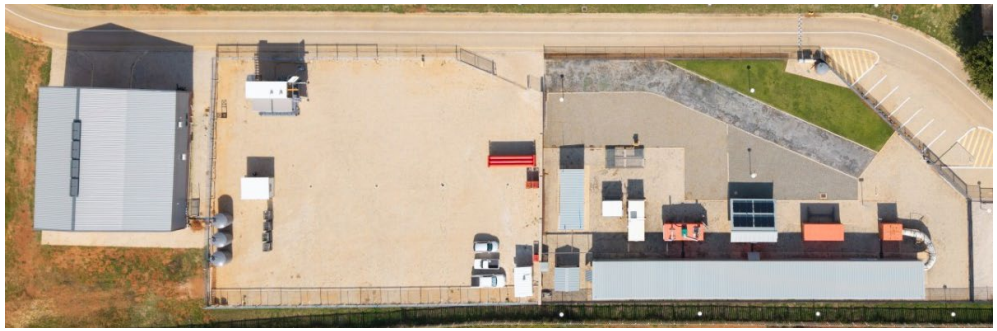
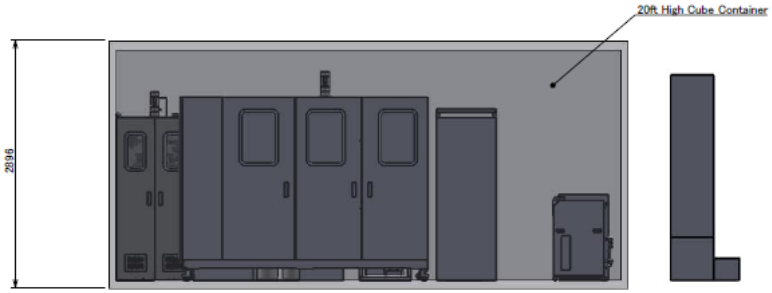
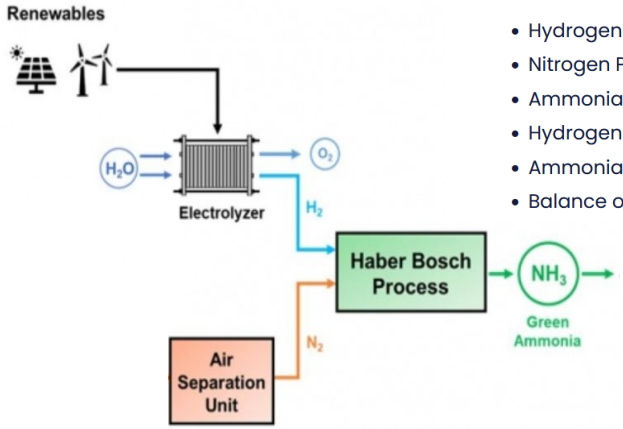






A Green Ammonia Plant consists of following units:

- Hydrogen Production
- Nitrogen Production
- Ammonia Production
- Hydrogen Storage
- Ammonia Storage
- Balance of Plant (utilities and infrastructure)



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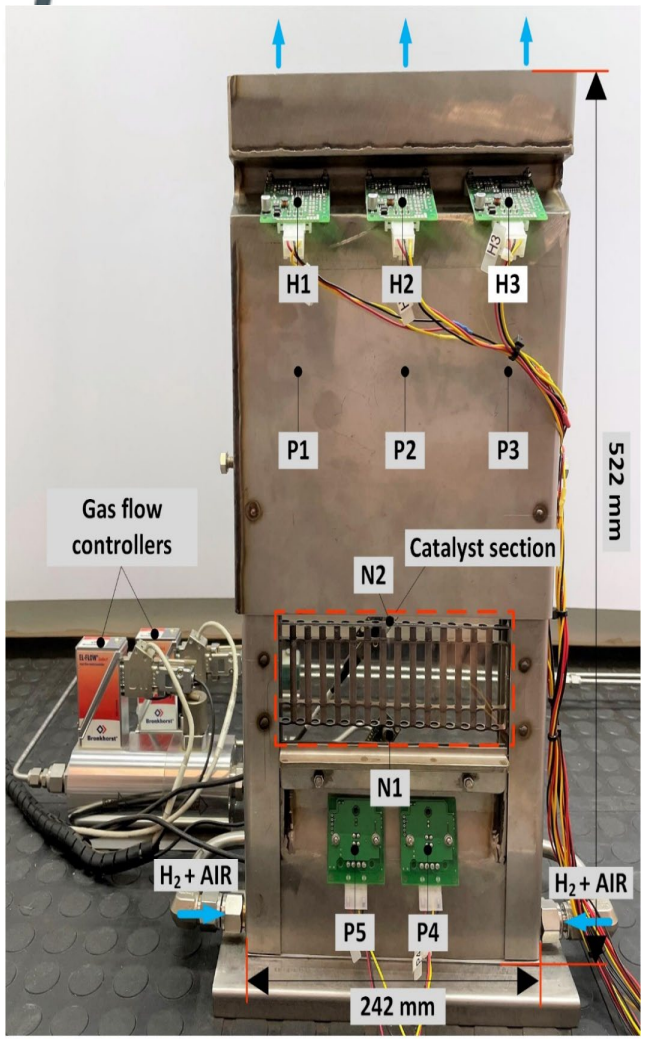
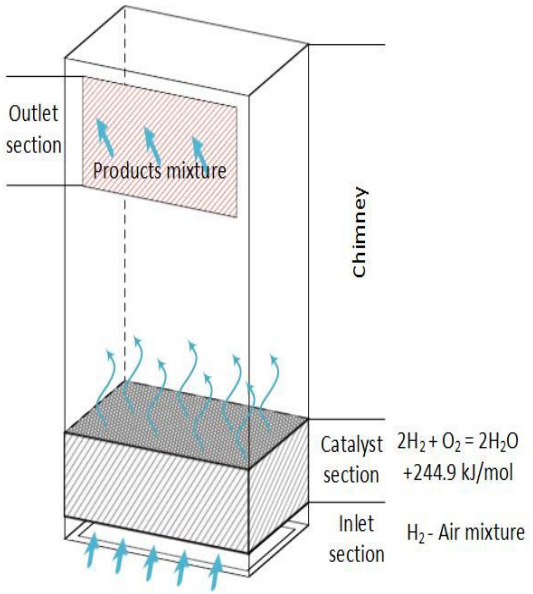
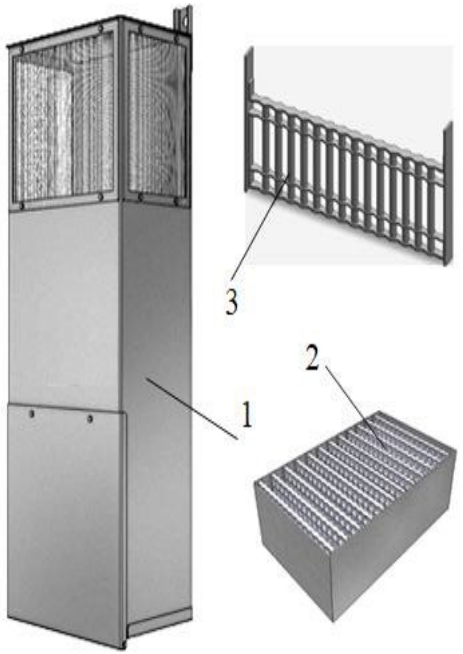
Hydrogen safety: Accidental hydrogen release in confined spaces







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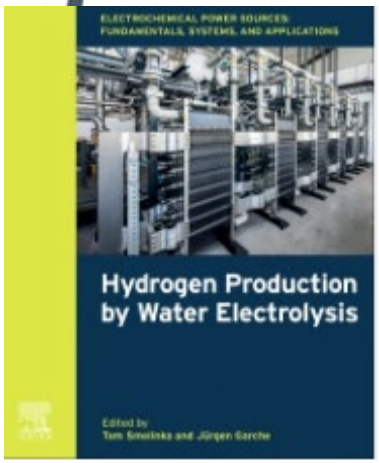

Electrochemical Power Sources: Fundamentals, Systems, and Applications

Hydrogen Production by Water Electrolysis

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Chapter 13 - Hydrogen storage

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Abstract

This chapter presents an overview of the key hydrogen storage approaches being pursued. It discusses the recent status of hydrogen storage options and provides an outlook for the development of hydrogen storage technologies. It

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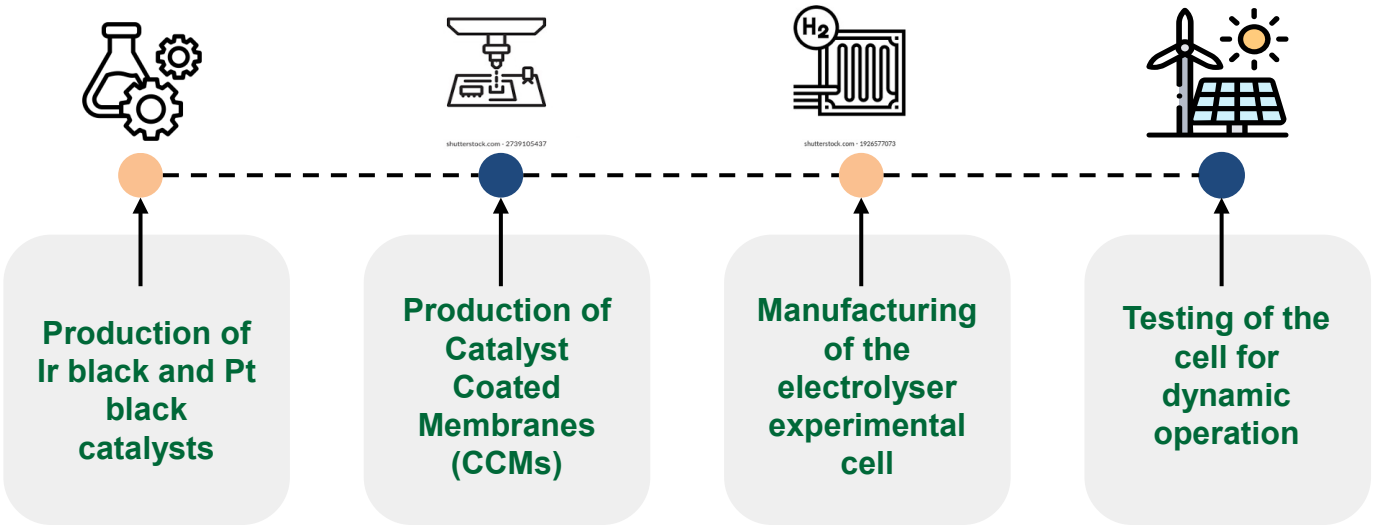

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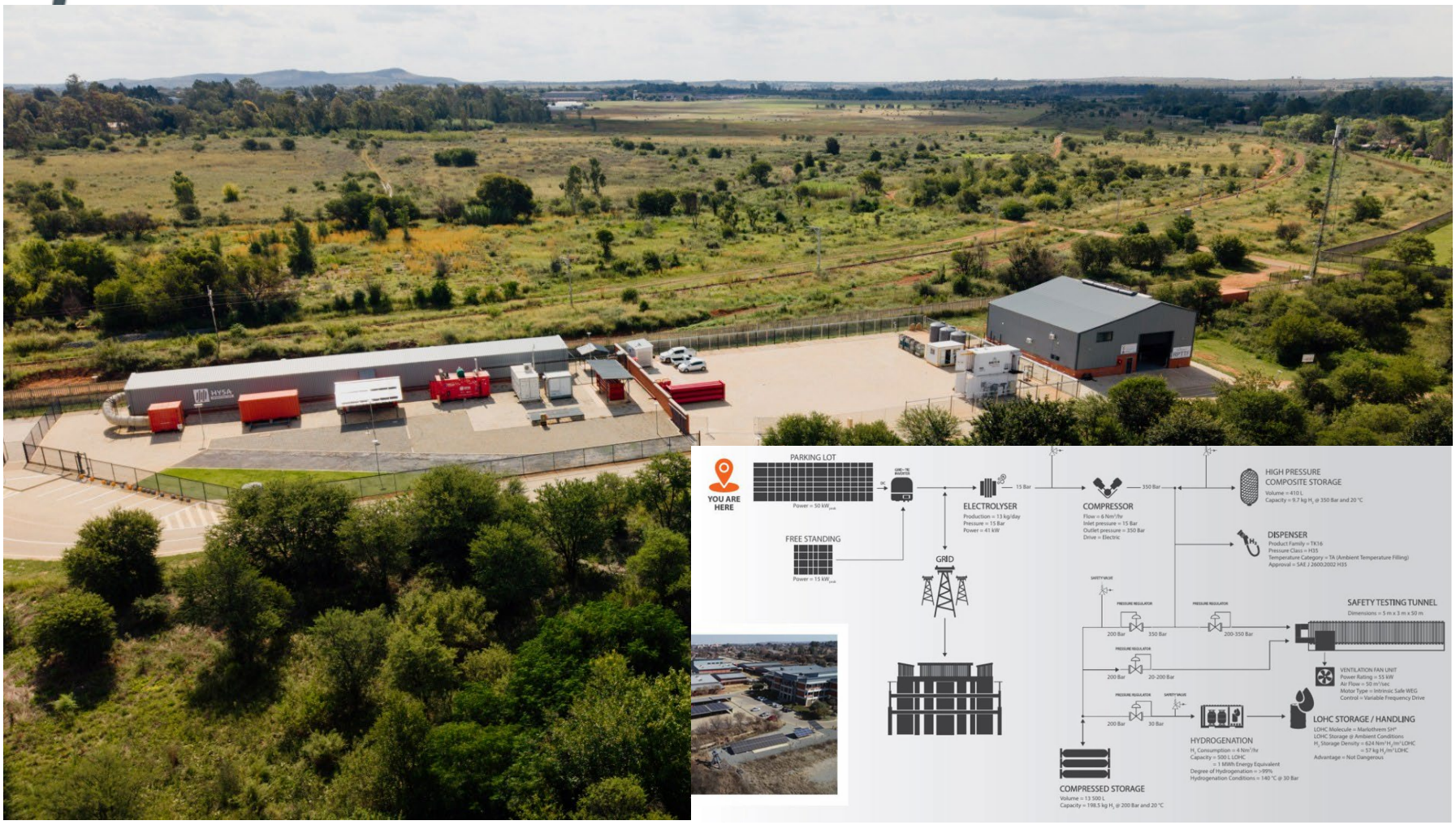

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