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SA INC. and the HYDROGEN ECONOMY

The roadmap for the hydrogen economy – is the South African mining industry leading the way?

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Key points driving the Minerals Council HYDROGEN STRATEGY

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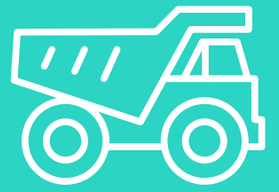
1	Facilitate high-level strategic thinking about the current state, potential and future of the green hydrogen economy in SA and globally
2	Discuss and agree what success for a green hydrogen industry could look like by 2030 and 2050
3	Agree an industry view of the key foundational pillars that would support the establishment of a large green hydrogen industry SA This could include:

Policy support for promoting adoption of green hydrogen technologies, including development of targets and milestones, hydrogen codes and safety standards, policy support to enable early scale up of capacity and scale

Tax incentives that encourage investment in RD&I in green energy sources to help produce green hydrogen and in various green hydrogen related applications

Cooperation on establishing hydrogen corridors (and the related refueling infrastructure), supply chains and green hydrogen industrial nodes



Engagement and cooperation with OEMs in areas such as heavy-duty trucking, rail and sea transport, air transport and in stationary base load fuel cells

Consideration of skills requirements and potential changes to curricula to enable the availability of the requisite skills in the future

RENEWABLE ENERGY SOURCES

Background

Study spearheaded by Department of Science and Innovation (DSI), energy and services company ENGIE, SA National Development Institute (SANEDI) and clean energy solutions provider Bambili Energy.

Purpose - to identify and design hubs in Hydrogen Valley, assess economic viability and understand impacts on society.

Objective - to identify at least 3 actionable projects as part of the broader efforts promoted by SA government to develop a Hydrogen Society Roadmap, integrating hydrogen into the economy to revitalise and decarbonise key industrial sectors.

Key features

- Proposed Hydrogen Valley will stretch approximately 835km - from Mogalakwena mine near Mokopane, along the industrial and commercial corridor to Johannesburg, and to the coast south of Durban
- Collaboration as part of a public-private partnership (PPP) promoting the use of hydrogen fuel cell heavy duty vehicles through the development of infrastructure along key freight routes, and further builds on Anglo American's market development work to promote the adoption of fuel cell electric vehicles (FCEVs) for commercial uses
- Anglo American, through its PGM Market Development division, contributed project coordination expertise, access to company's broad hydrogen network and financial investment to cover part of the cost of the feasibility study
- Study findings include a qualitative analysis of project's socio-economic impact and will inform guidance on the regulatory framework necessary to bring the project to life

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Investing in hydrogen hubs

HYDROGEN VALLEY

- Hydrogen presents a significant opportunity for economic development in SA
  - Job creation
  - Monetisation of the platinum industry
  - Contributor to South Africa’s decarbonisation objectives
  - Energy export

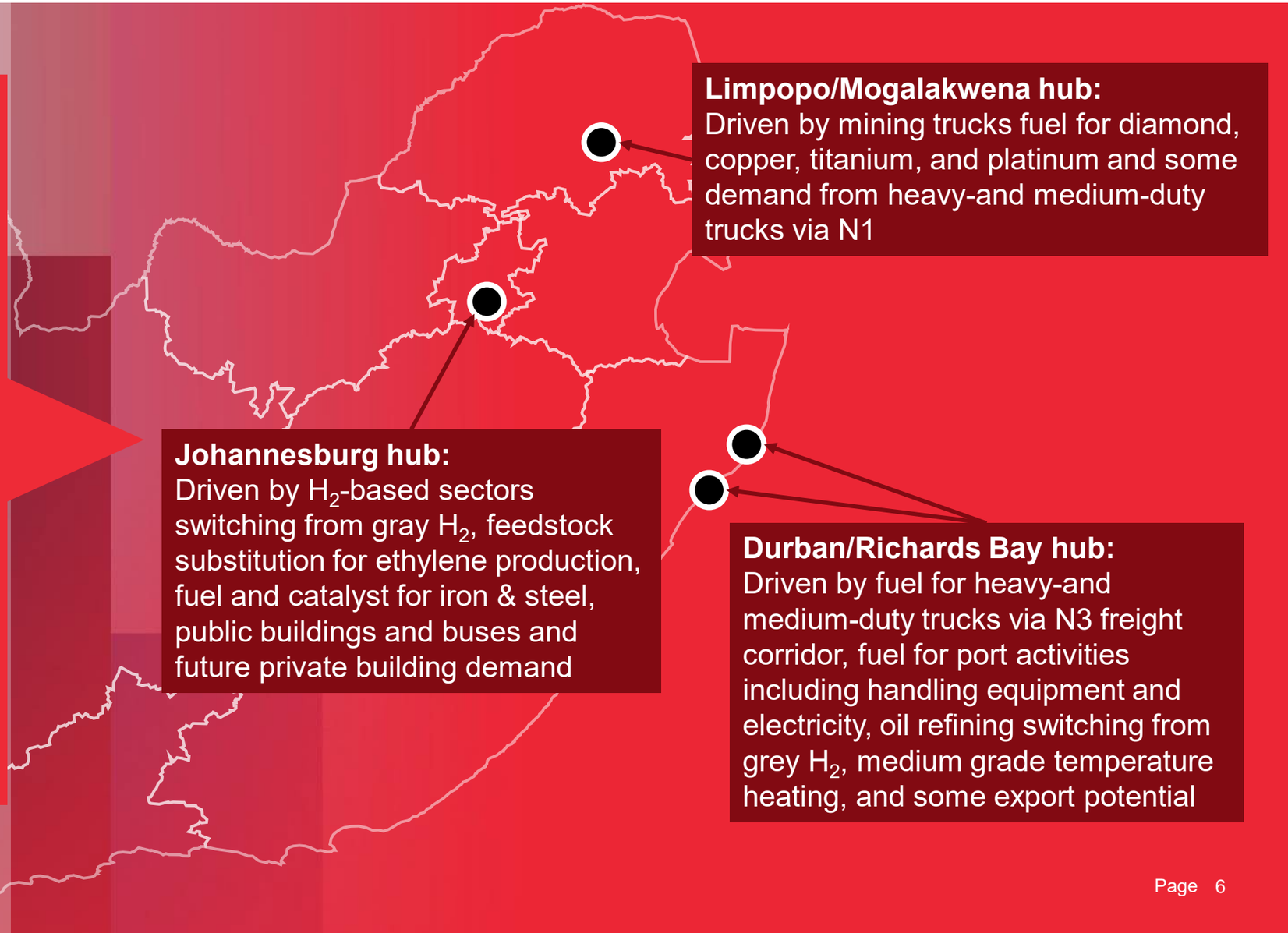
To realise these objectives for South Africa, Hydrogen Valleys can be leveraged to kickstart the hydrogen economy, leading to cost savings through shared infrastructure investments, improving the cost competitiveness of hydrogen production through economies of scale, enabling a rapid ramp-up of hydrogen production within a given territory, and leveraging an incubator for new pilot hydrogen project.

Hydrogen is a key priority for South Africa. In his last State of the Nation address, President Ramaphosa cited that hydrogen fuels cells are a national priority as an alternative energy source.

HYDROGEN HUBS

3 catalytic green hydrogen hubs identified in SA's Hydrogen Valley.

Based on locations with potential for high concentration of future hydrogen demand, possibility to produce hydrogen (eg access to sun/wind, water infrastructure), and contributions to the just transition—an economic development plan that brings positive social impact particularly to more fragile groups and communities

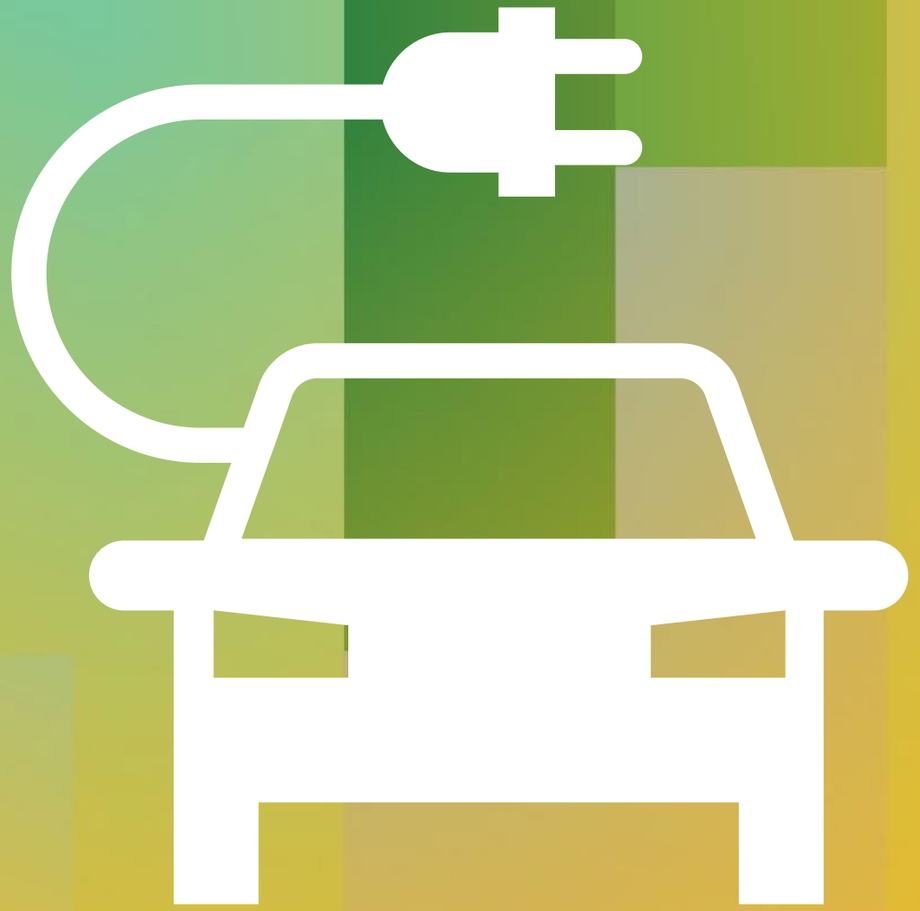


Limpopo/Mogalakwena hub:
Driven by mining trucks fuel for diamond, copper, titanium, and platinum and some demand from heavy-and medium-duty trucks via N1

Johannesburg hub:
Driven by H_2-based sectors switching from gray H_2, feedstock substitution for ethylene production, fuel and catalyst for iron & steel, public buildings and buses and future private building demand

Durban/Richards Bay hub:
Driven by fuel for heavy-and medium-duty trucks via N3 freight corridor, fuel for port activities including handling equipment and electricity, oil refining switching from grey H_2, medium grade temperature heating, and some export potential

Source: Hydrogen Roadmap

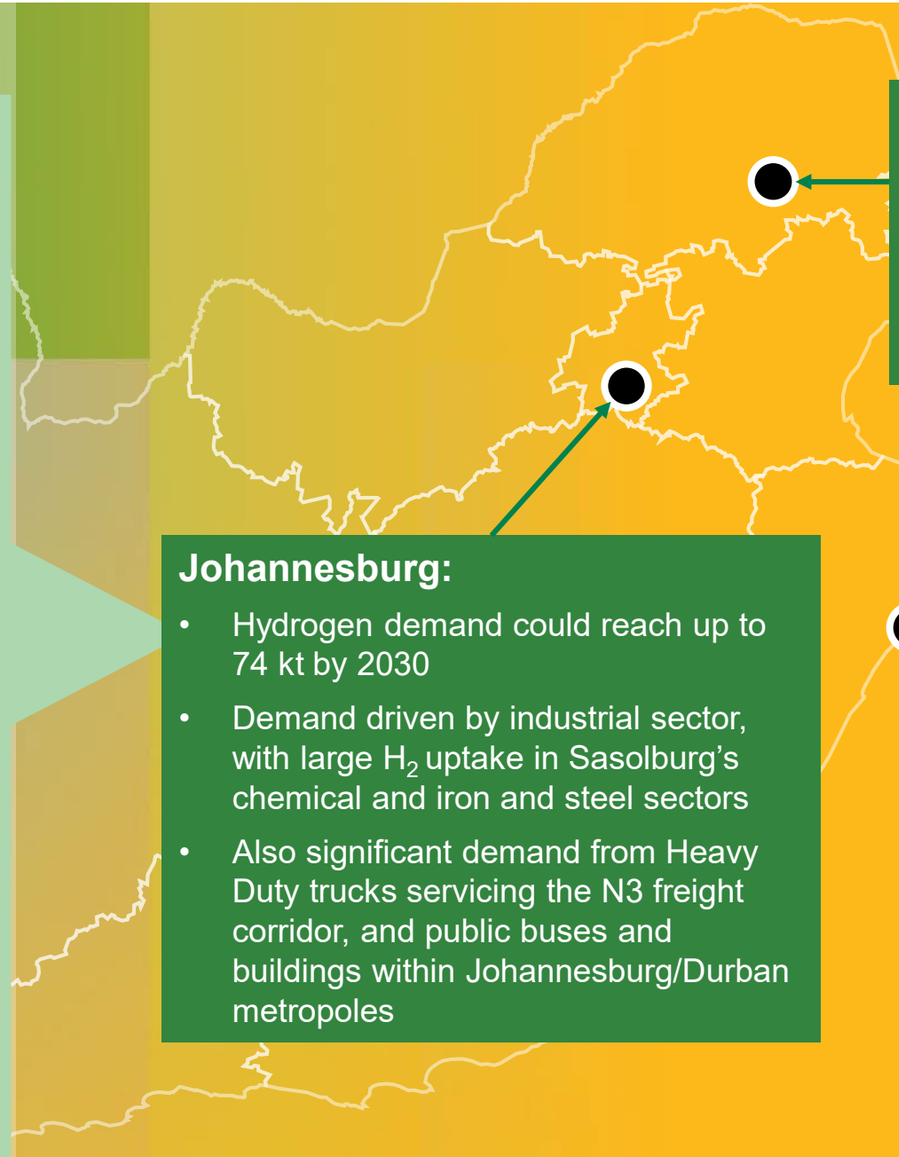


What about supply and demand?

HYDROGEN DEMAND

Hydrogen demand in the Valley could reach up to 185 kt H_2 by 2030, or 40% (low demand case) to 80% (high case) of demand in the national hydrogen roadmap.

Hydrogen export could be potential future source of demand. But Valley will face competition from other hydrogen exporting countries such as Morocco and Australia and from other ports in South Africa such as Boegoebaai.



Mogalakwena/Limpopo:
Positioned as the mining hub, with 90% of its nearly 40 kt of H_2 demand driven by possible demand from mining trucks
Flagship Limpopo Science and Technology will also provide demand for fuel cells to power its building stock.

Johannesburg:

- Hydrogen demand could reach up to 74 kt by 2030
- Demand driven by industrial sector, with large H_2 uptake in Sasolburg's chemical and iron and steel sectors
- Also significant demand from Heavy Duty trucks servicing the N3 freight corridor, and public buses and buildings within Johannesburg/Durban metropoles

In Durban:

- Hydrogen demand could reach 70 kt by 2030
- Demand driven by mobility sector, with growth of fuel cell Heavy and Medium-duty trucks along the N3 freight corridor, as they reach cost parity with diesel trucks.
- Ports of Durban and Richards Bay present opportunities for hydrogen in port operational vehicles such as forklifts and cold ironing from fuel cells as well as marine bunkering in the long-term. Some industrial demand, such as pulp and paper factories, and public building demand is also foreseen.

Source: Hydrogen Roadmap

HYDROGEN SUPPLY

- By 2030, green H_2 LCOH is expected to be ~$4 per kg H_2 across hubs, still more expensive than grey hydrogen, with a green premium of $2-$2.5 per kg
- All three hubs see similar costs of hydrogen production - costs in 2030 will be lower in Johannesburg due to higher solar irradiation levels
- Additional transports cost up to 0.5 USD/kg H_2 considered to bring hydrogen from supply locations to off-takers within the hubs
    - With the addition of transport, hydrogen production costs reach 4.70 –5.00 USD/ kg H2 by 2030
    - Recommend using solar PV for green hydrogen production, with some onshore wind as the cost optimal supply mix
- SA H_2 Valley LCOH estimates are higher than some other analyses, due to the use of PEM electrolysers instead of alkaline electrolysers,
- Given the estimated demand of hydrogen, optimal transport solution consists of transporting hydrogen through trucks from production site to off-takers, while hydrogen pilot projects take shape and begin to scale. Building a hydrogen pipeline requires high levels of hydrogen demand before becoming economically-viable.
- Report anticipates infrastructure constraints and each hub must anticipate infrastructure requirements in electricity supply, water supply, pipeline infrastructure and storage.
    - For electricity supply, a dedicated RES off-grid supply is recommended to mitigate grid reliability risks and avoid network charges and taxes.
    - Most hubs are vulnerable to water supply and hubs may consider locating hydrogen supply next to existing water sources, desalination infrastructure, or implementing water recycling or truck delivery.
- With no extensive H_2 network in the region, existing gas pipelines could be leveraged for H2 transport and distribution in the longer term.

Source: Hydrogen Roadmap

SOCIO-ECONOMIC IMPACT

The H2 Valley could potentially add
US$3.9-8.8 bn
14,0000 -30,000+ jobs
By 2050

- These jobs are based on the RES and electrolyser investment only
- Fuel cell investment may further contribute to job creation beyond these figures
- Jobs across entire value chain (resources to product and logistics), including R&D, engineering, maintenance, training, outreach etc

The PGM sector is expected to see a marginal increase in demand from the Hydrogen Valley

- Platinum is a required raw material for both fuel cell and (PEM) electrolyser manufacturing. However, volume of platinum required for Valley only constitutes a small percentage of platinum production today
- No platinum supply constraint to satisfy the demand of Valley is anticipated.
- Could contribute 70 million USD (high case) to platinum industry in SA in 2030

Source: Hydrogen Roadmap

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How to make this happen?

What are the regulatory and policy enablers needed?

REGULATORY & POLICY ENABLERS to kickstart the hydrogen economy

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BARRIERS

- Sourcing green electricity (grid reliability and limited green electricity on grid)
- Electrolyser scale up (high costs), Hydrogen demand (lack of clear targets and strategies at sector level)
- Infrastructure (missing hydrogen transport and storage regulation)

Policy and regulatory enablers should:	Policy and regulatory instruments needed
Ease deployment of RES and electrolysers	To ease deployment of RES and electrolysers, we recommend offering financial incentives to lower capex cost and fast track RES deployment through simplified permitting procedures
Make near-term capex affordable	To make near-term capex affordable for hydrogen supply infrastructure, we recommend the following suite of policy instruments: direct financial support, financial incentives and CO2 taxes
Encourage H_2 applications	
Create momentum for future demand	Sector planning for provide transparency on future off-take and encourage technology partnerships between suppliers and off-takers to share risk of new projects
Formalise hydrogen sector through standards and labels	Required to harmonise technology specifications and guarantee safety of hydrogen production, transport and of applications
Support policies around RES deployment, land and water use - must also be coherent with creating a hydrogen economy and sustainable future	

Source: Hydrogen Roadmap

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Thank you