

Green Hydrogen (GH₂) Commercialisation in South Africa

A path towards industrialisation, decarbonisation and
socioeconomic upliftment for South Africa

Date: 20 October 2023

Presentation to PCC Energy Dialogue: The Role of Green Hydrogen



A solid historical base supports accelerated commercialisation

1

2007

Development of the **National Hydrogen and Fuel Cell Technology Strategy** by the Department of Science and Innovation and approval by Cabinet

2

2008-2018

Various demonstrator projects : an underground fuel cell powered mining locomotive, solar-to-hydrogen system, battery and fuel cell golf cart, fuel cell generator providing lights for the UWC Nature Reserve, fuel cells for power storage for homes and cellular phone tower base stations; a Hydrogen refueling station; and fuel cell powered forklift. Green Hydrogen fuel cell system with on-site production and storage and a Hydrogen in Mining test facility, Hydrogen production, Liquid Organic Hydrogen Carriers and the use of PGM catalysts for the production of Hydrogen. HySA demonstrated a 2.5kW fuel cell system at Poelano Secondary School

3

2020

The DSI, Hydrogen SA and North West University initiate a process with the South African government to develop a **Hydrogen Society Roadmap**.

4

JUNE 2021

Presidency announces that GH₂ has been identified as the first of five "**Big Frontier**" strategic investment opportunities

5

JULY 2021

The DTIC and IDC coordinated a joint approach to sector planning by establishing a **Green Hydrogen Panel**

6

NOVEMBER 2021

At COP 26 in Glasgow, Scotland, South Africa **mobilizes funding support** for the country's decarbonization

7

FEBRUARY 2022

The HSRM is released to the public marking a momentous milestone for South Africa's hydrogen industry development

8

OCTOBER 2022

The JET-IP was approved by Cabinet and presented at COP27

9

NOVEMBER 2022

Inaugural Green Hydrogen Conference held in Cape Town

10

NOVEMBER 2022

IDC and KfW sign MOU to deploy €23m of grant funds towards catalytic green hydrogen projects

11

DECEMBER 2022

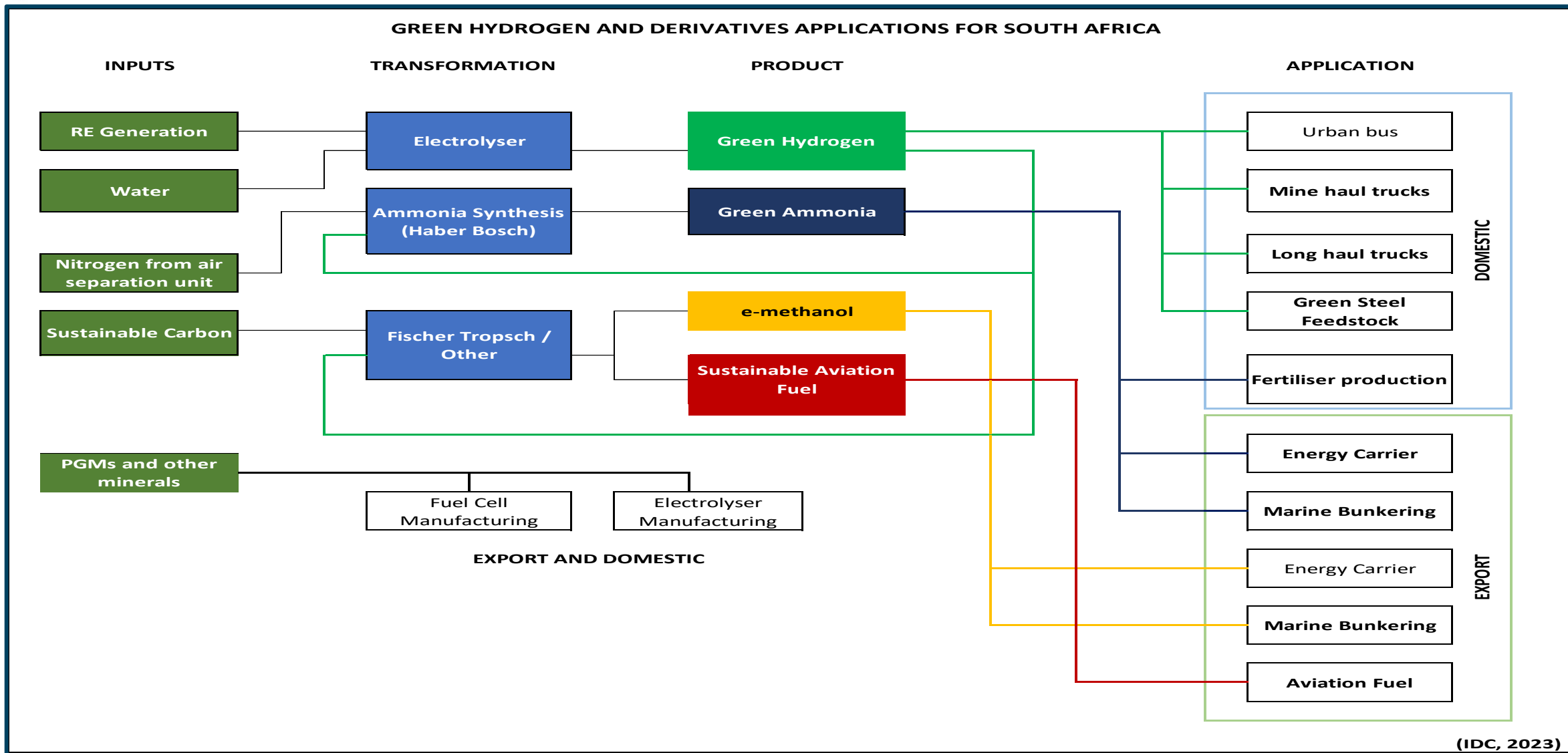
Government gazette lists 20 green hydrogen projects with 9 of them being granted SIP status

12

DECEMBER 2022

GHCS released to the public for comment (Comments closed on 31 March 2023)

The Green Hydrogen Value Chain for South Africa



The Opportunity presented by Green Hydrogen for South Africa

Why it is critical for South Africa to develop the GH₂ industry

Market driven commercialisation

Import Markets for GH₂ to 2050 will be the EU (2030: 20mtpa); Japan (2040: 12mtpa; South Korea (2050: 1.2 mtpa), the United Kingdom (2050: 0.7 mtpa).

Industrialisation opportunities

Value chain impact across multiple industries – renewable energy, steel, petrochemicals, transport, manufacturing, mining, construction, agriculture

Infrastructure build

GH₂ projects will serve as anchor demand to justify shared infra. investment, e.g., Boegoebaai port, accel. Northern Cape grid expansion, reskilling initiatives, etc

Decarbonisation

GH₂ can decarbonize much more than RE alone by replacing fossil fuel inputs in industrial processes; Last mile decarbonisation in hard to abate sectors

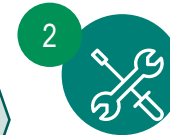
The GH₂ economy presents new economic, skills, employment and community opportunities for South Africa

GDP Increase of R100-R250bn, 1-3%



GH₂ value chain can drive industrialisation of heavy manuf. (e.g., green steel), petrochem (e.g., SAF, green MeOH and other PtX) to drive economic growth

650,000 to 1m new jobs



GH₂ value chain drive long-term net job creation in new green, and preserve jobs in at-risk industries (e.g., heavy man, petrochem)

BBBEE including community empowerment



Opportunity to empower previously disadvantaged people by taking ownership in new businesses and by providing new job opportunities. Communities can be empowered by shareholding in projects and by SMMEs contracting along the GH₂ value chain.

Gender equality and social inclusion



Opportunity to integrate gender equality through empowering women to take leadership roles in green industries as entrepreneurs and / or industry professionals



South Africa is well positioned to produce GH₂ thanks to our structural competitive advantages



SA with large scale, high quality RE potential and sufficient land

- ✓ Average **RE capacity factors** in South Africa are amongst the best in the world and on par with major competitors like Chile, Australia and Saudi Arabia
- ✓ SA with vast land available, just **1% of SA land area** (1.1 million ha) would be sufficient to produce **10 mt of GH₂**
- ✓ ~ 5,4 million ha in REDZ alone (areas not in competition with agriculture or settlements)
- ✓ REDZ zones alone can hold 900+ GW of RE capacity with premium capacity factors



Unique expertise for beneficiation into e-fuels and endowment of PGMs

- ✓ Proprietary **Fischer-Tropsch** technology lacking in other countries (critical for power to liquids)
- ✓ Endowment in **PGMs** required in the GH₂ value chain



8 challenges must simultaneously be overcome for South Africa's GH₂ industry to materialise

Misconception that GH₂ is water intensive

Public awareness that projects are not water intensive; cost of water on GH₂ overall cost is minimal, leverage on desalination to provide water to communities

Cost of green products is at a premium compared to grey products

Utilise pricing subsidies to support export project business case
Target scale and learning rates will bring prices down successively

Water requirements

Green Premium

Awareness

Lack of understanding of the benefits and applications of GH₂
Awareness campaigns with NEDLAC, PCC, lobby groups ; JET-IP implementation plans will address knowledge sharing

Transportation of GH₂ is very costly

GH₂ exports will be via conversion to ammonia; indications from SA commercial project pre-feasibility studies is that long distance transportation via ship is not a high cost
Pipeline feasibility study for SA will provide more clarity on costs to transport hydrogen from the cost to inland via a hydrogen pipeline

Transportation costs

Energy Security

GH₂ should not compete with energy crisis
Projects will come on line after energy crisis resolved, projects will feed into the grid, community mini grid opportunities

Funders risk averse due to tech & offtake uncertainty

\$100m of grant funding being sourced to overcome high development risk

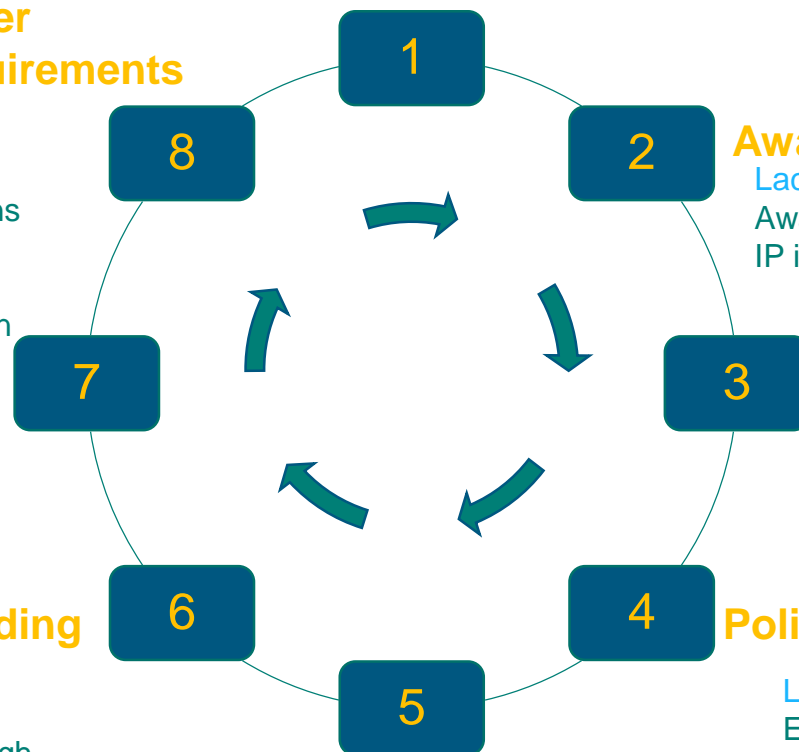
Funding

Policy Alignment

Lack of inter-government and private sector policy alignment
Expedite GHCS approval by Cabinet
Execute implementation plans in GHCS and JET-IP targeting policy alignment

Infrastructure Coordination

Lack of coordination on infrastructure plans for ports, pipelines, road and rail
TNPA coordinating ports work, pipeline study being initiated,





South Africa's approach is anchored on 6 elements

The successful implementation of the commercialisation strategy will depend on the execution of the six key elements :

1

TARGET EXPORTS

Target exports of green hydrogen and green chemicals by leveraging on South Africa's proprietary Fischer Tropsch technology and utilising financing support mechanisms including grants, concessional debt and contract for difference/price subsidies to improve the financial viability of these projects

2

STIMULATE DOMESTIC MARKET

In parallel to the export strategy, develop projects along the value chain to stimulate demand for green hydrogen in South Africa. "Low hanging fruit" opportunities to be prioritised to provide confidence in the domestic market. Examples include green steel, fertiliser, hydrogen valley mobility programme and sustainable aviation fuel projects.

3

SUPPORT LOCALISATION

Develop local industrial capability to produce fuel cells, electrolyser, ammonia cracking and balance of plant equipment and components by leveraging on South Africa's PGM resources. Together with demand stimulation this will drive longer term GH₂ price reduction allowing penetration in various sectors.

4

SECURE FINANCING

"Crowd in" and secure funding from various sources and in various forms including grants, concessional debt and contract for differences.

5

PROACTIVE SOCIO ECONOMIC DEVELOPMENT

Maximise development impact (incl. skills and economic development and social inclusion).
Ensure gender equality, BBBEE and community participation.
Maximise job creation and alternative options for potential job losses.

6

ROLE OF GOVERNMENT IN POLICY AND REGULATORY SUPPORT

Position GH₂ as a key early contributor to decarbonization and a just transition in the country programme of work being collated by the JET-IP Task Team ensuring a fair proportion of climate finance is sourced to enable development of this industry.

Prioritize the execution of the green hydrogen commercialisation strategy and the development of a national GH₂ infrastructure plan

Drive the required policy and regulatory changes required to sustain long term growth of the new hydrogen industry.

Mobilise and coordinate the Government support required to support the development of this new industry for South Africa.

Target a minimum of 7 mtpa by 2050

EXPORT MARKET

South Africa will have to secure a long term global market share and competitive trade position against competition from other exporters.

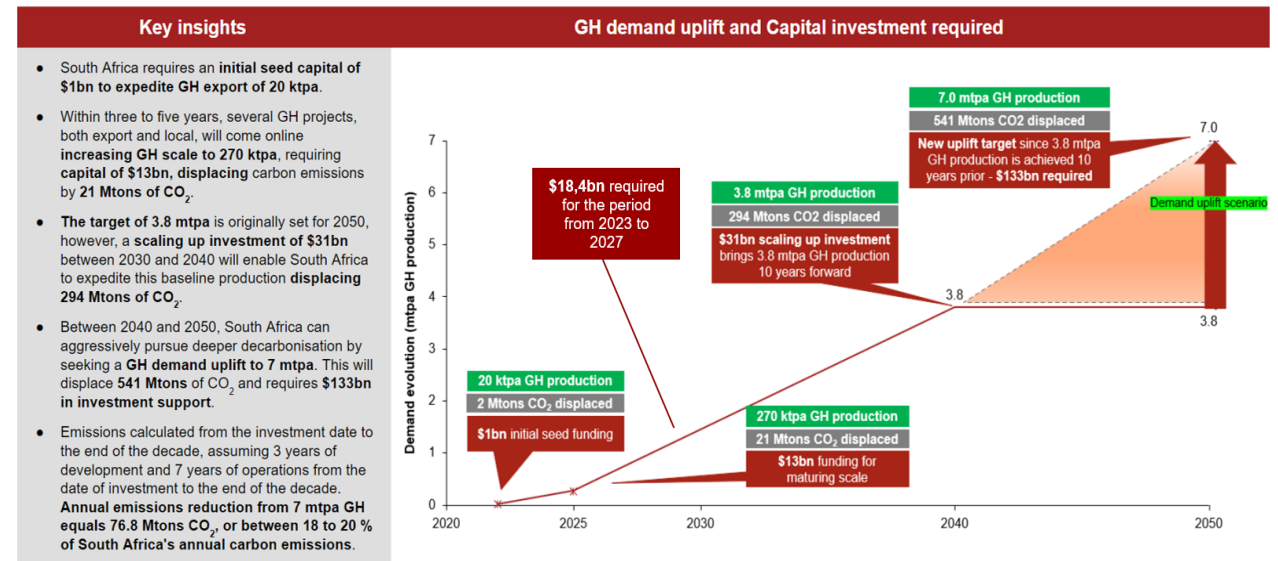
Export potential is estimated at **4 to 8 mtpa by 2050**

DOMESTIC MARKET

Domestic demand will accelerate as price parity gets closer to fossil fuels. However niche applications areas may be driven sooner than reaching price parity e.g. green steel and fertilizer.

Domestic potential estimated at **3 to 6 mtpa by 2050**

GH₂ demand uplift and Capital investment required



PRODUCTION TARGETS

YEAR	2025	2030	2040	2050
TARGET	20	270	3.8	7
UNITS	ktpa	ktpa	mtpa	mtpa



Key Consideration: Infrastructure

The creation of a hydrogen economy will require new infrastructure investments, particularly related to transmission infrastructure, ports, and transport (e.g. pipelines)

1 Transmission Grid



- Currently challenges experienced around the availability of transmission infrastructure to transport electrons from the areas of high renewables availability to areas of demand.
- **It is vital that the transmission infrastructure investment be reassessed to align the transmission infrastructure upgrades with increased accommodation of electricity demand for GH₂.**

2 Ports



- A number of hubs and ports have been identified to connect production, conversion, transport and export infrastructure.
- **As more interest and investments accrue into these and other ports in South Africa, it is vital that port infrastructure is assessed with respect to the readiness for green hydrogen integration and projects. Importantly, no single port should be viewed as a silver bullet export option and the commercial cases for various exported GH₂ products, markets and value chain focuses should be tested and established across the ports of interest.**

3 Transport (e.g. Pipelines)



- GH₂ can be transported via ship, pipeline, trains and trucks. Pipelines are an important transport infrastructure that can be leveraged to transport green hydrogen from production to consumption sites, particularly for domestic and regional access.
- Based on European Commission analysis: for distances up to 2 600km, GH₂ pipeline and compressed hydrogen shipping are the cheapest options. For distances above 2 600km, liquefied hydrogen or ammonia are the cheapest options.
- **It is thus recommended that a pre-feasibility study be undertaken to determine the suitable transport modes and their cost variance for transporting GH₂, including the costs and viability of building new hydrogen pipelines in the country.**

Skills development is a key enabler

SKILLS DEVELOPMENT

The creation of a hydrogen economy will require a new skill sets as well as an increase in capacity of a productive workforce

Value chain	Localisation opportunity (Priority)	Skills required	Skills sourcing	Government can build local skills capacity by...
Renewable Energy generation	Hydrogen and renewable energy specialists (High)	Circular economy skills	Outsource	<ul style="list-style-type: none"> Incentivising the private sector to support local capacity as they outsource for missing and limited skills. Support educational institutions with development and funding of training programmes focused on the GH industry. Creating financial incentives for the private sector to roll out upskilling initiatives.
		Green architecture and future cities planning skills	Outsource	
		Green engineering and tech skills	Local, but limited	
		Natural capital skills	Outsource	
		Sustainable agriculture skills	Local, but limited	
Electrolysers and Balance of Plant	PGM mining and processing (High)	Technical engineering (renewable, marine)	Local, but limited	<ul style="list-style-type: none"> Incentivising the private sector to support local capacity as they outsource for technical engineering expertise specific to electrolyser manufacturing Supporting the roll out of upskilling initiatives through funding and financial incentives to encourage quicker uptake by the private sector
		Circular economy skills	Local, and growing	
	Recycling of used PGM products (Medium)	Circular economy skills	Local, but limited	
Beneficiated Products	CCM* and MEA* electrolyser component manufacture (High)	Green engineering and tech skills	Outsource	<ul style="list-style-type: none"> Incentivising the private sector to support local capacity as they outsource for technical engineering expertise specific to CCM and MEA component manufacture, fuel cell stack manufacturing, green engineering, and circular economy integration. Supporting educational institutions with development and funding of training programmes focused on the GH industry.
		Manufacturing and Assembly	Local, but limited	
		Circular economy skills	Outsource	
	Fuel cell stack and systems manufacture (Medium)	Green engineering and tech skills	Local, but limited	
		Manufacturing and Assembly	Local, but limited	
Automotive manufacture (Medium)	Manufacturing and Assembly	Local, and mature		
All	Systems Integration and Operation and maintenance (High)	Circular economy skill	Local, but limited	<ul style="list-style-type: none"> Incentivising the private sector to support local capacity as they outsource for missing and limited skills. Incentivising the private sector to roll out upskilling initiatives to develop growing skills, through funding models and financial incentives Developing ecosystem and research partnerships to diversify mature skills into other segments of the GH value chain and other industries.
		Environmental justice skills	Local, and growing	
		Green career pathways	Outsource	
		Green architecture and future cities planning skills	Outsource	
		Operations management and system integration skills	Local, and mature	
Foundational skills South Africa has developed strong expertise in		Ancillary and support services/ Architecture and Engineering design services/ Business and Management services Construction/ Finance and Legal services/ Information and Communications Technology/ Insurance and Healthcare services Logistics and transport/ Manufacturing and Assembly/ Risk Management/ Skilled labourers/ Technical engineering		

* CCM (catalyst coated membrane) and MEA (membrane electrode assembly)



Just Transition: Inclusion & Social Impact

Significant opportunity exists for economic development and social inclusion which should be pro-actively driven through the commercialization strategy.

Hard to abate industries are sustained through GH₂

Our steel, cement, petro-chemicals and agricultural sectors currently rely on carbon-intensive heat and chemicals, which are at risk give their carbon intensity. GH₂ has the potential to accelerate the decarbonisation of these heavy industries thereby protecting local jobs

New GH₂ Industry Potential

BBBEE including community empowerment

- Opportunity to empower previously disadvantaged people by taking ownership in new businesses and by providing new job opportunities.
- Communities can be empowered by shareholding in projects and by SMMEs contracting along the GH₂ value chain.

Gender equality and social inclusion

- Opportunity to integrate gender equality through empowering women to take leadership roles in green industries as entrepreneurs and / or industry professionals..



Key Considerations : South Africa's Energy Security Priorities

- ✓ No competition for the electrons that is meant to address our electricity crisis
- ✓ Timing – GH₂ projects will come on line in 2025/2026 – giving us sufficient time to implement NECOM actions and address the electricity shortfall
- ✓ Renewable energy for GH₂ production to be complementary to the general electricity supply situation in the country.
- ✓ Supply of Curtailed Energy: Projects can supply excess electricity into the national energy system to reduce the demand on electricity from other sources.
- ✓ Electricity supply to proximal/vulnerable groups: GH₂ projects can also increase electricity access for remote communities or groups currently facing electricity challenges as part of JET initiatives.
- ✓ Facilitating transmission infrastructure and thereby enabling other RE projects to connect to the grid
- ✓ Longer term ENERGY security as input to decarbonize chemical production



Synergies in solving for water security

- ✓ Water required for green hydrogen **less than 0.5%** of SA water demand
- ✓ Increasing water security making financially viable desalination plants at the coast (desalinated water cost is a fraction of a premium commodity like GH₂ ~**\$0.01/kg**) = 1-2% of GH₂ production cost
- ✓ Oversize desalination by 300% and provide excess water to communities
- ✓ For the production of hydrogen for inland domestic use, the feedwater can be treated water from heavily contaminated sources not treatable by municipal wastewater treatment plants i.e. mine water, acid mine drainage and industrial waste-water specifically in the Vaal region.
- ✓ Municipal waste-water should only be used when these other sources are fully exhausted, as industry may need this water source in the future



Public Consultation and Social Acceptance

The GHCS was updated with inputs from public comments, PCC comments on the JET-IP and presentation at NEDLAC.

Theme	Concern Raised	How concerns are addressed
Energy Security	GH ₂ should not compete with South Africa's energy crisis. Eradicating energy poverty is a more pressing priority.	GHCS updated to provide assurance that GH ₂ can help alleviate the electricity crisis by feeding power into the grid, feeding power into micro grids for the community and by grid infrastructure upgrades allowing other RE projects to feed into the grid.
Funding	GH ₂ should not direct critical grant funding away from the energy crisis and other pressing issues.	GH ₂ implementation plan does not seek to obtain grants from the IPG offer already earmarked for other sectors. Grant funding will be sourced from dedicated global funds mandated for supporting GH ₂ initiatives on a global level.
Workforce skills	Insufficient local workforce skills to deliver the pipeline of projects.	GHCS provides a reskilling framework that will be developed in to a skills development plan.
Transparency	Governance that provides transparency on progress and fund use is required.	GH ₂ implementation dashboard will be developed and made publicly available.
Infrastructure	Lack of coordination on infrastructure build for GH ₂	New governance structures will be set up that will allow improved coordination between government entities and private sector



Next steps approved by Cabinet

In order for the 2050 vision to materialise the defined action in the GHCS will need to have a prioritized implementation with focus on the following actions in the short term – 2023 to 2027

Theme	Action No.	Action	Owner
Policy, regulations and incentives	1	Implementation of regulatory changes as defined in the GHCS action plans and develop regulations and standards for refuelling, storage and transportation.	Presidency
	2	Development scenarios to determine ability of private sector to mobilise and opportunity for public sector to accelerate deployment of green hydrogen projects. Mobilise a task team to investigate the economic potential of green hydrogen scenarios.	DTIC and National Treasury
	3	Establish bilateral engagements and agreements between South Africa and key international consumers to increase and secure market access, offtake and pricing subsidies.	Presidency
	4	Develop wheeling framework to provide increase transparency on wheeling	Presidency
	5	Attract investment into establishing manufacturing facilities for fuel cells and electrolysers.	DTIC
Funding	6	Source increase grant funding as defined in the JET-IP	IDC
	7	Develop new funding instruments to lower the cost of capital	IDC



Next steps approved by Cabinet

In order for the 2050 vision to materialise the defined action in the GHCS will need to have a prioritized implementation with focus on the following actions in the short term – 2023 to 2027

Theme	Action No.	Action	Owner
Infrastructure	8	Develop national infrastructure masterplan linking to provincial infrastructure plans.	IDC
Project and hub development	9	Project development support for the projects that have been granted SIP status as Gazetted in December 2022 towards reaching final investment decisions.	Presidency / ISA
	10	Lead a project development coordinating entity that will initiate additional projects aligned to the medium term ramp up targets of the industry.	IDC
	11	Support the development of the identified GH ₂ hubs and valleys to ensure accelerated impact in developing the new GH ₂ industry and associated green industries.	Provinces
Social dialogue and skilling	12	Social dialogue and engagement with affected communities on socioeconomic benefits	DTIC
	13	Develop national skilling and job transition programme	DHET



Showcasing projects status – Government Gazette List

In December 2022, Minister of Public Works and Infrastructure, gazetted the nine projects that have received Strategic Integrated Projects and are progressing well

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	Atlantia 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, Rynbow project completed pre-feasibility study

Showcasing projects (1/2)

Green Ammonia Production for export



HIVE COEGA GREEN AMMONIA PROJECT

Hive Energy and Built Africa are developing a \$4.6bn Green Ammonia Plant. The plant will have a dedicated power supply at the Coega Special Economic Zone, alongside the Port of Ngqura. The plant will produce approximately 780,000 tons per year of green ammonia for the export market. This project is working together with Cerebos in a mutually beneficial way, which entails Cerebos providing the project with desalinated, demineralized water while the project will supply green energy to Cerebos

Fuel Cell Manufacturing



PROJECT PHOENIX

Mitochondria Energy is planning to build a hydrogen fuel cell manufacturing facility in the Vaal Special Economic Zone (SEZ) in partnership with the IDC, DTIC and DBSA. Mitochondria's plans involve developing manufacturing capacity to build units totaling 250 MW a year, with plans to eventually ramp up to 1 000 MW a year, dependent on demand at the time.

Showcasing projects (2/2)

Green Steel Production



AMSA SALDHANA GREEN STEEL PRODUCTION


ArcelorMittal South Africa (AMSA) is investigating the viability of restarting the Saldhana Bay operations to produce green steel with green hydrogen. AMSA plans to be the first African green flat steel producer using green hydrogen by producing direct reduced iron (DRI) via the Midrex facility at its Saldanha Works

Sustainable Aviation Fuel



HYSHIFT SUSTAINABLE AVIATION FUEL IN SECUNDA

Sasol as part of a consortium known as HyShiFT, is developing a sustainable aviation fuel (SAF) project in Secunda. Other partners in the consortium include German-based renewable energy company Enertrag and chemicals company Linde and South African company Hydrogen. The project entails using green hydrogen and sustainable carbon to produce SAF for the export market.



“You can't cross the sea by merely standing and staring at the water”

The GH₂ economy presents new opportunities for South Africa for energy security, economic development, skills development, employment and community participation.

**THANK YOU
QUESTIONS?**

*Partnering you.
Growing the economy.
Developing Africa*