Proposed South African
Green Hydrogen (GH₂)
Commercialisation Strategy and implications for equipment localisation

Summary of the Green Hydrogen Commercialisation Panel Report

Date: 06 June 2023

Presentation to Electrolyser & Hydrogen Fuel Cell Event





Preamble

- This Green Hydrogen Commercialisation Strategy (GHCS) builds on the strong foundation of the work undertaken by the Department of Science and Innovation (DSI) with respect to its HySA programme and the recent development and publication of the Hydrogen Society Road Map (HSRM)
- In June 2021 the Minister of Trade, Industry and Competition established the Green Hydrogen (GH₂) Commercialisation Panel (GHP) which consists of private and public sector champions in the potential green hydrogen value chain and is currently being co-ordinated by the Industrial Development Corporation of South Africa (IDC)
- The objective of the Panel is to specifically focus on the development of a South African Green Hydrogen Commercialisation Strategy and Action Plan which was approved by Cabinet in November 2022 for release to the public for comments.
- Public comments closed on 31 March 2023 and the GHCS is being updated with the comments from the public for re-submission to Cabinet
- The objective of this document is to present the Green Hydrogen Commercialisation Strategy (GHCS) and Action Plan for South Africa



GH₂ Commercialisation Summary – Strategic Elements

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

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, hydrogen valley mobility programme and sustainable aviation fuel projects.

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.

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 BEGULATORY 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.



~						
	1. Strategy	1.1 Position GH ₂ as a key early contributor to decarbonisation and a just transition in the country programme of work being collated by the Climate Deal Task Team ensuring a fair proportion of climate finance is sourced to enable development of this industry.	1.2. Expedite International GH ₂ National Strategy with international partners (finance, technical, off take) — — —	1.3. Set up a single GH ₂ governance mechanism to coordinate public sector and suppert private sector investment.	1.4. Prioritise the development of a national Infrastructure Plan, including undertake land/ corridor appraisal assessments for dedicated renewables and electrolysis.	1.5. Design and introduce a Guarantees of Origin system to install investor confidence in key import nodes.
	2. Industrialisation	2.1. Conduct a detailed PGM potential market study, Including local CCM/MEA manufacturing opportunities.	2.2 . Establish relationships with OEMs to attract anchor partnership for investment in SA (electrolysers).	2.3. Develop clear sector coupling plans and techno economic planning of sector impact and transition costs	2.4. Invest in R&D opportunities to advance localisation of specialised skills.	
	3. Projects	3.1 Incentivize expedited private sector project investment, with specific focus on early export projects e.g. green methanol, aviation fuel, green ammonta	3.2. Support local demand stimulation and localisation projects including mobility applications, green steel and equipment manufacturing.	3.3 Support development of both coastal and inland port development for green hydrogen	3.4. Develop GH ₂ standards and specifications for mobility, production, refueling, storage, transportation and end-use applications based on international best practice standards.	
	4. Finance	4.1. Apply for GH ₂ funding from International green funds and South Africa investment support to meet GH ₂ production of 200 ktpa by 2025/2026.	4.2. Structure/ support green financing instruments and innovative funding with private sector for GH ₂	3. Build up investment fund to prioritize and enable government investment into initial projects.		
	5. Skills & R&D	5.1. Develop GH ₂ Socio-economic plan to enhance local content inclusion of SMME's and entrepreneurs.	5.2. Engage with training partners and tertiary institutions on GH ₂ training			



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The Opportunity presented by Green Hydrogen for South Africa

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



Global Opportunity

Hydrogen will play a significant role in the transition to a net-zero energy system.

It will establish SA as a future energy market global trader, securing foreign direct investment, earning foreign income and creating economic growth and development

Import Markets for GH₂ to 2050 will be the EU (2050: 11-15 Mt GHpa); Japan (2050: 5 to 10 Mt GHpa); South Korea (2050: 1.0 to 1.2 Mt GHpa) and the United Kingdom (2050: 0.5 to 0.7 Mt GHpa).



Competitiveness

South Africa's natural endowments of Land, Wind, Solar, Oceans and Green Minerals and existing Petrochemical base can be leveraged.

Together with innovations in the hydrogen sector, a robust financial system, globally recognised renewable energy programme and inclusion of GH₂ as a key element of the Government's energy transition plans

South Africa's clear differentiators are proprietary Fischer Tropsch technology and resources of platinum group metals (PGMs)



Just Transition

The just energy transition focuses on the transition of South Africa's energy sector as the country navigates the shift away from coal towards cleaner sources of energy

The just energy transition requires that the transition is equitable to all communities and is better for our people and planet.

Transitioning away from fossil fuels will require the training and re-skilling of communities reliant on fossil fuel industry.



Decarbonisation

- GH₂ will be the global clean fuel of the future and critical to SA decarbonising our economy and ensuring the competitiveness and sustainability of our industries.
- In a global Net Zero environment, "dirty" economies will increasingly be financially penalised
- GH₂ can decarbonize much more than RE alone by replacing fossil fuel inputs in industrial processes



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A solid historical base supports accelerated commercialisation



2007

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



2008-2013

Demonstrator projects include an underground fuel cell powered mining locomotive, solar-tohydrogen system, battery and fuel cell golf cart, fuel cell generator providing lights for the UWC Nature Reserve



2014-2016

Demonstrator projects include: fuel cells for power storage for homes and cellular phone tower base stations: a Hydrogen refueling station; and fuel cell powered forklift



2017

Demonstrator projects include a Green Hydrogen fuel cell system with onsite production and storage and a Hydrogen in Mining test facility



2018

Demonstration projects concluded for 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



2020

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



JUNE 2021

Presidency announces that GH has been identified as the first of five 'Big Frontier' strategic investment opportunities



JULY 2021

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



SEPTEMBER 2021

Cabinet approves the Hydrogen Society Roadmap developed by the DSI



OCTOBER 2021

The drafting of the Green Hydrogen Commercialisation Strategy for South Africa was completed



NOVEMBER 2021

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

NCEDA releases GH Strategy at COP26



FEBRUARY 2022

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



The strategy for

Commercialisation.

aligns with the

objectives and

outcomes of, and

builds on the strong

foundation of the

Hydrogen Society

Roadmap

The roadmap for

commercialisation

provides detail and

granularity

differentiating

between short and

long term actions by

public and private

sectors

Commercialisation leverages the Hydrogen Society Roadmap

science & innovation

Department:

Science and Innovation

REPUBLIC OF SOUTH AFRICA

Hydrogen Society Roadmap

Objectives

Investment



- Just Labour transition
- Balance of payment
- **Energy Security**
- Reduced inequality and poverty

Outcomes

- Creation of export market for SA
- Decarbonisation of transport sectors
- Decarbonisation of energy-intensive industry
- Manufacturing sector for H2 products and excellence
- Green and enhanced power sector and buildings
- *Hydrogen generation storage and distribution linked to objectives, outcomes and levers of change

Specific actions identified in the following areas:

- Establish Targets and Policy Signals
- Mitigate Investment Risk
- Strategic demonstration and deployment projects
- Promote RDI

- Development of a national commercialisation strategy

GH₂ Commercialisation Strategy

Objectives

- **Export Markets**
- Domestic Markets (includes applications in hard to abate sectors and mobility)
- Local industrial capability (includes manufacturing of equipment)
- Investment and Finance
- Economic and socio-economic impact
- Affordability of a Just Transition
- Regulatory Environment

Enablers

- Skills development
- Financing
- Policy and Regulation
- Catalytic projects





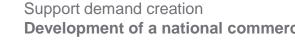
Specific actions identified in the following areas:

- Skills and R&D
- Regulations and Policy
- Finance
- Technology Partners
- Raw Materials
- Masterplan
- Foundation for projects
- Hydrogen Hubs
- Additional project development
- Mobility projects

- Manufacturing projects
- Material handling projects
- Stationery and back up power projects
- Refueling and Distribution
- Production / Industrialisation / Manufacturing
- GH₂ Beneficiation and Export















Role of the Commercialisation Strategy

Role of a commercialisation strategy ...

- National coordination / shared vision
- Provide policy certainty
- Encourage investors
- Guide decision makers (government, private sector)
- Ensure proactive industry development
- Execution orientated action plan

... towards a Vision



Developing a globally competitive, inclusive and low carbon economy by harnessing South Africa's entrepreneurial spirit, industrial capability, strong financial sector and natural endowments



A customised approach to develop a new GH₂ industry

Proactive industry planning

- Have a long term strategy
- Develop short, medium and long term action plans
- Setting up a viable and globally competitive sustainable industry

Create momentum with real examples on the ground

Balance long-term strategic thinking/planning & immediate implementation of shorter term opportunities

3 Value chain and holistic approach

- Holistic approach to address enablers across the value chain
- Enablers will include the non technical aspects e.g. regulations and financing.

Market Approach

- Address real market needs
- Flexibility to respond to market changes
- Have a multiple market orientation to learn and exploit the different opportunities

Leverage country strengths

- Utilise country's existing strengths
- Provide a unique global value proposition

Risk sharing partnerships

- Partnerships are key on different levels to facilitate commercialisation
- Partnerships in a variety of areas (finance, policy, technical, manufacturing, ...)

Support Catalytic Projects

- Identification, development and implementation of catalytic H2 projects
- Provide project development funding to catalytic project
- Utilise these pilot projects as industry de-bottlenecking vehicles

Proactive risk management

- Lessons learnt from other industries
- Balance technology risks
- Develop commercial risk mitigation instruments

Continual RD&I

 Innovative out of box thinking for long term sustainability and competitive advantage

Address socio economic needs and just transition

 We cannot leave anyone behind in the process



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Demand-driven Commercialisation: Market focus

A range of local and export use cases can anchor demand for GH₂ in South Africa

	Application Hydrogen and derived product use	Application Key Configuration		Long-term competitiveness Considered in demand scenario	Potential end-users in SA (non-exhaustive)
	Ammonia production	H ₂ NH ₃ MeOH C _x H _y	Feedstock	For own demand and export	
>	Methanol production	H2 NH3 MeOH C _x H _y	Feedstock	For own demand and export	Sasol Puregas Alement the linet (ingu
Industry	Refineries	H_2 NH $_3$ MeOH C_xH_y	Feedstock	Potential decarb. of PetroSA	
르	Steel	H ₂ NH ₃ MeOH C _x H _y	FC/Comb.	For local steel industry	ArcelorMittal ArcelorMittal ArcelorMittal
	High-Temp Process	H ₂ NH ₃ MeOH C _x H _y	Combustion	For local glass industry	
	Light Road	H ₂ NH ₃ MeOH C _x H _y	FC	BEV assumed dominant alternative	
	Heavy Road	H ₂ NH ₃ MeOH C _x H _y	FC	FCEV in commercial and public transport HDV as dominant tech	
iity	Off-highway	H ₂ NH ₃ MeOH C _x H _y	FC	FECV in commercial HDV as dominant tech	AngloAmerican GAUTRAIN
Mobility	Rail	H ₂ NH ₃ MeOH C _x H _y	FC	Potentially relevant (e.g., to replace diese gen. where grid power unavailable)	(OGISTICS TOYOTA
_	Shipping (Ocean)	H ₂ NH3 MeOH C _x H _y	FC/Comb.	Ammonia for long-distance maritime shipping fuel demand	MAERSK & Barloworld Logistics
	Aviation (International)	H ₂ NH ₃ MeOH C _x H _y	Combustion	Green kerosene to meet aviation fuel demand	
at	H2 adapted turbines	H ₂ NH3 MeOH CxHy	FC/Comb.	As part of last mile decarbonisation of power	
H W	Backup power	H ₂ NH3 MeOH C _x H _y	FC/Comb.	Assumed negligible	⊗ Eskom O vodacom ⊆ CHEM ENER
Power & Heat	Long/mid storage	H ₂ NH3 MeOH C _x H _y	FC/Comb.	As part of last mile decarbonisation of power	Eggli MIN
Pov	Grid blending (heat)	H ₂ NH ₃ MeOH C _x H _y	Combustion	Assumed negligible	

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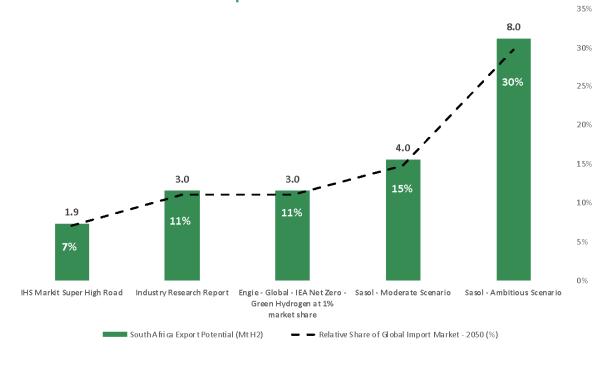


Demand-driven Commercialisation: Exports

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 2mtpa by 2040 with upside to be as high as 8mtpa in longer term.

- Global Market for GH₂ is forecast to be 300-320 Mt GH₂ by 2050 using the benchmark International Energy Agency's (IEA) Net Zero GH₂ Scenario to 2050.
- There is potential for 91% of this demand (279 Mt GH₂) to be met within the country or region of demand, with the balance of 9% (27 Mt GH₂) sourced through imports.
- Import Markets for GH₂ to 2050 will be the European Union (2030*: 10 mtpa); Japan (2050: 5 to 10 mtpa); South Korea (2050: 1.0 to 1.2 mtpa) and the United Kingdom (2050: 0.5 to 0.7 mtpa).
- Export Potential: South Africa is well positioned for global exports with estimates of the potential ranging between 1.9 to 8.0 Mt GHpa. Positioning on the Indian and Atlantic shipping routes could enable 8-10% market share of the global ammonia / methanol fuels market for shipping, equivalent to a further 0.8 to 1.0 Mt per year of GH₂.
- * Based on the REPowerEU plan (18 May 2022), Europe has increased GH₂ demand projections planning to import 10mtpa by 2030 which was previously planned for 2050.

South Africa - Export Market Assessment Based on Share of Global Import Market



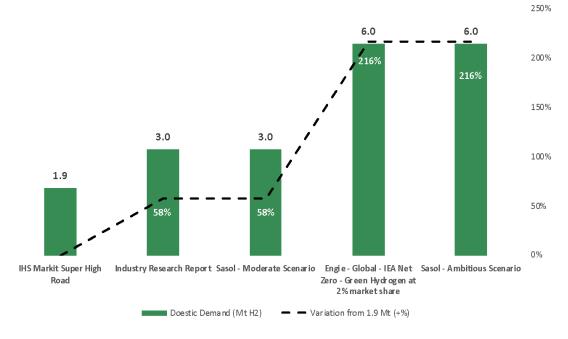


Demand-driven Commercialisation: Domestic Market

Domestic demand will accelerate as price parity gets closer to fossil fuels. Co-located production projects (eg. Mining sector) will have accelerated commercial value due to lower infrastructure and supply chain dependencies and hence lower cost. Domestic potential estimated at 2 - 3 mtpa by 2040 with upside as high as 6mtpa

- Domestic Market: The domestic market for GH₂ has the potential to range between 1.9 to 6.0 Mt GHpa.
- South Africa's potential to move higher on the range is price sensitive and will require specific co-ordination and intervention between the public and private sector to ensure higher efficiency at scale.
- Broader domestic penetration will take longer due to affordability but co-located projects have expedited commercial benefits due to lower infrastructure cost and dependencies
- Affordability considerations:
- Considering GH₂ production cost at 2025 is estimated at \$6/kg, which will be 55% more expensive than Diesel (R17,28/l) and 111% more expensive than Eskom (R1.28/kwh) without considering transition costs for users and applications.
- Accelerating price parity will be a combination of GH₂ cost and fossil fuel carbon taxes. Even if energy price parity is achieved (estimated by 2030) the total cost of transition must be considered per sector.

South Africa - South Africa - Domestic Market Assessment





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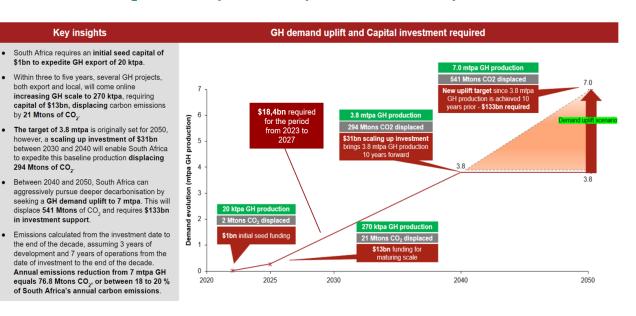
Strategic Ambitions: (i) Projected Production Growth Path

Long term growth aspirations could exceed 7mtpa of production by 2050

- \$1bn investment could expedite GH₂ export of 20 ktpa.
- Within three to five years, several GH₂ projects, both export and local, will come online increasing GH₂ scale to 270 ktpa, requiring capital of \$13bn, displacing carbon emissions by 21 Mtons of CO2.
- The target of 3.8 mtpa by 2040 will require total investment of \$164 bn by 2040.
- Between 2040 and 2050, South Africa can aggressively pursue deeper decarbonisation by seeking a GH₂ demand uplift to 7 mtpa. This will displace 541 Mtons of CO₂ and increase investment support to \$133bn.
- Emissions calculated from the investment date to the end of the decade (assuming 3 years of development and 7 years of operations) could result in annual emissions reduction of between 18 to 20 % of South Africa's annual carbon emissions.

PRODUCTION TARGETS								
YEAR	2025	2030	2040	2050				
TARGET	20	1.0	3.8	7				
UNITS	ktpa	mtpa	mtpa	mtpa				

GH₂ demand uplift and Capital investment required

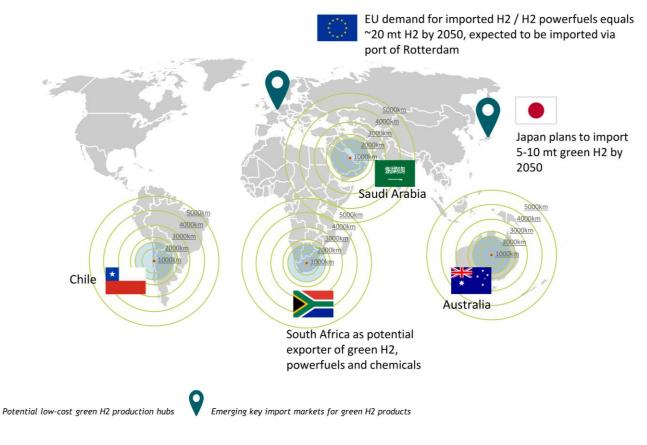




Strategic Ambitions: (ii) Market Focus - Exports

Significant additional GH₂ demand could arise from supply of GH₂ products to Europe and Japan where imports of 25-30mt GH₂ is expected by 2050

- Import Markets for GH₂ to 2050 will be the European Union (2050: 11-15 Mt GHpa); Japan (2050: 5 to 10 Mt GHpa); South Korea (2050: 1.0 to 1.2 Mt GHpa) and the United Kingdom (2050: 0.5 to 0.7 Mt GHpa).
- Export Potential: South Africa is well positioned for global exports with estimates of the potential ranging between 1.9 to 8.0 Mt GHpa. Positioning on the Indian and Atlantic shipping routes could enable 8-10% market share of the global ammonia / methanol fuels market for shipping, equivalent to a further 0.8 to 1.0 Mt per year of GH₂.



Source: NBI BUSA BCG, October 2021, "The green H2 opportunity in South Africa"



Strategic Ambitions: (ii) Market Focus – Domestic Market

GH₂ Vision will progressively unfold penetrating multiple markets

2023 to 2025



Road transport, primarily Fuel Cell Vehicles (FCVs) with a focus on Heavy- Duty Vehicles (HDVs). Pilot projects already underway including hydrogen-powered trucks (Anglo Platinum's Mogalakwena mine), the Hydrogen Valley (835km industrial and commercial mobility corridor) and Sasol and Toyota South Africa Motor's partnership exploration of a mobility ecosystem.

2025 to 2030



Chemical and Industry, notably the non-ferrous metals, green steel, and cement sectors, which will need to decarbonize to remain globally competitive. Early opportunities in Green steel are under consideration.

2028 to 2030



Green ammonia and methanol, which will replace current production from high carbon techniques. Ammonia is widely traded globally and regarded as an attractive transport vector for exporting and trading in green hydrogen.

2030



Sustainable aviation fuel offers an opportunity to decarbonise air travel.

+ 2030



Power Storage and Balancing - Hydrogen being used for long-duration storage based on daily, monthly, and cross-seasonal balancing requirements.



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- 7 Commercialisation Roadmap



Localisation can be a phased approach

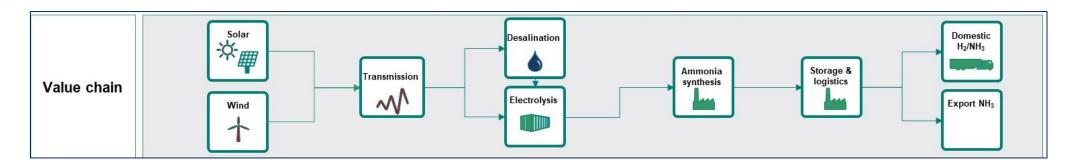
Topologies for localisation

Manufacturing topology	Description	Intellectual property
Local subsidiary of foreign company	Can be an OEM or supplier to OEM	OEM / supplier
Local manufacturer: under toll or license	Set up equipment to manufacture	OEM / supplier
Local assembly plant	OEM combines imported and locally made components	OEM / supplier
Local partner manufacturer	OEM / supplier to OEM provides manufacturing support (e.g., tooling, expertise)	OEM / supplier
Local manufacturing partnership	Installs local production line in partner company	OEM / supplier
Local manufacture	Supplier to OEM / balance of plant	Local

Source: SAREM



Leverage the value chain synergies



storage and dispensing GH and beneficiated	products Electricity from Fuel cell & Battery systems
X	X
X	X
х	X
х х	
X X	X
X X	X
X X	X
X X	X
X	(X

Focus area include:

- Raw material mining, processing and beneficiation – battery minerals, PGMs…
- Synergies with RE industry solar panel, wind towers, BOP…
- Electrolyser / fuel cell stack, system and component
- Automotive manufacturing



Production ambitions will be ramped up

2024: Scale up CCM and MEA local manufacturing

2025: Pilot scale fuel cell manufacturing

Pilot scale electrolyser manufacturing

2030: Target 1GW of local fuel cell and electrolyser manufacturing capacity

2040: Increase investment in local component manufacturing targeting 25% of global market

2050: Support investment in ~15GW fuel cell and electrolyser manufacturing



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Detailed Action Plan: Short Term Roadmap: 2022 - 2025

	GH project dev	velopment {	2021	2022	2023	2024	2025
		Skills & R&D	transiti Invest i Incenu adjace Invest i	n local GH value chain/green skills capac vise nydrogen/green skills training throug nt industries In Research and Development opportuniti	programs ity through upskilling and reskilling budget allocation and training es to advance localisation of spe	course training programs/ Identify and partner with in ng initiatives offered through SETA, technicons, colle incentives, industry ecosystem partnerships, and cro- cialised skills roliferation against local capacity building	eges, and universities
SI	Enablers	Regulations	Prepare Regulatory development timeline to amend and/or introduce and policy Develop GH regulatory objective will drive GH development in a coordinated fashion	ce law 19(1) of the National Energy	Act Introduce Guaranteer Freducing, Introduce Guaranteer Fredu	idy/ tax incentive mechanisms for H2 vehicles and international	
tor Actions		Finance	Build u	p investment fund to support government Structure green financing in	t investment into initial projects	orable tariffs for hydrogen export Fundraising for pilot	projects
Public Sector		Technology Partners	Establish relationships with OEM Evaluate Localisation Options	s (electrolysers)	Negotiate terms for localisation	. Construction of 1GW/year PEM electrolysis	facility.
q	Capabilities	Manufacturing	Chem SA, HYENA, etc) Detailed market potential study for	nbled fuel cell technology pilots (HyPlat, E or local CCM/MEA manufacturing (e.g. Hyl or local assembly of plant / equipment / co	Plat MEAs) Technology sci	ale up feasibility study Construction of a local pending	I manufacturing plant
		Raw Materials	Detailed PGM potential market st Detailed study on local resource components for all GH value cha	Assess integration with Valu	ue Chain		

Prioritis ed actions 2



	GH project dev	elopment 20	21	2022	2023	2024	2025
ons	Strategy	Masterplan	Undertake land appraisal asse	Develop technical s Define sate investm report Conduct feasibility regulatory incentive	governance mechanism to support GH tandards GH sector lent and financial studies on possible e mechanisms		hub (e.g. Saudi Arabia, NEOM)
S		International Strategy		Develop G-G relation	possibilities	ermany, Japan, UK) entities like International Maritime Organisation and the International Carbon Reduction and Offs ote SA's GH products in shipping and aviation s	set Alliance (ICROA) in order to
Sector Acti		Foundation	Create a fav Promote pro Facilitate G-	ourable regulatory and financial epoces at Hubs for further developed. G offtake agreements with internating public infrastructure needed	ment ational countries	22 - 2030 development plans, and GH production investment into GH production capacity	on times cores
Public	Leading Projects	Hubs			MW electroly capacity Support pilot	scale development of 12 Support devel	lopment of 300 MW electrolyser, or 20 ktpa GH export
		Vaal Triangle		d incentivise the roll out pilot mob alley and Hydrogen mobility comi	domestic cap	900 MM/DE fo	or 30 ktpa GH domestic capacity
		Additional development	AMSA Salda the local GH Review exis manufacturi	ondo, HyPlat, Project Phoenix, Cheanha as flagship manufacturing polydiale chain ching public infrastructure at the polydiale chain chastructure at the polydiale chains to determine infrastructure development	rojects that will link green steel in	scale manufacturing of fuel cell, CMM and MEA icentivising linkages to GH production infrastru- Support full s and CMM and	electrolyser components, and cture locally cale manufacturing of fuel cell IMEA electrolyser components
		Boegoebaai		Expedite compundertaken by	pletion of Boegoebaai feasibili the Northern Cape Economic	ty studies and provide full support Development Agency (NCEDA)	to the initratives being



	GH project dev	velopment	2021 N	Mobilisation	2022	Value chain assessment and Infrastructure support	2023 (0	Concept projects .8 - 1.5 ktpa GH production)	2024	Pilot projects (1.5 - 20 ktpa GH production)	
	Enablers	Skills		Invest in Research and	d Develop	ment, and proliferation of hydrogen ment opportunities to advance loca rtise to expedite local skills prolifer	lisation of s	-			
		Foundation		Apply for GH funding f	ı	national green funds and South Afric	!		of 20 ktp	a by 2025/2026	
SU						duct a pre-feasibility and feasibility	!		Fi	nal investment decision on projects	
	Leading Projects	Hubs	Hubs	Hubs				devel	n and construct pilot scale opment of 12 MW electrolyser, 20 E for export	55	esign and construct 300 MW electrolyser, 60 MW RE for 20 ktpa GH export
ACIIO		Vaal Triangle Additional development			Cond	luct a pre-feasibility and feasibility	1		oi de	onduct a pre-feasibility and feasibility study n location site for the next phase of G H evelopment	
CIO						deve 20 M	gn and construct pilot scale lopment of 12 MW electrolyser, W RE for domestic capacity		esign and construct 450 MW electrolyser, 00 MW RE for 30 ktpa GH domestic capacity		
le oe					man Rell	Conduct a pre-feasibility and feasibility study on the best site location for the manufacturing projects Refl-out pilot mobility projects across the Anglo/DSI Hydrogen Valley and Hydrogen mobility corridor hubs				esign and construct hydrogen refuelling frastructure across the Anglo/DSI ydrogen Valley and Hydrogen mobility	
Filvate							manufa ME A ele green s	and construct pilot scale acturing of fuel cell, CMM and ectrolyser components, and steel, incentivising linkages to GH tion infrastructure locally	D m	orridor hubs esign and constructs full scale lanufacturing of fuel cell, CMM and ME A ectrolyser components, and green steel	
		Engie/Anglo/D		Proto	type minii	ng truck demonstration / testing				Commercial prototype (3 mine trucks)	
		SI/Sahedi/Bam bili Hydrogen	i	Johannesburg hub			-			Johannesburg hub, Pilot bus demonstration	
		Valleys	F reight corrido	or kfW funding proposal		Pilot bus demonstration ect development	1		R	oad truck / bus pilot project	
		Manufacturing		/ MEA local manufacturing	(HyPlat &	& Isondo)		le up CCM / MEA local ufacturing (HyPlat & Isondo)		Scale up CCM / MEA local manufacturing HyPlat & Isondo)	
			Establish partı	nership with OEMs	Ţ,				į		



	GH project developme	nt 20	021	2022	2	023		2024	2025
			CAPEX subsidy or st	te tax exemption for H2 vehicles an	d infrastructure			1	
	Danistani and adini a		Low interest funding	for H2 projects					
	Regulatory and policy er	nabiers	Regulations and stan	dards for H2 fueled equipment / veh	icles and infrastructure)			
			Regulations and stan	dards for H2 in mining					
			Mogalakwena / Limpop	oo hub feasibility & permitting					
			Johannesburg hub fea	sibility & permitting	Commissioning and r	silatin a			
S U	Mobili	ity	Durban / Richards Bay	feasibility & permitting	Commissioning and p	onoung			
Action	Domestic		H2 mobility corridor fe	asibility & permitting					
S	use			Prototype mining truck dem	nonstration / testing			Commercial prototype (3 mine trucks)	
ector A	Materi handli		Identify partners	Feasibility study	Project development	Pilot demons	tration / testing		
		nary &	Data center site selec	tion / development Data center	Feasibility, permitting & procu	i irement		Implement	
		p power	Feasibility, permitting	& procurement	Commissioning		Pilot demonstrati	on / testing	
Ñ				į					
ല	Refuelling and distribution	nn -	Engage with partners		Commissioning and	nemitting		Pilot demonstration / testing	
g	reducining and distribute	511	Permit	ting, licensing, feasibility	Commissioning and	pennitung		Prior demonstration / testing	
Private			Enertrag feasibility stu	idy		Develop project			
т	Production / Industrial		NCP H2 by-product red	covery feasibility study		Develop project		Blue H2 supply for domestic use	
			Ubuntu green hydroge	n project feasibility study				Develop project	
				roduction offtake negotiating, permi	tting and feasibility	Develop project			
	GH Beneficiation		Prieska Energy Cluste					Develop project	
	On Beneficiation		Sustainable Aviation F	uel (15 ktpa GH)	Develop project				
			e-Methanol feasibility	study		Develop project			
	Export		1	Boegoebaai	i green hydrogen project feasil	oility study		Develop project	



	GH project dev	velopment 2	021	Pilot projects (50 - 300 ktpa GH production)	2030	Maturing projects (2 - 4 mtpa GH production)	2040	Scale-up projects (4 - 6 mtpa GH production)	2050
		Skills	Invest in Io Incentivise Invest in R	hydrogen/green skills training through b esearch and Development opportunities t	through upskillin udget allocation to advance locali	g and reskilling initiatives offered through SE and training incentives, industry ecosystem p sation of specialised skills local skills proliferation against local capacity	partnerships, and cro		s
Public Sector Actions	Enablers	Regulations	Introduce (production Introduce) and tax inco	a revised IRP incorporating GH capacity GH regulatory framework and standards n, storage, refueling and transport) regulatory incentives (reduced import dut rentives) H Guarantees of Origin system in order to duct premiums	Intrarecy	uce tax incentives as industry matures oduce explicit an implicit carbon pricing and r cling mechanisms to drive investment in GH			
		Finance	Negotiate f Build up in investment	avorable tariffs for hydrogen export vestment fund to support government into initial projects preen financing instruments	cour	are long-term off-take arrangement with key atries / customers ded finance still required, but private sector s	scaling	etitive market financed by private sector	
		Technology Partners	Auction ele participation	elationships with OEMs (electrolysers) ectrolyser capacity, and invite global on – min 10 MW (e.g. Chile) direct air capture opportunities and bion	elect	ufacture established to support 1GW/year rolysis capacity.	Expand	I manufacturing capability to meet dema	nd.
ď	Capabilities	Manufacturing	plants and Promote >1 incentivise	te clean hydrogen as an input into existing support fuel cell pilots I GW of local electrolyser / FC capacity, was OEMs to invest in local production capacity of a component manufacturers (CCM & Manufacturers)	which acity	and replicable business model to other count ase investment in local component manufact 8 MEA) Targeting 25% of global market.	Sector Increase	r coupling – Long duration electricity sto se investment in local component manuf & MEA) Targeting 30% of global market.	
		Raw Materials	Target PGI	Ms of 536 koz, 65 GW elect, 31 GW FC	Targ	et PGMs of 1,51 moz, 90 GW elect, 145 GW FC	Target	PGMs of 3,19 oz, 140 GW elect, 673 GW	FC

Prioritised actions



	GH project de	velopment 2	Pilot projects (50 - 300 ktpa GH production)	Maturing projects (2 - 4 mtpa GH production)	2040	Scale-up projects (4 - 6 mtpa GH production)	2050	
	Strategy	Masterplan	Develop a benchmark large-scale GH project to anchor the hub (e.g. Saudi Arabia, NEOM) Undertake land appraisal assessments for dedicated renewables and electrolysis. Set up a single GH governance mechanism to support sector. Make strategic ministerial or treasury announcements of a defined process rather than set targets	Reduce government stimulation and allowinds Investigate the feasibility of a GH pipeline Promote South Africa as a regional green aviat Create awareness of emissions embodied in for	ion fuel hub	hub commodities to help inform consumer choice.		
ions		International Strategy	Develop G-G relationships with off taking countries (EU, Germany, Japan, UK) Engage with entities like International Maritime Organisation (IMO) and the International Carbon Reduction and Offset Alliance (ICROA) in order to promote SA as future shipping and aviation fuel supplier	Link to global strategic Hubs in target regions, Link to other Hubs in South Africa and regiona Leverage SADC relationship to develop region	ally in Sub-Saharan Afric			
Public Sector Actions		Foundation	Generate support, awareness, and capital funding into South Create a favourable regulatory and financial environment to Promote GH hubs for export and domestic, manufacturing professional control of the control of	incentivise private sector investment into GH pro		on milestones		
	Leading Projects	Hubs Vaal		Support expansion of additional 25 GW electro GW RE for export through GH Tocal deployment of hydrogen through EV, FCEV ceuticals, and FMCG manufacture	∫ GW RI	ort expansion of additional 17 GW electro E for export	lyser, 30	
	Flojecis		beneficiation and P	Support linking of GH value chain locations acro Rustenburg, Limpopo, Mpumalanga, and Gauter Support linking	Support linking GH va into neighbouring SA oss	DC countries chains into Rest of	value	
		Additional development	linking to GH production infrastructure	ell, CMM and MEA electrolyser components, and o	green steel			
		Boegoebaai	•	plementation of Boegoebaai port and re programme	d rail			



ndica	tive GH projec	t development 20	(20 -	270 ktps GH production)		nt based on current inc ntpa GH production)	2040	(4 - 6 mtpa GH production)	2050
			Budget allocation	, skills assessment, and proliferation of	\	ech training			
	Enablers	Skills	Invest in Researc	h and Development opportunities to adv	ance localisation of special	ised skills			
			Outsource GH va	lue chain expertise to expedite local skil	s proliferation				
			Apply for GH fund	ding from International green funds and	; South Africa investment sup	pport to meet GH production	from 0.3 - 6 mtpa by	2050	
2		Foundation	Pre-feasibility and	l feasibility study at GH hub locations	Diversifying into nich	ne industries, for example in	dustry feedstock, heat	and power (industrial and building), c	hemicals
ספעוטו אינווי		Hubs		energy production Local	electrolyser, 46 GW F FGH through GH production deployment of GH through manufacture Linking of GH value ch		electrol	and construct expansion of additional yser, 30 GW RE for export	17 GW
	Leading	Vaal Triangle	1	Design and construct 2 GW electrolyser, 4 GW RE for domestic use	Design and construc	t expansion of additional 25 RE for domestic use	electrol	and construct expansion of additional yser, 30 GW RE for domestic use	
וואמנם	Projects			Local deployme PG M processin		rain locations across Rusten	Linking GH value chain neighbouring SADC co nburg,		chains into
					Limpopo, mpumaianga	Linking of GH valu	ue chain locations acro stern Cape, Free State,	oss Northern Cape, , and Kwa-Zulu Natal	
				the manufacturing projects Roll out hydrogen mobility projects and demand centres across the co	s across all GH production untry	the Anglo/DSI Hydrogen hubs	Valley and Hydrogen	mobility corridor	



			Indicative Pr	Indicative Project Portfolio development based on current indications from industry							
dicative GH proje	ect development (2	(20 -	270 ktpa GH production)	2030	(2 - 4 mtpa	GH production)	204	(4 - 6 mtpa GH production)			
Domestic use	Mobility	Mogalakwena / Limpopo hub development (14 – 40 kT) Johannesburg hub development (39 – 69 kT) Durban / Richards Bay development (41 – 74 kT) H2 mobility corridor heavy long haul (bus/truck) trial Prototype mining truck demonstration / testing Forklift fleet pilot at logistics center			Scaling up and expansion of SEZ and Demand hubs		s	Full commercial deployment and expanding acro sectors. Competitive market development			
	Material handling			Scaling	Scaling up and expanding forklift fleets			Commercial rollout of forklift fleets			
	handling Stationary &	Pilot fuel cell at data center		Trial la	Trial large fuel cell system			Large scale integration of fuel cell			
	backup power	Pilot fuel cell at office buildings			Trial large fuel cell system			Large scale integration of fuel cell			
Refuelling and	Refuelling and distribution		H2 Valley hubs fuelling stations H2 mobility corridor N3 fuelling stations		Scaleup existing fuelling stations, additional stations along N1 and N2 corridors						
					Potential national green hydrogen			peline/ Grid linking NC, hubs and export nodes			
		Enertrag (30 ktpa	GH)	E nertra	ag (300 ktpa GH)			Enertrag (600 ktpa GH)			
Production / Industrial		NCP H2 by-produ	ct recovery (1.5 ktpa BLUE hydroge	en) NCP H	2 by-product recove	ry 200 ktpa BLUE hydrog	gen)	NCP H2 by-product recovery 300 ktpa BLUE hydr			
		Ubuntu green hyd	Irogen project (0.8 ktpa GH)	Ubunti	green hydrogen pro	oject (50 ktpa GH)	1	Ubuntu green hydrogen project (150 ktpa GH)			
					Ammonia / SAF / GH export		rt				
				i	Saldanha GH steel making		g				
			Sasolburg 60 MW H ₂ production (1.8 ktpa G H)		Sasolburg 60 MW H ₂ production (200 ktpa GH)			Sasolburg 60 MW H ₂ production (400 ktpa GH)			
GH Beneficiation		Prieska Energy Cluster (50 ktpa GH)		Priesk	Prieska Energy Cluster (300 ktpa GH)			Prieska Energy Cluster (500 ktpa GH)			
		Sustainable Aviation Fuel (15 ktpa GH) e-Methanol (100 ktpa green hydrogen)		Sustai	Sustainable Aviation Fuel (700 ktpa GH) e-Methanol (600 ktpa green hydrogen)			Sustainable Aviation Fuel (1,500 ktpa GH)			
				e-Meth				e-Methanol (1,200 ktpa green hydrogen)			
Export		Sasol pipeline		Sasol	Sasol pipeline			Sasol pipeline			
		Boegoebaai port and rail project (25 ktpa GH)		Boego	Boegoebaai port and rail project (200 ktpa GH)			Boegoebaai port and rail project (500 ktpa GH)			



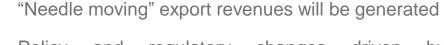
Conclusion: The path to achieve our Vision for 2050

VISION 2050 – A WELL ESTABLISHED NEW SUSTAINABLE GREEN HYDROGEN INDUSTRY FOR SOUTH AFRICA

- The National Hydrogen Commercialisation will build on momentum of HySA programme and the Hydrogen Society Roadmap to position South Africa as a global player in GH₂ and green chemicals
- The development of this new green hydrogen industry will support South Africa's Economic Reconstruction and Recovery Plan
- Implementation of the action plans should ensure a just transition tackling gender equality and social inclusion, addressing the triple challenge of poverty, inequality and unemployment.
- Stronger partnerships will be built between Government, the private sector and civil society by creating an enabling environment
- Implementation should drive international partnerships while protecting national interest
- South African should be rebranded as a destination investment sustainable incorporating Environmental, Social and Governance principles





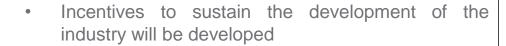


and implemented over the next 20 year

Policy and regulatory changes driven by Government will be implemented

Projects along the value chain will be developed

Financial support instruments will be sourced e.g. grants, concessional debt and contract difference



- Skills training programs and institutions will be established
- Socio economic development will take fruition, jobs will be created and the just energy transition will be well on its way
- Significant decarbonization will be achieved in South Africa and across the Globe









Key takeaways for equipment manufacturing

Think commercialisation

- Have a long term strategy
- Develop short, medium and long term action plans
- Setting up a viable and globally competitive sustainable business
- Scale, market, technology

2 Begin with the market in mind

- Projected market growth
- Export and domestic placement
- Product needs
- Partnering upstream and downstream
- Flexibility

Have a funding plan

- Debt : Equity 70:30
- Equity partnership
- Early engagement with funders

 DFIs, private, MDBS,
 commercial banks

Focus on financial viability

- Early stage financial modelling
- Target pricing, target volumes, breakeven cost, capex sensitivity, other sensitivities

Synergize country offerings

- Government support policy
- ISA
- SEZ incentives
- · Natural endowments

Be partnership friendly

- Partnerships are key on different levels to facilitate commercialisation
- Partnerships in a variety of areas (finance, policy, technical, manufacturing, ...)

Proactive risk management

- Lessons learnt from other industries
- Balance technology risks
- Develop commercial risk mitigation instruments

Sharpen the tech

- Flexibility to keep up to technology changes
- Build into business plan and financial model
- Innovative out of box thinking for long term sustainability and competitive advantage