Proposed South African
Green Hydrogen (GH_2)
Commercialisation Strategy

Summary of the Green Hydrogen Commercialisation Panel Report
Date: 30 November 2022
Released for public comment – December 2022

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 (GH_2) Commercialisation Panel
- The Panel 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
- The objective of this document is to present the proposed Green Hydrogen Commercialisation Strategy (GHCS) and Action Plan for South Africa.

GH_2 Commercialisation Summary (1/4) – Strategic Elements

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

1 PRIORITISE 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.

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 GH_2 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 GH_2 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 GH_2 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.

GH_2 Commercialisation Summary (2/4) – Government Actions

Summary of immediate actions to be taken by government

THE PRESIDENCY
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Presidency

1.1 Prioritise an in-depth analysis of required GH_2 regulatory framework.

1.2 Develop a programme to implement the required regulatory changes – i) Prepare a Regulatory Development Timeline; ii) Develop regulatory objectives for how the GH_2 industry should be regulated. iii) Develop a set of Regulations specifically aimed at creating enabling environment for GH_2

1.3 Fast track project regulatory approvals with support from the ISA office

1.4 Prioritise support of project applications to the H_2 Global organization

THE PRESIDENCY
REPUBLIC OF SOUTH AFRICA

international relations & cooperation
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International Relations and Cooperation
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Presidency and DIRCO

2.1 Advocate for policies at EU level to support GH_2 development in RSA: namely

a) Extension of the time allowed to use hard to abate CO_2 for the production of Sustainable fuels with GH_2. The current EU directives allow use of CO_2 till 2036

b) Modify the current rules for emission allocation to product to allow for “flexible” allocation (and use of existing facilities)

c) Support global advocacy for unavoidable carbon for steel and Fischer Tropsch for a transition period.

2.2 Facilitate bilateral government to government agreements relating to off take of GH_2 derivatives

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DMRE

3.1 Clarify the power planning regime for GH_2 power requirements and specifically differentiate between GH_2 grid tied projects and non-grid tied projects. With regards to specifically GH_2 grid tied projects, the IRP should align to the GHCS and make the necessary allocation for both wind and PV technology to enable the development of the new GH_2 industry.

3.2 Utilise section 19(1), subsection (f) of the National Energy Act to introduce incentives to promote the production, consumption, investment, research and development of renewable energy and green hydrogen.

GH_2 Commercialisation Summary (3/4) – Government Actions

Summary of immediate actions to be taken by government

DTIC

4.1 Attract investment into establishing equipment manufacturing facilities specifically for electrolysers, fuel cells, ammonia crackers and balance of plant components along the hydrogen value chain in the country for both internal demand and export, with significant incentives (tax breaks, infrastructure support)

4.2 Develop and introduce GH_2 Standards and specifications.

4.3 Design and introduce a Guarantees of Origin system to install investor confidence in key import nodes. Engage with zaRECs Pty Ltd to explore expansion of current renewable energy certificate system to include GH_2.

4.4 Import duties: Exempt imported GH_2 equipment under Schedule 7 of the Customs and Excise Duties Act

National Treasury

5.1 Incentivize expedited private sector project investment, with specific focus on early export projects e.g. green methanol, aviation fuel, green ammonia and support local demand stimulation and localisation projects including mobility applications, green steel and equipment manufacturing.

5.2 Develop focused tax incentives on investment in GH_2 projects

5.2 Explicit Carbon Pricing: Phased approach to increase carbon tax rate or carbon fuel levy under the Carbon Tax Act and Customs and Excise Act

5.3 Implicit Carbon Pricing: Phased approach to remove fossil-fuel subsidies and reallocation of subsidies to GH_2 development.

5.4 Special Economic Zone and REDz incentives: Reduced corporate tax rate from 28% to 15%; accelerated depreciation allowance of 10% for buildings; VAT and customs relief; employment tax Incentives under SEZ Act.

5.5 Tax allowances: Apply Incomes Tax Act provisions to GH_2 (Sections 12L, 12B(1)(h), 12I, 12K, 11D, 11A, 12C, 13(1)

GH_2 Commercialisation Summary (4/4) – Government Actions

Summary of immediate actions to be taken by government

DSI

6.1 Drive innovation, RD&I and skills development

6.2 Together with dtic, support commercialisation of innovative products, processes and services that will reduce costs and enhance competitiveness of SA component production

6.3 Assist with management of patents and licenses, both local and foreign

6.4 Co-ordinate research on critical mineral value chains

6.5 Research and insights into chemical value chains to support sustainability and global competitiveness

DHET

7.1 Align to the identified skills and action plan in this commercialisation strategy

7.2 Co-create technical training courses to develop future skills requirement to support GH_2 and associated value chains

7.3 Focus on systems and design thinking to under-pin inter-related nature of GH_2 development

7.4 Co-ordinate funding and support for university programmes

7.5 Support and coordinate skills development in industry

7.6 Bring SETA funding at industry level

7.7 Funding support for GH_2 PhD projects, programmes and scholarships

GH_2 Commercialisation Summary (3/3) – Action Plan

1 Export Markets	2 Domestic Markets	3 Investment & Finance	4 Economic & Social Economic Development	5 Local industrial capability and participation	6 Just Transition
• Strategically position South Africa as a preferred and reliable provider to key markets, leveraging trade relationships and government support. • Secure global market and off-take with national procurement programmes such as H_2 Global. • Expedite export pilot projects to position South Africa as a serious global player and achieve early market entry. • Progress international strategy working with export promotion agencies.	• Introduce supportive policies and regulatory framework for GH_2 to aid price parity to increase domestic GH_2 demand. • Support demonstration projects in hydrogen mobility applications, specifically focused on Heavy Duty Fuel Cell Vehicles. • Demonstrate feasibility of GH_2 applications in industry including non-ferrous metals, green steel, cement and petrochemical industries for short term pilot projects and long-term commercialisation.	• Secure strong inflow of foreign direct investment and outflow of GH_2 exports by means of comprehensive incentive packages including tax incentives, grant schemes and reduced import surcharges on technology options. • Establish a regulatory and market framework to drive investment • Support a key set of “catalytic” infrastructure projects that frames the national GH_2 strategy, enabling private sector players while meeting Government’s objectives for inclusive economic growth. • Define government role's for financial investment and support for pilot projects to expedite and enable private sector investment.	• GH_2 can significantly contribute to achievement of South Africa’s revised Nationally Determined Contribution targets. • Focus on hard-to-decarbonise industrial sectors by aligning sectoral carbon budgets with GH_2 mitigation potential and financial support required for a just transition • Ensure integration of RE through a robust GH_2 sector and regulatory framework. • Extension of the HySA programme to support further R&D for innovation as a means of developing South Africa’s competitive advantage and supporting identified “deep dive” studies.	• Integrate the potential for industrialization of the RE manufacturing supply chain aligning to the masterplans for renewable energy, steel and automotive sectors as well as other relevant initiatives. • Create partnerships and joint ventures to secure investment in the local manufacturing of equipment and components in the GH_2 value chain including fuel cells, electrolysers, ammonia cracker and balance of plant equipment. • Implement projects to develop skills and support localised industrialisation for key parts of the GH_2 value chain. • Invest and implement research and development programmes.	• Quantify the macro economic and socio economic impact and sustainability of GH_2 applications in industrial sectors to advise a socio-economic and just transition plan. • Develop GH_2 Socio-economic plan to enhance local content inclusion of SMME’s and entrepreneurs and empower previously disadvantaged groups. • Analyse and plan for a Just Transition, ensuring appropriate public and social dialogue and understanding. • Ensure appropriate training and skills development programmes as part of the Just Transition plan.

Presentation Outline

1. **Opportunity Statement**
2. The need for a Commercialisation Strategy
3. Demand-driven commercialisation
4. Competitive Supply
5. Strategic choices
6. Key Enablers
7. Commercialisation Roadmap

The Opportunity presented by Green Hydrogen for South Africa

The GH_2 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 GH_2 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 GH_2 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

- GH_2 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
- GH_2 can decarbonize much more than RE alone by replacing fossil fuel inputs in industrial processes

South Africa's Green Hydrogen Value Proposition

A unique combination of resources and capabilities will enable South African to compete in multiple areas.

South Africa will differentiate itself by using proprietary **Fisher Tropsch technology** to target the **sustainable aviation fuel** market and using **PGM resources to target fuel cell, electrolyser and ammonia cracker manufacturing.**

Global leader in **Platinum Group Metals Mining** (Platinum, Iridium and Rhodium)

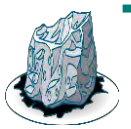
Multiple water sources (from mining, sea and fresh water)

Renewable Energy endowments and a rapidly developing Renewable sector

Established petrochemical sector & technology base including **proprietary Fisher Tropsch technology** critical for power to liquids

Geographic positioning

Relatively well developed infrastructure



Export to EU, Japan, South Korea, UK

Decarbonization of local industry e.g. steel, petrochemicals, mining

Local and global sustainable mobility e.g. fuel cell buses, trucks and associated infrastructure

Manufacture of equipment and components e.g. fuel cells and electrolyser

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

Maximise development impact (incl. skills and economic development and social inclusion). Ensure gender equality, BBBEE and community participation.

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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

2008-2013

Demonstrator projects include 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

3

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.

4

2017

Demonstrator projects include a Green Hydrogen fuel cell system with on-site production and storage and a Hydrogen in Mining test facility.

5

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

6

2020

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

7

JUNE 2021

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

8

JULY 2021

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

9

SEPTEMBER 2021

Cabinet approves the Hydrogen Society Roadmap developed by the DSI

10

OCTOBER 2021

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

11

NOVEMBER 2021

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

NCEDA releases GH Strategy at COP26

12

FEBRUARY 2022

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

Existing policies will be leveraged to support GH_2 industry development

1	National Development Plan	Advocates the transition to a low carbon and diversified energy system
2	White Paper on Renewable Energy Policy, 2003	Increased renewable energy contribution to the energy mix.
3	National Climate Change Response White Paper (2011)	Commitment to reduced emissions through a peak, plateau and decline trajectory.
4	Integrated Resource Plan (2019)	Increased contribution of renewable energy in the energy mix and potential longer term need for hydrogen for energy storage at large scale.
5	Beneficiation strategy for minerals industry of South Africa (2011)	Supports the development of technologies that locally beneficiate mineral resources for increased revenue earnings.
6	Green Transport Strategy for South Africa (2018)	Advocates for the deployment of electric vehicles including hydrogen fuel cell powered vehicles as a means for decarbonizing the transport sector.
7	National hydrogen and fuel cell strategy (HySA) 2008	Supports for the development of hydrogen and fuel cell technologies through the 15-year Hydrogen South Africa RDI programme
8	South African Economic Reconstruction and Recovery Plan	Supports the development of a new industry that will contribute towards job creation, economic growth and enhancing the role of SMEs.
9	South African Renewable Energy Master Plan (SAREM)	Supports the planning of renewable energy capacity required for GH_2 production and for the localisation of equipment manufacturing in the renewable energy value chain

Commercialisation leverages the Hydrogen Society Roadmap

The strategy for Commercialisation, aligns with the objectives and outcomes of, and builds on the strong foundation of the Hydrogen Society Roadmap

Hydrogen Society Roadmap

Objectives
- Investment
- Reduced GHG emissions
- 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

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GH_2 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

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Trade, Industry and Competition
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The roadmap for commercialisation provides detail and granularity differentiating between short and long term actions by public and private sectors

Specific actions identified in the following areas: **70**
- Establish Targets and Policy Signals
- Mitigate Investment Risk
- Harmonize standards and remove barriers
- Strategic demonstration and deployment projects
- Promote RDI
- Skills development and public awareness
- Support demand creation
- **Development of a national commercialisation strategy**

Specific actions identified in the following areas: **257**
- 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
- GH_2 Beneficiation and Export

The Commercialisation Strategy in Summary

Role of a commercialisation strategy …

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

… to achieve Strategic Objectives

- Secure early positioning for global export market share & competitive trade position;
- Establish domestic markets in mobility applications and hard to abate sectors;
- Secure foreign direct investment and low-cost green finance;
- Maximise Economic and Socio-Economic development benefits;
- Create an enabling policy and regulatory environment to sustain the long term growth;
- Support Local industrial capability and participation and
- Ensure a Just Transition

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

Strategic Pillars

1 EXPORT MARKET	2 DOMESTIC MARKET	3 INVESTMENTS & FINANCE	4 ECONOMIC DEVELOPMENT	5 LOCALISATION	6 JUST TRANSITION
Secure global market share and competitive trade position	Decarbonise SA economy; energy security and reliability	Mobilise foreign direct investment, domestic funding and low-cost green finance	Maximise development impact (incl. skills and economic development and social inclusion)	Establish local production facilities for both fuel cell, electrolysers and ammonia cracker equipment / components	Maximise job creation and alternative options for potential job losses
Global exports potential ranges between 4 to 8 mtpa	Domestic market for GH_2 has the potential to range between 2 to 6 mtpa	Secure grants and concessional debt from e.g. KFW and contract for difference from H2 Global	Ensure gender equality, BBBEE and community participation		Realise opportunities to create 650,000 new jobs across the value chain

7 POLICY & REGULATORY

Clear enabling environment with stimulating policies.

Additional actions to be taken by government

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 support 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 ammonia	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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Demand-driven Commercialisation: Market focus

A range of local and export use cases can anchor demand for GH_2 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)
Industry	Ammonia production	H_2	NH_3	MeOH	C_xH_y	Feedstock	✓ For own demand and export	
	Methanol production	H2	NH3	MeOH	C_xH_y	Feedstock	✓ For own demand and export	
	Refineries	H_2	NH_3	MeOH	C_xH_y	Feedstock	✓ Potential decarb. of PetroSA	
	Steel	H_2	NH_3	MeOH	C_xH_y	FC/Comb.	✓ For local steel industry	
	High-Temp Process	H_2	NH_3	MeOH	C_xH_y	Combustion	✓ For local glass industry	
Mobility	Light Road	H_2	NH_3	MeOH	C_xH_y	FC	✗ BEV assumed dominant alternative	
	Heavy Road	H_2	NH_3	MeOH	C_xH_y	FC	✓ FCEV in commercial and public transport HDV as dominant tech	
	Off-highway	H_2	NH_3	MeOH	C_xH_y	FC	✓ FECV in commercial HDV as dominant tech	
	Rail	H_2	NH_3	MeOH	C_xH_y	FC	? Potentially relevant (e.g., to replace diesel gen. where grid power unavailable)	
	Shipping (Ocean)	H_2	NH3	MeOH	C_xH_y	FC/Comb.	✓ Ammonia for long-distance maritime shipping fuel demand	
	Aviation (International)	H_2	NH_3	MeOH	C_xH_y	Combustion	✓ Green kerosene to meet aviation fuel demand	
Power & Heat	H2 adapted turbines	H_2	NH3	MeOH	CxHy	FC/Comb.	? As part of last mile decarbonisation of power	
	Backup power	H_2	NH3	MeOH	C_xH_y	FC/Comb.	✗ Assumed negligible	
	Long/mid storage	H_2	NH3	MeOH	C_xH_y	FC/Comb.	? As part of last mile decarbonisation of power	
	Grid blending (heat)	H_2	NH_3	MeOH	C_xH_y	Combustion	✗ Assumed negligible	

1. Indicative example of long-term (2050) cost competitiveness of presented green tecs but relevant to all categories, P2G power to gas, P2L power to liquid | Source: BCG
2. Efficiency improvements not included here,

Source: NBI, BUSA, BCG, 2021

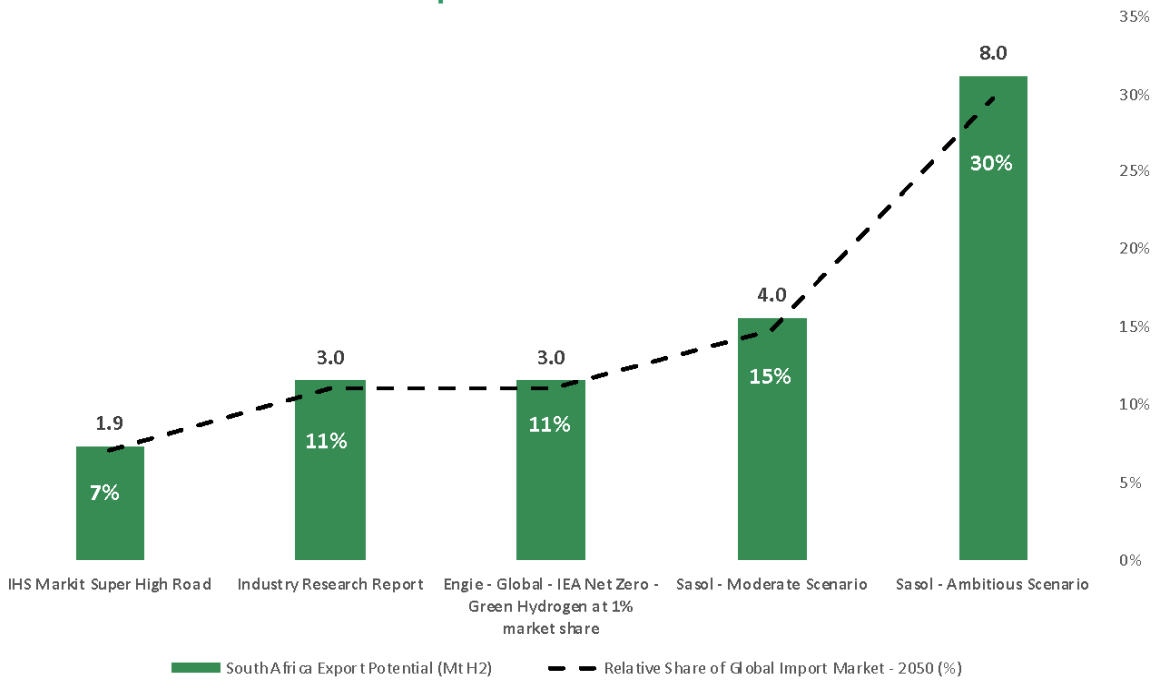
Demand-driven Commercialisation: Exports

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 GH_2 is forecast to be 300-320 Mt GH_2 by 2050 using the benchmark International Energy Agency's (IEA) Net Zero GH_2 Scenario to 2050.
- There is potential for 91% of this demand (279 Mt GH_2) to be met within the country or region of demand, with the balance of 9% (27 Mt GH_2) sourced through imports.
- Import Markets for GH_2 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 GH_2.

*** Based on the REPowerEU plan (18 May 2022), Europe has increased GH_2 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

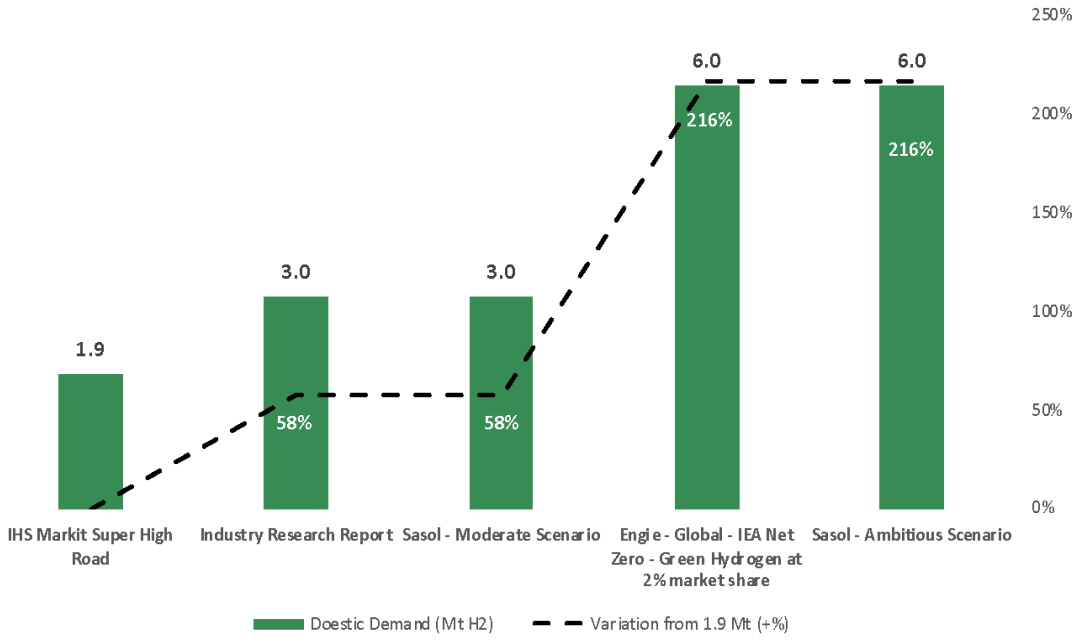


Demand-driven Commercialisation: Domestic Market

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 GH_2 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 GH_2 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 GH_2 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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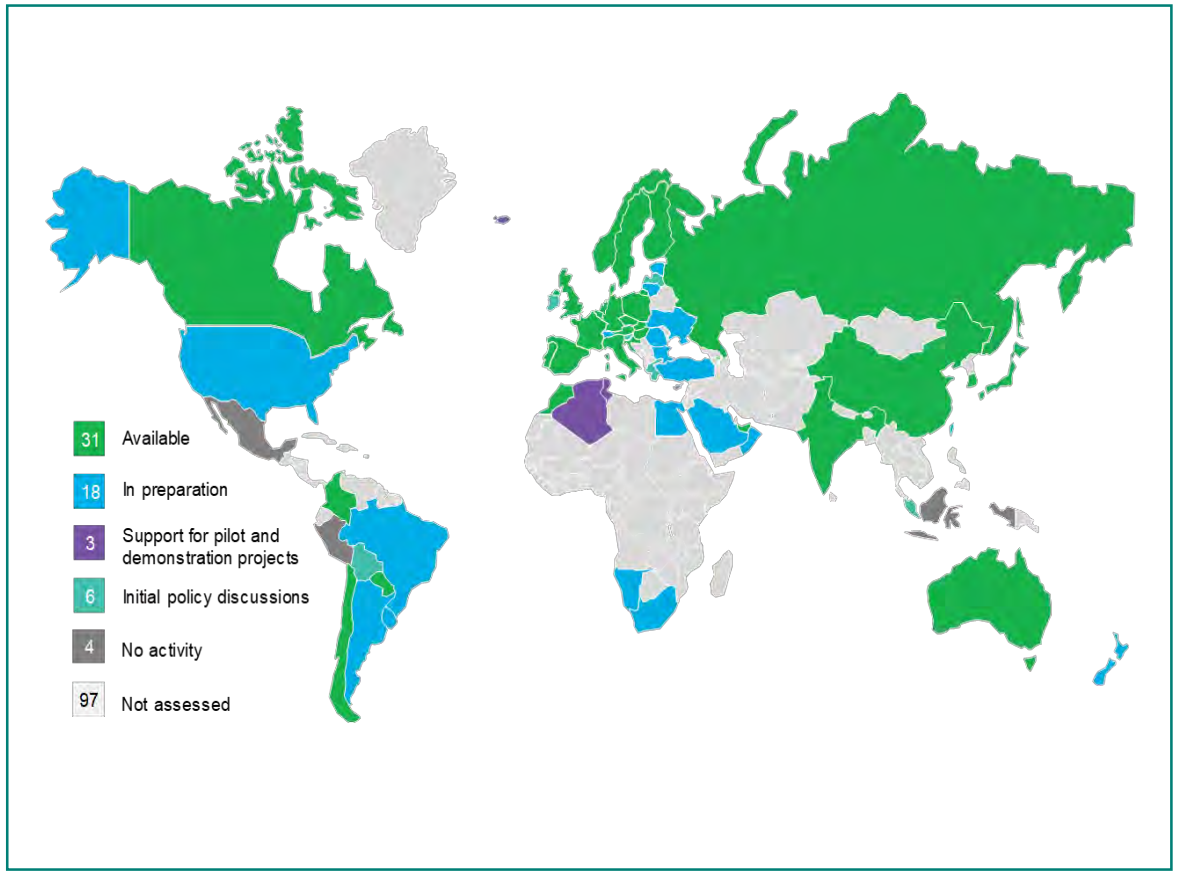
Competitive Supply: Global developments

Globally countries and private companies are developing strategies for the commercialisation of the sector.

Global hydrogen strategies
Source: Bloomberg NEF, 16 June 2022



- More than 30 countries have published a hydrogen strategy and over 200 hydrogen projects have been announced with governments committing to over $70 billion in public funding
- Themes of strategies:
  - Early investment support to scale assets and infrastructure required to meet desired targets
  - Opportunities for sector-coupling.- optimising gas and electricity infrastructure to deliver low-cost GH_2
  - Seeding local market focus areas; including setting of national standards and priorities
  - Commercial model assessment inclusive of opportunities and the role of the state
  - Policy and detailed regulatory frameworks
  - Focus on Research and Development to improve technologies and identify initial projects
  - A social licence assessment – looking at the holistic impact of the new GH_2 market
  - International strategies on partnerships, including bi-lateral MOU's and agreements

Competitive Supply: South Africa's competitive advantages

South Africa is well positioned to produce GH_2 thanks to three structural competitive advantages

SA with large scale, high quality RE potential

- **Power sector decarbonization alone requires ~150GW of solar PV and wind** installed capacity by 2050
- **Green H_2 opportunity will need additional ~100GW of RE capacity** (with 2-10GW by 2030)
- **REDZ[1] alone can hold 900+ GW RE** capacity with premium load factors
- **Average load factors in SA amongst the best in the world** and on par with major competitors like Chile, Saudi and Australia

Sufficient land and synergies in solving for water security

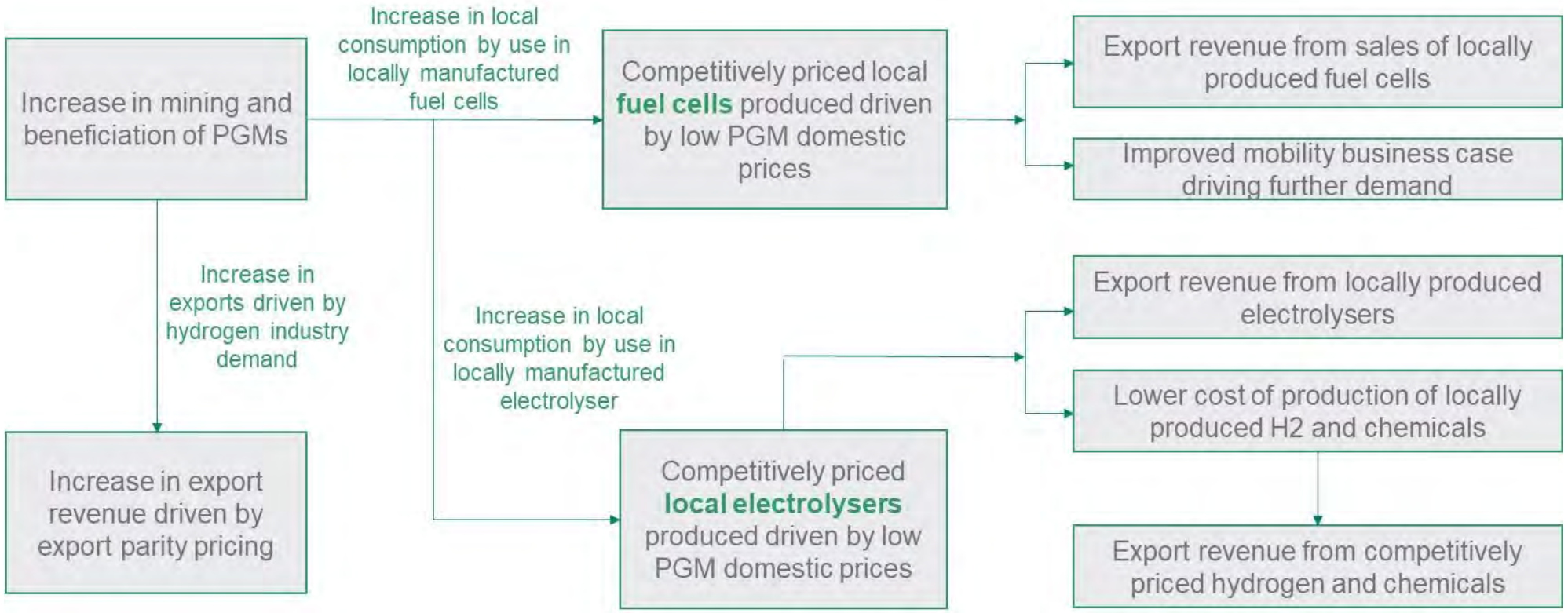
- Just **1% of SA land area** (1.1MHa) would be sufficient to produce **10Mt of green H2**
- **SA with vast land available,** with ~5.4 MHa in REDZ alone (areas not in competition with agriculture or settlements)
- **Reducing water requirement** (10Mt/yr. of green H2 production is only 31% of current power sector use in coal-based generation), **and 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 H2)

Unique expertise for beneficiation into e-Fuels

- **Proprietary Fischer-Tropsch tech**—lacking in other countries (critical for Power-to-Liquid)
- **Existing assets and knowledge** (e.g., multiple Fischer Tropsch and steel facilities) allow for local beneficiation of green H2 and enhances potential for large scale local demand
- **Opportunity to capture portion of global export market** for e.g., green ammonia/methanol/jetfuel

Competitive Supply: PGMs

Increase demand for PGMs driven by the global Hydrogen Industry will enable South Africa to take advantage of both export market and local consumption



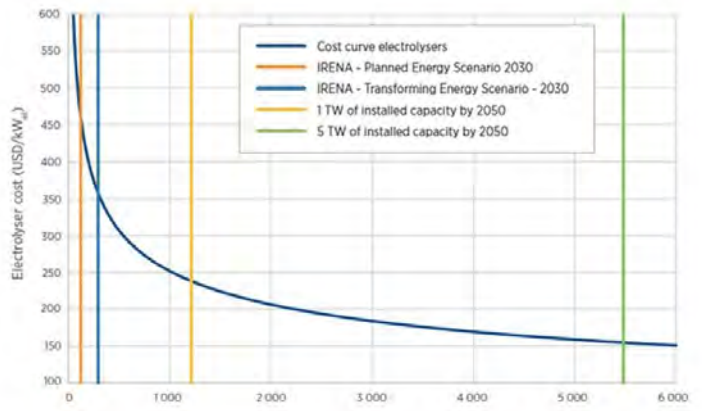
Competitive Supply: Cost of production drivers

Hydrogen is currently not cost competitive when compared with other sources of energy but it is globally anticipated that the cost will reduce to facilitate improved competitiveness

Renewable Energy Power Prices declined 67% for Solar and 49% for Wind since 2012

Between 2011 and 2021, four Bidding Windows through competitive tenders resulted in more than US$ 20 bn (R320 bn) of investment in renewable energy generation capacity,

Learning rates and investment in technology will see similar price declines for electrolysers



Potential cost decrease for electrolyzes based on learning rates and costs achieved by deployment in IRENA scenarios 2030 to 2050.
Source: International Renewable Energy Agency (IRENA) Analysis

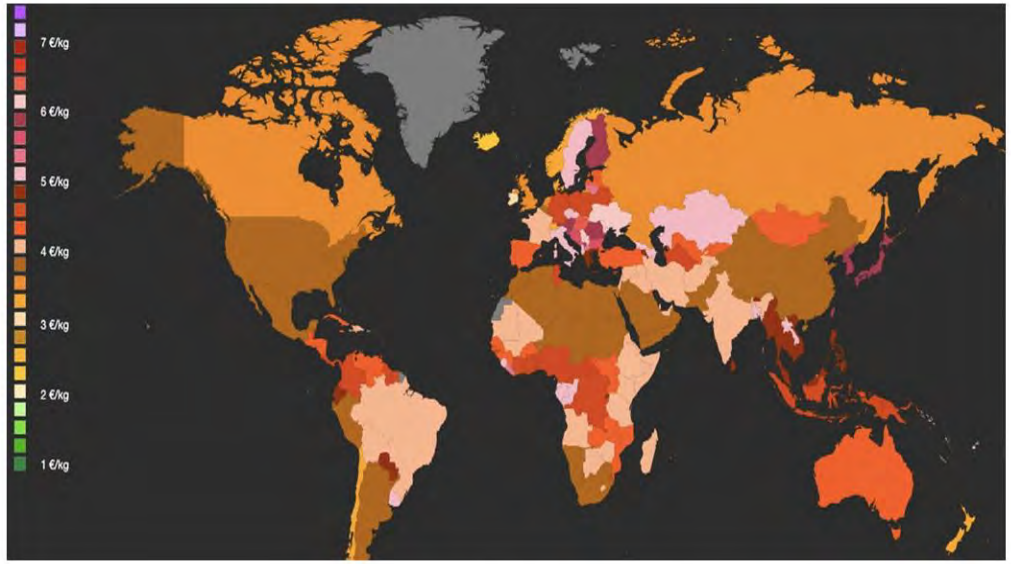
- A combination of cost reductions in electricity and electrolysers, together with increased efficiency and operating lifetime, has the potential to deliver 80% reduction in hydrogen cost over time
- Targeting projects with scale will contribute to equipment cost reductions by aggregating demand

Competitive Supply: South Africa's long term cost of production

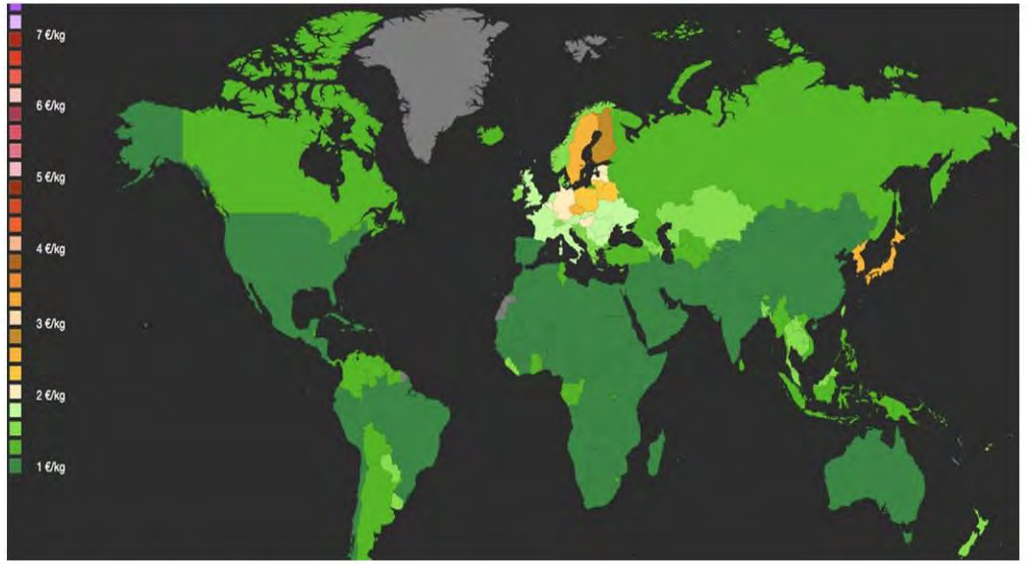
SA GH_2 could approach the $1/kg GH_2 mark by 2050, equivalent to indigenous low cost energy, making South Africa **one of the competitive industrial economies**, however South Africa will differentiate itself by using proprietary Fisher Tropsch technology to target export of sustainable aviation fuel and will manufacture electrolysers and fuel cells using PGMs available locally

Levelised Cost of Hydrogen (LCOH) comparable with the lowest cost producers in the world

Global Green Hydrogen Pricing - 2025*



Global Green Hydrogen Pricing - 2050*



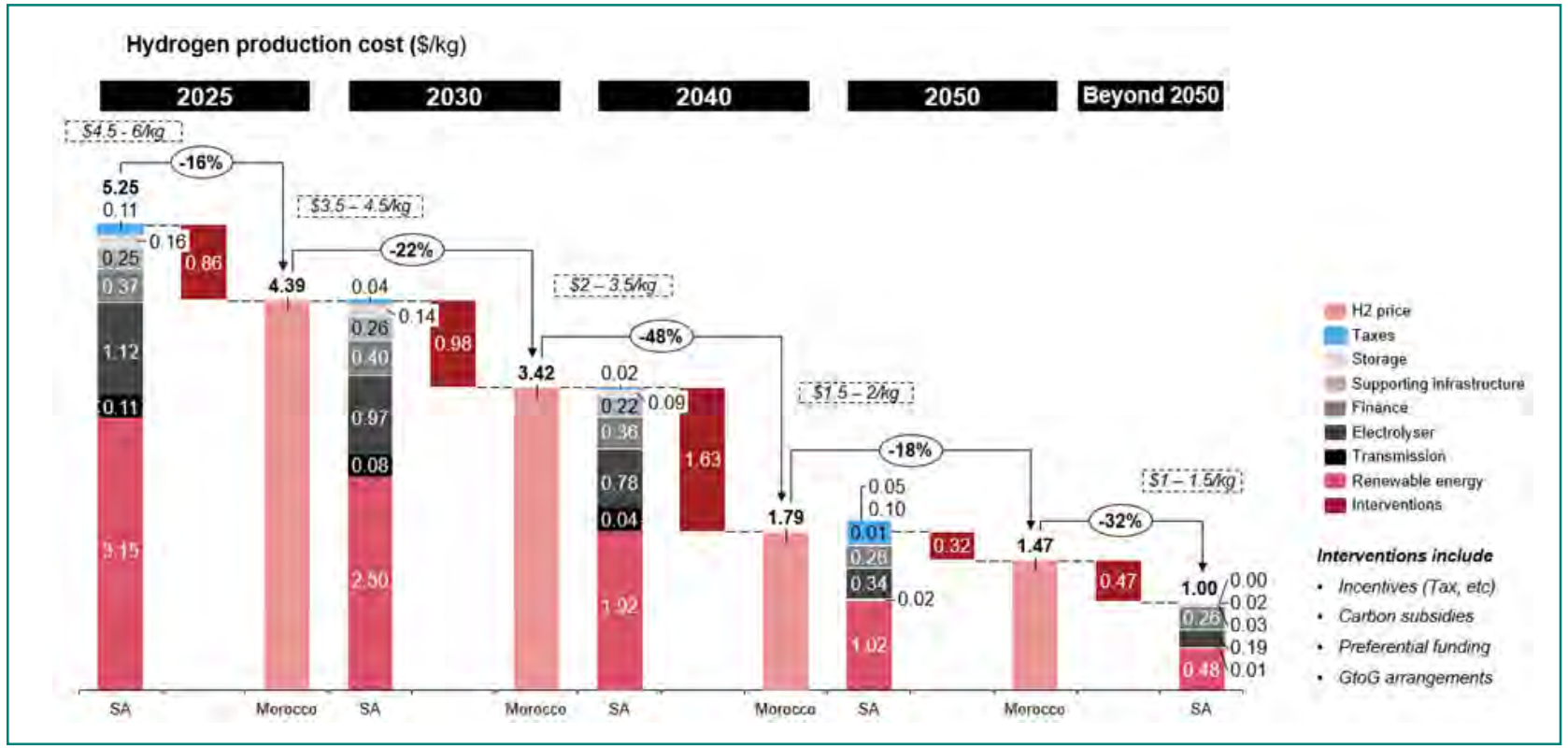
*PwC research (2021) | based on an analysis of various renewable energy sources and electricity generation / hydrogen equipment cost reductions worldwide

- Although far from the GH_2 importing markets in Europe and Asia, South Africa has the potential to make up the cost differential through greater efficiency and government support programmes.
- In 2025, the initial focus will be on the export of GH_2 at competitive prices as domestic use will not have reached commercial parity with local fuels. As GH_2 prices decline, a broader domestic transition will unfold.

Competitive Supply: Project Support Mechanisms

The cost reduction path can be influenced by a number of levers including taxes, supporting infrastructure, funding costs, electrolyser and transmission costs. Development of a detailed master plan and integrated value chain design will ensure our GH_2 development remains globally cost competitive

Measures to Improve Competitiveness and Possible Effects on Price (2030 - 2050)

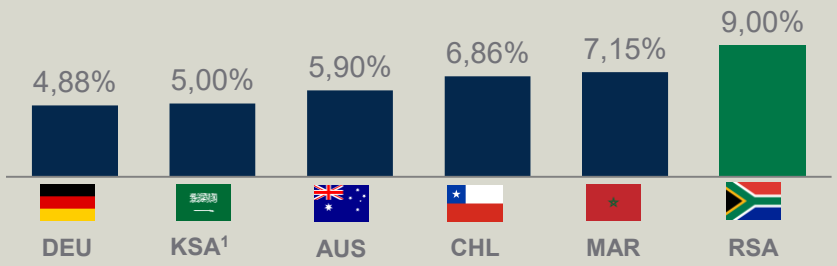


- South Africa will face significant competition for the European Union market from Morocco and Ukraine, who have already announced EU initiatives for GH_2, as well as Russia and Iceland. Namibia, due to its historical ties to Germany, will also compete with South Africa.
- Focusing on the hydrogen-supportive policies and creating a regulatory framework that encourages cost competitiveness will allow South Africa to play to win in the global GH_2 landscape.
- The graph indicates the different cost component levers that could facilitate improved competitiveness for South Africa, if compared to Morocco

Cost of capital as a means of comparative advantage

Cost of capital in South Africa is a key constraint that if addressed can provide a comparative advantage

Cost of capital comparison[1]

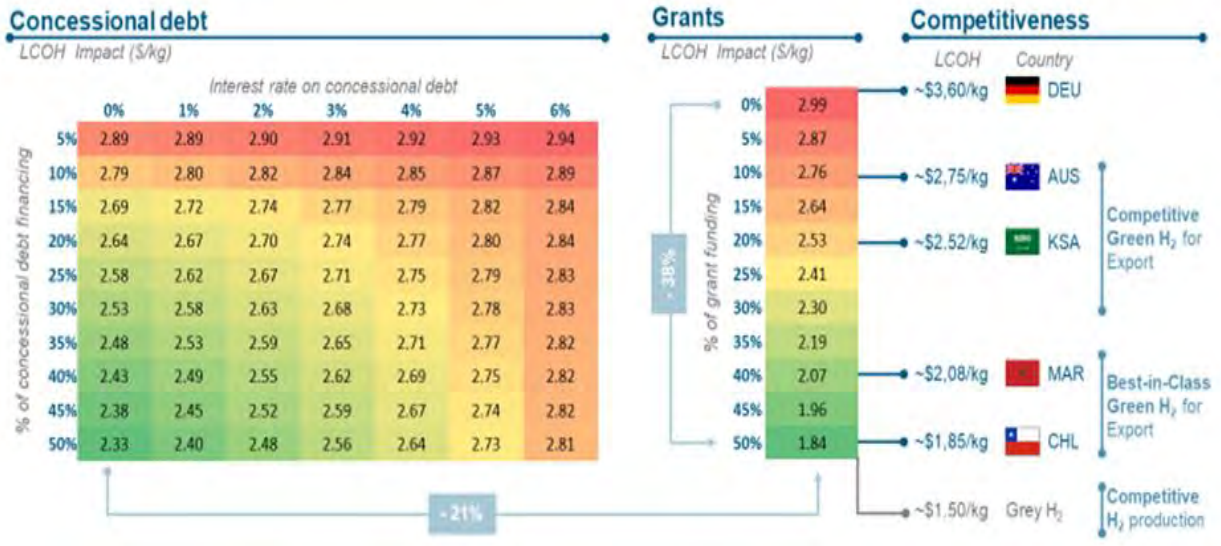


[1] Based on a bottom up calculation from first principles using a mixture of debt and equity. German and KSA assumed highly leveraged and the remaining countries medium leverage.

Three financing instruments are needed to improve the financial viability of projects:

- Grants: Decreases total capital burden of a project to produce H2
- Concessional debt: Varies project WACC which acts as a discount rate
- Contract-for-Difference: Price difference between green hydrogen / chemicals and conventional grey hydrogen / chemicals will be subsidized

Analysis shows grants have a greater impact than concessional debt with both able to improve a project's competitiveness to be in line with Australia and Saudi Arabia. However, a significant portion of grants compared to the total capital stack is required to achieve competitiveness compared to countries with best-in-class load factors for example Chile and Morocco. Expectations are that initial off takes to Europe can attract premium prices and these off takers will be looking for a diversity of supply



Typical project funding support requirements

Analysis for a typical 200MW build with a CAPEX requirement of $440m indicates that grant, concessional debt and contract for difference (e.g. H2 Global) will be required for each project

To ensure a minimum level of competitiveness for a single project requires blended funding. However, to be competitive with best-in-class green export for a typical 200MW installation, a $440m project will require increased grant funding availability ($110m – $130m). Therefore, additional financing is required if a portfolio of projects is to be supported and made globally competitive.

Short term grant funding projections*

Based on South Africa's targeted production volumes it is estimated that between $250m to $3.25bn in grant funding will be needed to become a best in class GH_2 exporter

2025 – $ 1bn total capex required and $250m*** in grants

2030** – $ 13 bn total capex required and $3.25bn*** in grants

*this assumes a typical $440m projects needs at least 25% grant component in addition to concessional debt and contract for difference

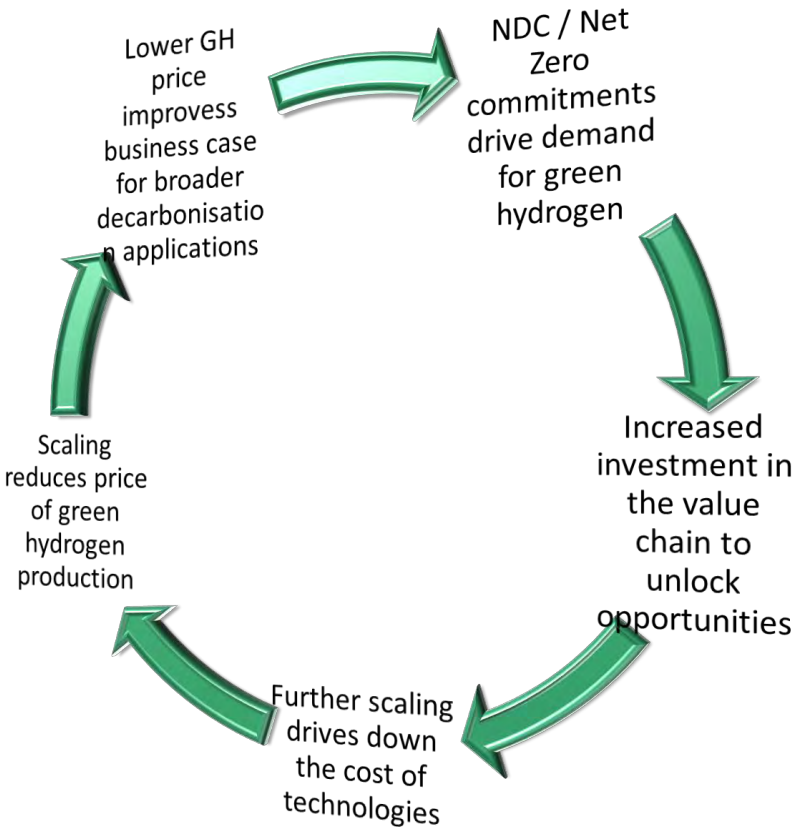
** - beyond 2030, cost of production is expected to decrease, lowering the need for grants. Projects would need to be globally competitive without grants.

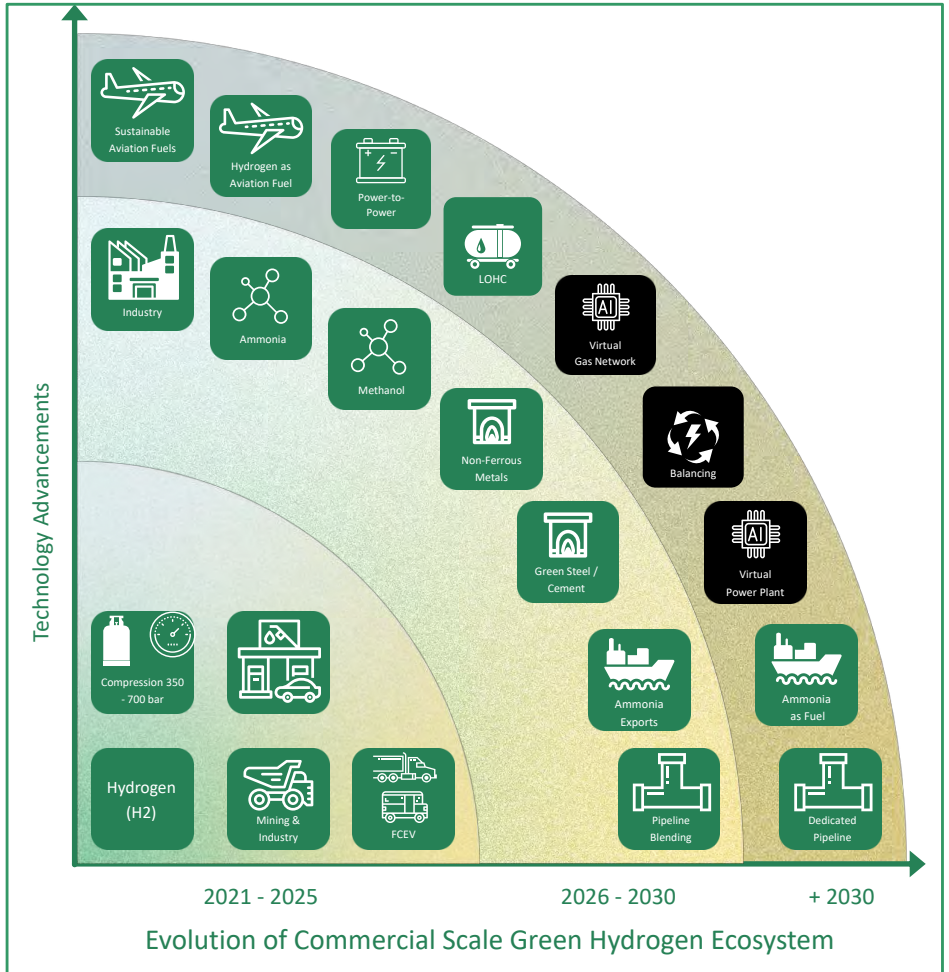
***If premium prices can be locked in, this will reduce the grant requirements

	Grants	Debt	Rate
funding pool	~25	~200	
Competitive Green H_2 for Export	0	~65-220	0-5%
	~25	~25-65	0-6%
	~45	0	NA
Best-in-Class Green H_2 for Export	~110	~130	0%
	~130	~65-110	0-3%
	~180	0	NA
Competitive H_2 production	>220	NA	NA

Demand-driven Commercialisation: Value Chain Focus

Declining GH_2 prices will unlock opportunities across key sectors to decarbonise industry





Evolution of Commercial Scale Green Hydrogen Ecosystem

Presentation Outline

1. Opportunity Statement
2. The need for a Commercialisation Plan
3. Demand-driven commercialisation
4. Competitive Supply
5. **Strategic choices**
6. Key Enablers
7. Commercialisation Roadmap

Strategic Choices

In order to facilitate accelerated commercialisation certain strategic choices will have to be made including:

i. Targeted volumes
ii. Market focus and sequencing
iii. Supply Location Archetypes
iv. Spatial focus
v. Localisation
vi. Social inclusion & development impact
vii. Maximisation of benefits and the minimisation of costs

Strategic Choices: (i) Projected Production Growth Path

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

- $1bn investment could expedite GH_2 export of 20 ktpa.
- Within three to five years, several GH_2 projects, both export and local, will come online increasing GH_2 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 GH_2 demand uplift to 7 mtpa. This will displace 541 Mtons of CO_2 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.

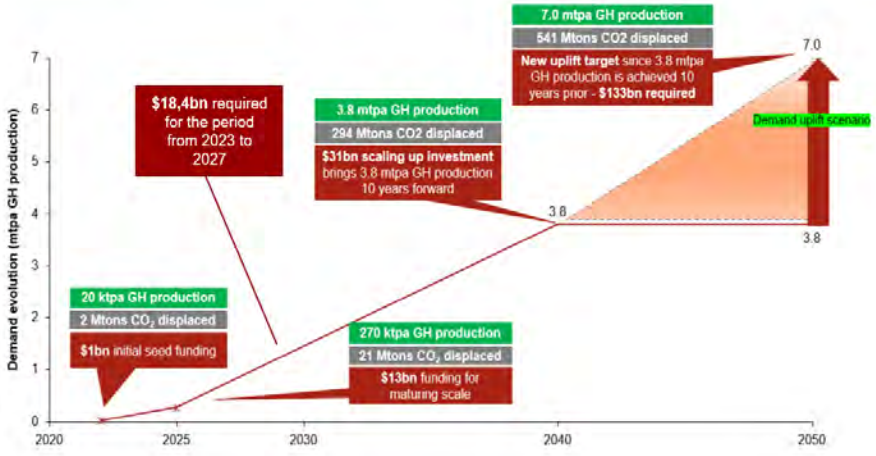
PRODUCTION TARGETS				
YEAR	2025	2030	2040	2050
TARGET	20	1.0	3.8	7
UNITS	ktpa	mtpa	mtpa	mtpa

GH_2 demand uplift and Capital investment required

Key insights

- South Africa requires an **initial seed capital of $1bn to expedite GH export of 20 ktpa.**
- Within three to five years, several GH projects, both export and local, will come online **increasing GH scale to 270 ktpa**, requiring **capital of $13bn, displacing** carbon emissions by **21 Mtons of CO_2.**
- **The target of 3.8 mtpa** is originally set for 2050, however, a **scaling up investment of $31bn** between 2030 and 2040 will enable South Africa to expedite this baseline production **displacing 294 Mtons of CO_2.**
- Between 2040 and 2050, South Africa can aggressively pursue deeper decarbonisation by seeking a **GH demand uplift to 7 mtpa**. This will displace **541 Mtons** of CO_2 and requires **$133bn in investment support.**
- Emissions calculated from the investment date to the end of the decade, assuming 3 years of development and 7 years of operations from the date of investment to the end of the decade. **Annual emissions reduction from 7 mtpa GH equals 76.8 Mtons CO_2, or between 18 to 20 % of South Africa's annual carbon emissions.**

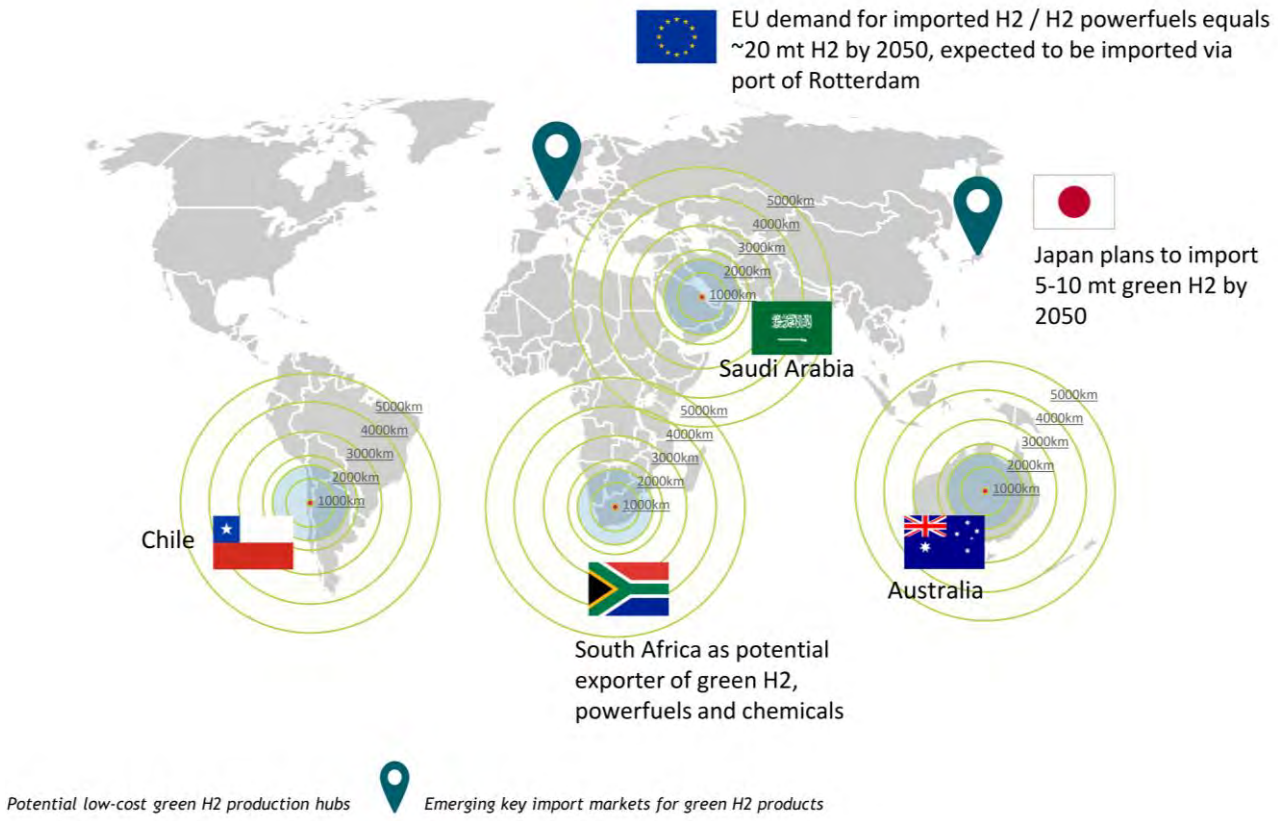
GH demand uplift and Capital investment required



Strategic Choices: (ii) Market Focus - Exports

Significant additional GH_2 demand could arise from supply of GH_2 products to Europe and Japan where imports of 25-30mt GH_2 is expected by 2050

- **Import Markets** for GH_2 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 GH_2.



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

Strategic Choices: (ii) Market Focus – Domestic Market

GH_2 Vision will progressively unfold penetrating multiple markets

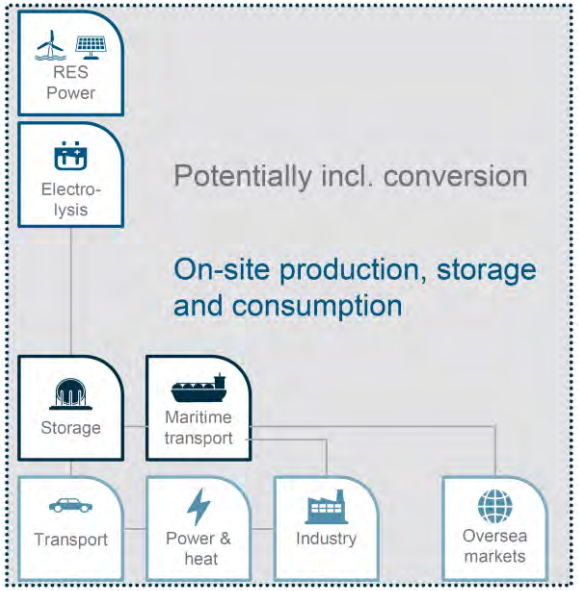
2023 to 2025		Road transport, primarily Fuel Cell Vehicles (FCVs) with a focus on Heavy- Duty Vehicles (HDVs). Pilot projects already underway including hydrogen-powered trucks (Anglo Platinum's Mogalakwena mine), the Hydrogen Valley (835km industrial and commercial mobility corridor) and Sasol and Toyota 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.

Strategic Choices: (iii) Supply Location Archetypes

Three supply archetypes need to be considered for meeting SA's future GH_2 demand. Selection of the optimal archetype configuration across SA will require a coordinated infrastructure approach to build long term national competitive advantage

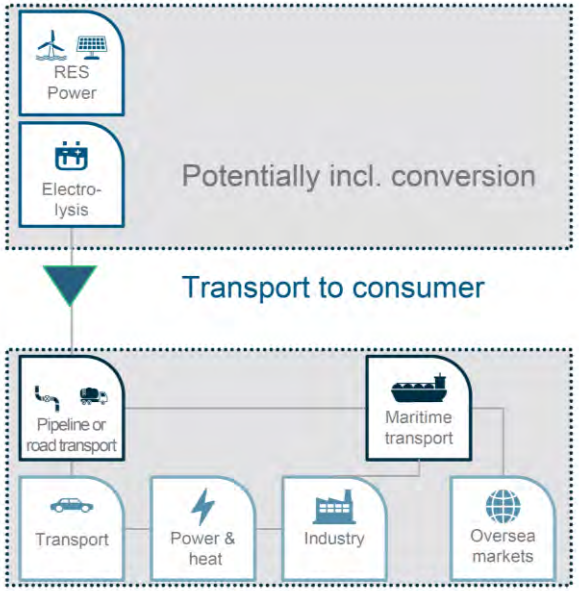
1 Co-locate RE and electrolyser with demand

On-site co-located power generation & GH_2 production [1]



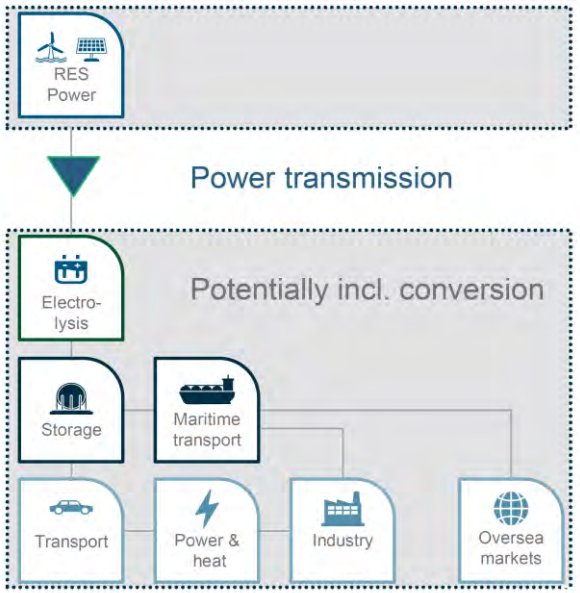
2 Decentralise RE and electrolyser (pipeline)

Decentral co-located1 power generation and GH_2 production (GH_2 molecule piped to demand centre.)



3 Decentralise RE, co-locate demand and electrolyser (wheeling)

Decentral power generation and on-site GH_2 production (power wheeled across grid to electrolyser)



1. RE and Electrolyser within 50-100km radius. 2. Ability to ensure power source for GH_2 production is completely green. Source BCG Analysis

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

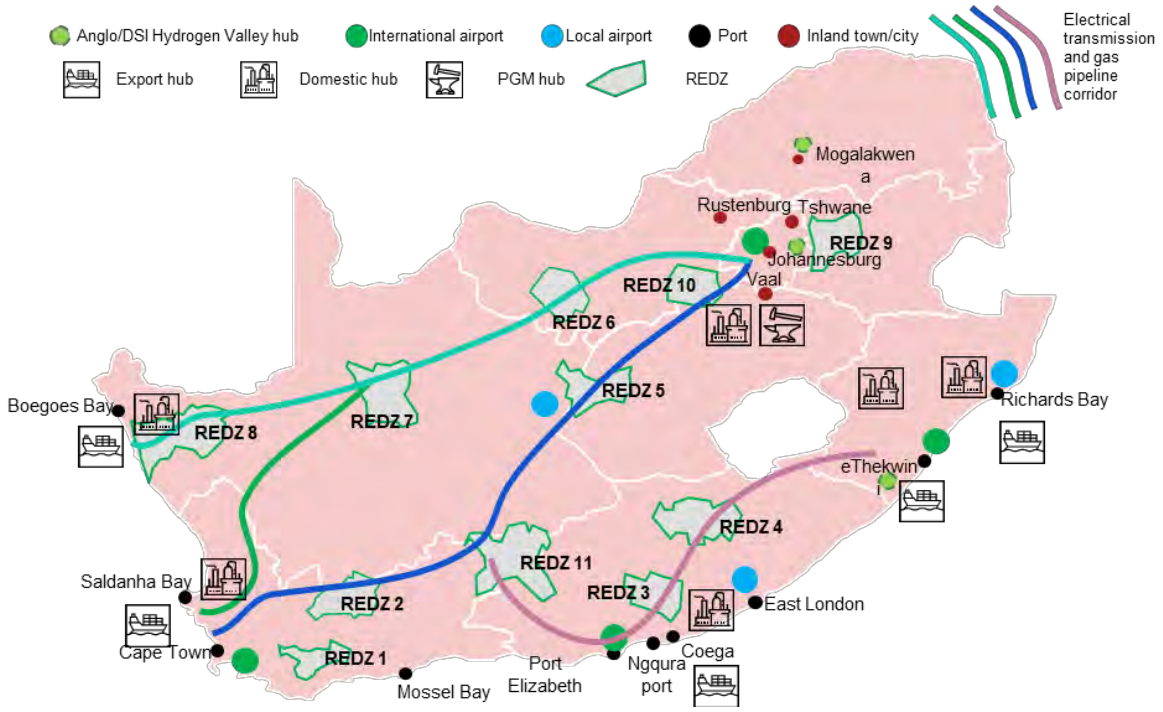
Strategic Choices: (iv) Spatial Considerations

South Africa has prioritized Hubs, Zones and Ports for Renewable Energy development and investment.

The REDZ zones are wide enough to include gas pipelines

- Hydrogen generation projects need to be located in areas with the best RE resources and when produced at scale, major hydrogen pipelines can be justified to transport hydrogen to demand nodes.
- The co-location of value chain players at GH_2 hubs could drive innovation, efficiency and economies of scale.
- Export projects are best placed near coastal ports in REDZs
- Equipment manufacturing projects are best located in SEZs to take maximum advantage of SEZ incentives
- Refueling infrastructure for mobility projects are best placed near transportation routes
- Location of GH_2 production projects required for demand centers not in close proximity to REDZs should be assessed on a case-by-case basis considering the 3 archetypes
- The cost associated with transportation of molecules or electrons need to be weighed against the difference in load factors between the demand centre and nearest REDZ.
- Locations able to aggregate demand are a further key consideration.

South Africa - Hubs, REDZs and Ports



Strategic Choices: (iv) Hydrogen Hub Considerations

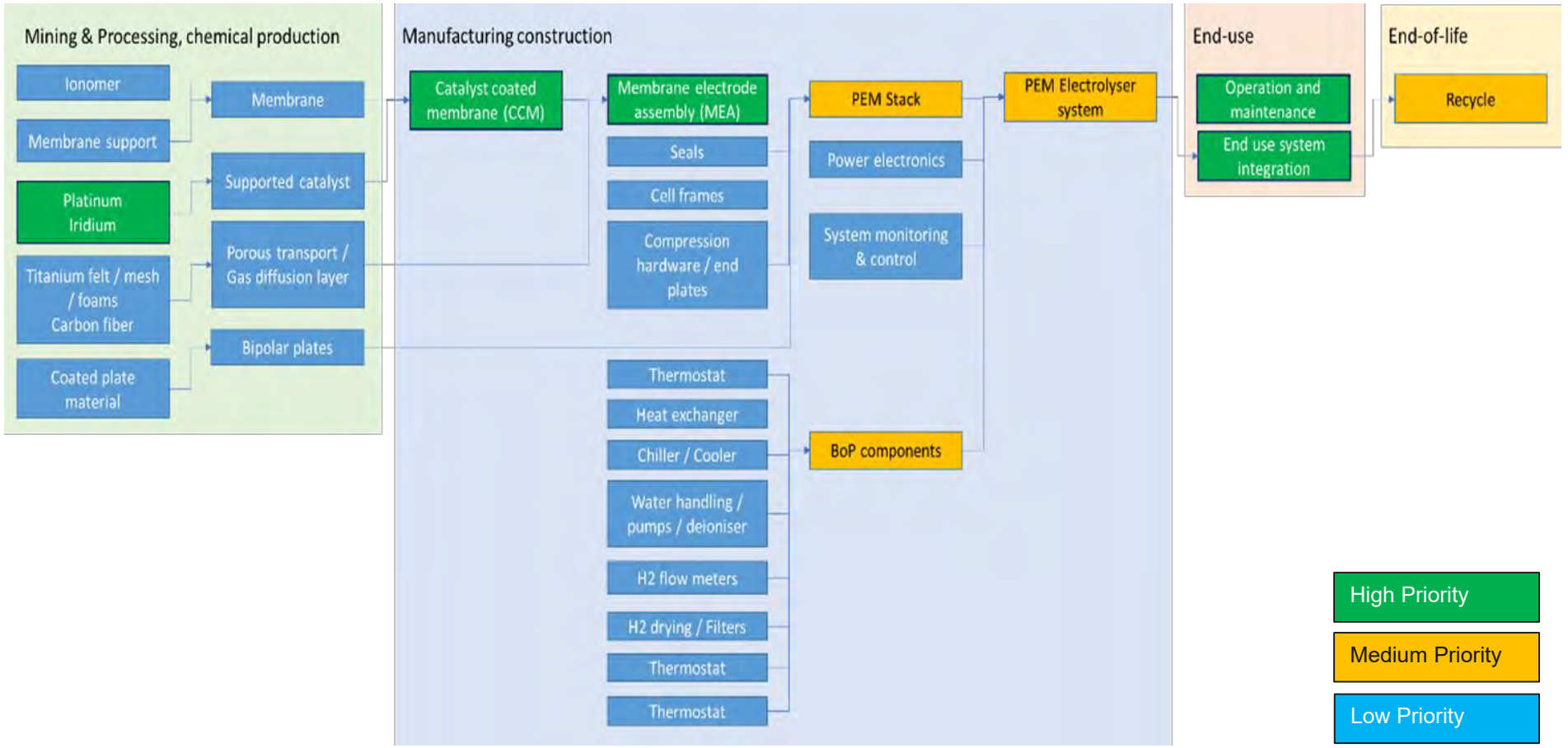
An analysis utilising the three archetypes suggested the following areas for GH_2 development in order to achieve an accelerated impact

	West Coast		Central (Inland)	Southeast coast		
	Boegoe Bay	**Saldanha Bay**	**Vaal**	**Coega**	**eThekwini**	**Richards Bay**
Advantages	• *Potential R13bn investment into port infrastructure* • *Access to the Americas and Europe market* • *Option to upscale freely for future production* • *Incentivised renewable energy production* • *Possibility to anchor local hydrogen uptake through the mining industry* • *Driven by NCEDA (OBL) and Sasol (IBL)*	• *Best quality renewable energy resource* • *Access to the Americas and Europe market* • *Option to upscale freely for future production* • *Possibility to anchor local hydrogen uptake through industrial activity* • *Easy access to resources* • *Can fulfil short-term export trading requirements*	• *Incentivised renewable energy production* • *Possibility to anchor local hydrogen uptake through the PGM and manufacturing industry* • *Well established existing infrastructure* • *Very easy access to resources*	• *Access to the East and West markets without incurring additional costs* • *Option to upscale for future production freely* • *Incentivised renewable energy production* • *Possibility to anchor local hydrogen uptake through the manufacturing industry* • *Very easy access to resources*	• *Access to the East market* • *Possibility to anchor local hydrogen uptake through the mining industry* • *Very easy access to resources*	• *Access to the East market* • *Possibility to anchor local hydrogen uptake through ammonia production* • *Easy access to resources*
Risks	*Access to resources will be a constraint*	*Access to East markets is possible with an increase in logistics cost*	*Possible constraint on upscaling for future production*	-	*High traffic port with a lack of available space to increase capacity*	*Ammonia might be the only major option to drive local uptake of hydrogen*
Aggregate factor	*The Boegoebaai green hydrogen hub in the Northern Cape can be a strategic project to open Southern Africa's full green energy potential. Sasol has commenced with a 24 month prefeasibility study*	*Saldhana can leverage existing logistics and industrial infrastructure*	*The Vaal triangle's large industrial footprint gives it a strong domestic focus, with the added option to anchor local hydrogen uptake through the PGM industry*	*Coega could also fulfil short-term export requirements, but is mainly attractive due to its central coastal location and designated industrial development zone*	*The port of eThekwini's limited capacity and high traffic frequency isn't ideal when considering future upscaling requirements*	*Richards bay could support the local and export focus through the production and export of ammonia and hydrogen*
Purpose	*Export focused*	*Export focused*	*Domestic focused PGM focused*	*Export focused*	*Export focused*	*Support hub - Export and domestic focus*

Strategic Choices: (v) Localisation of PEM Electrolysers

The GH_2 value chain presents opportunities for localisation – especially relating to the beneficiation of Platinum Group Metals

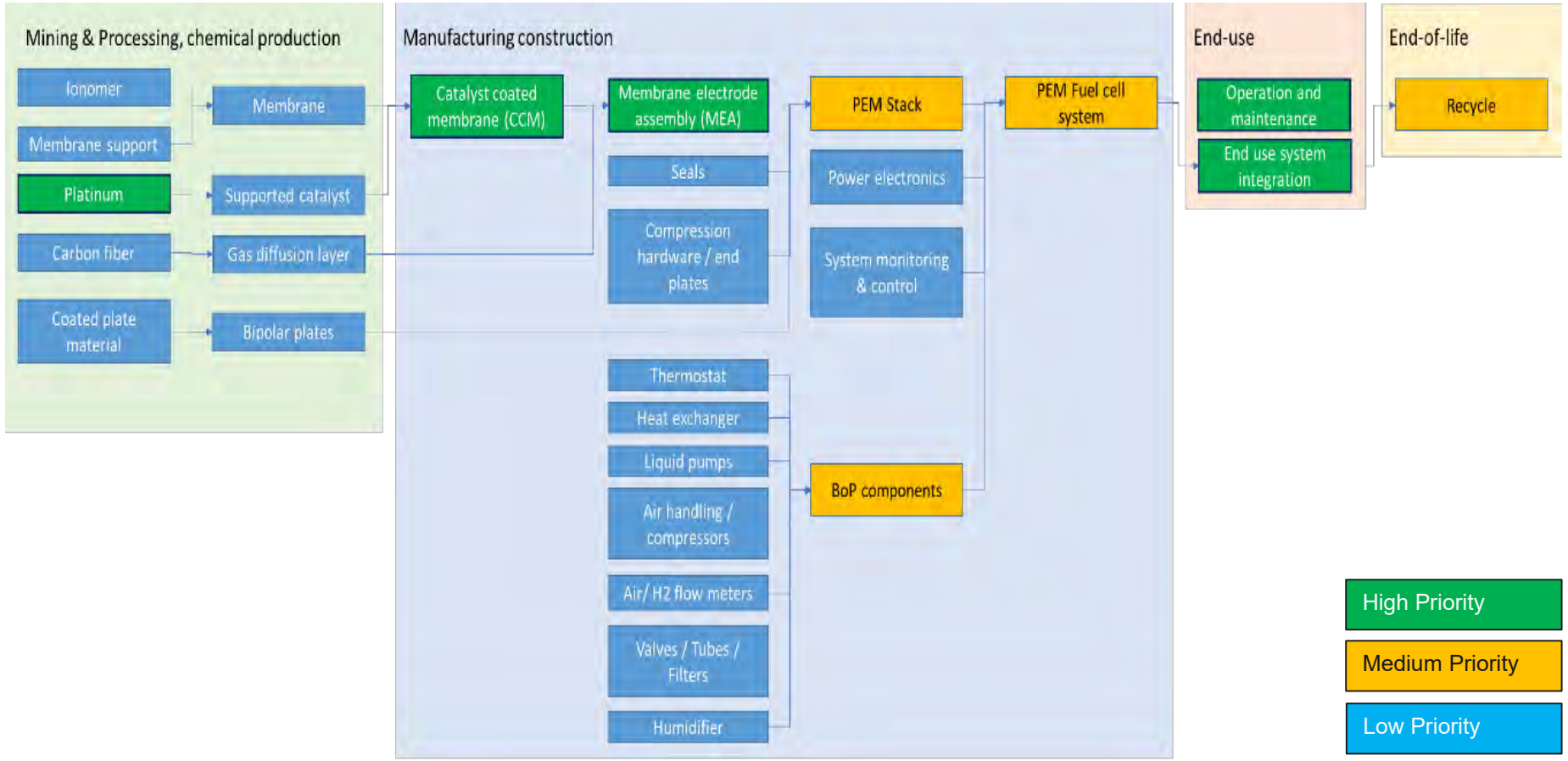
South Africa should attempt to leverage its PGM resources to promote localisation of PEM electrolysis technology equipment and components.



- Equipment and components include
  - electrolyser stacks,
  - electrolyser systems,
  - electrolyser catalyst coated membranes (CCMs) and membrane electrode assemblies (MEAs),
  - electrolyser Balance of Plant components.
- High priority components for localisation include platinum, iridium, CCMs, MEAs, system integration and O&M

Strategic Choices: (v) Localisation of Fuel Cells

PEM Fuel Cells are expected to generate substantial PGM demand 2030+ as GH_2 use becomes mainstream



- Equipment and components include fuel cell stacks, fuel cell systems, fuel cell catalyst coated membranes (CCMs) and membrane electrode assemblies (MEAs), as well as Balance of Plant components.
- High priority components for localisation are platinum, CCMs and MEAs

Strategic Choices: (vi) Inclusion & social impact

Significant opportunity exists for economic development and social inclusion which should be pro-actively driven through the commercialization strategy. **The estimates below are high level and will be validated by a comprehensive study.**

Gender equality and social inclusion

- The development of the hydrogen industry provides the opportunity to integrate the element of gender equality.
- Women's potential in green industry needs to be realised, and women need to be empowered to take leadership roles in green industries as entrepreneurs and / or industry professionals.

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 GH_2 value chain.

Impact on the South African economy

Based on projected exports by 2050:

- Export Sales - ~ R223bn per annum
- GDP - ~ R 74bn per annum
- Tax Revenue - ~ R 19bn per annum

Significant net job gains

- In total up to **650,000** additional jobs in South African by 2050 from exports and from local demand

Strategic Choices: (vii) Costs vs. Benefits

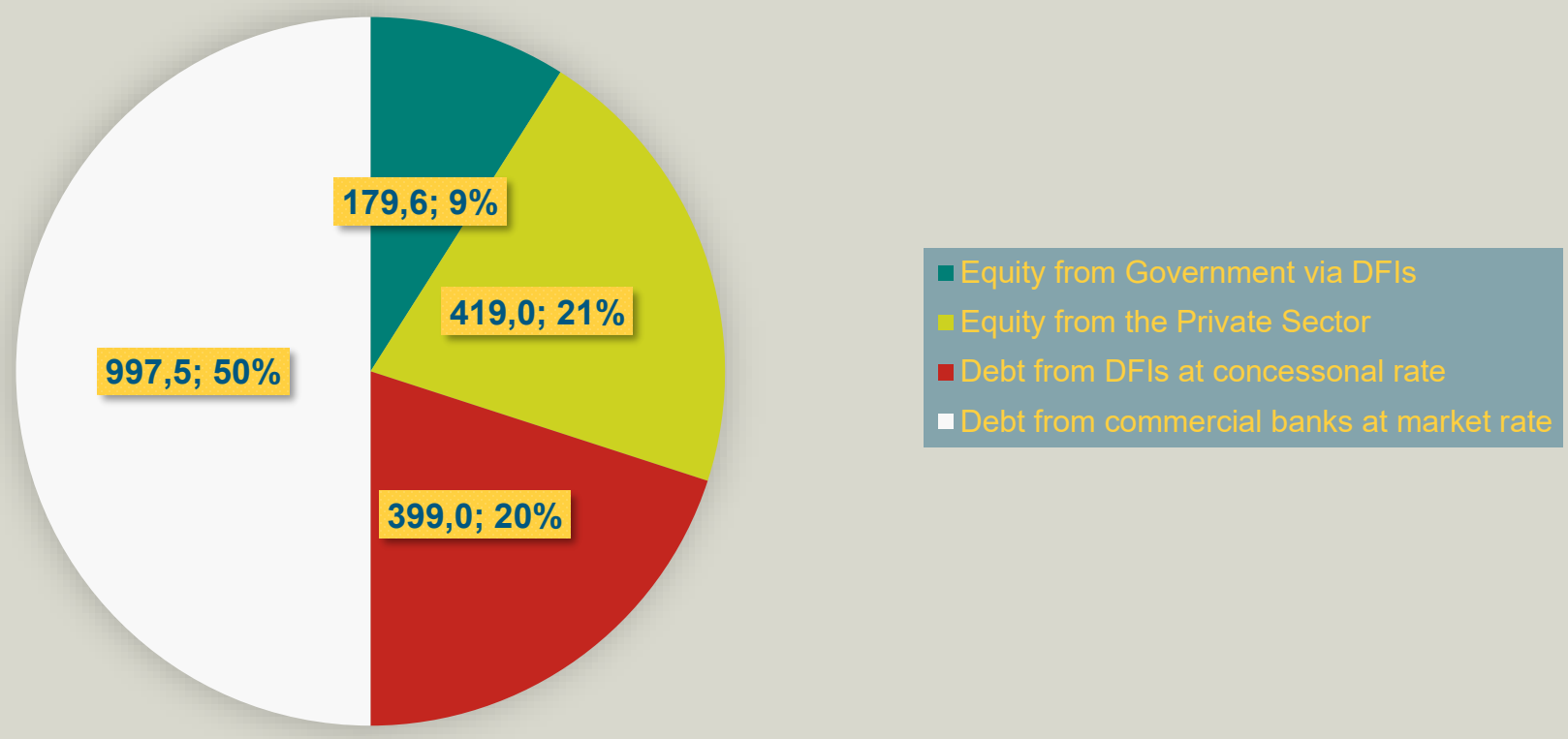
The **costs** associated with the development of the Hydrogen Economy is summarised below. **The estimates below are high level and will be validated by a comprehensive study.**

1	There will be a need for funding from DFIs in the form of grants, project development funds or concessional debt facilities. It is estimated that DFIs will need to contribute about **R180bn in equity and R400bn in debt at concessional rates by 2050**.
2	Capex funding requirement from private sector. It is estimated that the private sector will need to contribute about **R410bn in equity** and would need to source a further **R956bn in debt from commercial banks.**
3	Government subsidies and incentives will be required to support the catalytic hydrogen projects by the introduction of supportive policies and a regulatory framework for GH_2 that aids GH_2 price parity to increase domestic GH_2 demand.
4	Costs associated with changes / new regulations and policies.
5	R&D spending to stay ahead of innovation and technology and remain competitive (amount still to be determined)
6	Gradual reduction in income from petrochemical levies (impact to the economy still to be determined)
7	Development of state procurement programme / s
8	Costs to develop hydrogen infrastructure
9	Cost associated with establishing global partnerships and bi-lateral government to government agreements.
10	Costs to develop training and skills development programmes to support job creation within the GH_2 sector.

Strategic Choices: (vii) Investment required

The breakdown of the investment required for debt and equity from both private sector and Government is summarised below. **The estimates below are high level and will be validated by a comprehensive study.**

Investment required by 2050 in the GH_2 Industry in Rbn[1]



1. Assumptions:
a) Debt to equity ratio 70:30
b) DFIs contribute 30% of total equity requirement
c) DFIs contribute 30% of total debt required

Strategic Choices: (vii) Costs vs. Benefits

Although there are challenges and costs associated with developing the GH_2 economy, in the long term both the economic and social **benefits** to the country will far outweigh the costs. **The estimates below are high level and will be validated by a comprehensive study.**

1	New industrialisation opportunities in multiple sectors will enable South African to have a comparative advantage
2	Foreign direct investment into new hydrogen projects in South Africa will include grants and concessional debt facilities from DFIs
3	Creation of new jobs in many new industries across the hydrogen value chain - estimated at **650,000**
4	Income from exporting hydrogen, ammonia, methanol, marine bunkering and sustainable aviation fuel estimated at **R 223bn in export sales by 2050.**
5	Income from increased beneficiation and exports of minerals (especially PGMs) (Macroeconomic impact to be determined)
6	Income from export of locally produced equipment for example fuel cell components and electrolysers
7	Green house gas emission reduction by using GH_2 as a replacement energy carrier in traditional fossil fuel based processes e.g. steel making, transportation, petrochemical production and other heavy industries, will contribute towards reaching South Africa's emission reduction goals as per the Peak, Plateau, Decline Emissions Trajectory Range reflected in the NCCRP and NDP. **Estimated 540 million tons of carbon dioxide will be displaced.**
8	Security of energy supply by providing alternative, reliable and clean base load energy to the commercial and industrial market will support decarbonisation, green steel, mining etc. and maintain South Africa's competitiveness over time
9	Gradual reduction in importation of petrochemical products and positive impact on balance of payments
10	Maximisation of social inclusion including empowerment of BEE/women/youth/BIs

Presentation Outline

1. Opportunity Statement
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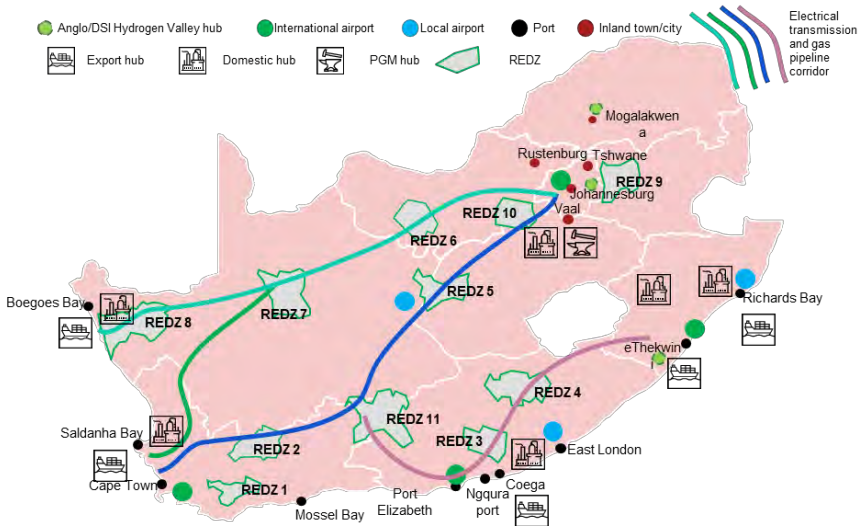
5. Strategic choices
6. **Key Enablers**
7. Commercialisation Roadmap

Key Enablers: (i) Co-ordinated development of efficient value chain

Capturing the GH_2 opportunity requires a nationally coordinated approach / master plan (value chain design) to ensure end-to-end efficiency, planning and control of GH_2 molecules.



- **Co-ordination:** Since the value chain touches on land, water, energy, natural resources, logistics and finance, it will require significant co-ordination between the various government departments, public sector institutions and the private sector.
- **Technology:**. Securing technology partnerships as well as targeted industrialisation plan will unlock significant economic benefits for SA economy. Fortunately, SA is not starting from scratch thanks to the RD&I efforts already underway by the DSI.
- **Value Chain Elements:** GH_2 production is an industrialisation opportunity. Equipment manufacture can service both domestic and export markets.

Recommendations

1. Existing private sector project opportunities identified should be expedited and supported. (these have been identified and plotted in the GH_2 roadmap)
2. Export hubs (SEZ) at **Boegoebaai**, Coega and Freeport Saldhana to be prioritised to enable exports.
3. A manufacturing hub (SEZ) at Vaal must be prioritised to enable early manufacturing and foreign technology partnerships and transfer.

Key Enablers: (ii) Regulatory & Policy Framework

The key regulatory recommendations are as follows

Prepare a Regulatory Development Timeline

- Outline detail and timing of regulatory review and introduction of new law and policy.
- Outline regulatory responses for the GH_2 industry including the introduction and phase out of such mechanisms.

Develop regulatory objectives for how the GH_2 industry should be regulated.

- Agree on regulatory objectives to simplify coordination of regulatory responses across government departments.
- Conduct feasibility studies to establish the financial impact of possible GH_2 regulatory incentives.

Develop a set of Regulations specifically aimed at creating enabling environment for GH_2

- Utilise section 19(1) of the National Energy Act to introduce GH_2 regulations.
- Consider other existing laws and policies that could support the uptake of GH_2 and amend accordingly.
- Develop GH_2 standards and specifications for mobility, production, refuelling, storage, transportation and end-use applications based on international best practice standards.

Key Enablers: (ii) Regulatory & Policy Framework

Development of regulatory measures and incentives for the import and export market production

Export Market

1. Introduce measures for SEZs to produce and export hydrogen at a cost competitive price.
2. Design and introduce a Guarantees of Origin system to install investor confidence in key import nodes.
3. Special Economic Zone and REDz incentives: Reduced corporate tax rate from 28% to 15%; accelerated depreciation allowance of 10% for buildings; VAT and customs relief; employment tax Incentives under SEZ Act.
4. Guarantees of Origin System: Engage with zaRECs Pty Ltd to explore expansion of current renewable energy certificate system to include GH_2; ensure alignment of South African GO system with EECS (European Energy Certificate System) in order to satisfy European GH_2 investors.

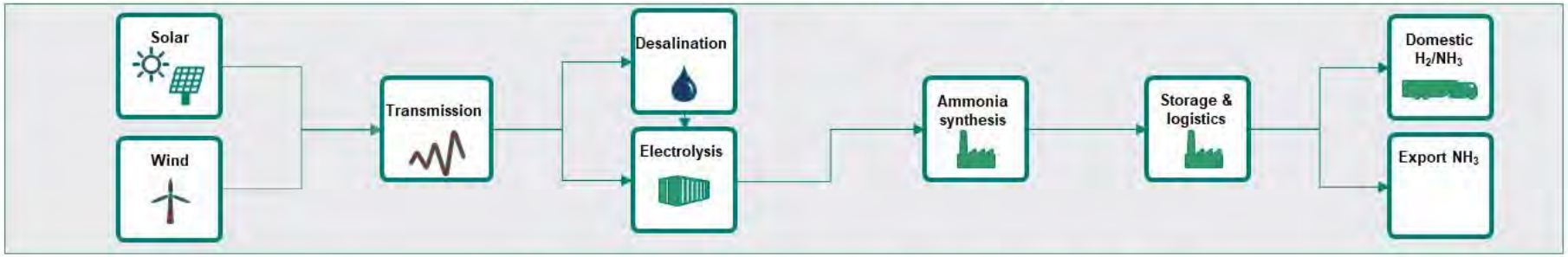
Domestic Market

1. Introduce explicit and implicit carbon pricing mechanisms coupled with GH_2 revenue recycling mechanisms.
2. Build on existing regulatory tax incentives set out in the Income Tax Act to support the GH_2 value chain.
3. Introduce a single institutional body to expedite licensing processes and facilitate the development of the GH_2 sector.
4. Explicit Carbon Pricing: Increased carbon tax rate or carbon fuel levy under the Carbon Tax Act and Customs and Excise Act.
5. Implicit Carbon Pricing: Removal of fossil-fuel subsidies and reallocation of subsidies to GH_2 development.
6. Tax allowances: Apply Incomes Tax Act provisions to GH_2 (Sections 12L, 12B(1)(h), 12I, 12K, 11D, 11A, 12C, 13(1))
7. Import duties: Exempt imported GH_2 equipment under Schedule 7 of the Customs and Excise Duties Act. (Still in draft)

Key Enablers: (iii) Finance & Investment

The estimated total capital investment scaling from $970m for pilot projects to $164bn as 2040 target

(indicative in 2021 terms)

	Project 1 - 20 ktpa Hydrogen (to be commissioned in 2025)	Long term high growth scenario - 3.8mtpa tons Hydrogen 2040 (investment over 15 years)	Long term low growth scenario - 3.8mtpa tons Hydrogen 2050 (investment over 25 years)
Value chain			
Value Chain capacity	**20,000 tpa hydrogen*** 114,000 tpa Ammonia (Export capacity - 114,000 tpa) 180,000 tpa water	**3.8 mtpa hydrogen production*** 22 mtpa Ammonia (Export capacity - 11 mtpa (50%)) 34 mtpa water	
Scale & land take	290 MW electrolyser 370 MW solar - 730 ha 160 MW wind - 5,600 ha (**based on identified pilot projects**)	60 GW electrolyser 70 GW solar - 0.14 Mha; 30 GW wind - 1.05 Mha (**6.5x** IRP allocation for RE) (indication of size required: **equivalent to 66% of Gauteng Province**)	
Capital Cost	**$970m total;** 67% RE capex; 22% electrolysis capex; 10% Ammonia plant capex	**$164bn total;** 65% RE capex; 21% electrolysis capex; 13% Ammonia plant capex	**$133bn total;** 67% RE capex; 9% electrolysis capex; 23% Ammonia plant capex

Key Enablers: (iii) Finance & Investment

Eight distinct challenges identified in SA Hydrogen ecosystem & funding landscape

1 Lack of an integrated policy and gov alignment

- Multiple policies or roadmaps that are not interlinked to provide a coherent and clear path forward for green H_2
- Different departments within government using different strategies to make decisions

2 Green H_2 Supply-demand mismatch blocks offtake

- All projects on IDC-KfW radar have no offtake agreements
- Offtakers don't want to lock-in prices long term since price will go down
- Market unclear on whether green or blue hydrogen will dominate market

3 No clear path on which H_2 projects to invest in

- Lack of strategic catalytic project pipeline and map on how capital stack evolves as project matures

4 Low IRR creates barrier for private funding

- High LCOH makes green H_2 less competitive today
- Low IRR, long payback period compared to other projects
- Current tech maturity increases risk profile for private investors

5 Lack of local blended finance

- Public-private blended finance in RSA green projects is 100% from international sources
- Domestic bias with increase, local blended finance required

6 Insufficient funds for key parts of H_2 value chain

- Synthesis concept dev only has debt today, too high-risk for that stage
- Direct Air Capture, Carbon Capture and Carbon Storage tech in low maturity, but only debt offered for these problems

7 No strategy or funds for distri. & storage infra.

- Only debt financial instrument is offered No clear path on who will support funding for green H_2 infrastructure
- No plan on how infrastructure will be shared or how "no island grid' policy will change to accommodate new projects

8 Lack of common understanding of 'green'

- No global definition of green H_2
- No global method to track green funds and their uses
- Unclear standards for measurement criteria of LCOH
- True cost of tech kept proprietary

Low criticality Medium criticality High criticality

Source: KfW/Boston Consulting Group/IDC 2022

Key Enablers: (iii) Finance & Investment

Potential sources of funding will need to be obtained from government, private finance and development finance institutions

1 Government on-balance sheet finance

- **Direct public funding:** includes allocation of taxation revenue, budget surplus', borrowings
- **Green/project bond financing:** Effective means of encouraging development of infrastructure focused on reducing carbon emissions and provides a form of de-risking by providing long-term grant and concessionary funding to an investment

2 Private Finance

- **Traditional private sources of private finance such as** direct equity investments and lending
- **Public-private partnerships:** Combining public and private sector involvement by partnering government with key private stakeholders, including infrastructure developers, renewable energy companies, research institutions, vehicle manufacturers, and infrastructure focussed private equity funds, are key themes in this space globally.

3 Development Finance

- **Leveraging funding from developed markets:** A number of larger, developed countries have committed funding to support the decarbonisation initiatives of developing countries. Taking advantage of those additional pockets of funding will support the development of larger scale projects locally, which will enhance efficiencies and ultimately reduce pricing.
- **Leveraging funding from export credit agencies:** often used to fund infrastructure projects (especially those in the developing world) in conjunction with, or as an alternative to, more traditional project financing. It enables project companies to obtain more flexible (and often cheaper) financing arrangements. In addition to financing, export credit financiers may also provide insurance, particularly political risk insurance that is either unobtainable or prohibitively expensive in the commercial market place, which incentivises investment by international financiers.
- **Blended finance mechanisms** including on-lending structures from DFIs and subordinated debt

Key Enablers: (iv) Catalytic Projects – GH_2, Chemicals and Green Steel Production

2.1 Prieska Energy Cluster
Green Ammonia Production facility in Prieska, Northern Cape.
Stakeholders: Mahlako a Phahla investments and Central Energy Corporation (Cenec), IDC

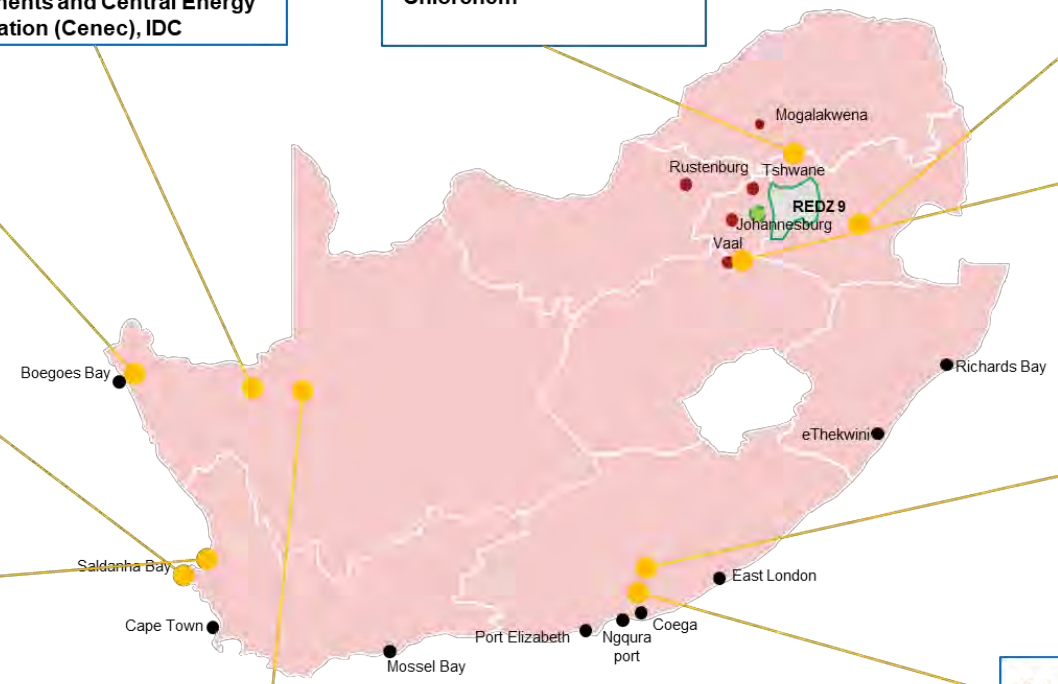
2.2 NCP Chlorchem waste hydrogen recovery project
Stakeholders: NCP Chlorchem

2.3 Sustainable Aviation Fuel
Stakeholders: Sasol, Enertrag, Navitas, Linde

2.4 Sasolburg 60 MW H_2 production
Stakeholders: Sasol, IDC

2.10 Boegoes Bay GH port
Port, Rail and Infrastructure Project driven by the Northern Cape Provincial Government to support GH projects.
Stakeholders: Northern Cape Economic Development, Trade and Promotion Agency, Sasol

2.9 AMSA Saldanha Steel Green Steel Project
Stakeholders: ArcelorMittal South Africa



2.5 Hive Green Ammonia export project
Stakeholders: Hive Hydrogen, Built Africa and Afrox (subsidiary of Linde)

2.8 Mainstream GH Production new Saldhana Bay
Stakeholders: South Africa Mainstream Renewable Power Developments

2.6 Eastern Cape e-Methanol Project
Stakeholders: Enertrag South Africa, Earth and Wire, 24Solutions

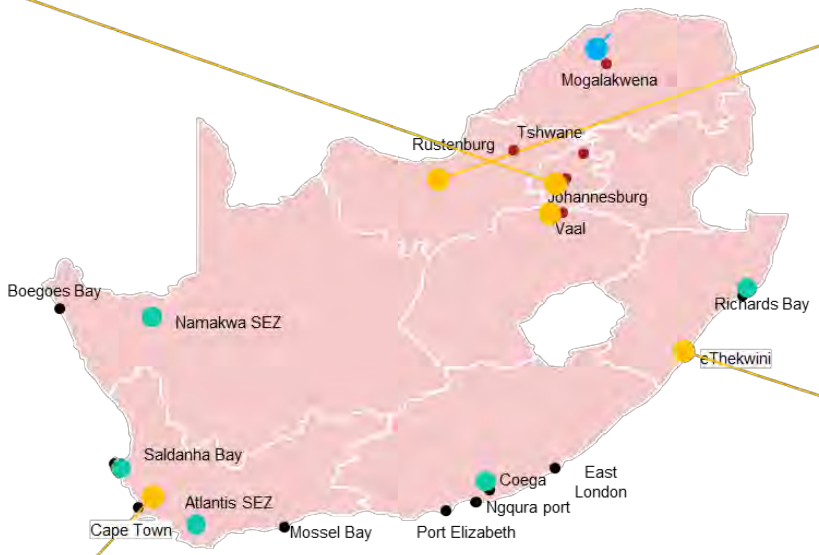
2.7 Enertrag GH / Ammonia Production
Stakeholders: Enertrag

The current strong pipeline of GH_2, chemicals and green steel projects will support the export focus element of the commercialisation strategy

Key Enablers: (iv) Catalytic Projects – Manufacturing in Value Chain

1.1 Isondo Precious Metals
Fuel cell and electrolyser component manufacturing facility
Stakeholders: IPM, DTIC

1.2 Project Phoenix
Solid Oxide Fuel Cell manufacturing facility
Stakeholders: Mitochondria, IDC, DBSA, DTIC

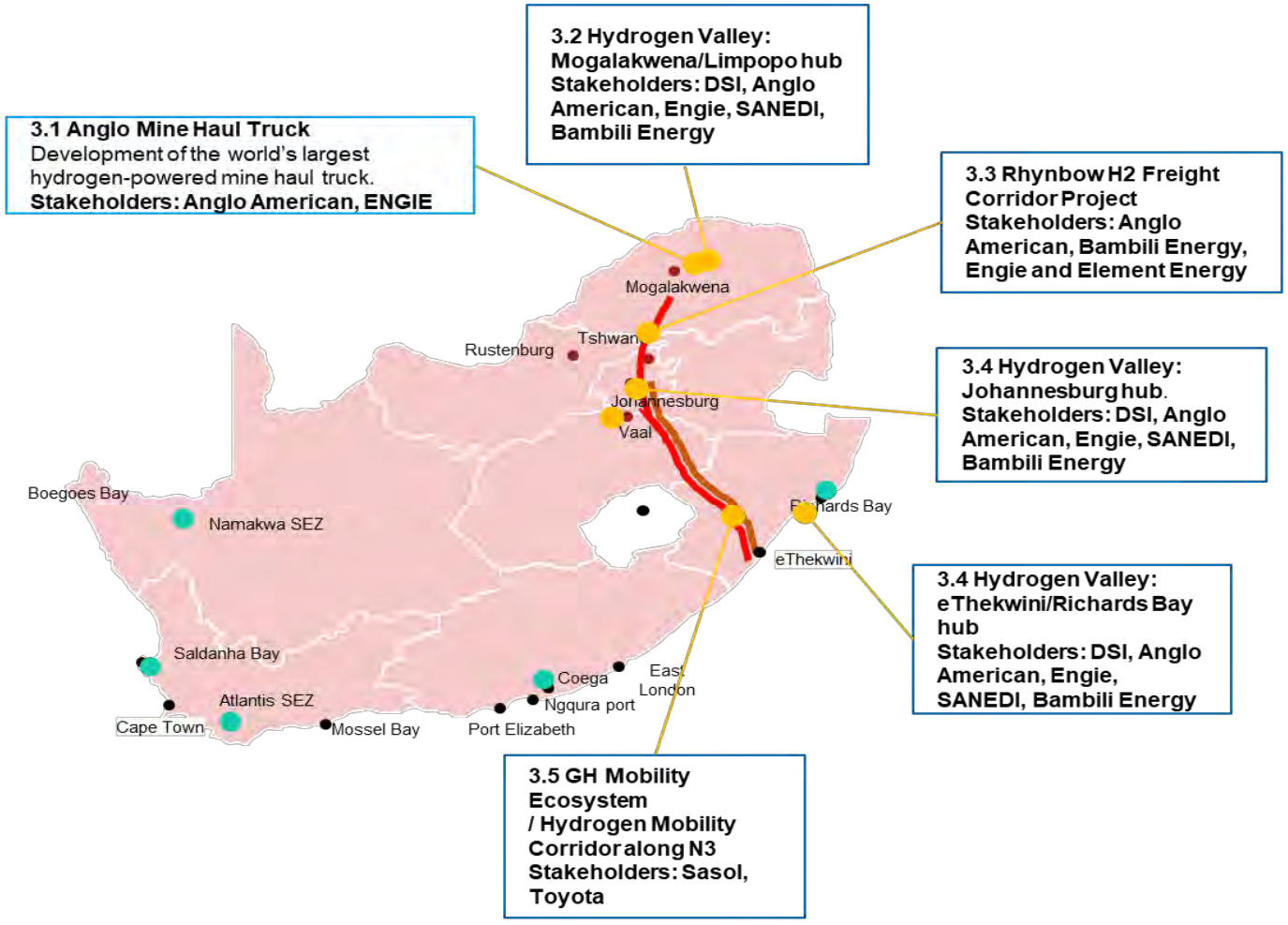


1.3 Chem Corporation
CHEM ENERGY SA, fuel cell production factory.
Stakeholders: CHEM Energy SA

1.4 HyPlat
Manufacturing of Membrane Electrode Assemblies (MEA) and Catalyst Coated Membranes (CCM).
Stakeholders: HyPlat, Bambili Energy

The current strong pipeline of equipment manufacturing projects will support the industrialisation element in the commercialisation strategy

Key Enablers: (iv) Catalytic Projects - Mobility



The current strong pipeline of mobility projects will support the domestic demand stimulation and decarbonisation strategy

Key Enablers: (v) Skills

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

The DHET will be central to the implementation of the skills action plan with consultation of the DSI.

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	• **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	**Incentivising the private sector to support local capacity** as they outsource for technical engineering expertise specific to electrolyser manufacturing
	Recycling of used PGM products **(Medium)**	Circular economy skills	Local, and growing	**Supporting the roll out of upskilling initiatives** through funding and financial incentives to encourage quicker uptake by the private sector
	CCM* and MEA* electrolyser component manufacture **(High)**	Circular economy skills	Local, but limited	• **Incentivising the private sector to support local capacity** as they outsource for technical engineering expertise specific to **CCM and MEA component manufacturing**, **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.
		Green engineering and tech skills	Outsource	
		Manufacturing and Assembly	Local, but limited	
Beneficiated Products	Fuel cell stack and systems manufacture **(Medium)**	Circular economy skills	Outsource	
		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	• **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

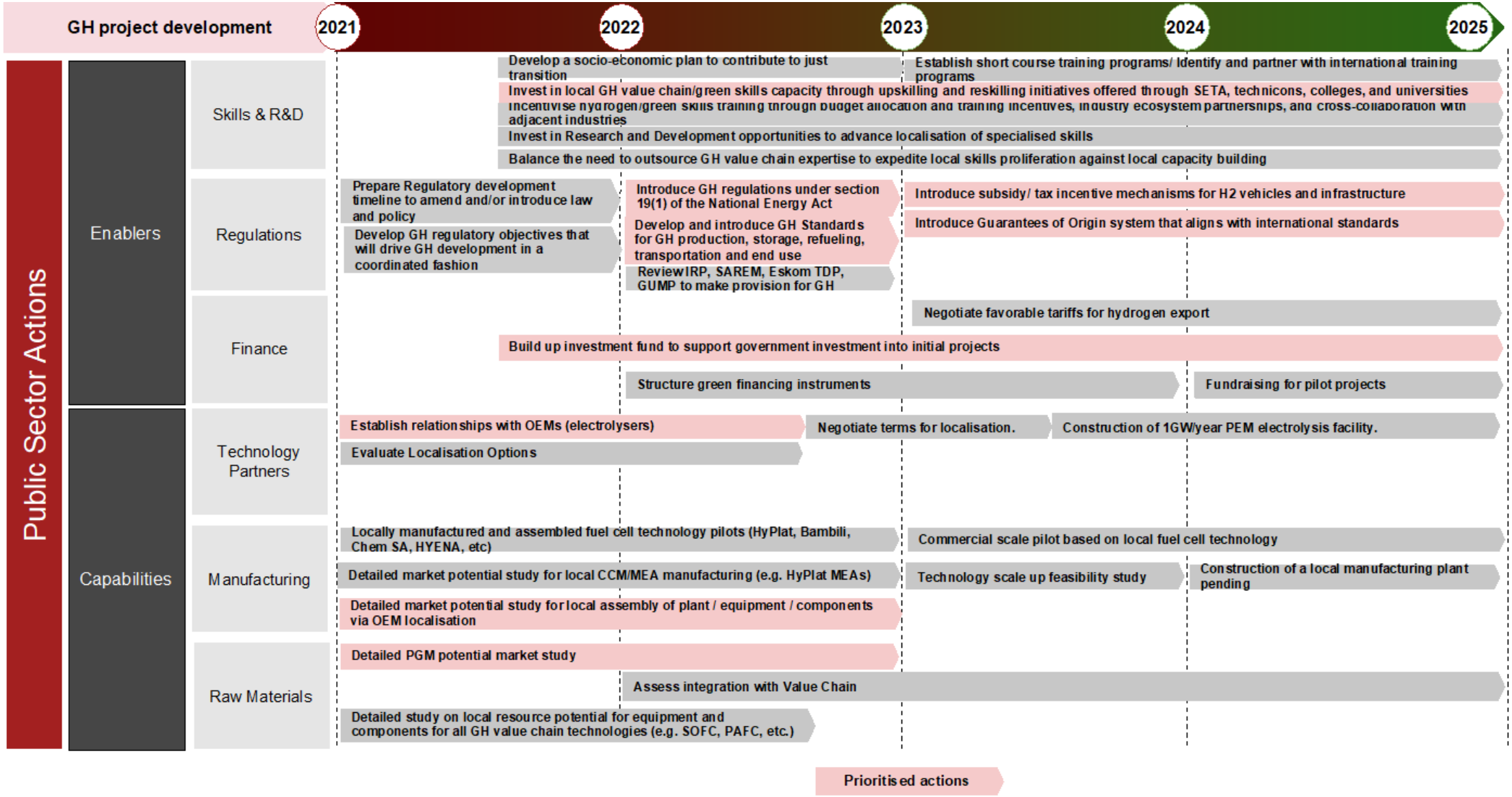
Logistics and transport/ Manufacturing and Assembly/ Risk Management/ Skilled labourers/ Technical engineering

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

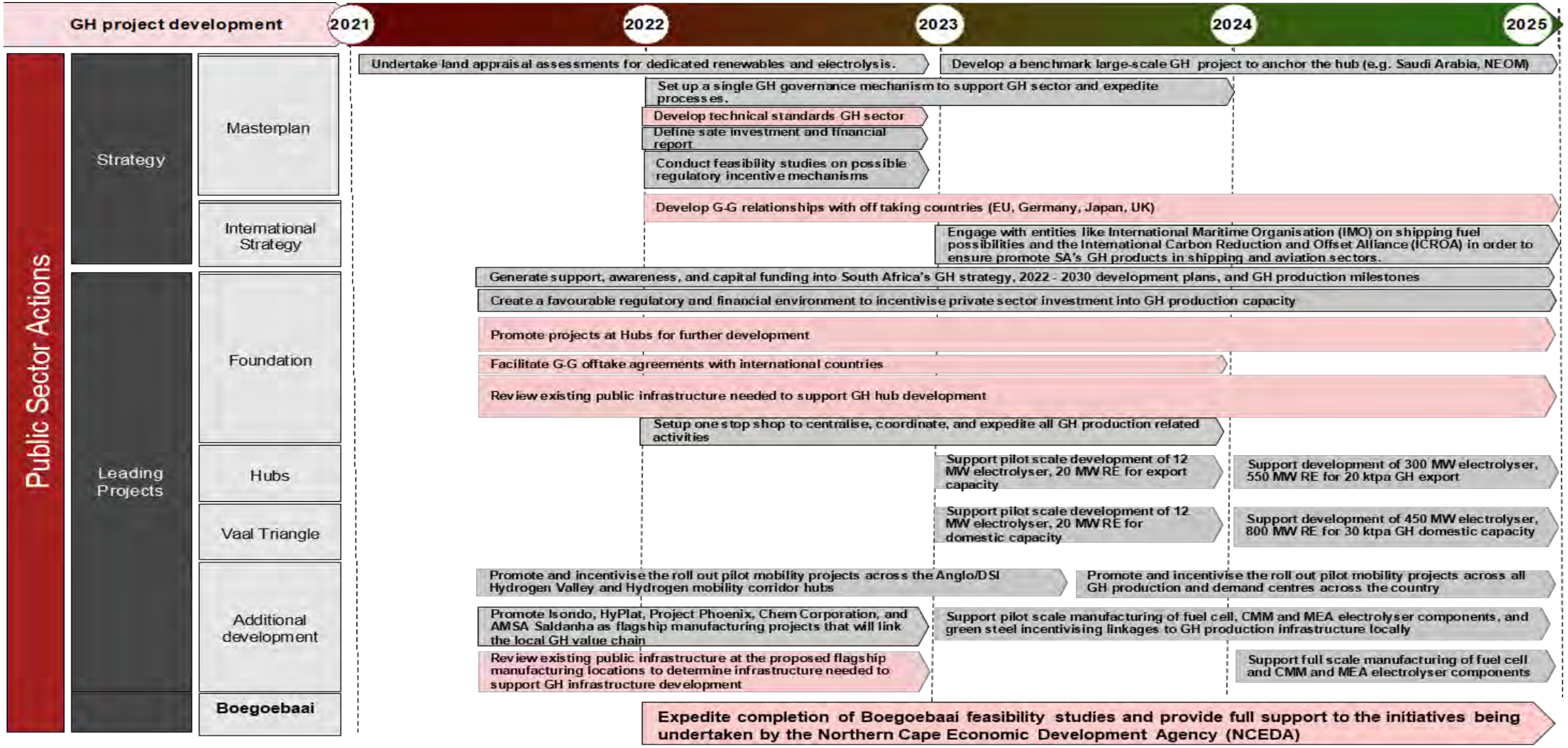
Presentation Outline

1. Opportunity Statement
2. The need for a Commercialisation Plan
3. Demand-driven commercialisation
4. Competitive Supply
5. Strategic choices
6. Key Enablers
7. **Commercialisation Roadmap**

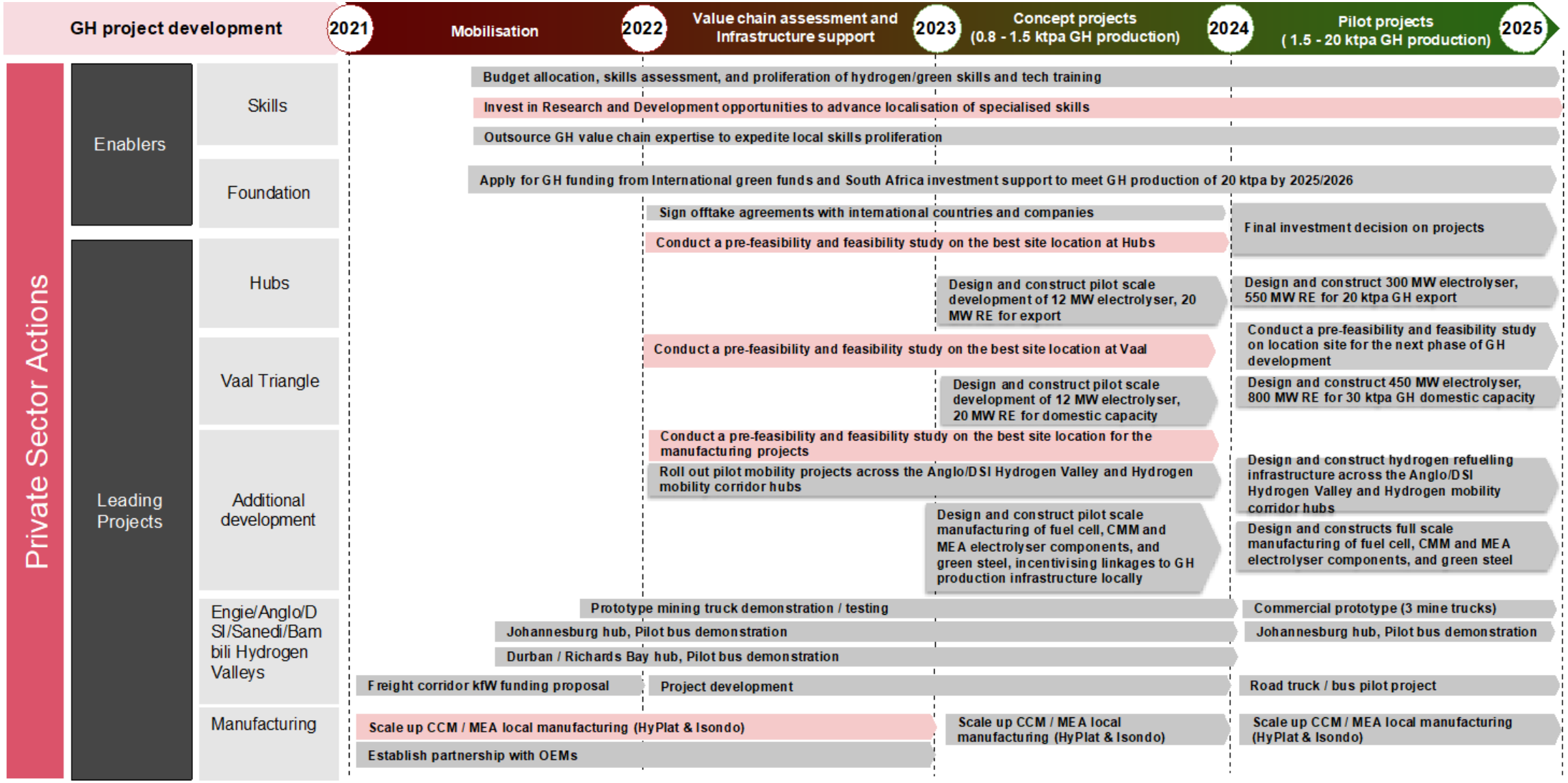
Detailed Action Plan : Short Term Roadmap : 2022 - 2025



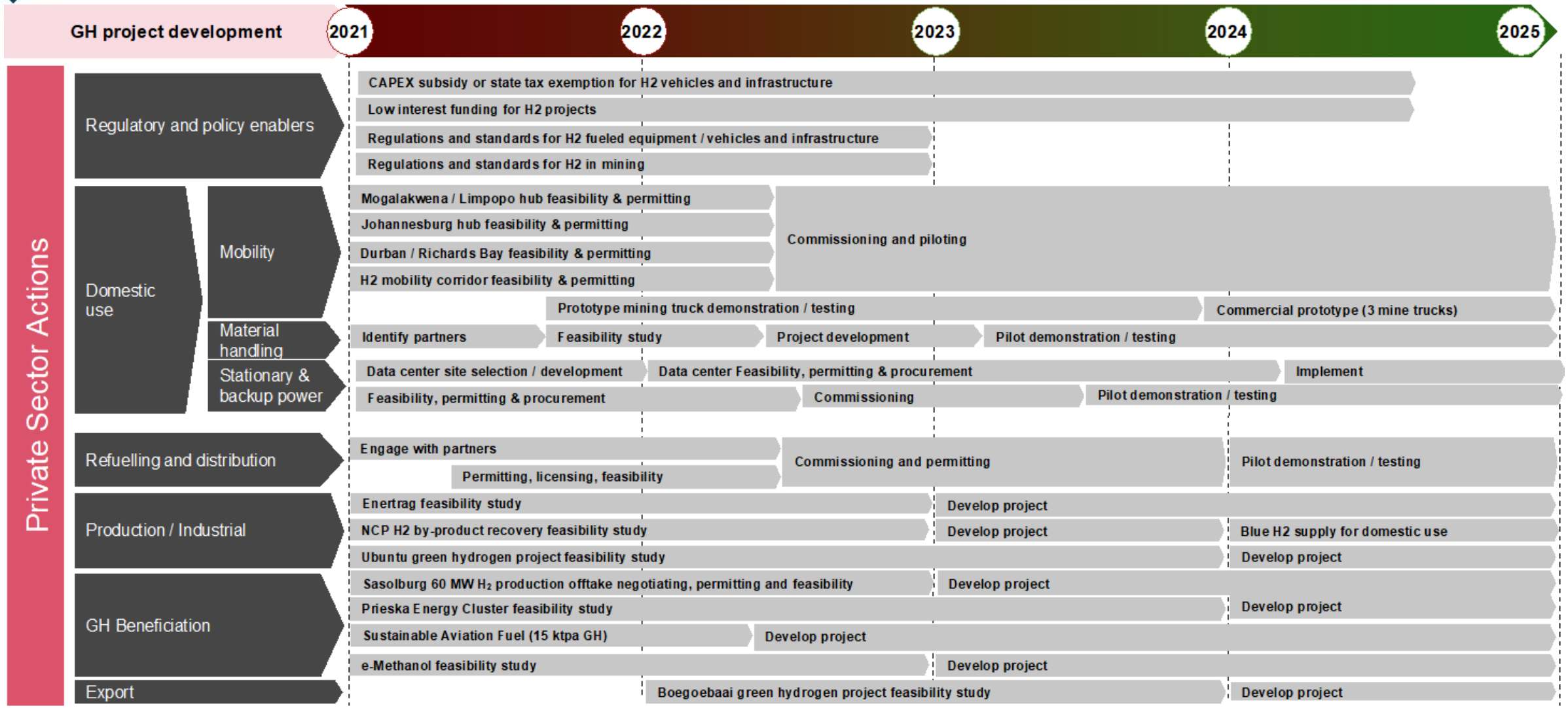
Detailed Action Plan - Short Term Roadmap : 2022 - 2025



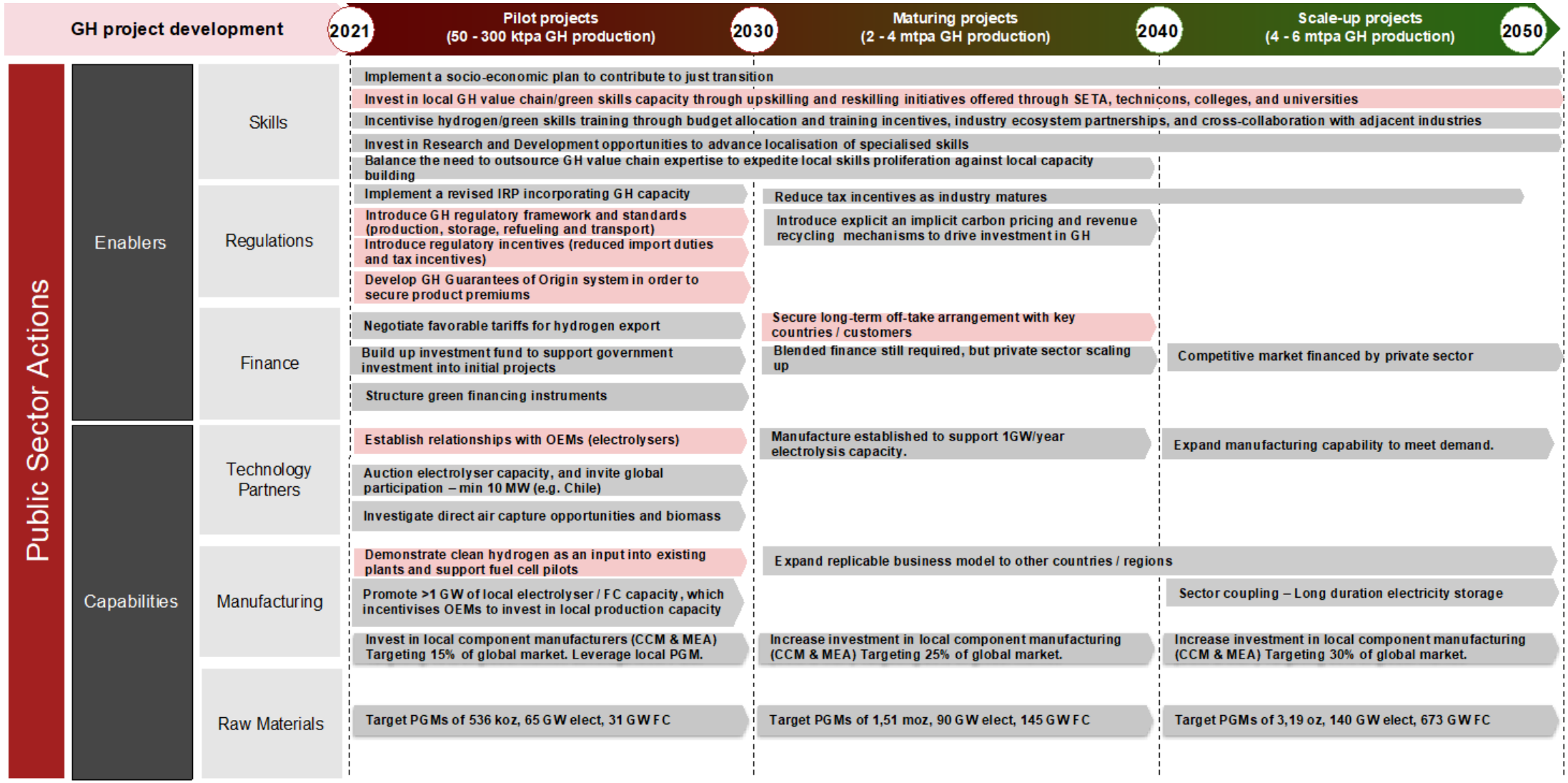
Detailed Action Plan - Short Term Roadmap : 2022 - 2025



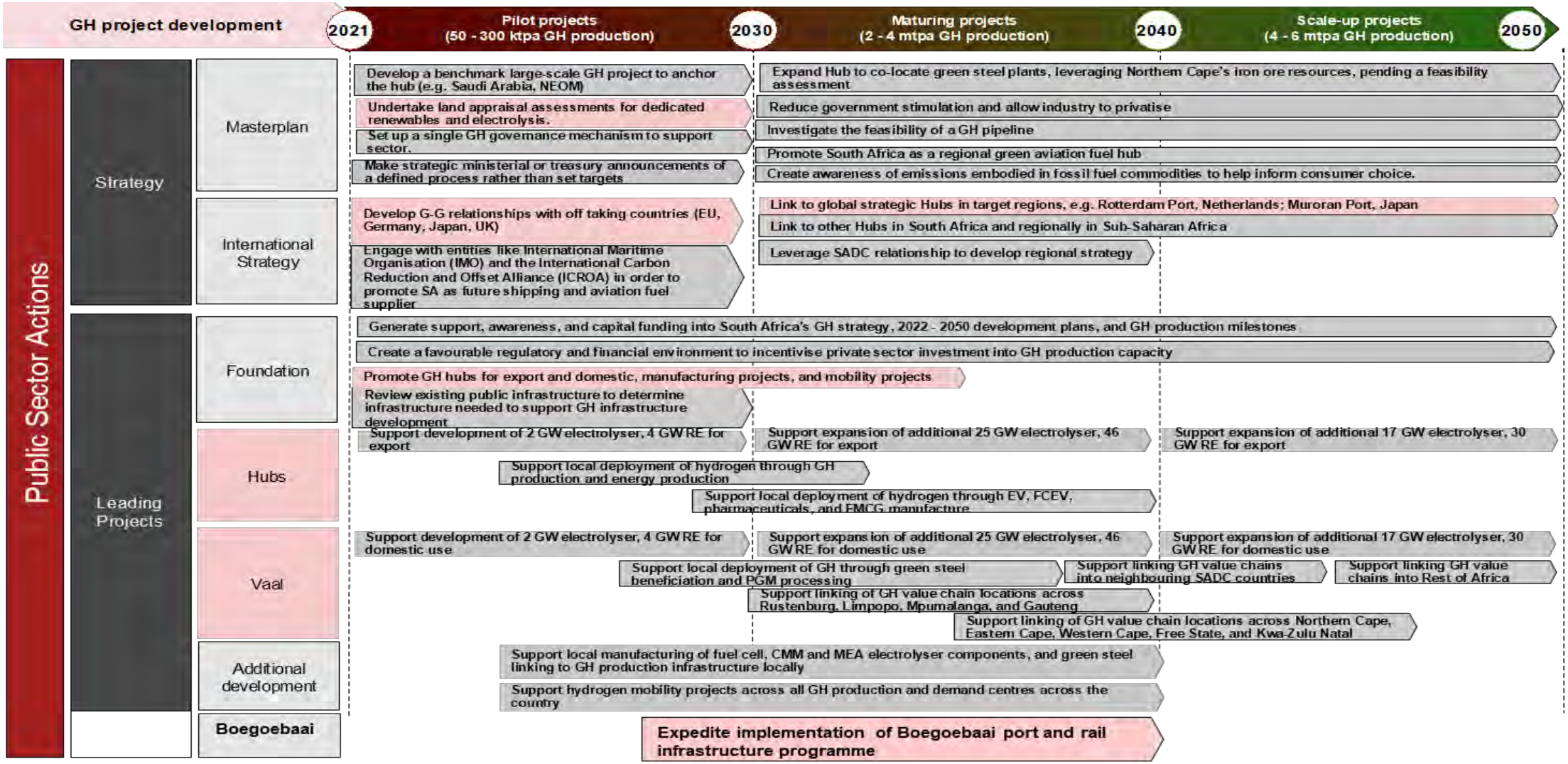
Detailed Action Plan - Short Term Roadmap : 2022 - 2025



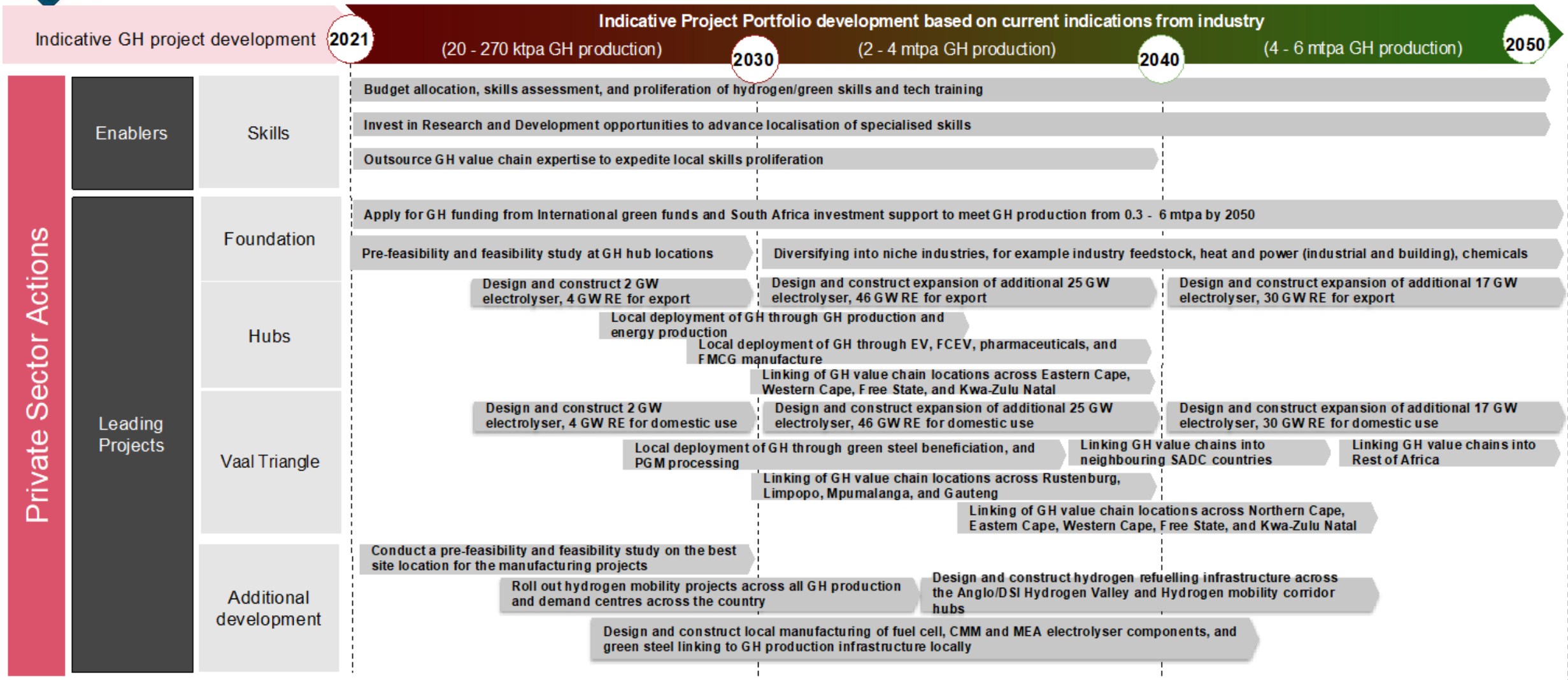
Detailed Action Plan - Long Term Roadmap : 2022 - 2050



Detailed Action Plan - Long Term Roadmap : 2022 - 2050



Detailed Action Plan - Long Term Roadmap : 2022 - 2050



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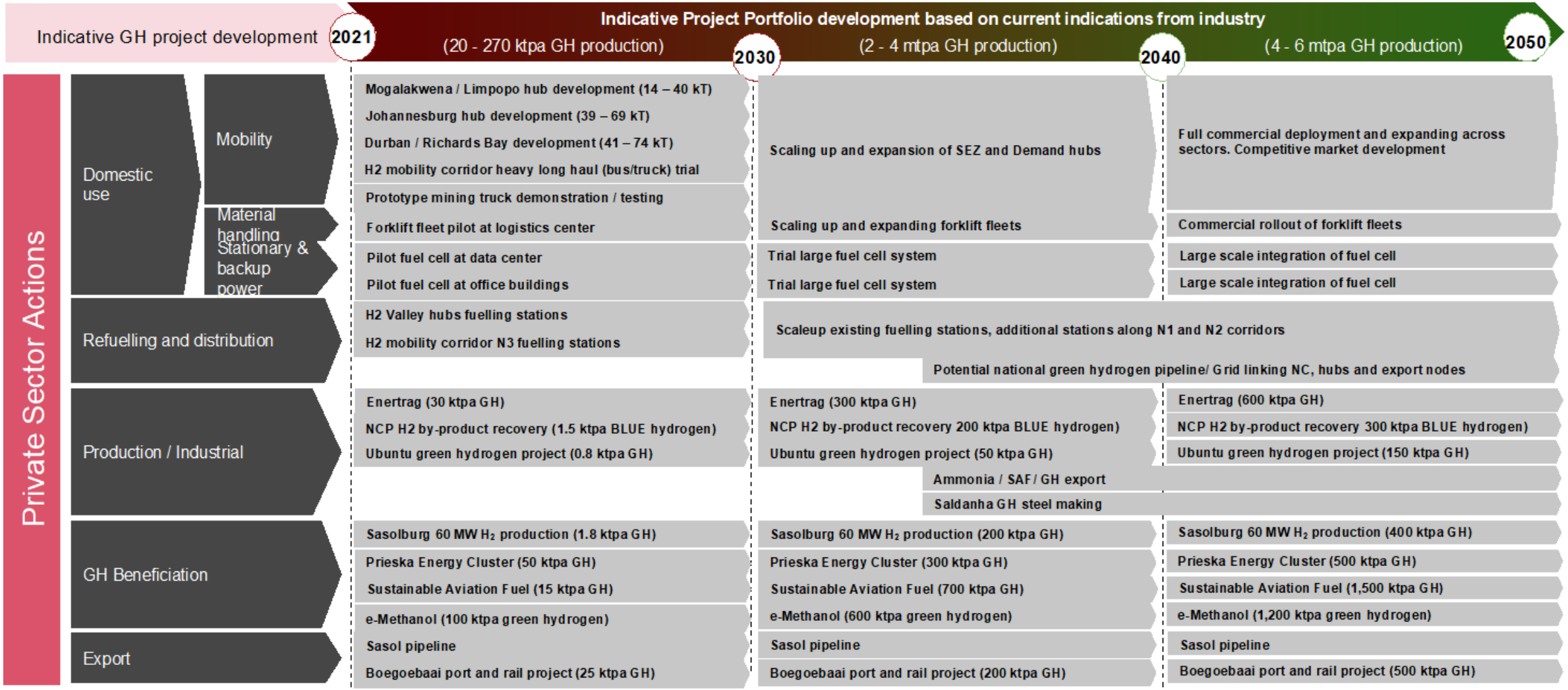

Conclusion : The path to achieve our Vision for 2050

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 GH_2 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 for sustainable investment incorporating Environmental, Social and Governance principles

- Projects along the value chain will be developed and implemented over the next 20 year
- "Needle moving" export revenues will be generated
- Policy and regulatory changes driven by Government will be implemented
- Financial support instruments will be sourced e.g. grants, concessional debt and contract for difference
- Incentives to sustain the development of the industry will be developed
- 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