GREEN HYDROGEN COMMERCIALISATION STRATEGY FOR SOUTH AFRICA

EXECUTIVE SUMMARY

30 NOVEMBER 2022

1 Introduction and Background

The rapidly developing global Green Hydrogen (GH) market is a significant opportunity for South Africa to position itself as a global competitor in future green energy markets. Developing a vibrant GH domestic demand landscape and manufacturing capability in South Africa will be critical to decarbonise our economy and to mitigate the risk of declining fossil fuels usage linked to industrial activity. Ultimately, a thriving GH sector in South Africa will contribute to the country's sustainable competitiveness as the world transitions to Net Zero.

Under the guidance of the IDC and the Green Hydrogen Panel (GHP), the GH strategy report addresses six (see Figure 1) of the broader work packages identified under the remit of the GHP with the primary aim of establishing a strategic framework and roadmap for commercialisation. This will support further efforts to develop a full and detailed GH sector master plan. Such a sector master plan will require significant further quantitative studies and modelling as well as stakeholder alignment, some of which is already ongoing under the GHP. The report does not provide the technical, financial, socio or economic quantitative analyses ultimately required for investment decision making and quantifying economic cost-benefits.

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).

The report approach outlines a commercial framework, principally a) Strategic objectives for a GH sector vision b) Assessment of demand drivers, c) Technical value chain definition and related delivery supply chain options, d) opportunity to embed local manufacturing and local content and e) creating an attractive and enabling investment environment. A combination of direct analysis, benchmarking through a literature review and stakeholder input from the GHP has been used to develop the outputs.

In defining the opportunity for South Africa, it is important to recognize that GH is currently a nascent market representing less than a quarter of a percent of global energy. However long-term demand potential for a green transportable fuel could grow to between 15% to 20% of global energy demand. Although the potential scale is enormous at this early stage of market development, the end-state remains very uncertain. The pace and scale of such GH market development and adoption will depend on the combination of production cost, driven down over time by equipment and operational learning curves that are synonymous with renewable energy technologies and increasing carbon pricing and fossil fuels costs as the world drives more stringent decarbonization policies.

The timing to achieve price parity between GH and fossil fuels will differ between countries, between export and domestic markets as well as between sectors, thus emphasizing the complexity and risk that must be dealt with in a holistic national GH sector master plan.

National development opportunities that leverage GH can be considered under three key areas as outlined below. Although these opportunities have differing needs, timing and opportunities, they must all be supported by a holistic national plan for sector development.

1. Production of GH that will attract foreign direct investment as well as generate export revenues.
2. Industrialisation and manufacturing of GH related equipment that will stimulate the local economy and job creation

3. Decarbonising South Africa's economy and industry in order to remain globally competitive

This report builds on the findings of the GHP interim report and aims to address the following six core Work Packages as a key next step towards a South African GH sector masterplan.

Figure 1: Six core work packages of GH commercialisation plan

The report outlines significant opportunities and benefits that can be derived for South Africa and suggests initial prioritisation and focused actions. It is important to note that recommendations are made based on relative ranking of multi-criteria and qualitative analysis as the detailed technical and financial quantitative modelling typically required for investment decisions has not been developed at this stage.

Developing a clear and coherent policy and regulatory environment is a priority action and will need strong public sector alignment considering the interfaces between Industrial development, Energy, Environmental and Infrastructure development. Optimising large scale infrastructure and project development is complex and often requires a strong state capability in balancing national objectives, economic viability, commercial bankability, procurement mechanisms and a fair and competitive market for private sector investment.

Bold policy and government support for private sector investment must take multiple forms, especially when considering that South Africa's low economic growth and fiscal weakness will not allow for large subsidies as has been seen in developed countries. Securing international technology partnerships, financing support and bankable long term off-take agreements through bi-lateral and commercial arrangements should be expedited by government.

2 Strategic design and objectives

Based on a review of other foreign National Hydrogen strategies, the following critical elements were identified as leading and best practice and should be developed in detail in future phases of South Africa's GH strategy and master plan:

- Direct investment by the state
- Economic and financial support mechanisms
- Legislative and regulatory measures and policies
- Setting of standards and priorities

- Research and development
- International strategy

South Africa's Green Hydrogen Vision must incorporate key strategic design principles, be responsive to competitive market forces and optimise South Africa's natural endowments, including minerals to ensure a long term sustainable, responsive and vibrant sector master plan design:

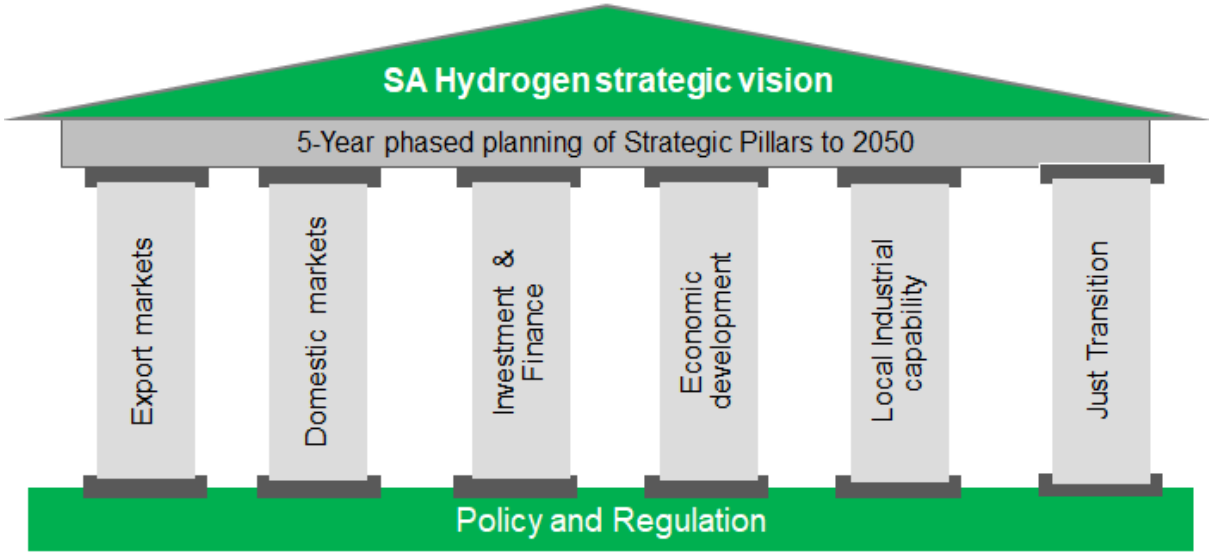


Figure 1: Potential SA Hydrogen Strategic Vision - *Developing a globally competitive, inclusive and low carbon economy by harnessing South Africa's entrepreneurial spirit, industrial capability, strong financial sector and natural endowments.*

The following key objectives should be considered in pursuit of South Africa's Green Hydrogen Strategic vision outlined above:

1. **Export Markets: secure early positioning for global market share and competitive trade position:**
    - Strategically position South Africa as a preferred and reliable provider to key markets, specifically EU/ UK, leveraging trade relationships and government support.
    - Secure global market and offtake MoUs with national procurement programmes such as H2 Global.
    - Expedite an export pilot project to ensure SA is seen as a serious global player and achieves early market entry.
    - Progress international strategy.

2. **Domestic Markets:**
    - Introduce supportive policies and a regulatory framework for GH that aids GH price parity to increase domestic GH demand.
    - Support research and development in hydrogen mobility applications, specifically focussed on Heavy Duty Fuel Cell Vehicles.
    - Demonstrate feasibility of GH applications in hard-to-abate sectors such as non-ferrous metals, green steel, and cement in order to foster short term pilot projects and long-term commercialisation.

3. **Investment & Finance: Foreign Direct Investment and low-cost green finance:**

- Secure international engagements and commitments through green finance programmes to provide grants, concessional finance and export credit commitments.
- Establish a dedicated GH regulatory and market framework attractive to local and foreign direct investment. Include GH incentive schemes for both production as well as local manufacturing that leverage appropriate SEZ development benefits.
- Define government role and financial investment and support for pilot projects in order to expedite and enable private sector investment. Such projects could be declared as Strategic Integrated Projects (SIPs) through Infrastructure South Africa (ISA).

4. Economic and socio-economic development:

- Quantify the benefits and value of emissions reductions and offsets that can be achieved through accelerated GH adoption.
- Focus on decarbonising hard-to-abate industrial sectors in SA economy to ensure they can remain globally competitive through the energy transition.
- Ensure integration of GH renewable energy and broader energy sector coupling through a robust GH sector and regulatory framework and Integrated Energy Plan (IEP).
- Incorporate non-financial criteria in procurement processes that support socio-economic development, skills transfer, local supply and enterprise development, and opportunities for local ownership.
- Develop training and skills development programmes and capacity to support job creation within the GH sector.

5. Local industrial capability and participation

- Target international technology partnerships and transfers to expedite local manufacturing capability. Invest and implement research and development programmes.
- Focus on localised industrialisation and manufacturing for key parts of the GH value chain, with specific consideration for leveraging raw material and beneficiation as a competitive advantage.
- Green industrial sector transition plans should be clear, specifically sectors such as heavy-duty mobility, steel, cement and automotive sectors.
- Expedite development of manufacturing hubs or centres of excellence through SEZ's.
- Work closely with the Department of Science and Innovation and Department of Higher Education and Training to drive the identified skills action plan.

6. Consider the need and role of a Just Transition:

- Analyse and plan for a Just Transition, ensuring appropriate public and social dialogue and understanding.
- Quantify the commercial and economic impact and sustainability of industrial sectors as they invest in decarbonising their businesses through the energy transition.
- Ensure appropriate training and skills development programmes to limit job losses and support employment as industry sectors decarbonise.

- Engage in a social dialogue between workers and their unions, employers, government and communities in order to ensure that GH development contributes to climate change mitigation as well as adaptation.

Work package summary

3 Salient points of literature review

It is abundantly clear that GH is a global focal point due to its versatile nature as a clean energy carrier and ability to decarbonise hard to abate sectors. Benefits in terms of storage, trade and energy efficiency are clear. However significant cost reductions must be realised to make GH price competitive, therefore significant focus on technology and scaling of manufacture capability is necessary. Focus is predominantly on GH with other colour derivatives mostly seen as bridging options. Various technology options for electrolysis are being developed with PEM electrolysers being of particular interest to SA due to the PGM contribution.

All countries are planning to meet some of their GH demand through local production, but those countries with favourable renewable energy conditions and space are likely to become net exporters of GH vs countries with less favourable conditions and higher demand likely to become net importers.

Multiple countries and regions feature GH as a key strategic contributor to their Net Zero targets. As of 2021, more than 30 countries have a roadmap highlighting over 200 hydrogen projects with governments committing to over $70 billion in public funding.

The global market for GH is nascent, but countries are already positioning domestic production and potential export market share. Leading countries are already breaking ground on projects. The race for first-mover advantage is under way. South Africa is lagging behind competing export countries such as Morocco, Ukraine, Saudi Arabia, Chile, Australia and others.

Other Key Takeaways:

Carbon pricing is key to pricing in favour of green energy and specifically GH over conventional fossil fuels. This may be a useful leverage point for South Africa, but affordability of the energy transition must be assessed.

Every country's GH strategy is unique to local conditions, production, and sector targets. Some key common themes are:

- **Defining scale of assets and infrastructure** required to meet desired targets. The pace at which scale is reached is crucial as well as choosing **optimal locations for initial projects** with the resources and ability to expand (this should be included in a SA sector master plan);
- **Opportunities for sector-coupling**. This relates to optimising integration with other energy sectors such as gas and electricity infrastructure to deliver low-cost GH (this will be key to ensuring SA global competitiveness and integration with IRP and network planning);
- Seeding **local market focus** areas, for example Australia will focus on heavy road transport and manufacturing. The strategy for South Africa should include key focus areas for prioritisation into the market, for example sustainable aviation fuel or the green steel industry. Localised heavy mobility in the mining sector is also seen as an early mover advantage for South Africa;
- Clear **commercial and market model** to expedite investment opportunities and define the **role of the state**. SA must ensure an attractive investment environment for the private sector to limit the need for state subsidies;

- **Clear policy and regulatory environment** to support the development of the GH sector through well-defined regulatory incentives;
- Identifying focus areas for **Research and Development** to improve technologies and identify initial projects. This will be important for **localisation** and an area SA government should emphasise support; and
- A **social licence assessment** – looking at the holistic impact of the new GH market on domestic socio-economics is key for a South African strategy to ensure a smooth adoption of GH production and a just energy transition.
- The **creation of hydrogen hubs** is being leveraged e.g. Australia's national strategy to support producing hydrogen at a globally cost-competitive price. This would be the equivalent of SEZ's being created in SA but which should differentiate between export production vs component manufacturing hubs.
- Countries identified as dominant **export nodes** are all establishing early mover advantage through a combination of optimised supply chains, early project development and technology pilots.

4 Hydrogen Demand Analysis

GH production will be driven by two distinct markets, namely: export demand as international trade of GH between countries and regions; and domestic demand for fuel switching through applications such as mobility, industrial processes and power.

The demand analysis has been considered from four perspectives, namely:

1) Public domain information (studies from IEA, IHS Markit, Sasol, Engie have been shown as potential ranges).
2) Using a global GH production cost model developed by PwC, the World Energy Council and the Electricity Research Institute, the forecast of local demand vs production has been used to show net imports or global trade.
3) Based on known data of potential export countries, a market share analysis has been completed to assess the likely market share of global trade that SA could capture.
4) Local industry data analysis, including marine bunkering trade.

4.1 Export Demand

A global demand baseline for 2050 of 300 to 320 Mtpa is used based on the International Energy Agency's (IEA) Net Zero GH Scenario for 2050. Of this total demand country forecasts indicate circa 90% of this demand (279 Mt GH) could be met through local production within each country or region, indicating a minimum net balance of (27 Mt GH) to be sourced through trading and imports. The primary import markets for GH to 2050 will be the European Union (2050: 11-15 Mt GHpa); Japan (2050: 5-10 Mt GHpa); South Korea (2050: 1.0-1.2 Mt GHpa) and the United Kingdom (2050: 0.5-0.7 Mt GHpa). Depending on long term pricing dynamics of GH, these figures could increase substantially.

It is therefore recommended that South Africa should expedite production capacity for exports targeting a minimum of 2 Mtpa with a master plan that could expand up to 7Mtpa. Depending on global market growth in net imports these SA figures could range from 7% to 30% of global tradable market share when compared to all exporting countries.

The demand analysis shows that SA currently lags other exporting countries and significant intervention by government and the private sector will be required to move to higher levels of market share. By example, leading countries already have detailed sector master plans, are

advancing pilot projects; developing technical expertise and capability; creating investment anchors through the development of GH hubs, and securing bilateral agreements with importing countries.

Included in export demand is potential for marine bunkering of green fuels. SA positioning on east-west global sea trade routes could enable bunkering demand of 0.8 to 1.0 Mtpa in shipping ammonia / methanol marine fuels by 2050.

4.2 Domestic Demand

Given South Africa's energy intensive economy, an important driver of South Africa's domestic GH economy will be decarbonisation commitments made on both national, as well as company levels. Other domestic drivers for South Africa will also include fuel switching and new user applications in mobility, industrial processes and power generation. Current demand for hydrogen in South Africa is dominated by Sasol through the Fischer Tropsch processing for Petro-chemicals but also in key mining applications.

On a similar analysis of demand studies, the domestic market for GH in South Africa has the potential to range between 2 to 6.0 mtpa (million tons per annum). Based on the current price and analysis it is recommended that South Africa should progress capacity development on the lower end of the range (2mtpa - 3mtpa) while keeping close watch of market and price trends. This will require specific incentives, supportive policies and coordination between the public and private sector and further detailed studies will be needed to consider the overall economic cost-benefit impact and value for money proposition of deeper government support and interventions to achieve more aggressive domestic market adoption targets.

4.3 Summary of Demand Analysis

Modelling of demand scenarios and associated costs have been completed with the following broad recommendations:

- Existing private project opportunities identified should be expedited and supported. (these have been identified and plotted in the GH roadmap)
- An export hub (SEZ) at Coega should be prioritised to enable early exports.
- A manufacturing hub (SEZ) at Vaal must be prioritised to enable early manufacturing and technology partnerships.

Expediting the identified early stage projects could result in the 3 - 5-year production target of nearly 300 000 tpa of GH and capital investment of USD 13 billion. Based on a comprehensive country strategy and clear sector master plan a 2040 production target of 4mtpa and capital investment of USD 164 billion could be realised. If global market growth continues to accelerate and based on successful sector development South Africa could continue to increase production to 7 mtpa requiring additional investment of USD 133 billion by 2050. Potential aspiration to 13mtpa total production has been identified but is likely to push beyond 2050 and be very dependent on market development over the next 20 years.

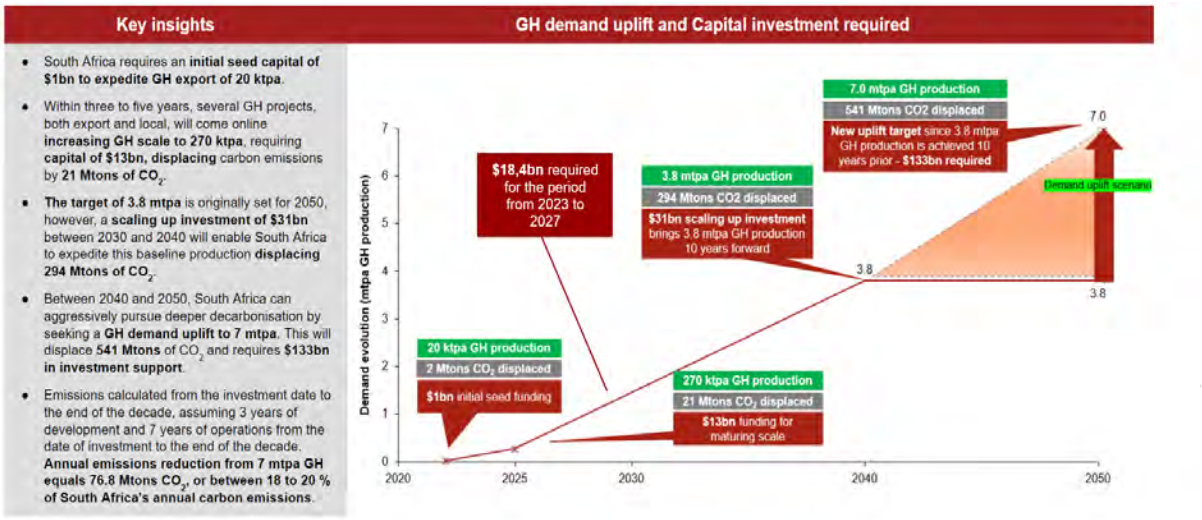
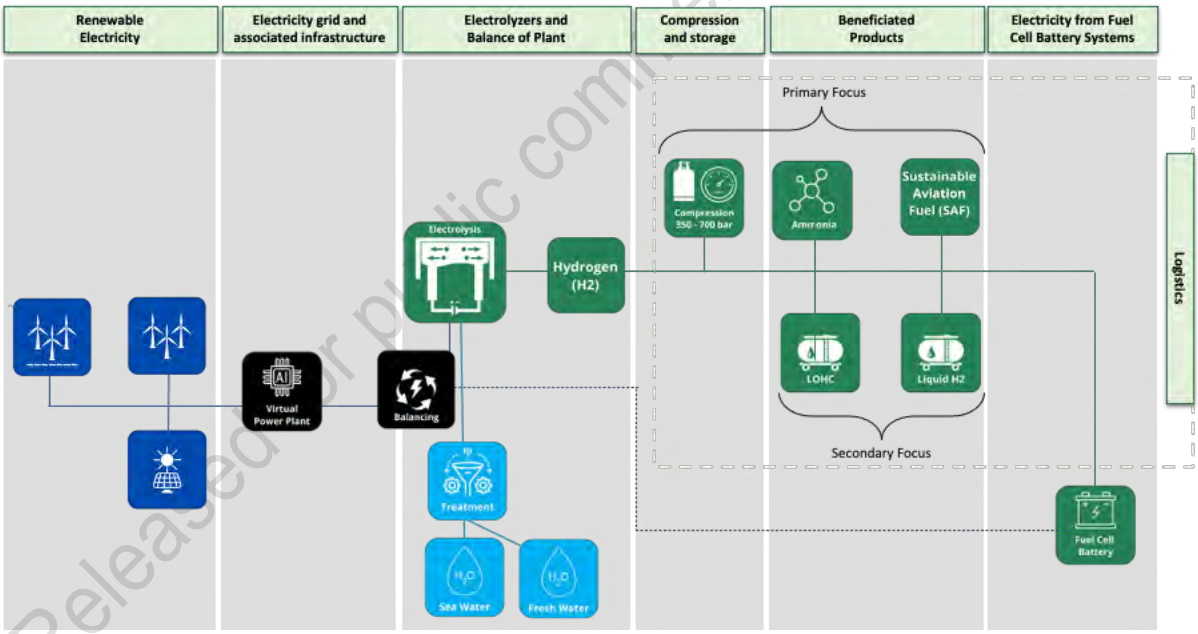


Figure 2: GH Demand projection and capital investment required.

5 Value Chain Analysis

The primary value chain elements defined and analysed in the report are outlined in the graphic below.



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. To enable a GH project requires interaction with the following departments and / or state entities (non-exhaustive): Water Affairs and Sanitation; Agriculture, Forestry and Fisheries; Environmental Affairs; Human Settlements; Trade, Industry and Competition; Mineral Resources and Energy; Transport; International Relations and Cooperation; National Treasury; NERSA, Transnet (TNPA); and the Ports Regulator; and Infrastructure coordination through Infrastructure South Africa (ISA).

Global projects largely fall into 2 categories as follows: a) large scale GH projects for multiple GH customers or open markets, and b) isolated or co-located GH production for specific use case/s. Such in-house or specific user projects are simpler to develop and quicker to market as they solve in-house demand challenges and use carbon incentives for fuel switching to fund these projects from internal resources.

To get to GH production levels advocated in global forecasts i.e. contributing 15-20% of global primary energy demand by 2050, it is estimated that more than two million GH projects will be required globally consisting of large scale but mostly smaller isolated/co-located GH projects.

This emphasises the importance of a holistic master plan that does not treat the sector development under a "one-size-fits-all" approach. While SEZs and state supported hubs are important enablers, direct user-case projects and private sector led developments should also be recognised and incentivised (an example of a such a private sector led development would be the Hydrogen Valley). SEZ hubs can be categorised as export focused or manufacturing focused and detailed analysis is included in the report.

Irrespective of the size or type of project, all GH projects will face similar price parity pressure in order to secure and grow market share. This emphasises the need for sector coupling, integrated planning, lowest capital cost and efficient supply chain development to produce the least cost product in the market.

By focusing on leveraging its natural endowments and engaging strategically with industry players to localise production / assembly of key components for GH production through strategic hubs, will allow South Africa to maximise its participation in the GH value chain.

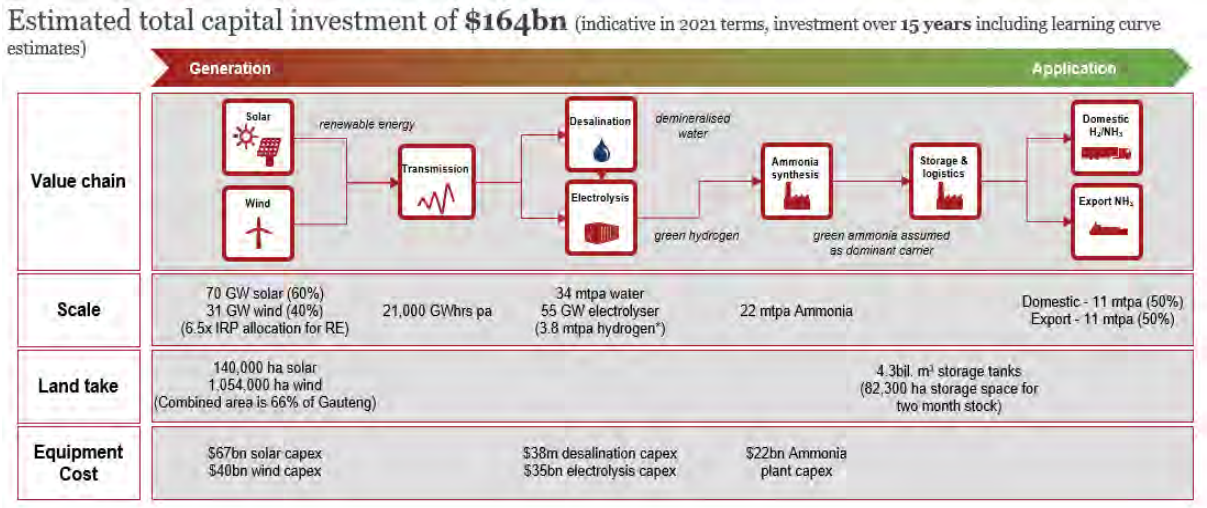


Figure 3: Value Chain components of GH

6 GH localisation and manufacturing opportunities

As the most industrialised economy in Africa, South Africa has the benefit of a strong balance between export and domestic demand. This provides a larger market opportunity for stronger localisation and manufacture of both SA production demand as well as becoming a global competitor for supply of components and equipment for GH.

The projected SA GH production ramp-up implies end state electrolysis installed capacity of between 48GW (3.8Mtpa GH) to nearly 90GW. In the near term an estimate of 13 GW of

installed electrolyser capacity is required by 2030. Based on discussions and an understanding of international OEM operations, South Africa requires approximately 0.5-1GW/year in order to anchor local manufacturing. To match this level of electrolysis production of GH, an additional 17GW PV and 8GW wind deployment is required by 2030. This scale of renewable energy demand provides further opportunity for localisation and economic benefits through construction and operations etc. Grid capacity is however seen as a short-term constraint and will also require further investment.

Under the demand analysis it was emphasised that all countries requiring GH are to some extent trying to develop local production capability. Although this reduces the demand for net import of GH product form South Africa, the manufacturing and supply opportunity can target the full global market requirement for both electrolysis as well as fuel cell components.
As the largest global producer of platinum-group metals (PGMs), producing more than 72% of the world's PGM demand, as well as having other important renewable energy mineral endowments, this global component manufacturing demand has emerged as a very attractive industrialisation opportunity for South Africa. PGMs in particular are used as a catalyst in polymer electrolyser membrane (PEM) electrolyser and multiple fuel-cell technologies but are largely beneficiated outside of South Africa.

PGM beneficiation to produce equipment used in GH equipment supply chain (i.e. catalyst coated membrane (CCM) and membrane electrode assembly (MEA)) is also a nascent market. However, to the extent that South Africa can leverage its raw materials endowments as a competitive advantage, it is estimated that South Africa could become a dominant global supplier of such equipment. In this regard, the country has a window of opportunity to develop PGM based component manufacturing capacity and position itself to claim a considerable portion (15-30%) of this global market. CCM and MEA component manufacture alone is estimated to exceed USD 100 million by 2030 with significant expansion opportunities beyond that as the market scale accelerates beyond 2035.

South Africa's attractiveness to promote localisation opportunities are therefore it's

- Abundant local resources, particularly PGM's.
- Abundance of renewable energy resources (wind and solar).
- Large land availability served by a transmission grid that is the size of Europe.
- Established manufacturing, engineering, and technical expertise to support a developing manufacturing industry as well as the operation and maintenance of the hydrogen production plants.

Support to assist existing local content must be the highest priority. Several existing local system and component manufacturers and system assembly entities are already established. Supporting these entities will ensure scale up of capabilities, getting components and systems in demonstration and pilot projects, thereby building confidence in South Africa's GH products and capabilities.

7 Supply chain and GH Hub development

7.1 Identification of hydrogen hub and Supply chain analysis

Based on analysis and industry engagement, the following SEZ hubs have been identified as preferred locations for GH development to support exports and manufacturing. When considering the technical Value Chain definition outlined above, it is evident that supply chains can be designed on 2 models as follows: a) co-locating renewable energy (RE) and production equipment (electrolysis process) and evacuation of the product or GH molecules by transport or pipeline if economies of scale can be achieved. Or b) locating Production (electrolysis process) near the demand node and evacuate RE via wheeling on the national grid or

dedicated grids if economies of scale can be achieved. Distribution of hubs and supply chains are shown in the Figure below.

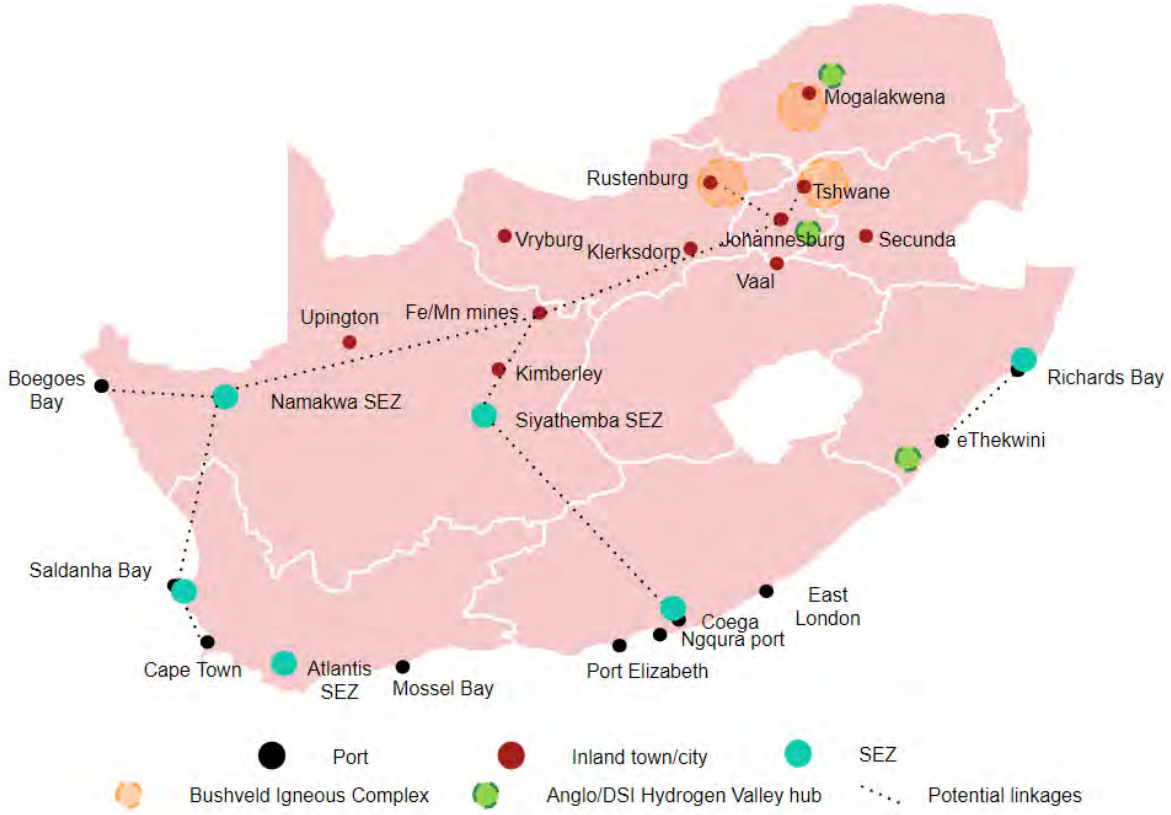


Figure 4: Geographic location of potential GH hubs

7.1.1 Overview of key options

At a strategic review level, the preferred priority hubs based on a criteria analysis such as status of infrastructure, location and cost would be to target the Boegoebaai GH hub in the Northern Cape, Coega and Freeport Saldhana as export hubs and Vaal as a priority manufacturing hub. These locations can develop quickly and have strong political sponsors to support expedited development. **Supporting the efforts by the Northern Cape Economic Development Agency in the development of the Boegoebaai programme needs to be given top priority.**

This does not preclude the development of other hubs or supply chains but as stated above, it is evident that SA must accelerate the GH sector development to be seen as a market leader.

Inland, the Vaal Triangle is an attractive location due to the concentrated industrial manufacturing activity developed over the years, including Sasol's Sasolburg plant, ArcelorMittal's (AMSA) steelworks, and Safripol's polymer processing. The Vaal would specifically focus on domestic uptake of GH (Sedibeng District Municipality, 2012) and could also serve the purpose of anchoring GH in the PGM industry; the existing pipeline infrastructure could also be used to transport GH across the North West, Gauteng, Limpopo, and Mpumalanga where most PGM activity occurs.

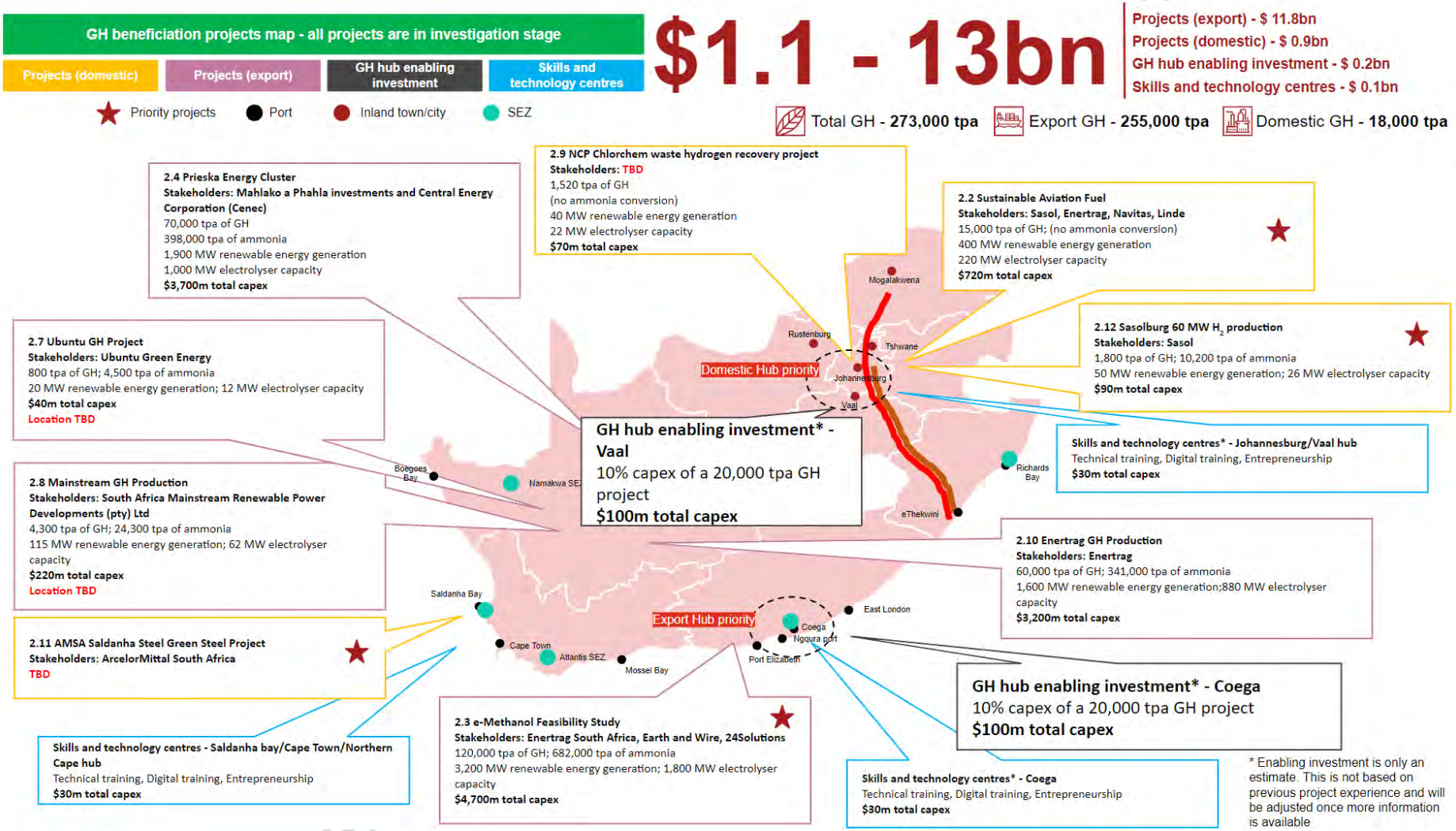


Figure 5: Capital investment support needed for GH production projects to be commissioned in 2025

8 Designing an Enabling ecosystem

Key ecosystem enablers that will help make South Africa a globally competitive player in the GH economy include GH Skills development, Regulation and Financing mechanisms.

8.1 Skills development for a successful GH economy

The creation of a hydrogen economy will require new skill sets as well as an increase in capacity of a productive workforce. A key benefit is that such new skills can be broadened to include a green economy and only to service the GH sector. It is well documented globally that for equal investment, renewables and green sector development creates 3 - 4 times the amount of jobs as fossil fuel sector investment. The broadening of skills must include aspects such as climate mitigation, circular economies and the social compact for a Just Transition. A holistic skills development approach should include the following steps at a minimum:

- Determination of future skills and roles in the green energy and hydrogen sector;
- Understanding of SA skills and competencies capacity and alignment to above; Understanding and the creation of the skills pipeline in the Higher Education Sector (including TVET);
- Inform Learning and Development initiatives and investments;
- Inform the Strategic Workforce Planning conversations; and
- Understand and inform diversity and inclusion initiatives.

Skills development must be done through both public and private sector and should include reskilling or upskilling initiatives to build and grow local capacity; these initiatives can be incentivised through SETA funding with a long-term view to support upskilling in tertiary and technical institutions. The skills required for a successful GH economy have been discussed in the report and are outlined in the figure below.

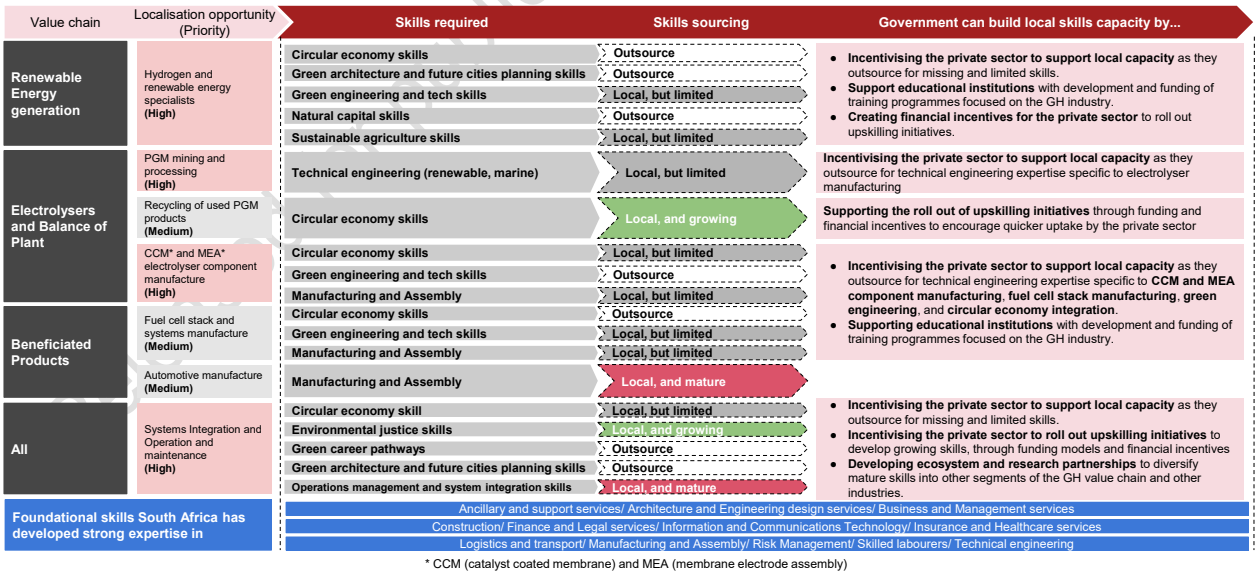


Figure 6: GH Skills matrix

8.2 An enabling GH regulatory framework

South Africa does not currently have a dedicated GH regulatory framework. Thus far, pilot projects have been implemented within the confines of South Africa's existing regulatory frameworks and laws, of which many implicitly support the development of GH projects.

Considering the opportunities that GH presents, and the sector complexities highlighted in the report, the government should consider introducing a set of regulations specifically aimed at promoting South Africa's GH economy. Based on the preliminary assessment, key regulatory recommendations include, but are not limited to the following:

1. **Prepare a GH Regulatory Development Timeline:**
    - **a.** The timeline must, where practicable and relevant, detail the timing of the review of the relevant law and/or including the expected date for the promulgation of new law and policy based on actions outlined in the commercialisation roadmap.
    - **b.** Outline timed regulatory responses for the GH industry in alignment with anticipated technological and commercial developments. This includes the introduction of incentive mechanisms, as well as the phase out of incentive mechanisms once economies of scale and GH price parity is achieved.
2. **Develop objectives for how the GH industry should be regulated.**
    - **a.** Agreeing on regulatory objectives would simplify coordination of regulatory responses across government departments given the overarching objective would be consistency across all sectors and departments.
    - **b.** A key element in this regard would be to ensure that integrated stakeholder management processes and coordinated public sector responses are in place in order to align public and private sector opinions and inputs.
    - **c.** Conduct feasibility studies to establish the financial impact and benefits of possible GH regulatory incentive mechanisms.
3. **Develop a set of regulations specifically aimed at creating enabling environment for green hydrogen**
    - **a.** Utilise section 19(1) of the National Energy Act to introduce regulations that regulate and support South Africa's GH economy and includes measures and incentives designed to promote the production, consumption, investment, research and development of GH.
    - **b.** Consider and leverage other existing laws and policies that could support the uptake of GH.
    - **c.** Develop GH standards and specifications related to production, storage, transportation, refuelling and end-use applications based on international standards and best practice such as ISO 19880-1:2020 related to Gaseous hydrogen, SAE International standards (SAE J2601/2, "Fueling Protocol for Gaseous Hydrogen Powered Heavy Duty Vehicles," and SAE-J2601, "Fueling Protocols for Light Duty Gaseous)
4. **Introduce regulatory measures to support South Africa's GH export market**
    - **a.** Introduce measures for GH SEZs to produce and export hydrogen at a cost competitive price.
    - **b.** Design and introduce a Guarantees of Origin system that aligns with international standards such as the EECS (European Energy Certificate System) in order to install investor confidence in key import nodes.
5. **Introduce regulatory measures to support South Africa's domestic green hydrogen market**
    - **a.** Introduce explicit and implicit carbon pricing mechanisms coupled with GH revenue recycling mechanisms.
    - **b.** Build on existing renewable energy-based regulatory tax incentives set out in the Income Tax Act to support the GH value chain.
    - **c.** Introduce a single institutional body to expedite licensing and permitting processes and facilitate the development of the GH sector.

8.3 Securing availability and low-cost finance

Although there is a growing investment appetite globally for “green investment”, given the market maturity, risk and complexity of the value chain, financing green hydrogen projects will still require innovative financing structures and support to achieve bankable projects. Ensuring that the financing landscape incentivises investment both from local and international sources is also critical.

The broad principles of traditional project finance are likely to apply, necessitating collaboration by government, local and international development finance institutions, multilateral financing agencies, local commercial lenders and private sector investors to achieve bankable transactions. Given the anticipated involvement of international OEMs, export credit agencies are another key stakeholder. As discussed earlier, strong bilateral and trade relationships and agreements with developed country GH programmes should be pursued by government.

Globally, various forms of funding mechanisms are being applied to enhance the financing landscape, including:

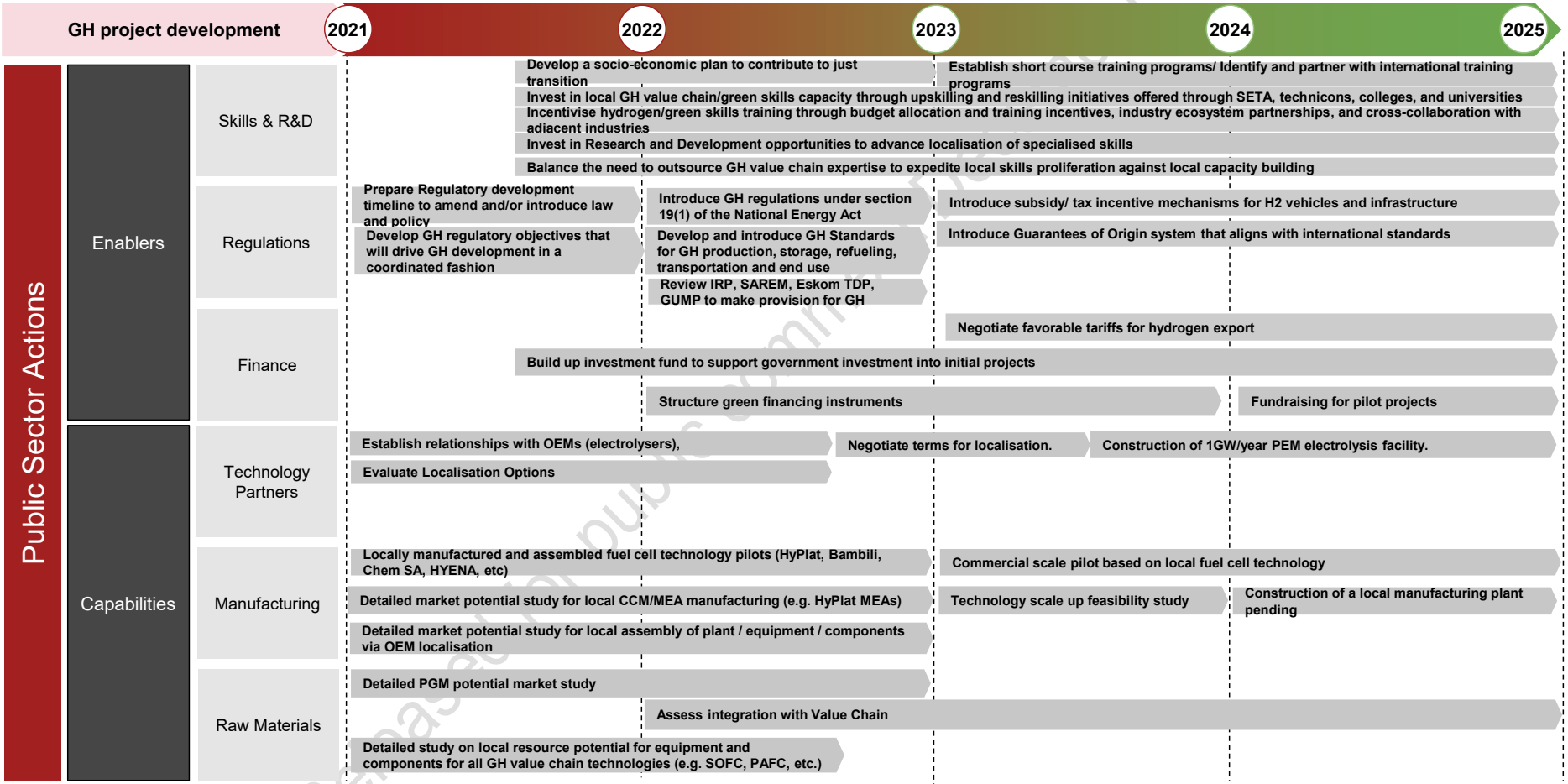
- **Government on-balance sheet finance**
  Direct public funding, green/project bond financing and partial guarantees;
- **Government to government enablement**
  Concessional finance and technical assistance grants, climate swaps and emissions credits;
- **Private finance**
  Public-private partnerships;
- **Development finance**
  Leveraging funding from developed markets specifically set aside to support the green transition in developing/carbon intensive countries; leveraging funding from export credit agencies and blended finance mechanisms.

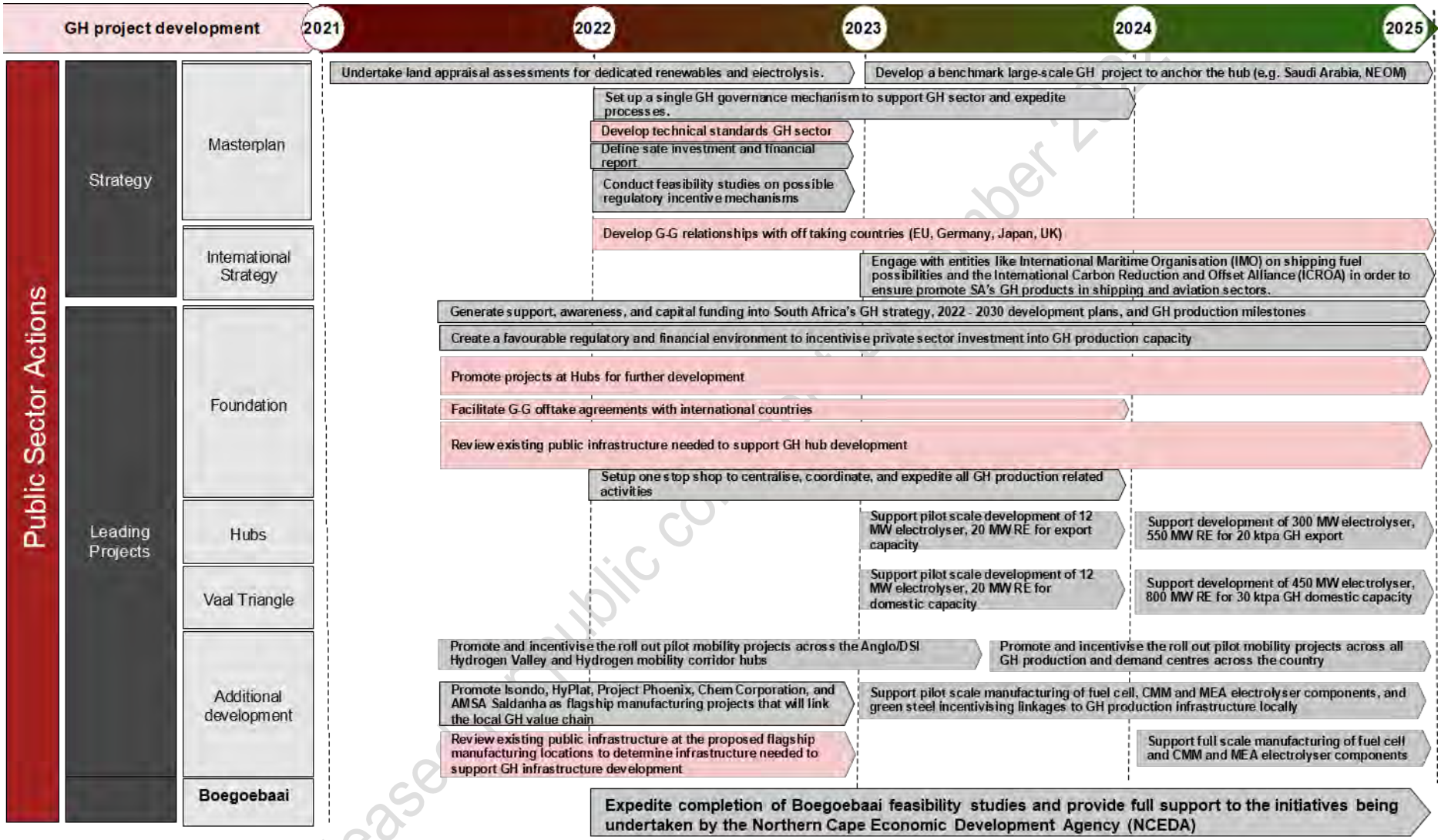
Possible innovative sources of funding for government to support the above objectives include:

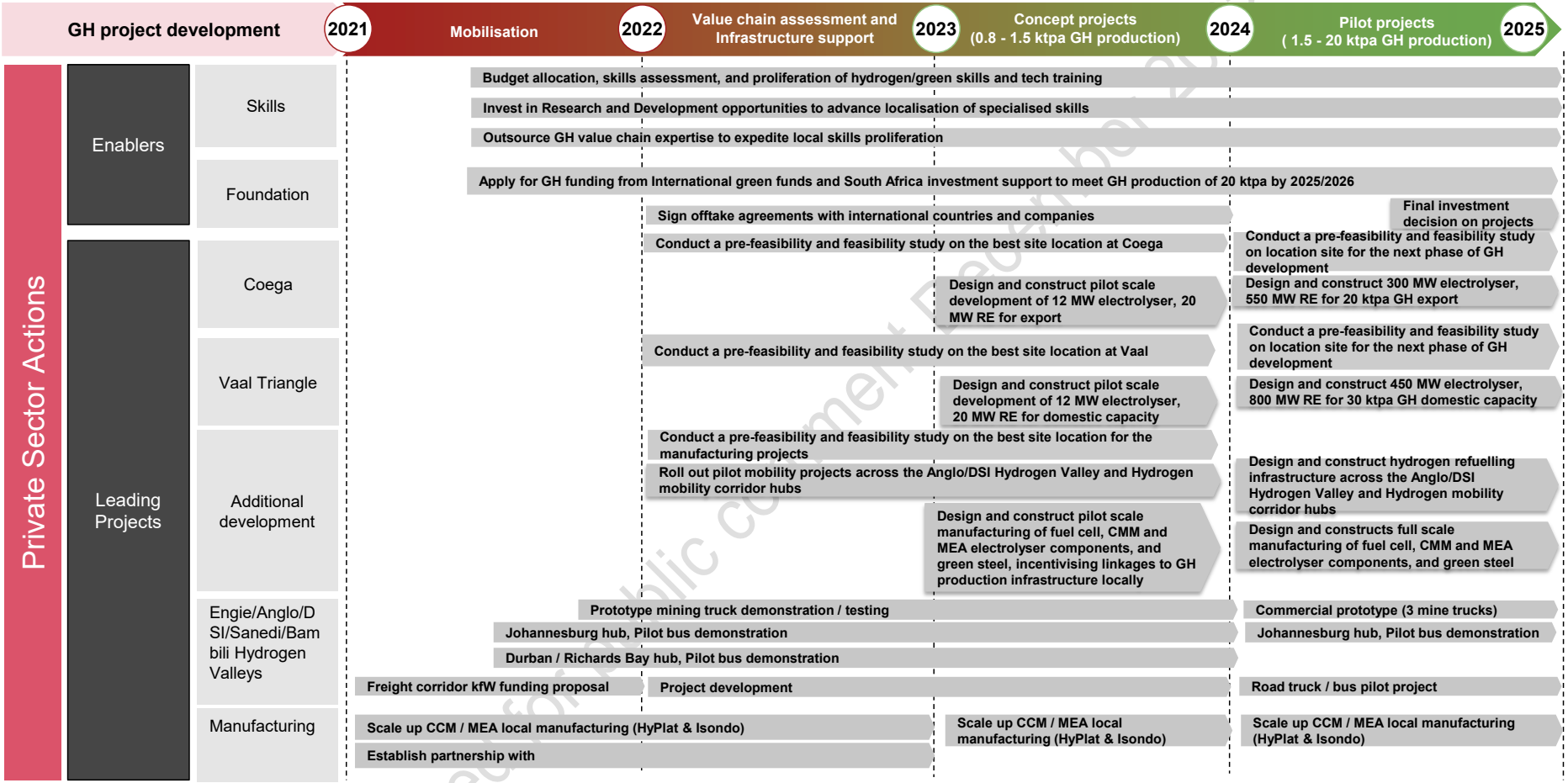
- issuing a government-backed green bond;
- introducing special, marginal levies on existing carbon fuel consumption (e.g. additional levy on fuel at the pumps) which could generate a pool of funding which could be applied to the country’s movement towards greener fuels; and
- redirecting income from carbon taxes towards green initiatives.

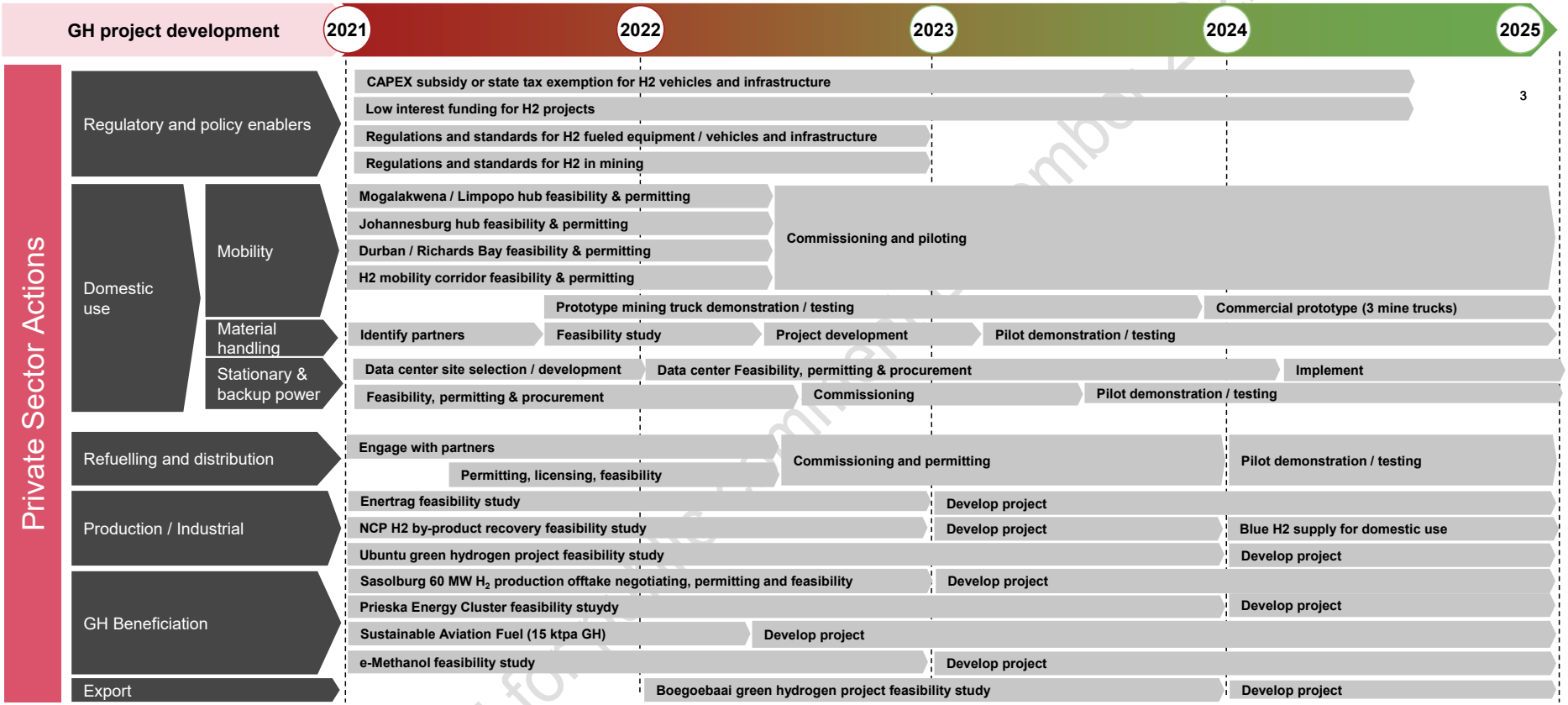
9 GH Commercialisation Roadmap and Funding Plan

9.1 Short-term Roadmap (2021-2025)

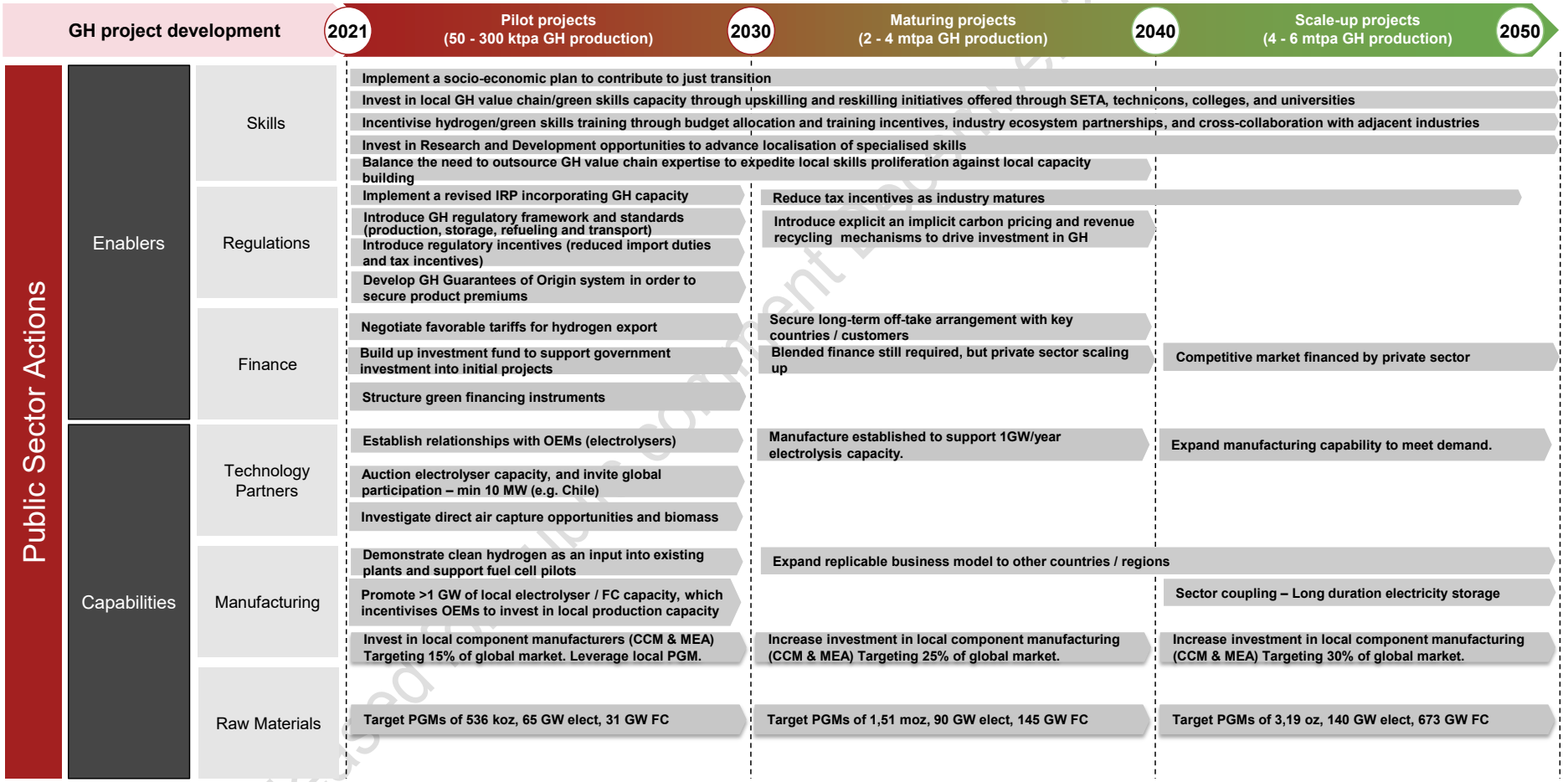


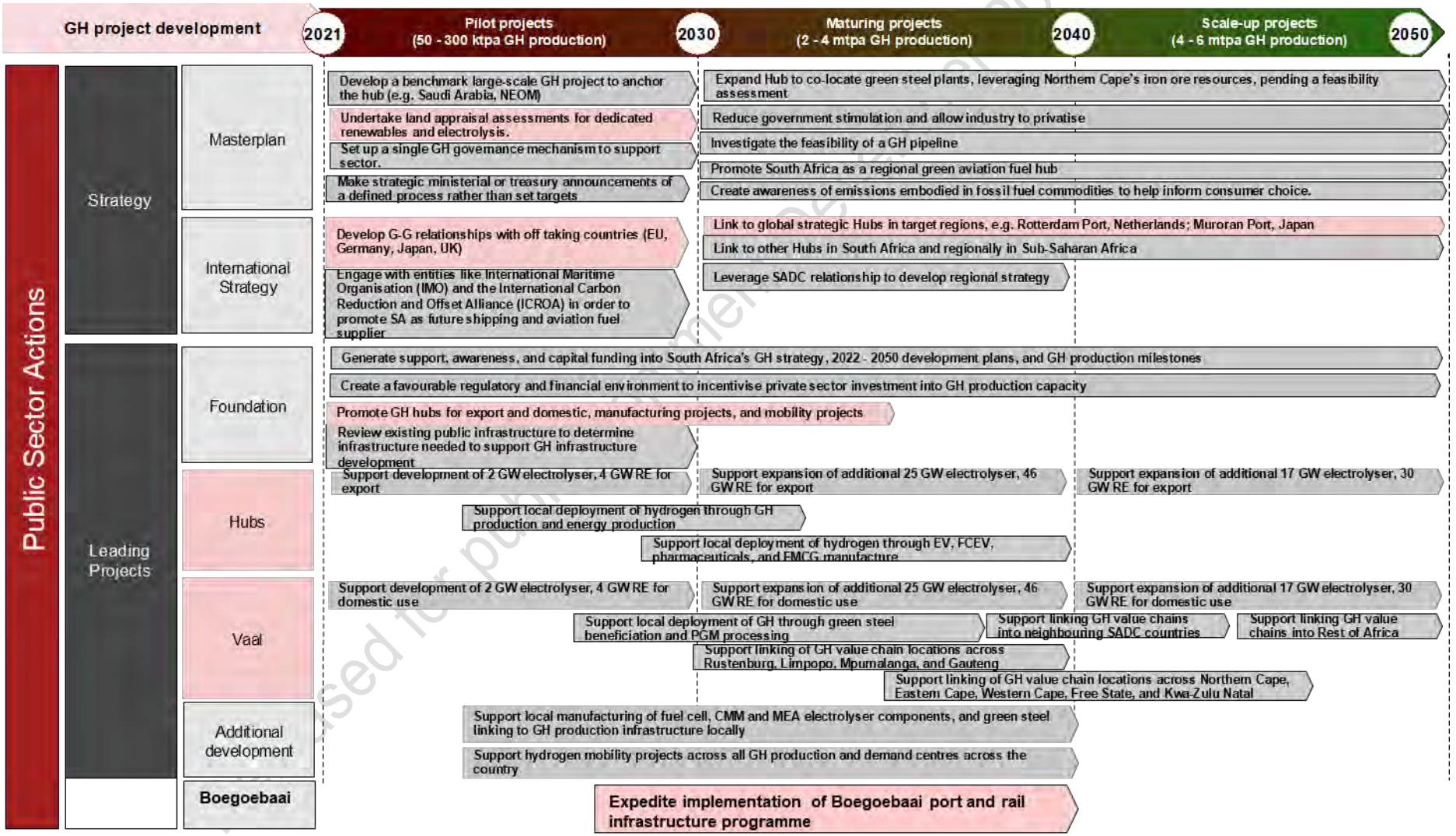


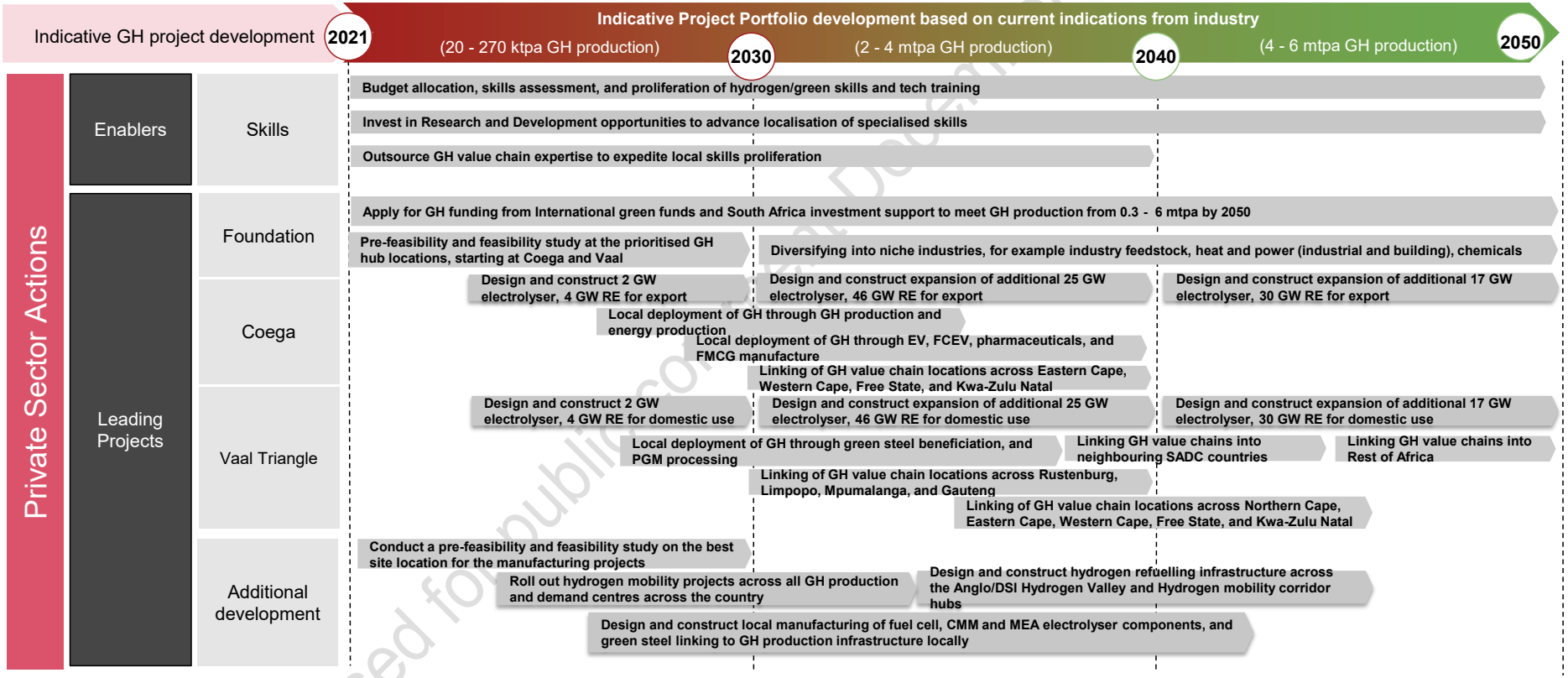


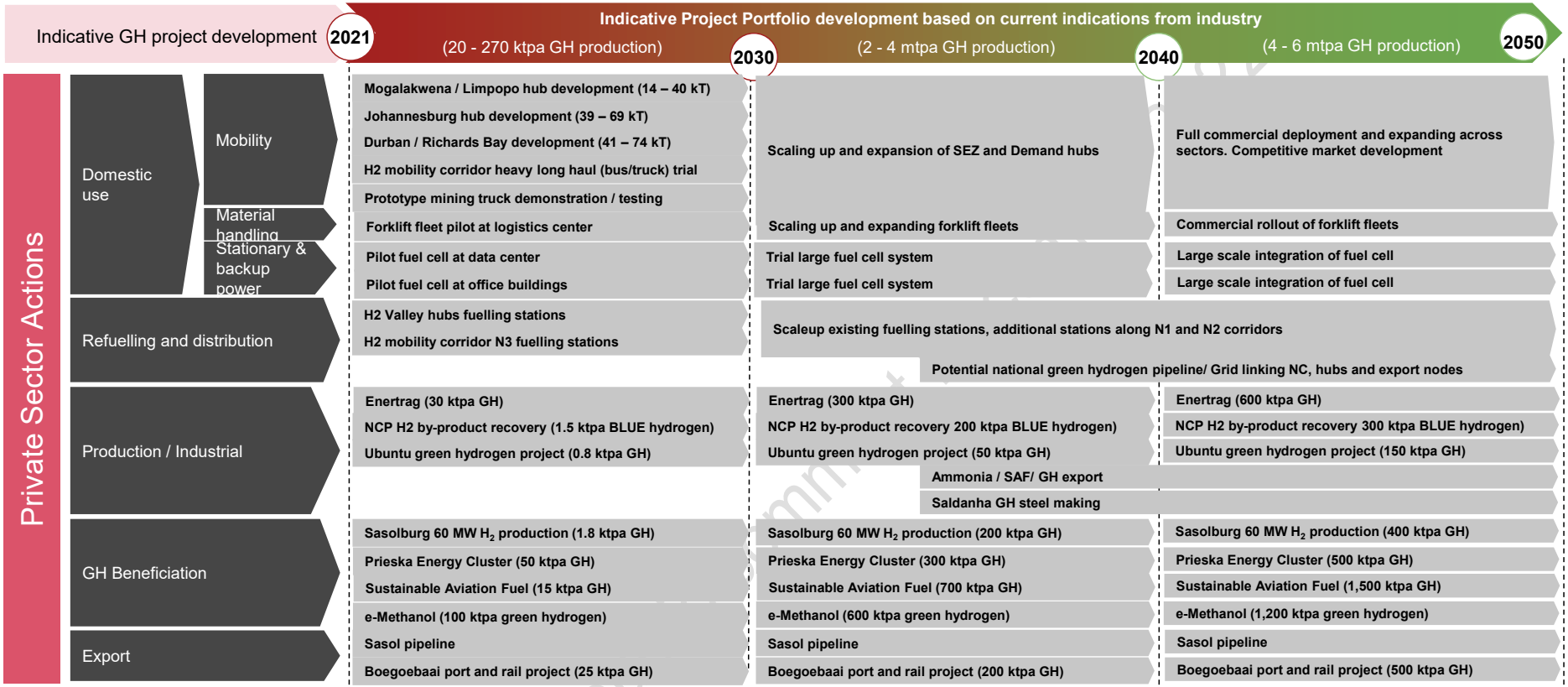


9.2 Long-term Roadmap (2021-2050)









9.3 Short term funding plan (2023-2027)

Based on the projected production targets, required projects and the roadmap actions, investment needs for the period from 2023-2027 is summarised below.

Funding for project development (pre-feasibility and feasibility studies)	
Description	**ZAR billion**
Sustainable Aviation Fuel Production	0.10
e-methanol Production	0.12
Fuel Cell Manufacturing	0.16
GH and Green Ammonia Production	3.70
Green Steel Production	0.20
Hydrogen Mobility	0.10
Infrastructure	0.13
Port project development	1.00
TOTAL	**5.51**
Capital Costs for the implementation of the above projects	
Description	**ZAR billion**
Sustainable Aviation Fuel Production	8.00
e-methanol Production	12.00
Fuel Cell Manufacturing	1.40
GH and Green Ammonia Production	109.30
Green Steel Production	13.20
Hydrogen Mobility	6.60
Infrastructure	13.00
Port infrastructure capital	150
TOTAL	**313.5**
TOTAL FOR PROJECT DEVELOPMENT AND CAPITAL COSTS FOR IMPLEMENTATION	**319.01 ($18,4bn)**

9.4 Summary of Commercialisation Strategy

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

1 PRIORITISE EXPORTS	2 STIMULATE DOMESTIC MARKET	3 SUPPORT LOCALISATION	4 SECURE FINANCING	5 PROACTIVE SOCIO ECONOMIC DEVELOPMENT
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	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.	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.	"Crowd in" and secure funding from various sources and in various forms including grants, concessional debt and contract for differences.	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.