Western Cape Green Hydrogen Strategy and Roadmap

Western Cape Government FOR YOU

CITY OF CAPE TOWN ISIXEKO SASEKAPA STAD KAAPSTAD

atlantis special economic zone cape town

FREEPORT SALDANHA INDUSTRIAL DEVELOPMENT ZONE

SALDANHA BAY

wesgro cape town & western cape tourism, trade & investment

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Abbreviations

CHIETA	Chemical Industries Education and Training Authority
CO2e	Carbon Dioxide
CSIR	Council for Scientific and Industrial Research
GDP	Gross Domestic Product
GH2	Green Hydrogen
GHCS	Green Hydrogen Commercialisation Strategy
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit
H2	Hydrogen
HySA	Hydrogen South Africa
IPG	International Partners Group
IRP	Integrated Resource Plan
JET IP	Just Energy Transition Investment Plan
JETP	Just Energy Transition Partnership
Kt	Kilo tonnes
Mt	Million Tonnes
MtCO2e	Million Tonnes of Carbon Dioxide equivalent
MW	Megawatt
NDCs	Nationally Determined Contributions
PGM	Platinum Group Metals
PMU	Programme Management Unit
R&D	Research and Development
REDZ	Renewable Energy Development Zone
SA	South Africa
SADC	Southern African Development Community
SAF	Sustainable Aviation Fuel
SAREM	The South African Renewable Energy Masterplan
Sasol	Sasol Limited
SEZ	Special Economic Zone
SMF	Sustainable Marine Fuel
WCG	Western Cape Government

Foreword by Premier Alan Winde

South Africa may have been given a reprieve from the load shedding crisis that for over 15 years left the country and its residents fumbling around the dark while the economy was brought to its knees.

Of course, the Western Cape Government welcomes this relief from relentless rolling power cuts, but we dare not let our guard down. We must work harder than ever to ensure this crisis is behind us and prepare ourselves for future pressures. While not a mandate of provincial governments, the Western Cape Government chose to address this crisis with the urgency that it required.

The energy crisis presented us with an opportunity: to seek out alternative, green power sources and pivot away from our damaging over-reliance on coal-based power. The Western Cape Energy Resilience programme - developed and implemented in early 2023 - is the province's guiding light toward a brighter, more sustainable future where the region is gradually weaned from its dependence on Eskom for all its energy needs. Alternative power sources are key to our strategy, enabling and empowering municipalities, and other stakeholders, to put measures in place to make the Western Cape energy resilient.

Green hydrogen (GH2) is integral to our efforts to avoid another power crisis, and we are pioneering its many benefits to our economy and residents.

Among the key objectives of the Western Cape Green Hydrogen Strategy are:

- To facilitate the generation and supply of 15 GW required for Green Hydrogen production in the Western Cape. The province also aims to support projects that generate their own power for electrolysis to meet the Western Cape's domestic needs and goals.

- To ensure excess supply capacity generated by Green Hydrogen electricity requirements, contribute towards the 1 800MW - 5 700 MW goal target of the Energy Priority Focus Area of the Growth for Jobs Strategy, to reduce reliance on energy from Eskom.

Partnerships are crucial. At the country's inaugural GH2 conference, held in Cape Town in 2022, the Western Cape Government signed a Memorandum of Understanding with the Northern Cape to set in motion the development of South Africa's first GH2 corridor. And we are gaining momentum. This partnership has grown and now includes the Eastern Cape Government. The private sector and other stakeholders are also playing their part in diversifying our energy mix

By embracing and exploiting new technologies, such as GH2, we are futureproofing our province and country, better preparing us all for the inevitable pressures of being the province with the highest population growth in South Africa. More crucially, by harnessing the potential of GH2 we are opening new avenues in our economy to create more jobs and boost growth.

Foreword by the Minister of Agriculture, Economic Development and Tourism, Dr Ivan Meyer

With the clock is ticking to combat climate change, the world is urgently needing to move toward a low-carbon future. A swift and responsible shift from fossil fuels to sustainable energy sources has never been more pressing. As decarbonisation takes centre stage in global economic and energy discussions, green hydrogen is emerging as a game-changer—an innovative, viable, and sustainable fuel that can power a greener future.

For South Africa, the stakes are high. The nation urgently requires sustainable energy solutions to fuel its economy and drive its transition to a low-carbon future. In line with its commitments under the 2015 Paris Climate Agreement, green hydrogen offers a transformative opportunity for South Africa to achieve its emissions reduction goals and position itself as a leader in the global move toward net-zero carbon.

With worldwide commitments to decarbonisation and significant funding directed towards the Just Energy Transition (JET), the Western Cape has gained global recognition as a prime location for developing a thriving green hydrogen industry. The region's abundant natural resources — land, wind, solar, and ocean energy — combined with South Africa's established petrochemical infrastructure, provide a competitive edge in the burgeoning green hydrogen market.

The Western Cape Government is stepping up to the challenge, driven by a clear vision and plan for the green energy transition, decarbonisation and economic development. As a forward-thinking and environmentally conscious province, the Western Cape has set bold targets for reducing greenhouse gas emissions and championing sustainable energy innovations.

This transition is not just about energy, it is about equity. A fair and just energy transition means ensuring our communities benefit, including those currently dependent on the fossil fuel industry. This will require training and reskilling programs to empower communities with the skills needed for a sustainable future.

Green hydrogen aligns seamlessly with the Western Cape Growth for Jobs Strategy and its seven Priority Focus Areas, especially in enhancing energy resilience and advancing toward a net-zero carbon future. It represents a powerful growth opportunity for the Western Cape, opening new domestic and export markets, stimulating economic activity, and fostering innovation.

The development of a green hydrogen sector in the Western Cape is more than an economic opportunity — it is a chance to build a more sustainable, prosperous future. It promises not only economic benefits, such as job creation and skills development, but also societal gains, including reduced transport emissions, energy security, cleaner air, and a robust export market for green hydrogen. The future is green, and the Western Cape is ready to lead the charge!

1 Western Cape Green Hydrogen Economy Vision & Objectives

Vision:

The Western Cape is a 'pioneering' Green Hydrogen economy and an integral part of the Western SADC Hydrogen Corridor, thereby contributing to breakout economic growth, energy resilience and export growth in the province.

The Western Cape's Green Hydrogen Strategy aims to create an enabling environment for the private sector and other stakeholders to achieve the following:

- **Economic growth and job creation.**
- **Energy security** in the Western Cape and South Africa.
- **Decarbonisation** in the Western Cape and South Africa through increased renewable energy production and using green hydrogen to decarbonise hard-to- abate sectors.

To realise these achievements, the Western Cape Government will:

- Support and encourage policy and regulatory changes to develop the green hydrogen industry.
- Support the development of a value chain in the province for production, processing and logistics for green hydrogen and its derivatives. This will be aimed at both domestic use and exports, in partnership with the private sector and national and international partners.
- Support and encourage the expansion of renewable energy generation capacity and green hydrogen coproduction to realise the strategic objectives of the western cape energy resilience programme (wcg, 2023). In turn this programme aims to reduce the impact of load shedding on businesses and citizens in the western cape and to lower reliance on eskom in the western cape.
- Support the development of local capability in the construction and manufacture of green hydrogen value chain components and thereby seek to maximise socio- economic benefits from green hydrogen.
- Support and encourage infrastructure upgrades, including ports, energy, water and transport infrastructure, to unlock green hydrogen production, while strengthening the economic functioning of the entire area.
- Support the development of the Western SADC hydrogen corridor in partnership with the Northern and Eastern Cape provinces.
- Support and encourage technology, R&D and skills development that will enable the development of the green hydrogen economy.

The specific goals of the Western Cape Green Hydrogen strategy are, by 2035, to:

- Facilitate the **generation and supply of 15 GW** required for Green Hydrogen production in the Western Cape. The province also aims to support projects that generate their own power for electrolysis to meet the Western Cape's domestic green hydrogen demand, contributing significantly to hydrogen and hydrogen derivatives exported from the Western Cape. The quantum of this additional capacity will be demand led by private-sector green hydrogen projects.[1]
- Through excess supply capacity generated by Green Hydrogen electricity requirements, contribute towards the **1 800MW – 5 700 MW** goal target of the Energy Priority Focus Area of the Growth for Jobs Strategy, in order to reduce reliance on energy from Eskom.
- Utilise between **90kt and 132kt** green hydrogen in hard to abate sectors **in the province** to reduce greenhouse gas emissions by 3.3Mt to 5 Mt of carbon dioxide equivalent (MtCO2e) per annum.
- **Export between 300kt and 420kt** green hydrogen as pure hydrogen or in derivative forms, such as green ammonia, methanol, or synthetic aviation fuel. This can happen both through bulk exports and through refuelling of international marine and aviation transport.

1 As per the Growth for Jobs Strategy, the longer-term aspirational 2050 goal for Green Hydrogen in the Western Cape, will be to facilitate the generation and supply of 57 GW of electricity for Green Hydrogen production (as well as to support the domestic electricity needs) and this will be inclusive of municipal, national and private sector-driven energy generation initiatives. This aspirational 2050 figure will be refined or confirmed during the development of the Western Cape's long- term Integrated Resource Plan.

2 Green Hydrogen Potential

2.1 The need for Green Hydrogen

Green hydrogen is produced by splitting water into hydrogen and oxygen using renewable electricity, making it a clean energy source and feedstock for industrial processes. For this reason, it is seen as a key part of the solution to address the global challenge of reducing carbon emissions. Not only is it clean, but it is also versatile. The immediate potential of the Green Hydrogen industry is evident in **two** main areas:

- Green hydrogen, either as a fuel or feedstock, can address the **de-carbonisation of various "hard-to-abate" sectors**, like heavy industry and long-haul transportation. These sectors cannot easily transition to direct renewable electricity usage due to their specific energy requirements. The use of green hydrogen in "hard-to-abate" sectors will **reduce** greenhouse gas emissions and **advance** the transition to a low- carbon, environmentally friendly, energy mix. This is **required** to meet both South Africa's carbon reduction commitments, and to decarbonise export value chains increasingly subject to carbon border adjustment taxes, and other similar mechanisms implemented by South Africa's trade partners.
- Green Hydrogen also offers a **means to balance the grid and store excess renewable energy efficiently.**

Since the Paris Agreement in 2015, where world leaders agreed to the overarching goal to hold "the increase in the global average temperature to below 2°C above pre-industrial levels" and pursue efforts "to limit the temperature increase to 1.5°C above pre-industrial levels", green hydrogen has gained greater impetus to decarbonise certain industries.

Under the Paris Agreement, South Africa - under its Nationally Determined Contributions (NDCs) - committed to a fixed target for greenhouse gas emissions (GHG) levels of 398-510 million tonnes of carbon dioxide equivalent (MtCO2e) by 2025, and 350-420 MtCO2e by 2030, Both South Africa and the Western Cape committed to net zero emissions by 2050.

South Africa also committed to penalties for not decarbonising. In a global net-zero environment, 'dirty' economies increasingly will be financially penalised through mechanisms, such as the EU's Carbon Border Adjustment Mechanism.

As part of an economic impact analysis of the South African Green Hydrogen Commercialisation Strategy (GHCS), it has been estimated that domestic use of green hydrogen could reduce GHG emissions by 16.5 MtCO2e per annum by 2030 and up to 21.6 MtCO2e by 2050. The contribution by 2030 represents 17% of South Africa's NDCs.

In fulfilling its NDCs, South Africa implemented key legislation to facilitate the lowering of its emissions. The **Carbon Tax Act**, effective since June 2019, aims to curb greenhouse gas emissions by imposing a tax on CO2 emitted from fuel combustion and industrial processes. This tax is calculated on the amount of CO2 emitted and the carbon content of the fuel. It increased from R159 to R190 per tonne of CO2e with effect 1 January 2024[2]. Carbon taxes, if set at sufficiently high levels, make green hydrogen more competitive as it raises the cost of fossil fuel use.

2 http://communications.kpmg.co.za/tax/Tax%20Alert_Carbon%20Tax.pdf

A fair contribution towards combating global climate change through decarbonisation is also essential because it avoids the increased cost burdens of disaster relief, infrastructure repairs, and healthcare due to climate change.

In parallel, the South African **Climate Change Bill**, introduced in February 2022, and passed by the National Assembly on 24 October 2023 aims to facilitate a robust response to climate change. It outlines plans for a just transition to a low-carbon, climate-resilient economy, aligning with the United Nations' Sustainable Development Goals. The Climate Change Bill proposed the establishment of a Climate Change Commission responsible for crafting and implementing a national strategy for climate change adaptation and mitigation. Additionally, it proposed the creation of a Climate Change Fund to finance projects focused on adaptation and mitigation efforts.

The **Presidential Climate Commission** (PCC) has been actively engaged in advancing South Africa's climate goals. In November 2022, the PCC developed South Africa's Just Energy Transition Investment Plan (JET IP) which provides recommendations for the energy transition. It emphasises a shift towards cleaner and more sustainable energy sources and identifies green hydrogen as one of its four focus areas for the just energy transition.

Given its significant ability to offset CO2 emissions, green hydrogen could be an important pillar of the country and Western Cape province's climate change strategy. Additionally, through power balancing and long-term storage, as expanded below (section 2.4). Green Hydrogen's use as an energy source can also alleviate South Africa and the Western Cape's energy supply crisis.

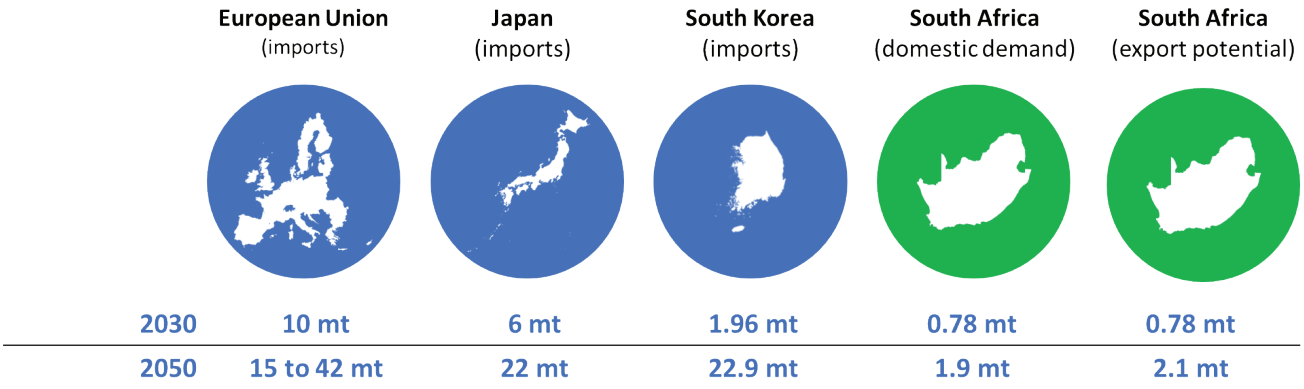
Demand estimates for decarbonisation with green hydrogen have been calculated by a number of energy institutions and consulting firms and are indicative of the opportunity for the Green Hydrogen economy.

Global demand

The annual **global demand for green hydrogen** is estimated at 70 Mt to 154 Mt by 2030. Some forecasts project this increase to between 614 Mt and 660 Mt by 2050 (Hydrogen Council and McKinsey, 2023; IRENA, 2023b).

Many countries will have the capacity to generate ample green hydrogen domestically due to their abundant solar and wind resources. Notable examples of such countries include the United States and China. However, for certain regions and countries, such as the European Union, Japan, and South Korea, it will be more cost-effective to import some of their hydrogen requirements rather than producing it domestically. The graphic below summarises the green hydrogen import targets for the EU, Japan and South Korea, which range from 1.96 Mt to 10 Mt in 2030 (total ~18 Mt) up to 42 Mt in 2050 (total ~60 Mt to 87 Mt).

Figure 1: Green Hydrogen Demand estimates 2030 – 2050 for importing regions and South Africa's domestic and export targets to these regions



Sources: IHS Markit (2021), Super H2igh Road Scenario for South Africa; and European Commission (2022), REPowerEU Plan, calculation, and adaption by Rebel Group. Note the figures for Japan are an interpolation of targets in different years and the EU 2050 figure assumes that between 25% and 70% of a demand of 60 Mt will be imported.

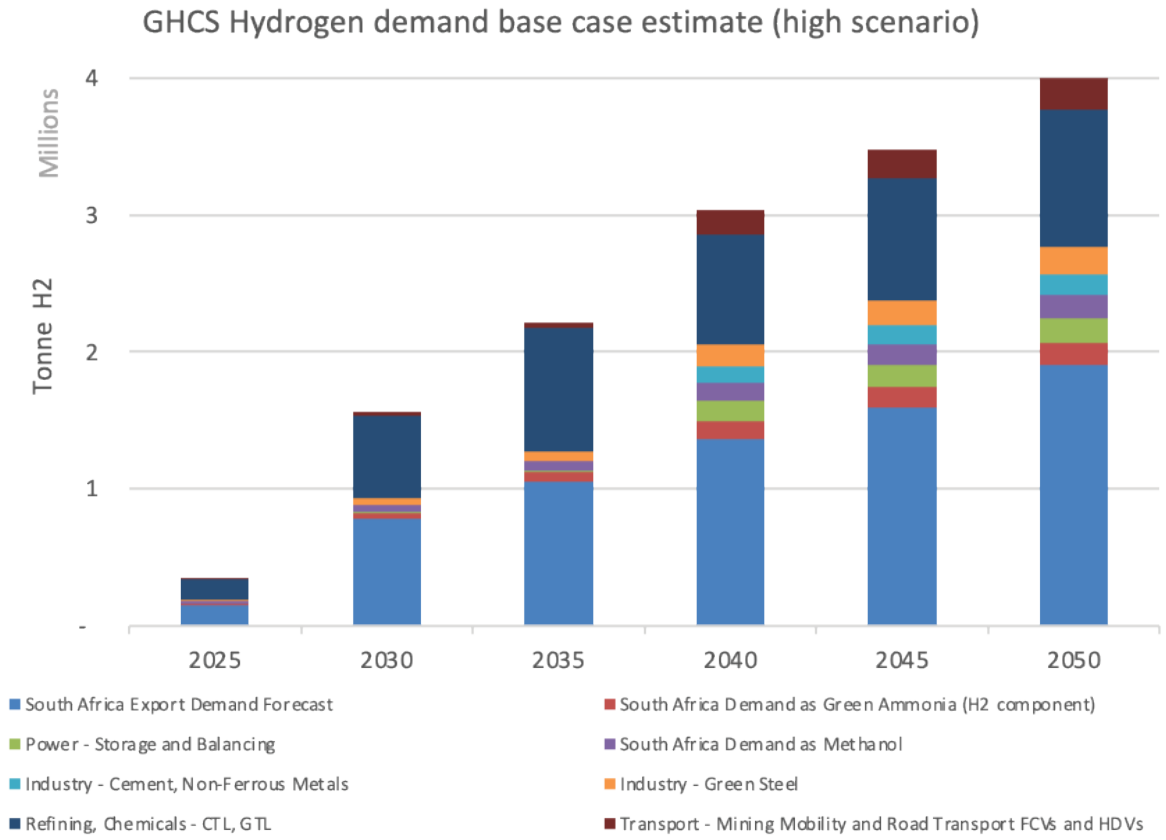
Global production presently yields 87 Mt of pure hydrogen annually, with 95% stemming from grey hydrogen processes, reliant on unabated natural gas or coal emitting substantial CO2. To attain the 1.5° C climate goal by 2030, low-carbon (green and blue) hydrogen must grow from almost zero annually to between 70Mt3[3] and 125Mt[44], increasing to between 523 Mt[4] and 6604[4] Mt by 2050. There is considerable uncertainty on the volume of low carbon hydrogen that will be traded globally. Estimates for global trade in green hydrogen by 2050, range between 117 Mt[5] and 400 Mt[6]. The gap between current green hydrogen production costs and the price that off-takers are willing to pay has been a key barrier to hydrogen trade. To address this, mechanisms are being put in place by countries and regional blocks that will fund the difference in the production price and what off-takers are willing to pay. Important examples in this regard include the German government's H2Global mechanism[7] and the European Hydrogen Bank[8].

Demand for South African green hydrogen

South Africa's GHCS has estimated the country's **annual green hydrogen export potential** at 2.1 Mt per annum by 2050. This estimate is at the low end of various analyses, some reports estimating much higher export potentials (as much as 8 Mt per annum[9]). These estimates are based on import demand projections for various regions, and in consideration of competition from Chile, North Africa, Australia and the Middle East.

The **estimated domestic demand for South Africa** in the GHCS is expected to reach 0.78 Mt per year by 2030, increasing by just over 5% per annum to 1.9 Mt per year by 2050 (IDC, 2023). Refer to GHCS demand figures below in Figure 2.

Figure 2 South Africa's green hydrogen export and domestic demand estimates



Source: IDC (2023), South Africa's Green Hydrogen Commercialisation Strategy

3 Hydrogen Council & McKinsey. 2023. Global Hydrogen Flows - 2023 Update - Considerations for evolving global hydrogen trade. Council, H. (Brussels).
4 IRENA. 2023b. World Energy Transitions Outlook 2023: 1.5°C Pathway. World Energy Transitions Outlook, 2, Agency, I. R. E. (Abu Dhabi).
5 IRENA. 2022. Global hydrogen trade to meet the 1.5°C climate goal: Part I – Trade outlook for 2050 and way forward. Global hydrogen trade to meet the 1.5° C climate goal, (Abu Dhabi).
6 Hydrogen Council & McKinsey. 2023. Global Hydrogen Flows - 2022 Hydrogen trade as a key enabler for efficient decarbonization. Hydrogen Counci (Brussels).
7 https://www.h2-global.de/project/h2g-mechanism
8 https://energy.ec.europa.eu/news/commission-outlines-european-hydrogen-bank-boost-renewable-hydrogen-2023-03- 16_en
9 Sasol Ambitious Scenario as quoted in IDC (2023).

2.2 Uses of Green Hydrogen

2.2.1 Industries likely to require Green Hydrogen

The GHCS identified several hard-to-abate sectors where decarbonisation is expected to create significant domestic demand for green hydrogen. These sectors are important contributors to the South African GDP, as well as providing key inputs to other sectors (steel and cement are for example, essential in the building and construction industry) and in creating employment. Decarbonising these hard-to-abate sectors allows South Africa to compete in global markets and to enable the country to meet its global greenhouse gas emissions targets. This is critical in accessing concessional and other finance to strengthen the country's transition to low carbon energy. The industries likely to use Green Hydrogen include:

- **Iron and steel production** – Steel production, globally, contributes 7% of the world's greenhouse gas emissions, due primarily to the iron-ore reduction process, using fossil fuels as a feedstock (IEA, 2020). The decline in iron and steel production in South Africa, has resulted in the lowering of greenhouse gas emissions in this sector from 12% of total emissions in 1995[10][10] to less than 1% by 2020[11][11]. Decarbonisation of the production process for Direct Reduced Iron (DRI) and steel making in South Africa is largely motivated by the opportunity it provides to leverage South Africa's abundant renewable resources to target export markets that are willing to pay a green premium. There may also be a case for domestic use of green DRI and green steel as economies of scale reduce the cost and other regulatory penalties make regular steel (using grey hydrogen) more expensive. Green DRI and steel would be a significant support to enhancing the competitiveness of South African export sectors, such as motor vehicle manufacturing.
- **Methanol** – Methanol serves as a precursor for various complex chemicals and an alternative transport fuel. Most methanol production currently involves the conversion of fossil fuel gas or coal into synthetic gas ("syngas"), then transformed into methanol. The use of green hydrogen and sustainable carbon sources12[12] (such as biomass), and methanol produces a near net-zero carbon footprint.
- **Ammonia** – Ammonia plays an essential role in fertilizer production, industrial chemicals, and refrigeration, making it a crucial compound for agriculture, manufacturing, and cooling processes. Green hydrogen could replace carbon-intensive processes of ammonia production with environmentally friendly methods, reducing emissions and enabling the integration of renewable energy into the ammonia manufacturing process.
- **Heavy vehicle transport** – Green hydrogen is critical to decarbonise heavy vehicle road logistics transport sectors where battery electric locomotion is not feasible, due to the size of the batteries required and the length of time to charge these. Shipping and aviation are two other major transport modes where green hydrogen used in sustainable aviation fuel (SAF) and sustainable bunker fuel could provide a carbon free fuel.
- **Cement production and non-ferrous metals processing** – The cement production process releases CO2 when limestone is heated, as well as from the fossil fuels used for the high heat required in cement kilns. The processing of non-ferrous metals, similarly, has high heat requirements that cannot be produced effectively by electricity. Green hydrogen is key to replace fossil fuels used in the abovementioned heating processes.
- **Refining and chemicals production** – Hydrogen is an important feedstock in the petrochemical sector where demand is currently satisfied by grey hydrogen produced from fossil fuels in a process that emits substantial amounts of greenhouse gasses. The large synthetic fuel production facilities in South Africa, based on the Fischer-Tropsch process, present a major demand potential for green hydrogen.

The decarbonisation of these sectors is likely to result in a 'greening' of many other sectors. These will benefit from products/ services such as 'green' steel, low carbon long-haul transportation fuel and low-carbon ammonia production, leading to long-term benefits.

10 OSTI, Energy use and carbon dioxide emissions in the steel sector in key developing countries https://www.osti.gov/servlets/purl/783473

11 National GHG Inventory Report South Africa 2000 – 2020 https://cer.org.za/wp- content/uploads/2022/09/Draft_8th_National_Greenhouse_Gas_Inventory_Report_For_South_Africa1-1.pdf

12 "Sustainable carbon" in the context of Sustainable Aviation Fuel (SAF) or other "power fuels" based on green hydrogen refers to the carbon derived from renewable sources like biomass, waste, or other sustainable feedstocks. The carbon in biological sources were removed from the atmosphere during crop growth and their rerelease therefore do not add to the global carbon stock, unlike in the case of fossil fuel combustion that releases carbon captured over millions of years.

2.3 Green Hydrogen for power storage and grid balancing

Green hydrogen can also play a significant role in power storage and grid balancing in a future electricity system dominated by intermittent renewables, which are cheaper and faster to roll out than fossil fuel or nuclear alternatives. (IRENA, 2023a; IEA)

Hydrogen production, through electrolysis, can play a significant role in stabilising intermittent renewable energy systems – required for decarbonised electricity generation – by supporting power balancing.

A use case specific to the South African context is to contract green hydrogen producers for off-take of renewable energy to avoid loadshedding by using the excess energy capacity often produced in green hydrogen projects. This will require commercial arrangements to compensate green hydrogen producers for lost electrolysis capacity, if required when there is no excess renewable energy capacity. Given the negative economic impacts of load shedding on the Western Cape economy, estimated at R8.2 billion in 2022 (WCG, 2023), this may be a small price to pay and could, in the short term, stimulate the development of green hydrogen production in the absence of firm export or domestic demand.

Hydrogen could act also as a form of large-scale energy storage. It is particularly well suited to long term storage, not losing its "charge" over time and, unlike batteries, can endure many charge and discharge cycles.

The investment in green hydrogen production is likely to also support the broader WC Energy Resilience Programme objectives by attracting additional investments in renewable energy generation infrastructure and leveraging the green hydrogen as a new component in the energy system.

3 The Green Hydrogen Opportunity

Alignment in South Africa

South Africa recognised the potential for green hydrogen at an early stage, with the establishment of the Hydrogen South Africa (HySA) programme in 2007. This enabled the establishment of three HySA Centres of Competence, two of which are located in the Western Cape (wholly and partly).

South Africa has subsequently developed two important hydrogen policies, **The Hydrogen Society Roadmap**, and the **GHCS**, which was approved by national Cabinet in October 2023. The GHCS outlines the country's strategy for developing its green hydrogen industry, provides estimates of domestic demand for green hydrogen and assesses South Africa's green hydrogen export potential.

Potential impact of Green Hydrogen in South Africa

Building the value chain to produce green hydrogen for domestic use and export will enable significant positive socioeconomic and environmental impacts. The GHCS also recognises the potential of technological innovation and industrialisation associated with local manufacturing and assembly of the capital equipment required to realise these value chains. Such localisation is supported by the draft **South African Renewable Energy Masterplan** (SAREM). This would harness South Africa's advantages, including the country's access to critical minerals like platinum group metals (PGMs), world-class expertise in the Fischer-Tropsch process for producing carbon-neutral synthetic fuels, technological capabilities developed through the HySA programme, and a growing hydrogen ecosystem with a wide range of participants.

An economic impact evaluation of the GHCS estimates that its implementation could support nationally up to R102 billion increase in GDP per annum by 2030, rising to R106bn by 2050. It is also estimated to support up to 397 000 jobs by 2030, rising to 437 000 in 2050, having a cumulative reduction of 493 MtCO2e emissions by 2050.

Potential Western Cape impact

Figure 3 below summarises an adjustment of these socioeconomic and environmental effects to contextualise the potential impact on the Western Cape economy.

Figure 3: Western Cape Green Hydrogen Impact Potential

Potential of the Green Hydrogen Economy in the Western Cape

	2030	2040	2050
GDP (billion)	R 57	R 79	R 87
Employment (no of jobs)	125 586	118 053	83 397
Fixed investment (billion)	R 238	R 388	R 464
Balance of payment effect (billion)	-R 2	R 9	R 16
Tax revenue (billion)	R 9	R5	R 6
Accumulated CO2 reduction (Mt)	6	43	103

- Production of marine **bunker fuels** and ship supply along the sea route around the Cape
- Production of **sustainable aviation fuels** and other synthetic hydrocarbons based on green hydrogen and sustainable carbon sources for export and local demand
- Contribute to strengthening **energy independence and resilience** and eliminating loadshedding through accelerated renewable energy rollout and peaking supply

Source: GHCS EIA, Rebel Group analysis (see Appendix A for methodology and assumptions)

Western Cape – promoting energy security and the transition to renewables

The Western Cape seeks to make the province less dependent on Eskom and more energy secure, through the province's **Energy Resilience Programme**. Green Hydrogen production presents an opportunity to help accelerate the fulfilment of this goal. The green energy production also presents an opportunity for the region to achieve net zero emissions and become a climate resilient province by 2050, fulfilling the objectives laid out in the **Western Cape Climate Change Response Strategy:** Vision 2050.

The transition to renewables in South Africa has increased in pace but faces several constraints, including delays in finalising power purchase agreements with Eskom, significant transmission, and distribution grid constraints (notably in the Cape provinces). These constraints have been acknowledged by Eskom (2022) in the Transmission Development Plan (TDP) 2023 – 2032 and significant investment in the transmission grid is planned to enable South Africa's transition away from fossil fuel-based generation. Various regulatory and institutional reforms in relation to the use of the national grid infrastructure are underway in support of energy resilience and the national energy transition.

Importantly, hydrogen can serve as the missing ingredient that enables a speedy transition to cheap renewables, by helping to address both the intermittency and grid constraints issues retarding this transition. Green hydrogen's contribution arises from several factors including:

- **The scale of renewables required for green hydrogen** will contribute towards providing market certainty for investment and drive efficiencies in the costs of renewable electricity generation. For example, the GHCS projections will require additional generation capacity (combined solar and wind installed capacity) of 24GW by 2030 rising to 80GW by 2050.
- Green hydrogen producers can act as **peaking electricity suppliers to eliminate load shedding** under appropriate market models.

- Hydrogen can be used for **long term seasonal storage of energy**. The need and quantum of seasonal storage remains to be determined.
- Hydrogen can serve as an energy carrier for transporting **long distance, large volume energy transport.**
- Hydrogen's **sector coupling** properties[13] means that it can be used in a diverse range of applications from energy storage to low carbon industrial feedstock, fuel for industrial heat and transport fuel.

Green hydrogen could therefore contribute to realising the Western Cape's Energy Resilience Programme and combating climate change by accelerating the adoption of renewables and by decarbonising hard-to-abate sectors.

Competition

While the scale of import demand from Europe, Japan and South Korea is very significant, there is still competition among countries and regions looking to produce green hydrogen for export. North Africa, the Middle East, Chile and Australia are some of the main competitors that South Africa and the Western Cape will need to be aware of as key international partners consider where to import green hydrogen from and where to fund projects.

13 Hydrogen's sector coupling priorities refers to its ability to connect and integrate various sectors of the economy by serving as an energy carrier. This means that hydrogen can be produced from different energy sources and used across multiple sectors, including transportation, industry, power generation, and heating.

4 The Western Cape's Strategic Advantage

4.1 Global and National Factors

The Western Cape's green hydrogen opportunity is underpinned by several contextual factors at the global and national level.

As outlined, the emergence of a global green hydrogen economy is driven by the need to avoid further catastrophic climate change effects and, at a local level, to safeguard the competitiveness and sustainability of its industries.

At the national level, South Africa is strongly evaluating the potential for green hydrogen as a future transport and industrial fuel and industry feedstock (particularly companies such as Sasol). The country is also differentiated from some other regions with hydrogen export ambitions because it has a substantial domestic market for green hydrogen and is relatively industrialised, enabling it to build sophisticated green hydrogen value chains more easily.

Specifically, the following global and national drivers support the Western Cape Green Hydrogen ambition:

- **Global demand:** As outlined, global hydrogen demand is estimated to be between 70 Mt to 125 Mt by 2030, with longer-term forecasts projecting this increase to between 523 Mt and 660 Mt by 2050. The total demand by 2050 that is estimated will be traded internationally amounts to 322 Mt of which 45% will be transported by ship and 55% via pipeline.
- **South African and Western Cape export potential** is supported through bilateral cooperation with off-take markets. Premium-paying export markets are crucial for anchoring the emerging green hydrogen economy. This is a result of initial higher costs of green hydrogen compared to fossil-fuel based alternatives (see further cost detail in box below). The Western Cape is well positioned to capitalise on the export opportunity given its strong renewable resource, technological and commercial capability and relevant infrastructure, such as the Port of Saldanha.

The **cost of Green Hydrogen** is a key part of building the viability of this new industry. The cost of producing green hydrogen is currently between €3 and €8 per kg, which is considerably higher than grey hydrogen which ranges from€0.63/kg to €2/kg5. As a result of technology advances and scale effects, the price of green hydrogen is projected to drop to €2 per kg in areas with limited renewable resources, such as Europe, Japan, and Korea, to as low as €1 per kg in parts of the world with favourable renewable energy conditions14[14] by 2050. Differences in renewable electricity costs will enable trade as several countries with high green hydrogen demand will import from renewable energy-rich regions.

Although **South Africa** is located relatively far from importing markets, it is exceptionally **well-endowed** with **combined wind and solar resources**, which positions it to produce green hydrogen competitively, despite the costs involved with maritime transportation.

14 PWC, Analysing the future cost of green hydrogen, https://www.pwc.com/gx/en/issues/esg/the-energy- transition/analysing-future-cost-of-green-hydrogen.html

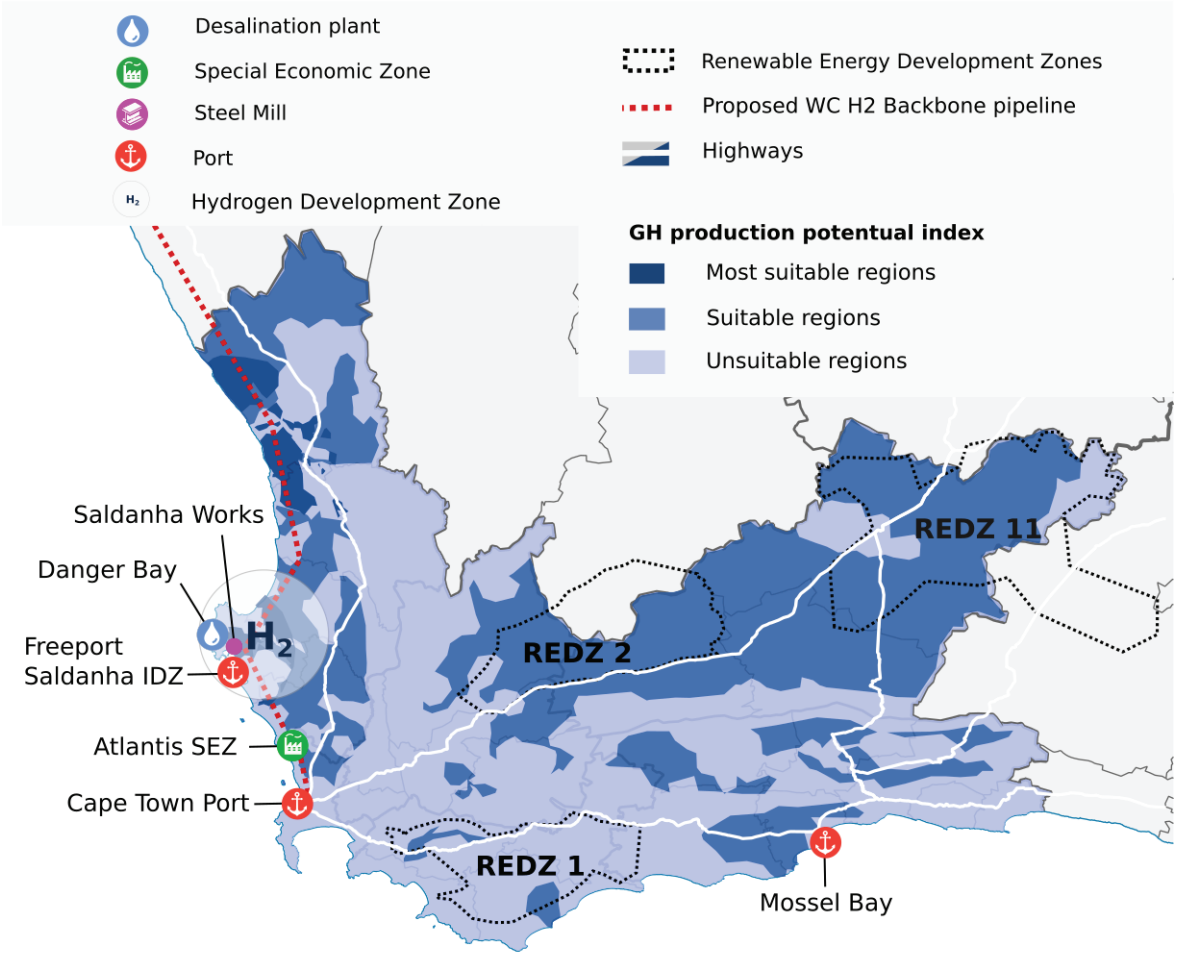
- **Specific policy context:** South Africa has firmed up its commitment to green hydrogen through various policy initiatives, including the HySA Strategy, Hydrogen Society Roadmap, and the GHCS. This is increasingly supported by strong political buy-in and institutional capacity. Other policy initiatives relevant to green hydrogen include SAREM, the South African Integrated Resource Plan (IRP), the Industrial Policy Action Plan, the Steel Masterplan and the Gas Masterplan. In the Western Cape, green hydrogen development aligns with the Western Cape Growth for Jobs Strategy 2023-2035, the Western Cape's Energy Resilience Programme, the Western Cape's Climate Change Strategy and Implementation Plan, and the Western Cape Green Hydrogen Position Paper.
- **Investment appetite:** According to various estimates, realising the infrastructure to supply the future global demand for green hydrogen will require USD 700 billion by 2030 (McKinsey, 2022) and between USD 1.2 trillion and USD 4 trillion by 2050 (IRENA, 2022). South Africa's initial (2023-2027) investment requirements for green hydrogen are estimated at over USD 21.3 billion (The Presidency, 2023). Although the financing of green hydrogen remains a challenge, various funding initiatives have recently emerged, amongst which is the SA-H2 fund, and a range of DFIs and commercial funders.
- **Clear market signal:** South Africa has a growing profile as a destination for investment in green hydrogen for domestic consumption and export. Investment into electricity infrastructure and improving the resilience of grid infrastructure in line with the Western Cape's Energy Resilience Programme should further provide a clear market signal to investors.
- **Addressing the energy crisis:** Leveraging green hydrogen supports accelerated deployment of renewables, thereby creating new generation capacity to help overcome the energy crisis. (See Appendix C). The provision of renewables to the Western Cape grid can support the viability of green hydrogen producers, while the green hydrogen market develops to maturity.
- **Support for the just energy transition:** International support has been committed for South Africa's JET as exemplified by the International Partners Group (IPG). The Just Energy Transition Investment Plan (JET IP) has identified a funding requirement of R319 billion for green hydrogen in the period 2023–2027 of which R36 billion has been secured from public sources and the IPG (The Presidency, 2023).
- Within this context, the Three Capes MoU provides a framework for the provinces to have a joint voice in advocating for green Hydrogen-enabling infrastructure.
- **PGM and other mineral resources:** South Africa's rich mineral endowment provides it with access to critical inputs to the hydrogen value chain such as electrolysers and fuel-cells. The mining and processing of these minerals is also associated with large industrial players that have an interest in promoting green hydrogen at national and international levels.
- **Fischer-Tropsch capability:** South African has an unsurpassed capability in the Fischer-Tropsch process, which supports the production and export of high value low-net-carbon fuels from green hydrogen and sustainable carbon in sectors such as aviation, where there are no other decarbonisation alternatives. Notably, the University of Cape Town and Sasol have a long-standing research partnership on the fundamental aspects of Fischer-Tropsch technology[15].
- **Industry interests and commitment:** various private sector players in South Africa such as Sasol, ArcelorMittal, and Anglo American have taken the initiative in developing the hydrogen economy in South Africa. In the Western cape, Sasol, ArcelorMittal and Mainstream are, as a consortium, studying the feasibility of the production and supply of green hydrogen to the Saldanha Works plant. In addition, various project developers, such as Atlanthia, Phelan Energy, RRS, SALIKA and S.E.T. Group, amongst others, are at different stages of development of their green hydrogen projects.

15 https://www.news.uct.ac.za/article/-2021-09-07-ucts-and-sasols-significant-step-toward-co2-hydrogenation-technology

4.2 Provincial Attributes

The Western Cape possesses several geographic, economic, and other attributes that position it as a lead contributor to South Africa's green hydrogen ambitions and as a leading green hydrogen economy. These include its **natural endowments** as a coastal province with 3 ports, including the strategically located Port of Saldanha, as well as abundant combined wind and solar resources. Lastly, the **resilient Western Cape economy** is strongly focused on decarbonisation and has a prominent green economy ecosystem, including a collection of renowned renewable energy developers. The figures below outline the potential for these attributes to be further expanded upon on in developing additional regional and inter- regional infrastructure – including a possible H2 pipeline, desalination plants and utilising the REDZ areas for renewable energy production.

Figure 4: Western Cape Hydrogen Potential



The Western Cape's key attributes that position it as a favourable investment destination for Green Hydrogen include:

- **Strong and growing regional economy:** The Western Cape economy largely tracks the national economy but has marginally exceeded national growth over the past decade. The province has had positive annual GDP growth in every year since 2012, with the exception of 2020, (due to the impact of COVID-19). It is the third largest provincial economy in South Africa, contributing 14.2% to South Africa's GDP, translating into the second highest real GDP per capita after the Gauteng province. Overall, provincial growth is driven by several sectors that are expected to show growth in future. These include Services (including ICT, Trade and Transport), Agriculture and Manufacturing. Underpinned by an open economy and an investor- friendly government, the Western Cape is an attractive investment destination, well positioned to support a Green Hydrogen economy.[16]

16 Sources: WCG (2023), 2022/23 Provincial Economic Review and Outlook; WESGRO (2023), An Economic Overview of the Western Cape, 2023, Quarter 3, 23 December 2023.

- **Significant renewable energy resources:** The western part of southern Africa including Namibia, the Northen Cape and the Western Cape has amongst the highest combined wind and solar resources in the world. The combination of these two types of renewable energy, which contributes towards resilience through diversity, is a key factor in having the potential to consistently produce cheap electricity for green hydrogen electrolysis.
- **Prime coastal position:** the Port of Saldanha is well located and has some of the required infrastructure, enabling both hydrogen exports and feeding into local demand, either located in downstream industries in Saldanha or feeding the major economic hub, Cape Town. Saldanha is also well located on the west coast, close to the Northern Cape and is geographically well positioned in relative terms to Namibia - both regions that will form part of the Western SADC Green Hydrogen corridor. In addition, the province's coastal geography positions it well as a supplier of low carbon marine fuels (also known as bunker fuels) to ships traversing the Cape Sea route at its Saldanha, Cape Town and Mossel Bay ports.
- **Regional collaboration:** In October 2023, the Western Cape, Northern Cape and Eastern Cape signed a joint MoU on Green Hydrogen collaboration to promote the three Capes region as an attractive green hydrogen destination to investors, off- takers, technical partners and financiers. This collaboration, together with collaboration at a national level between South Africa and Namibia, will allow the region to be seen as a viable and attractive Green Hydrogen corridor. This enables the region to be seen as key import market and development zone for major international partners.
- **Significant industrial and human capacity:** the Western Cape is home to four universities, possesses the relevant industrial and knowledge capabilities, attracts skilled human resources (from other parts of SA and the world) and has a reputation for good governance.
- Skilled human resources and knowledge institutions are essential to the development of a new socio-technical system such as the green hydrogen economy. This is required to enhance the potential for industrial innovations and accompanying economic growth. It also enables the technological absorptive capacity to allow for the identification, adoption and adaptation of imported technology required to build complex hydrogen value chains. The Western Cape's knowledge capability in the green hydrogen landscape is exemplified by the **four universities** within the province, helping to build vibrant knowledge and innovation capacity.
- Two **HySA Centres of Competence** and a **thriving tech startup ecosystem** are also located in the province. Significantly the region's research to GDP spend is one of the highest in the country at 1.5% GERD/GDP ratio[17] achieved by 2019/20. The Chemical Industries Education and Training Authority (CHIETA) has identified 17 future skills required for hydrogen economy. These include hydrogen fuel technicians, hydrogen systems engineers, hydrogen power plant managers, hydrogen power system electricians, hydrogen storage specialists, electrolysis engineers, hydrogen pipeline installers, and hydrogen safety specialists. In addition, the South African Energy Skills Roadmap identifies skills requirements in the short, medium and long term categorised according to themes such as "Climate Change: Resilient and adaptable energy system", "Shifting towards sector coupling" and "Evolving energy markets" (SANEA, 2023).

  Notably, the **University of the Western Cape** is working with Keren Energy, Sakhumnotho, Cape Stack and Namaqua Engineering as the lead technology and skills development partner on a green hydrogen proof of concept project in Vredendal, West Coast district.

  In addition, **Freeport Saldanha** are active in supporting skills and enterprise development in green hydrogen including through the hosting of workshops on topics such as green hydrogen and electricity-based fuels and feedstocks.
- **Institutional capacity:** The following factors demonstrate the strength of the Western Cape's institutional capacity:
  - The Western Cape Government is spearheading the implementation of the WC Energy Resilience Programme (WCG, 2023), which provides a clear market signal, builds energy-related capacity in the WCG (cuts across 12 WCG departments) and that of municipalities, and is developing a track record in attracting international and other finance.
  - As an extension of this energy resilience programme, the province is also creating a **provincial level Just Energy Transition Investment Plan (JET-IP)**. This is currently in development but will ultimately help in directing climate funding to Green Hydrogen-related or enabling projects.

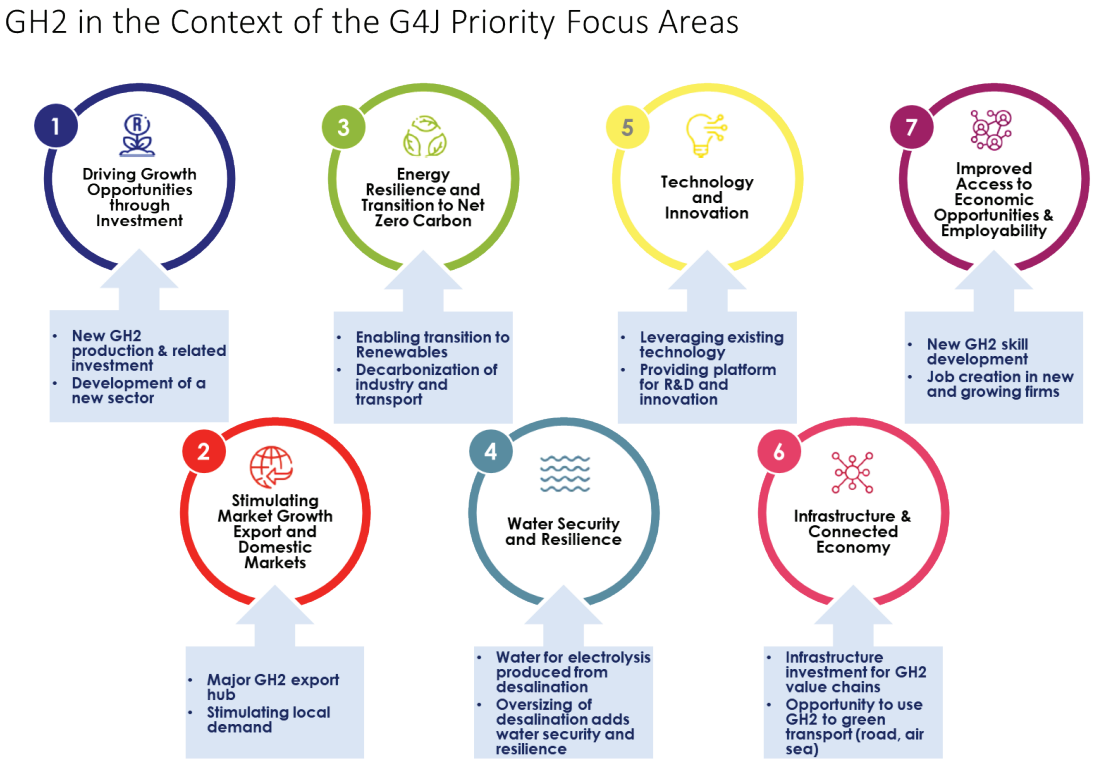
17 Source: calculated from South African National Survey of Research and Experimental Development Statistical Report 2019/20 and Wesgro - Provincial Economic Review & Outlook 2020

- In addition, the province aims to achieve net zero emissions by 2050 through its Climate Change Strategy and Implementation Plan.
- The Western Cape is known for being business friendly and for having an efficient and well governed civil service. This is reflected in unqualified audits for all 14 Western Cape provincial Departments, as well as each of its 11 entities (in 2022- 23) and very low irregular expenditure (0.4% of total provincial budget)[18].
- Proactive spatial and environmental planning and efficient permitting will be critical to the development of the hydrogen economy and the relevant Western Cape departments are well placed to assist in this regard.
- The Western Cape is home to a number of the best performing municipalities in South Africa. In 2022, the Saldanha Bay Municipality was voted as one of the two best-run municipalities in South Africa (by the Municipal Financial Sustainability Index – Ratings Afrika).

- **Key Infrastructure:** The development of the green hydrogen economy both for domestic use and for midstream processing and exports is supported by several existing infrastructure assets including:
  - Port of Saldanha in combination with the Freeport Saldanha Special Economic Zone
  - Saldanha Works iron and steel plant, South Africa's only MIDREX based plant, which is amenable to conversion to green hydrogen
  - Atlantis Special Economic Zone (SEZ) for green technology industrial development
  - Along with the Port of Saldanha, the Ports of Cape Town and Mossel Bay could serve as important hydrogen-based marine (bunker) fuel refuelling stations
  - In addition, the PetroSA facilities at Mossel Bay may have potential for Power-to-X fuel production
  - The Western Cape and specifically the City of Cape Town has developed capabilities in commissioning desalination plants, which will be an important infrastructural element of green hydrogen projects
- **Concentrated domestic demand:** The City of Cape Town Metro, the second-largest metropolitan area in South Africa, together with neighbouring municipalities such as Drakenstein, Stellenbosch and Saldanha Bay form a highly concentrated centre of domestic demand, which can act as an early adopter of green hydrogen. Concentrated demand lowers the cost of hydrogen infrastructure deployment and creates more sustainable domestic energy. The province also includes several airports, which could be key offset points for sustainable aviation fuel (SAF) produced using green hydrogen. Additionally, and with agriculture being a key economic sector in the Western Cape, the production of fertilisers from green ammonia instead of conventional fertiliser production (using a CO2 intensive process) is a significant opportunity to reduce GHG emissions in accordance with domestic and export market requirements19[19].
- **Alignment to the Growth for Jobs Economic Strategy:** The Western Cape's Growth for Jobs (G4J) Strategy sets out a comprehensive, challenging, and ambitious goal for the Western Cape to grow its economy to a R1 trillion economy by 2035, requiring growth of between 4% and 6% per annum. The G4J Strategy is underpinned by several priority focus areas, including resilience and transition to net zero carbon; creating growth opportunities through investment; stimulating market growth through exports and domestic markets; water security and resilience; technology and innovation; infrastructure and connected economy; and improved access to economic opportunities and employability. Green hydrogen aligns well with the goals and objectives of the Growth for Jobs Strategic Framework and is especially well-matched with priority focus areas as presented in Figure 4 below.

18 Auditor General of South Africa, Consolidated General Report on National and Provincial Audit Outcomes 2022-23
19 https://www.spglobal.com/ratings/en/research/articles/210422-the-hydrogen-economy-green-hydrogen-may-transform- the-fertilizer-industry-11904543

Figure 5: WGH2 in the Context of the G4J Priority Focus Areas



Source: WCG (2023), Growth for Jobs Strategy 2023 – 2035; Modified

4.3 Western Cape Green Hydrogen Opportunities

The above global and national factors, together with the Western Cape's strong provincial attributes, demonstrate the Western Cape's potential to become a global leader in the green hydrogen economy. The key opportunities for the Western Cape are as follows:

(a) **Renewable energy generation and hydrogen production** within the Western Cape for early export off-take, green steel production, satisfying local demand for other hard to abate sectors.

(b) Establish the **Western SADC Hydrogen Corridor** as a global green hydrogen region, including through the Three Capes MoU and other national and international collaboration.

(c) Enable South Africa's GHCS through **logistics, manufacturing and innovation support** along the green hydrogen value chain.

(d) Serving as a **logistics and midstream processing hub for green hydrogen export** through the Port of Saldanha in the form of green ammonia and green DRI or steel exports. This would involve a partnership with the Northen Cape, which would generate hydrogen through electrolysis in the Northern Cape on a large scale, which would then be transported to Saldanha Bay for conversion to ammonia and the production of green steel.

(e) Production of **low-carbon marine bunker fuels** and **SAF.**

(f) Satisfying local demand for green hydrogen to **decarbonise hard-to-abate sectors,** such as transport and mobility and various industrial processes.

(g) Enable the transition to a **resilient and decarbonised energy system** through an integrated hydrogen and renewable electricity infrastructure in the province.

5 Supporting the Green Hydrogen Economy in the Western Cape

5.1 Strategic Pillars

Realising the Western Cape's green hydrogen ambition hinges upon unlocking key enablers. This requires collaboration between government, the private sector and civil society leadership. The three strategic pillars below demonstrate the Western Cape's strategy to realise their green hydrogen objectives and maximise the benefits and opportunities.

Figure 6: Strategic Pillars

Pillar 1: Creating an Enabling Environment

Put in place the essential requirements for the development of green hydrogen value chains by the private sector.

Interventions:

1. Institutional Capacity
2. Land Availability and Permitting
3. Stakeholder Integration Strategy
4. Regulation, Codes & Standards and Certification
5. Skills Development and Training
6. Innovation, Research and Development Capacity
7. Investment Promotion and Facilitation plan

Pillar 2: Facilitating Infrastructure Development and industrial Capability

Enable the emergence of the green hydrogen economy: Invest in seeding the emergence of the green hydrogen economy.

Interventions:

1. Infrastructure Master Planning
2. Safety Infrastructure
3. Hydrogen Industrial capability

Pillar 3: Supporting Scale

Steer the green hydrogen economy towards large scale production.

Interventions:

1. Critical mass through collaboration
2. Hydrogen Hubs to Catalyse Scale
3. Stimulate local demand
4. Catalysing Export
5. Industry-scale-up support

5.2 Pillar 1 – Creating an Enabling Environment

Pillar 1 lays the foundations for a vibrant hydrogen economy in the province, ensuring critical enablers are in place.

A. Institutional Capacity

- **Operationalisation of the Western Cape GH_2 Programme Management Unit (PMU):** A Programme Management Unit (PMU) will play a crucial role in the delivery of the Western Cape Green Hydrogen Strategy and Roadmap. The PMU will serve as the central coordinating body responsible for overseeing, implementing, and monitoring initiatives outlined in the strategy. The PMU will play a role across all strategic pillars, in some cases leading interventions, while in others supporting or monitoring interventions. Ideally, it will comprise representatives from multiple provincial government departments, relevant to Green Hydrogen (including Department of Economic Development and Tourism; Department of Environmental Affairs and Development Planning; Department of Infrastructure; Department of Local Government; Department of the Premier; Provincial Treasury and Western Cape Mobility Department), and other provincial entities, including Wesgro, Freeport Saldanha, Atlantis SEZ, as well as seconding technical advisors, where appropriate.

In addition to overseeing the interventions under the three pillars (outlined broadly above and in detail in the sections below), the PMU will also broadly:

(a) Oversee strategic planning and coordination, including setting and achieving of various milestones

(b) Coordinate resource mobilisation for government-led initiatives to promote and develop the Green Hydrogen sector

(c) Perform relevant monitoring and evaluation

(d) Coordinate Green Hydrogen-focused stakeholder engagement across the Western Cape, other SA provinces, SA National government and international partners

B. Investment Promotion & facilitation and positioning

- **Promote investment and positioning:** It is important to highlight the positive attributes of the Western Cape as an investment destination to attract interest from different stakeholders in the Green Hydrogen value chain. Wesgro, together with provincial partners (including Freeport Saldanha) will promote investment into current and new Green Hydrogen projects, as well as business opportunities in the value chain (e.g. solar panel manufacturing, electrolyser components, etc) and ensure that the Western Cape is a recognised Green Hydrogen Hub.
- **Facilitate investment:** It will be critical for the various stakeholders within the Western Cape operate as a team to facilitate investment into the Green Hydrogen value chain, which will overlap with other parts of the three strategic pillars. Freeport Saldanha, Wesgro, Western Cape Government, Atlantis SEZ as well as other local, provincial and national government entities will all help facilitate investment in Green Hydrogen projects, business opportunities in the value chain, as well as the infrastructure upgrades required. This will be led by different organisations for different aspects of the facilitation work, in according with their mandate and the value that the parties bring in successfully landing investment and projects.

C. Stakeholder Integration and Coordination

- **Public Awareness:** Raising awareness about the benefits of green hydrogen is critical for the development of a green hydrogen economy and will allay fears and combat disinformation. The province will support public education campaigns, engage with industry stakeholders, and establish partnerships with academic institutions and research organisations.
- **Industry Engagement Model:** The role of the private sector is crucial in terms of the development and operation of green hydrogen value chains, spanning financing, technology provision, project development, operation and various other roles. The Western Cape will support the development and implementation of an industry engagement model of public-private partnerships, industry clusters, and innovation hubs to advance green hydrogen in the province.

D. Regulations, Codes & Standards and Certification

- **Regulations Codes and Standards:** Regulations and standards are largely handled at a national level, but the Western Cape will work with municipalities on regulations developed at local government level that impact on the Green Hydrogen value chain. The Western Cape government will work as a partner to national government to ensure the effective adoption and implementation of national Green Hydrogen- related regulations at a provincial and local level.
- **Green Hydrogen Certification for export:** Green hydrogen produced in South Africa and exported from the Western Cape must comply with the requirements of the targeted exported markets. To this end, voluntary certification schemes are being established that are or will be recognised by the importing authority. Exporters will be audited and certified against the different schemes by specialist firms trained on the certification schemes. The Western Cape will keep abreast and support up-to- date guidance on the available certification schemes and auditing firms of green hydrogen exports.
- **Certification of domestic hydrogen:** Certification of green hydrogen for domestic use is critical in ensuring environmentally sustainable hydrogen products that meet required quality standards. The Western Cape will support national regulations and certification schemes that enhance efficiency within the South African green hydrogen sector.
- **Land Availability and Streamlined Permitting:** The availability of land for renewable energy generation and hydrogen production is crucial to the development of the hydrogen economy. To ensure land for green hydrogen production, and renewable energy generation in particular, the Western Cape will support land audit work to identify suitable areas for renewable energy projects. Building on existing work by the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) and the Council for Scientific and Industrial Research (CSIR), the audit work would identify areas with high solar and wind potential, as well as areas with existing infrastructure that can be repurposed for renewable energy projects (CSIR, 2023). Additional criteria will include environmental and heritage considerations as well as existing use for agriculture, industry, conservation, or housing. Once suitable areas have been identified, the province (in cooperation with municipalities and national government) will support proactive identification of land for renewable energy generation. The WCG will put in place measures to streamline the permitting process in collaboration with local and national government. The WCG will also support efforts to identify land availability mechanisms, which could support project development. In addition, the province will collaborate with partners to maintain a database of biodiversity offset areas to facilitate the management of environmental impacts. The WCG in collaboration with WC municipalities, leveraging their strong track record in this regard, will work with partners to investigate approval and permitting processes for green hydrogen projects, identifying bottlenecks and investigating interventions to improve efficiency.

E. Skills Development and Training

- The Western Cape Government will encourage and support hydrogen skills development and training. This will be achieved by partnering with academic institutions and research organisations, developing training programmes and courses in the green hydrogen sector. Building on existing initiatives, such as the CHIETA identification of 17 future skills for success in the hydrogen economy, the WCG will participate to advance skills advancement programmes.

F. Innovation, Research and Development Capacity

- The Western Cape is an important hub for green hydrogen research in South Africa, hosting HySA Catalysis and HySA Systems nodes at the University of Cape Town (UCT) and University of the Western Cape. In addition, Stellenbosch University hosts the Centre for Renewable and Sustainable Energy Studies (CRSES) and the Cape Peninsula University of Technology's (CPUT) SARETEC plays a key role in certifying renewable energy equipment. The Western Cape will leverage this strong capability for research and innovation to advance the province's research capability and maximise local value add in green hydrogen value chains.

5.3 Pillar 2 – Facilitating Infrastructure Development & Industrial Capability

Pillar 2's focus is on the Western Cape's responsibility in ensuring the creation of the necessary infrastructure and industrial capability required for the establishment of green hydrogen value chains.

A. Infrastructure Master Planning

- **Western Cape green hydrogen and electricity system:** This will form part of the Provincial Integrated Resource Plan and the Provincial Network Development Plan, which are focal areas in the Western Cape Energy Resilience Programme and will take account of the Eskom Transmission Development Plan (TDP) 2023 – 2032 (Eskom, 2022). The renewable sources of energy for hydrogen plants will likely be from a solar or wind source located close to a hydrogen production plant. With the limited grid capacity in the Western Cape and, specifically on the West Coast, network upgrades, strengthening and refurbishment will be critical to enable green hydrogen production at Saldanha (and other ports), both within the municipal and Eskom networks grids. The WC PMU will ensure this a key workstream activity of the broader Western Cape Energy Resilience Programme, to enable not only green hydrogen production but also energy security in the immediate area, province, and country. Infrastructure plans will address the potential for integrating renewable electricity produced by green hydrogen producers in the Western Cape. This will address base load requirements or mitigate loadshedding through contracted peaking supply. These plans will take account of the additionality requirements in the certification of green hydrogen.
- **Green hydrogen backbone:** Hydrogen transport by pipeline is considered cost- effective for high-volume transport over long distances. The feasibility of a green hydrogen pipeline at provincial and national level must be investigated. A pipeline could be developed along the West Coast, connecting Cape Town and Saldanha Bay, with a national and regional backbone connecting the Western Cape, Northern Cape, Gauteng, Mpumalanga and extending into Namibia. The Western Cape will engage with local and international technical and financial partners to determine the business case and feasibility of this, particularly in light of the Western SADC Hydrogen Corridor proposal. proposed.
- **Water infrastructure:** The water required for Green Hydrogen production will, in almost all situations, be sourced from desalination plants. The costs, to be paid for by the Green Hydrogen developers, are minor – desalinating water for green hydrogen most often contributes less than 1% of the cost of hydrogen. There is an added opportunity for the desalination plants to be oversized when built, which could then provide for the local municipalities and communities. Western Cape government will work with national and local government to decide on the most appropriate regulations for water infrastructure, as well as the disposal of brine, which is released from desalination plants.
- **Hydrogen highway corridors and metropolitan circular routes:** The Western Cape will develop hydrogen highway corridors and metropolitan circular routes, targeting the decarbonisation of heavy vehicle road transport, promoting green hydrogen adoption, particularly for logistics systems and leveraging simplified refuelling at overnight depots on circular routes.

B. Safety Infrastructure

- Hydrogen is a highly combustible and explosive gas and therefore the production, movement and storage can be complex. Developing safety infrastructure, robust processes and a cautious approach to safety is imperative. The Western Cape will implement measures to ensure the safety of hydrogen infrastructure, classified into proactive and reactive capabilities, as follows:
- **Proactive capabilities** are measures taken to prevent accidents and incidents from occurring, including establishing the necessary regulatory framework, conducting risk assessments, as well as training and education.
- **Reactive capabilities** are measures that respond to accidents and incidents. These measures include an emergency response plan, equipping emergency services to respond to hydrogen-related incidents and establishing investigation and reporting mechanisms.

C. Hydrogen Industrial Capability

The Western Cape will provide support to foster industrial capability along the green hydrogen value chain enabling local supply chains to help meet industry demand.

- **Hydrogen equipment manufacturing programme:** A hydrogen technology manufacturing programme in the Western Cape will seek to capitalise on existing infrastructure and institutional capacity and aim to produce key green hydrogen- related components like wind turbines, solar panels, electrolysers, and related components and sub-components. Building sufficient industrial capacity will be supported by local demand, technological innovation from universities, and a skilled workforce, achieving economies of scale for both local and global markets.
- The Western Cape will leverage both the **Atlantis SEZ and Freeport Saldanha** to contribute to the manufacturing of key components and sub-components of the green hydrogen value chain, serving the local, South African, regional, and global markets.

5.4 Pillar 3 – Supporting Scale

Pillar 3 emphasises the importance of the partnership between the Western Cape Government, National Government, neighbouring provinces and international partners, in supporting industries to quickly expanding their operations to achieve larger-scale production. This scaling effort will bring about cost reductions and efficiencies throughout the entire hydrogen supply chain. It will also secure the Western SADC Hydrogen Corridor as a preferred region for off-takers in the EU, Japan and South Korea. The mechanisms to do so are discussed below:

A. Critical Mass through Collaboration

- **Provincial Coordination:** Effective collaboration between the Western Cape, Northern Cape, and Eastern Cape provinces (collectively the Cape Provinces) will potentially position South Africa as a major global hydrogen player. The three provinces have signed an MOU to cooperate on the development of the green hydrogen economy in South Africa, to position South Africa as a global hub for the production of green hydrogen and derivative products, and to produce the components required in the green hydrogen value chain. South Africa's hydrogen opportunity will be advanced through cooperation in the areas of shared infrastructure, skills development, trade, and investment promotion, as well as on the development of supportive policy and regulation.
- **National Alignment and Coordination:** The Western Cape Green Hydrogen Strategy is aligned with South Africa's GHCS and will serve as part of its implementation. The province will engage with relevant national structures, coordinating provincial initiatives with national plans to achieve South Africa's ambitious targets for green hydrogen exports and domestic use.
- **Regional Collaboration:** In addition, the Western Cape, along with the Northern Cape, and Eastern Cape, will extend cooperation on hydrogen to the region, including Namibia, in an effort to create a Western SADC Hydrogen Corridor. While led by national government, it is important for provincial government to be closely involved in the collaborative work on workstreams, such as shared infrastructure (e.g. gas pipelines).

B. Saldanha Hydrogen Hub to Catalyse Scale

Hydrogen hubs, clusters or valleys are emerging as integrated regional hydrogen ecosystems, beyond initial demonstration phases, pioneering and paving the way for a fully scaled Green Hydrogen Economy. They serve as stepping stones towards industrialising key hydrogen technologies by integrating supply and demand, fostering regional 'mini hydrogen economies,' and reducing costs through collaboration and asset optimisation. Typically, such hubs pool hydrogen supply and demand and are centred around long-term agreements to de-risk investments and synchronise project elements.

A flagship initiative of this strategy will be the establishment of the **Saldanha Hydrogen Hub**. Centred in the Saldanha Bay area, it will capitalise on the strategic location of Saldanha Bay, with its surrounding renewable electricity generation potential, for hydrogen midstream processing and logistics. Leveraging the Port of Saldanha and the Freeport Saldanha Special Economic Zone, the Saldanha Hydrogen Hub will serve as hub for:

- **Desalination of seawater** for hydrogen electrolysis.
- **Production of green hydrogen** through water electrolysis from renewable energy.
- The generation of **green hydrogen derivatives** such as green ammonia, methanol, and synthetic aviation fuel.
- Enable **bulk export of green hydrogen** (including in derivative forms) produced in the Western Cape and in the Northern Cape through the Port of Saldanha.
- The production of **green DRI and steel** at the Saldanha Works iron and steel plant for export and domestic markets.
- Along with the Port of Cape Town and Mossel Bay, supply **green bunker fuel** for maritime transport.
- Enable **import logistics** required for constructing green hydrogen value chain components in South Africa. This includes the importation of raw materials or bulky capital equipment for renewable energy generation, electrolysis, pipeline materials as well as construction equipment for ports and other infrastructure.
- Enable **innovation, manufacturing and industrial development** aligned to the GHCS, in collaboration with the Atlantis SEZ and other manufacturing nodes in the province.

The Saldanha Hydrogen Hub will support the goals of the Western Cape Energy Resilience Programme, facilitating accelerated rollout of large-scale renewable energy generation, and balancing green hydrogen grid properties.

The Saldanha Hydrogen Hub presents a cross-sectoral opportunity. It could reduce costs of green hydrogen production, enable market scale and stimulate competitive domestic and export markets with ambitious carbon reduction targets. This approach helps address uncertainties in both demand and supply, breaking the initial phases' challenges, focusing solely on domestic use or exports.

A West Coast Hydrogen Master Plan, encompassing a comprehensive and strategic roadmap for the Hub, is essential for orchestrating the alignment of infrastructure development, regulatory incentives, technological innovation, job creation, and environmental sustainability. This would ensure the success of the hub as a thriving centre for private sector-driven green hydrogen projects in the brownfield SEZ and port area. The plan will aim to identify the upgrade of Saldanha to enable exports of green ammonia for such projects. The Master Plan is a key activity in the establishment of the Saldanha Hydrogen Hub.

The Western Cape will also consider Master Planning work for nodes that may be considered away from the Port of Saldanha but this will be determined based on locational considerations and private sector interest.

C. Stimulate Local Demand

- **Decarbonisation Plans:** Domestic demand for green hydrogen stems mainly from the need to decarbonise hard-to-abate sectors. Hydrogen generated within the province will be used to decarbonise hard-to-abate sectors such as heavy vehicle transportation, aviation and marine transport and various forms of manufacturing, including fertilisers and other ammonia-based end-products, cement production, petrochemicals, and heat-intensive non-ferrous and non-metal industries. Decarbonisation of critical value chains will safeguard the competitiveness of exports and vital economic sectors including manufacturing, agriculture, and tourism. The production of green steel in the Western Cape will serve as a high value export commodity and a crucial input for the manufacture of exported goods across South Africa. Driving decarbonisation, in line with South Africa's NDCs, relevant legislation, and the Western Cape Climate Change Response Strategy: Vision 2050, the Western Cape will contribute towards the creation of a sustainable market for domestic use of green hydrogen.

- **Public procurement for green hydrogen:** The Western Cape will investigate opportunities for public procurement of green hydrogen in the development of local off-take at the provincial and local government levels. Public procurement will be used to create demand for green hydrogen and its related technologies. This will assist in reducing costs and increasing investment in the sector. Public procurement will also be used to support the development of local supply chains, encouraging innovation in the sector.

D. Catalysing Export

- **Leverage International Partnerships:** The significant differences in renewable energy resources between South Africa and major centres of demand in the EU, Japan and South Korea present a significant opportunity for exports of green hydrogen and its derivatives. This is further supported by growing international collaboration, exemplified by the International Partnership Group (IPG) commitment to South Africa's Just Energy Transition Investment Plan (JET IP). Efforts are underway to unlock international green hydrogen trade, including the H2Global mechanism and the European Hydrogen Bank. These financial mechanisms need to be complemented with the first concrete volume off-take projects. Such projects will build confidence with international and local investors. The Western Cape will, therefore, support the nurturing and fast tracking of lead projects aimed at producing and exporting green hydrogen at volume. The WC H2 PMU aims to facilitate engagement with countries and aggregators on off-take of green hydrogen.

E. Industry-scale-up Support

- **Project Preparation Support:** The Western Cape aims to support and encourage the leveraging of development finance and international grants to support the development of green hydrogen project. In addition, the province will support and encourage feasibility studies to assess the technical and economic viability of green hydrogen projects and engage with stakeholders to identify opportunities for collaboration, ensuring that projects are aligned with local needs and priorities.

- **Funding and Financing:** The Western Cape aims to support and encourage funding and financing of green hydrogen in the province, primarily through access to public and private funding sources, such as the SA-H2 Fund, a dedicated green hydrogen fund aimed at facilitating and accelerating the development of a green hydrogen sector and circular economy in South Africa.

6 Roles and Responsibilities

The Western Cape Green Hydrogen Strategy and Roadmap envisages a highly collaborative partnership model to drive the development of the Green Hydrogen economy. While it is proposed that the Western Cape Government and the Programme Management Unit (PMU) will lead and provide strategic oversight, it is recognised that several private and public sector stakeholders will play an important role. Collaborative work with the Eastern Cape and Northern Cape will also take place where it aligns with the Three Capes MoU.

The table below summarises the key stakeholder groupings, their relevance and envisaged role and responsibility in supporting the Western Cape Green Hydrogen Strategy and Roadmap. The precise programmatic details of the strategy implementation will be developed once the strategy is adopted.

#	Stakeholder	Relevance	Role & Responsibility
1	Office & Department of the Premier (WCG)	Programme Sponsor and Political Champion	• Alignment with WC Energy Resilience Programme • Political support • Inter-governmental relations • Investment promotion
2	GH2 PMU (WCG)	Programme management	• Programme development • Implementation support • Partnership development • Resource mobilisation • Coordination • Monitoring & evaluation
3	Saldanha SEZ	Primary GH2 Hub and Export Port	• Land and infrastructure including infrastructure master planning • Investment attraction • Business and project support • Stimulation of the local market and manufacturing opportunities • Export support • Value chain development
4	Department of Economic Development & Tourism (WCG)	Custodian Western Cape Growth for Jobs 2035 Strategy	• Policy, advocacy and strategic direction • Strategic oversight • Alignment to Provincial Strategy • Coordination role – within WCG and liaison with public sector stakeholders, nationally and internationally • Partnerships and eco-system support
5	WESGRO (WCG)	GH2 Strategy development lead	• WC GH2 Strategy Development and project management • Trade and investment promotion • Export support • Investment facilitation support, together with the SEZs or outside of them
6	Provincial Departments (WCG): Environmental Affairs and Development Planning Infrastructure; Provincial Treasury and Mobility	Policy, Regulatory and Investment functions	• Regulatory approvals • Identifying land availability identification • Infrastructure development • Provincial transport • Provincial procurement • Funding
7	National Departments: Infrastructure SA, Agriculture, Land Reform and Rural Development; Cooperative Governance; Forestry, Fisheries and Environment; Mineral Resources and Energy; Public Enterprises; Science and Innovation; Trade,	Policy, Regulatory and Investment functions	• Regulatory approvals • Coordination of national entities (this will be particularly Infrastructure SA's role) • Infrastructure development • Funding • Incentives • Sector and Skills Development support

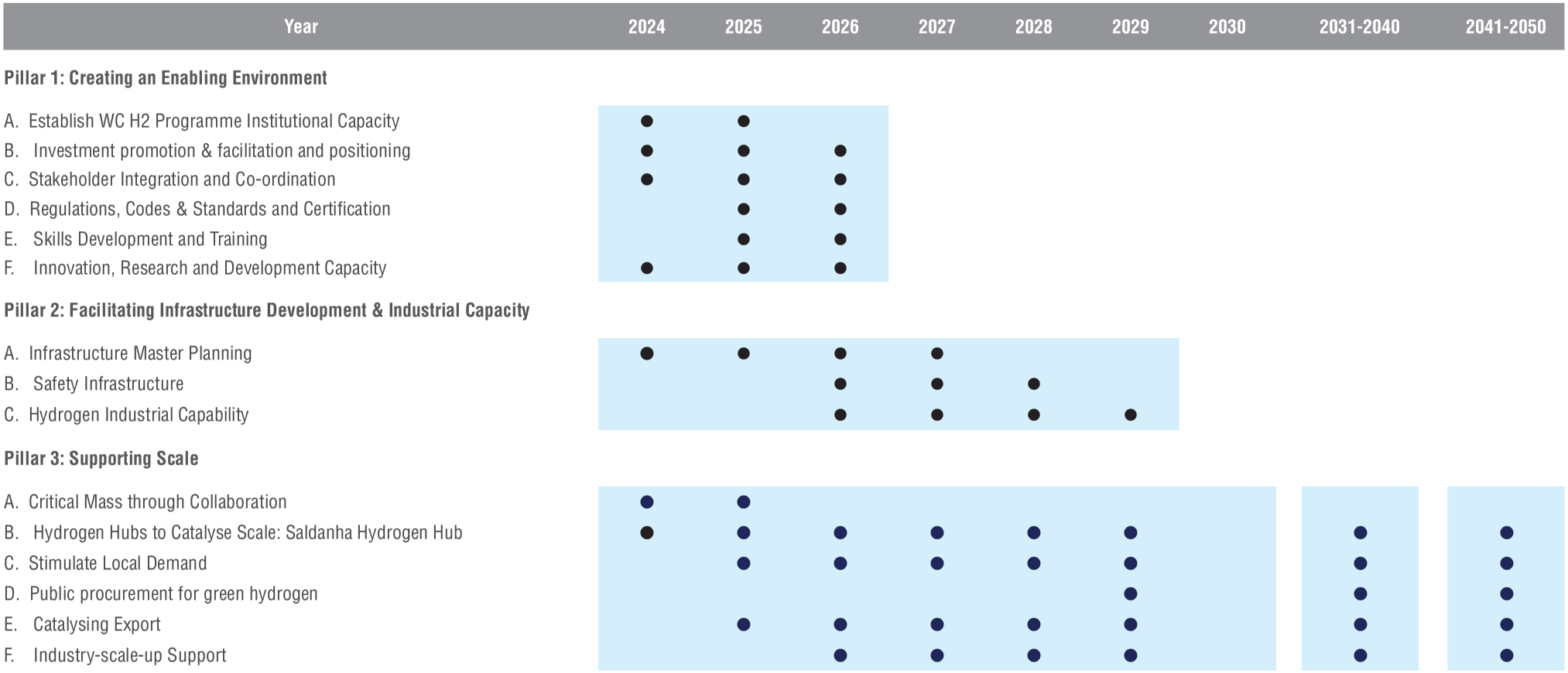
#	Stakeholder	Relevance	Role & Responsibility
	Industry and Competition; and National Treasury		
8	Northern Cape Province	Key regional partner (Renewable energy) MoA signatory	• Supply of renewable energy • Green hydrogen production for potential export through Saldanha • Regional infrastructure • Trade and investment coordination • Three Cape MoU collaboration
9	Eastern Cape Province	Key partner MoU signatory	• Supply of renewable energy • Regional infrastructure • Trade and investment coordination • Three Cape MoU collaboration
10	Municipalities including: City of Cape Town Metropolitan; Cape Winelands District Central Karoo District, West Coast District, Saldanha Bay, Mossel Bay, Garden Route District	Planning, regulatory and investment functions Potential off takers	• Regulatory approvals • Identifying land availability Infrastructure development • Offtake of GH2 • Water reticulation (water services authority)
11	Atlantis SEZ	GH2 Value Chain / Industrialisation Partners	• Land and infrastructure • Investment attraction • Value chain development
12	Transnet National Ports Authority (TNPA)	Operator of Port, Rail and Pipeline infrastructure	• Infrastructure planning, investment and upgrades • Operations • National logistics demand modelling and planning
13	Eskom, including the National Transmission Company	Operator of Electricity Infrastructure	• Infrastructure planning and investment • Operations • Grid Connection • Power Purchase Agreements • Wheeling agreements where necessary
14	Industry Associations: Sustainable Energy Society of Southern Africa; Association for Renewable Energy Practitioners; others	Private sector representative bodies Partners to strategy	• Collaborative planning • Sector and investment needs identification • Member mobilisation
15	Private Firms	Primary project developers and investors Domestic off-takers	• Project development • Investment • Operations • Input into infrastructure, funding, and investment support needs • Domestic GH2 off-take
16	SA DFIs: Development Bank of Southern Africa and Industrial Development Corporation	Infrastructure and Project Funders	• Funding availability • Technical assistance to projects • Feasibility study support • De-risking instruments

#	Stakeholder	Relevance	Role & Responsibility
17	International DFIs and Funders: e.g. World Bank, GIZ, KfW Development Bank. AFD, Proparco, Invest International, UK PACT others	Infrastructure and Project Funders	• Funding and grants • Technical assistance to projects • Feasibility study support • De-risking instruments
18	Country partners: European Union, Germany, Netherlands, Belgium, Denmark, Japan, South Korea	Country/region strategies and green hydrogen targets Specification and regulation of green hydrogen imports Carbon taxes	• Provide clarity on requirements for GH2 and derivative specifications. • Technical assistance • Funding for Green Hydrogen technical work • Bilateral and multilateral cooperation to establish international green hydrogen trade
19	Certification bodies (CertifHy, TÜV SÜD) and certification service providers (TÜV SÜD, Bureau Veritas)	Development of GH2 certification schemes Auditing of GH2 production	• Green hydrogen certification
20	International Off-takers and intermediaries: Port of Rotterdam and other ports, European Hydrogen Bank, H2 Global, shipping lines, airlines	Green Hydrogen off- take Import logistics	• Export off-take • Export logistics • Bunker-fuel off-take • SAF off-take
21	South African Financial Sector: BASA and key Investment Banks	Project Financing	• Project finance
22	Universities and Research Institutes: University of Cape Town, University of the Western Cape; Stellenbosch University, Stellenbosch University, Cape Peninsula University of Technology, CSIR	Knowledge partners	• Technology and innovation development and expansion for GH2 • Skills Development for GH2

7 Western Cape Green Hydrogen Roadmap

The Western Cape Green Hydrogen RoadMap envisages key enablers and critical investment requirements addressed over the next ten years. These lay the foundation for the further growth and expansion of the green hydrogen economy in the province. The roadmap forms the basis of a detailed action plan, including measurable milestones, to be developed by the PMU, in consultation with key stakeholders.

Figure 7: Roadmap for the Western Cape Green Hydrogen Economy



Priority Actions

The Western Cape Province has committed itself to the following priority actions in the immediate term.

Figure 8: Priority Actions

8 Acknowledgements

The Western Cape Green Hydrogen Strategy and Roadmap represents the combined effort of stakeholders from various facets of the South African sustainable development landscape. These stakeholders have participated in the development of this publication, either as interviewees, reviewers, advisors or as organisations sharing information. The Western Cape Government wishes to express its sincere gratitude to the following stakeholders for their contributions and insights:

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9 Appendices

9.1 Appendix A - Data Sources, Assumptions, and Limitations

Data Sources:

The data used in formulating the Western Cape demand estimates relied predominantly on secondary sources. The primary source of information for the demand projections was the South Africa GHCS. The GHCS itself was formulated based on a comprehensive analysis guided by the Green Hydrogen Panel, appointed by the President, reflecting both national export potential and domestic demand across various sectors.

Assumptions:

GHCS adopted as authoritative data source: the strategy assumes that the South Africa GHCS was crafted by means of a meticulous and thorough process, guided by the insights and expertise of the Green Hydrogen Panel. This assumption forms the foundational basis for extrapolating demand projections for the Western Cape.

Domestic sectoral demand: the GHCS estimates encompass diverse sectors, including Power (Storage and Grid Balancing), Green Ammonia, Methanol, Cement, Non-Ferrous Metals, Green Steel, Refining, Chemicals (CTL, GTL), and Transport (Mining Mobility, Road Transport FCVs, and HDVs). The Western Cape Green Hydrogen Strategy assumes a proportional allocation of these demands to the Western Cape.

Export demand: to evaluate South Africa's potential export demand, the GHCS analysed the global import market for hydrogen, focusing on key import destinations such as the European Union, Japan, South Korea, and the United Kingdom. The analysis revealed a projected global import market for hydrogen ranging between 4 and 27 Mt annually, by 2050.

Various studies and assessments, including a global hydrogen model by PwC and the International Energy Council, presented divergent scenarios for South Africa's potential share in this market. The estimations for 2050 span a spectrum from 1.9 million to 8 million tonnes annually. Considering factors like renewable resources, infrastructure investments, and policy frameworks, South Africa's estimated share of the export market stands at approximately 7%, translating to an export range of 1.5 million to

1.9 million tonnes annually. Achieving a larger market share would necessitate competition with countries like Morocco, Russia, Chile, Saudi Arabia, and Australia.

Adjustment of Domestic and Export Demand to Provincial Level:

The GHCS demand estimates were adjusted to the provincial level within the Western Cape as follows:

- Western Cape Export Demand: it is assumed that the Western Cape, being an early adopter geared for bulk green hydrogen exports, will initially facilitate a significant portion of South Africa's exports through the Port of Saldanha. Subsequently, as additional export facilities come online nationwide, the Western Cape's share of South African exports is projected to decrease gradually. However, within this shift, the volume of exports from the Western Cape is anticipated to grow to a range between 350,000 to 500,000 tonnes.
- Western Cape Domestic Demand: for most sectors, including Green Ammonia, Methanol, Cement, Non-Ferrous Metals, and Transport (Mining Mobility, Road Transport FCVs, and HDVs) it is assumed that the Western Cape Demand will be a share of the national demand that is proportional to the size of the Western Cape Economy to the national economy. For the Refining and Chemicals and Steel Sector, the following assumptions were made:
- Refining and Chemicals: Considering the magnitude of Sasol's current grey hydrogen demand, it is assumed to dominate the refining and chemicals demand estimate in the GHCS.

- Sasol's current operations are located at Secunda in the Mpumalanga province and Sasolburg in the Free State province. In this strategy, it is assumed that the demand at Secunda and Sasol will not be served from the Western Cape. Sasol is, however, devising a feasibility study for green hydrogen production in the Western Cape which could supply green hydrogen within the Western Cape province. In addition, should the Astron adopt low-sulphur standards for its fossil fuel refining activities or if it should engage in future low-carbon fuel production, some demand in this sector can be expected in the Western Cape, but not proportional to the national projection.

- Green Steel: Given the presence of South Africa's only Direct Reduced Iron (DRI) plant at Saldanha Works, the province is presumed to represent the bulk of hydrogen demand for green iron and steel production, aligning with projections for hydrogen in green steel corresponding to Saldanha Works' hypothetical full conversion to hydrogen-based iron reduction processes.

- Western Cape Economic Growth: a further assumption used in the Western Cape demand estimation is that the province's economy will grow as a percentage of the national economy form just over 14% to 19%.

These assumptions result in the scaling factors from the GHCS national levels to Western Cape provincial levels depicted in the table below:

Western cape demand scaling

	2025	2030	2035	2040	2045	2050
Export Demand	100,0%	50,0%	40,0%	35,0%	35,0%	35,0%
Demand as Green Ammonia (H2 component)	14,2%	15,2%	16,2%	17,2%	18,2%	19,2%
Power - Storage and Balancing	14,2%	15,2%	16,2%	17,2%	18,2%	19,2%
Demand as Methanol	14,2%	15,2%	16,2%	17,2%	18,2%	19,2%
Industry - Cement, Non-Ferrous Metals	14,2%	15,2%	16,2%	17,2%	18,2%	19,2%
Industry - Green Steel	100,0%	100,0%	100,0%	100,0%	100,0%	100,0%
Refining, Chemicals - CTL, GTL	2,0%	2,4%	2,8%	3,2%	3,6%	4,0%
Transport	14,2%	15,2%	16,2%	17,2%	18,2%	19,2%

Calculation of economic and environmental impacts

The economic impacts, including GDP effects, employment, fixed investment, taxes and balance of payments as well as GHG emissions resulting from the implementation of this strategy were estimated through scaling of an economic impact model developed to estimate the effects of the GHCS's national impacts for the Western Cape, by using the demand scaling presented above.

The socio-economic impacts were calculated using an Economic Impact Assessment model developed by RebelGroup that is based on Leontief methodology which uses economic multipliers to estimate direct, indirect and induced effects of capital and operational expenditure in the green hydrogen value chain using Type II multipliers.

In economic impact analysis direct, indirect, and induced effects refer to different levels of impact resulting from a specific activity or investment, like those associated with the Green Hydrogen Commercialization Strategy (GHCS):

- Direct Effects: These represent the immediate impacts of an economic activity or investment. In the context of the GHCS, direct effects would include the jobs created and economic output generated directly from green hydrogen projects, such as constructing and operating renewable energy facilities, electrolysis plants, and related infrastructure.

- Indirect Effects: Indirect effects capture the secondary impacts in the supply chain. They result from the procurement of goods and services necessary for the primary (direct) activity. For example, in the GHCS, indirect effects might include the increased business for suppliers of materials, components, and services required for green hydrogen projects, like solar panels, wind turbines, or electrolysis equipment.

- Induced Effects: These effects arise from the increased spending in the broader economy due to the income generated by direct and indirect activities. When employees and business owners earn income from GHCS projects and related activities, they spend it on goods and services like housing, food, and transportation, leading to a ripple effect that further stimulates the economy.

The methodology relies on economic multipliers and a mapping of the value chain. RebelGroup developed custom multipliers for the green hydrogen sectors that are composed of various stages such as renewable electricity generation, electrolysis, transport of green hydrogen and end-use and which take into account the proportion of capital equipment value that will have to be imported (higher local content leads to greater effects in South Africa). The economic multipliers are based on om Quantec's Supply and Use Tables (SUT) for South Africa. To estimate the Western Cape impacts, the CAPEX and OPEX values were scaled in proportion to the demand estimates provided in the WC Green Hydrogen Strategy and Roadmap.

GDP, jobs and tax revenues were calculated using the multipliers as explained above.

Balance of payments was assessed by estimating the changes in imports and exports resulting from the GHCS. This includes direct exports of green hydrogen (e.g., as ammonia) and import substitution (e.g., reduced imports of fossil fuels) as well as imports of capital equipment.

The CO2 emissions reduction was calculated by assessing the anticipated usage of green hydrogen across industries in 2030, 2040, and 2050, comparing it with baseline scenarios where fossil fuels remain the primary energy source.

The economic impacts were calculated for three specific years (2030, 2040, and 2050), with intermediate years interpolated through cubic monotone spline interpolation. As in the other cases, values were scaled to the Western Cape Demand estimates.

Limitations:

- Reliance on Secondary Data: the absence of primary data collection poses inherent limitations. Reliance solely on secondary data introduces the risk of overlooking localised nuances or specific regional variations that might impact the accuracy of the demand estimates for the Western Cape.

- Generalisation of National Projections: extrapolating national projections to a regional scale might oversimplify the unique dynamics of the Western Cape. Variations in economic, industrial, or infrastructural landscapes could potentially lead to deviations from the projected demands.

Dynamic Nature of Industries: industrial sectors, especially those listed for hydrogen adoption, are subject to dynamic changes, influenced by technological advancements, policy alterations, and market fluctuations. The estimates might not fully encompass unforeseen developments or shifts in these sectors.

External Factors: The estimates within the GHCS and subsequently utilised in the Western Cape Green Hydrogen Strategy are contingent on external factors, such as global market trends, geopolitical dynamics, and regulatory frameworks. Changes in these elements could affect the accuracy of the projections.

9.2 Appendix B – The role of green hydrogen in the electricity system

This section considers three roles that Hydrogen can play in an electricity system, namely as a:

1. **Zero carbon fuel to produce electricity** – in this case green hydrogen would be used like a conventional fuel to generate electricity, either by powering a hydrogen powered generator or through a hydrogen fuel cell that directly converts hydrogen to electricity. In general, this is an inefficient use of hydrogen and an inefficient way to generate electricity, compared to directly generating electricity from renewable or other zero carbon sources (such as nuclear power). However, there a few cases where is makes sense to generate electricity from green hydrogen. These include:

    - **Insufficient exploitable renewable capacity:** where the renewable resource is insufficient, due to poor wind or solar potential, or where the availability of land prevents the construction of adequate renewable energy generation capacity, it makes sense to use green hydrogen to generate electricity.

    - At a country scale, this applies to Japan and South Korea, which both plan to import green hydrogen to generate electricity as this would be more efficient than generating renewable energy in these countries, due to space limitations and less favourable renewable endowments (IRENA, 2022 pp 44 and 55). This case does not apply to South Africa, in general, and even less so to the Western Cape.

    - **Inadequate transmission or distribution capacity:** In regions where access to grid electricity is limited, or non-existent, and where renewable electricity cannot be generated locally, green hydrogen for electricity generation can be a viable option.

    - **Backup and generation and temporary power generation:** most residential and commercial backup electric power, as well as a substantial portion of utility scale peaking power, is currently generated from Diesel which is both expensive and inefficient. At current diesel fuel prices, green hydrogen is competitive with diesel fuel at a price as high as €8 per kg. However, this does not consider the required CAPEX investment which is currently 3 to 4 times higher for hydrogen fuel cell generation than diesel generation.

2. **Store of electric energy** – Hydrogen can act as an energy store i.e. using electricity to generate hydrogen when there is excess electric power available, and the hydrogen is then used to generate electricity through hydrogen fuel cells or hydrogen powered turbine generators when demand exceeds generation capacity.

In this case, hydrogen acts as a type of battery. In electricity systems, demand never perfectly matches supply. This problem can be managed through variable dispatchable supply, curtailment, load shedding or grid scale storage of electricity. As the percentage of intermittent renewables, such as wind and solar, increases, the need for utility scale storage increases.

For short term storage (less than 16 hours), lithium-ion battery storage is more efficient than hydrogen storage. However, for long term seasonal storage, hydrogen may be more efficient. In countries with large seasonal variations in renewable energy potential hydrogen is a viable option for storing electricity during high production months and generating electricity during low renewable phases.

3. **Grid stabilisation through hydrogen and renewable electricity cogeneration** – a third case for hydrogen in an electricity system with high renewables is leveraging co-generation and optimisation of renewable energy generation and hydrogen production. In an electricity system with a high penetration of renewables both supply and demand are variable which could lead to losses through curtailment when supply exceeds demand or the need for peaking supply or storage when demand exceeds supply. By “overbuilding” renewable energy generation capacity, the second case of demand exceeding supply can be minimised, but this would normally lead to a higher need for curtailment. However, by integrating hydrogen generation into the system curtailment can be avoided by utilising this spare electricity for electrolysis. An example of this approach is provided in an analysis by Das et al. (2024) who show that a combined renewable energy and hydrogen production system could produce electricity at $0.252/kWh and $ 2.59/kg.

Implications for the Western Cape

Table 1 summarises the implications of the preceding discussion for the Western Cape.

Table 1 Implications of the three RE-GH2 use cases for the Western Cape

Green hydrogen use case in the electricity grid	Potential of the use case for the Western Cape	Knowledge gaps	Recommendation
1. Zero carbon fuel to produce electricity	• Transition to GH2 based backup at residential and commercial levels • Utilise pure GH2 or high percentage GH2 peaking in peaking plants • Power remote locations unable to produce own RE with GH2 generated electricity	• What is the levelized cost of hydrogen- based backup systems vs diesel? • Is there a need for new peaking plants and what is the potential for conversion of existing plants to pure GH2 or blended GH2? • Is there a need for remote off-grid power in the WC?	• Study GH2 potential for backup and other temporary / intermittent generation requirements • Determine status quo and likely scenarios for peaking plants. • Determine need for remote off-grid generation
2. Store of electric energy	• Long term storage of electrical energy	• Is there a need for seasonal storage in the WC?	• Analyse storage requirements for optimal grid level storage under different RE penetration scenarios
3. Grid stabilisation through hydrogen and renewable electricity cogeneration	• Consider overbuilding renewable energy generation capacity to allow co-generation of electricity (for non- GH2 uses) and green hydrogen	• Can cogeneration for GH2 production and electricity help meet Provincial energy targets (5,700MW)? • What electricity and renewable energy infrastructure is required to enable cogeneration of electricity and GH2? • What market models will incentivise co- production of electricity and GH2? • What are the requirements for green hydrogen certification under co- production model?	• Develop model and study the potential of cogeneration of RE and GH2 at provincial level • Develop Provincial IRP based on coproduction paradigm • Develop infrastructure master plan

9.3 Appendix C – References:

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