

WEST COAST GREEN HYDROGEN MASTER PLAN

PHASE 1



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Funding:

Saldanha Bay IDZ Licencing Company SOC Ltd (Trading as Freeport Saldanha), Western Cape Government - Department of Economic Development and Tourism

Formatting:

Magdel van der Merwe (DTP Solutions)

Date of publication:

February 2026

Recommended Citation: Moodley, D., Maritz, J., Schreiner, G., Snyman Van der Walt, L., Coetzee, R., Abed, R., Lochner, P., Jele, J., Roos, T., Nqoko, L., Rathogwa., Mans, G & Meyer, I. (2026) *Phase 1 of the West Coast Green Hydrogen Master Plan: Guiding the Establishment of the Saldanha Hydrogen Hub*. CSIR: Stellenbosch. CSIR report number CSIR/SPLS/Ems/ER/2026/0001/A

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WEST COAST GREEN HYDROGEN MASTER PLAN PHASE 1

EXECUTIVE SUMMARY

The West Coast region, anchored by Saldanha Bay, is emerging as a strategic hub for South Africa's green hydrogen (GH₂) and Power-to-X (PtX) economy. The region's unique combination of natural resources, industrial capacity and established port and logistics infrastructure, coupled with proximity to abundant renewable energy resources, provides a strong foundation for large-scale, cost-competitive GH₂ production. In addition, the Special Economic Zone (SEZ) status of the port and Freeport area provides strong business incentives, further enhancing the port's attractiveness for large-scale GH₂ production and export. Supported by provincial and national hydrogen ambitions and recognized internationally through initiatives such as the World Economic Forum's Transitioning Industrial Clusters program, the West Coast has the potential to become one of the cornerstones of South Africa's green industrial transition, driving investment, decarbonization and regional economic growth.

Realizing this potential will require large-scale investments in energy and water supply systems, along with production and storage infrastructure. The speed, scale, and intensity envisaged under national ambitions could result in unforeseen cumulative consequences. Given these uncertainties, a comprehensive master plan is essential to guide sustainable development across the port, SEZ and the West Coast GH₂ Hub. Developing such a master plan requires a data-driven, phased approach to support informed decision-making at both the site and regional scale.

Phase 1 of the West Coast GH₂ Master Plan, which commenced in March 2025 focuses on a high-level analytical review of infrastructure and land use planning, transport and distribution and socio ecological sustainability in relation to GH₂ ambition for the region. This review is supported by focused expert led stakeholder engagement through a Project Steering Committee and Working Group. The overall aim of this Phase 1 was to identify the most salient strategic, technical and regulatory questions facing GH₂ development, frame the critical issues, and highlight knowledge gaps necessary to support sustainable rollout across the West Coast region. To explore the cumulative impacts of GH₂/PtX development at scale, an explorative scenario approach was adopted, informed by five major GH₂ projects (in their mature stages of assessment) serving as archetypes for GH₂ narratives. This framework ensures that planning aligns with national strategies while remaining responsive to local development realities.

The findings from this Phase 1 Master Plan highlight both opportunity and complexity. The envisaged scale of GH₂ development in the region raises several challenges related to cumulative ecological, resource and social impacts. While the West Coast possesses strong renewable resources, available industrial land and existing infrastructure capacity are increasingly constrained. The SEZ, Besaansklip Industrial Zone and surrounding areas are already partially developed, with several land parcels subject to high environmental offset ratios or designated for other uses. While these proactive conservation measures provide a strong foundation for enhanced environmental stewardship, they underscore the need for integrated spatial planning, strategic land banking, investigation of multi nodal SEZ configurations and shared infrastructure corridors to maintain flexibility, manage cumulative impacts, and prevent fragmented development

Regional landscape suitability modelling revealed that renewable energy development opportunities are more pronounced further away from Saldanha Bay in the more northern parts of the West Coast region where renewable energy resources are more favorable. Further, the West Coast region could theoretically support sufficient renewable energy development to meet GH₂ production ambitions five-fold, offering opportunities to locate generation facilities

away from incompatible or sensitive environmental and social features. However, constrained grid capacity, high wheeling costs, and fragmented grid expansion proposals present challenges that must be addressed to align electricity supply with GH₂ ambitions.

Regulatory clarity also emerged as a critical issue. While permitting, safety, and environmental processes are already in place, there exist some ambiguity across the value chain from production and storage to transport and end use, resulting institutions without clear mandates and developers. In addition, although municipalities in the region recognize that the production of GH₂ might have considerable consequences, planning frameworks have yet to fully integrate GH₂ ambitions. Alignment with international best practices is essential to provide a predictable investment environment and ensure that hydrogen development contributes meaningfully to the Just Energy Transition. Building on these findings, Phase 1 recommends that Phase 2 shift from strategic framing to implementation readiness, with a focus on four key areas.

- Cumulative Impact Assessment, Thresholds and Life Cycle-Informed Planning
 - Detailed cumulative impact assessments and life cycle–informed planning should be undertaken to quantify the combined footprint of production and transport infrastructure, define thresholds for sustainable resource use and provide insight into trade-offs between cost-optimal and most sustainable transport modes
- Alignment of Provincial and Municipal Planning with GH₂ Ambitions and Strategic Infrastructure
 - Spatial and municipal planning frameworks must be aligned with GH₂ infrastructure needs, supported by land consolidation strategies, land banking, and the exploration of multi-nodal SEZ configurations to accommodate all value chain components.
- Strengthening regulatory clarity and adaptive permitting pathways
 - Clear guidance for producers, provincial and regulating authorities can assist in identifying and effectively interpreting relevant regulations to ensure projects meet lender and offtake requirements. Legal and sectoral experts should be engaged to diagnose specific barriers and develop a strategic outlook on environmental authorizations to establish streamlined permitting processes tailored to the needs of the Hub. To support this an actionable dynamic implementation plan should be developed to provide insight into the formation of governance/coordination structures (task teams) to oversee infrastructure delivery, inter-governmental alignment, and shared investment in common-use infrastructure.
- Scenario Modelling for Strategic Infrastructure Capacity and Phasing
 - Scenario-based modelling and simulation tools should be developed to support electrical grid, water, and transport planning, and to inform phasing, identify bottlenecks, and align capacity with demand. It is recommended that supply and distribution networks be captured via a dynamic map which includes feedstock flows, derivative products, and supporting supply chains for key industries such as steel, ammonia, and cement. The establishment of the South African Wholesale Energy Market should also be closely monitored as it has the potential to enhance the electricity landscape, improve the grid efficiency and facilitate investment.

Phase 1 has established a foundation by identifying uncertainties in infrastructure and land-use planning, transport and distribution, and socio-ecological sustainability, setting the stage for more detailed, targeted work. Phase 2 should focus on deepening understanding, enhancing coordination, and building the institutional and technical capacity needed to translate the Master Plan into spatially grounded, implementable strategies. Digital and systems-based tools should be a defining feature of Phase 2 enabling simulation of cumulative impacts, streamlined environmental authorizations, and coordinated planning. These tools, alongside strengthened institutional collaboration between municipalities, provincial departments, and national agencies, will be critical in moving from high-level strategy to implementation readiness. Phase 2 will also advance socio-economic readiness by assessing community perceptions, local capacity, and opportunities for employment, skills development, and conservation-linked initiatives. Proactive engagement and co-investment mechanisms will ensure that the benefits of hydrogen-driven industrialization are broadly and equitably shared, supporting a sustainable and resilient West Coast Hydrogen Hub.

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GLOSSARY OF ACRONYMS AND ABBREVIATIONS:

AMSA	ArcelorMittal South Africa
ASU	Air Separation Unit
CGH ₂	Compressed Gaseous Hydrogen
CSIR	Council for Scientific and Industrial Research
DAC	Direct Air Capture (CO ₂ capture technology)
DFFE	Department of Forestry, Fisheries and the Environment
DITP	District Integrated Transport Plan
DSTI	Department of Science, Innovation and Technology
EIA	Environmental Impact Assessment
ESKOM	Electricity Supply Commission of South Africa
GHG	Greenhouse Gas
GIS	Geographic Information System
GH ₂	Green Hydrogen
GH ₂ e	Green Hydrogen equivalent
IDP	Integrated Development Plan
JET PMU	Just Energy Transition Project Management Unit
LNG	Liquefied Natural Gas
LOHC	Liquid Organic Hydrogen Carrier
LH ₂	Liquid Hydrogen
NERSA	National Energy Regulator of South Africa
NTCSA	National Transmission Company South Africa
MSDF	Municipal Spatial Development Framework
OREX	Ore Export Railway (Sishen-Saldanha ore corridor)
PtX	Power-to-X (conversion of hydrogen to other energy carriers)
SAF	Sustainable Aviation Fuel
SBIDZ	Saldanha Bay Industrial Development Zone
SBM	Saldanha Bay Municipality
SEZ	Special Economic Zone
TNPA	Transnet National Ports Authority
TOC	Train Operating Company
VOC	Volatile Organic Compound
WCDM	West Coast District Municipality

GLOSSARY OF TERMS:

Circular Economy	An economic model focused on reducing waste and reusing resources to create closed-loop systems.
Common-User Infrastructure	Shared infrastructure facilities (such as pipelines, desalination plants, storage tanks, or port handling facilities) used by multiple developers or industries.
Cumulative Impacts	Impacts that result from the incremental impact of the proposed activity on a common resource when added to the impacts of other past, present or reasonably foreseeable future activities. Cumulative impacts can occur from the collective impacts of individual minor actions over a period of time and can include both direct and indirect impacts.
Environmental Authorisation	Formal approval granted by authorities for a project following environmental assessment and public participation.

Freeport/SEZ	A designated economic zone offering business and tax incentives to attract investment and promote industrial development.
GH ₂	Hydrogen produced using renewable energy sources (such as wind, solar, or hydro), with minimal or no greenhouse gas emissions. While production in the West Coast region is expected to mainly use electrolysis, other production methods exist.
GH _{2e}	Green hydrogen equivalent quantifies the amount of pure green hydrogen contained in or required to produce a hydrogen-derived product.
Green Steel	Steel produced using hydrogen instead of fossil fuels, reducing carbon emissions in the production process.
PtX	Conversion of renewable energy into other energy carriers or products such as green ammonia, methanol, synthetic fuels, or heat.
Sustainability Thresholds	Quantitative or qualitative limits defining the point beyond which environmental or social systems may not recover from degradation.
Wheeling	The process of transporting electricity from a generator to an end-user through a third-party's transmission or distribution network.

1 VISION, POLICY CONTEXT AND APPROACH

1.1 Vision for the West Coast Industrial Hub

Underpinned by a combination of good natural resources, industrial capacity, and existing logistics infrastructure, Saldanha Bay, and the broader West coast region is emerging as one of South Africa's most strategically positioned hubs for the development of a potential green hydrogen (GH₂) and Power-to-X (PtX) economy (see Box 1). The Saldanha Bay Industrial Development Zone (SBIDZ), designated in 2013 as part of the National Development Plan (NDP) and New Growth Path (NGP) frameworks, under the Manufacturing Development Act, 1993 (Act No. 87 of 1993), is central to this positioning. With the promulgation of the Special Economic Zones Act (SEZ) (Act No. 16 of 2014), all previous IDZs, including SBIDZ, were brought under new SEZ legislation, aligning the SBIDZ with a national framework for investment incentives, governance frameworks, and economic coordination.

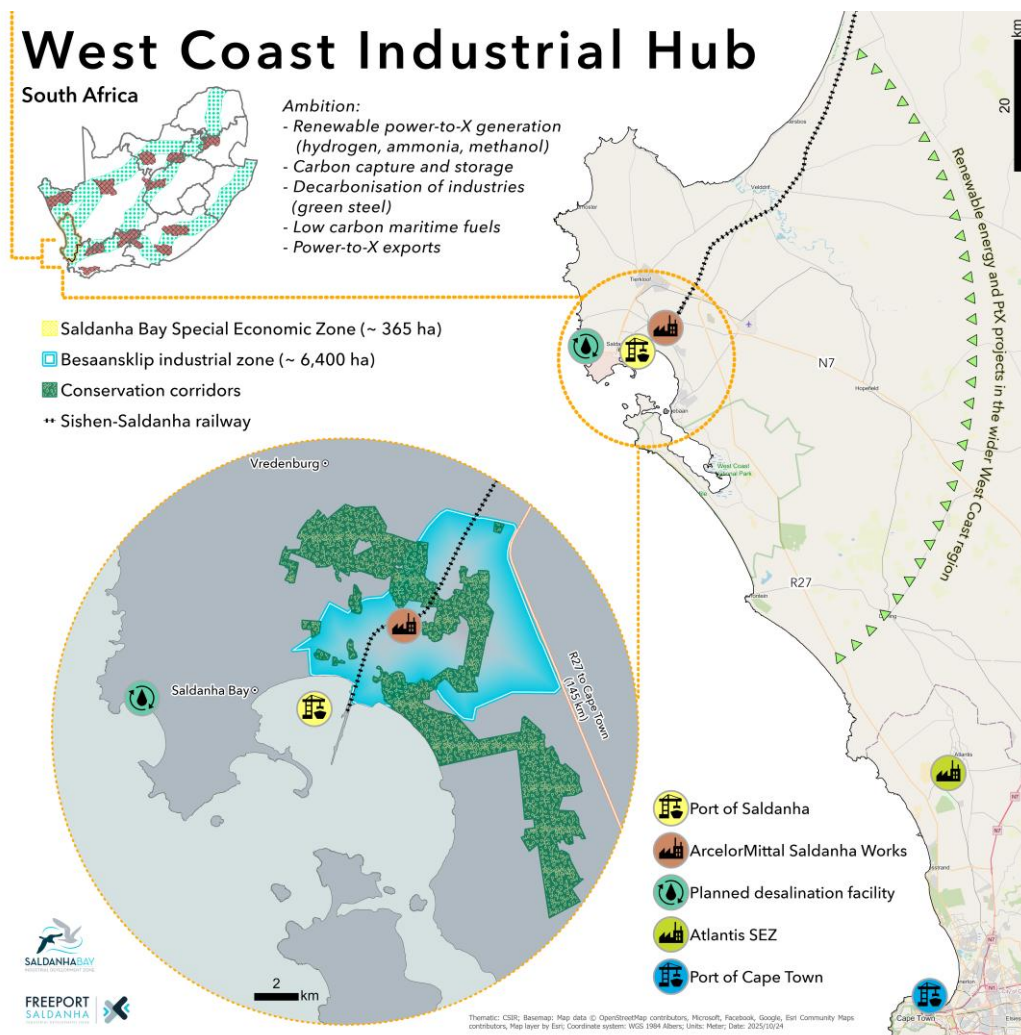


Figure 1: Overarching GH₂/PtX ambitions for the West Coast Hub highlighting Saldanha Bay's role as a strategic energy and industrial development zone in South Africa. It illustrates planned infrastructure including the port, industrial zones, desalination facilities, and PtX projects. The hub is positioned to drive decarbonisation of industries, low-carbon fuel production, and green exports.

The SBIDZ is 356 hectares (ha) and located within the Saldanha Bay municipal area in the Western Cape. It focuses primarily on industrial activity across energy, maritime, oil and gas (upstream, midstream, and downstream), marine repair, fabrication, and logistics (Figure 1). Other active sectors near the SEZ include mining, steel, aquaculture, fishing, agriculture and tourism (SBIDZ, 2023a).

The deep-water Port of Saldanha, with six berths and 23 m draft, offers direct access to global shipping routes, with dedicated rail links to Northern Cape iron ore mines and national and regional road corridors (N1, N2, N7, R27) that support efficient domestic and export logistics (Transnet Ports Authority, 2010). Freeport status further enhances Saldanha's suitability for large-scale GH₂/PtX production and export. The West Coast region's substantial renewable energy potential enables cost-competitive electricity for electrolysis and downstream processing, aligning with the Western Cape Green Hydrogen Strategy and Roadmap (May 2024) and national initiatives such as the Department of Science and Innovation (DSI) Hydrogen Society Roadmap (DSI, 2021).

Saldanha Bay has benefitted from a growing skills base and research capacity, with over 1 300 participants involved in SBIDZ development programmes, regional universities, and training through the SMART Skills Centre and regional universities offering hydrogen research and specialist training (SBIDZ, 2023b). Catalytic projects such as ArcelorMittal's green steel initiative (2023)¹, and Atlantia Green Hydrogen Project², together with the Western Cape Energy Resilience Programme (2025)³, together with global recognition through the World Economic Forum's Transition Industrial Clusters initiative⁴, demonstrate the region's strategic role in South Africa's GH₂ transition and its potential as a globally competitive export hub. Global policy, market shifts and EU support, have further reinforced Saldanha's potential advantage.

Box 1. What is a GH₂/PtX Hub?

The term hydrogen hub refers to an integrated network of infrastructure related to the production, storage, distribution, and use of hydrogen within a region. These applications can include industrial and distributed power generation, transport fuels, and manufacturing processes or derivative production systems.

The concept is often used interchangeably with hydrogen valleys or industrial clusters, which generally describe similar systems but may span larger geographic areas.

Regardless of terminology, these hubs connect supply and demand across sectors such as industry, transport, and power generation. When the hydrogen is produced using renewable energy sources (such as wind or solar power) to split water into hydrogen and oxygen through a process called electrolysis, the result is a green hydrogen (GH₂) hub. Unlike hydrogen made from fossil fuels, green hydrogen generates significantly less carbon emissions, making it a cleaner energy carrier that can decarbonise hard-to-abate sectors like certain industries (e.g. steel, aluminium, cement, fertilizer), transport (e.g. maritime shipping, bulk rail), and power generation while supporting energy security and a just energy transition.

1.2 International policy context and drivers

The decarbonization of maritime shipping fuels offers tangible opportunity for the Port of Saldanha and the region. An international driver is the International Maritime Organization's commitment to move

¹A decarbonisation programme by ArcelorMittal South Africa focused on transitioning the Saldanha Works towards low-carbon steel production using green hydrogen. Available at: [https://arcelormittals.com/Portals/0/ArcelorMittal%20South%20Africa%20Decarbonisation%20Roadmap%20\(January%202023\)%20\(2\).pdf](https://arcelormittals.com/Portals/0/ArcelorMittal%20South%20Africa%20Decarbonisation%20Roadmap%20(January%202023)%20(2).pdf)

² A proposed renewable energy and green hydrogen production facility in the Western Cape designed to supply clean energy to local industries and export markets

³ A provincial initiative supporting municipalities and businesses to improve energy security and integrate renewable energy solutions to mitigate load-shedding impacts. Available at: https://static.pmg.org.za/250822WC_ERP_Standng_Committee_Presentation_22_Aug25-Final_v3_AL.pdf

⁴ The World Economic Forum's Transitioning Industrial Clusters (TIC) Initiative seeks to accelerate the decarbonisation of industrial zones by promoting collaboration between governments, businesses, and investors. The initiative supports clusters in developing coordinated net-zero strategies through shared infrastructure, clean energy integration, and innovation across hard-to-abate sectors such as steel, cement, and chemicals. The West Coast Hydrogen Hub has been identified as one of 32 global clusters participating in this initiative, and one of only two in South Africa, alongside the Coega Development Corporation.

away from fossil-fuels (such as heavy fuel oil) for maritime transport to low-carbon shipping fuels such as green ammonia and e-methanol (International Maritime Organisation, 2025). While a final IMO decision on binding regulations may take longer to materialise, there are already committed transport operators pursuing zero-carbon fuels in advance of an international framework, many of them driven by targets set by the European Union (EU) targets. With port facilities capable of handling bulk chemicals and minerals, Saldanha Bay is well placed as a potential supplier to this growing demand⁵.

Furthermore, the European Union (EU) has policies that drive the transition away from using fossil fuels for maritime shipping, in particular the FuelEU regulation. This regulation promotes the use of renewable and low-carbon fuels in the maritime sector and aims to reduce greenhouse gas emissions by 55% by 2030, applying from 01 January 2025. Fuel offtake requirements under complementary policies such as the revised Renewable Energy Directive (RED II) from 2023⁶, could represent an even larger demand pool than FuelEU alone. In addition, the EU-Saldanha Green Shipping Corridor is a partnership focusing on zero-emission shipping of iron ore between South Africa and Europe, leveraging renewable energy sources and positioning South Africa as a leading port for green maritime trade (Parker, 2023). Various parties including Saldanha Freeport, and TNPA are involved exploring bunkering and offtake arrangements, available green fuel supplies, as well as financial and business model alternatives. This likely to affect or possibly accelerate the development of bunkering infrastructure at the port⁷.

1.3 National and provincial policy context

At the national level, the Master Planning effort for Saldanha, and the West Coast region, must align with the objectives set out in the National Industrial Policy Framework, the Industrial Policy Action Plan (IPAP 2014/15–2016/17) and the New Growth Path (NGP, 2010) which promote industrialisation beyond traditional commodities of higher value added products such as green fuels, hydrogen derivatives, and green steel. This must be implemented while addressing infrastructure bottlenecks such as ports, transmission, and export capacity through the prioritisation of common-user port facilities, transmission upgrades, and export capacity, with a view to supporting the NGP's emphasis on strategic infrastructure as a catalyst for long-term industrial growth. It further integrates with broader planning frameworks like the South African Green Hydrogen Roadmap (2022), the Just Energy Transition Investment Plan (2023), Green Hydrogen Commercialisation Strategy (2022) and other national priorities such as skills development and socially inclusive growth.

At the level of provincial policy, the Master Plan has been guided by the Western Cape Provincial Strategic Plan (2025), the Western Cape Energy Resilience Programme and several Department of Trade, Industry and Competition (DTIC) strategies, including SBIDZ's transition to a Special Economic Zone. The latter's emphasis on common-user infrastructure, efficient logistics, and streamlined regulatory pathways is consistent with the SEZ mandate to attract investment and drive industrial development. By integrating infrastructure readiness, logistics optimisation, and regulatory streamlining, the Master Plan intends to position the Saldanha–West Coast corridor as a strategic hub for South Africa's GH₂ economy and global export ambitions.

⁵ Recent significant decisions in green shipping include the International Maritime Organization's (IMO) approval of draft net-zero regulations in April 2025, which mandates a transition from fossil fuels to zero-carbon alternatives for shipping fuels, and growing industry commitment to a multi-fuel approach using methanol and ammonia. These measures, aiming to decarbonize the shipping sector and support the EU's Carbon Border Adjustment Mechanism (CBAM), are planned to be formally adopted in October 2025 before entry into force in 2027, and will become mandatory for large ocean-going ships over 5,000 gross tonnage, which emit 85% of the total CO₂ emissions from international shipping (International Maritime Organisation, 2025).

⁶ https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=OJ:L_202302413

⁷ The EU-Saldanha Green Shipping Corridor is not part of Fuel EU, but it is a project designed to help shipping comply with regulations like FuelEU Maritime. The corridor is a private-sector initiative, while FuelEU is a legislative regulation enacted by the European Union. The corridor is a practical pathway to help companies meet the regulatory requirements set out by FuelEU

1.4 Need for the Master Plan

Major technology and infrastructure are required to create the electricity and water inputs for this potentially burgeoning economy (including wind turbines, solar PV panels and reverse osmosis desalination plants). If developed at a sufficient speed, scale, and intensity, they could have cumulative, unforeseen consequences. With respect to the novel technologies of electrolysis, synthesis and Haber-Bosch, there currently exists very little research and monitoring data at an industrial scale, making our current understanding mostly theoretical. Given these uncertainties, a comprehensive master plan is critical to guide sustainable development in the port, SEZ, and the Green Hydrogen Hub.

The Master Plan provides a framework to align infrastructure development, regulatory incentives, and environmental sustainability, ensuring the Hub develops as a thriving centre for private sector-driven green hydrogen projects within the brownfield SEZ and port area. Developing a Master Plan for the Saldanha Hydrogen Hub in the brownfield SEZ, port and wider industrial area requires a data-driven, stepwise approach to site and regional scale decision-making to achieve the overall purpose set out above. As such, several phases of the project are envisaged, due to the iterative nature of the analyses required and in consideration of budget availability and envisaged timelines (see Box 2).

Box 2: Phased approach to the West Coast Master Plan

Phase 1 is to undertake a high-level analytical review to surface the most salient strategic, technical, and regulatory questions that must be addressed to enable the successful implementation of the Master Plan. This phase aims to frame the critical issues, identify gaps, and establish a clear foundation for the more detailed technical and research work to follow in Phases 2 and 3.

Phase 2 is to focus on decision making tools and engagement platforms, with the main aim being to build institutional and technical readiness by bridging current planning gaps, deepening sectoral analysis, and supporting municipalities and provinces in translating the Master Plan into actionable, spatially grounded plans.

Phase 3 is to focus on implementation planning, including compliance and monitoring with the main aim being to establish the implementation ecosystem and governance architecture needed to drive green hydrogen projects forward in a coordinated and integrated manner. The goal of all phases of the Master Plan is to create an enabling investment environment and to stimulate job creation within the West Coast for GH2 projects that are proposed by private sector into the West Coast Hydrogen Hub by defining sustainable, bankable common-user/public infrastructure projects, and the regulatory, institutional, and environmental frameworks that facilitate private investment in the Hub and the wider West Coast district.

1.5 Objectives of Phase 1 of the Master Plan

Phase 1 of the Master Plan was developed through a structured process combining technical analysis with cross disciplinary stakeholder coproduction, assessed within the context of important national and provincial policies. Technical outputs were iteratively coproduced in consultation with a multi-sector, multi-disciplinary Working Group (WG), with guidance provided by a Project Steering Committee (PSC). The four main objectives for Phase 1 of the Master Plan included:

1. Infrastructure Optimization and Expansion

- Development of an infrastructure portfolio which describes the strategic common-user infrastructure required to accommodate the specific needs of the green hydrogen projects in the Hub.
- Assess existing and planned transport networks including road, rail, maritime, and pipelines to optimise the movement of hydrogen and derivatives, identify gaps, and support coordinated, multi-modal logistics across the hub.

2. Energy, Planning and Environment Legal Review

- Provide an overview of the relevant authorities, their roles, legal mandates, and the approvals in terms of the environmental, energy and planning aspects required for the development of the strategic common-user infrastructure defined above.

3. Environmental Sustainability

- Identify potential impacts, proposing mitigation measures, addressing socio-ecological and regulatory considerations, and providing guidance on co-location, shared infrastructure, and visual impact management. Ensure growth aligns with regulatory requirements, best-practice Environmental, Social, and Governance (ESG) standards, and socio-ecological sustainability.

4. Stakeholder Communication and Collaboration

- Provide a platform for stakeholder involvement, allowing stakeholders to voice concerns, providing transparency, and fostering positive relationships and solutions in the development of the West Coast Green Hydrogen Master Plan.

1.6 Integrated governance model

The Master Plan adopted an integrated governance framework and co-production model of knowledge generation, which emphasized iterative and collaborative processes involving diverse types of expertise to produce context-specific knowledge. An integrated governance framework aligned Phase 1 of the Master Plan with national and regional policy, enabled coordinated decision-making, and ensured Phase 1 was adaptable to changing technical, regulatory, and market conditions. The key governance bodies for the Master Plan are the PSC and the WG (Box 3).

Insights from representatives of State-Owned Entities, industry leaders including GH₂ producers, financiers, and local communities were incorporated through targeted consultations to ensure that technical findings were grounded in operational realities. To strengthen legitimacy, assumptions, data sources, methodologies, and projections were systematically documented and validated through workshops and bilateral reviews, enabling continuous refinement of outputs as new information became available. The process followed an iterative approach in which stakeholder feedback was consistently integrated to refine both the evidence base and the findings.

Box 3: Integrated governance framework

Institutional coordination was delivered through a PSC, constituted at the inception of the Master Plan and composed of representatives from commissioning authorities, state owned entities and major stakeholders, that met monthly to provide strategic oversight, ensure policy alignment, and coordination.

A multi-stakeholder WG of ~30 representatives from government, industry, academia, NGOs and community organisations provided input into technical and sector-specific elements. Structured public-private dialogue channels ensured the Plan responded to investor needs and market signals.

PSC responsibilities: strategic guidance on implementation priorities; oversight to align with green hydrogen policy; coordination with major institutions (e.g., Transnet, port authorities).

WG functions: technical review and sectoral input; ensure outputs reflect operational reality; co-produce content to strengthen technical robustness; facilitate feedback between experts and lead authors.

1.7 Study methods

A multi-method approach was adopted, integrating stakeholder engagement, literature reviews, GIS modelling, and technical assessments. The study area for Phase 1 of the Master Plan comprised two scales: The port and SEZ which was considered in relatively finer detail; and the wider West Coast area which was assessed at a coarser scale. Engagements included structured interviews and expert-led workshops with government agencies, private developers, and utilities, providing insights into infrastructure requirements, regulatory considerations, and socio-environmental priorities. Three main

assessments comprised Phase 1 of the Master Plan: Social and ecological sustainability; Infrastructure and land-use planning; and Transportation. Each assessment approach is elaborated upon in more detail in the following sections.

1.7.1 Approach to Social and ecological sustainability

A comprehensive literature review was undertaken, peer-reviewed studies were analysed, along with technical reports, Environmental Management Frameworks (EMFs), and to characterise the environmental, social, and economic baseline conditions of the study area. Regulatory and governance frameworks were reviewed and tabulated to identify compliance requirements and planning constraints, including national and provincial legislation, municipal planning instruments, and environmental management frameworks. Lender and investor considerations, including Equator Principles and IFC Performance Standards, were also integrated to ensure that identified risks and mitigation strategies align with international environmental, social, and governance (ESG) expectations (Equator Principles, 2020). Opportunities for shared infrastructure, including co-located production facilities, storage, pipelines, and electricity transmission, were evaluated by applying information garnered from literature review, stakeholder input, and spatial analysis. Detailed methodology for the spatial analysis is provided in the subsections below.

Environmental screening

The environmental screening aimed to identify potentially feasible areas for new infrastructure development, based on key environmental and land use features that may prevent or constrain new energy development such as large-scale renewable energy and associated infrastructure for the production of GH₂ and PtX derivatives. The social and environmental constraints analysis entailed an overlay of available spatial data for conservation planning, aquatic ecosystems and land use. Social-environmental features (Table 1) were classified as follows:

- **Avoid:** Areas that may be considered as unavailable, potential fatal flaws or critical conflicts for utility-scale renewable energy development.
- **Constrained:** Areas that may be considered as constrained for utility-scale renewable energy development. In the case of rivers and wetlands, new development within 32 meters of would require non-consumptive water use authorisation (i.e. procedural constraint). In the case of landcover / uses, these areas may be potential opportunities for new utility-scale renewable energy development sites but would require a transition to new / multi-purpose land use or innovative co-location approaches such as agrivoltaics.
- **Mostly Open:** Areas that may be considered as potential areas for new development in terms of land availability (least constrained / open / undeveloped land).

Table 1: Social-environmental features, constraint rating and consideration rationale used as basis for environmental screening.

Class	Feature	Rationale
AVOID		Areas protected under law. Must be avoided by energy and other industrial development.
	Critical Biodiversity Areas (CBA 1 & 2, all subcategories)	Areas identified through systematic conservation planning processes and are important for the persistence of ecosystems and species as well as the long-term ecological functioning of the landscape.
	Rivers and wetlands	Aquatic ecosystems should be avoided by new energy and industrial development.
	High-value agriculture, including Viticulture, Horticulture, Pivot Irrigation, Non-pivot Irrigated Annual Crops / Planted Pastures, Food Gardens	High-value permanent / perennial agriculture, like orchards, or that are characterised by large permanent infrastructure, such as irrigation systems, should be avoided.
	Built-up landcover	Areas that are already occupied by infrastructure and / or where people live and work.
CONSTRAINED	Rivers and wetlands 32 m buffer	Proximity to watercourses may also trigger the need for non-consumptive water use licenses, which adds a permitting requirement to new development.
	Rainfed Annual Crops / Planted Pastures, Smallholdings, Strip Field Cultivation, Old Fields, Shadenets	Annual crops, like grains, may present more opportunities for negotiating land use change or synergistic multi-functional spaces (e.g. shadenet agriculture as agrivoltaics).
	Mines & quarries landcover	Likely in conflict with energy developments but may provide an opportunity for synergistic multi-functional spaces or for targeting disturbed areas for brownfield development.
OPEN	Remaining areas, including Barren Land, Forested Land, Shrubland, Grassland landcover	Areas that, based on the spatial data considered, could theoretically present opportunities as development sites.

Regional renewable energy landscape potential

The regional renewable energy landscape potential was spatially modelled to broadly indicate the extent to which the West Coast region could theoretically support renewable energy development to meet GH₂ / PtX production targets. Firstly, the renewable energy needs to satisfy GH₂ production scenarios are quantified, then the renewable energy need is translated into physical footprint (land-take) requirements. Theoretical clusters of renewable energy were then modelled spatially in the study area landscape assuming certain environmental and techno-economic optima, to provide an indication of whether energy needs could be met.

The following important assumptions underpinned the renewable energy landscape potential modelling:

- Techno-economic optimum means (as determined by (Snyman-van der Walt & Schreiner, 2025):
 - Within a distance of 20 km from existing electricity grid infrastructure routing corridors
 - Solar resource potential > 1800 kWh/kWp (PV output)
 - Wind resource potential > 400 W/m² (power density).
- Environmental optimum means:
 - Avoidance of Protected Areas, Critical Biodiversity Areas, existing agricultural areas (as determined by Snyman-van der Walt & Schreiner, 2024)

- Selection of theoretical renewable energy clusters in areas considered as “open” or “constrained” based on the environmental screening conducted for the Phase 1 Master Plan.
- A 10 GW electrolyser has the potential to produce 1 mtpa of GH₂, that is powered by 20 GW renewable energy.
- Renewable energy generation is 70 % from solar PV and 30 % from wind energy.
- Solar PV land-take requirement is 2 ha/MW and direct footprint of the wind energy land-take requirement is 1 ha/MW.

1.7.2 Approach to Infrastructure and land use planning

The methodological approach comprised several core components to ensure a comprehensive and evidence-based analysis. Initially, geospatial data sourcing involved collecting spatial information from official repositories and assembling it into a structured geospatial database. This step supported spatial analysis by delineating land ownership, environmental constraints, and infrastructure distribution, providing a foundational understanding of physical and regulatory contexts. Subsequently, a literature review was conducted to assess regional planning frameworks, reports, and studies relevant to hydrogen development. The review aimed to evaluate the extent of existing planning considerations for hydrogen infrastructure, including key recipient areas such as the SEZ and Besaansklip industrial zone, thereby informing the spatial analysis and identifying potential planning gaps. To validate and enrich the data, targeted stakeholder engagement was undertaken with planning authorities, infrastructure agencies, and developers through interviews and consultation series. These interactions confirmed issues identified during literature review, provided additional insights, and facilitated understanding of operational, regulatory, and infrastructural challenges. Finally, all data layers - geospatial information, literature insights, and stakeholder inputs - were synthesized through spatial overlay and thematic analysis to identify critical issues and constraints impacting the establishment of a green hydrogen hub. This integrated methodology aimed to produce an evidence-based, multi-dimensional understanding of the region’s planning and infrastructure landscape, laying a foundation for subsequent detailed planning phases.

1.7.3 Approach to Transport and distribution networks

The study applied a structured, multi-stage methodology to systematically extract and analyse information from municipal and regional planning documents. Each document was first mapped by title, year, authority, and thematic focus (e.g., IDPs, DITPs, MSDFs), and its contents were scanned through indices, tables of contents, and keyword searches to identify material relevant to infrastructure, transport, spatial growth, and capital projects. Key themes such as road networks, public and non-motorised transport, water and sanitation, and spatial development priorities were then thematically extracted and cross-analysed, enabling the identification of consistencies, gaps, and divergences, as well as the alignment of projects with budgets and implementation timelines. Recent drafts, including the 2024 IDP and 2025 MSDF, were used as primary references, while older reports such as the West Coast DITP (2015) provided historical context. Discrepancies or omissions were flagged for cross-checking with other official sources, ensuring that the findings were evidence-based and reflective of both current and planned infrastructure. This document review was complemented by semi-structured interviews and questionnaires with key stakeholders—focusing on large-scale hydrogen producers, major demand users such as AMSA and the cement industry, and transport authorities like TNPA—with additional inputs from SEZ, Transnet, and the Western Cape Government. Collectively, these methods supported a comprehensive thematic analysis of transport systems, infrastructure initiatives, regulatory frameworks, and hydrogen supply chains in the West Coast region, with emphasis on Saldanha Bay, and allowed for the

identification of strengths, weaknesses, opportunities, threats, and knowledge gaps requiring further investigation.

1.7.4 ***SWOT Analysis***

A Strengths, Weaknesses, Opportunities, Threats (SWOT) analysis was undertaken for each of the above workstreams (i.e. and environmental/social, infrastructure and transport) within the following exploratory framework:

- **Strengths** (internal, positive): What existing assets, capacities, or conditions in Saldanha Bay support GH₂/PtX development?
- **Weaknesses** (internal, negative): What current gaps, constraints, or challenges could hinder GH₂/PtX development?
- **Opportunities** (external, positive): What external trends, drivers, or enabling conditions could enhance prospects for the Hub?
- **Threats** (external, negative): What external risks, pressures, or uncertainties could undermine GH₂/PtX development?

1.8 Generation of Scenarios

1.8.1 ***Approach to developing the scenarios framework***

To explore the cumulative impacts of GH₂/PtX development at scale, an explorative scenario approach was adopted building on the scenarios developed by Schreiner et al. (2024). Explorative scenarios examine multiple plausible futures under conditions of uncertainty, mapping diverse “what-if” pathways rather than forecasting a single most probable outcome. The explorative scenarios developed by Schreiner et al (2024) described plausible and diverse GH₂/PtX futures under different levels of ambition, intervention, and opportunity-level to examine potential outcomes across a 25-year time horizon, chosen to align with South African policy targets for greenhouse gas (GHG) emissions, and global GH₂/PtX uptake by 2050.

Box 4: What is GH_{2e}

Green hydrogen equivalent (GH_{2e}) quantifies the amount of pure green hydrogen contained in or required to produce a hydrogen-derived product. It provides a standardized metric that enables consistent comparison across different derivatives, supporting production planning, reporting, and benchmarking within the hydrogen sector. The concept has become an industry standard in the renewable hydrogen and PtX industries alongside the global scale-up of green hydrogen initiatives.

The development of these scenarios included top-down, quantitative volumetric estimates of GH₂/PtX production and PtX products in and around Saldanha Bay, based on national policy, literature reviews, stakeholder interviews, project mapping, and analyses of value and supply chains, with key assumptions on quantity splits provided. To ground the scenarios and extend the relevance of the top-down outlook, a bottom-up, project-based perspective was also adopted by adapting the scenarios after Schreiner et al (2024). Five GH₂ projects were selected for the bottom-up calibration, based on them being in their mature stages of assessment and their ability to delineate distinct challenges impacting the realization of their initiatives. It was presumed that the selected projects had either conducted or were performing

preliminary studies capable of providing comprehensive insights, highlighting potential challenges, and identifying opportunities for shared infrastructure utilization. Archetypal project configurations were developed, informed by stakeholder interviews with GH₂ project developers and interrogated via expert-led workshops. Quantitative volumetric estimates were then refined to align with national GH₂ targets, illustrating how export volumes could realistically materialise through these representative project pathways. Where feasible, preliminary dialogues with other stakeholders were conducted to identify additional projects likely to influence overall regional infrastructure planning and investment. Insights from these engagements, together with the developer consultations and expert workshops, informed the

development of plausible, evidence-based narratives describing potential development pathways in and around the SEZ.

1.8.2 Scenario quantification and narratives

Two GH₂/PtX development scenarios were generated and compared to a baseline scenario where no GH₂/PtX development occurs, as follows (Figure 2):

- **Scenario 0 ('Dirt Track') (2024–2050):** No GH₂/PtX development occurs around Saldanha Bay
- **Scenario 1 ('Provincial Road') (2024-2050):** Production of 0.51 million tonnes per annum (mtpa) Green Hydrogen Equivalent (GH₂e) around Saldanha Bay
- **Scenario 2 ('National Highway') (2035-2050):** Production of 1.52 mtpa GH₂e around Saldanha Bay

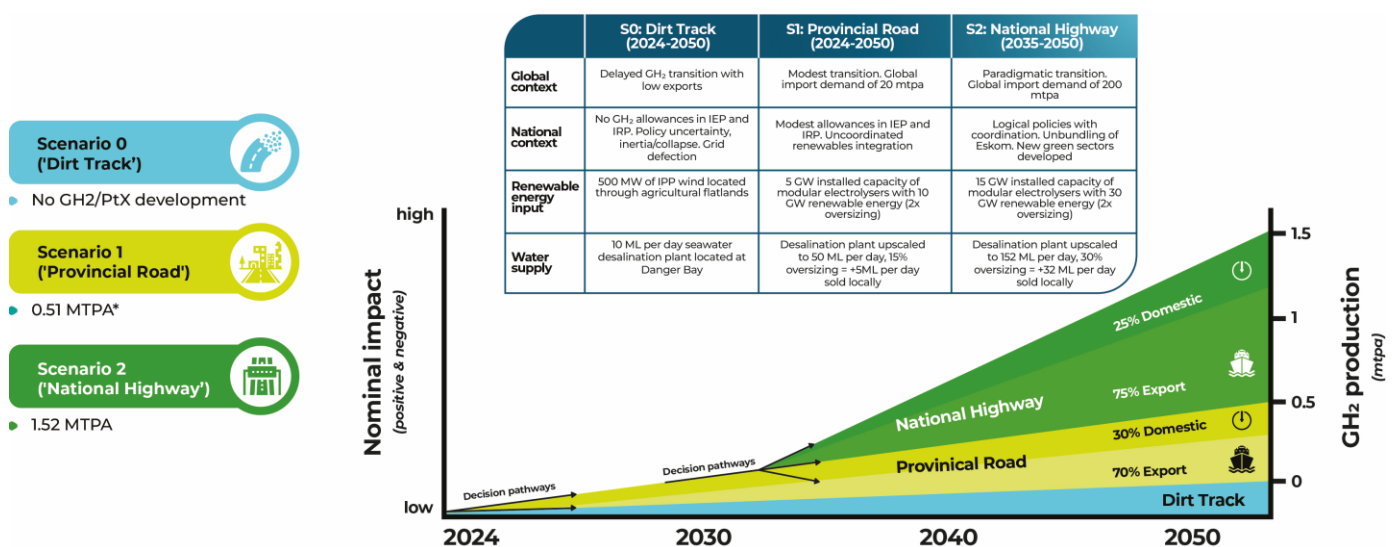


Figure 2: Three possible development pathways for GH₂/PtX on South Africa's West Coast from 2024 to 2050. Scenario 0 ("Dirt Track") represents no GH₂ growth, Scenario 1 ("Provincial Road") shows moderate production reaching 0.51 mtpa, and Scenario 2 ("National Highway") reflects large-scale growth to 1.52 mtpa with global export integration.

The **National Highway scenario** represents an optimistic view of the future where Saldanha Bay becomes a world-class GH₂/PtX hub, underpinned by coordinated governance, integrated infrastructure, and large-scale renewable deployment. With shared storage, dedicated pipelines, and regional trade links, hydrogen costs are reduced, investors gain confidence, and South Africa firmly positions itself in global green value chains. Under this scenario, the global transition to decarbonised energy is well underway, with global GH₂ market reaching 200 mtpa. Initially reliant on international funding, GH₂ projects gradually gain traction with local financiers. As project viability improves and infrastructure matures, domestic funding increases, unlocking broader investment and scale-up potential.

Within the **Provincial Road**, the more realistic scenario, momentum around transport and industrial efficiency builds, with the global GH₂ market reaching around 20 mtpa. The introduction of International Maritime Organization (IMO) carbon taxes on shipping fuels from 2028 accelerates demand for low-carbon alternatives such as green ammonia and methanol. However, financing continues to depend heavily on international partners, particularly the EU, Germany, Japan, and climate agencies, as South African financiers remain conservative and risk averse. This slows domestic investment and prevents projects from scaling rapidly. At the national level, decarbonisation targets are stimulating renewable

energy uptake, though planning remains fragmented. GH₂ features modestly in the Integrated Energy Plan (IEP) and Integrated Resource Plan (IRP), reflecting a peripheral role in official strategies.

With less favourable conditions, the **Dirt Track scenario** assumes no GH₂/PtX development occurs around Saldanha Bay. Under this scenario the global transition to GH₂/PtX has been delayed with low exports from hydrogen producing countries. In South Africa, an unattractive investor environment and policy uncertainty has stifled decarbonisation efforts, with only modest reductions in fossil-based energy. Some integration of renewables has continued, albeit driven mainly by private enterprise and wealthier households defecting from the grid, exacerbating inequality and reducing social cohesion. Service delivery, investment and local governance in the Saldanha Bay region have remained relatively efficient compared to national averages, although development needs are still urgent. In 2030, of the 160 000 people living in the Saldanha Bay Municipality, one quarter are unemployed and 60% fall below the Upper Bound Poverty Line. Most people employed in the region are classified as low and medium-skilled labour and skills development opportunities are limited. Inequality, spread along racial lines, remains pervasive and persistent.

2 CHARACTERISATION OF THE RECEIVING ENVIRONMENT

The receiving environment can be considered at three scales as illustrated in Figure 3. At the broader level, the West Coast Green Hydrogen Hub spans the entire West Coast District Municipality (3.1 million ha), which includes five local municipalities: Matzikama, Cederberg, Bergrivier, Swartland, and Saldanha Bay. The Saldanha Bay Local Municipality encompasses several small to medium-sized towns and the Bay of Saldanha, renowned as the deepest and largest natural harbour in the southern hemisphere. Adjacent to the town of Saldanha lies the Besaansklip Industrial Zone (~ 6 400 ha), which hosts both the Port of Saldanha and the Saldanha Freeport SEZ (365 ha). The impact and therefore also the planning considerations for the Saldanha Green Hydrogen hub extends across all three scales.

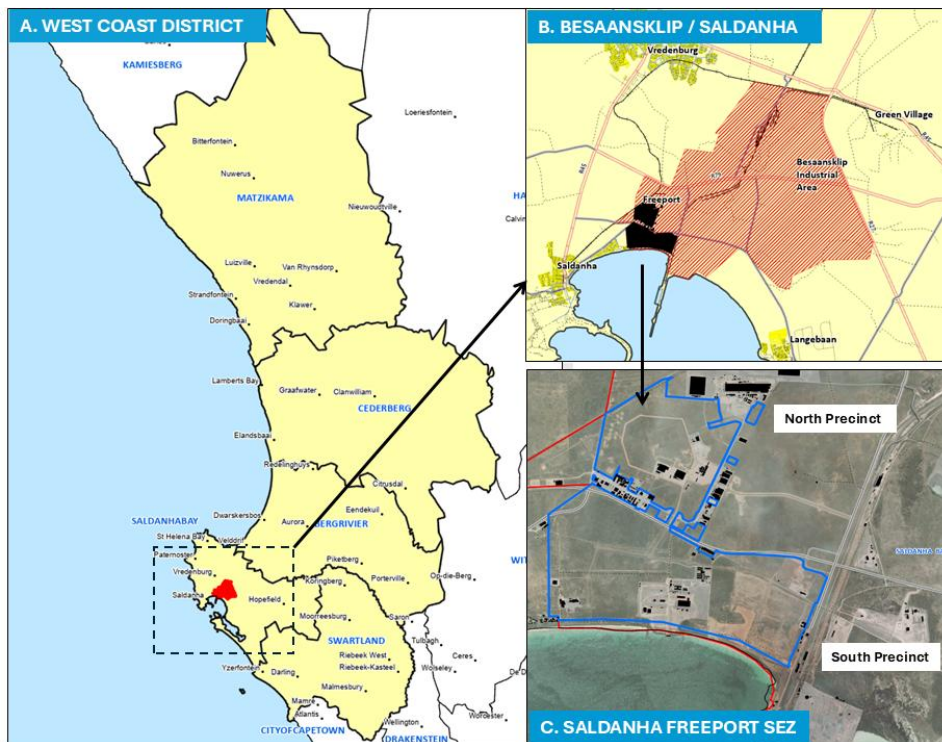


Figure 3: Receiving environments at three scales. Panel A depicts the broader West Coast region, Panel B highlights the Besaansklip/Saldanha Industrial Area, while Panel C zooms into the Saldanha Freeport SEZ divided into North and South Precincts.

2.1 West Coast regional context

2.1.1 *Ecological and agricultural features*

The West Coast region has varied topography, encompassing low-lying coastal plains and the rugged Cederberg and Winterhoek mountain ranges, with elevations exceeding 2 000 meters. This topography influences local microclimates, hydrological regimes, and renewable energy resource distribution, with implications for infrastructure siting and energy generation potential (SANBI, National Biodiversity Assessment 2020: Saldanha Bay Region, 2021). Land use in the region is heavily dominated by agriculture, particularly irrigated and rainfed (predominantly annual) agriculture (Figure 4), resulting in significant transformation of large tracts of natural ecosystems. The remaining patches of fynbos and renosterveld vegetation are largely confined to Critical Biodiversity Areas (CBAs) and Ecological Support Areas (ESAs)

(Figure 4), reflecting the ecological significance of the remaining intact habitats (DEA&DP, 2022). The region hosts several major protected areas, including the West Coast National Park (~36,000 ha along the southern coast), the Cederberg Mountain Catchment and Wilderness Area, Winterhoek Mountain Catchment Area, Grootwinterhoek Nature Reserve and Wilderness Area, and the Matjiesrivier Nature Reserve (~359,000 ha along the southeastern border). In the northern parts of the region, the Moedverloren/Knersvlakte Nature Reserve and Lutzville Conservation Area (~69,000 ha) provide additional conservation coverage for semi-arid and succulent karoo ecosystems. The region also encompasses globally significant avifaunal habitats, including the Cedarberg–Koue Bokkeveld Complex Important Bird Area (IBA) and several coastal estuarine IBAs including the Olifants River, Verlorenvlei, Berg River Estuary, West Coast National Park and Saldanha Bay Islands. These areas provide critical breeding, foraging, and migratory stopover sites (International, BirdLife, 2020).

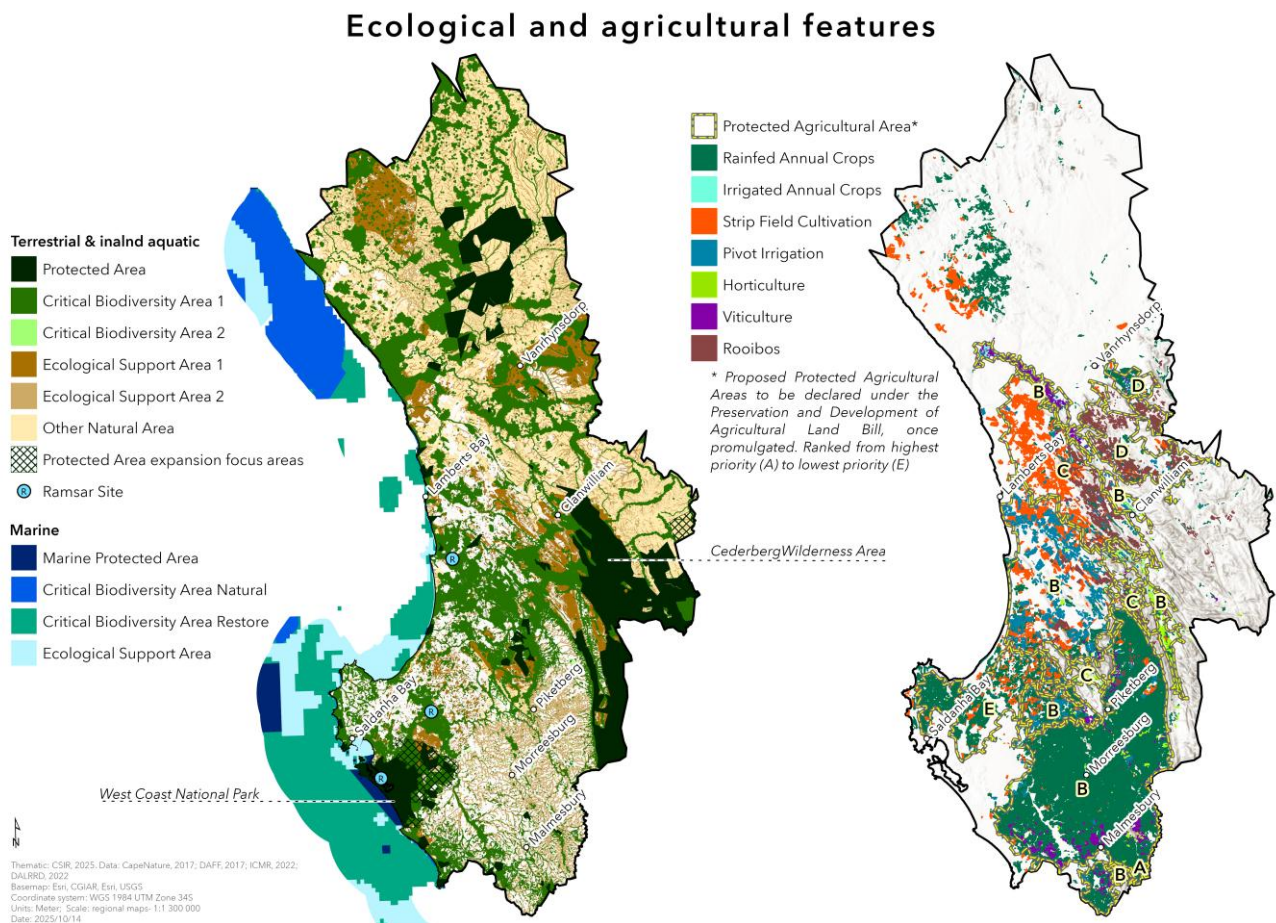


Figure 4: Key ecological and agricultural features of the West Coast region which will limit the extent to which large scale renewable energy development is possible.

The Saldanha Bay region functions as a critical industrial and maritime hub of the Western Cape, identified as a strategic anchor for green hydrogen production and export due to its deep-water port, industrial infrastructure, and proximity to Renewable Energy Development Zones (REDZs). However, the region's biophysical sensitivity, marked by diverse ecosystems and intricate coastal processes, presents both constraints and opportunities for sustainable GH₂ hub development.

2.1.2 Regional planning context

The West Coast region is strategically located within the Western Strategic Transmission Corridor, one of the seven Electricity Grid Infrastructure (EGI) corridors gazetted to facilitate efficient transmission expansion and connectivity between renewable energy generation areas and major demand centres (Government Gazette 41445, GN 113 of 16 February 2018; GN 383 of 29 April 2021) Figure 5). The region is also in relatively close proximity to three Renewable Energy Development Zones formally gazetted in South Africa to prioritise investment in large-scale solar PV and wind energy generation (Government Gazette 41445, GN 114 of 16 February 2018, and GN 144 of 26 February 2021), specifically, the Springbok REDZ 8 to the north, Komsberg REDZ 2 to the south east, and Overberg REDZ 1 to the south. Refer to Appendix B for a description of the REDZs within 500 km of the Saldanha Bay SEZ

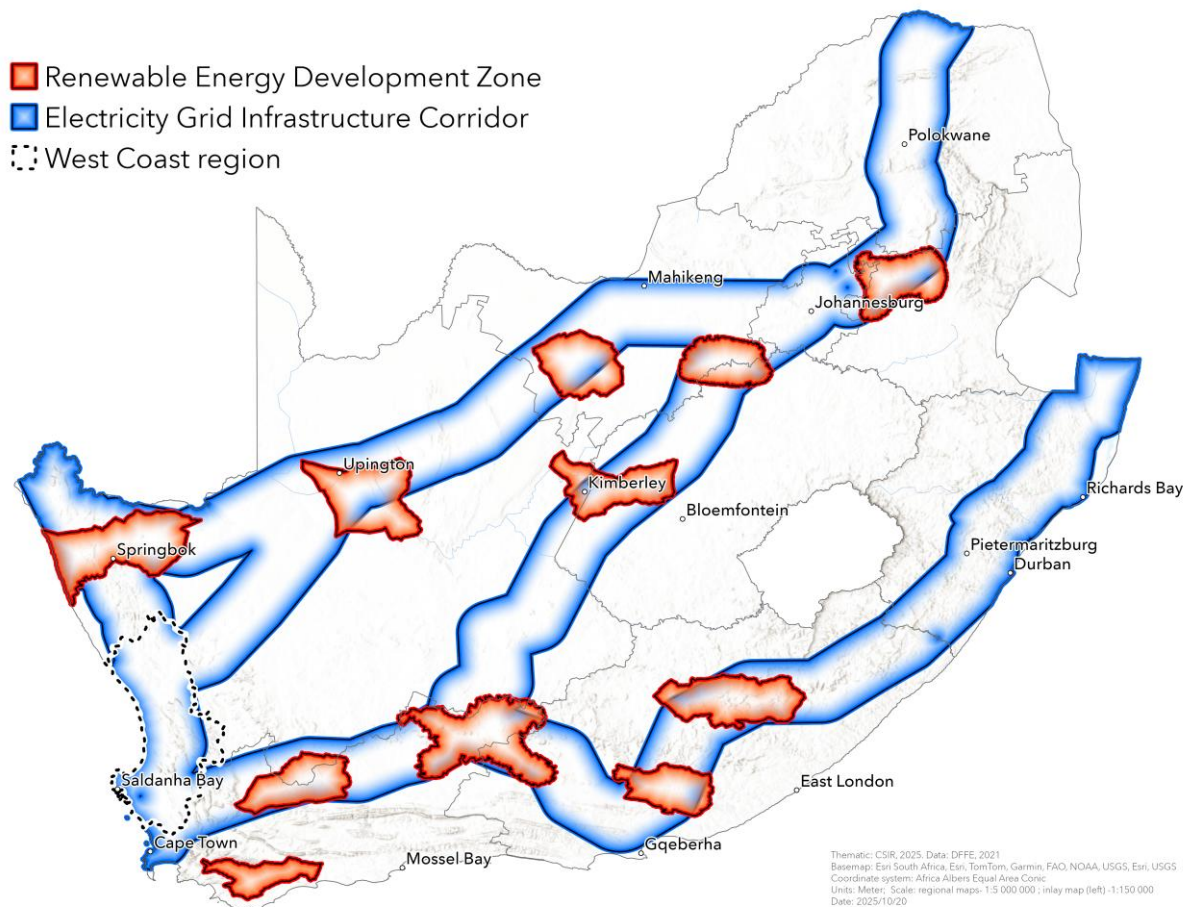


Figure 5: The West Coast region has been identified for strategic electricity grid infrastructure expansion and is located in proximity to Renewable Energy Development Zones.

This positioning enables streamlined environmental authorisation processes and supports renewable energy integration into emerging GH₂/PtX value chains.

2.2 The Saldanha municipality and wider region

The Saldanha municipality is located along the west coast of South Africa, approximately 140 km north of Cape Town, and is part of the West Coast District Municipality. A major asset of the area is the deep-water port of Saldanha Bay, which is able to accommodate large vessels, making it a critical infrastructure hub. While the West Coast Green Hydrogen Hub is centred on Saldanha Bay, it leverages the strengths of the

broader district and surrounding region, particularly access to abundant expanding regional green energy resources such as onshore wind and solar energy facilities. The region benefits from strong road and rail connections to the Northern and Western Cape and is within close proximity to key economic centres including Cape Town and the Atlantis SEZ. In addition, a network of towns and settlements throughout the region offers a solid foundation to accommodate settlement growth, to support future economic growth, particularly those linked to the emerging green hydrogen industry.

2.2.1 Socio-economic conditions

The trends of economic development in the Saldanha Bay Municipality indicate a diversified economic structure with significant contributions from the agriculture, manufacturing, finance and wholesale-retail sectors. Between 2020 and 2025, the municipality's total economic production has grown at an average annual rate of 5.8% (Quantec, 2025). Agriculture and manufacturing sectors contribute notably to the Gross Value Added (GVA), accounting for 19.2% and 33.7% respectively. Concurrently, settlement development trends show a population growth rate exceeding 2.4% per annum, expected to increase to 2.7% by 2027 (Western Cape Government, 2023, pp. 124, 130). Under current growth trajectories, the population is projected to require accommodation for approximately 13,748 additional households by 2035, with the bulk of growth concentrated in Saldanha, Vredenburg, and Langebaan. This will necessitate roughly 579 ha of land and address an estimated housing backlog of 12 963 households (Saldanha Bay Local Municipality, 2025, p. 193). The anticipated growth (excluding growth generated by proposed green hydrogen developments) will place pressure on current municipal infrastructure and services, and could lead to infrastructure strain, particularly in services like electricity, which is already under pressure.

Several challenges have been identified linked to the current settlement and development landscape:

- A challenge identified in the Saldanha SDF is conflicts between critical biodiversity/environmentally sensitive areas and the footprint of the proposed industrial areas in Saldanha. Lack of certainty can affect investor confidence in the area.
- Infrastructure in Saldanha Bay, especially for waste and sewage facilities, is inadequate to meet the demands of ongoing development, with seasonal overloads exacerbating the issue.
- Water resources are increasingly strained due to population growth and climate change impacts. The timely planning, approval, and implementation of the proposed seawater desalination plant are essential, particularly to support water-dependent industries.
- Electricity supply constraints persist, with the Duferco substation in Besaansklip undersupplied and requiring demand adjustment to support Special Economic Zone (SEZ) development. Similarly, the Blouwater substation in the same area is inadequate, necessitating Eskom's Saldanha Bay Network Strengthening project (Saldanha Bay Local Municipality, 2025, p. 154).

While the primary concentration of the Green Hydrogen Hub development is situated within the Saldanha Municipality, specifically within the designated industrial zone, it remains crucial to account for existing infrastructural challenges, particularly those associated with the settlements in the vicinity of the port and the SEZ.

2.2.2 The Besaansklip Industrial Zone and SEZ

The Besaansklip Industrial Zone, within which the Saldanha Freeport SEZ is located, is a core focus area for green hydrogen development. The current Freeport SEZ site covers approximately 365 ha of industrial land within the broader Besaansklip area, which spans a total of 6 447 ha, with a developed footprint currently covering 687 ha (about 11%). It is partially developed and includes commercial complexes, warehouse structures, and port-linked infrastructure and customs-controlled zones. The site comprises two adjacent precincts:

- The **northern precinct**, owned by the Saldanha Freeport, contains various structures and is served by an internal road network and upgraded water, electricity, and sanitation infrastructure.
- The larger **southern precinct** is leased from Transnet and accommodates the Transnet Centre and the National Ports Authority, providing direct access to the main port terminals.

The SEZ focusses on the energy and maritime sectors with projects in oil, gas, marine repair, fabrication, logistics, and related services. Appendix C list the SEZ focus sectors. Although the Freeport SEZ already features several tenants, some areas of land have been earmarked for green hydrogen production facilities, as well as for the logistics and storage of renewable energy equipment.

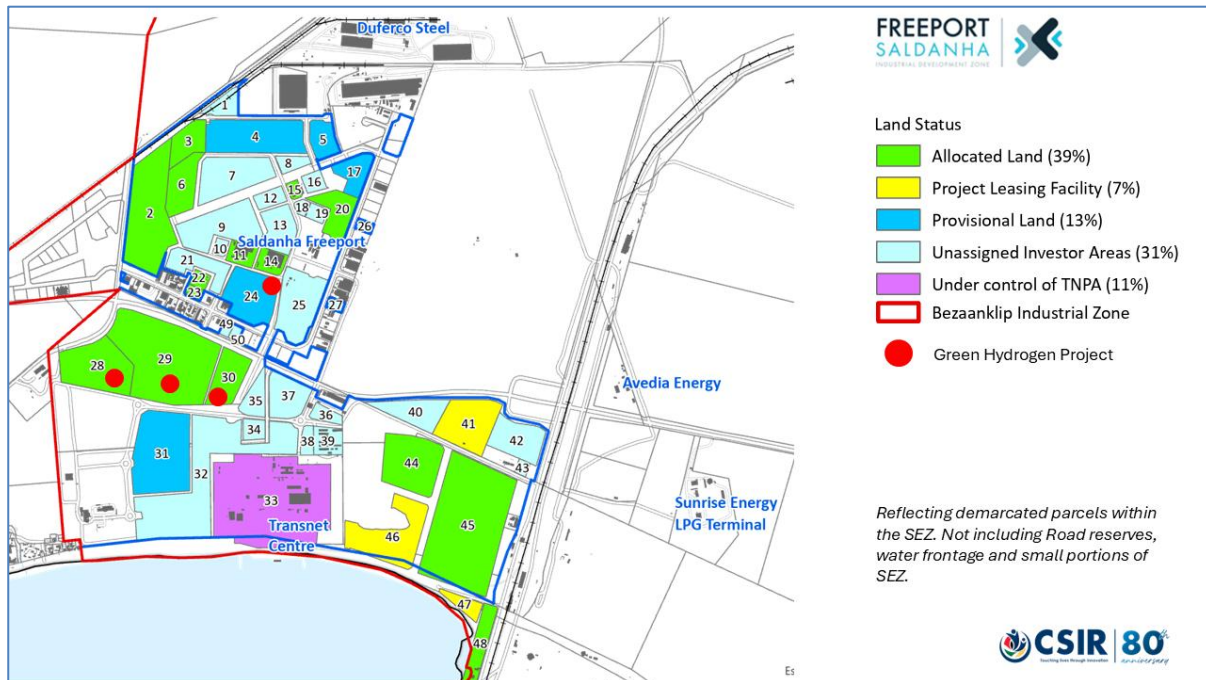


Figure 6: Saldanha Freeport SEZ land allocation (2025)

Figure 6 represents the allocation of land parcels demarcated within the SEZ – of this 31 % of parcels are unassigned and land provisionally assigned comprise 13% of all parcels. Several parcels are earmarked for green hydrogen production. The remainder are allocated to other projects, leased facilities or is under control of TNPA. The implication is that not many parcels remain where green hydrogen can be accommodated and that the footprint of the SEZ and CCA should be increased (Pandorum, Rakaibe, Snyman-Van der Walt, & Roos, 2024, p. 45).

The zone hosts several large-scale industrial users, including Transnet Port Facilities, which operate the iron ore and multi-purpose terminals, a liquid bulk terminal, and a liquefied petroleum gas (LPG) terminal. Other key facilities in the zone include the Saldanha Offshore Support Base, the ArcelorMittal Saldanha Works steel plant, Namakwa Sands, and the Transnet School of Rail. The SEZ, which occupies ~5.5% of the total Bezaansklip Industrial Zone, offers a range of preferential conditions such as tax concessions, streamlined customs and administrative procedures, and regulatory exemptions to create a more conducive environment for economic activity.

Ecological features in the industrial zone

Approximately 1 403 ha of the Besaansklip Industrial Zone, within which the Saldanha SEZ is nested, is delineated as a no-development zone in the Saldanha Bay Municipal Spatial Development Framework (MSDF 2025–2030), owing to its high ecological value and role in maintaining biodiversity connectivity. This zone encompasses approximately areas classified as CBA 1 (Core 1), CBA 2 (Core 2), and ESA 1 (Core 2), representing the most sensitive and least transformed land parcels in the municipality. These spatial biodiversity categories are aligned with the Western Cape Biodiversity Spatial Plan (WCBSP) and the Greater Saldanha Environmental Management Framework (EMF) (DEA&DP, 2021; CapeNature, 2023). Collectively, they provide fine-scale guidance on land use compatibility and conservation management.

The area supports several threatened vegetation types including the Saldanha Limestone Strandveld, which hosts a high diversity of endemic plant species adapted to exposed limestone substrates, and Saldanha Granite Strandveld vegetation types, classified as *Critically Endangered* under the National Biodiversity Assessment (DEA&DP, 2020) (DEA&DP, 2021). The Besaansklip biodiversity corridor provides essential connectivity between the West Coast National Park, Langebaan Lagoon Ramsar Site, and inland dune systems, supporting gene flow, pollination, and hydrological regulation (DEA&DP, 2022; SANBI, 2021).

The area also supports diverse fauna, including priority avian species such as the Black Harrier (*Circus maurus*) and Ludwig bustard (*Neotis ludwigii*), both of which are listed as Endangered (Birdlife International, 2017).

The Saldanha Bay coastal system, comprising semi-enclosed sub-bays and estuarine inlets, including the Langebaan Lagoon, is designated as a Ramsar Wetland of International Importance. These systems are ecologically sensitive, with limited tidal exchange increasing the sensitivity to salinity shifts and industrial effluent inputs (Ndhlovu, et al., 2024). As freshwater scarcity intensifies, desalination has been proposed as a supplementary source for industrial and GH₂ applications as well as to supply growing settlements in water scarce areas. While viable from a supply perspective, desalination introduces challenges such as brine disposal and marine water quality degradation, necessitating proactive environmental monitoring and discharge management.

Geologically, the region is underlain by Malmesbury Group shales and Cape Granite Suite intrusions, overlain by Pleistocene calcareous sands and aeolian deposits (Nel, 2018). These substrates exhibit moderate to high erosion potential and variable load-bearing capacity, imposing engineering constraints for heavy industrial development. The Besaansklip area, exposed to strong coastal winds and dynamic

Box 5: Biodiversity Spatial Planning Categories as outlined in the Saldanha Bay Municipal Spatial Development Framework (MSDF 2025–2030)

Core 1 (CBA 1):

- Areas in a natural condition that are required to meet biodiversity targets, for species, ecosystems or ecological processes and infrastructure.

Allowable land use: No go area, only non-consumptive activities are permitted, e.g. passive recreation and tourism (hiking trails, bird watching), religious ceremonies, research and environmental education & associated buildings. No Critical Biodiversity agriculture.

Core 2 (CBA 2):

- Areas in a degraded or secondary condition that are required to meet biodiversity targets, for species, ecosystems or ecological processes and infrastructure.

Core 2 (ESA 1):

- Areas that are not essential for meeting biodiversity targets, but that play an important role in supporting the functioning of Protected Areas or CBAs and are often vital for delivering ecosystem services.

Allowable land use: Biodiversity compatible and low impact conservation land uses as per Core 1 areas, but allowing for a limited increase in the scale of development in less sensitive areas.

dune movement, poses additional geotechnical challenges for the design of pipelines, storage tanks, and renewable energy infrastructure, necessitating tailored anchoring and stabilisation measures.

The Besaansklip zone functions as an ecological and hydrological buffer between the core industrial port area and the surrounding conservation landscape. The delineation of the no-development corridor across this area therefore serves a dual purpose: reducing industrial encroachment while safeguarding ecosystem function, dune mobility, and the integrity of threatened vegetation and wetland systems.

2.3 West Coast transport landscape

The West Coast district transport system is road-dominant for both people and most freight, supported by a small set of strategic maritime and heavy-haul freight assets notably, the Port of Saldanha and the Sishen–Saldanha ore corridor (West Coast District Municipality, 2015). Public transport for passengers is overwhelmingly minibus-taxi based with scattered formal ranks; scheduled bus services are limited and mainly inter-urban. The rail within the district is mainly freight (Transnet Freight Rail) with no regular commuter rail. The port infrastructure (Saldanha) is a deep-water strategic asset focused on bulk exports (iron ore) and supporting marine services, fishing, and the SBIDZ/Freeport (West Coast District Municipality, 2015).

The N7 and R27 are two significant corridors⁸ on the West Coast that serve as significant distributors of products, services, and people from the WCDM to other municipalities within the Western Cape, as well as to other provinces and beyond borders (the N7 is the only route connecting the Cape to Namibia). The distribution of goods and services to the communities within the district is facilitated by other minor roads that support these major corridors (Western Cape Government, 2016). The provincial road network of the west coast indicating the national, trunk, main, and divisional roads along with the rail can be seen in Figure 7.



Figure 7 : Provincial Road Network in WCDM (West Coast District Municipality, 2015)

⁸ A transport corridor is a linear area that is ordinarily defined by one or more modes of transportation that cross the boundaries of multiple cities or counties, such as highways, railroads, or public transit, and which share a common destination

The total length in kms from the highways in the West Coast region is approximately 10 000 km. The class 1 road system of the WCDM includes the N7 national road, district roads that connect the various towns, and a variety of significant provincial roads (Western Cape Government, 2016). The district municipality allocates the majority of its budget to the maintenance of gravel roads. The Provincial Road Network is made up of 80% gravel roads and approximately 20% are surfaced. Approximately 60% of the road network is comprised of provincial minor roads. The N7 national road serves as the principal access route through the WCDM, providing connections to the Cape Metro in the south and the Northern Cape Province and Namibia in the north (Western Cape Government, 2016). The municipalities within the district are connected by a network of lower-order roads, which also connect to adjacent districts.

Table 2: Surfaced and Gravel Roads in the Area (source: Western Cape Government (2016))

Road Type	Surfaced (km)	Gravel (km)	Total Length (km)
National Road N7	271.31	-	271.31
Provincial Trunk Roads	430.72	-	430.72
Provincial Main Roads	838.65	424.74	1263.39
Provincial Divisional Roads	279.27	1608.10	1887.37
Provincial Minor Roads	85.03	5939.26	6024.29
Total	1904.98	7972.10	9877.08

According to a 2021 study (West Coast District Municipality, 2020), the Saldanha Bay Municipality has 450 km of tarred roads and 36.6 km of gravel roads. More than 50% of the paved roads were found to have surfaces in either good or very good condition, with an additional 13% categorized as fair. Consequently, about one-third of the paved surfaces were rated as poor or very poor. The structural condition of these roads was comparatively better, with around 60% in good or very good condition, and another 12% deemed fair. Less than one-third of these roads were assessed as poor or very poor in terms of their structural state.

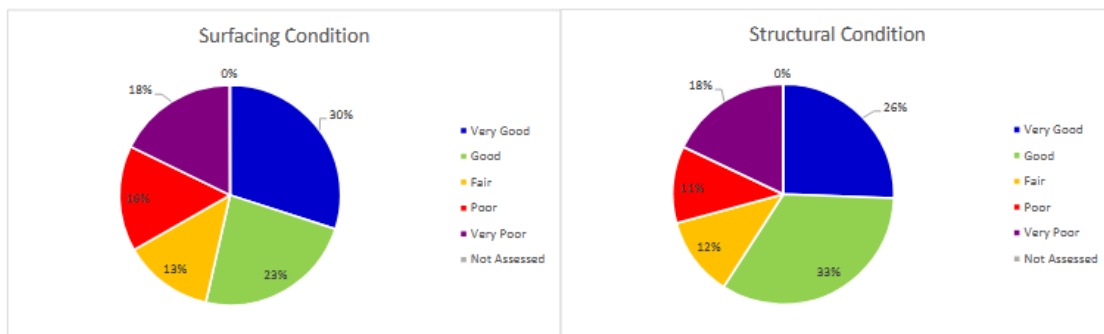


Figure 8: Surface and structural condition in the municipality of the West Coast district (West Coast District Municipality, 2020)

To evaluate each town's road conditions, a score from 1 to 5 was applied, categorizing them from very poor to very good.

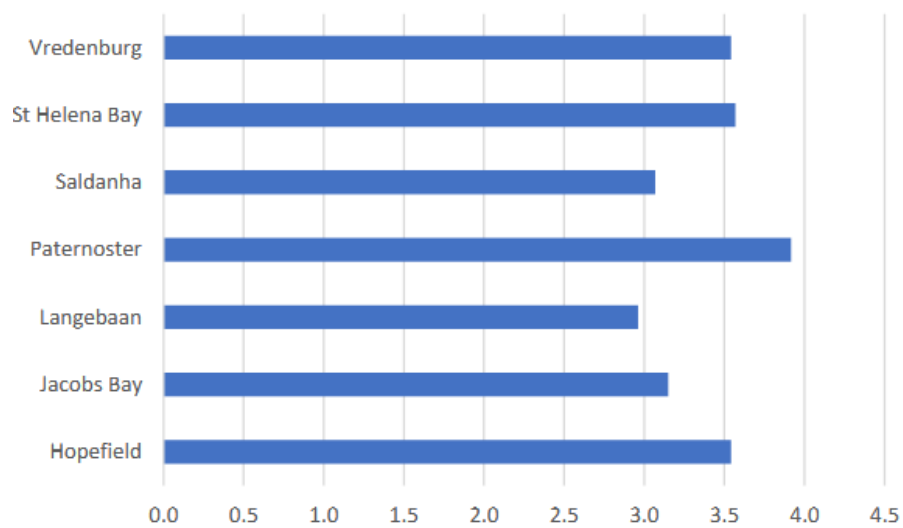


Figure 9: Road condition by town on the west coast: StratEcon calculations based on the municipality of the West Coast District municipality (West Coast District Municipality, 2020)

The road structures and surface conditions of towns were analysed, rated, and compiled. Figure 9 demonstrates the distribution of condition scores, adjusted for road length, for both structural and surface assessments (West Coast District Municipality, 2015). Paternoster has the best road conditions, with St Helena Bay, Vredenburg, and Hopefield following. Conversely, the road conditions in Langebaan, Saldanha, and Jacobs Bay are rated the poorest. Therefore, enhancing and reassessing road conditions is advised to meet the safety standards necessary for the transportation of hazardous materials by road.

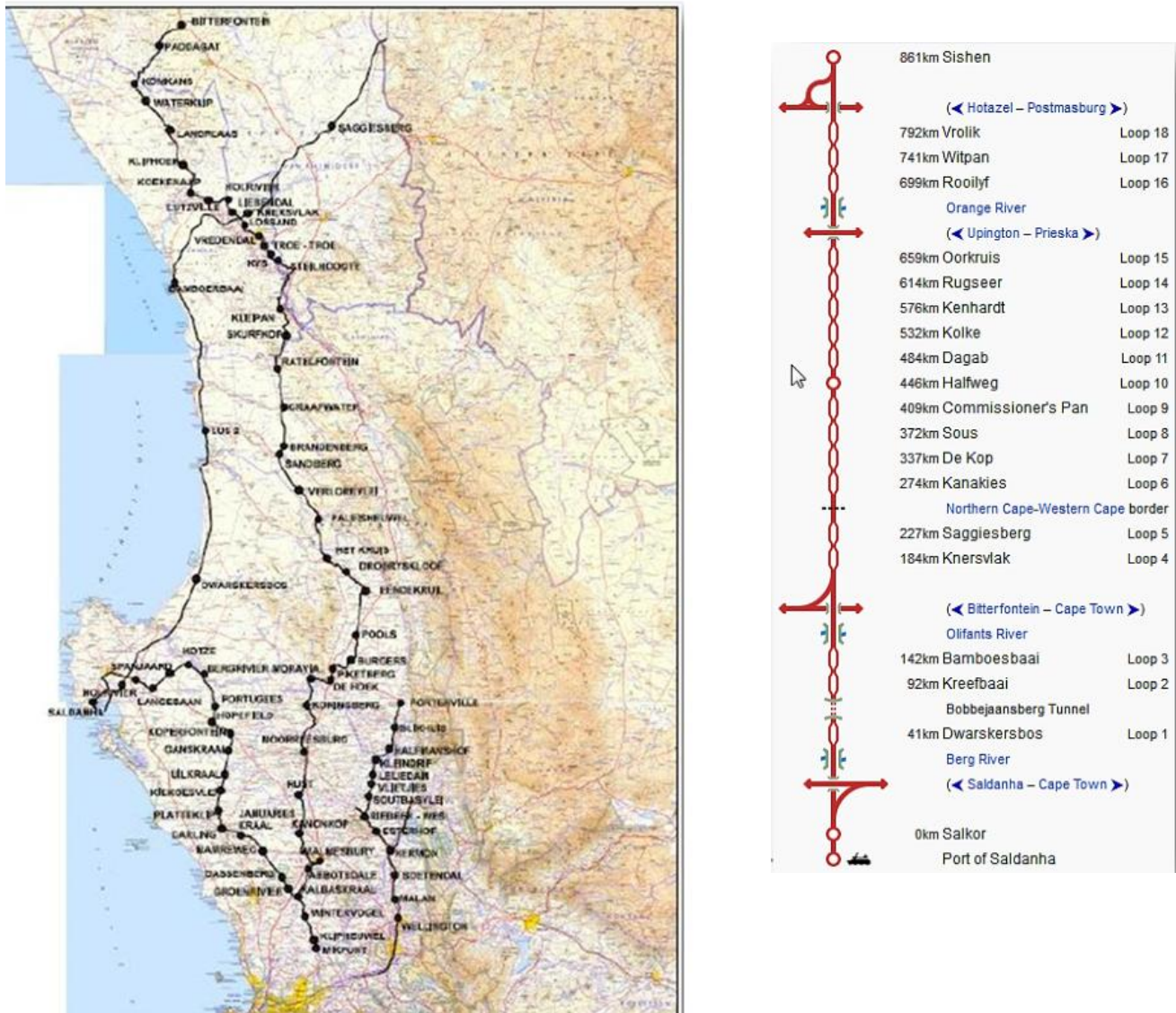


Figure 10: Existing freight railway line network in WCDM (right) and Transnet freight rail network (left) (West Coast District Municipality, 2015)

For freight movement, the district is strategically important due to the Port of Saldanha, SEZ, and its location on the Cape Town–Windhoek corridor. The N7 and the rail line are critical freight routes, with the break-bulk the most common cargo type. Air transport is limited to small municipal, private or military airfields, with no commercial airports in the district (West Coast District Municipality, 2015).

2.3.1 Saldanha Bay transport landscape

The economic anchor of the West Coast District is the Saldanha Bay Municipality, which is fueled by the Port of Saldanha, the Sishen–Saldanha heavy-haul iron ore rail, steel and fisheries value chains, and the expanding energy and maritime services associated with the SEZ as, indicated in Figure 11. Road-based mobility is the predominant mode of transportation for both people and general freight. Minibus taxis are the primary mode of public transportation, with improved and planned taxi ranks that will enhance accessibility in primary settlements (Western Cape Government, 2016).

The municipal main road network comprises (Saldanha Bay Municipality, 2024):

- R27 (West Coast Road): The primary north–south corridor to Cape Town.
- R45: Connects the Vredenburg–Saldanha inland with the N7 (via Hopefield/Velddrif/Malmesbury).
- R399: Provides connectivity between Vredenburg and Saldanha, as well as the surrounding communities.
- Urban streets: Ongoing improvements to access roads (e.g., SBIDZ access), intersections, pedestrian facilities, parking management in CBDs, and traffic calming near schools and public facilities (Saldanha Bay Municipality, 2024).

The port is the deepest natural harbor in South Africa and is equipped with specialised iron ore, petroleum, and multi-purpose terminals. Critical transport nodes include:

- Urban nodes: Vredenburg (administrative/commercial hub & main taxi interchange), Saldanha (port-adjacent industrial/marine node), Langebaan (tourism/residential), St Helena Bay, Paternoster, Hopefield.
- Logistics nodes: Port of Saldanha (Iron Ore Terminal, Multi-Purpose Terminal, Crude berth), Salkor rail yard & sidings, SBIDZ/Freeport Saldanha precincts (Saldanha Bay Municipality, 2022-2027).

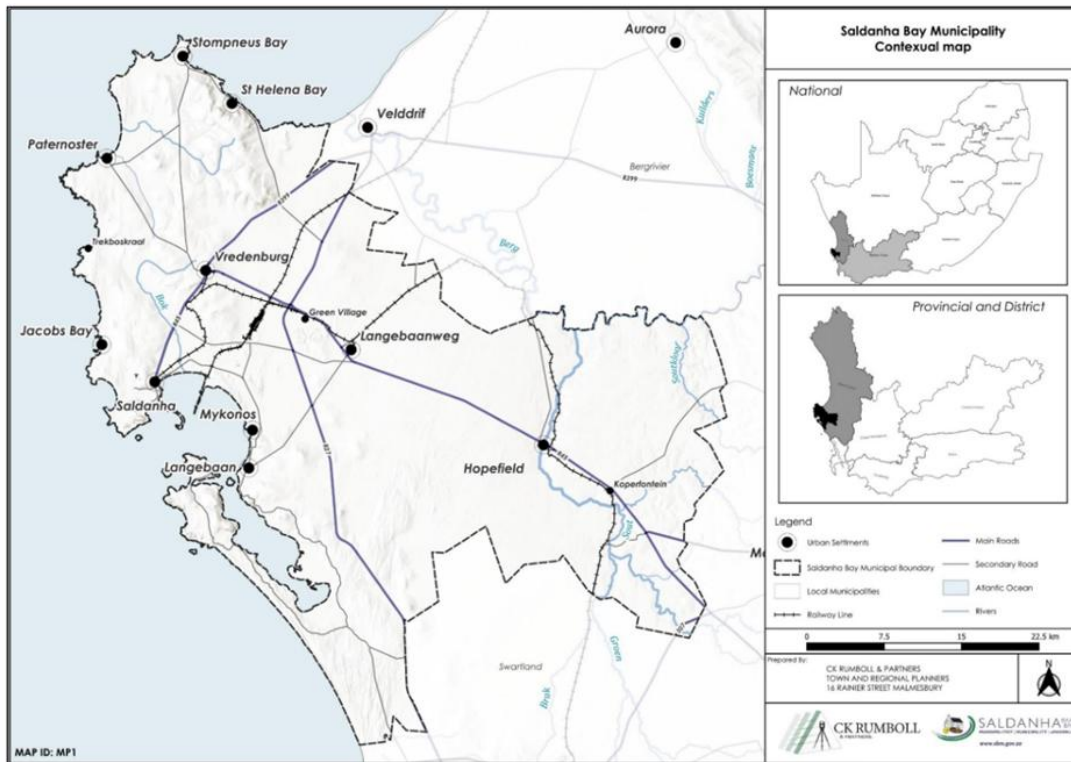


Figure 11: Saldanha Bay Map Source 2025-2030 Saldanha Bay Spatial Development Framework

The table below outlines different public and road transport modes, their facilities and taxi ranks, rail, air and maritime infrastructure.

Table 3: Current Status Quo of Transport Available in Saldanha Bay (Saldanha Bay Municipality (2022))

Transport mode	Public and road Transport	Facilities & taxi ranks	Rail (Freight & People)	Air and Maritime
Description	Dominant mode Private vehicles and minibus taxis throughout the settlement network (Vredenburg, Saldanha, Langebaan, St Helena Bay, Hopefield, Paternoster)	<p>Vredenburg Taxi Interchange: upgraded/ extended in 2022–2023 (additional stacking bays, canopy extensions, covered seating, active box, washbay, lighting and stormwater enhancements). In Saldanha and other towns, smaller ranks/holding areas are in operation, with additional rank investments identified in municipal planning (e.g., Witteklip, Ongegund).</p> <p>Vredenburg Taxi Interchange was completed in 2023, this improved circulation and formalization, expanded ranks/stacking, canopy, and passenger amenities, However in the pipeline (2024–2027), traffic management, pedestrian crossings, sidewalk improvements, shelters/ enclosures, additional taxi rank works (e.g., Witteklip, Ongegund) and the appointment of traffic engineering support to implement recommendations (Saldanha Bay Municipality, 2022-2027).</p> <p>Bus services: Intercity coaches and charter services operate on demand along regional routes; there is no formal scheduled municipal bus system.</p> <p>Non-motorised transport (NMT): Town centres are equipped with sidewalks and crossings; traffic calming and enhancements are among the ongoing priorities of the Intergrated Transport Plan (ITP).</p>	<p>Passenger: SBM does not have a regular commuter rail system. Regional lines offer limited / historic services; however, daily passenger mobility is dependent on the road.</p> <p>Freight: The iron ore terminal of the port is supplied by the heavy-haul line from Sishen to Saldanha (OREX), while the port/steel complex is also served by additional industrial sidings/yards (e.g. Salkor).</p> <p>The OREX heavy-haul line is a 50 kV electrified single track with passing loops connecting Sishen to Saldanha; terminals interface with local industrial sidings and port rail yards. Pipeline: Nationally, capacity and reliability interventions related to the ore export value chain (rolling stock, yards, signaling, maintenance regimes) are prioritized; locally, initiatives are aligned with the growth scenarios of port terminals (Saldanha Bay Municipality, 2025).</p>	<p>Maritime: The Port of Saldanha is responsible for the transportation of bulk exports (iron ore), liquid bulk (crude), and multi-purpose/break-bulk cargo. It also provides support for fishing, offshore/oil & gas marine services, and fabrication/repair activities that are associated with the Freeport/ IDD.</p> <p>Air: There is no commercial airport. General aviation is served by Saldanha/Vredenburg Airfield (FASD), while Langebaanweg Air Force Base is located in close proximity (military).</p>

2.4 Current planning frameworks and emerging GH₂/PtX projects

South Africa's spatial planning and land use management is governed by the Spatial Planning and Land Use Management Act (Act 16 of 2013) (Department of Land Reform and Rural Development (South Africa), 2013), promoting sound development and sustainable land use. Municipalities regulate land use locally, with the Saldanha Bay Local Municipality overseeing the Saldanha Industrial Area. The Municipal Spatial Development Framework (SDF) and its land use scheme guide development and protect environmentally significant land, are applicable to all municipalities, and are relevant, especially for new green hydrogen projects.

2.4.1 Regional planning – remaining municipalities in the West Coast District

The municipalities surrounding Saldanha Bay acknowledge it as the central anchor of the emerging GH₂/PtX economy. Their spatial development frameworks (SDFs) generally position them as supportive enablers aligned with Saldanha's regional hydrogen-driven growth strategy.

The Bergrivier SDF (2024–2029) references GH₂/PtX as an emerging alternative energy source, complementing wind and solar power. It supports establishing hydrogen facilities along the coast, emphasizing environmental care to minimize ecological and social impacts. Wards 6 and 7 are identified as preferred zones for hydrogen infrastructure due to accessibility, proximity to energy and transport networks, and environmental suitability. The Saldanha Bay SEZ is recognized as Bergrivier's key regional economic link, with the N7 highway highlighted as a major north–south connector fostering access and integration with the Saldanha region. The Cederberg SDF promotes solar and wind energy as its main renewables and aligns indirectly with the greater Saldanha Bay green hydrogen ecosystem. It does not propose direct local hydrogen production or transmission infrastructure but instead supports complementary renewable energy that strengthens the regional hydrogen strategy. The Matzikama SDF contains minimal reference to green hydrogen or the regional hydrogen economy. Its renewable energy focus is modest and largely solar-based, with little emphasis on low-carbon technologies or integration with the Saldanha hydrogen hub, contrasting with municipalities like Bergrivier and Cederberg. The Swartland SDF does not mention GH₂/PtX directly but prioritizes solar and wind energy within designated renewable energy zones. These zones were chosen for land suitability, environmental fit, and proximity to grid infrastructure, making Swartland a renewable energy node that indirectly supports regional decarbonization.

2.4.2 Saldanha Bay Local Municipal Planning

The latest Saldanha Bay Spatial Development Framework 2025-2030 references the potential establishment of a GH₂/PtX initiative within the SEZ. Additionally, it supports the promotion of renewable energy facilities—specifically wind and solar—where such developments are guided by specialist studies (Saldanha Bay Local Municipality, 2025, p. 336). However, the document does not provide further guidance or indicate a clear preference regarding the implementation or prioritisation of these initiatives.

In parallel with the municipal SDF, the Review and Amendment of the Fifth Generation Integrated Development Plan (Saldanha Bay Local Municipality, 2025) has raised several issues of relevance to GH₂/PtX developments, to respond to an emerging economic landscape:

- Develop a **green hydrogen strategy** to investigate the viability of the SEZ and how it can support it (Saldanha Bay Local Municipality, 2025, p. 119).
- Develop a **strategy for release of national and provincial land**, in view of likely pressures brought about by the emerging GH2 sector. This issue could also link with the issue of SEZ nodes (Saldanha Bay Local Municipality, 2025, p. 127).
- **Airport development** - the SEZ to be approached to include the Saldanha airport in their development strategy (Saldanha Bay Local Municipality, 2025, p. 135). Apart from providing ease of access to the SEZ and industrial zone, it can also serve to promote cleaner aviation as a potential off taker.
- **Supporting development and investment** – Bureaucratic processes can hamper development opportunities and reduce the attractiveness of opportunities. Consequently the following has been proposed to remedy the issue: establish a Red tape reduction office working closely with the WCG DEDAT Red Tape Reduction Unit; and improve processing and approval times for building approvals and land use change applications (Saldanha Bay Local Municipality, 2025, p. 262).
- Updating the IDP could also affect the **updating of several municipal master plans** such as, the Disaster Management plan, Electricity master and maintenance plans, Infrastructure plans (including Water, sanitation etc.), Roads master plans, Renewable energy plans, Spatial Development Framework, Settlement planning and the development of a freight strategy.
- Proposals are made regarding **areas for industrial development**, including consolidating the industrial area quadrant between Vredenburg, Saldanha town and the rail corridor. Industrial development east of the rail corridor should only commence once sufficient critical mass has been reached with industrial development to the west (Saldanha Bay Local Municipality, 2025, p. 230).

Land Zoning of the Basaansklip Industrial Zone

The Besaansklip Industrial Zone (~6 400 ha) is a large spatial area on the Besaansklip Plain, within which the Saldanha SEZ is nested. The Besaansklip Industrial Zone was originally earmarked to accommodate several large industries that were spaced apart from each other across the zone, featuring a rail marshalling yard, ArcelorMittal steel plant, Duferco steel plant. These are connected by the Orex rail line terminating at the port. The Port features an ore storage area, several terminals and tippler plants. Also, present is the Avedia and Sunrise Energy sites located closer to the port (Figure 12). Both the Sunrise and Avedia plants would require additional land for expansion.

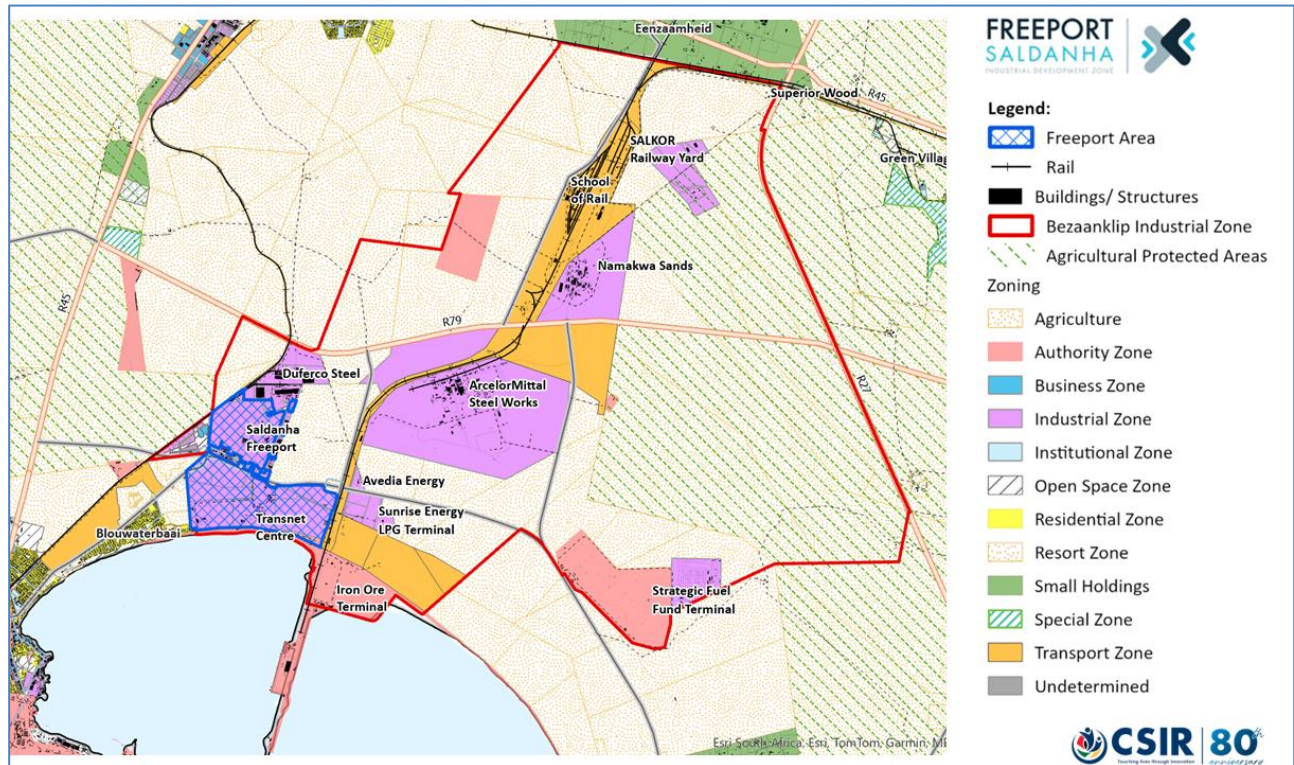


Figure 12: Land zoning across the Bezaanklip IDZ and surrounding area.

Source: (Saldanha Bay Local Municipality, 2025)

Established industrial areas are zoned as industrial, including the SEZ although it is only partially developed (Figure 12). Several areas are zoned as transport zones and intended for the rendering of a transport service, for the transport of goods (including liquids and gases) or passengers by rail, air, pipeline, sea, or road. There are also several Authority Zones with land used by government bodies. The remainder of the land within and surrounding the industrial zone and port is zoned as agriculture. This is predominantly used for the purposes of *bona fide* agricultural production and the conservation of suitable agricultural land. A significant portion of agricultural land within the eastern part of the industrial zone is also designated as Protected Agriculture Areas (PAAs). These areas are considered high-value agricultural land and designated for preservation against non-agricultural uses. PAAs comprise 31% (2 007 ha) of land within the Industrial zone. This might represent an added challenge when considering new industrial development in an already environmentally constrained context.

Although the area benefits from extensive rail and road access, it is situated within an environmentally sensitive zone. Large portions of the area fall within designated CBAs. Additionally, a climate change corridor (Figure 13) cuts through the zone, contributing to spatial fragmentation and limiting opportunities for cohesive, high-density development (Saldanha Bay Local Municipality, 2025, p. 280)

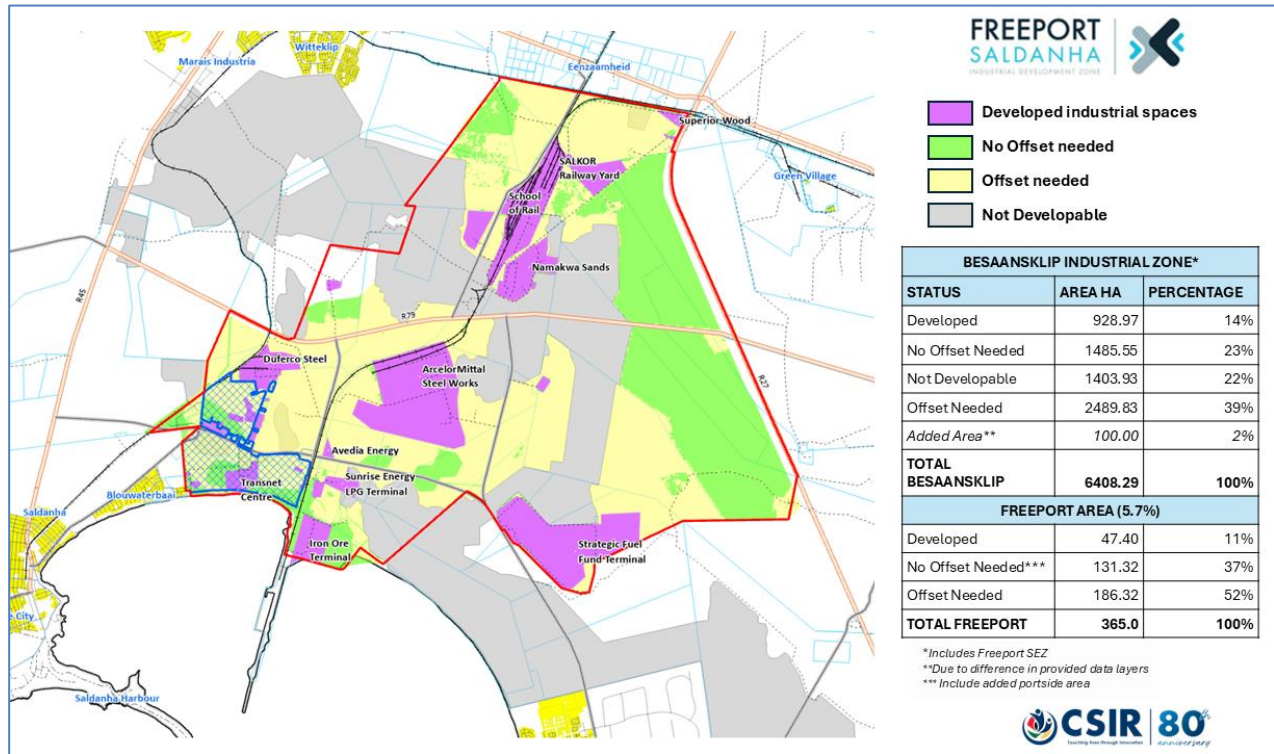


Figure 13: Focal area for industrial development – Besaansklip.

Source: Author, 2025.

The Saldanha Strategic Offset Strategy depicts delineated areas of restriction resulted from work undertaken during the update of the Greater Saldanha Environmental Management Framework (EMF) as part of the RSIF process (Western Cape Government Environmental Affairs and Development Planning, 2020, p. 1). A core-corridor that is not developable because of biodiversity features runs through the industrial zone dissecting it. Two further spatial categories were established because of this strategy, namely areas that require biodiversity offset and areas without offset requirements. A significant amount of the Besaansklip zone requires biodiversity offsets -39% - yellow areas in Figure 13 (Environmental Affairs and Development Planning, Western Cape Government, 2020).

Land ownership

The majority of land in the industrial zone is privately owned land. The limited availability of state land implies that procurement of land is required by developers wanting to establish GH₂ projects outside the SEZ. The Review and Amendment of the 5th Generation Integrated Development Plan (Saldanha Bay Local Municipality, 2025, p. 127) indicate that considering the likely pressures brought about by the emerging green hydrogen sector, a strategy should be developed to release national and provincial land. This could also link to considerations for SEZ nodes.

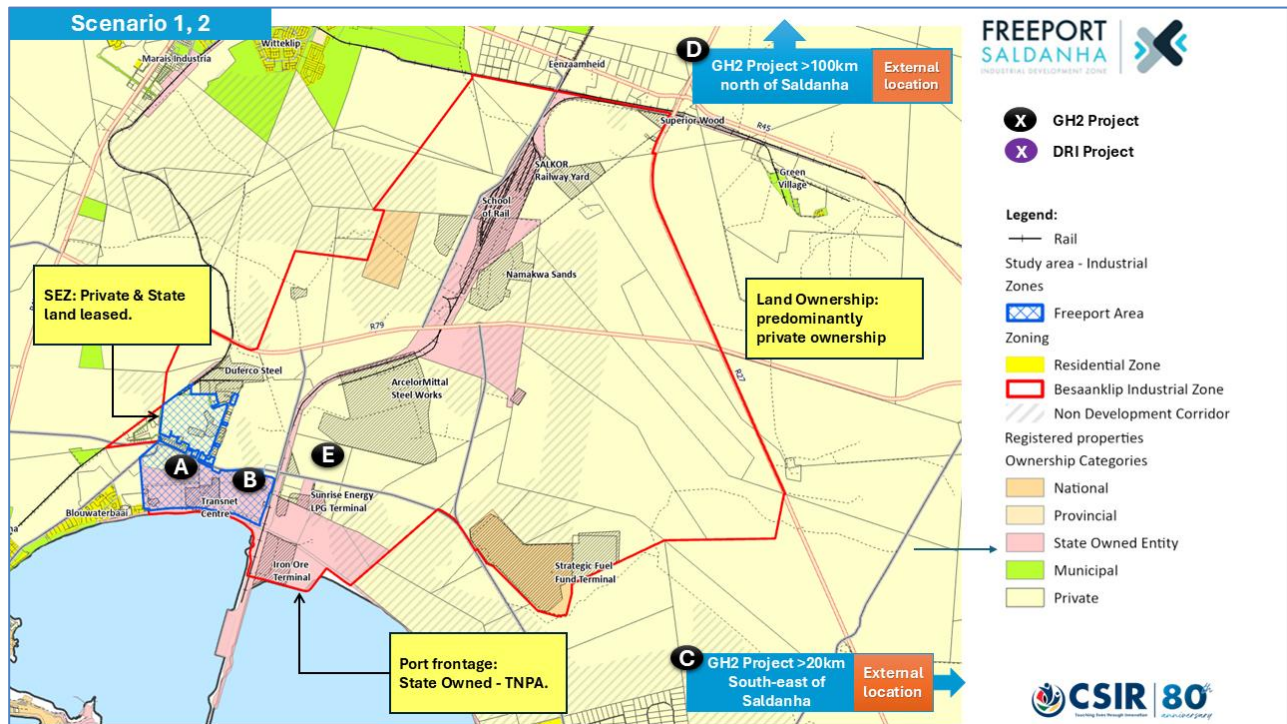


Figure 14: Land ownership in industrial zone and surrounds.

Accommodating further developers would prove difficult within the SEZ given limited space, which would require other areas within the Besaansklip industrial zone be secured and utilised. When considering access and use of potential shared infrastructure further projects run the risk of developing in a scattered manner across the industrial zone. Most land in the remainder of the industrial zone is also privately owned according to recent data (Saldanha Local Municipality, 2025). Procuring and consolidating land to accommodate GH₂ production and storage should be considered as a strategy to secure more land.

Proposed development - Besaansklip

Figure 15 highlights several land parcels proposed for industrial development (i.e., Spatial proposals) as set out in the latest SDF, while Table 1 outlines the potential development areas within the industrial zone. In particular, most of these areas would require environmental offsets. The accompanying map also identifies the proposed road infrastructure aimed at improving access and unlocking parts of the zone. The optimal use of the port and back-of-port areas is emphasised. The location and scale of emerging hydrogen-related developments have not been taken into account. As a result, the SDF recommends the creation of a services master plan to address the infrastructure needs associated with future growth.

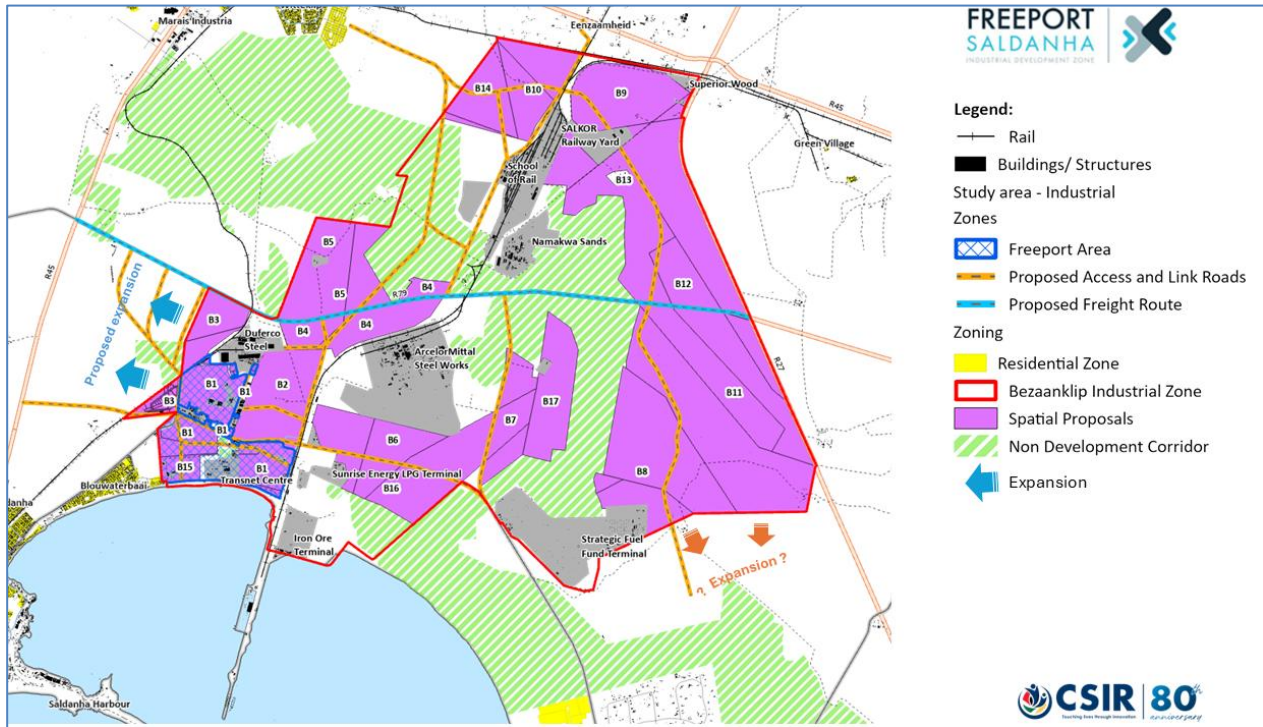


Figure 15: Besaansklip Industrial zone Spatial proposals, 2025-2030.

Source: (Saldanha Bay Local Municipality, 2025)

Table 4: Besaansklip parcels available for development (March 2025)

Proposal – requiring offset		Proposal – no offset	
Code*	Extent (Ha)	Code*	Extent (Ha)
B1	241.68	B11	692.67
B2	167.34	B12	204.16
B3	110.12	B13	389.32
B4	115.17	B14	114.49
B5	205.01	B15	30.27
B6	220.28	*Relate with items in Figure 15	
B7	104.83		
B8	361.45		
B9	196.51		
B10	116.76		
B16	134.48		
B17	141.62		

Source: (Saldanha Bay Local Municipality, 2025)

In general, the Saldanha local municipality would encourage growth across the Besaansklip Industrial Zone to stimulate the development of the SEZ (Saldanha Bay Local Municipality, 2025, p. 283).

3 POTENTIAL GH₂/PTX DEVELOPMENT PATHWAYS

The configuration of how individual projects will fit into the broader Saldanha GH₂/PtX technology system is inherently context-dependent, influenced by factors such as resource availability, technological maturity, market orientation, local development realities and logistical considerations that collectively determine the type of products produced and their respective target markets. Figure 16 depicts the core components of a potential GH₂/PtX value chain on the West Coast, illustrating a series of interconnected, interdependent processes involved in production, conversion, storage, transport, and end-use.

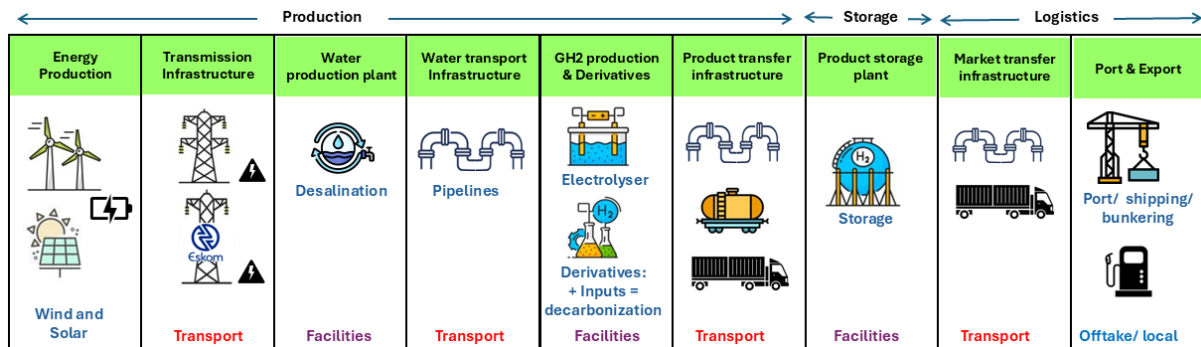


Figure 16: Core components of the envisaged West Coast GH₂/PtX system outlining the full green hydrogen (GH₂) value chain from production to export. It begins with renewable energy generation (wind and solar), followed by desalination, electrolysis, and derivative production, and continues through transport, storage, and market transfer infrastructure. The chain concludes with logistics for domestic offtake and international export via port facilities.

Based on insights gathered through stakeholder consultations and expert-led workshops, a series of development scenarios and associated narratives were formulated to illustrate potential development pathways for the West Coast GH₂ hub (Figure 17), which depicts the core components of the emerging West Coast GH₂ system and illustrates how the hydrogen value chain could materialise in and around the SEZ under optimistic conditions.

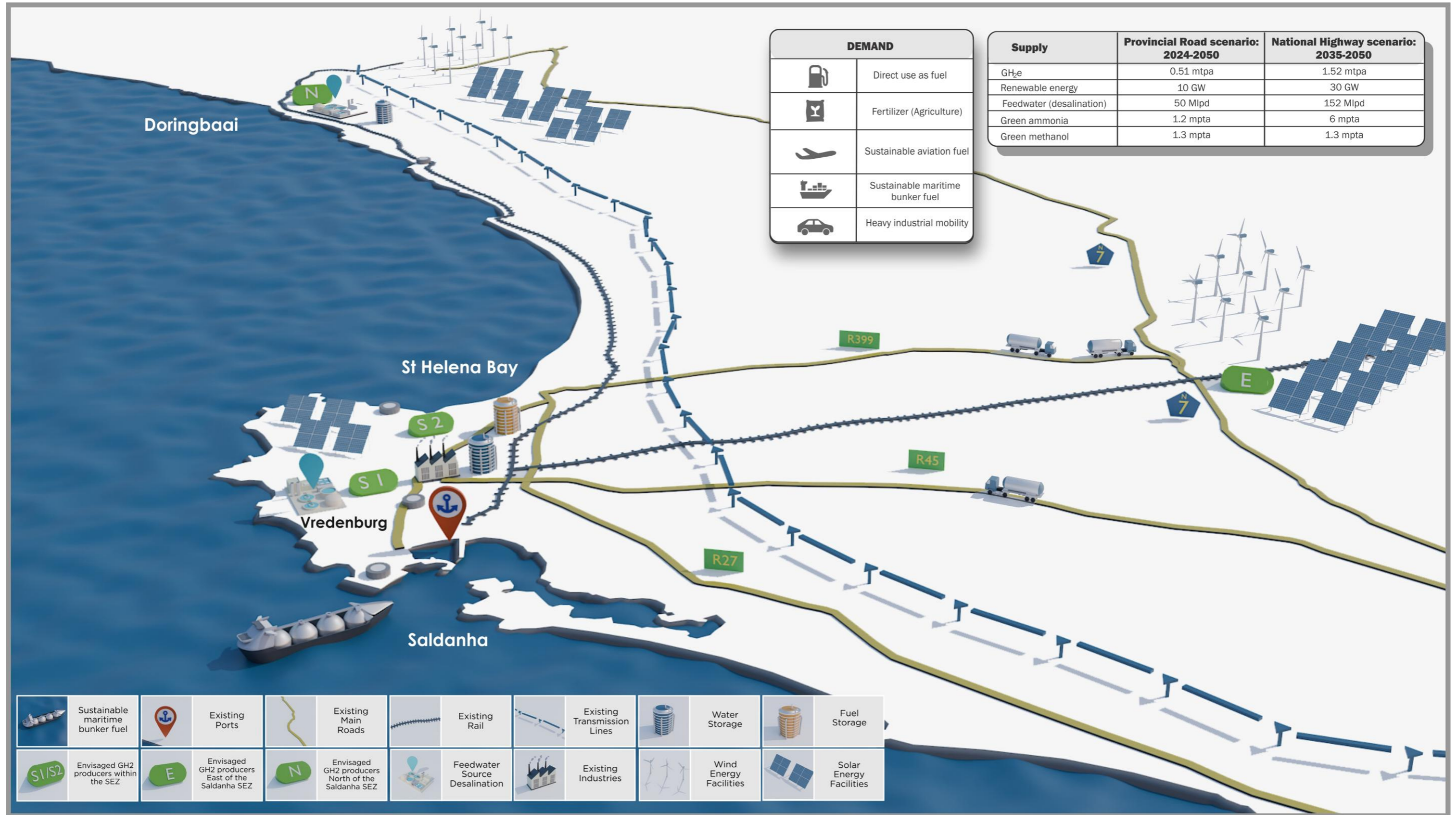


Figure 17: Conceptual schematic illustrating what the West Coast GH₂/PtX Hub might look like assuming the manifestation of the Provincial Road and National Highway scenarios

In the event that green hydrogen initiatives are lacking (Sc0), there continues to exist a substantial number of significant projects that contribute to the effort to augment industrial development within the municipality (Figure 18). It is also the mandate of Saldanha Freeport to stimulate industrial growth and investment in the maritime and energy sectors. Numerous projects have been suggested within the SEZ, in the broader Besaansklip zone and its surrounding areas. Should green hydrogen projects be incorporated (Sc1 and Sc2), this would likely contribute to the increased allocation of industrial land, implications for infrastructure requirements, and the enhancement of available skill sets.

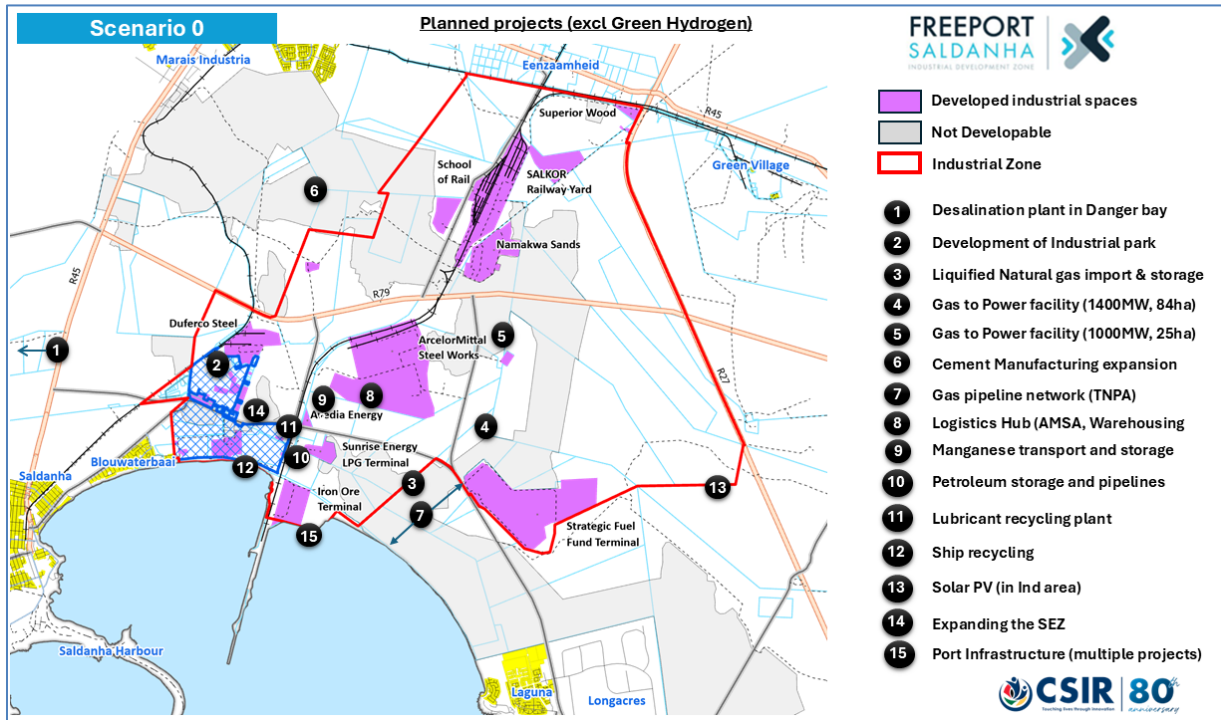


Figure 18: Development proposals within and surrounding the Besaansklip Industrial Zone, excluding renewable energy proposal and GH₂ archetypal projects (considered in the scenario framework)

Appendix C lists other key projects already planned within the proximity of the industrial zone, distinguished by their developmental stages and implementation timelines. Many of these projects necessitate substantial infrastructural investment. Energy projects notably the LNG import project would also require pipelines to transport the product from the port over 100 km to Atlantis. Additionally, several projects are contingent on the port enhancing its waterside infrastructure to facilitate their operation. The combination of these proposed projects in addition to the hydrogen projects proposed would require the municipality to also review their planning, including updating their infrastructure demand quantification. Similarly, the Capital Expenditure Framework 2024/25, outlining the financial roadmap for the municipality, will need to be revisited due to the emergence of GH₂/PtX development, and it is especially aspects such as water provision, waste removal, electricity provision, and roads infrastructure that would be impacted.

The following subsections outline the critical infrastructure and technology elements of a GH₂/PtX system ranging from feedwater and renewable energy supply to hydrogen derivatives and shared infrastructure, as they could unfold under different scenarios as well as the current status quo. The scenarios highlight differences in scale, coordination, and integration, offering a forward-looking view of how the hub could evolve under varying levels of investment, governance, and market conditions. Each of the three scenarios depict potential development pathways for the West Coast GH₂ Hub, highlighting the opportunities and constraints that may influence system design, scale, and integration.

3.1 Electricity generation via renewable energy and transmission

Renewable electricity supply is a core component of the GH₂ value chain and must be generated at scale to power electrolysis and derivative production. In the Saldanha region, the most viable renewable energy sources are solar, onshore wind, each with distinct spatial, technical, and cost considerations. The West Coast region has abundant solar PV and wind (onshore and offshore) potential which are already being harnessed by eight operational renewable energy facilities feeding into the national grid. High voltage electricity grid infrastructure is established with planned expansion around Saldanha Bay and toward the north of the region. The medium voltage grid network infrastructure diminishes farther north.

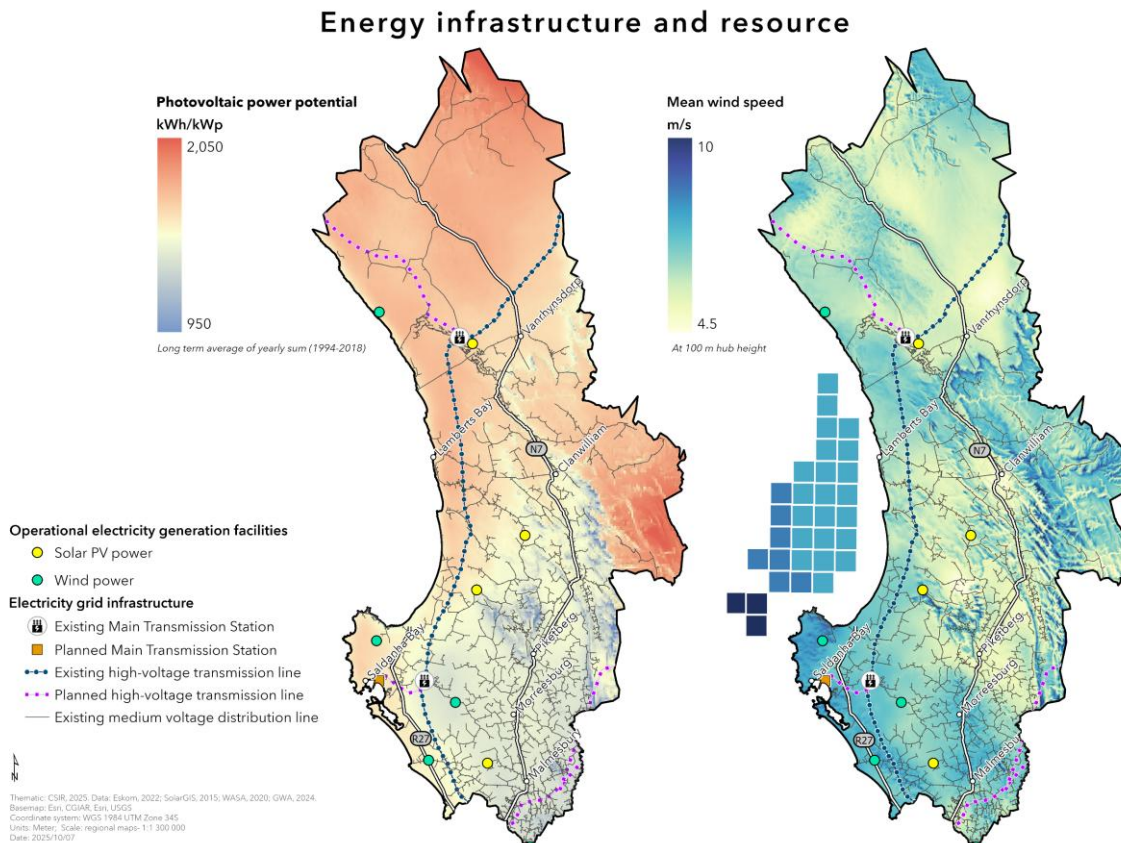


Figure 19: Core Spatial distribution of operational renewable energy facilities in relation to wind and solar resource potential.

GH₂ producers located within and around the SEZ are expected to source renewable electricity either directly from nearby renewable energy facilities or through power wheeling across the Eskom transmission network. Shared transmission lines are essential to deliver renewable energy efficiently to multiple desalination and hydrogen production facilities while minimising land take and visual impacts associated with redundant infrastructure. These lines can take the form of dedicated connections from generation sites or coordinated use of the Eskom grid, allowing clusters of production facilities to access electricity without duplicating networks.

Under the **Dirt Track scenario**, in the absence of enabling conditions for the establishment of the GH₂/PtX hub, renewable energy development progresses incrementally, with some generation continuing in the agricultural flatlands west of the Cederberg, contributing approximately 500 MW to the grid. In the region east of Saldanha Bay, 700 ha have been used for solar PV facilities, while 1 500 ha have been dedicated to onshore wind. These developments provide between 920 and 3 400 potential employment opportunities to local communities in the region.

Under a moderate growth pathway (**Provincial Road scenario**, to 2050), renewable energy rollout advances steadily albeit constrained. Green hydrogen production is supported by 5 GW of electrolyzers powered by 10 GW of renewable capacity with surplus electricity supplied to the SEZ, local municipalities, and the national grid. A lack of coordination between authorities leads to separate transmission lines being constructed by individual producers. Renewable electricity comes from a mix of onshore wind (30%) and solar PV (70%), with developers oversizing capacity up to twice operational needs (the 10 GW includes the oversizing), to ensure self-sufficiency, sell surplus electricity to storage facilities, and support grid integration. The combined land footprint for solar and wind totals 17 000 ha, roughly 10% of the Saldanha Bay Local Municipality, while offshore wind contributes an additional 2 GW of capacity without impacting the land footprint.

Under optimistic conditions (i.e., **National Highway scenario**, to 2050), renewable energy deployment within the West Coast region is diversified and oversized to guarantee both self-sufficiency and grid support. A total, ~121,650 ha of land, equivalent to about 45% of the City of Cape Town Municipality, are dedicated to solar and onshore wind, complemented by 6 GW of offshore wind capacity. Electrolyser capacity reaches 15 GW, powered by 30 GW of renewables. This infrastructure supports GH₂ production while supplying surplus power to the SEZ, municipalities, and the national grid. Electricity is transmitted via new and existing infrastructure across the Saldanha region and the Central and Western Corridors. Developers purchase renewable power from third parties and wheel it through the national grid under new utility agreements, with decreasing wheeling costs facilitating greater participation and more efficient integration of renewable electricity into large-scale hydrogen production.

3.2 Feedwater production for electrolysis

Freshwater input into the electrolysis process can be produced from Seawater reverse osmosis (SWRO) or Mine Water Reverse Osmosis (MWRO). In the Saldanha Bay region, feedwater for GH₂ production is most likely to be supplied via SWRO, potentially developed at scale within the coastal SEZ. SWRO involves forcing seawater through semi-permeable membranes under high pressure, filtering salts and impurities, to produce freshwater. Standard SWRO facilities include large seawater intake and pre-treatment systems, high-pressure pumps, reverse osmosis membranes, post-treatment systems, and brine management systems, including marine outfalls located offshore of the plant facility to discharge brine (Schreiner, et al., 2024). Several small desalination plants are present in the municipality, notably with TNPA, AMSA, and SeaHarvest. Further, the Municipality has an approved EA for a still to be constructed desalination plant at Danger Bay (Pandorum, Rakaibe, Snyman-Van der Walt & Roos, 2024, p. 71). Construction of the plant will need to start on 26 March 2028 or the Environmental Authorisation shall lapse (Toefy, 2022).

Under the **Dirt Track scenario**, desalination capacity remains modest, with the government-led 8.5 million litres per day (MLPD) plant near Danger Bay providing partial relief to local water scarcity. While this facility supports community and municipal needs, no significant allocation is directed toward GH₂ production, and limited rail and industrial capacity continue to constrain large-scale development.

In the **Provincial Road scenario**, freshwater supply expands more substantially. The Danger Bay facility is scaled to 50 MLPD, powered largely by renewable electricity. Of this, 35 mlpd is allocated to hydrogen production, while the remaining 15 MLPD serves local consumers. A dedicated pipeline connects the plant to the Besaansklip reservoir, where water is integrated into both industrial and municipal distribution systems, ensuring a more balanced supply between hydrogen production and local demand.

By contrast, the **National Highway scenario** sees desalination capacity dramatically expanded, with an additional desalination facility becoming established in Dooringbaai and the Danger Bay facility reaching

152 mlpd, powered entirely by renewable energy. Approximately 105 mlpd is directed to hydrogen production and 32 mlpd to local users, with surplus stored in aquifers to counteract saline intrusion risks. Brine is safely discharged through offshore diffusers, and existing water pipeline infrastructure is extended to storage and distribution hubs such as the Besaansklip reservoir. This scale of development ensures both security of supply for the hydrogen hub and long-term resilience for regional water users.

3.3 Green hydrogen derivatives and carrier forms

Hydrogen can be utilised directly as a fuel or converted into a range of derivative products and carrier forms that enable safer, more efficient storage, transport, and end-use across sectors. These derivatives such as ammonia, methanol, and liquid organic hydrogen carriers (LOHCs) extend the versatility and market reach of hydrogen by integrating with existing industrial and energy systems. The choice of carrier or derivative depends on factors including production pathways, infrastructure availability, transport distance, energy density, and end-use application.

Carrier forms of hydrogen within the region include:

- **Compressed Gaseous Hydrogen (CGH₂)**: A mature and widely used technology requiring no additional preservation measures compared to other hydrogen carriers, suggesting its potential as a replacement for subterranean. Hydrogen gas is stored in high-pressure tanks (350–700 bar) and can be transported through specialized or retrofitted natural gas pipelines. While compression consumes around 3–18% of hydrogen’s lower heating value, this energy demand is generally manageable, with pipeline transport adding only about 3% per 1 000 km. The infrastructure involves high-pressure tanks, and specialized pipelines that can be easily retrofitted into existing natural gas pipelines and construction frameworks, alongside refuelling stations. Compression is the main processing requirement, though pressure reduction may be needed for certain applications (Hydrogen Europe, 2024).
- **Liquid Hydrogen**: Hydrogen reaches its liquid state at –253 °C, making it much denser than CGH₂ and allowing much higher transport volumes. Specially designed cryogenic tanks, by road, rail or ship, can carry about 2500 kg per container, more than double gaseous equivalents of MEGC (Fuel Cells Works, 2024). However, liquification plants require large amounts of energy, and boil-off remains a persistent challenge. Evaporation increases tank pressure, necessitating relief measures such as controlled venting, ullage management, or its limits on trip duration (Ortiz-Cebolla et al., 2022). Despite these barriers, LH₂ is increasingly attractive for long-distance export. Cryogenic storage tanks, specialised transport trailers, and dedicated filling stations are the common infrastructure used to store or distribute.
- **LOHC**: LOHCs such as dibenzyl toluol (DBT) enable hydrogen to be chemically bonded to a stable organic liquid, which can then be transported using existing oil-handling infrastructure. This makes it compatible with pipelines, tankers, and storage systems, offering immediate logistical solutions (Hydrogen Europe, 2024). At the end-use site, hydrogen is released via dehydrogenation, an endothermic and energy-intensive process. The high cost of LOHC liquids and the energy penalty remain challenges to competitiveness. However, LOHC systems represent a promising transitional solution in settings where oil-based infrastructure is already dominant.
- **Green Ammonia (NH₃)**: Ammonia is a well-established global commodity with a synthesis, storage, and transport infrastructure already in place. It is emerging as one of the most promising hydrogen carriers, particularly for export and marine bunkering. Inland, ammonia can be transported by road and rail tankers, pipelines, or shipped in bulk. At the end-user point, it can be used directly as fertiliser or cracked back into hydrogen. Ammonia as a fuel can be directly supplied and utilised, especially in the production of fertilisers or as a prospective zero-carbon fuel for the maritime industry. Ammonia is generally stored in large-scale storage infrastructures and vessels at a

cryogenic temperature of -33°C (Jinyue & Muhammad, 2023). In contrast, smaller storage facilities and pipelines typically liquefy ammonia by applying pressure, often exceeding 10 bar (Hydrogen Europe, 2024). Although ammonia is hazardous to health and the environment, requiring strict safeguards and large-scale cracking technologies. The energy penalties for reconversion are also high. Nevertheless, its maturity and dual-use value make ammonia indispensable to South Africa's hydrogen vision.

- **Green Methanol (CH_3OH):** Methanol as a fuel is not reconverted to hydrogen but is delivered directly to end users as a fuel or chemical feedstock. The current infrastructure for natural gas and gasoline, such as storage and pipelines, can be leveraged. There is a requirement for facilities to store and transport CO_2 and for processing centres involved in dehydrogenation. Alternatively, there may be a need to deliver or generate biogenic or air-captured CO_2 at the synthetic fuel hydrogenation sites (Jinyue & Muhammad, 2023). For South Africa, these pathways have special relevance. CO_2 streams make methanol synthesis viable in the near term, while the established fertiliser industry of the country provides a natural foundation for the ammonia infrastructure. In both cases, these carriers can extend the reach of hydrogen, enable long-distance trade, and create industrial by-products that integrate into existing economic systems.

In the Saldanha region, GH_2 /PtX products will primarily be green ammonia, green methanol, and direct reduced iron (DRI), with opportunities to produce sustainable maritime fuels. These derivatives support both export markets and domestic applications, with production scaled according to hydrogen availability, industrial demand, and infrastructure capacity.

Each derivative stream has distinct feedstock, processing, and transport requirements, and their development reflects the evolution of the regional hydrogen economy under different growth scenarios.

Under the **Provincial Road scenario**, GH_2 production advances steadily but not at full potential:

- **Green ammonia** will dominate the derivative mix, with 1.2 mtpa (0.2 mtpa GH_2e) produced primarily for export, bunker fuel supply to Saldanha Bay and Cape Town, and fertiliser applications, mainly driven by shipping fuel demand. While a local fertilizer plant will become

Box 6: Production of Green hydrogen derivatives

Green Ammonia (NH_3):

- **Feedstocks:** GH_2 + nitrogen (N_2) extracted from ambient air using Air Separation Units.

Process & Output: Hydrogen is combined with nitrogen in the Haber-Bosch process under high pressure and temperature ($400\text{--}500^{\circ}\text{C}$) using an iron based catalyst, producing green ammonia. Green ammonia is an efficient hydrogen carrier, globally traded commodity, and key input for fertilizers, fuels, and energy storage. Port facilities at Saldanha Bay provide a strong platform for developing ammonia export infrastructure. Green ammonia is expected to dominate the derivative mix within the West Coast region.

Direct Reduced Iron (DRI):

- **Feedstocks:** Iron ore (Fe_2O_3 or Fe_3O_4) + GH_2 .

Process & Output: Hydrogen reduces iron ore pellets in a shaft furnace at $600\text{--}1000^{\circ}\text{C}$, where hydrogen reacts with oxygen in the ore to form sponge iron (DRI), emitting only water vapor. The DRI is then melted in an electric arc furnace to produce low-carbon steel, supporting decarbonization of the steel sector.

Green Methanol (CH_3OH):

- **Feedstocks:** GH_2 + captured carbon dioxide (CO_2) from biogenic or industrial sources.

Process & Output: Hydrogen reacts with captured CO_2 in a methanol synthesis reactor at $200\text{--}300^{\circ}\text{C}$ and $50\text{--}100$ bar using a $\text{Cu/ZnO/Al}_2\text{O}_3$ catalyst. In cases where industrial CO_2 is lacking, Infrastructure II utilises Direct Air Capture (DAC) technology to extract CO_2 directly from the atmosphere. The product is then condensed and purified to obtain green methanol. Green methanol serves as a renewable fuel, chemical feedstock, and maritime fuel. Port infrastructure at Saldanha Bay provides opportunities for export, with methanol expected to complement ammonia and DRI within the West Coast derivative mix.

established and operates, weak domestic demand means all output is exported to the EU. Some ammonia projects will be located outside the SEZ and will not benefit from SEZ incentives.

- **Green methanol**, at 1.3 mtpa (0.2 mtpa GH₂e), will be produced approximately 20 km east of the SEZ and transported by road to the port.
- **DRI** production will reach 1.8 mtpa (0.1 mtpa GH₂e) near the southeastern SEZ border, with the majority exported to the EU. GH₂ will be used to reduce iron ore to DRI using widely available scrap metal, replacing coking coal. DRI production supplies provides limited feedstock to domestic steel smelters (15–20% of output) supplying the motor industry in the Eastern Cape with most output exported to the EU as local green steel demand remains weak. Expected demand from heavy-duty transport will not have materialised, as buyers still favour battery electric trucks.

In contrast, under optimistic enabling conditions (**National Road scenario**), South Africa could emerge as a major global production hub, supported by coordinated policy, least-cost renewables, storage, and a functioning power market (Figure 17). Further, Eskom's unbundling would enable an independent transmission and market operator, while government policies will ensure a just transition and foster green manufacturing.

Under these conditions, additional green hydrogen facilities islanded outside Freeport (a few hundred km north of the SEZ), will come online, scaling production rapidly:

- **Green ammonia** will continue to dominate, supplying export markets, domestic fertiliser plants, and bunker fuel. Green ammonia will increase to 6 mtpa (1.2 mtpa GH₂e), transported via rail and pipeline. Fertiliser uptake will strengthen locally, helping reduce EU CBAM risks for agricultural exports.
- **Green methanol** production will remain at 1.3 mtpa (0.2 mtpa GH₂e) with bunker barges supplying Cape Town Harbour. This will be supported by carbon captured from cement plants, seaweed cultivation, and eventually direct air capture.
- **DRI** output remains at 1.8 mtpa (0.1 mtpa GH₂e), building on the success of earlier phases. Most DRI will continue to be exported to the EU, with limited domestic demand.

3.4 Distribution and storage

Transport and logistics are central to the functioning of the West Coast region, not only for enabling the movement of people and goods within towns such as Saldanha Bay, Vredenburg, Langebaan, and Hopefield, but also for connecting the area to provincial, national, and international markets (West Coast District Municipality, 2015). Over the past decade, municipalities within the West Coast District, in collaboration with provincial and national authorities, have worked to expand and improve transport infrastructure (West Coast District Municipality, 2015). The focus has been on balancing the unique demands of rural and urban settlements, strengthening the linkages between key nodes, and supporting the functionality of the Port of Saldanha as a critical national asset. At the same time, challenges remain in ensuring affordable public transport, upgrading road and rail networks, and integrating long-term projects into broader spatial and economic development frameworks (West Coast District Municipality, 2015).

3.4.1 Road and Rail

The Saldanha Spatial Development Framework (SDF) identifies several proposed road upgrades within the industrial zone to support port and SEZ expansion. Road infrastructure is critical for material handling, equipment transport, and service access across the hydrogen value chain. Integrated road–rail–pipeline networks are required to enable the movement of hydrogen and its derivatives between production hubs, storage facilities, and export terminals, while minimizing redundancy and land disturbance.

Rail infrastructure will play a central role in bulk hydrogen logistics, particularly where pipelines are unavailable. Terminal and depot upgrades will be necessary to accommodate hydrogen handling, fleet refuelling, and modal transfer between rail and road. Rail utilisation in the region has declined as industries have shifted freight to road transport, increasing road congestion, pavement deterioration, and emissions (Western Cape Government, 2022). The Ore Corridor currently links Northern Cape mining operations to the Port of Saldanha for manganese and iron ore export, while a regional line connects Saldanha with Cape Town and the broader Western Cape, providing a foundation for future hydrogen freight operations.

Road transport, though currently a costly mode, provides flexibility and immediacy for small-scale and early-stage markets. Hydrogen trailers, whether gaseous or liquid, can be delivered directly to refuelling stations, laboratories, and small industrial users, ensuring access even in the absence of permanent infrastructure. CGH₂ can be transported using Multiple Gas Containers (MEGCs). MEGCs consist of high-pressure cylinders mounted on ISO frames and can carry 300–1,200 kg of hydrogen per trip, depending on design and operating pressure. Steel tube trailers typically transport ~380 kg at 180–250 bar, while composite trailers achieve 560–900 kg at 350–500 bar. Cryogenic liquid hydrogen trailers enable larger payloads of 1,500–3,000 kg per trip, reducing transport cost per unit mass (Ortiz-Cebolla et al., 2022; Svetlana et al., 2024). High-pressure composite vessels offer improved energy density but are capital-intensive and require high turnover rates to be cost-effective.

3.4.2 Pipelines

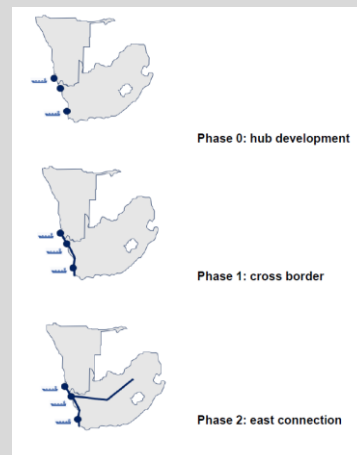
Pipelines serve as a key component for delivering water from desalination plants to nearby or co-located hydrogen production facilities, as well as for transporting bulk GH₂ products to shared storage or port facilities. Centralising pipeline networks across multiple producers enhances operational efficiency and lowers infrastructure costs relative to individual, producer-specific systems.

Pipelines represent the most cost-effective mode for transporting hydrogen across distances of up to 1500 km (Ali et al., 2024). However, their efficiency relies on sufficient utilisation. Full pipelines enable lower unit costs and ensure financial viability. Networks can be designed with variable diameters to accommodate different capacities, and repurposing existing pipelines can reduce costs, provided material compatibility and long-term integrity are verified (Ortiz-Cebolla et al., 2022).

Centralising pipeline networks across multiple producers enhances operational efficiency and lowers infrastructure costs relative to individual, producer-specific systems. Important to note that experience

Box 7: South African – Namibian cross border hydrogen infrastructure (WESGRO, 2024)

The Pre-feasibility study outlines the following phases for the project (WESGRO, 2024):



- **Phase 0:** The hydrogen pipeline network will develop in phases to 2040, starting with existing hubs in Lüderitz, Boegoebaai, and Saldanha Bay as well as the grouping of operations in these areas.
- **Phase 1:** This phase of the project aims to connect hydrogen hubs in Lüderitz, Northern Cape, and Western Cape through an open-access pipeline network. This infrastructure will act as a system integrator, ensuring full connectivity among these regions and countries. The proposed pipeline will span approximately 925 km at 80 bar pressure to handle 1.8 mtpa.
- **Phase 2:** The pipeline infrastructure is set to expand towards central South Africa, establishing a connection between Boegoebaai and Prieska, and further extending into Gauteng. This phase aims to link the hydrogen network with key industrial energy users in the area. The extension will span approximately 1250 km at a pressure of 86 bar.

from other regions, such as Europe, shows that developing pipeline networks requires heavy risk bearing by public authorities and robust policy support. As such similar processes require a multi stakeholder consultation process embedded into the planning processes.

Long term planning and research efforts, including the Pre-feasibility study: South African – Namibian cross border hydrogen infrastructure (WESGRO, 2024), conducted in 2024, highlighted that the development of a hydrogen network advances gradually. Initially, supply and demand are limited and centred around specific hydrogen hubs. As the network grows, the pipelines that connect these hubs enhance scalability and reliability. Over time, the network can expand into carbon-intensive industrial sectors to assist in decarbonization efforts. The project, originating from the pre-feasibility study of South African Namibian cross-border hydrogen infrastructure, plans to construct a pipeline from the west coast to Namibia and onwards to central South Africa.

3.4.3 Storage

Centralised storage facilities enable buffering of fluctuations in production and demand for multiple producers. Shared storage, designed to accommodate different hydrogen products and derivatives, reduces the need for separate facilities, providing operational and cost efficiencies.

3.5 Common User Infrastructure

Common User Infrastructure (CUI) provides opportunity for efficient and scalable development of the Saldanha GH₂/PtX Hub, allowing multiple producers to access essential facilities while mitigating impacts and cost. This infrastructure can be classified into nodal components, such as hydrogen and ammonia storage, port terminals, and desalination plants, and linear components, including roads, rail, pipelines, and transmission lines. Nodal infrastructure supports centralized handling, storage, and processing of GH₂ and its derivatives, while linear infrastructure facilitates the movement of feedstocks, products, and electricity across the hub and to export markets. Certain production-related facilities, such as electrolysis units, liquefaction, synthesising, and hydrogen facilities, could also be co-located in shared hubs. Shared use of large tracts of land and processing facilities, including potential integration of CO₂ from other sectors, would maximise land efficiency and reduce infrastructure duplication. The development of shared infrastructure in the West Coast region would differ depending on the level of coordination, investment, and planning. In a low coordination and investment scenario (**Dirt Track**), infrastructure remains fragmented and underdeveloped. Roads may be over-specified relative to demand, rail operators continue to operate with limited capacity, and pipelines and storage facilities are minimal, forcing producers to rely heavily on trucks for product transport. Visual impacts and land required for duplicated electricity transmission lines could be significant, and production hubs may be inefficiently dispersed.

With moderate coordination (**Provincial Road scenario**), shared infrastructure emerges in a partial and mixed form. Producers may construct separate transmission lines and private hydrogen/ammonia storage facilities, but licenses of existing port terminals expand under TNPA regulations to accommodate multiple producers by allowing the handling and transport of ammonia and other chemicals. Roads are upgraded for transport of renewable energy components and methanol from the production sites east of the SEZ to the port, yet rail capacity remains largely unchanged due to authorities' reluctance to invest new capital into constructing new rail lines. Cross-border pipeline projects may be deferred (e.g., Lüderitz–Boegoebaai–Saldanha) due to insufficient volumes, requiring trucks or dedicated connections for derivative transport. Some co-located production hubs allow partial sharing of land, electrolysis, and processing facilities, improving land efficiency and reducing duplication.

In a highly coordinated, strategic scenario (**National Highway scenario**), shared infrastructure becomes fully integrated and optimised. Multi-stakeholder agreements enable harmonised standards for shared hydrogen and ammonia storage, pipelines, and production hubs. Centralised pipelines connect desalination, production sites, storage facilities, and port terminals, minimising road congestion and visual impacts. A new ammonia pipeline links offsite storage to the port, reducing road impacts, while a cross-border Namibia–Saldanha pipeline is commissioned through bilateral cooperation, phased planning and integrated market planning. Shared electricity transmission lines supply renewable energy to multiple facilities efficiently, avoiding redundant networks and optimising land use. Rail and road networks are coordinated with roads being primarily used to for renewable energy component transport and short-haul methanol deliveries and hydrogen refuelling expands along the N7 and to rail via dual-fuel locomotives. Northern producers invest in upgrading rail capacity for ammonia transport to the port. TNPA expands terminal operations to support shared storage and export capacity. Eastern corridors linking the hub to Coega and Mossel Bay further facilitates movement of liquid fuels and other PtX products and enhances inter-regional connectivity. Coordinated investments in transmission, substations, and grid infrastructure allow nationwide wheeling of renewable electricity under streamlined utility agreements, while shared storage and production hubs enable multiple producers to operate efficiently within the same footprint.

Literature highlights that shared infrastructure reduces habitat fragmentation, lowers environmental costs, and supports more equitable regional development (IRENA, 2022). In the context of green hydrogen, coordinated infrastructure provision can lower capital costs, streamline approvals, and improve social acceptance by consolidating development footprints (IEA, 2021). In Saldanha, shared infrastructure offers significant potential to reduce land-use pressures and ecological impacts. Common-use facilities such as transmission corridors, bulk water pipelines or desalination plants, hydrogen/ammonia storage, and port logistics can be co-located or jointly developed by multiple GH₂/PtX projects. The Besaansklip Industrial Zone could accommodate shared facilities; however, ecological sensitivities are a key constraint. Locating shared facilities within the less sensitive, already industrially zoned portions of Besaansklip and the Saldanha Bay SEZ would minimise cumulative impacts, avoid duplication of infrastructure, and maximise efficient land use.

The above demonstrates how shared infrastructure could evolve from fragmented and isolated networks in low-coordination contexts to fully integrated, multi-modal systems capable of supporting large-scale production, storage, transport, and export of GH₂ and its derivatives. However, gaps remain in understanding the optimal spatial configuration, coordination mechanisms, and technical standards required for shared infrastructure. Further research is needed to investigate these challenges, assess the feasibility of co-located production hubs, shared storage, and pipeline networks, and develop strategies to maximise efficiency while mitigating adverse impacts.

3.6 Port and market access

Common access to port terminals and distribution infrastructure would allow multiple producers to export hydrogen and derivatives without duplicating terminal facilities, while also supporting local market distribution.

3.6.1 Maritime

Saldanha Bay serves as a strategically important deep-water port, recognized as one of the deepest natural harbours in South Africa, and operates mainly as an export hub, particularly for iron ore along the Sishen–Saldanha route. Its deep berths cater to large tankers and project cargo. The primary facilities include the Iron Ore terminal, equipped with high-capacity conveyors and stockyards, berths for crude oil handling liquid bulk, and versatile berths for break-bulk cargo supporting regional industries and

offshore/marine services. Additionally, it offers auxiliary services such as tug operations, pilotage, marine repairs and fabrication (expanding through the SEZ), as well as fishing quay and cold storage functions. The port's growth strategy, highlighted in district and municipal plans, focuses on enhancing terminal efficiency, gradual capacity expansions, and collaboration with SEZ/Freeport initiatives to attract maritime services and create value-chain employment opportunities (Saldanha Bay Local Municipality, 2025-2030).

3.6.2 Aviation

The proximity of the Vredenburg/Saldanha Airport to the SEZ presents a strategic opportunity to integrate hydrogen and Sustainable Aviation Fuel (SAF)-powered aircraft, drones, and similar initiatives. While large-scale aviation activities will remain centred at Cape Town International and future expanded facilities in the Western Cape, Saldanha's airport could serve as a testing and demonstration site for alternative aviation fuels and hydrogen-powered mobility (Box 8).

In parallel, the anticipated regional airport expansions underscore the growing demand for sustainable fuel supply chains. This positions Saldanha as a supporting hub for SAF production and hydrogen logistics, reinforcing its role within a broader, decarbonised aviation corridor across the Western Cape.

Box 8: Airport expansion initiatives around the SEZ

Cape Winelands Airport Expansion (2028): (Chamber, 2025)

- The project is positioned to become Cape Town's second major airport, boosting domestic and international flight capacity.
- The plans involve adjusting and lengthening the primary runway to a length of 3 500 m and the development of a passenger terminal intended to accommodate approximately 5.2 million travellers each year.

Cape Town International Airport Phased Development (2026-2029): (ATTA, 2024)

- The Airports Company South Africa (ACSA) steadily progresses with planned upgrades and expansions at Cape Town International Airport.
- Enhancements include the building of an additional runway, terminal upgrades, along with new aircraft contact stands to boost capacity.
- Current tenders are focused on infrastructure development initiatives and enhancing both capacity and passenger experience.

George Airport Expansion: (Getaway, 2025)

- The terminal at George Airport is set to undergo an expansion project with a budget of R 310 million, scheduled to begin approximately in October 2026 and to be completed by July 2028.
- This development will boost the airport's ability to accommodate the growing demand for tourism and business travel in the Garden Route area.

3.7 Transport distribution networks

To understand the transport infrastructure, an assessment of the supply chain's distribution networks was conducted with key stakeholder sectors identified from the demand centres across the West Coast area; from the data attained, the following is visualised from the inbound and expected outbound transport distribution networks.

3.7.1 Demand centres

As stated in South Africa's 2023 green hydrogen commercialization strategy, major demand centres have been pinpointed in sectors such as power, storage and balancing technologies, chemical refining, cement and non-ferrous metals, iron and steel production, methanol and ammonia, and transportation, particularly focusing on heavy vehicle transport. The primary impetus for domestic green hydrogen demand is the urge to decarbonise particularly challenging sectors. Hydrogen produced within the province will facilitate the carbon reduction of hard-to-decarbonise sectors, such as heavy vehicle transport, aviation, marine transport, and diverse manufacturing processes, including fertilizers, other ammonia-related end-products, cement production, petrochemicals, and heat-intensive industries involving non-ferrous and non-metal materials. Decarbonising essential value chains is crucial to maintaining the competitiveness of exports and key economic areas such as manufacturing, agriculture,

and tourism. The West Coast's production of green steel will act as a high-value export and a vital component in the production of goods for export from South Africa. Supporting decarbonisation, aligned with South Africa's NDCs, applicable laws, and the Western Cape Climate Change Response Strategy: Vision 2050, the Western Cape aims to foster a sustainable green hydrogen market for internal use (WESGRO, May 2024).

In projecting the demand for exports from the Western Cape, it is presumed that this region, as an early mover in the green hydrogen market ready for large-scale exports, will initially handle a substantial share of South Africa's exports via the Port of Saldanha. Over time, as more export infrastructures are established across the country, the Western Cape's proportion of South African exports is expected to decline progressively. Nonetheless, amidst this transition, the Western Cape's export volume, in which Saldanha port will play an important role, is expected to increase, reaching between 350,000 and 500,000 tonnes (WESGRO, May 2024).

3.7.2 Inbound transport distribution network:

The supply chain for inbound precursor transport must be sustainable and low-carbon to align with net zero objectives.

Water distribution

For hydrogen, in particular, the inbound elements involve piping systems designed to deliver the necessary water to hydrogen production plants. From interviews, the following methods are noted:

1. Desalination of seawater (preferred option);
2. Desalination of wastewater (preferred option); and
3. Licenced use of municipal potable water (not preferred option).

An aspect that needs evaluation is the energy source for the pumping of water to the facilities. If carbon-based sources are employed, a proportion of non-renewable production is documented as utilising electricity from the local grid, which relies on coal power rather than local renewable energy installations. In efforts to achieve net-zero goals, the use of electrons mixed within the grid complicates matters, as carbon credits may be acquired without the consumer being able to determine whether the electrons powering the pumping network come from solar, wind, nuclear or coal-based sources.

Renewable energy sources

The supply of renewable energy from solar or wind sources is anticipated to be managed through sole ownership, allowing direct transmission of electricity to the hydrogen production plant and/or through integration into the local grid for distribution to meet local commercial or domestic demands. Alternatively, energy can be procured from third-party providers or municipal sources. The critical aspect of distribution involves the use of the current wheeling infrastructure, which may need grid reinforcement, network expansion, or the development of private grid wheeling systems.

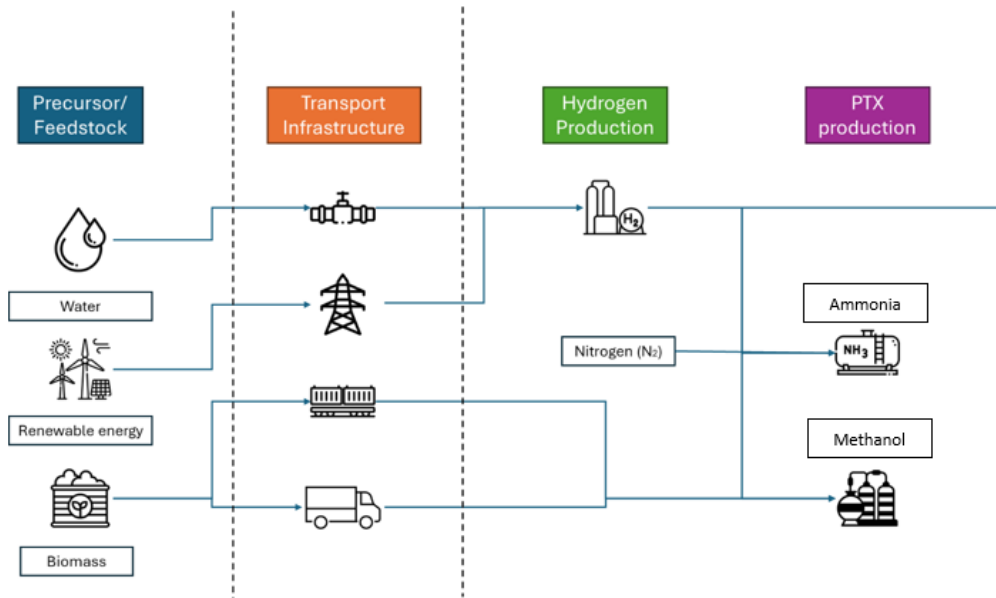


Figure 20: Inbound transport distribution network: emphasizing the routes from raw materials towards hydrogen production and subsequently the PTX derivatives, ammonia and methanol

Feedstock for manufacturing processes

An additional consideration for inbound transport involves the necessary feedstock for manufacturing e-fuels such as ammonia and methanol. The production of ammonia utilises processes such as the Haber-Bosch method to combine nitrogen with green hydrogen molecules, thereby producing green ammonia, which can be sourced locally near production sites. In contrast, methanol requires a sustainable carbon feedstock, such as biomass. The biomass is expected to be transported to facilities mainly by road transport. Given that not all methanol and hydrogen supply facilities are conveniently located for rail use, it is anticipated that carbon sources might be transported over the national rail network, with road transport handling the final delivery to production locations. Initially, logistics is expected to focus on the collection of biomass from local zones to supply these facilities, with a view to extending to biomass-rich regions throughout the nation as alternative energy sources become more prevalent. By adopting this approach, the facilities aim to establish a sustainable and secure feedstock of carbon sources, enabling extended facility operation and facilitating potential expansion of production in the local region.

3.7.3 Outbound transport distribution network:

Following the synthesis of hydrogen and the PtX molecules, a two-phase transportation stage is established in the outbound section of the supply chain. Initially, there is the choice for transporting these molecules to the end user or trader. This is categorised into local demand consumers, export demand traders, and the application in the manufacturing of items such as steel, cement, fertilisers, and additional value-added products, including energy storage technologies.

For producers aiming to convey their goods to consumers or traders, road freight would typically be the preferred option. However, interviews reveal conflicting opinions; while some stakeholders plan to use roadways to distribute their fuels (methanol, in particular), others argue that the expected production volume makes road transport impractical. Instead, rail and pipeline offer larger capacity and present the sole option for substantial Hydrogen and PtX-fuel production facilities (ammonia in particular). Thus, the strategy should clearly outline the acceptable volume for road transport of hydrogen and platinum fuels

along the west coast and develop infrastructure plans for new distribution networks, particularly focussing on local rail, local pipeline distribution, and interconnected hubs to facilitate feedstock exports.

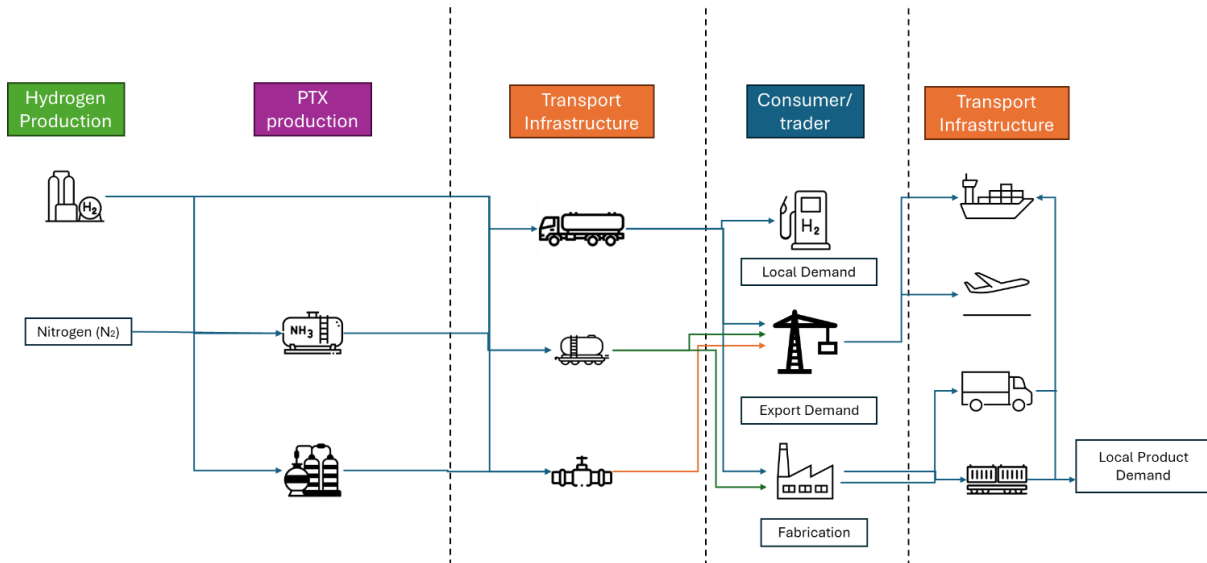


Figure 21: Outbound transport distribution network: Focusing on the allocation of hydrogen and PTX derivatives for consumers and traders. Following this, the method of transportation from consumers/traders to meet export or other local product requirements.

The following transport stage involves distribution strategies utilised by consumers and traders. This primarily takes the form of shipping, where the cargo consists of goods or PtX-fuels, with ships possibly being powered by PtX-fuels as well. In the maritime industry, green ammonia is regarded as the preferred fuel when used as cargo. Both ammonia and methanol serve as alternative fuel options for shipping, which benefit both local and international fleets. Moreover, methanol can be converted into SAF aviation fuel to supply airports on the West Coast, as well as neighbouring areas such as Cape Town and the Cape Town international Airport.

Fabrication focal points

Third, industrial fabrication sectors make use of transported Hydrogen and PtX fuels alongside other feedstock sources to create or supply their products or services. These manufactured goods are then transported to their final destinations to satisfy local demand or for export, using rail networks for medium- (provincial distance) and long-distance (National/cross border distance) travel within the country, or road networks. Ideally, roads should be planned for the last-mile short-distance distribution of goods. Currently, goods transportation is conducted more and more on the road network rather than using the rail network (**Dirt Track Scenario**).

Concentrating on the inbound and outbound stages of fabricating goods and fuels, it is evident that these sectors should ideally be supplied with feedstocks through the road and rail. Roads are preferable for small to medium enterprises, while rail is suitable for larger industries with direct rail access, such as the Saldanha steel manufacturing industry. However, both inbound and outbound feedstock and finished goods require infrastructure to accommodate fuel needs. Currently, the methods predominantly rely on high-carbon fuels such as diesel and gasoline for ICE operated vehicles, or a mixture of coal-based, nuclear, and renewable electricity from the local grid for electrically powered vehicles. As the production and availability of electronic fuels become increasingly prevalent, it is anticipated that incoming vehicles will utilise these alternative fuels or low-carbon electrification options, necessitating local supply hubs to

fuel the logistics fleets. Similarly, just as inbound vehicles need refuelling, outbound vehicles will require an established network to facilitate the distribution of goods and services.

According to the **Provincial Road scenario** outlined in this report, this infrastructure would primarily cater to local short-distance needs, typically located at origin and destination points, with shared infrastructure envisioned along certain major routes. It is also projected that both road and rail transport will be primarily powered by low-carbon electrification vehicles. From a **National Highway scenario** perspective, the network must provide ample hubs and re-fuelling stations throughout the area, and it is expected that the national and cross-border distribution of goods will be supported by infrastructure linked to neighbouring e-fuel generation and utilisation initiatives. This discussion becomes significant because the interviews highlighted the identification of both raw materials and finished products that are transported across the country to and from the west coast. This transportation supports sectors that are difficult to decarbonise and involves sensitive commodities such as fertiliser, cement, and steel, among others. Ensure that the distribution of the inbound feedstocks and outgoing goods has low carbon emissions transport capability.

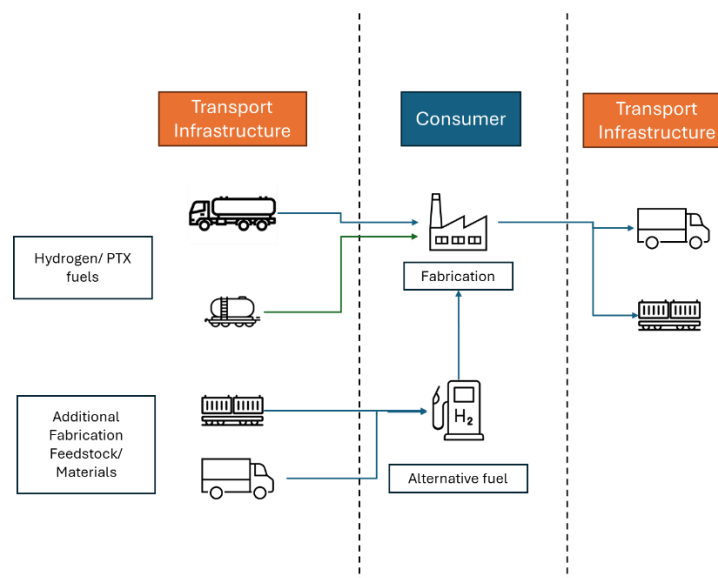


Figure 22: Fabrication transport distribution network: Manufacturing consumers utilize shared hydrogen, PtX derivatives, and other basic materials to create finished products, with alternative fuels facilitating the process beyond primary energy sources.

3.7.4 Sole ownership distribution networks:

In the interviews, another idea emerged: exclusive control over the feedstock supply of hydrogen-based fuels, dedicated entirely to their operational requirements for creating value-added products through their fabrication processes. However, it remained uncertain whether all processes involved low-carbon transportation and operations. As noted previously, the water distribution system might rely on high-carbon sources for pumping, despite the fact that the hydrogen production facility being powered by renewable energy. Similarly, additional fabrication feedstock brought in from outside may not be produced or transported by low-carbon means. It was found that these companies do not manage transportation logistics themselves, instead outsourcing these tasks. Thus, the responsibility for low-carbon initiatives should rest with the entities in lease agreements, though encouraged by the industry partners to reduce overall emissions. Unlike inbound supplies, the final products are distributed to consumers or exporters, and these third party-managed entities should maintain their own low-carbon

distribution systems, as discussed previously. Thus, the discussion does not refer to exclusive ownership throughout the distribution chain but varies conceptually.

Sole ownership distribution networks primarily target the production of hydrogen-based fuel molecules to be exclusively utilised by the industrial entity either for meeting their internal consumption needs or for selling surplus as a manufactured commodity in the market. This ensures that the entity's feedstock largely constitutes part of their operational expenditures, minimising dependence on fluctuating market prices, demand, or availability. Such a strategy is particularly appealing to large industries that aim to power their manufacturing operations and manage energy and transportation logistics within their facilities using self-produced fuels. However, a significant downside of this approach is the high initial setup costs and ongoing maintenance expenses necessary to support the infrastructure, which are mainly practical for larger industrial companies.

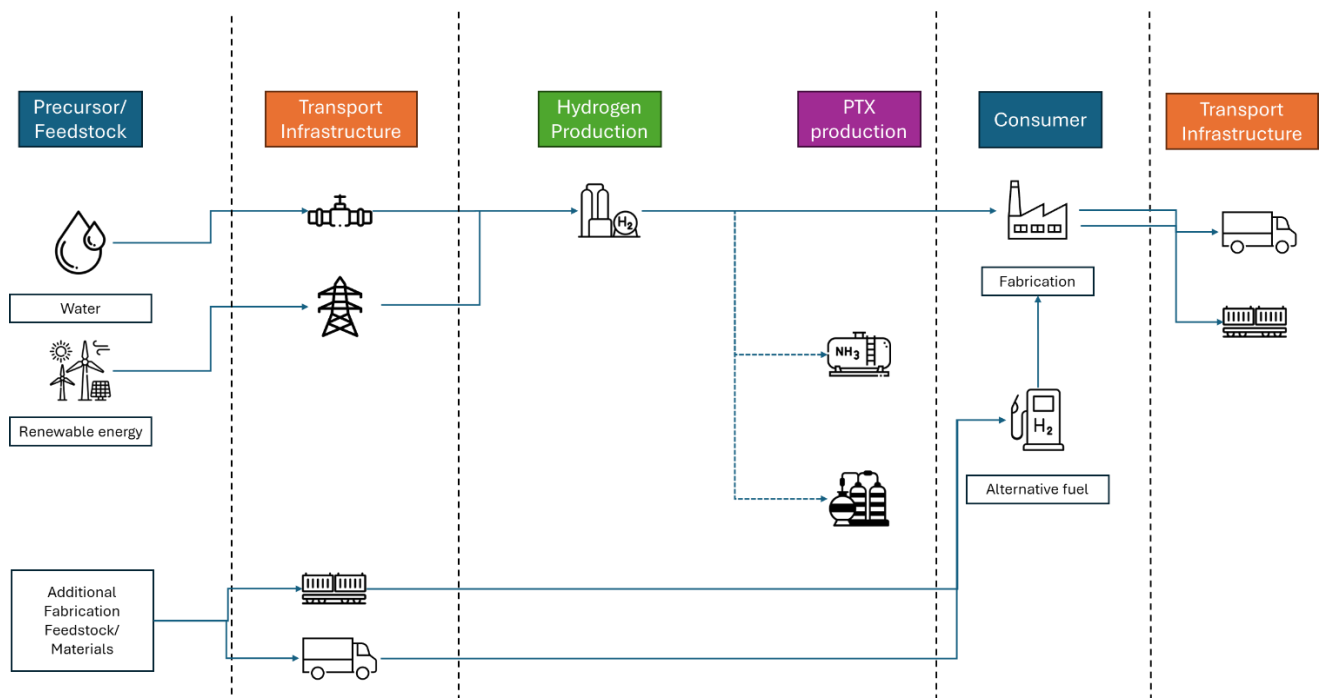


Figure 23: Sole Consumer Ownership Infrastructure: Manufacturing consumers utilize sole produced hydrogen, PtX derivatives, and other basic materials to create finished products, with alternative fuels facilitating the process beyond primary energy sources.

3.7.5 Summative analysis

To summarise, road and rail networks are anticipated to have similar usage trends and infrastructure requirements across both distribution systems. The transport modes for the scenarios of Dirt Track, Provincial Road, and National Highway development pathways are outlined below and in Table 5.

For the **Dirt Track** context (Sc0), it is anticipated that traditional methods using high carbon fuels will remain standard, along with some fleets equipped with electric drivetrains. These electric fleets would derive power from a mixed-source municipal grid. Currently, no pipeline is available.

The **Provincial Road** scenario (Sc1) envisions a network where different modes are typically integrated, offering various options. Currently, the availability of hydrogen for local use is limited and is expected to be divided between utilisation as a carrier in industrial processes and as a transport fuel. In light of this,

electric transport vehicles are anticipated to be the primary option to achieve low-carbon transport in the region. Although ageing fleets and available fuel persist, carbon-based internal combustion engines (ICEs) are expected to remain, but their market operations will likely diminish due to more stringent emission demands from clients. The major pipeline previously predicted to facilitate the transfer of molecules between the north and south corridors between Saldanha port and Lüderitz in Namibia. It is expected that there will be few, if any, local demand secondary piping networks in addition to supply networks that primarily serve the port. Local maritime operations are anticipated to continue to utilise existing carbon-based fuels, while newly developed PtX fuels will be used exclusively for the initial bunkering of international fleets in the port. In terms of aviation, SAF are expected to be produced locally and used as blended fuels for local aircraft.

The **National Highway** scenario (Sc2) would reveal a significant availability of hydrogen-based fuels to meet local demands. Consequently, hydrogen vehicles are expected to become a more sustainable choice, along with electric freight, for local, national, and cross-border distribution. Similarly, rails are expected to integrate hydrogen along with electric locomotives to support the decarbonised network. The electricity required for this is well-documented from renewable plants developed to power hydrogen-based industries. Additionally, the National Pipeline is projected to grow, with proposed west-to-east corridors and the expansion of secondary lines distributing hydrogen to major industrial sectors. The maritime industry is anticipated to have an extensive supply of methanol and ammonia-based fuels for shipping routes, allowing it to offer the necessary bunkering options to meet the demands of international fleets. In aviation, it is expected that Sustainable Aviation Fuels (SAF) will transition from being just a blended choice to becoming widely accessible in their pure form.

Table 5: Transport options per scenario

Scenario	Dirt Road	Provincial road	National road
Road	Carbon based fuel	Electric/Diesel/hydrogen combination freights	Hydrogen/electric vehicles
Rail	Diesel/ Electric	Diesel/electric	Electric/Hydrogen
Pipeline	-	Major pipeline (both north and south routes) has limited to no direct industrial connections, aside from the port.	Connection of the national pipeline system between the western and eastern regions Decentralised industrial auxiliary lines
Shipping	Carbon based fuel	The local fleet uses carbon-based fuels or synthetic alternatives, whereas the international fleet uses PtX fuels.	Ammonia- and methanol-based e-fuels
Aviation	Conventional aviation fuels	SAF mixture	SAF availability

4 REGULATORY CONSIDERATIONS

The GH₂ value chain spans renewable energy generation, electricity and water inputs, hydrogen production and conversion processing, storage facilities, and transport infrastructure. The components forming part of the Saldanha GH₂/PtX infrastructure and technology system considered in this review are described in Section 2. These project components, possibly developed by different entities, may be spatially dispersed across one or several municipalities, affecting land use environmental features and requiring the approvals, licences and permits and approvals by various Competent Authorities.

South Africa has extensive experience in the chemical industry, including decades of (grey) hydrogen production, storage, and transport. While GH₂ production and new end uses are still emerging, hydrogen storage and transport are well established and supported by mature regulatory and standards frameworks, largely independent of hydrogen classification. However, at present South African lacks, a dedicated hydrogen regulatory framework governing all aspects of the GH₂ production value chain (Altmann, et al., 2022). Instead, hydrogen projects currently rely on a regulatory baseline framework informed by a combination of existing laws and standards that partially cover aspects of the hydrogen production value chain but were never designed specifically for it⁹¹⁰¹¹. A comprehensive body of legislation is applicable to all development activities across the lifecycle, particularly in the transport, planning, and environmental sectors. The main Acts and their implementing standards are summarised in Appendix B. The absence of a unified regulatory regime introduces complexity and uncertainty for project developers, resulting in duplicated requirements, extended timelines, and inconsistent decisions across projects and provinces.

4.1 Infrastructure and land-use regulatory context

Municipalities such as Saldanha are responsible to regulate and manage land use as prescribed by the Spatial Planning and Land Use Management Act (SPLUMA) and associated local by-laws. Two critical instruments under SPLUMA within a municipality is the Spatial Development Framework, Land use scheme and planning by-laws. The SDF sets the strategic spatial planning framework, while the Land Use Scheme provides the legal land use control mechanism. Projects generally need to satisfy municipal land use requirements first (or concurrently) before sectoral permits can be fully granted. Municipal plans and zoning schemes can influence the routing, siting, and impact mitigation measures to avoid conflict with urban areas, protected zones, or environmentally sensitive areas. Municipal land use approvals must be coordinated with relevant sectoral authorizations from national or provincial government departments responsible for energy, water, environment, and transport.

The Saldanha Land Use Scheme does not include specific land use or spatial planning categories for GH₂ facilities however, it provides flexibility for industrial, energy, and utility developments that could accommodate hydrogen related developments.

Zoning categories in the Saldanha Bay Integrated Zoning Scheme (2021) that would typically permit industrial hydrogen facilities include:

- Industrial Zone 1-3 (ranging from light, heavy to noxious),

⁹ The Gas and the Petroleum Products Act which provide a framework for piped gas and fuel regulation, however, both acts were not produced with pure hydrogen in mind as they were specifically tailored toward hydrocarbon gases (methane, ethane, propane and butane) (Altmann, et al., 2022, p. 54).

¹⁰ National Environmental Management Act (NEMA), which governs environmental authorisations for hydrogen activities

¹¹ Occupational Health and Safety Act (OHSA), which governs the safe application of hydrogen projects such as hazardous chemical handling, pressure equipment and major hazard installations

- Transport Zone I (Transport Uses) used for infrastructure related to transport and logistics, possibly covering hydrogen bunkering or distribution terminals near port areas.

These zones provide the framework for accommodating various components of a hydrogen value chain including production, storage, processing, and logistics support. Site-specific conditions and environmental considerations from the Integrated Zoning Scheme and municipal by-laws would apply. Hydrogen facilities must comply with all relevant environmental, safety, and development standards as set by municipal planning authorities and national regulations. Thus, the permitted zoning categories for industrial hydrogen-related developments in Saldanha primarily fall under the various industrial zones and potentially transport zones near port precincts (Saldanha Bay Local Municipality, 2021).

4.1.1 Multi nodal SEZs

The Saldanha Freeport SEZ, covering 356ha within the Besaansklip Industrial zone, is adjacent to the port. Despite being partially occupied, it lacks sufficient land for large-scale green hydrogen facilities. Environmental sensitive areas also reduce remaining available land. Expansion options beyond the current SEZ are needed. SEZs are typically single zones for industrial activities, but South Africa's SEZ Act (No 16 of 2014) allows multiple precincts within an SEZ. The Act permits SEZs to operate under one license and management, with the flexibility for multiple sector-focused sub-areas (Department of Trade and Industry, 2012, p. 19). SEZs or parts of them can be customs-controlled areas, with potentially more than one within a single SEZ (South African Revenue Service, 2025).

South Africa's SEZ framework, although originally focused on individual zones, is supporting integrated multi-nodal regional development strategies. These approaches enable clusters of industrial and logistics activity across multiple sites, maximizing regional strengths and supporting shared infrastructure investments. Provincial governments and the Department of Trade, Industry and Competition (DTIC) encourage SEZs to coordinate transport, energy, and manufacturing corridors—effectively fostering networks of nodes that operate synergistically, even if they are physically discrete SEZs.

Benefit of a multi-nodal SEZ

Multi-nodal SEZs have the potential to facilitate job creation throughout a region, rather than concentrating opportunities in just one specific locale. While this approach might initially present challenges, it encourages investment in transportation and related infrastructure. By promoting economic development over a wider geographic area, these nodes can become specialized, leading to a diversified range of economic activities. Moreover, having multiple sites can appeal more to investors, given the wider array of available opportunities.

To complement the SEZ strategy, a package of tax incentives will be available to companies locating in certain SEZs, subject to specific criteria. The tax incentives that companies may qualify for include VAT and customs relief if located within a Customs Controlled Area (CCA), employment tax incentive, building allowance, and reduced corporate income tax rate.

Progress with establishing nodal SEZ in the Saldanha municipality

The process to establish a SEZ node is detailed in the SEZ planning guidelines and the SEZ Act documentation. The process involves several deliberate phases as outlined in the SEZ act. Figure 24 schematically illustrate the required steps.

1. Application Initiation	2. Phased Application Process	3. Submission and Evaluation
<p>Eligible Applicants:</p> <ul style="list-style-type: none"> National, provincial or local government, public/municipal entities, public-private partnerships 	<p>Critical phases:</p> <ul style="list-style-type: none"> Concept Note Pre-Feasibility Study Comprehensive Feasibility Study Business Plan 	<ul style="list-style-type: none"> Submission to the SEZ Advisory Board Secretariat Appraisal: The SEZ Advisory Board assesses the application. Public Comment: If recommended, an intention to designate is published in the Government Gazette for public comment (typically 30 working days). Ministerial and Cabinet Approval: The Minister and Cabinet assess the proposal. Upon approval, the Minister designates the SEZ area and issues an SEZ license.
<p>Application must:</p> <ul style="list-style-type: none"> Define geographic area suitable for development. Clear ownership or control of the land Comprehensive feasibility and economic analysis Environmental assessments as needed Plans infrastructure skills development, logistics, and SEZ management. Stakeholder letters of support/intent and statutory compliance documentation 		
4. Operator Appointment and Resource Provision		5. Ongoing compliance

Figure 24: Process required to establish an SEZ node as set out in the SEZ planning guidelines and the SEZ Act documentation

As of the date of this report, the Saldanha municipality had not yet conducted investigations into potential external SEZ nodes within its jurisdiction. Municipal officials indicated that the initiative to propose and promote the establishment of such external nodes would primarily rest with the Freeport SEZ authorities. Subsequently, the municipalities impacted by any proposed locations would be responsible for evaluating these sites, considering the potential development implications and alignment with their respective spatial development frameworks. It is therefore advisable that investigations into SEZ nodal locations be initiated at an early stage in collaboration with the affected municipalities to ensure coordinated planning and integration.

Risks and Challenges with establishing nodal SEZs

Although the establishment of SEZ nodes suggests an easy and quick solution to overcome land challenges within the current SEZ precincts, there are several risks and uncertainties that need to be considered. These are briefly listed as follows:

- The DTIC units dealing with establishing SEZ have reduced (less staff) which could affect the capacity in DTIC to address such proposed developments.
- Although the time required can be accelerated, experience with other SEZ has shown that it can take up to 5 years to establish an SEZ.
- Although there is a SEZ fund that provides financial support for investor related infrastructure, this fund might not have the resources to support SEZ nodal development. The SEZ act still needs to be amended to allow for the funding of SEZ by the private sector (Qumba, 2023)
- It is unclear how long the SEZ incentive schemes will continue. It is advisable to investigate this, as this could affect the attractiveness of a node or investment in the SEZ.
- SEZ nodes need to be investigated to ensure the best possible opportunity for success (New studies undertaken should be detailed and thorough. All stakeholders must be involved, and the nodes must have acceptance.
- DFFE, dealing with environmental approvals, might prefer a SEZ in a single area rather than over multiple areas

- The development of the nodal SEZ should be part of a wider regional development and must have strong links with the SEZ.
- The process of benefitting from incentives could be drawn out and unclear; this should be investigated and clarified
- Land ownership control - There is a clear preference and legal expectation that a Special Economic Zone (SEZ) node should be established on land that the applicant either owns or controls. The South African SEZ legal and regulatory framework requires that the applicant demonstrate ownership or control of the land proposed for designation as an SEZ. If the land is not already owned by the applicant, a clear acquisition or control strategy must be provided as part of the application process. This is important to ensure that the SEZ entity can effectively manage, develop and operate the zone without domain-related disputes or uncertainties.

4.2 Socio-ecological regulatory context

The establishment of the Saldanha Hydrogen Hub will require various environmental related approvals, licences and permits. The components forming part of the Saldanha GH₂/PtX infrastructure and technology system considered in this review are described in Section 2. One of the main approvals required is the Environmental Authorisation (EA) governed by the National Environmental Management Act (Act 107 of 1998, as amended) (NEMA) and the 2014 NEMA EIA Regulations (as amended). In terms of the EA, either a Basic Assessment (BA) (which takes ~6 months) or Scoping and EIA process (which takes ~12 months) will most likely be required for most GH₂/PtX infrastructure. Given the scale and extent of the infrastructure proposed around the Saldanha Hydrogen Hub, it is likely that most projects will be required to undergo a Scoping and EIA process.

GH₂/PtX project components may be geographically separated, proposed by different Applicants or third parties, and/or managed by different operators. Separate approvals for each project component could be necessary depending on the context; however, as far as possible, an integrated approach should be followed to both meet legal requirements across several Acts, as well as allow for a streamlined authorisation process. For Applications for EA, the Provincial Environmental Department i.e. the Western Cape Department of Environmental Affairs and Development Planning (DEA&DP)¹¹² will serve as the Competent Authority for GH₂/PtX projects in the Province, unless a proposed development triggers subparagraphs in Section 24C(2) of NEMA, or unless otherwise agreed to in terms of Section 24C(3)(b) of NEMA, in which case the National Department of Forestry, Fisheries and the Environment (DFFE) will serve as the Competent Authority. For example, if the Applicant for any of the project components is the Saldanha Bay IDZ SOC Ltd, then Section 24C(2)(d)(iii) of NEMA would apply (i.e. the proposed development is being undertaken by a statutory body performing an exclusive competence of the national sphere of government), and the National DFFE will serve as the Competent Authority. The National DFFE would also serve as the Competent Authority for renewable energy projects that have private off-taking agreements of more than 100 MW, and for all renewable energy projects that will be bid into the Renewable Energy Independent Power Producer Procurement Programme.

In addition to EA, various other environmental related permits and approvals will be required for GH₂/PtX developments proposed including, but not limited to,

- Heritage Approval;
- Atmospheric Emissions Licence;
- Coastal Waters Discharge Permit;

¹² For renewable energy projects proposed in the Northern Cape and Eastern Cape, the relevant Competent Authorities would respectively be the Northern Cape Department of Agriculture, Environmental Affairs, Rural Development and Land Reform; and the Eastern Cape Department of Economic Development, Environmental Affairs and Tourism.

- Use of Vehicles in a Coastal Area;
- Waste Management Licence;
- Water Use Authorisation;
- Approvals in terms of the Subdivision of Agricultural Land;
- Land Use Rezoning,
- Licence to operate a Major Hazard Installation; and
- Approval to use the land surface in a way which may contradict the Mineral and Petroleum Resources Development Act (Act 28 of 2002, as amended) (MPRDA).

These are discussed in more detail in in Appendix B. To what extent these permits are, or are not, required for GH₂/PtX projects in the region, depends on project specifications and the geographical extent of specific project layouts.

4.3 Transport and logistics regulatory context

The safe transport of hydrogen in South Africa is currently being governed by the same regulatory frameworks that apply to other hazardous goods, as outlined in the Western Cape Land Transport Framework 2024/25-2028/29. Currently, hazardous goods transport is regulated under the 2000 National Road Traffic Regulation, issued in terms of the National Road Traffic Act (Act 93 of 1996). These regulations incorporated South African National Standards (SANS), including SANS 10228, 10229, 10231, and 10232, which set requirements for tanker design, vehicle equipment, identification and packaging of hazardous materials and emergency response documentation. The National Land Transport Act (NLTA) requires provinces to identify designated routes for the transport of dangerous goods, including compressed gaseous hydrogen (UN 1049) and liquid hydrogen (UN 1996).

Permitting is overseen by municipalities, where operators must obtain dangerous goods certificates, often referred to as a fire permit, which must be renewed annually. These permits are enforced through by-laws and ensure that vehicles and operators comply with baseline safety standards. However, in practice, most of the carriers transporting hazardous goods rely on national and provincial roads, as the design of dedicated municipal routes has proved challenging. Issues such as congestion, cargo variability, low bridge clearances, and insufficient infrastructure capacity have limited the effectiveness of route planning in urban areas. The framework acknowledges that there is a gap in providing alternative hazardous routes in cities, a critical consideration for hydrogen transport planning.

The dominance of road over rail in hazardous goods transport further compounds safety risks. With South Africa's rail system struggling to provide reliable capacity, road transport has become the default mode for fuel, gases, and chemicals. This raises concerns about accidents, environmental hazards, and community exposure. To address these risks, enforcement priorities have been identified, reducing overloading and weighbridge avoidance; upskilling of workforce (such as maintenance, inspection personnel and drivers, among others) by specialized training for hydrogen and gas systems; and encouraging industry compliance through certification systems. However, enforcement remains fragmented between multiple authorities, such as SANRAL, Transnet, provincial governments, and municipalities, limiting coherence. Economic Regulation of Transport Act (Act No. 6 of 2024) has been introduced to consolidate transport regulation across modes, establishing the Transport Economic Regulator and Council to provide integrated oversight of pricing, access and safety standards.

Benchmarking South Africa against international best practice could become the strength and limit gaps. The ADR (European Agreement Concerning the International Carriage of Dangerous Goods by Roads) provides detailed, hydrogen-specific provisions covering compressed and liquid hydrogen, including vehicle construction standards, driver training, tunnel restriction codes, and harmonised emergency

response documentation (UNECE, 2025). Engineering standards such as ASME B31.12 (2023) set comprehensive requirements for hydrogen pipelines, including materials to mitigate embrittlement, design pressures, testing, and operational safety (ASME, 2023). For South Africa and the Western Cape, aligning the national frameworks with these international benchmarks will be essential. This means not only strengthening the enforcement of existing SANS-based regulations but also adapting them to include hydrogen-specific safety considerations such as cryogenic boil risks, embrittlement in pipelines, and emergency response protocols tailored to hydrogen's dispersion and ignition properties. Municipal route designation policies must also evolve to reflect the unique hazards of hydrogen, potentially drawing on European approaches that employ GIS-based hazardous goods route mapping, tunnel codes, and time of day restrictions.

The relevant regulatory framework includes municipal Integrated Transport Plans, national road traffic legislation, port regulation under the National Ports Act, and rail safety regulation under the Railway Safety Regulator (Saldanha Bay Municipality, 2022).

4.4 Port planning

Transnet indicated that port planning must consider market trends and adapt accordingly. At the same time, the port requires a clear surety of demand (offtake agreements) before committing to infrastructure investments, to mitigate financial risk.

The Transnet National Ports Authority is presently updating the port planning for the Saldanha Bay Port in response to the emergence of green hydrogen. Planning is reflected for three distinct periods: Short-medium and long term. Adjusted planning is based on a request-for-information-process initiated in 2023 to assess market interest and inform forward planning for GH₂ infrastructure at the port of Saldanha. A market assessment was also conducted to gauge interest and inform port future planning. Green Hydrogen development is viewed as a key part of the port's diversification strategy and an update to the Port Development Framework Plan 2022-2032 (short term). Currently, a study titled "Identification of Offset Areas" is investigating potential sites for this purpose.

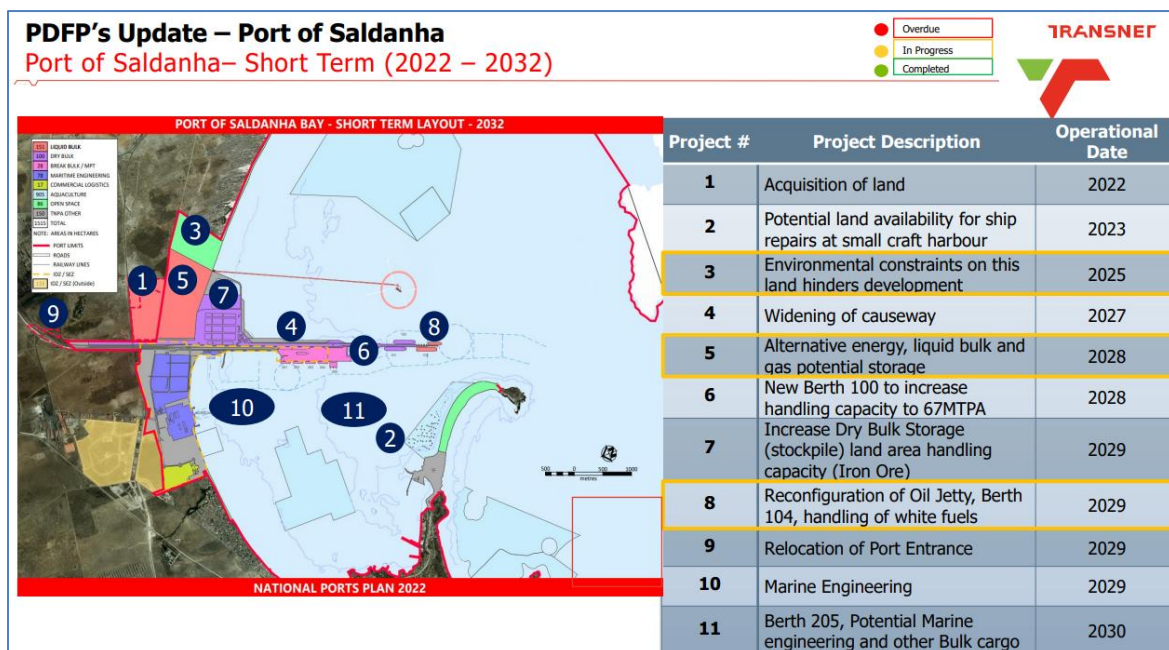


Figure 25: Port Development Framework Plan – Short term: 2022-2032 (Port of Saldanha, 2025)

GH₂ is being considered alongside LNG and white fuels, as the growth of these sectors is integral to the port's strategic plans. To support these developments, the 'Dunes Area' (marked as No. 5 on Figure 25) has been identified as a possible land reserve for storage facilities for LNG and petroleum products, however no storage facility is being considered for Green Hydrogen or derivatives within this area. Back of port areas such as 129/0 and 195/2 Malmesbury Road could be considered for developing storage facilities. In addition to land allocations, related physical infrastructure needs are being evaluated, particularly berthing facilities. Berth 104 (marked as No. 8 in Figure 25), is proposed to handle white fuels, and has the potential to expand the commodity basket to include green Ammonia. The development of LNG infrastructure at the port could also lead to the accommodation of GH₂. Prefeasibility studies for these infrastructure components are yet to be performed. The port is also considering an expansion that will include the area east of the rail line (vicinity of Sunrise Energy, No 1 in Figure 25).

Currently, there is no pipeline infrastructure in place. There are no berths equipped to handle the export of green hydrogen derivatives. The Offshore Supply Base (OSSB) is not fit for purpose due to its draught limitations and entrance channel constraints. The Moss gas Berth (near nr 10) would support the marine engineering sector and cannot accommodate Green Hydrogen. However, a feasibility study for the handling of GH₂ is planned for the period 2025/26. It is important to note that new proposals for hydrogen production could significantly impact potential demand at the port.

In the **medium term (2027–2035)**, bankable feasibility studies will be undertaken, followed by the commencement of infrastructure rollout. The project will initially be small scale, focused on trials for hydrogen. Medium to Long-term plans (2035 onwards) envisage full-scale hydrogen bunkering operations starting from this period.

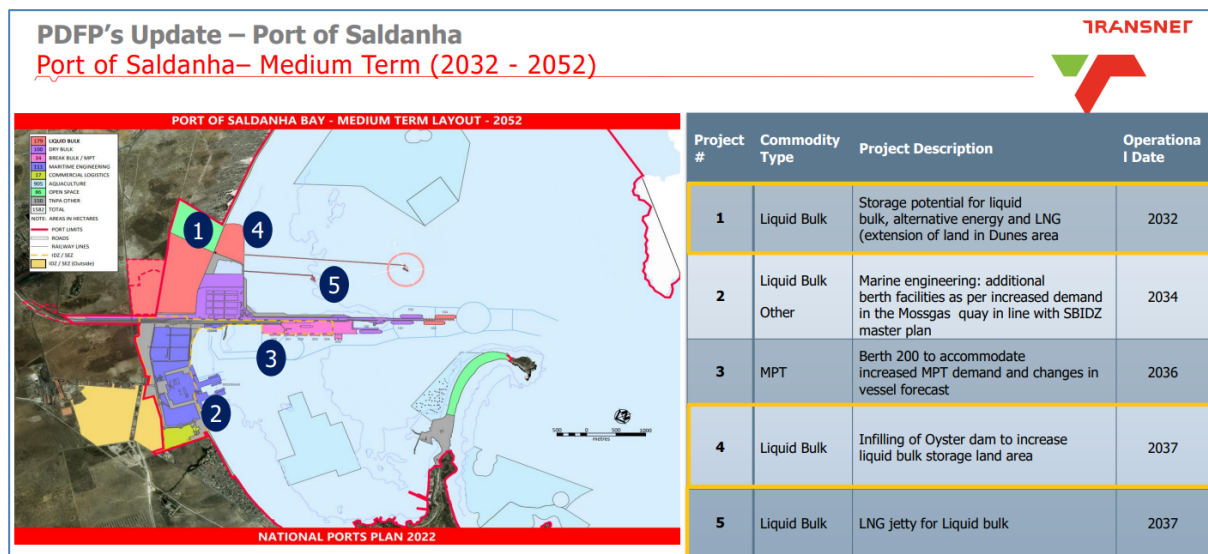


Figure 26: Port Development Framework Plan – Medium term: 2032-2052 (Port of Saldanha, 2025)

In this period the possible expansion for liquid bulk, alternative energy and LNG is considered as part of the extension of the dunes area (No 1 in Figure 26) which can possibly be extended further if the infilling and expansion of the Oyster dam can be undertaken. (Nr 4 in Figure 26). Additional berths for handling liquid bulk and LNG and other energy products (such as GH₂ and derivatives) are only envisaged after 2052. These berths are planned to be connected to the expanded liquid bulk Dunes area and its adjacent reclaimed Oyster Dam (no 1 in Figure 27).

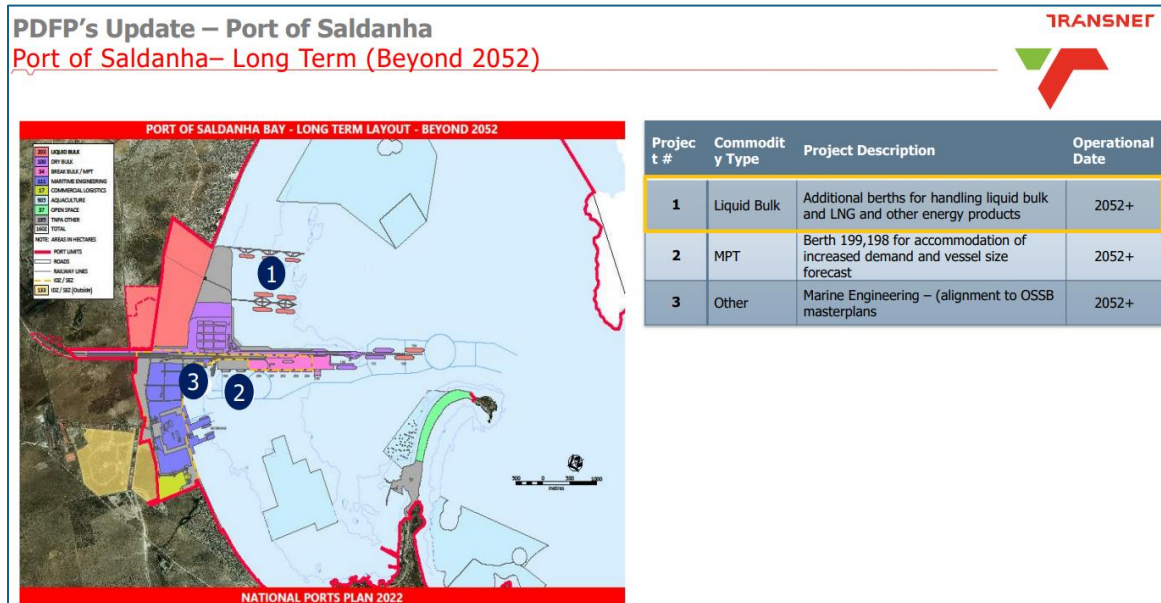


Figure 27: Port Development Framework Plan - Long term: beyond 2052 (Port of Saldanha, 2025)

In the **long-term (beyond 2025)**, the port layout is expected to undergo several key modifications to support future growth and operational efficiency. These include the addition of new berths dedicated to the handling of liquid bulk, liquefied natural gas (LNG), and other energy-related products. Furthermore, berths 198 and 199 are planned for expansion to accommodate the anticipated increase in both vessel size and cargo volumes. In parallel, maritime engineering interventions will be aligned with the OSSB masterplans to ensure coordinated and sustainable port development.

4.4.1 Port level regulatory context

Several regulatory issues need to be addressed to enable the port to hold a licence for the operation of GH₂ facilities and handling of derivatives these include:

- The existing Environmental Authorisations (EAs) under NEMA to include GH₂ products need to be amended.
- Awaiting the amended new Major Hazard Installation (MHI) Regulations. The new MHI Regulations, 2022 is set to repeal Government Notice (GN) 692 of 30 July 2001.
- Water Use License under the National Water Act for the water required in hydrogen production.
- Relevant energy sector licenses, including potential amendments to the Gas Act and Petroleum Pipelines Act for handling and storage.
- Occupational health, safety, and maritime regulations for safe handling and transport of hydrogen and derivatives.
- South African Maritime Safety Authority (SAMSA)'s approval process for berth and vessel interfaces under the IMO IGC Code ensures the safe handling of liquefied gases at ports through strict adherence to international and national safety standards. Operationally, bunkering (fuel transfer) activities involving liquefied gases within ports also require SAMSA's approval and a license from Transnet National Ports Authority (TNPA). This includes compliance with the broader South African Bunkering Code of Practice, which aligns with IMO conventions, ISGOTT guidelines, and MARPOL regulations.
- Terminal operator: Will either follow a Section 56 terminal operator agreement or a Section 79 ministerial directive, depending on the cargo's strategic designation. A Section 56 terminal operator agreement is a formal contract between TNPA and an operator to design, construct,

develop, finance, maintain, or operate port terminals or facilities. A Section 79 ministerial directive can be issued by the Minister to impose additional controls or directives on cargo handling, especially for cargoes with strategic importance.

4.4.2 Common User Infrastructure

The TNPA is the landlord Port Authority is mandated to provide and maintain this common user infrastructure. From the perspective of the port, CUI is predominantly waterside infrastructure, berthing. The landside is considered terminal infrastructure and is the responsibility of the relevant terminal operator. Private operators may run specific terminals (like container terminals or bulk terminals), but the underlying infrastructure (quays, access roads, marine services) remains common user unless specifically concessioned. If an external storage facility is to be connected to a port, especially through a pipeline leading to a berth, a partnership or agreement with the port operator is essential since the operator manages the port infrastructure within the port boundaries. The pipeline requires a connection point located on the port boundary. Inside the port, the port operator typically provides the necessary infrastructure for this connection. The port authority, which oversees port governance and land use, grants a wayleave (a legal right to install and use infrastructure on the port land) for the positioning of the pipeline or associated infrastructure within the port.

4.5 Regulatory gaps along the value chain

The gaps and challenges currently limiting South Africa's green hydrogen economy ambitions can be identified through various steps of the GH₂ value chain i.e. the production phase, storage, transport and distribution (including pipelines), as well as end user applications.

- **Production phase –**
 - At the production phase, the country currently lacks a defined legal approval process for hydrogen electrolyzers which are central to green hydrogen production (Altmann, et al., 2022). Electrolyzers are treated as generic industrial plants requiring multiple permits across various agencies (Department of Forestry, Fisheries and the Environment, South African Bureau of Standards, National Energy Regulator of South Africa etc.), instead of a streamlined hydrogen specific process (Altmann, et al., 2022). Ultimately, the absence of a hydrogen specific set of permitting rules leaves developers without a clear compliance pathway and results in delays and inconsistent permitting decisions across projects.
- **Storage –**
 - Hydrogen storage is a critical bottleneck in the South African context as the country currently lacks hydrogen specific standards for large scale storage applications. Large scale storage applications fall under NEMA, which requires environmental impact assessments for dangerous goods. However, without hydrogen specific permitting set of rules (as is the case in South Africa), these processes are prolonged, usually lasting 200-500 days (Altmann, et al., 2022, p. 26). The absence of dedicated hydrogen storage standards and permit pathways creates uncertainties for developers and increases the risk of project take-off. Hydrogen infrastructure in South Africa, especially green hydrogen projects, fall under regulatory requirements related to Major Hazard Installations (MHIs) due to the flammable and explosive nature of hydrogen. This not only includes the production of Hydrogen but also transportation and storage. All hydrogen projects must navigate the MHI regulations including meeting quantitative thresholds for hazardous substances, conducting risk assessments and safety case submissions, and securing required licenses. A gap exists in the planning space where no definitive planning norms and standards provide guidance to planners considering all appropriate safety distances. Given the relative newness of green hydrogen, planning issues such as the appropriate safety distances to apply for all the infrastructure components of GH₂/PtX system are potentially hampering planning

approvals for new projects (Hydrogen Europe, 2024). Saldanha Freeport is in the process of appointing a service provider to address MHI regulatory aspects focussing on the GH₂ sector.

- **Transport and distribution –**

- The transportation of hydrogen through pipelines is governed by the South African National Standards (SANS 10260), particularly SANS 10260-2: Industrial gas pipelines. While these standards exist, their current parameters only permit pressures at 1.6MPa and the current review is considering a maximum pressure of 5MPa, both of which are pressures far below what is required for industrial scale hydrogen transport (8MPa) (Altmann, et al., 2022, p. 30). Another challenge relates to the fact that while the GAS Act regulates the transmission of hydrocarbon gases, the National Energy Regulator (NERSA) does not recognise pure hydrogen as a gas under the Act. This ultimately leaves hydrogen pipeline construction, outside the defined licensing framework (Altmann, et al., 2022) (GFA Consulting, 2023, p. 53). The future regulation of this is unclear and created uncertainty with investors. The transportation of hydrogen through pipelines is also covered in Listing Notice 2 of the NEMA EIA Regulations, which includes the development and related operation of facilities or infrastructure for the bulk transportation of dangerous goods *(i) in gas form, outside an industrial complex, using pipelines, exceeding 1 000 metres in length, with a throughput capacity of more than 700 tons per day; or (ii) in liquid form, outside an industrial complex, using pipelines, exceeding 1 000 metres in length, with a throughput capacity of more than 50 cubic metres per day.*
- The road transport of hydrogen in South Africa is similarly constrained, despite the existence of standards for the movement of dangerous goods under SANS 10228, 10231, and 1518. The limitation stems from the fact that these standards have not been adapted to account for the unique properties of hydrogen. In contrast, Europe regulates the transport of dangerous goods through the Agreement concerning the International Carriage of Dangerous Goods by Road (ADR), an international framework adopted by several non-European countries as well (though not South Africa) (Altmann, et al., 2022, p. 27). The ADR incorporates standards specifically designed for green hydrogen, considering its distinct characteristics and safety considerations.

- **End user application –**

- The lack of regulations for hydrogen end-use applications represents another critical barrier. In the mobility sector, South Africa has, to date, had no operational national standards for hydrogen refuelling stations (HRS) or for the homologation of hydrogen fuel-cell vehicles (FCEVs), meaning neither can readily be type-approved or legally operated at scale in the country, despite emerging work on SANS adaptations of ISO 19880 and related fuelling protocols (Altmann, et al., 2022, p. 54). While compressed natural gas (CNG) station standards (SANS 308) exist and could be adapted, this has not yet occurred (Altmann, et al., 2022, p. 35). South Africa is, however, a contracting party to the UN 1958 Agreement and can therefore accept UN ECE vehicle Regulations, including UN Regulation No. 134 on the safety-related performance of hydrogen-fuelled vehicles of categories M and N, which primarily addresses onboard compressed hydrogen storage systems. While this Regulation is, in principle, applicable to hydrogen-powered road vehicles, including certain mining support trucks that fall into standard M or N categories, many large off-road mining trucks and specialised underground vehicles are not explicitly covered within its type-approval scope, leaving a regulatory gap for key segments of South Africa's prospective hydrogen mobility market.

- **Certification –**

- A possible gap is the absence of a certification framework for green hydrogen. Although EU recognition does not strictly require a uniquely South African domestic certification scheme, what does matter is that hydrogen is certified under a scheme that is recognised as compliant with its Renewable Energy Directive (REDII) and RFNBO delegated Acts (European Commission, 2024). International off takers, particularly in the European Union and Asia, require certified guarantees of origin (GOs) to verify the renewable source and carbon intensity of hydrogen (Altmann, et al.,

2022). South Africa currently has no domestic certification body or scheme in place, nor is there clarity on which institution will take on this role (Altmann, et al., 2022, pp. 40 - 45), this absence not only undermines export competitiveness but also creates uncertainty for domestic developers, who cannot be assured that their product will meet the requirements of international buyers. Without a recognised certification framework, South Africa risks producing hydrogen that is not eligible for premium export markets, thereby forfeiting one of its key competitive advantages in the global green hydrogen economy. Therefore, South Africa and the West Coast should consider supporting project developers in this regard (note that direct line project in principle also need to cancel Energy Attribute Certificates (EACs) to proof the origin as renewable).

To fully tap into the innate potential of the green hydrogen economy in South Africa, regulatory clarity is essential. The most pressing actions that ought to take priority include the establishment of clear approval pathways for electrolysers, the adoption of a specific set of storage and refuelling standards, the clarification of hydrogens legal status under the Gas Act and the development of a national certification system which is aligned to international schemes.

5 REGIONAL AND LOCAL CONSTRAINTS

5.1 Environmental screening and spatial constraints

The West Coast region is extensively constrained by agricultural activities which consist of a combination of irrigated and rainfed (predominantly annual) crops. Perennial high-value crops (fruit trees, especially citrus, as well as viticulture) are also present. Due to the extent to which agriculture has transformed natural landscapes in the region, many remaining areas, especially where threatened fynbos and renosterveld vegetation is remaining, are either protected or identified as CBAs and are best avoided by new development. This is particularly evident in the direct vicinity of the Port of Saldanha and SBIDZ where extensive areas may require biodiversity offsets (DEA&DP, 2020) if avoidance and mitigation cannot effectively circumvent residual impacts (Figure 28, left).

Renewable energy as input to PtX production is the component that requires the largest land footprint of the entire PtX technology system. To meet the West Coast hydrogen ambition scenarios (see Section 1.8) additional renewable energy generation capacity of 10 GW (Sc1) and 30 GW (Sc2), which is respectively 1.5 and 4.7 times South Africa's total installed wind and solar PV capacity of 6.4 GW (as at August 2025) (CRSES, 2025).

Table 6: Scenario quantification – land-take requirement of regional renewable energy infrastructure required to meet the West coast GH₂ production ambitions.

Aspect	Unit	Scenario			Assumptions
		Sc0	Sc1	Sc2	
GH₂ volume	mtpa	0	0,51	1,52	
Electrolyser capacity	GW	0	5	15	10 GW electrolyser produces 1 mtpa GH ₂
RE capacity total	GW	0,5	10	30	1 mtpa of H ₂ needs 10 GW electrolyser, that is powered by 20 GW RE
RE total land-take requirement	ha	2 100	44 880	133 760	
SOLAR PV capacity	GW	0,35	7	21	70 % solar : 30 % wind split
PV facilities	no of sites	1	7	21	Assume clusters of 1 GW facilities
PV footprint - solar	ha	700	14 280	42 560	0,5MW/ha
WIND ENERGY capacity	GW	0,15	3.06	9.12	70 % solar : 30 % wind split
Wind facilities - wind	no of sites	1	2	6	Assume clusters of 1,5 GW facilities
Turbine footprint - wind	ha	150	3 060	9 120	1 MW/ha
No of turbines	no of turbines	19	383	1 140	8 MW turbines, each occupying an 8 ha space
Wind facility extent	ha	1 500	30 600	91 200	0,1 MW/ha, accounting for separation distances between individual turbines

The 10 and 30 GW renewable energy additionality translates into a land-take requirements in the order of 44 800 ha and 133 760 ha respectively. When considering theoretical renewable energy development potential in the West Coast region (refer to Section 0 for approach and assumptions), the landscape could “comfortably” support the renewable energy required to meet the West Coast GH₂ ambition. Environmentally and techno-economically optimal onshore wind energy development may be constrained and not able to account for 30 % of renewable energy capacity, this can be compensated for by an increased fraction of solar PV generation or addition of offshore wind energy generation. The **West Coast region could theoretically support sufficient renewable energy development to meet its own GH₂**

production targets five-fold (Figure 28); thus, opportunities exist to pursue development that avoids incompatible or sensitive environmental and social features.

Short-term opportunities to fast-track renewable energy for GH₂ production could be to target some of the 5.8 GW of renewable energy development proposals that have already progressed into more mature development planning stages and have already received Environmental Authorisation (Appendix C). Renewable energy development opportunities are more pronounced further away from Saldanha Bay in the more northern parts of the West Coast region (Figure 19), where renewable energy resources, especially solar, tend to be more favourable (Figure 19). This implies that renewable energy facilities could be located rather distant from PtX production and water source sites at Saldanha Bay, and that strengthening of existing electricity grid (or development of new grid corridors) is imperative.

Table 7: Renewable energy potential of the West Coast region consists of 5.8 GW of project that have received Environmental Authorisation, and 162 GW of theoretical potential.

Renewable energy potential	GW
Approved projects	5.8
<i>Solar PV</i>	3.7
<i>Onshore wind</i>	2.2
Landscape potential	162
<i>Solar PV</i>	146
<i>Onshore wind</i>	6
<i>Offshore wind - fixed</i>	1.5
<i>Offshore wind - floating</i>	8.4
Total capacity	167.7

Environmental screening and regional renewable energy potential

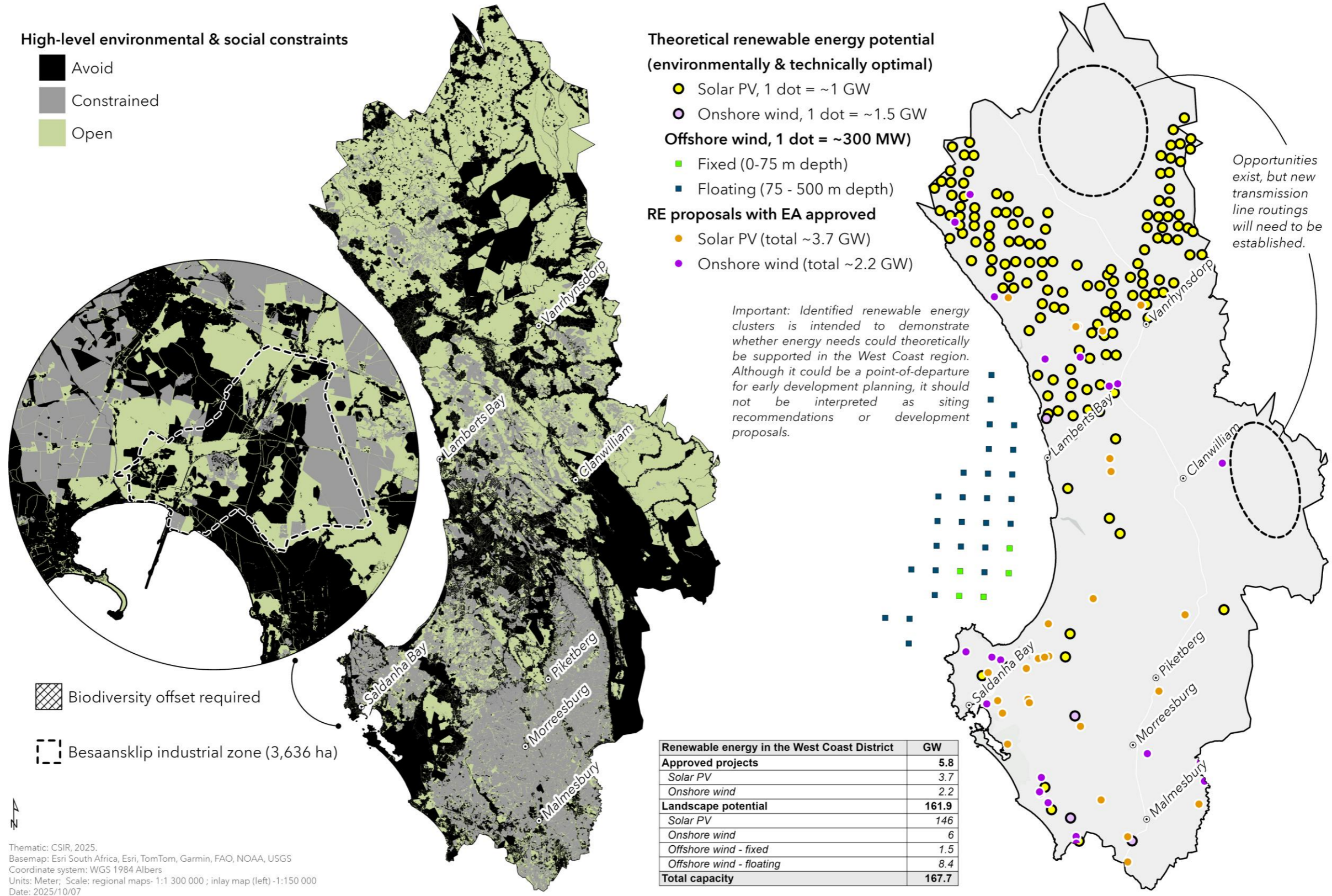


Figure 28: Environmental and social features that may constrain new energy development in the West Coast region (left); solar PV, onshore wind and offshore wind renewable energy potential of the West Coast region (right).

Spatial constraints and expansion opportunities

The Besaansklip zone is a large, sparsely developed area adjacent to the port, covering approximately 6 447 ha. Much of the zone remains environmentally sensitive, with extensive critical biodiversity areas that restrict development or require offsets. A non-development conservation corridor further divides the area, limiting densification and functional cohesion. Several additional challenges constraining development include:

- High visual exposure due to flat terrain, requiring careful visual impact management given the area's scenic value.
- Dust pollution from iron ore storage affecting surrounding environments.
- Limited agglomeration, complicating service provision and reducing logistical efficiency.
- Inadequate power supply (Enterprises University of Pretoria, 2025).
- Absence of a formal industrial park framework to regulate land use and infrastructure provision.

Planning strategy emphasises containing industrial activity within the defined development edge; however, opportunities exist to extend development westward, towards the precinct where the airport is located, south of the TR08501, and between the R399 and the existing industrial area. This westward growth is supported by planning policy to facilitate the continued expansion of the SEZ. Although there is potential for expansion towards the south-east, current municipal planning discourages this approach, instead maintaining a buffer between the industrial zone and the northern parts of Langebaan is favoured.

5.2 Infrastructure component constraints

Several projects within the Saldanha Bay region are already engaged in GH₂/PtX production activities. Building on these initiatives, this section provides a high-level assessment of the principal technical and environmental challenges associated with the development of key infrastructure components identified in Section 3 of this Phase 1 Master Plan. This section outlines the principal constraints and considerations associated with the main GH₂/PtX infrastructure components in the Saldanha system. It highlights engineering limitations, environmental sensitivities, and spatial conflicts relevant to each, providing a technical basis for subsequent infrastructure planning and integration in later project phases.

5.2.1 Electrical transmission and distribution infrastructure

Investment in the transmission and distribution infrastructure is needed since the substation (i.e. 400 MVA Aurora substation via a 132kV Line to the Blouwater substation) that supplies the Saldanha area is already constrained on Transmission capacity and required upgrades and strengthening (Pandorum, Rakaibe, Snyman-Van der Walt, & Roos, 2024, p. 73). The Basaansklip area is currently undersupplied – thus to accommodate future growth the electricity supply would need to be increased (Saldanha Bay Local Municipality, 2025, p. 154)

The GH₂ projects located outside the Besaansklip zone and SEZ have direct access to onshore wind and solar renewable energy facilities. Sites located within the zone and SEZ require either direct access to renewable energy facilities or access wheeled over the Eskom transmission network. Most developers are opting for direct-feed renewable energy configurations due to the high cost of wheeling through the grid. Some developers specifically prefer direct access to renewable energy because of concerns regarding the reliability of the Eskom network and the associated use-of-system charges. These concerns, particularly over wheeling tariffs, have already made wheeling a less attractive option for at least two projects within the industrial zone (GFA Consulting, 2023, p. 51). Figure 29 highlights two projects which would require private transmission lines be constructed from renewable energy facilities directly to production sites.

Planning related to investment in IPPs and grid connections such as through the Western Cape Energy Resilience Programme, should be seen in combination with the need to supply renewable energy to hydrogen production facilities. Shared planning and investment in transmission infrastructure could reduce the long lead times, preparatory work, approvals, land arrangements and regulatory issues. It could also reduce the creation of multiple transmission paths through the western cape landscape. The possibility of defined infrastructure corridors should also be considered.

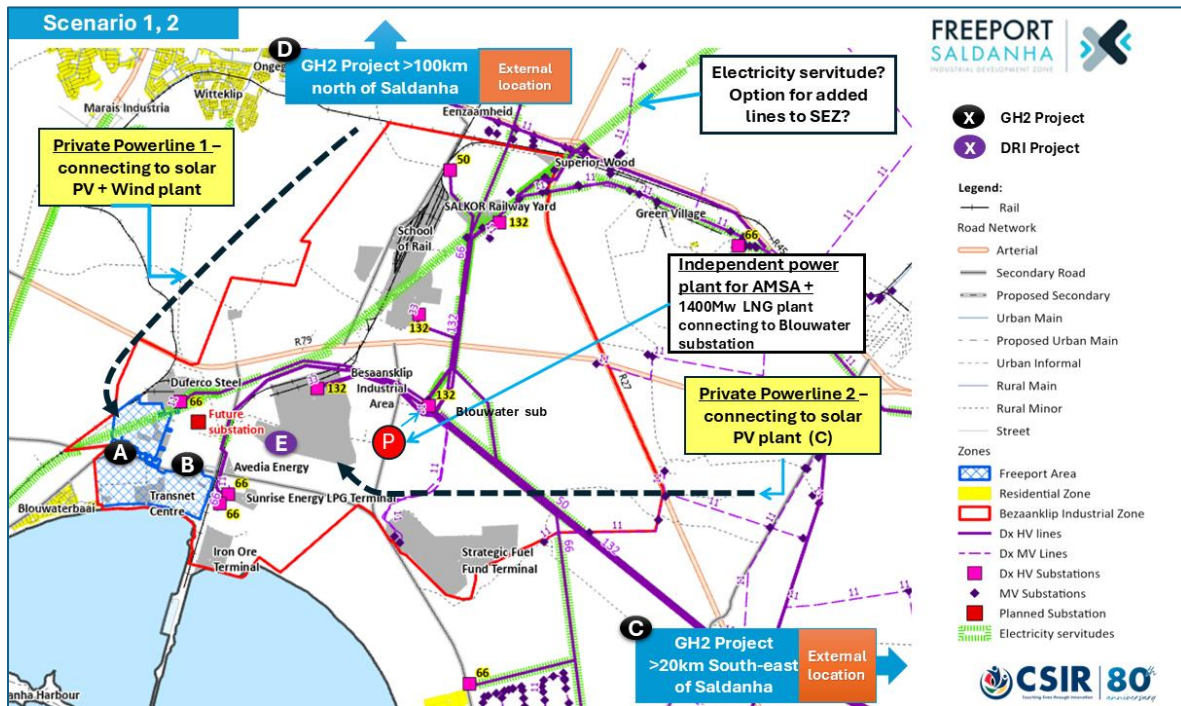


Figure 29: Electricity distribution network impacts.

Private transmission lines would require the establishment of rights that grant the developer the right to use a specific area of land for the installation, maintenance, and operation of power lines, including both overhead and underground lines. This right is realised through a servitude. Such servitudes can be difficult and time consuming to establish, without which such infrastructure cannot be constructed. Compensation is often required to pay the landowner for the loss incurred due to electricity infrastructure. The establishment of servitudes (right of way) can take a long time period to establish. A further challenge is the refusal of landowners to establish transmission line servitudes. Any future new transmission lines need to consider the likely impact on current and future developments in the area. It is also preferable that new lines align with existing infrastructure as far as possible. Power line routes would also need to avoid routing near the Langebaan Weg Airforce base (Visagie, 2016). Existing electricity servitudes does serve the industrial zone which can potentially be used to accommodate transmission lines.

5.2.2 The South African Wholesale Electricity Market

The South African Wholesale Electricity Market (SAWEM) is highly relevant for future green hydrogen developments as it is likely to create a competitive, transparent, and flexible electricity market that helps enable the large-scale deployment of renewable energy required for green hydrogen production. SAWEM supports the energy transition by fostering competitive pricing, encouraging investment in renewables and energy storage, ensuring grid stability, and enabling consistent supply through flexibility mechanisms such as battery storage. These features are crucial for the cost-effective and reliable supply of renewable electricity that green hydrogen electrolysis depends on. Additionally, SAWEM's design would hopefully

promote innovation and fair cost distribution, reducing reliance on state resources and enhancing energy security, which are important for sustaining green hydrogen projects commercially. The shift in market structures, including changes to wheeling mechanisms and hourly reconciliation for power purchase agreements, will influence how green hydrogen producers manage electricity procurement and risks in their operation.

It is also hoped that SAWEM will significantly affect the development of the electricity grid in South Africa by acting as a catalyst for grid modernization and expansion. This is important as the Saldanha region currently does not have sufficient grid infrastructure to transport the large volumes of energy required by the Green hydrogen sector located near the port. The SAWEM is currently in its final preparatory stages for launch, targeting an initial phased start in April 2026.

5.2.3 Transport and distribution

The success of hydrogen as a clean energy carrier will depend on the ability to design, implement, and scale safe, reliable, and affordable transportation systems. Hydrogen exists in multiple states depending on temperature and pressure, which means that no single transport method can serve all purposes. Instead, transportation is tailored to distribute hydrogen in its various states, such as compressed gas, liquid, or chemical derivatives such as ammonia and methanol. Each form has its benefits and trade-offs across cost, safety, and environmental outcomes, all dependent on the end user's goal/requirement.

As McGregor and Young (2025) caution, hydrogen's logistical journey is energy-intensive, often demanding costly infrastructure. Compressing gas, liquefying hydrogen at cryogenic temperatures as low as -253°C , or converting it into chemical carriers, each comes with penalties, sometimes eroding up to 48% of its original energy value before it even reaches the end user.

Pipelines

Several pipelines are required for different commodities; The Danger Bay desalination plant can potentially serve the needs of Green Hydrogen producers located within the industrial zone – two possible pipeline routings have been proposed to transport desalinated water into the Besaansklip zone (Figure 30) connecting with the Besaansklip reservoir. Hydrogen developers located within the SEZ that would require desalinated water for production – requiring connections to such a line. The Danger Bay desalination plant has been proposed for several years, initially to supply additional water to the settlements in the region – but it has found renewed uptake in possible production of green hydrogen.

Long term planning further suggests regional pipelines connecting Namibia (near Lüderitz), Boegoebaai with Saldanha. Although this is viewed as a long-term item, the alignment of such a common user pipeline should be considered and its routing planned. A possible future GH_2 pipeline from the port to Cape Town has also been proposed, especially considering uptake within the local region. An LPG pipeline, extending from the Saldanha port to Atlantis, is also proposed. These proposals when considered together indicate the need for several pipelines between the port and Atlantis/Cape Town. Possible pipeline corridors could be established to accommodate such infrastructure. Given the importance of Ammonia production, a pipeline from an Ammonia storage facility to the port would also be required for efficient and safe export of green ammonia. This together with the storage facility would be critical shared infrastructure items. The route of the pipeline would be determined by the placement of the storage facility, which would ideally need to serve multiple producers. MHI considerations would also contribute to the approval of siting the storage facility as well as the route of the pipeline.

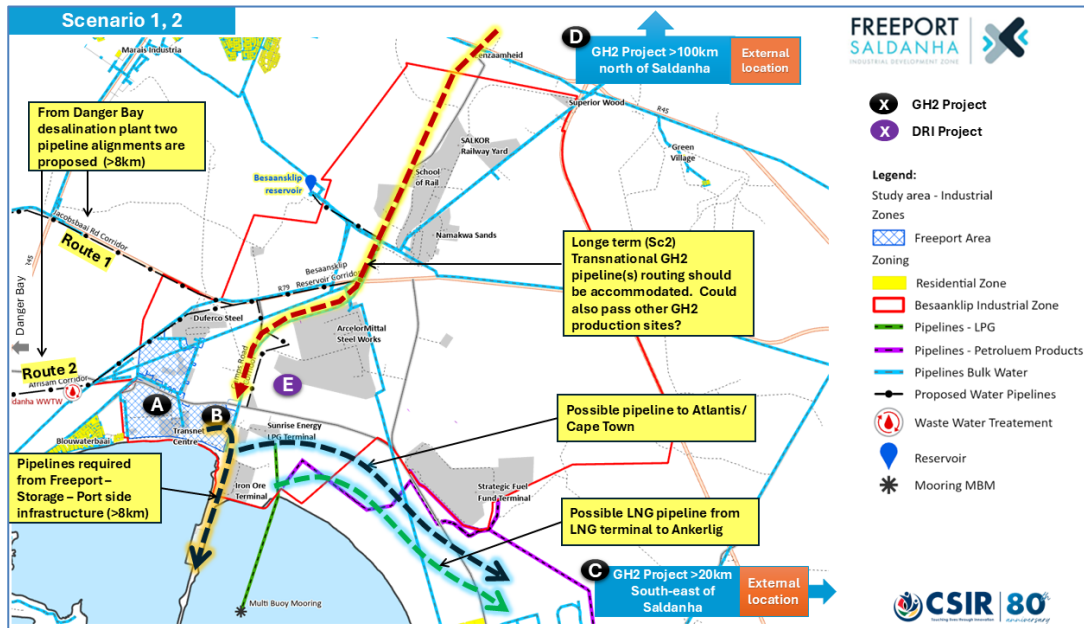


Figure 30: Schematic mapping of possible pipelines across the Besaansklip zone

Transporting hydrogen through pipelines is seen as an economical option for moving large volumes over extended distances. Capital investments for pipelines are substantial, and projects span decades from planning to delivery. Complex permitting, regulatory ambiguities, and the need for economies of scale create barriers. For consumers far from the main routes, additional investment in secondary networks is needed. Pipelines offer large scale continuous feed, but their development must be framed as a long-term strategic investment rather than a short term. Sharing a corridor could also reduce the effort, environmental permitting approvals, hazard installation permits and costs required to establish land use rights/servitudes and agreements with affected landowners. It is likely that the CBAM energy-use requirement could in future mandate renewable energy use for pipeline pump operations. This is likely to have some infrastructure implications to ensure full compliance.

Rail

The railway network in South Africa carries bulk commodities across vast distances, a role that positions railway as a natural candidate for hydrogen transport. However, global evidence suggests that rail use for hydrogen is still limited. Cryogenic railway tanks, such as road trailers, suffer losses of up to 15% per cooling cycle and average daily boil-off of 0.5% due to insulation limitations (Dauletbay et al., 2024). This does not diminish rail's strategic potential. Given the nature of South Africa's heavy freight corridors, investment in purpose-built hydrogen rail tanks could leverage existing logistics chains while reducing pressure on roads. The challenge lies in upgrading rail infrastructure, ensuring safety standards, and securing the large upfront investment required.

The rail is only being considered to serve a green Hydrogen producer located approx. 150 km north of Saldanha. This producer will only transport ammonia to the port from the period 2032 onwards, so it will only feature as part of scenario 2. Connecting the production site to rail will require the construction of connecting rail lines. This rail line construction will affect several land related issues; Land acquisition – land to be used for rail must be procured from current landowners. This can take a long time and require a long time-period and will be a significant cost item. Compliance - Will require compliance with laws and regulations, including performing environmental impact studies.

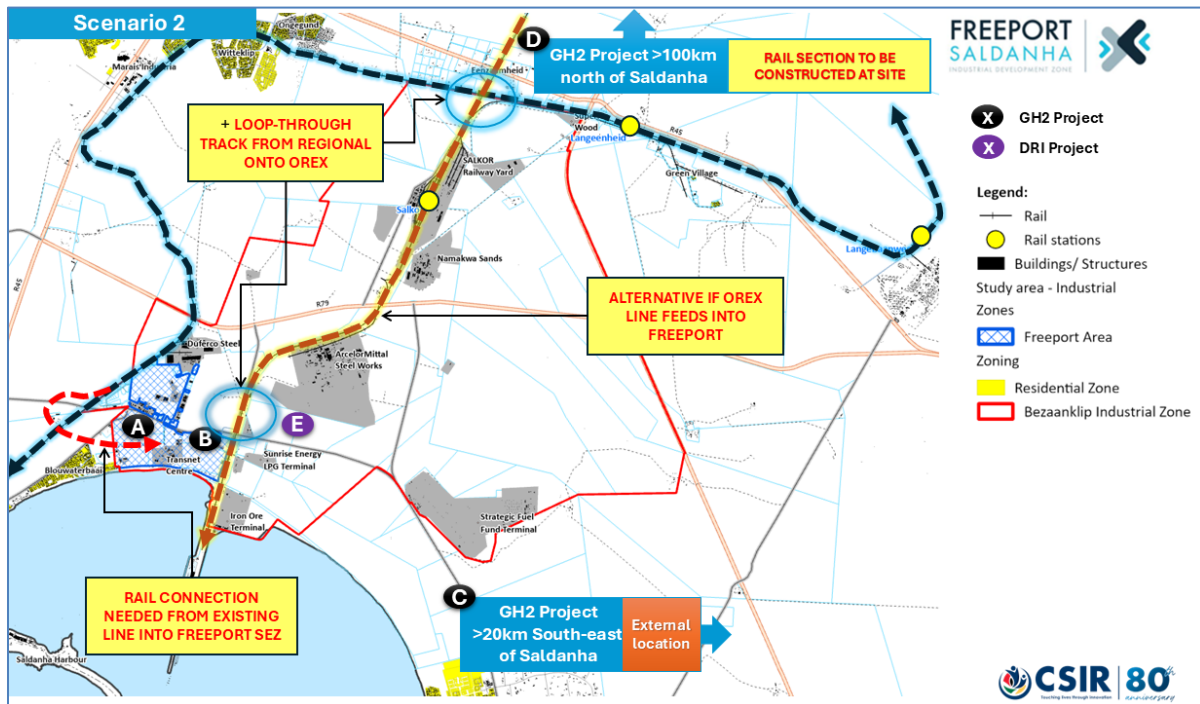


Figure 31: Schematic mapping of possible railway lines across the Besaansklip zone under moderate enabling conditions (i.e., Provincial Road scenario)

In order to improve the current scenario, various projects and initiatives have been undertaken. Among these is the enhancement of rail connectivity. Investments in rail infrastructure are intended to better link Cape Town, Saldanha Bay and Mossel Bay for bulk exports and cold chain logistics. In addition, ongoing infrastructure upgrades are expected to boost competitiveness by 2028, focussing on key projects (Western Cape Government, 2025). The iron ore corridor established a new offloading facility located behind the port, streamlining shunting operations. Saldanha has introduced Trans Africa locomotives (TAL) to assist with yard activities leading to the tippers. Efforts are underway to formalize a partnership between the Ore Corridor and the Ore Users Forum (OUF) to swiftly provide essential spares to Transnet Engineering and materials for the rail network to expedite infrastructure restoration. By redirecting emerging miner slots to sites capable of supporting higher axle loads, the Ore Corridor has increased the iron ore capacity through Saldanha by 4 mtpa. This strategy has also created additional capacity for slots in the Manganese segment, aligning with Saldanha Freight Rail's plans to enhance iron ore capacity by 4 mtpa through similar re-routing efforts. (Transnet, 2024).

The OreCor is one of the two primary heavy haul corridors in South Africa, stretching 861km from Sishen in the Northern Cape to Saldanha on the coast of the Western Cape. This crucial iron ore path operates on a state-of-the-art platform, supporting a substantial 30 tonnes per axle heavy haulage capacity. By leveraging advanced technologies and operational efficiencies, it accounts for 35% of Freight Rail's total volume (Transnet, 2024).

The iron ore export process has been streamlined using a fleet of 348 CR13/14 wagon ore trains that resulted in improved efficiency and productivity. Over the years, it has emerged as a global competitor, providing an extensive array of robust logistics solutions for both domestic and international clients. Additionally, since 2014, it has effectively handled manganese exports, reinforcing its standing in the global market (Transnet, 2024). The 375 CR17 wagon manganese train, recognized as the longest train for production purposes globally, mainly carries iron ore and manganese. In response to increasing customer demands and variable global commodity prices, OreCor aims to reduce logistics costs. Key strategies

include prioritizing economies of scale and increasing density to boost operational efficiency and effectiveness (Transnet, 2024).

At present, the Orelina's capacity is restricted to 60 million tonnes of iron ore annually because of air emission license limitations. Efforts are underway to obtain a new license that would enable the Sishen-Saldanha line to carry 67 million tonnes. To reach this goal, it is necessary to enhance the OreCor's fleet of locomotives and wagons and to undertake joint financial investments throughout the entire pit-to-port infrastructure. The effectiveness of these initiatives is contingent upon both the long-term prospects of the iron ore market and the accuracy of the volume forecasts. The distribution of new Train Operating Companies (TOCs) in the Cape Corridor seeks to direct manganese rail traffic from the Northern Cape to the Port of Saldanha, a key element for bulk export. This initiative aims at accelerating the transition of freight transport from roadways to rails, in order to alleviate road congestion, increase the competitive edge of the port, and encourage private sector investment in rail infrastructure. (South African Government, 2025). In Annexure C, a compilation of rail infrastructure projects relevant to the west coast area is listed.

Road networks

Roads master plan reflects the importance of efficient access between the port, industrial precincts, and regional transport nodes such as the roads to Cape Town and Johannesburg. This master plan is currently out to tender A for update (Saldanha Bay Local Municipality, 2025, p. 200). However, a key concern expressed by the Saldanha Municipality is the increase in heavy vehicles due to expanding industrial output and the increase in bulk commodities such as manganese. Additionally, should future green hydrogen producers located outside the SEZ transport their product to port via road, this could, apart from added truck volumes, add road safety and maintenance challenges. Given the implications of regional roads to provide access to economic activities, tourism and settlements in the region, significant increases in road freight can result in faster infrastructure degradation, higher maintenance costs, congestion, safety risks, and broader environmental/social challenges, unless mitigated by planning, investment, and regulation. Hydrogen-powered trucks and their networks have not yet been established in South Africa. Meanwhile, electric trucks are becoming more prevalent, although they are mainly used for short urban routes rather than long-distance travel. Until sustainable infrastructure is established to accommodate vehicles powered by alternative fuels, diesel-powered internal combustion engines are expected to remain standard for distribution, particularly in the short and medium term where local supply will fall short of meeting all demand points.

The roads on the west coast will continue to be shared infrastructure, as is currently practice. However, with the transport of hydrogen, e-fuels, and their feedstock to manufacturing industries, roads will experience increased surface wear, necessitating more frequent maintenance. It is recommended that strategic road network evaluations be conducted regularly to predict and monitor wear due to the increased transport density of these materials. Consequently, this review does not address the tracking of maintenance activities, road revitalisation, or similar efforts. Infrastructure projects for road transportation are in progress, not specifically targeting the hydrogen economy on the West Coast but rather concerning overall freight transport. Because hydrogen and its derivatives are also expected to be transported using tanker trailer vehicles, the list (as seen in Annexure C) highlights both ongoing and upcoming projects in the West Coast area.

Terminal, depots and hydrogen refuelling stations:

Currently, there are no general truck terminals established equipped to refuel heavy-duty freight fleets using hydrogen. However, these trucks are part of the hydrogen mobility shift that may align with terminal development. The Western Cape Green Hydrogen Strategy underscores opportunities for

regional logistics and mobility solutions utilising hydrogen to meet local demands, such as decarbonising transport and mobility sectors, but commercial-scale hydrogen truck terminals remain in the early stages of planning or are in pilot phases (IDC, 2023). Saldanha Bay (Green Hydrogen & Ammonia Hub) is designated as the primary green hydrogen export and logistics hub of the Western Cape. The plans include infrastructure for green hydrogen production, conversion (to ammonia), and bulk storage, enabled by proximity to steel, port, and bulk terminal facilities. Currently, there is no truck refuelling depot in place, but it is strategically positioned for future needs. It is particularly suitable for supplying ammonia and hydrogen for logistics and distribution in shipping, industry, and possibly freight trucks. In the December 2024 feasibility study of the South African Namibian cross-border hydrogen infrastructure, it is projected that the hub at Saldanha Bay will include a fuel station designed to accommodate two tube trailers, five hydrogen trucks, a garbage collection vehicle, and two street sweepers (WESGRO, 2024). While these projections are contingent upon the criteria for adoption scenarios and forthcoming investment collaborations in the near future.

5.2.4 Storage

No hydrogen or derivatives facilities exist at present in the industrial zone. However, potential development exists to develop storage facilities for hydrogen and ammonia that can be utilised by multiple producers. Such facilities could be placed at back-of-port areas or possibly within the SEZ safety issues permitting. Back of port areas such as farms section 129/0 and 195/2 Malmsbury Road could be considered for developing storage facilities.

5.2.5 Maritime

The Saldanha port is a critical gateway for GH_2/PtX distribution, but its operations face constraints related to access and logistics. Heavy vehicle traffic and oversized loads contribute to congestion on surrounding road networks. Coordinated access management, aligned with the port's operational schedule, is essential. Beyond these operational challenges, the transport of hydrogen and its derivatives via maritime routes presents additional technical and safety considerations, including vessel design, compression or storage requirements, and the handling of chemical carriers such as ammonia and e-methanol. Local service provision including bulk water, electricity, and internal road maintenance within industrial zones such as SBIDZ should be synchronised with port investment timelines. The port's throughput depends heavily on the reliability of the rail network (OREX), rolling stock availability, and terminal handling equipment, all of which are overseen at the national or Transnet level (Saldanha Bay Local Municipality, 2025-2030).

Maritime transport of hydrogen and its derivatives introduces additional technical and safety considerations. Dedicated compressed hydrogen shipping is a novel concept in development for short- and long-haul markets (Kongstein, 2023). Onshore compressor stations are used to build tank pressures of around 250 bar during loading. Current design studies suggest ship capacities ranging from 430 to 2000 tonnes per voyage (Provaris Energy Ltd, 2023). For South Africa, with the port of Saldanha as a major maritime gateway, CGH_2 shipping could unlock both domestic coastal transport and international exports. Hydrogen derivatives such as ammonia and methanol also provide options for coastal shipping. Ammonia is considered one of the most promising hydrogen carriers, especially for export purposes and maritime bunkering applications. Inland transportation of ammonia can be carried out efficiently via road and rail tankers, pipelines, or by shipping it in bulk, making it a versatile option. However, its toxicity and the complexities associated with handling present significant drawbacks. E-methanol remains a liquid at room temperature, an easy and well-known shipping commodity; it is also less toxic than ammonia, potentially reducing the risks and costs associated with its handling.

5.2.6 The role of Competition Policy

The Competition Act of 1998 serves as a mechanism for advancing economic policy and assisting industries that face challenges. This provision empowers the Minister of Trade, Industry and Competition, after consulting the Competition Commission, to exempt a category of agreements or practices in order to give effect to the purposes of the Act. An exemption is a regulatory tool that allows firms to conclude agreements or engage in practices that would otherwise be prohibited under the Act, to advance competition objectives. This may designate industries for special treatment in exemptions or public interest assessments.

5.3 Potential impacts, drivers and best practice mitigation

The large-scale development of GH₂/PtX technologies in the Saldanha region will have wide-ranging environmental and social implications. These include both opportunities and risks that extend across ecosystems, communities, and economic sectors. While the types of impacts are broadly consistent with those observed internationally, the specific character and scale of impacts in the West Coast will be shaped by the region's unique ecological sensitivity, resource constraints, economic structure, and settlement patterns. The following subsections provide a high-level overview of potential environmental and social impacts most relevant to the West Coast context. These impacts are framed at a strategic level, recognising that the detailed scope, significance, and management of project-specific impacts will depend on individual project design, siting, and implementation. Table 7, informed by literature review and stakeholder discussions, highlights key environmental sensitivities and pressure points associated with GH₂/PtX development in the Saldanha Bay region. It summarises potential impacts, drivers, and best practice mitigation measures to guide further investigation and sustainable project planning.

Table 8: Summary of potential impacts, drivers and best practice mitigation measure relevant the establishment of the West Coast GH₂/PtX hub

Impacts	Drivers/pressure	Best Practice Mitigation Measures
<p>GH₂/PtX production can substantially reduce greenhouse gas emissions by replacing coal- and gas-based processes in steelmaking and transport fuels and cement production.</p> <p>During construction and early operational phases, localized air quality impacts may arise from earthworks, material handling, and heavy-vehicle traffic, generating dust and particulate matter that can affect nearby settlements, roads, and sensitive ecological receptors, especially in dry or windy conditions. In addition, hydrogen leakage during production, storage, or transport could indirectly contribute to global warming, altering atmospheric concentrations of potent gasses such as methane and ozone (Sand, Berntsen, & Samset, 2023). The scale of PtX activities planned for the West Coast heightens the importance of these risks.</p>	<p>Local air pollution; safety concerns; indirect Green House Gas emissions</p>	<ul style="list-style-type: none"> • Implement continuous air quality and fugitive emission monitoring programs aligned with the IFC EHS Guidelines for Hydrogen Production (2023). • Design sealed hydrogen and ammonia handling systems with real-time leak detection and emergency isolation valves. Ensure compliance with DFFE Air Quality Standards (GN 1210 of 2018) and the National Environmental Management: Air Quality Act (NEMAQA). Adherence to international best practice for pipeline and storage safety should be followed • Apply water-based dust suppression on haul roads, stockpiles, and cleared areas. Establish exclusion and buffer zones around pressurised storage and transfer areas. Develop an Emergency Response and Fire Safety Plan in accordance with the South African National Standard (SANS) 10263-0 and local disaster management protocols. <p>If well managed, the decarbonisation potential of GH₂/PtX in the West Coast could outweigh these risks, positioning the region as a cornerstone of South Africa's low-carbon industrial transition while maintaining environmental integrity</p>
<p>SWRO offers an effective means to meet the high feedwater demands for projects comprising the West Coast hydrogen hub while alleviating pressure on local aquifers and municipal supplies.</p> <p>Brine discharge requires careful management, as elevated salinity can negatively affect sensitive marine and estuarine ecosystems in the region, including Langebaan Lagoon, Danger Bay, and nearby intertidal zones (UNEP, 2020). Potential impacts include habitat stress on seagrass beds, benthic invertebrates, shellfish, and feeding grounds for migratory birds, as well as cumulative effects when combined with port, aquaculture, and renewable energy infrastructure. Several GH₂ producers have indicated plans to establish independent desalination facilities to ensure market readiness. While it is unlikely that all proposed facilities will be constructed, the cumulative development of multiple desalination plants along the coastline could intensify localised environmental pressures, including elevated salinity, thermal alterations, and sediment redistribution.</p> <p>Desalination facilities could also provide co-benefits for the region: excess water could be supplied to municipal systems, enhancing water security and helping West Coast communities buffer against climate-related scarcity.</p>	<p>Soil and water contamination</p> <p>Depletion of local aquifers; reduced availability for communities; salinisation risk</p>	<ul style="list-style-type: none"> • Segregate and label waste in compliance with NEM: Waste Act (2008) and DFFE Waste Classification Regulations. Store all hazardous materials in bunded areas with 110% containment. • Conduct refuelling and maintenance >100 m from any watercourse. • Maintain fully stocked spill kits and trained personnel on site. Implement a Hazardous Materials Management Plan aligned with IFC Performance Standard 3 (Pollution Prevention and Abatement). • Perform regular audits and emergency drills; ensure contractors receive induction on chemical handling and spill response. <ul style="list-style-type: none"> • Prioritise desalinated seawater supply with proper brine dispersion design (as per DFFE and DEA Desalination Guidelines). Implement circular water use and recovery systems (closed-loop cooling). • Align abstraction and discharge with the Saldanha Bay Local Municipality Water Services Development Plan (WSDP). Coordinate intake and outfall locations among producers to avoid overlapping zones, implementing diffuser systems to enhance brine dispersion, and monitoring key marine indicators to ensure early detection of ecosystem changes. • Monitor groundwater abstraction, water table levels, and salinity through telemetry. Conduct routine water quality analysis (SANS 241:2015) and field checks during construction and operation. • Establish dedicated monitoring boreholes to track cumulative impacts. • Strategic regional planning, including integrated brine management guidelines and cumulative impact assessments. • Where feasible, oversizing desalination plants to provide additional water to surrounding municipalities could deliver co-benefits for regional water security and reduce the pressure to construct multiple small-scale facilities (Saldanha Bay Local Municipality, 2025).

Impacts	Drivers/pressure	Best Practice Mitigation Measures
<p>The West Coast region is underlain by a mix of shallow coastal sediments and weathered bedrock, which can affect foundation stability for large-scale installations, including wind turbines, pipelines, and hydrogen storage facilities (SANBI, 2018). Groundwater occurs in fractured aquifers and shallow alluvial deposits, which are critical for municipal water supply and agricultural use.</p> <p>Large-scale GH₂/PtX developments, particularly desalination plants and industrial abstraction, may alter local groundwater recharge and flow patterns, potentially affecting aquifer sustainability and nearby wetlands already under stress and urban and industrial activity (GEOSS, 2019) (Saldanha Bay Municipality, 2025a). Land clearing during construction phase of developments disturb vegetation cover and expose soils to erosion, while heavy machinery compacts the ground, reducing infiltration and increasing runoff, which can accelerate topsoil loss and degrade land quality (Hamed & Alshare, 2022) (Schreiner, et al., 2024). Disturbed soils may also contribute to sedimentation in rivers, wetlands, and coastal waters. In coastal zones, construction and operation of SWRO plants can modify sediment transport. Dredging and reclamation can resuspend seabed sediments, change erosion and deposition patterns, and impact marine habitats and biodiversity if not carefully managed (Lattemann & Höpner, 2008).</p> <p>Landscape and geomorphological features, such as kloofs, south facing slopes and riverine corridors enhance ecological resilience, support groundwater recharge, reduce erosion, and buffer infrastructure from hydrological and climatic variability and maintain landscape connectivity and variety of microclimates that support vegetation recovery and species persistence (Snyman-van der Walt, Blanchard, & Duffel-Canham, 2019) (Saldanha Bay Municipality, 2025a). Coastal processes, including tidal fluctuations, wave action, and storm surges, further influence the stability and design of port infrastructure and pipelines with low-lying areas being particularly susceptible to erosion, flooding, and sea-level rise (DEA&DP, 2021).</p>	<p>Soil degradation</p> <p>Land clearing, excavation, and foundation works for GH₂/PtX facilities, pipelines, and transmission infrastructure.</p>	<ul style="list-style-type: none"> • Develop a Stormwater Management Plan (SWMP) prepared by a qualified professional prior to construction, specifying drainage structures and sediment control measures. • Stabilise exposed surfaces using gabions, Reno mattresses, or vegetative cover. • Confirm geotechnical suitability before construction (soil bearing capacity and drainage). Incorporating geotechnical assessments, hydrological modelling, soil conservation, and sediment management into early project conceptualisation and long-term monitoring is therefore essential to mitigate risks to infrastructure and water resources while maintaining ecological function. • Apply erosion control measures aligned with the Conservation of Agricultural Resources Act (CARA, Act 43 of 1983). • Strip and store topsoil (upper 20 cm) separately for reuse during rehabilitation; reapply last to preserve soil structure and seed bank. Retain and maintain vegetated buffers where feasible to limit erosion and dust.
<p>Expansion of GH₂/PtX infrastructure, including renewable energy facilities, pipelines, and SWRO desalination plants, may fragment sensitive landscapes, reduce habitat connectivity, and disrupt ecological services across coastal plains (i.e., Cederberg, Winterhoek) and biodiversity corridors (Hamed & Alshare, 2022). Construction and operational disturbances, such noise, dust, erosion, and vehicle traffic, can affect species at substantial distances, particularly in coastal environments. Large-scale GH₂/PtX development may also facilitate the establishment of alien invasive plant species, exacerbate soil degradation, and lead to soil and water contamination if not properly managed.</p>	<p>Habitat and landscape fragmentation</p> <p>Strategic infrastructure development and expansion (transmission lines, pipelines, storage facilities) fragment natural vegetation and ecological connectivity.</p>	<p>At scale, regional GH₂/PtX development could produce cascading ecological effects; therefore, avoidance of sensitive areas, strategic siting, and implementation of biodiversity offsets are critical to mitigating impacts.</p> <ul style="list-style-type: none"> • To balance industrial expansion with biodiversity conservation, the Saldanha Bay Strategic Offset Strategy (DEA&DP, 2020) identifies offset corridors, including the Peninsula Consolidation Corridor and Berg River–West Coast National Park Corridor, to maintain ecosystem functionality and compensate for potential impacts within the Besaansklip area. Coordinated planning across multiple GH₂/PtX projects is essential to limit cumulative ecological impacts along the Saldanha Bay coastline. • Preparation of a Construction Rehabilitation and Monitoring Plan following environmental authorisation. Prioritise development in already disturbed or degraded areas. • Relocation of suitable plant species and stockpile topsoil for revegetation. Establish biodiversity corridors in servitude areas; minimise clearing and restrict to jeep tracks where possible. • Apply ecological sensitivity mapping (SANBI guidelines) to guide infrastructure routing. Restore disturbed areas promptly with indigenous vegetation and monitor success.
	<p>Disturbance to fauna and mortality</p> <p>Movement of heavy machinery, noise, and vertical structures (e.g., wind turbines, powerlines) impacting birds, bats, and mammals.</p>	<p>Avoid known bird and bat corridors, roosts, and nesting sites through pre-construction ecological surveys. Fit powerlines with bird flight diverters and insulation devices to minimise electrocution (BirdLife SA Guidelines, 2022). Use downward-directed, low-intensity lighting. Conduct driver awareness campaigns to reduce roadkill incidents. Apply for relevant conservation permits under <i>NEM:BA (2004)</i> before fauna relocation or rescue. Clearly demarcate “no-go” sensitive zones and brief all contractors.</p>
	<p>Loss of vegetation cover and establishment of alien invasive species</p> <p>Vegetation clearing for construction and road development; introduction of alien species from machinery or fill material.</p>	<ul style="list-style-type: none"> • Prepare and implement an Alien Invasive Species Management Plan following DFFE and Working for Water (WfW) Guidelines. Comply with NEM:BA (2004) invasive species regulations. • Obtain permits for removal or relocation of protected species. Restore disturbed areas with locally indigenous seed mixes. • Maintain less than 5% invasive canopy cover in restored areas as per Fynbos Forum Ecosystem Guidelines (2016). Schedule regular monitoring and control interventions.
<p>The anticipated growth associated with GH₂/ PtX development is expected to increase population density in areas such as Saldanha, Vredenburg, Hopefield, and Langebaan, escalating demand for housing, water, energy, and social services. The SBM IDP highlights the need for infrastructure development to support this growth, including desalination plants, port upgrades, and power transmission lines (Saldanha Bay Municipality, 2022). However, municipalities in the region face challenges related to service delivery and fiscal capacity, which may hinder their ability to meet the increased demand. The WCDM IDP underscores the necessity of coordinated planning to ensure that infrastructure development aligns with population growth and does not exacerbate existing service delivery issues (Saldanha Bay Municipality, 2022).</p> <p>At the same time, GH₂/PtX projects present opportunities to enhance local infrastructure. Investments in desalination, energy generation, and transmission networks could benefit both industrial operations and surrounding communities.</p>	<p>Road degradation; safety risks; contamination;</p> <p>Heavy transport of GH₂/PtX components and materials; increased use of port and logistics routes.</p>	<p>Develop a Green Logistics and Traffic Management Plan prioritising rail and maritime transport where feasible. Schedule deliveries during off-peak hours. Store all fuels and chemicals with secondary containment (bunds/berms) capable of holding 110% of the largest container. Conduct routine inspections and provide spill response equipment. Establish wash bays with sedimentation/evaporation ponds. Refuel and service vehicles >100 m from any river or drainage line. Site construction camps and batching plants >50 m from watercourses, consistent with <i>GN 509 (NEMA Listing Regulations, 2014)</i> buffer guidance.</p>
	<p>Increased pressure on strained service delivery systems</p> <p>Increase in local population numbers and construction activity</p>	<p>Integrate GH₂ and PtX developments into local and regional planning instruments, applying scenario-based approaches to anticipate population growth, infrastructure needs, and ecological pressures, and embedding these projections into municipal and environmental decision-making processes.</p>

Impacts		Drivers/pressure	Best Practice Mitigation Measures
<p>The West Coast region is characterized by its unique landscapes, biodiversity, and cultural heritage, which are integral to its identity and economy. Large-scale renewable energy and PtX infrastructure, such as wind farms, pipelines, desalination facilities, and storage facilities, could significantly alter the visual and functional character of both coastal and inland areas, potentially affecting tourism, agriculture, and conservation efforts (Saldanha Bay Municipality, 2022). Agricultural activities in the region have been declining due to climate variability, water scarcity, and economic pressures, including prolonged droughts that reduce productivity and increase vulnerability of farming communities (Saldanha Bay Municipality, 2022). This decline has prompted many residents to seek alternative livelihoods, including opportunities in emerging renewable energy sectors. While these developments offer economic benefits, they also increase the potential for land use conflicts, including competition between industrial infrastructure, agriculture, conservation areas, and tourism assets. Strategic spatial planning, cumulative landscape assessments, and alignment with land-use frameworks are essential to mitigate these conflicts and preserve the region's ecological integrity, cultural heritage, and sense of place.</p>	<p>Land use conflicts and change in sense of place</p>	<p>Visual and landscape alteration from large-scale energy and industrial infrastructure; increased vehicle activity and noise.</p>	<ul style="list-style-type: none"> Phase vegetation clearing to reduce large visual openings. Notify receptors within 500 m of construction activity in advance. Restrict high-noise work to daylight hours. Use existing access roads and locate laydown areas in low-visibility positions. Apply low-glare, neutral-toned materials for structures. Implement visual screening (berms, vegetation) where feasible. Rehabilitate cleared areas immediately after use to restore natural aesthetics. Align with IFC EHS Guidelines for Construction and Decommissioning (2007).
	<p>Disturbance of heritage sites</p>	<p>Excavation and development in previously undisturbed areas may expose archaeological or palaeontological remains.</p>	<ul style="list-style-type: none"> Report any evidence of archaeological sites or remains, fossils or other categories of heritage resources to the relevant Heritage authority as per section 35(3) of the National Heritage Resources Act 25 (NHRA) of 1999 so that mitigation (recording and collection) can be carried out. Engage a professional archaeologist for site inspection and documentation. Apply for a Phase 2 rescue excavation if required. Protect in situ and demarcate heritage finds until clearance is obtained. Non-compliance constitutes an offence under <i>Section 51(1)e</i> of the NHRA. Protect in situ and stop work in immediate area subsequent to reporting chance finds of graves and dense clusters of artefacts to the relevant heritage authority.
<p>The establishment and development of GH₂ is a new feature within the planning landscape within the region. The region does not have prior experience with this sector, resulting in uncertainties that could hamper planning decisions. Anticipated developments also must feature in the regional strategic planning documents, if not, these plans and strategies need to be updated. It is therefore critical to inform those dealing in the planning space of what green hydrogen development comprises and would require in terms of land use planning and permissions.</p>	<p>Pressures on the planning functions</p>	<p>Need to effectively and timeously address development applications and guide developers</p>	<p>Municipalities should be capacitated and informed about the requirements related to the various aspects of green hydrogen production. This will enable them to better respond to emerging planning issues, as well as to update various strategic and sectoral plans and strategies.</p> <ul style="list-style-type: none"> The development of a municipal green hydrogen strategy could provide clarity within municipal planning.
<p>Major Hazard Installations (MHIs) associated with GH₂ projects are critical considerations for local municipalities because they introduce unique safety, planning, and regulatory responsibilities. These installations, such as large-scale hydrogen and ammonia production, storage, and distribution facilities handle significant quantities of flammable and potentially hazardous substances. Their safety and management have direct implications for municipal land-use planning, public safety, emergency response, and local development outcomes. It places new technical, and governance demands on municipalities making early planning, robust approval processes, and continuous risk management central to safe and sustainable local development.</p>	<p>Development of appropriate safety distances</p>	<p>This could delay planning decisions and affect affective guidance to developers</p>	<p>Appropriate guidelines are required to guide planning decisions. Buffer zones need to be established between MHIs and other uses; however, this must be appropriate considering the risk levels related to various components of green hydrogen production.</p> <p>Note: Individual MHIs must still comply to South African Major Hazard Installation Regulations, including registration, licensing, and ongoing safety audits.</p>
<p>The development of GH₂ in the region and especially in the vicinity of the Saldanha Industrial Zone will require multiple infrastructure projects. Shared utilities such as grid connections, water supply, port and rail logistics, and common-use energy facilities provide the backbone for integrating renewable electricity and supporting massive hydrogen electrolyser installations, all critical elements in the GH₂ value chain. The planning and development of these needs to happen in a coordinated fashion.</p>	<p>Uncoordinated and fragmented planning and development</p>	<p>Delays in construction putting ultimate production targets at risk</p>	<p>A coordinating entity overseeing the various infrastructure projects for the establishment of hydrogen developments in Saldanha would deliver substantial benefits by streamlining planning, accelerating project delivery, and maximising regional economic and technical synergies. A detailed master plan could also guide and potentially optimise the placement of infrastructure, utilizing/ proposing shared infrastructure where possible</p>

5.3.1 Integrating best practice lender considerations

In order for GH₂ ambitions in South Africa and the Saldanha Bay region to be realised, strong policy support, clear regulatory frameworks, and coordinated financing structures are essential. Currently, policy uncertainty and an unattractive investment climate constrain financing, slowing project scale-up and limiting reductions in fossil-based energy use (Sc0, Appendix A).

Achieving the GH₂ ambitions outlined in national planning strategies, as reflected in Development Scenarios 1 and 2 (Appendix A), will require initial funding that relies heavily on international partners, including climate finance agencies and development-focused investors from the EU, Germany, and Japan, while domestic commercial financiers gradually engage as project viability and infrastructure maturity increase. Large-scale GH₂/PtX projects in Saldanha are likely to involve significant third-party financing, often via project finance structures, which necessitates that Environmental and Social Impact Assessments (ESIAs) align with both South African EIA Regulations (Appendix B) and international lender standards (Schreiner, et al., 2024).

Many financiers adhere to the Equator Principles (2020) and IFC Performance Standards (2012) to identify and manage environmental and social risks.

- The Equator Principles provide a structured framework for project categorisation, environmental and social assessments, management systems, stakeholder engagement, grievance mechanisms, independent review, and reporting.
- IFC Performance Standards establish requirements for assessing and managing E&S risks throughout a project's lifecycle, covering biodiversity, community health, labour, land acquisition, cultural heritage, and resource efficiency. PS1 emphasises integrated assessment and ongoing performance management, while PS6 highlights the mitigation hierarchy and critical habitat assessment for biodiversity.

Table 9: Summary of the Equator Principles and IFC Performance Standards
(Source: Extracted from Schreiner et al., 2024)

Standard	Objective
Equator Principles (2020)	<p>The Equator Principles consist of a set of principles and procedures adopted by financial institutions to ensure that the environmental and social issues associated with a project financed by those institutions are respected. The Equator Principles are summarised below:</p> <ul style="list-style-type: none"> • <i>Principle 1 – Review and Categorisation:</i> The projects are classified into three categories according to the potential environmental and social risks they represent. The categories are: <ul style="list-style-type: none"> ○ Category A – Projects with potential significant adverse environmental and social risks and /or impacts that are diverse, irreversible, or unprecedented; ○ Category B – Projects with potential limited adverse environmental and social risks and/ o r impacts that are few in number, generally site-specific, largely reversible, and readily addressed through mitigation measures; and ○ Category C – Projects with minimal or no adverse environmental and social risks and/or impacts. • <i>Principle 2 – Environmental and Social Assessment:</i> It is necessary to carry out an environmental evaluation of the project that addresses the risks identified during the analysis and categorisation. • <i>Principle 3 – Applicable Environmental and Social Standards:</i> The projects

Standard	Objective
	<p>implemented in emerging countries, apart from complying with local laws, must also follow the IFC Performance Standards and the WBG EHS Guidelines.</p> <ul style="list-style-type: none"> • <i>Principle 4 – Environmental and Social Management System (ESMS) and Equator Principles Action Plan:</i> The projects must have an action plan to address the risks identified during the environmental evaluation. • <i>Principle 5 – Stakeholder Engagement:</i> It is necessary to promote and carry out consultations with the stakeholders in a culturally appropriate and structured manner. • <i>Principle 6 – Grievance Mechanisms:</i> It is necessary to establish mechanisms for ongoing involvement of interested and affected parties, to allow for the submission of grievances or issues, during all phases of project development. • <i>Principle 7 – Independent Review:</i> The environmental performance must be audited by independent experts, with experience in the area covered by the project. • <i>Principle 8 – Covenants:</i> The laws and regulations, licensing, and action plans, must be carried out in all aspects. • <i>Principle 9: Independent Monitoring and Reporting:</i> The projects should appoint an independent environmental and social expert to carry out the monitoring and produce additional reports. • <i>Principle 10 – Reporting and Transparency:</i> The financial institutions must publish information on the loans granted, at least annually, in accordance with the rules of the Equator Principles.
<p>IFC Performance Standards (2012)</p>	<p>The IFC Performance Standards are applied to a project to manage E&S risks and impacts throughout the life of an investment. There are eight performance standards which cover the following areas:</p> <p>PS 1: Assessment and Management of environmental and social Risks and Impacts; PS 2: Labour and Working Conditions; PS 3: Resource Efficiency and Pollution Prevention; PS 4: Community Health, Safety, and Security; PS 5: Land Acquisition and Involuntary Resettlement; PS 6: Biodiversity Conservation and Sustainable Management of Living Natural Resources; PS 7: Indigenous Peoples; and PS 8: Cultural Heritage.</p> <p>Of these, PS 1 establishes the importance of undertaking an integrated approach to identifying the E&S impacts, risks, and opportunities of projects; effective community engagement through disclosure of project-related information and consultation with local communities on matters that directly affect them; and effective management of E&S performance throughout the life of the project.</p> <p>PS 2 through to 8 establish objectives and requirements to avoid, minimise, and where residual impacts remain, to compensate / offset for risks and impacts to workers, affected communities, and the environment. PS 7 (Indigenous People) is not considered applicable to this Project as there are no indigenous peoples (as defined by the Standard) living in the area impacted by the Project.</p>

Other standards ensure risks related to climate change, vulnerable groups, and associated facilities are also considered (IFC, 2012; Equator Principles, 2020).

While South Africa's EIA Regulations are broadly aligned with the ESIA requirements of the IFC Performance Standards, there are several gaps that require additional attention for GH₂/PtX projects. Examples include detailed stakeholder mapping and engagement with vulnerable groups, implementation of Environmental and Social Management Systems (ESMS), multi-seasonal biodiversity baseline studies, consideration of associated facilities, and comprehensive climate risk and adaptation assessments (Schreiner et al., 2024). Addressing these gaps will require further review and the development of a guiding document specific to GH₂ projects, providing clarity for developers and ensuring consistency with both local and international standards. For the West Coast, these requirements are particularly relevant given the ecological sensitivity of the region. Lenders typically expect that projects avoid or minimise impacts on these areas, assess cumulative effects of multiple GH₂/PtX developments, and implement robust Environmental Management Systems (EMS) with long-term monitoring. Effective financing requires close coordination among Development Finance Institutions (DFIs) and advisory bodies. A dedicated forum of DFIs would greatly improve funding coordination, linking to a new advisory committee to support strategic decision-making. At the project level, bankability depends on clarifying off-takers, securing strong early-stage engineering contracts, and managing costs, particularly renewable energy inputs, which constitute a significant portion of total project expenditures, among other critical requirements. The funding landscape is further challenged by a lack of clarity between DFI and private financing mechanisms. Blended finance approaches, combining grants, public, and private capital, are essential to de-risk early-stage projects.

6 SWOT ANALYSIS, KNOWLEDGE GAPS AND FUTURE RESEARCH

6.1 SWOT Analysis

A SWOT analysis was undertaken to synthesize insights from the analytical review and stakeholder engagements conducted during Phase 1 of the Master Plan. This assessment provides a structured overview of the internal strengths and weaknesses of the West Coast Green Hydrogen Hub, alongside external opportunities and threats influencing the regions development trajectory. The purpose of the analysis is to highlight key strategic factors that shape the regions potential for sustainable GH₂/PtX development and competitiveness. By identifying these factors, the SWOT analysis highlights priority actions and decision-making in subsequent phases of the Master Plan, ensuring that planning interventions are evidence-based, targeted, and responsive to both regional realities and emerging market trends.

Strengths



- **Abundant renewable energy potential**, including offshore wind with depths favorable for fixed-bottom technology.
- **Proactive conservation planning** to manage high ecological value and biodiversity provides a strong foundation for strategic ecological offsets and enhanced environmental stewardship.
- Existing industrial areas offer **concentrated development opportunities** that minimize habitat fragmentation, reduce cumulative impacts, support green hydrogen utilization, and facilitate co-location of production, storage, and distribution operations.
- Saldanha Bay Local Municipality demonstrates **strong planning capacity**, supported by recently developed frameworks guiding regional growth and development.
- The West Coast is well suited for developing **new transport infrastructure**, such as pipelines, and revitalizing underutilized rail and multimodal networks, with ongoing efforts to integrate sustainable transport methods into regional logistics.
- **Established infrastructure** within the deep-water port and SEZ (e.g., bulk handling and bunkering facilities, integrated road-rail-maritime logistics) enable local and international integration. Saldanha Works, South Africa's only DRI facility, well suited for GH₂ use.

Weaknesses



- Risk of brine related marine and coastal **water quality impacts** to sensitive coastal ecosystems due to the reliance of GH₂/PtX production on SWRO.
- **Insufficient MHI guidance** for municipalities can affect any future land use applications (e.g., safety distances).
- The West Coast falls within Eskom's Aurora, Helios, and Juno supply areas, all with 0 MW available capacity (Eskom, 2023). **Grid constraints** near the industrial zone limit new developments, and new transmission lines face long lead times due to servitude and permitting requirements.
- Many **roads are in poor condition**, still comprising gravel surfaces and requiring upgrades to support industrial freight near the port. Postponed maintenance increased lifecycle costs and safety risks.
- Local economic performance is constrained by inefficient **rail and port operations** (factors beyond municipal control) while **poorly coordinated heavy vehicle access** and gate operations create traffic congestion and safety risks at the port-town interface.
- **Land limitations** exist for large-scale GH₂ development within the SEZ, as portions are already allocated to other initiatives, while extensive offset requirements on certain parcels further deter investment and risk fragmenting development across the zone.

Opportunities



- **Existing EAs for RE projects** enable the Hub to tap into planned projects, to fast track and strengthen energy availability for GH₂/PtX developments.
- **Focused road rehabilitation** on key freight corridors (port/SBIDZ entry points) aims to stimulate investment and lower operational expenses.
- GH₂ water requirements support the establishment of **oversized desalination facilities** that can supply multiple producers and the local municipality, promote circular resource use and minimizing ecological impacts.
- Implementing **best-practice biodiversity management** avoid of sensitive areas and ecological offsets, can enhance sustainability and align projects with IFC PS6 and national guidelines.
- Development of **new socio-economic pathways** (e.g. conservation-linked jobs, ecotourism, and local capacity-building), while attracting foreign direct investment and public-private partnerships to accelerate infrastructure rollout.
- **Leverage the SBIDZ/Freeport status** to attract maritime, manufacturing, and value-added industries through improved access and services.
- **Enhance the Port-City logistics forum** to synchronize irregular load handling, scheduling activities, and the order of investments (involving the municipality, Transnet, SEZ, and industry stakeholders).
- **Decarbonization of industry and transport** through low-carbon product manufacturing, hydrogen refueling infrastructure, and emission reductions in hard-to-abate sectors (e.g., steel, chemicals, aviation, and shipping).

Threats



- **High wheeling tariffs** diminish the cost advantage of RE sources, prompting developers to construct new transmission lines creating dispersed transmission networks across the landscape.
- **Funding uncertainties** exacerbated by limited uptake of GH₂ products creates a risk of not obtaining investment finance.
- Multiple concurrent projects along the West Coast may result in **habitat fragmentation cumulative socio-ecological impacts**, triggering regulatory scrutiny or **public opposition**, and delaying project approvals.
- **Increased pressure on existing municipal infrastructure** including roads, settlements, and waste and sewage systems, some of which are already constrained, resulting from ongoing and additional development in the area.
- The West Coast Hydrogen Hub also **competes with other similar developments** in the country developing green hydrogen infrastructure.
- **Regulatory bottlenecks and misaligned municipal planning** constrain development, necessitating timely approvals and integrated support from district and provincial authorities.
- **Lack of hazard regulations and standards** for GH₂ transport and storage poses safety and commercial risks.
- **Socio-economic constraints**, including land ownership complexities, local opposition, and rent seeking behavior, may restrict project siting.

6.2 Infrastructure and land-use planning

Although municipalities in the region recognise that the production of GH₂ might have considerable consequences, the scope of these developments remains somewhat ambiguous. In particular, the effects on settlement are not well-defined (evident when looking at current planning frameworks). Far more detailed analysis is needed to understand the implications for housing and services, enabling municipalities to adapt their plans accordingly.

The establishment of GH₂ production is likely to require the review and update of multiple municipal sectoral plans, which in itself would require its own detailed research. The possibility of infrastructure corridors should be investigated. Potentially multiple electricity transmission lines and pipelines could be required, which all have significant implications for right of way establishment. Additionally, some projects could also materialise over a longer timescale yet would benefit from having land routings designed and banked for future availability. Such infrastructure corridors also need to consider the possible establishment of SEZ nodes within a region. The establishment of Special Economic Zones (SEZ) nodes may significantly influence the spatial distribution of electrolyzers. This influence could result in a concentration of these devices in proximity to renewable energy initiatives, thereby potentially reducing the necessity for the development of extensive new power transmission infrastructure.

The establishment of the South African Wholesale Energy Market has the potential to enhance the electricity landscape, allowing more developers to enter the market and to improve the grid network – there are, however, still unknowns, and it will be beneficial to unpack its implications and timing and how this could affect the energy needs of the Green hydrogen sector, especially in the West Coast Region.

The development of multiple infrastructure projects across the region might require an entity that can coordinate planning and development, while also assisting to overcome potential bottlenecks.

6.3 Transport and distribution

The transport landscape analysis evaluated infrastructure projects in the vicinity, highlighting that these could be directly linked to the logistics of hydrogen and hydrogen-based fuels. However, the present plans do not encompass all the transport modes essential for distribution. Nonetheless, findings indicate municipal and development agencies' existing plans inadvertently enhance the functioning and accessibility of these transport modes. It is crucial to emphasize that with the hydrogen industry's master plan, these transportation infrastructures should be reassessed to ensure efficient access to supply and demand hubs, thereby preventing bottlenecks and congestion in the current transportation network.

During interviews with key stakeholders in regions primarily requiring or producing hydrogen, the thematic discussions identified and examined the inbound and outbound distribution networks. This part enables the conceptual understanding of the supply and distribution networks from the stakeholders, which encompasses not only the hydrogen feedstock and products flow but also the additional supply chains necessary for delivering various feedstocks and production chains for industry-required products like methanol, ammonia, steel, and cement. Crucially, it raises the question of the structure of nodal distribution needed to provide industry access to hydrogen and hydrogen-based fuels. Considering the operations of supply hubs and demand centers within established supply chain networks, how will infrastructure development and management strategies be planned, adapted, and executed to accommodate green fuels and transporters? Additionally, what are the best transportation methods from both provincial and national viewpoints for distributing hydrogen to demand centers? It also appears that some sectors will rely on a shared infrastructure model, while larger industries plan to operate

independently. An important question arises: How will transportation requirements vary between sole ownership and shared infrastructure approaches within the supply chain of hard-to-abate sectors and bus and rail networks for public transport?

In South Africa, the transportation of hydrogen is currently governed by existing hazardous goods transport legislation, with national and provincial guidelines directing route selection and permitting processes. Nonetheless, issues like limited infrastructure, inconsistent enforcement, and the dominance of road transport pose safety and logistical challenges. Recent legislative efforts seek to unify transport regulation, highlighting the need for international alignment to enhance safety and regulatory oversight. To manage the specific risks associated with hydrogen, evolving local policies and infrastructure planning is essential, including the adoption of advanced tools like GIS mapping. In summary, enhancing South Africa's hydrogen transport regulation necessitates updating existing frameworks to incorporate international best practices alongside customized local strategies.

6.4 Socio-ecological sustainability

Despite growing understanding of Saldanha Bay's ecological, social, and industrial context, several critical knowledge gaps remain that are essential to address for sustainable GH₂/PtX development. While the West Coast landscape theoretically has the capacity to meet its hydrogen ambitions, the scale of land transformation required raises important questions about cumulative ecological, marine, and social impacts arising from multiple industrial and renewable energy developments. The recent announcement of the World Economic Forum Industrial Transition Accelerator Cluster in Saldanha further reinforces the area's strategic role in South Africa's decarbonisation pathway and industrial transition. This heightens the need for integrated environmental, social, and governance research to ensure that the hub's growth aligns with sustainability objectives and regional resilience. Further investigation is also needed into the cumulative input requirements for GH₂ production, particularly those affecting water and resource management. Scenario-based assessments examining the interaction between desalination, groundwater abstraction, and brine discharge under changing climatic conditions would help define safe operating thresholds for marine and estuarine ecosystems. Similarly, the cumulative footprint of multiple projects spanning renewable energy, port expansion, and industrial activities remains requires quantification. Complementary life cycle assessments (LCA) of different carbon sources, PtX production pathways, and delivery options including road, rail, pipeline, and powerline, would provide insights into environmental trade-offs, helping align infrastructure decisions with global sustainability standards while supporting cost and efficiency optimization.

Socio-economic and governance also present additional research needs. Local community capacity, perceptions, and potential socio-economic benefits, including employment, skills development, and conservation-linked initiatives, remain underexplored. Systems-based approaches, such as Causal Loop Diagrams, could highlight and identify dynamic interactions between policy, investment, and operational decisions, highlighting leverage points to accelerate development and guide governance structures. Finally, technical and regulatory research is necessary to strengthen sustainable development pathways. This includes evaluating the integration of renewable energy, desalination, and GH₂/PtX production, ensuring infrastructure resilience under climate variability, and supporting compliance with evolving green hydrogen sustainability criteria. Digital tools and dynamic databases could integrate regulatory analysis, scenario modelling, and strategic planning to streamline environmental authorizations, coordinate permitting, and guide shared investment in common-use infrastructure.

7 RECOMMENDATIONS AND WAY FORWARD

Phase 1 of the West Coast GH₂ Master Plan has provided a high-level, analytical review to identify the most salient strategic, technical and regulatory questions which may impact regional GH₂ prospects. A central theme of the Phase 1 Master Plan has been to identify priority activities for the West Coast region and specifically within the West Coast GH₂ Hub itself, to align activities and proposed developments in a manner that ensures that planning keeps pace with and remains grounded in development needs and realities. Based on the findings of Phase 1, the following key recommendations are proposed for future research and assessment during Phase 2 of the Masterplan:

Recommendation 1: Cumulative Impact Assessment, Thresholds and Life Cycle-Informed Planning

The scale of GH₂/PtX development anticipated along the West Coast raises complex challenges related to cumulative ecological, resource and social impacts. Integrated spatial and infrastructure planning will be essential to manage these pressures and ensure sustainable long-term development. To support informed development, it is recommended that detailed spatial analysis and Life Cycle Assessments and scenario-based modelling focusing on cumulative impacts be undertaken to understand how GH₂/PtX production and associated industrial activities will impact sensitive coastal and terrestrial ecosystems, settlements (including housing demand) and municipal service provision. A critical outcome from this assessment should include:

- quantification of the combined footprint of supply infrastructure (i.e., renewable energy facilities, desalination facilities),
- GH₂/PtX production infrastructure, and delivery pathways (i.e., road, rail and pipeline),
- identifying thresholds for sustainable resource use under varying climate and industrial scenarios, and
- insight into trade-offs between cost-optimal and most sustainable transport modes for hydrogen and related carriers.

Recommendation 2: Alignment of Provincial and Municipal Planning with GH₂ Ambitions and Strategic Infrastructure

Municipal support will be required to revise development and management frameworks and sectoral plans, ensuring alignment between hydrogen-related industrial growth and sustainable urban expansion. An important finding of Phase 1 is the presence of land constraints within and around the SEZ for GH₂/PtX development. In addition, recent data indicated that most developable land within the Besaanskop industrial zone is privately owned further limiting development potential.

It is therefore recommended that Phase 2 of the Master Plan focus on:

- The potential of multi nodal SEZs to accommodate the various requirements of GH_s projects as well as the option of the province procuring and consolidating land to accommodate efficient GH₂/PtX production and storage.
- Potential for strategic infrastructure corridors and the concept of “land-banking” (reserving or acquiring land in advance for future strategic infrastructure and industrial use) to provide long-term flexibility and enable coordinated expansion around SEZ locations.
- Developing a dynamic map of interrelationships among key drivers, development opportunities, barriers, and outcomes within the GH₂/PtX system in the Saldanha Bay region, given that the above approaches could lead to land use conflicts in and around the SEZ. This dynamic mapping would

highlight leverage points where targeted policy or investment interventions can unlock systemic change and accelerate green hydrogen project development, identify key catalytic feedback relationships and points of policy intervention.

Recommendation 3: Strengthening regulatory clarity and adaptive permitting pathways

While permitting, safety, and environmental processes are already in place, there exist some ambiguity across the value chain from production and storage to transport and end use, resulting institutions without clear mandates and developers. Clear guidance can support producers, provincial and regulating authorities in identifying and effectively interpret relevant regulations to ensure projects meet lender and offtake requirements, drawing on learning from existing large scale production facilities. Current frameworks address hydrogen as a conventional industrial or hazardous goods; possible amendments may be required to recognising its distinct properties and infrastructure needs. Alignment with international best practices is essential to provide a predictable investment environment and ensure that hydrogen development contributes meaningfully to the JET PMU.

Accordingly, it is recommended that Phase 2 focus on:

- Support for institutional capacitation, detailed legal analysis, and transaction structuring to enable implementation of the common-user infrastructure. Legal and sectoral experts should be engaged to diagnose specific barriers, co-develop reform proposals and develop a strategic outlook on environmental authorisations to establish streamlined permitting processes tailored to the needs of the Hub.
- Development of an actionable implementation plan to provide insight into the formation of governance/coordination structures to oversee infrastructure delivery, inter-governmental alignment, and shared investment in common-use infrastructure.
- Updated regulations should be aligned with international standards for hazardous goods transport, supported by advanced GIS-based tools for route optimisation, safety oversight, and infrastructure coordination across road, rail, port, and pipeline systems.

Recommendation 4: Scenario Modelling for Strategic Infrastructure Capacity and Phasing

Stakeholder engagements identified constrained grid capacity, high wheeling costs, and fragmented grid expansion proposals as critical challenges to GH₂ ambitions.

To support integrated transmission planning, it is recommended that electrical flow simulations (based on the Phase 1 scenarios) be developed and applied in engagement with the National Transmission Company of South Africa (NTCSA) and GH₂/PtX developers, informing the National Transmission Development Plan. The rollout of the SAWEM should also be closely monitored, as it may influence electricity access, pricing, and investment patterns critical to the GH₂ value chain. In addition, to strengthen transport and distribution planning, it is vital to ensure the efficient movement of hydrogen and derivative fuels. Infrastructure investment should balance shared-use and dedicated logistics models, recognising that some sectors will depend on common-user transport systems while others may require independent networks.

Existing transport frameworks, while indirectly supportive, do not yet account for the specific logistics, safety, and infrastructure requirements of the hydrogen economy. It is recommended that supply and distribution networks be captured via a dynamic map which includes include feedstock flows, derivative products, and supporting supply chains for key industries such as steel, ammonia, and cement. To provide guidance on the capacity and phasing of the strategic common-user infrastructure it is recommended that

a simulation/optimization model be developed, based on the Phase 1 scenarios, to align demand with infrastructure capacity and address issues related to demand, capacity, and potential bottlenecks.

Phase 1 has established a foundation by identifying uncertainties in infrastructure and land-use planning, transport and distribution, and socio-ecological sustainability, setting the stage for more detailed, targeted work. Phase 2 should focus on deepening understanding, enhancing coordination, and building the institutional and technical capacity needed to translate the Master Plan into spatially grounded, implementable strategies.

Overall, it is recommended that digital and systems-based tools should be a defining feature of Phase 2 enabling simulation of cumulative impacts, streamlined environmental authorisations, and coordinated planning. These tools, alongside strengthened institutional collaboration between municipalities, provincial departments, and national agencies, will be critical in moving from high-level strategy to implementation readiness. Phase 2 will also advance socio-economic readiness by assessing community perceptions, local capacity, and opportunities for employment, skills development, and conservation-linked initiatives. Proactive engagement and co-investment mechanisms will ensure that the benefits of hydrogen-driven industrialisation are broadly and equitably shared, supporting a sustainable and resilient West Coast Hydrogen Hub.

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