



GREEN HYDROGEN
SOUTH AFRICA

Green Hydrogen South Africa Studies Handbook

Comprehensive Insights into South Africa's
Green Hydrogen Potential



german
cooperation

DEUTSCHE ZUSAMMENARBEIT

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Promoting a South African Green Hydrogen Economy (H2.SA)

Capacity building and technical support for a green hydrogen economy and just energy transition in South Africa

The challenge

Globally, the demand for green hydrogen (H₂) and green hydrogen-based products such as ammonia and synthetic jet fuels (PtX) is rising. To fulfil decarbonisation targets, many off-takers (e.g., EU and Japan) are willing to pay a premium price and to sign long-term supply agreements to stimulate H₂/PtX market development. Due to the outstanding potential of renewable energies (RE) and existing H₂ production facilities, South Africa is regarded as one of the main future suppliers of green H₂ products. H2.SA support its partners from Government, private sector, and civil society, with expertise, resources, and building capacity to promote a South African green and sustainable hydrogen economy.

Despite the promising conditions available for the development of a H₂ economy in the country, certain challenges still exist. The development of a green H₂/PtX market requires a massive expansion of low-cost RE capacities. To this end, the project's focus is to ensure that existing market barriers are removed, that the political and regulatory frameworks are adjusted, and a far-reaching capacity building, skills development and training initiatives are implemented. Developing the H₂ economy in South Africa may also pose risks to the environment and society, which must be analysed, evaluated, and addressed.

The objective of H2.SA is to support the South African public and private sector to utilise the potential of a sustainable green H₂ economy for South Africa.

Our approach

H2.SA support its partners from Government, private sector, and civil society, with expertise, resources, and building capacity to promote a South African green and sustainable hydrogen economy. The project is structured around the four areas of intervention (1) Strategy, policy and regulatory framework, (2) Private sector cooperation, (3) Capacity building, research and innovation, (4) Sustainability and Just Transition.



2. Strategy Policy and Regulatory Framework



Strategy, policy and regulatory framework: South Africa will require cooperation and synchronisation between a variety of stakeholders to establish a green H₂ economy. For example, improved strategic and regulatory conditions could lead to the reduction of current existing market barriers for RE. A supportive regulatory framework will stimulate an investment friendly climate and provide clear guidelines for a green H₂ economy in the country.

The following policy briefs were designed in response to the gap in the Strategy, policy and regulatory framework:

1. Regulations, codes and standards in the frame of promoting a green hydrogen economy in South Africa.
2. Exploring the Viability of Green Hydrogen Propelled Cargo Trains – A Reasonable Option for RSA?
3. The potential benefit of GH₂ for RSA
4. Growing South Africa's competitive green hydrogen market



2.1 Regulations, codes and standards in the frame of promoting a green hydrogen economy in South Africa.

Type of Document:	Report Summary
Publication Date:	October 2022

The study aims to identify gaps in regulations, codes, and standards within the South African green hydrogen economy. It is motivated by the pressing need to create an enabling environment for the development and growth of green hydrogen and power-to-x technologies. By conducting a comprehensive gap analysis, the study seeks to provide actionable recommendations to support the advancement and implementation of these emerging sectors.

Key Highlights of the Study

1. Comprehensive Value Chain Coverage

The study thoroughly examined regulations, codes, and standards across the entire green hydrogen value chain, including production, storage, end-use, transport, distribution, Sustainable Aviation Fuels (SAFs), and Green Certification.

2. Stakeholder-Driven Input

Insights were gathered through extensive stakeholder interviews involving industry representatives, government officials, researchers, and academics, ensuring a well-rounded perspective.

3. Contextual Adaptation

Existing regulations, codes, and standards were reviewed to identify those that could be adopted or adapted to fit the unique South African context.

4. Gap Identification and Solutions

For areas where gaps were identified, particularly concerning emerging technologies and novel applications of green hydrogen and power-to-x, tailored recommendations were proposed to address these challenges and foster progress.

For more information on the study: thobeka.mchunu@giz.de

2.2 Exploring the Viability of Green Hydrogen Propelled Cargo Trains –A Reasonable Option for RSA?

Type of Document:	Policy Brief
Publication Date:	October 2022

The study explores the viability of green hydrogen-propelled cargo trains as a sustainable and practical solution for South Africa. It is motivated by the urgent need to address the decarbonisation imperative in the transportation sector and mitigate the challenges posed by vandalism and theft of the overhead power lines. By examining this innovative application, the study aims to foster the development of a domestic green hydrogen market, paving the way for greener, more efficient freight systems.

Key Highlights of the Study

Freight Rail:

1. Dual-Fuel Conversion Potential

The existing Transnet Freight Rail diesel-electric locomotives could be converted to dual-fuel hydrogen internal combustion engines (ICE), paving the way for gradual decarbonisation.

2. Operator Familiarity

Transnet operators and repair staff are more accustomed to diesel-electric locomotives than fuel cells, making dual-fuel conversion a practical interim solution.

3. Strategic Refuelling Infrastructure

Hydrogen refuelling infrastructure could be strategically located within heavy industrial or mining areas, leveraging shared resources and enhancing accessibility.

4. Alternative Fuel Options

In addition to hydrogen, green ammonia—manufactured from green hydrogen—can be used in a dual-fuel configuration alongside diesel for further emissions reduction.

Passenger trains:

Since passenger trains are not a heavy-traction, a hybrid electric/Fuel Cell Electric Vehicle (FCEV) approach can be explored during the transition phase.

For more information on the study: Thabo.Chauke@giz.de



2.3 The potential benefit of GH₂ for RSA

Type of Document:	Policy Brief
Publication Date:	October 2022

This study investigates the potential benefits that green hydrogen (GH₂) could bring to South Africa, particularly in the context of decarbonisation. It is motivated by the possibility that transitioning to a green hydrogen economy could yield positive externalities for the South African economy, such as job creation, energy security, and reduced emissions. The study aims to identify the steps necessary to foster the emergence of a robust GH₂ economy, laying the groundwork for sustainable growth and global competitiveness in this emerging sector.

Key Highlights of the Study

1. Financial incentives for investment

To support the initial investment required for the green hydrogen economy, the study advocates for introducing financial incentives such as tax breaks, subsidies, and grants.

2. Advancing research and development

Investing in research and development is crucial to drive innovation and technological advancements in green hydrogen, positioning South Africa as a global leader in this emerging field.

3. Comprehensive infrastructure development

Establishing robust infrastructure for green hydrogen production, storage, and distribution is essential to ensure scalability and efficient deployment of the technology.

4. Building the foundation for growth

Infrastructure development is highlighted as a priority to support not only the local adoption of green hydrogen but also its export potential, amplifying economic benefits for South Africa.

For more information on the study: Thabo.Chauke@giz.de

2.4 Growing South Africa's competitive green hydrogen market

Type of Document:	Policy Brief
Publication Date:	October 2022

This study focuses on growing a competitive green hydrogen market in South Africa. It is motivated by the need for green hydrogen prices to be shaped by competitive market forces to ensure affordability and sustainability. The study seeks to identify the key success factors required to establish a well-functioning green hydrogen market, positioning South Africa as a leader in the global green hydrogen economy.

Key Highlights of the Study

1. Develop a green hydrogen white paper to provide clear market signals and set a strong policy framework for the emerging green hydrogen market.
2. Support critical network industry reforms and infrastructure development to enable efficient integration of green hydrogen into the broader energy system.
3. Align transmission and distribution grid planning with green hydrogen ambitions, ensuring the energy infrastructure supports the sector's growth.
4. Effectively utilise development funding to create financial incentives across the green hydrogen value chain, including project preparation, financing, and operational phases.

For more information on the study: Thabo.Chauke@giz.de

3. Private Sector Cooperation and Finance



Private sector cooperation: focuses on fostering relationships with project developers and Development Finance Institutions (DFIs). By engaging closely with project developers, we gain insight into their needs, challenges, and the steps required to achieve bankability and successfully launch their projects. We support this through market research and studies, such as desalination studies, analysis of the global electrolyser and fuel cell markets, and facilitating Public-Private Partnerships (PPPs). Additionally, we maintain close ties with DFIs to understand their criteria for financing projects, providing grants, technical assistance, and supporting the next phase of the project lifecycle. The private sector cooperation and finance division of GIZ plays a key role in bridging the gap between project developers and financiers, ensuring access to funding and promoting the growth of green hydrogen in South Africa.

To successfully establish a green H₂ economy in South Africa, a lot of questions need to be answered. For example, what is the size of the potential market for green H₂ derived products, what are the international standards and market requirements that potential exported products would need to comply with, and how can adequate investment be attracted? To answer these and many other questions, H₂.SA will support the local public and private sector stakeholders in ways below:

- Develop a customisable costing tool for green hydrogen and other PtX derivatives
- Conduct model pre-feasibility studies for ammonia and methanol applications to showcase a typical project optimisation process
- Provide a global electrolyser and fuel cell manufacturer overview, including their perception and plans of/for the South African market
- Develop and pilot a toolkit that allows project developers to effectively integrate social performance aspects (e.g. community development) in their project design

Studies

- Fuel Cell Market Overview 2023
- Electrolyser Market Overview 2023
- Community development Toolkit
- H₂/PtX Projects in South Africa: A preliminary review of the environmental and social impacts
- Pre-Feasibility study on Lighthouse Technology: Methanol
- Financial Pre-Feasibility study on Lighthouse Technology: Ammonia
- A practical guide to developing sustainable green H₂/PtX projects in South Africa

3.1 FUEL CELL Market Overview 2023

Type of Document:	Report
Publication Date:	2023

This publication provides a comprehensive global market overview of fuel cell manufacturing, highlighting key trends, developments, and growth prospects in this rapidly evolving industry. It delivers valuable insights for stakeholders, investors, and industry players, enabling them to make informed decisions and seize emerging opportunities. By analysing current market dynamics and technological advancements, the report aims to contribute to the advancement of fuel cell manufacturing and support its integration into the green hydrogen economy.

Key highlights

1. Comprehensive market overview

The publication offers an in-depth analysis of the fuel cell manufacturing market, covering its current status, key trends, and future growth prospects.

2. Technological advancements

It highlights the latest technological developments in fuel cell manufacturing, examining how these innovations are shaping the industry's future.

3. Opportunities for stakeholders and investors

The study provides actionable insights for stakeholders, investors, and industry players, helping them identify opportunities to make informed decisions and capitalise on market trends.

4. Market dynamics analysis

Analysing the evolving market dynamics, the report sheds light on emerging opportunities and challenges, enabling industry players to adapt and grow within the rapidly changing fuel cell landscape.

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3.2 Electrolyser Market Overview 2023

Type of Document:	Report
Publication Date:	2023

This publication provides a market overview of electrolyser manufacturing, focusing on key trends, developments, and growth prospects in this rapidly evolving industry. It offers valuable insights for stakeholders, investors, and industry players, enabling them to make informed decisions and capitalise on emerging opportunities. By analysing current market dynamics and technological advancements, the report aims to support the continued advancement of electrolyser manufacturing and its critical role in the green hydrogen economy.

Key highlights

1. Market overview of electrolyser manufacturing

The publication offers a detailed analysis of the electrolyser manufacturing market, including trends, developments, and growth prospects.

2. Technological advancements

It highlights the latest technological innovations in electrolyser manufacturing, showcasing how these advancements are driving industry growth.

3. Insights for stakeholders and investors

The study provides valuable insights for stakeholders, investors, and industry players, helping them identify opportunities and make informed decisions in the electrolyser market.

4. Analysis of market dynamics

By examining current market dynamics, the report sheds light on emerging opportunities and challenges, guiding industry players toward strategic decision-making.

For more information contact: pinky.radebe@giz.de

3.3 The Green Hydrogen Community Development Toolkit

Type of Document:	Guide
Publication Date:	November 2024



The Green Hydrogen Community Development Toolkit is a practical guide for fostering meaningful community engagement in South Africa's green hydrogen sector. Developed with contributions from organizations like H2.SA, it offers step-by-step tools for stakeholder engagement, social impact assessments, and alignment with local governance. The toolkit addresses the sector's rapid growth and aligns with the Hydrogen Society Roadmap, ensuring that projects contribute to job creation, local development, and environmental benefits while securing a "social license to operate." It aims to mitigate community opposition, foster trust, and support the sector's sustainable and inclusive growth.

Key highlights

1. **Practical Toolkit:** Offers 15 tools for stakeholder engagement, conflict resolution, and social impact assessments, tailored for green hydrogen projects.
2. **Inclusive Approach:** Focuses on marginalized groups, local governance, and alignment with national development goals.
3. **Sustainable Growth:** Builds trust and secures community support to ensure smooth project implementation and broader benefits.

3.4 Pre-Feasibility study on Lighthouse Technology: Methanol

Type of Document:	Report
Publication Date:	November 2024



The Pre-Feasibility Study on Lighthouse Technology Methanol (GMeOH) assesses the viability of producing green methanol in South Africa, focusing on technical, financial, and environmental factors. South Africa's unique advantages, such as abundant renewable energy, existing infrastructure, and strategic location near global shipping lanes, position it as a key player in green methanol production. The study aims to guide stakeholders through the early stages of project development, support informed decision-making, and ensure sustainability by integrating environmental and social considerations. Additionally, it seeks to promote market readiness, encourage investment, and provide a scalable framework for green hydrogen and Power-to-X (PtX) initiatives.

Key highlights

1. South Africa's competitive edge in GMeOH production is driven by its vast renewable energy resources, strong port infrastructure, and strategic geographical location, positioning it as a key hub for production and export.
2. The study offers a comprehensive framework for project development, covering essential areas such as site selection, environmental impact assessments, financial modeling, and stakeholder engagement strategies.
3. By leveraging green hydrogen and sustainably sourced carbon, the study highlights GMeOH's potential to significantly cut greenhouse gas emissions, especially in hard-to-abate sectors like shipping.

3.5 A practical guide to developing sustainable green H₂/PtX projects in South Africa

Type of Document:	Report
Publication Date:	November 2024



The Practical Guide to Developing Sustainable Green H₂/PtX Projects in South Africa is a comprehensive resource designed to support stakeholders in the development of green hydrogen (GH₂) and Power-to-X (PtX) projects. It provides structured frameworks for assessing technical, economic, environmental, and social aspects of projects, promoting sustainability and aligning with global decarbonization goals. Motivated by South Africa's potential to lead in green hydrogen production, the guide aims to address regulatory gaps and technical challenges, facilitating informed decision-making, attracting investment, and supporting policy development in the green energy sector.

Key highlights

1. **Comprehensive Project Framework:** Covers all project phases, including feasibility studies, engineering design, financial modeling, and stakeholder engagement, ensuring thorough preparation.
2. **South Africa's Unique Advantages:** Highlights the country's strengths, such as vast renewable resources, strategic infrastructure, and expertise in related technologies like Fischer-Tropsch processes.
3. **Sustainability Integration:** Provides guidelines for mitigating environmental and social impacts while maximizing the positive outcomes of green hydrogen and PtX projects.

3.6 H₂/PtX Projects in South Africa: A preliminary review of the environmental and social impacts

Type of Document:	Report
Publication Date:	November 2024



The study explores the environmental and social impacts of establishing a Power-to-X (PtX) economy in South Africa, focusing on key subsystems like renewable energy, hydrogen production, and transportation infrastructure. The need to transition from fossil fuels to renewable energy, address energy security challenges, and take advantage of South Africa’s renewable resources and platinum group metals to become a competitive player in the global PtX market. The study aims to provide a comprehensive understanding of PtX technologies’ impacts, offer a preliminary impact assessment, and guide decision-making for future PtX projects. It will also contribute to the development of an Environmental Impact Assessment (EIA) guideline for PtX projects in South Africa.

Key highlights

1. South Africa’s advantages in PtX development include abundant renewable energy, strong port infrastructure, and key platinum group metal reserves for green hydrogen.
2. The study uses the DPSIR framework to assess PtX’s environmental and social impacts, focusing on ecosystems, water, livelihoods, and infrastructure.
3. It provides recommendations for guiding PtX project planning and policy, balancing environmental sustainability with social equity.

3.7 Pre-Feasibility study on Lighthouse Technology: Methanol

Type of Document:	Report
Publication Date:	November 2024



The Pre-Feasibility Study on Lighthouse Technology Methanol (GMeOH) evaluates the technical, financial, and environmental feasibility of producing green methanol in South Africa. Motivated by the country's abundant renewable energy resources and strategic location for global export, the study explores South Africa's potential as a leader in green methanol production. It provides a comprehensive framework for early-stage GMeOH projects, addressing challenges and offering practical guidance on technical design, market analysis, and financial modeling. The study aims to support informed decision-making, promote sustainability, and enhance investment confidence in green methanol projects, contributing to the growth of South Africa's Power-to-X (PtX) economy.

Key highlights

- Competitive Advantage:** South Africa's renewable energy resources, strong port infrastructure, and strategic location make it an ideal hub for green methanol (GMeOH) production and export.
- Comprehensive Framework:** The study offers a detailed roadmap for GMeOH project development, covering aspects such as site selection, environmental impact assessments, financial modeling, and stakeholder engagement.
- Sustainability and Innovation:** By using green hydrogen and sustainably sourced carbon, the study highlights the significant potential of GMeOH to reduce greenhouse gas emissions, especially in sectors like shipping that are challenging to decarbonize.

3.8 Financial Pre-Feasibility study on Lighthouse Technology: Ammonia



Type of Document:	Report
Publication Date:	November 2024

The Pre-Feasibility Study on Lighthouse Technology Methanol (GMeOH) explores the technical, financial, and environmental feasibility of producing green methanol (GMeOH) in South Africa. Designed to serve as a model for project developers, the study identifies South Africa's unique advantages, such as abundant renewable energy resources and existing infrastructure, for creating a sustainable methanol production ecosystem. It provides practical guidance and an exemplary case study, integrating technical design, market analysis, site selection, and financial modeling to support the development of the Power-to-X (PtX) economy. The study was motivated by South Africa's potential to become a global leader in green methanol production, driven by its strategic advantages: Vast renewable energy resources, including solar and wind, Proximity to global shipping lanes, ideal for exporting green methanol as a sustainable maritime fuel, The growing international demand for low-carbon fuels and chemicals. It also aims to address the technical, economic, and policy challenges of implementing GMeOH projects, providing a framework for scaling green hydrogen (GH₂) and PtX initiatives.

Key highlights

1. **Competitive Advantage:** South Africa's renewable energy potential, robust port infrastructure, and strategic location position it as a hub for GMeOH production and export.
2. **Comprehensive Framework:** The study provides a structured roadmap, including site selection, environmental impact assessments, financial modeling, and stakeholder engagement strategies, to support project development.

3. Sustainability and Innovation: By utilizing green hydrogen and sustainably sourced carbon, the study emphasizes the potential of GMeOH to significantly reduce greenhouse gas emissions, particularly in hard-to-abate sectors like shipping.

3.9 Financial Pre-Feasibility study on Lighthouse Technology: Ammonia



Type of Document:	Study
Publication Date:	November 2024

The “Financial Pre-Feasibility Study on Lighthouse Technology: Ammonia” assesses the financial viability of establishing a green ammonia (GNH₃) production facility in South Africa. It offers a model for evaluating the financial feasibility of large-scale green hydrogen and ammonia projects, addressing key aspects such as financing strategies, project costs, and economic risks. The study combines techno-economic analysis to assess cash flows, financing models, market dynamics, and necessary regulatory factors to attract investment and ensure project bankability.

Driven by the growing demand for sustainable energy solutions, the study recognizes green ammonia’s pivotal role as a hydrogen derivative for shipping fuels and fertilisers. It seeks to address challenges in early-stage projects, such as high upfront costs, market uncertainties, and technological risks, to bridge the gap between project concepts and viable investment decisions in the green hydrogen sector.

The study’s main objective is to provide a structured financial framework for evaluating green ammonia projects, enabling developers to assess economic feasibility and secure financing for further development. By identifying key financial parameters and viable funding mechanisms, it aims to guide stakeholders in making informed investment and policy decisions.

Key highlights

1. Comprehensive financial framework with financing models, cash flow scenarios, and risk mitigation strategies to attract investors.
2. Case study of a hypothetical green ammonia facility in Saldanha Bay with a \$2.7 billion capital cost.
3. Emphasis on public-private collaboration, concessional financing, and subsidies to boost South Africa’s green hydrogen economy.

3.10 Green Hydrogen Investment Profiles for South African Industrial Development and Special Economic Zones

Type of Document:	Report
Publication Date:	August 2024



The “Green Hydrogen Investment Profiles for South African Industrial Development and Special Economic Zones” study, published in August 2024, explores South Africa’s potential as a global leader in green hydrogen production and exports, particularly within Special Economic Zones (SEZs) like Coega, Richards Bay, Saldanha Bay, and Boegoebaai. Developed by the CSIR in collaboration with GIZ South Africa and funded by the BMZ’s H2.SA program, the study assesses economic activities, infrastructure, investment potential, and regulatory challenges. The study intends to assess the feasibility and investment potential of green hydrogen production in South Africa, particularly within Special Economic Zones (SEZs), to position the country as a competitive global exporter. It aims to provide a comprehensive framework for policymakers, investors, and industry stakeholders by analyzing economic activities, infrastructure, regulatory frameworks, and market opportunities.

Key highlights

South Africa is positioning itself as a major global producer and exporter of green hydrogen, aiming to produce between 4-8 million tonnes per year. The study outlines opportunities such as:

1. Green ammonia production (e.g., Hive Energy’s \$5.8 billion green ammonia project in Coega)
2. Decarbonization of heavy industries and transport (hydrogen fuel for ships, steelmaking, fertilizers)
3. Export potential to Europe, Japan, and other major markets

4. Capacity Building, Research and Development



Establishing a new sector requires skills and capacities. H2.SA will focus on identifying the skills required to service the H₂ sector and work towards ensuring the availability of these skills and capacities. The project will host a series of information events aimed at all levels of stakeholders as well as targeted training sessions for decision-makers. Apart from general training and capacity building, H2.SA will provide support to research and innovation stakeholders to ensure an ongoing development of research capabilities in the country.

- PtX Business Opportunities in South Africa
- Emerging Themes and Priorities of Green Hydrogen Research to Support Public and Private Sector Objectives
- PtX Competitiveness Analysis: Renewable Hydrogen Market Potential and Value Chain



4.1 PtX Business Opportunities in South Africa

Type of Document:	Study (report)
Publication Date:	May 2024



This study analyses the renewable hydrogen market potential, value chain, and business opportunities in South Africa. Motivated by the need to identify the most attractive business opportunities within the emerging green hydrogen (GH₂) and Power-to-X (PtX) value chains, it includes a SWOT analysis of these opportunities. The study also formulates market entry recommendations for local enterprises looking to participate in these growing sectors. The goal is to identify key business opportunities that align with South Africa's green hydrogen and PtX ambitions, driving sustainable economic growth.

Key highlights

1. The study examines the gaps, challenges, and opportunities in South Africa's energy security, providing insights into how the energy sector can evolve to meet future demands.
2. It assesses the potential of GH₂ and PtX technologies to address and mitigate current and future energy crisis scenarios in South Africa, positioning them as viable solutions for sustainable energy.

4.2 Emerging Themes and Priorities of Green Hydrogen Research to Support Public and Private Sector Objectives

Type of Document:	Report
Publication Date:	April 2024



This study examines the alignment between current green hydrogen (GH₂) research activities and public sector policy objectives, as well as the needs of the private sector in South Africa. Motivated by the desire to understand the research initiatives related to green hydrogen in the country, the study aims to provide an overview of ongoing research activities at South African universities, technology institutes, science councils, and other research institutions. By doing so, it seeks to identify any gaps and ensure that research efforts are in line with both national policy goals and industry needs.

Key highlights

1. Future GH₂ Research Focal Areas

The study provides recommendations on future research focal areas for South Africa's green hydrogen (GH₂) sector, ensuring alignment with national and industry priorities.

2. Differentiation of Value Chain Elements

It differentiates between upstream, midstream, downstream, and cross-cutting value chain elements, highlighting their unique contributions to the research landscape.

3. Identification of Specific Research Areas

The study identifies key research areas within each value chain element, providing a structured roadmap for targeted research efforts in the green hydrogen sector.

4.3 PtX Competitiveness Analysis: Renewable Hydrogen Market Potential and Value Chain

Type of Document:	Study (report)
Publication Date:	November 2023



This report provides the results of a competitiveness analysis between GH₂/PtX (ammonia for export, ammonia based fertilisers, green steel, green methanol for marine bunkering and sustainable aviation fuels) and their fossil-fuel-based and renewable alternatives using a levelised cost of PtX (LCOX) tool developed by the project. The study intended to explore how competitive PtX products can be in comparison with fossil and RE alternatives, or when will the price gap be eliminated. The study intended to explore how competitive PtX products can be in comparison with fossil and RE alternatives, or when will the price gap be eliminated. The study intended to explore South Africa's most feasible applications of GH₂ and PtX, develop a dynamix LCOX tool to monitor the development of GH₂/PtX costs and estimate the market potential and value for the selected applications in the medium and long term.

Key highlights

1. The modelling results show that some applications have a very small cost gap and can achieve cost parity without the introduction of a carbon tax, while others show bigger gaps.
2. Green ammonia (for fertilisers and export) and green steel are the most promising applications that South Africa can focus on in the medium and long term.
3. To bridge the existing cost gap between GH₂ products and their fossil-based alternatives, a combination of various mechanisms can be implemented, e.g a carbon tax or incentives.

5. Sustainability and just transition



The production of green H₂ and PtX is not sustainable by default. In order to avoid or minimise negative environmental or social impacts, it is important to consider aspects related to e.g. water supply, land use, biodiversity, critical raw materials as well as quality of jobs, labour standards, health and safety or local access to energy. H2.SA will assess these sustainability dimensions for selected flagship projects, those insights will support strategic decision-making processes about the expansion planning of RE and the necessary infrastructure. Cooperation with participating institutions and stakeholders will focus on developing hands-on and solution-oriented approaches with the aim of addressing ecological and socio-economic challenges. Neighbouring communities and villages near large H₂/PtX plants should benefit within the framework of the benefit-sharing approach via job quotas, financial levies, or infrastructure. A special focus is on enhancing gender equality by the advancement of women in line with guidelines for gender-responsive planning, budgeting, monitoring, evaluation, and auditing.

Studies:

1. Study on the Role of a Green Hydrogen/ Power-to-X Economy on Energy Security in South Africa
2. Impact Analysis of Critical Raw Materials' (CRMs) Mining and Use for the Green Hydrogen economy in South Africa
3. Managing the Impacts of a Green Hydrogen/Power - to - X Economy: An Environmental Impact Assessment Guideline for South Africa
4. Green Ammonia Life Cycle Assessment

5.1 Study on the Role of a Green Hydrogen/ Power-to-X Economy on Energy Security in South Africa

Type of Document:	Study/Report
Publication Date:	TBC - Ongoing study

The Green Hydrogen Commercialisation Strategy (GHCS) identifies Green Hydrogen (GH₂) as a critical enabler for energy security in South Africa. The study highlights the significant role GH₂ and PtX (Power-to-X) technologies could play in enhancing the country's energy security while advancing goals of decarbonisation and economic growth. The GHCS emphasises the importance of a coordinated public-private approach to realising the full potential of the green hydrogen economy, aligning with South Africa's climate commitments and economic development priorities. This study builds on these objectives, providing a detailed analysis of how a green hydrogen economy can contribute to South Africa's energy security.

The study aims to provide strategic insights and actionable recommendations to enhance energy security through the GH₂/PtX industry. It explores how GH₂ and PtX technologies can not only bolster national energy security but also stimulate economic growth and support environmental sustainability.

Key highlights

1. The study examines the gaps, challenges, and opportunities in South Africa's energy security, providing a comprehensive overview of the current energy landscape and the role GH₂ and PtX can play in addressing energy needs.
2. It assesses the potential of GH₂ and PtX technologies to address and mitigate current and future energy crisis scenarios in South Africa, positioning these solutions as critical enablers for long-term energy sustainability.

For more information on the study: mthokozisi.ndlela@giz.de

5.2 Impact Analysis of Critical Raw Materials' (CRMs) Mining and Use for the Green Hydrogen economy in South Africa

Type of Document:	Study/Report
Publication Date:	TBC - Ongoing study



The study is motivated by South Africa's potential as a major producer of platinum group metals (PGMs), which are essential for green hydrogen technologies such as fuel cells and electrolyzers. While green hydrogen has garnered global attention, there is a significant research gap in understanding the social, economic, and environmental impacts of mining these critical minerals. Additionally, the challenges and opportunities within South Africa's PGM supply chains remain under-explored, particularly in the context of the country's transition to a hydrogen-based economy. The study aims to assess the social, economic, and environmental impacts of PGM mining and its relevance to the green hydrogen sector in South Africa. It seeks to provide actionable insights and recommendations for the mining industry, policymakers, and other stakeholders to promote the sustainable sourcing and utilisation of critical minerals within the South African green hydrogen economy.

Key highlights

1. Both the negative and positive environmental, social, and economic impacts are identified, and recommendations are developed in the impact analysis assessment.
2. The study drives the promotion of sustainable extraction and utilisation of Critical Raw Minerals for the Green Hydrogen economy in South Africa, and in turn, promotes the sustainable development of other industries dependent on these critical minerals, such as renewable energy, electric vehicles, and electronics.

3. Maps highlighting the relationship between existing mines, key infrastructure, communities, and land use across South Africa are included.
4. The study includes an assessment of the supply chain in relation to the green hydrogen economy in South Africa, along with the use of innovative technologies.



5.3 Managing the Impacts of a Green Hydrogen/Power - to - X Economy: An Environmental Impact Assessment Guideline for South Africa

Type of Document:	Handbook/Guide
Publication Date:	TBC- Guide in progress of being designed and endorsed by the DFFE

The study addresses the gap in South Africa's ability to manage the environmental and social impacts of Green Hydrogen (GH₂) and Power-to-X (PtX) projects, which are crucial for the country's transition to a green economy. Motivated by the absence of tailored frameworks for conducting Environmental and Social Impact Assessments (ESIAs) for these specific technologies, the study aims to fill this gap by providing comprehensive guidelines. The guide introduces GH₂/PtX technologies, aligns projects with relevant policy and regulatory contexts, and ensures they are compatible with best practices in Environmental Impact Assessment (EIA). It further outlines the EIA processes, tools for assessing cumulative impacts, and offers valuable insights from environmental assessment practitioners, helping to ensure that the development of these technologies is environmentally responsible and socially beneficial.

Key highlights

1. The introduction of GH₂/PtX technologies in South Africa.
2. The integration of policy and regulatory contexts, and alignment of projects with planning frameworks and EIA best practices.
3. The guide provides tools that can be used to assess impacts and insights from environmental assessment practitioners.

For more information on the study: Susan.Byikika@giz.de

5.4 Green Ammonia Life Cycle Assessment

Type of Document:	Study
Publication Date:	Finalised Nov 2025, Presented at SASEC conference Nov 2025



The study evaluates the environmental impacts of green ammonia produced in South Africa and used in Germany for decarbonising heavy-duty transport. It addresses the limitations of hydrogen's low energy density by converting it into green ammonia, which is more efficient for long-distance transport. Using the ReCiPE life cycle assessment method, the study compares the environmental impacts of green ammonia against grey and black ammonia, focusing on its potential to reduce environmental damage in areas such as human health, ecosystems, and resources. The study aims to demonstrate how green ammonia can contribute to decarbonisation and offer environmental advantages over traditional ammonia sources.

Key highlights

1. Compared to grey and black ammonia, green ammonia offers over a 70% reduction in Global Warming Potential and is likely to achieve certification as a low-carbon fuel.
2. The production of green ammonia falls well below all certification thresholds; however, the risk lies in the reconversion (cracking) and distribution of hydrogen, a carbon-intensive process that could threaten its certification in Germany as a low-carbon fuel.
3. Most negative environmental impacts of green ammonia are linked to the carbon-intensive energy required for manufacturing infrastructure, particularly the production of solar PV and wind power components.
4. Green ammonia shows significantly reduced environmental impacts on human health, ecosystems, and resources when compared to grey and black ammonia.

5.5 Green Hydrogen Mechanisms for Community Beneficiation

Type of Document:	Handbook/Guide
Publication Date:	Launch Date: 03 April 2025

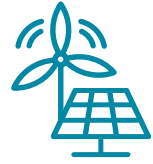
As green hydrogen is a new sector that is rapidly evolving in South Africa, it is believed that it will have to operate similarly to other sectors like energy, mining, transport, and construction to undertake business. As such, entities will likely have similar concepts and wording in terms of implementation of mechanisms for community beneficiation. This study therefore explore mechanisms for community beneficiation used by the South African Renewable Energy Independent Power Producer Procurement Programme (REIPPPP) and associated sectors in order to provide recommendations that could be adapted for mechanisms for community beneficiation in the green hydrogen economy. The goal of this study is to suggest strategies for effectively implementing community benefits in South Africa's emerging green hydrogen economy. It aims to facilitate the process of how green hydrogen projects can bring tangible benefits to communities.

Key highlights

1. The four B-BBEE Elements and how these can be used to conceptualise mechanisms for community beneficiation for the green hydrogen sector.
2. Several key factors will impact the implementation of community beneficiation in green hydrogen initiatives.
3. Recommendations to support improved community beneficiation efforts.

For more information on the study: marvelous.sibuyi@giz.de

6. PTX-HUB South Africa



South Africa - PtX Hub

Solar and wind resources are abundant across most parts of South Africa. This, combined with a large land area, mean the cost of renewable energy technology is decreasing substantially every year. At the same time, conventional fossil fuels resources are becoming more expensive to extract and utilise for energy production. Newly built solar PV and wind generators can each produce electricity at a cost well below that of newly-built coal generators.

In leveraging these favourable conditions, the PtX Hub aims to drive the technology uptake and market development for Power-to-X in South Africa.

Studies and tools

1. Carbon sources for the production of Power-to-X and synthetic fuels in South Africa
2. An overview on Carbon Capture and Storage or Utilisation in South Africa
3. Tool: Business Opportunity Analyzer
4. Interactive tool: PtX Business Opportunity Analyser, version 2.0



6.1 Carbon sources for the production of Power-to-X and synthetic fuels in South Africa

Type of Document:	Publication - Study
Publication Date:	March 2024



This study examines the role of South Africa's energy and industrial sectors in contributing to the country's greenhouse gas emissions, focusing on coal-fired power plants and heavy industries such as iron and steel, cement, and petrochemicals, which are the largest emitters. It assesses the technical feasibility of carbon capture (CC) technologies to capture CO₂ from these industries as a crucial step towards mitigating emissions. The study highlights the importance of expanding very low-cost renewable energy (RE) capacity on a large scale, in the gigawatt range, to support a green hydrogen economy in South Africa. Additionally, it emphasises the need for sustainable carbon sources, such as those produced through synthetic fuels, to complement the green hydrogen initiative. The publication contributes to analysing the South African potential for the production of Power-to-X (PtX) products and their use for domestic demand and export.

Key highlights

1. The study provides an overview of the potential for captured CO₂ from key South African sectors, focusing on unavoidable industrial emissions and applicable carbon capture technologies.
2. It recommends prioritising sectors with the highest share of unavoidable emissions for carbon capture to align with sustainability criteria.

6.2 An overview on Carbon Capture and Storage or Utilisation in South Africa

Type of Document:	Executive Summary Publication
Publication Date:	February 2024



The study provides an introduction to the concepts of Carbon Capture and Usage (CCU) and Carbon Capture and Storage (CCS), summarising their current status in South Africa. It is motivated by the emergence of new discussions around CCU, particularly in the context of a hydrogen economy and potential pathways for Power-to-X (PtX), despite the absence of specific national plans or targets for CO₂ utilisation. The study aims to explore the ongoing debate around CCS and CCU, identify key barriers and opportunities for South Africa, and place the country's situation in an international context, while also offering recommendations for further reading.

Key highlights

1. The study introduces Carbon Capture and Usage (CCU) and Carbon Capture and Storage (CCS) concepts in the context of South Africa.
2. It discusses the emerging role of CCU in the hydrogen economy and PtX pathways, with no national plans or targets yet for CO₂ utilisation.
3. The study identifies barriers and opportunities for implementing CCS and CCU in South Africa.
4. It emphasises the need for a national strategy to address CO₂ utilisation.
5. The paper compares South Africa's CCU and CCS situation with global trends, offering insights for future development.

6.3 Tool: Business Opportunity Analyser

Type of Document:	Tool
Publication Date:	June 2023



Countries worldwide view green hydrogen and Power-to-X (PtX) as essential elements for contributing to global decarbonisation and enhancing socio-economic development. The “Business Opportunity Analyser” is designed to support policymakers and project developers by helping them understand their country’s specific PtX cost potentials. It enables users to calculate the trade costs of PtX products, such as green ammonia, e-methanol, and synthetic fuels.

Key highlights

1. This “pre-feasibility” level information helps policymakers and project developers identify regions with promising business opportunities within the PtX value chain, supporting the development of targeted policies to stimulate investment.
2. The tool also provides comprehensive information on PtX policies and targets of major import markets, along with certification schemes and sustainability aspects.

6.4 Gender Sensitivity Training Manual

Type of Document:	Executive Summary Publication
Publication Date:	February 2024



In mixed group settings such as workshops, trainings and events consisting of both men and women, the conversations may likely be dominated by men in comparison to their female counterparts. Without the right tools and techniques on gender sensitivity, a moderator or facilitator may unintentionally be prone to overshadowing the often silent voices of women, and their accompanying unique challenges and insights may not be captured as a result. This manual provides the necessary guidance to navigate such situations. The Gender Manual offers practical knowledge and tools including checklists to promote the practice of gender-sensitive training or event facilitation. Applying this manual will assist moderators and facilitators of events to ensure that more representative perspectives and needs are drawn out, recognised and addressed from their audience, regardless of gender. With this approach differences in experiences and perspectives of women and men are recognised helping to ensure more complete solutions.

Key highlights

1. The manual offers comprehensive guidance on preparing for workshops and events, including strategies for understanding the audience, ensuring gender-sensitive invitations for guests and speakers, and integrating gender mainstreaming considerations for both virtual and in-person engagements
2. The manual includes a checklist designed to enhance active participation and foster inclusivity throughout the event.
3. The manual provides facilitators with guidelines for navigating challenging situations related to gender diversity and inclusion that may arise during the event.

4. After the event, the manual offers guidance on collecting feedback and engaging in self-reflection to enhance future engagements. To support the diversity of their events, facilitators can print or photocopy these check-lists for easy reference and use.



PtX Hub newsletter



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