A Study to Identify Opportunities for Green Ammonia and its role in Mining

13 May 2025, 10:00-13:00 SAST

International PtX Hub

Supported by:

Federal Ministry for Economic Affairs and Climate Action

on the basis of a decision by the German Bundestag

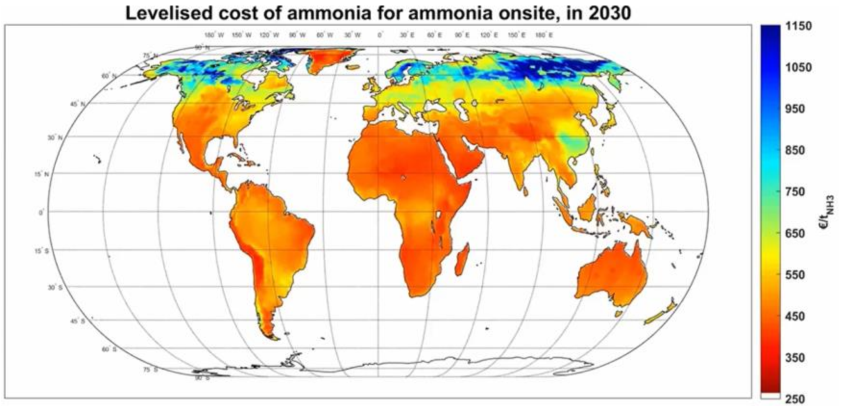
IKI INTERNATIONAL CLIMATE INITIATIVE

Implemented by:

giz Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH

Introduction

Overview	This literature review is part of a study commissioned by GIZ under the "Green Hydrogen South Africa" initiative. Its focus is on opportunities for green ammonia production in South Africa for domestic, regional (SADC), and international markets.
Key Points	Green ammonia is a sustainable alternative to traditional ammonia, primarily used in fertilizers, chemicals, and mining. Ammonia production is a key early adopter of green hydrogen, crucial for global decarbonization. With no viable low-carbon alternatives, it leverages hydrogen as a key input. South Africa's transition from coal to renewables by 2030, including 22 GW of new capacity and 5,000 km of transmission, unlocks major green energy opportunities.
Context	Green ammonia is emerging as a critical solution for sustainable energy, agricultural and mining development. Given its potential to reduce carbon emissions, enhance energy security, and contribute to a circular economy, it is gaining traction in both global and African markets.
Study Objectives	This review explores the opportunities for green ammonia and e-fertiliser production in South Africa, assessing its feasibility for domestic use, regional trade within SADC, and international export markets.



Source: M. Fasihi, R. Weiss, J. Savolainen, C. Breyer, Global potential of green ammonia based on hybrid –wing power plants (2021)

Supported by:
Federal Ministry for Economic Affairs and Climate Action
on the basis of a decision by the German Bundestag
INTERNATIONAL CLIMATE INITIATIVE
Implemented by:
Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH

Production of Ammonia: Traditional vs Green

Ammonia Production Pathways

- **Ammonia (NH3)** produced from **H2** and **N2** in the Haber-Bosch process
    - **Hydrogen production** typically accounts for >90% of total energy consumption of ammonia production, currently mainly fossil-based.

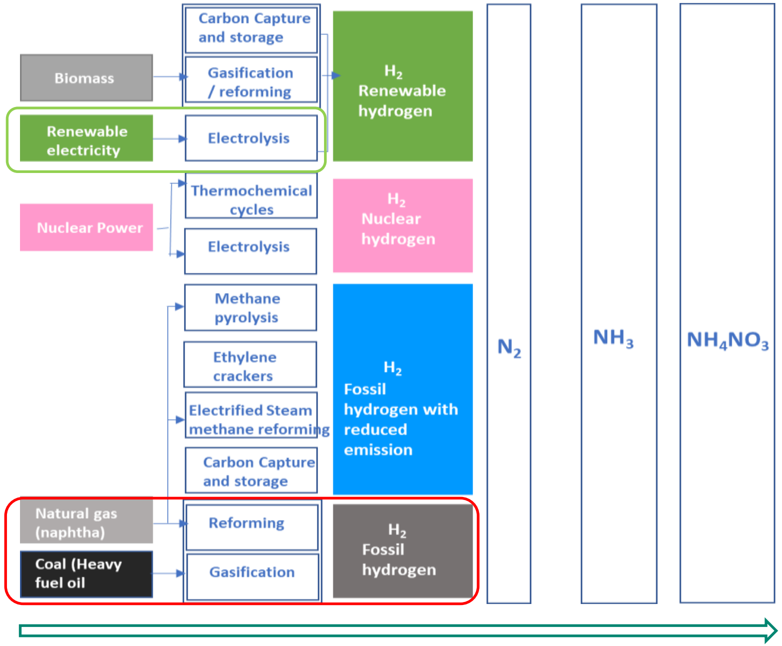
- **Ammonia production** currently generates about 0.5 Gt CO2 **equivalent** annually (around 1% global GHG emissions)
    - CO2 emissions from fossil-based ammonia production vary depending on the feedstock, range 1.6-4t CO2 per ton ammonia.

Methane Reforming

- $CH_4 + H_2O \longrightarrow CO_2 + H_2$

Ammonia Synthesis

- $N_2 + 3H_2 \longrightarrow 2NH_3$



Supported by:
Federal Ministry for Economic Affairs and Climate Action
on the basis of a decision by the German Bundestag
INTERNATIONAL CLIMATE INITIATIVE
Implemented by:
Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH

Renewable ammonia production: electrolysis

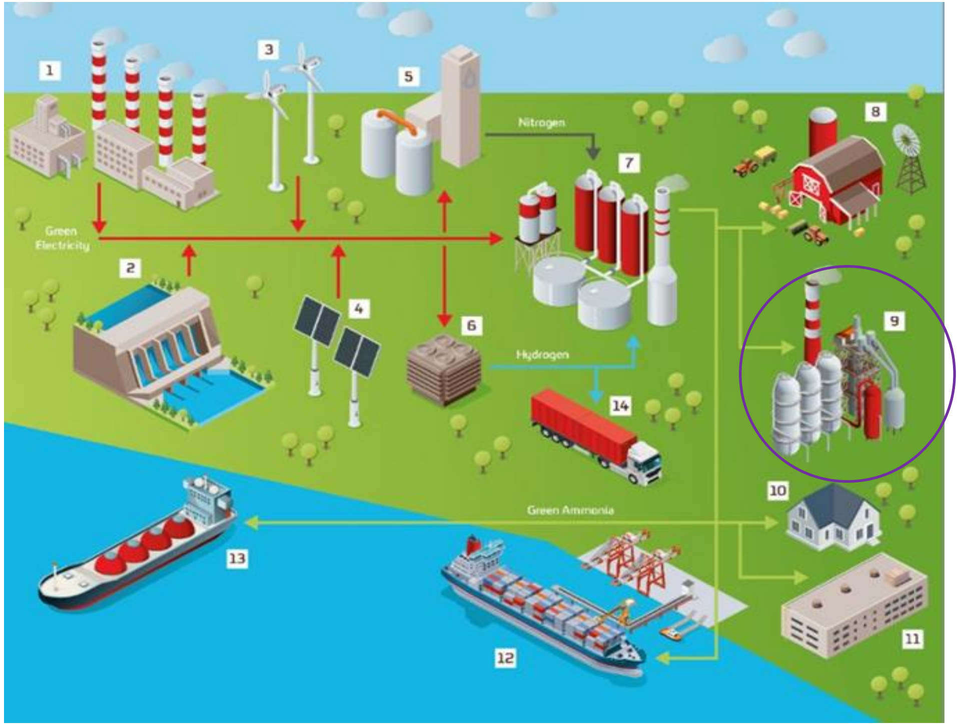


Figure 2: Production of Green Hydrogen, *Adapted from African Hydrogen Partnership , 2021*

Process Flow

- Renewable Electricity
- Nitrogen Gas
- Hydrogen Gas
- Green Ammonia

Renewable Electricity Sources

1. Geothermal Energy
2. Hydropower Energy
3. Wind Energy
4. Solar Energy

Gas Production

5. Air separation unit for Nitrogen gas production
6. Water electrolysis for Hydrogen gas production

Green Ammonia Production

7. Green Ammonia produced from Nitrogen and Hydrogen

Green Ammonia: Applications, Usage

8. Fertilizer for farms
9. Feedstock for many industrial processes, including the production of green fertilisers
10. Fuel for independent power supply of residential buildings
11. Fuel for independent power supply of commercial buildings
12. Shipping fuel
13. Energy to be exported to other regions

Green Hydrogen: Applications, Usage

14. Hydrogen trucks, buses, cars and many other applications

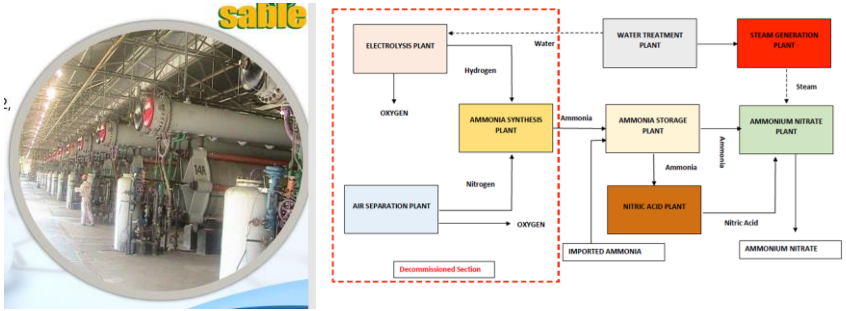


Figure 3: Hydorelectric Green Ammonia - SABLE Zimbabwe Plant Production 1972, *Adapted from SABLE , 2021*

International PtX Hub
Supported by:
Federal Ministry for Economic Affairs and Climate Action
on the basis of a decision by the German Bundestag
IKI INTERNATIONAL CLIMATE INITIATIVE
Implemented by:
giz Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH

Mining Sector Strategic Role and Benefits

- **How can South Africa's mining sector accelerate the transition to net zero through green ammonia production , leveraging its role as a significant consumer of ammonia:**

  - Leveraging its role as a significant consumer of ammonia derivatives like **Ammonium Nitrate (Explosives)** .

- **What Role can the mining sector play in creating a "win-win" strategy,**

  - Do they have a potential for reducing Scope 1, 2, 3 emissions through green ammonia?
  - Possibility of reducing emissions while unlocking carbon credits, carbon offsets, and market access in the global carbon economy.

- **With Critical Minerals essential for renewable energy transition.**
  - Can mining industry in South Africa drive demand for green hydrogen and ammonia as part of a broader decarbonisation strategy?
- **How can the South African Government enable and accelerate green ammonia production, ensuring that both the domestic mining industry and emerging export market benefit?**

- **What are the synergies between mining sector's decarbonisation efforts and the shift to green ammonia, and how can these leveraged to drive industrial competitiveness and long-term sustainability.**

Context and Current Status

South Africa's Mining Sector:

- Despite this, mining remains a crucial pillar of the South African economy, contributing R425.63 billion (USD 31.9 billion) in 2023, and accounting for 60% of the country's export value.
- 549 operational mines, **1 million tonnes of explosives used in 2022**.
- Contributed R425 billion USD 31.9 billion) to GDP in 2022, accounting for 60 % of exports.
- 5th largest contributor to global mining GDP, with mineral reserves worth over **$1.1 - 2.5 trillion**.
- ammonia market was valued at **$79.47 billion in 2024** and is projected to grow to **$91.95 billion by 2029**.

International PtX Hub
Supported by:
Federal Ministry for Economic Affairs and Climate Action
on the basis of a decision by the German Bundestag
IKI International Climate Initiative
Implemented by:
giz Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH

Mining Sector

South Africa’s Climate Obligation

- South Africa is the 12th largest greenhouse gas (GHG) emitter globally, making it a key player in addressing climate change (Deloitte, 2023)
- The mining sector is a major contribution to GHG emissions, significantly impacting the country’s environmental footprint.
- Current production emits **235 million tons of CO_2 annually**, emphasizing the need for green alternatives.

- **80% of ammonia is used in nitrogen fertilisers**, with the rest serving industrial applications such as mining, pharmaceuticals, and chemical synthesis.

Mining Sector Strategic Role and Benefits

Mining Sector in South Africa:

- High Ammonia Consumption for explosives (nearly 1 million tonnes annually.
- Supply of critical minerals (e.g., Platinum Group metals, Vanadium, Manganese) for electrolysers, fuel cells, and renewable energy technologies.
- Potential for reducing Scope 1, 2, 3 emissions through green ammonia
- Role in supporting for recuing Just Energy Transition through funding over 7,500 MW of renewable energy projects

Applications and Benefits for Mining:

- Use of ammonia in explosives (ANFO, emulsion explosives) and operational fuel alternatives.
- Potential for reducing Scope 1, 2, 3 emissions.
- Cost savings from carbon credits and reduced exposure to carbon pricing (CBAM, South Africa Carbon Tax.)
- Historical importance of ANFO and its evolution to modern emulsion explosives

Mining Example Case: Scope Emission

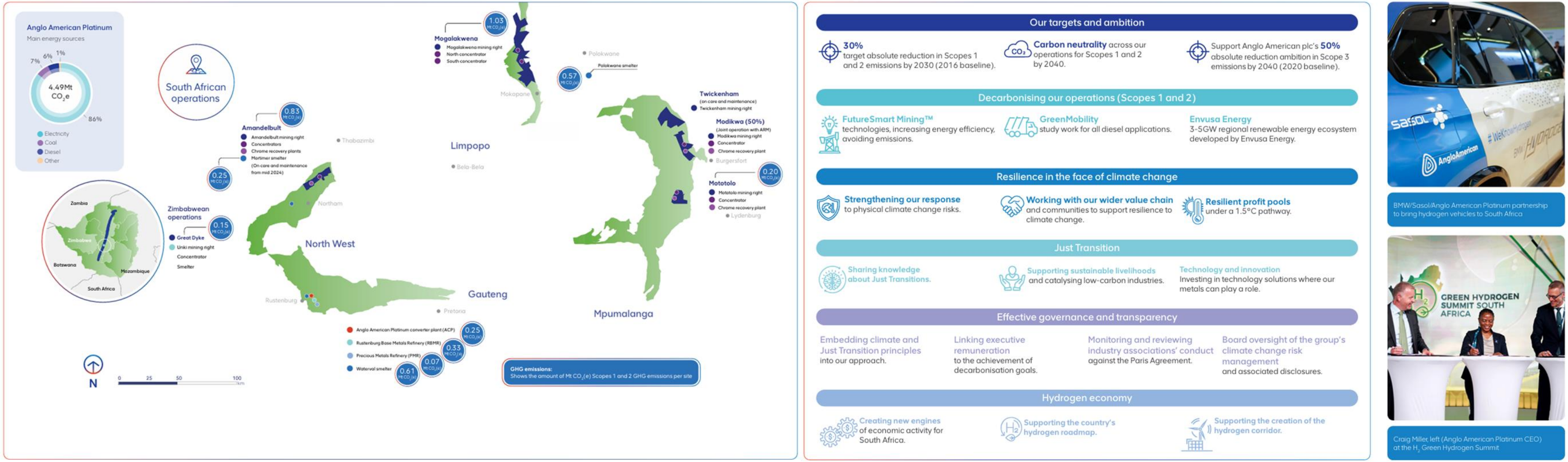


Figure 4: Anglo American – Total Emission Scope, *Adapted from Anglo American 2024 Annual Report.*

Project Landscape and Emerging Opportunities

Landscape of South Africa Hydrogen Transition:

1950

The South African Coal, Oil and Gas Corporation Ltd. Was found

1955

SASOL starts producing **synthetic fuel from coal** using Fischer-Tropsch Technology

2002

Petro SA formed from merger between Mossgas, Soekor and plant of SFF.

2007

Cabinet approves the National Hydrogen South Africa (HySA) RDI Strategy

2008

Successful **prototyping, fuel cell power installations** and **demonstration projects** for green hydrogen production

2009

Establishment of **the HySA Centres of Competence** at UWC, NWU & UCT

2019

.

2021

- DSI launches the **Hydrogen Society Roadmap (HSRM).**
- **The President** announces **GH2** as 'Big Frontier Investment Opportunities.
- Hydrogen Valley announced
- DTIC and IDC establish **GH2 panel.**
- NCEDA releases GH2 strategy at COP26

2022

- IDC and KfW sign MOU to deploy €23m of grant funds for catalytic GH2 projects.
- First South Africa Green Hydrogen Summit (SAGHS)
- **Nine GH2 projects gazette as Strategic Integrated Projects (SIPS).**
- NC and WC sign GH2 cooperation agreement.
- Anglo American unveils **prototype of the worlds largest H2-powered mine haul truck**

2023

- DTI's **Green Hydrogen Commercialisation Strategy (GHCS)** approved by Cabinet.
- **South Africa Renewable Energy Masterplan** published.
- **SASOL** produces first green hydrogen in Sasolburg.
- **SA and Germany** sign GH2 agreement.
- **Netherlands, Denmark & SA** established **US$ 1 billion GH2 Fund.**
- SA published **Country Investment Strategy (CSI).**
- Second South Africa Green Hydrogen Summit (SAGHS).
- **EC, NC, and WC** sign MOU for the establishment of a **GH2 corridor.**
- **Cabinet** approves JET IP, including GH2 as key sector

Government Role and Policy Support

Mining Sector in South Africa:

- Eskom's unbundling and the opening of the transmission network to private sector investment.
- EU support for South Africa's Just Energy Transition (COP26 commitments).
- Minister of Electricity and Energy's invitation to private sector investment in grid infrastructure
- Potential for new market-based incentives (Creation of Dispensation to accommodate investment, Guarantee of Origin, direct funding).
- Integrated Resource Plan (2019) (2024).
- Carbon Tax Act (2019)(2024) and implications for mining sector emissions.

Challenges and Barriers to Adoption

Barriers of Adoption:

- High production costs for green ammonia, energy supply intermittency.
- Economy optimisation.
- Infrastructure and investment hurdles for green hydrogen adoption.
- Uncertainty around carbon pricing and policy stability.
- Safety and regulatory challenges in handling ammonia, and ammonium nitrate.

Call for Action for the Mining Sector:

- Early adoption of green explosives as a strategic advantage.
- Partnership opportunities with ammonia production producers and grid operators.
- Potential to lead in global decarbonisation through integrated supply chains.
- Leveraging critical minerals resources for green hydrogen technologies
- Policy alignment, investment in R&D, and public-private partnerships are essential for advancing green ammonia in South Africa.

Conclusion

Barriers of Adoption:

- Recap of the opportunity for the mining sector to lead in the green hydrogen and ammonia transition.
- Alignment with South Africa's Just Energy Transition and global climate goals.
- Call for collaborative action across government, industry, and finance sectors.

Question and Answer Segment

Supported by:

Federal Ministry for Economic Affairs and Climate Action

on the basis of a decision by the German Bundestag

Implemented by: