renac
renewables academy

german cooperation
DEUTSCHE ZUSAMMENARBEIT

Implemented by:
giz Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH

Join our webinar on 16 July 2025

Expert Exchange: The Contribution of Green Hydrogen to Energy Security

Online – 16 July 2025

giz Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH

GFA CONSULTING GROUP

H_2 GREEN HYDROGEN SOUTH AFRICA

Impact Analysis of a Green Hydrogen/Power-to-X Economy on Energy Security in South Africa

Online – 16 July 2025

giz Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH

GFA CONSULTING GROUP

H_2 GREEN HYDROGEN SOUTH AFRICA

Study objectives and activities

Study objectives

"To assess South Africa's energy security challenges, evaluate the positive and negative impacts of GH2/PtX production on energy access, and recommend conditions to achieve a net positive outcome"

GH2

Methanol

Ammonia

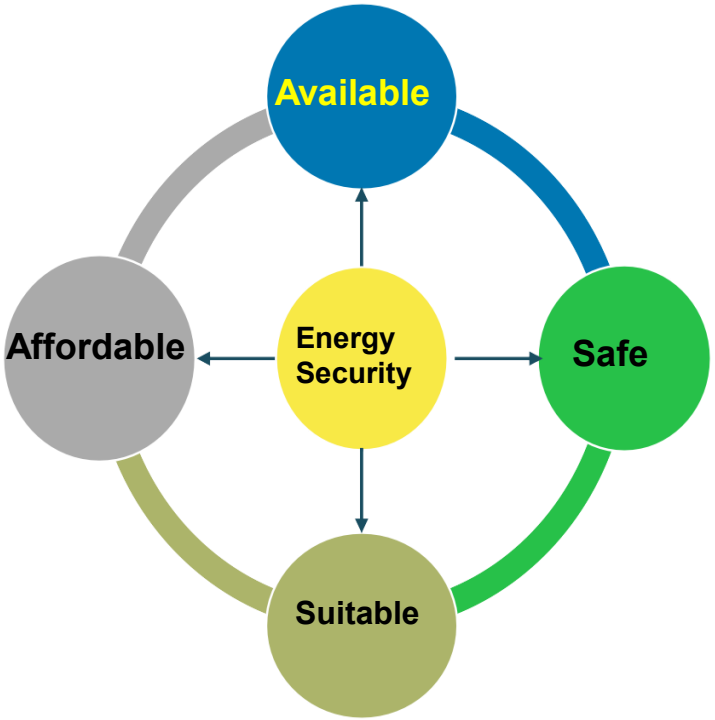
SAF (aviation)

Study activities

Analysis of the impact of a GH2/PtX on energy security in South Africa

- Analysis of South Africa's energy security gaps, challenges, and opportunities
- Assessment of GH2/PtX potential to off-set / Benefit the current and future energy crisis scenarios in South Africa
- Development of narrative on enablers and conditions for GH2/PtX – energy security benefits

Energy Security

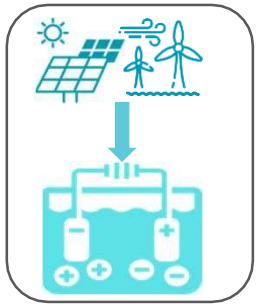


ENERGY SECURITY: reliable access to energy that is **available** in sufficient quantities, at an **affordable** cost, while being **suitable** to meet the specific needs/applications, and ensuring that energy systems are **safe** to people and the environment.

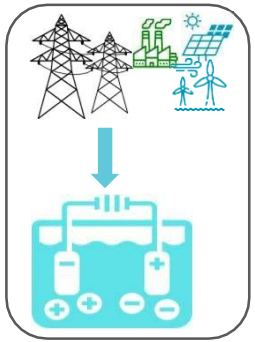
1. **Availability**: steady supply in required amounts
2. **Affordability**: energy is provided at reasonable costs to all consumer categories
3. **Suitability**: energy is provided in forms that are appropriate to meet specific application
4. **Safety**: energy systems are protected from from disruptions or hazards.

1. Energy security and GH2/PtX

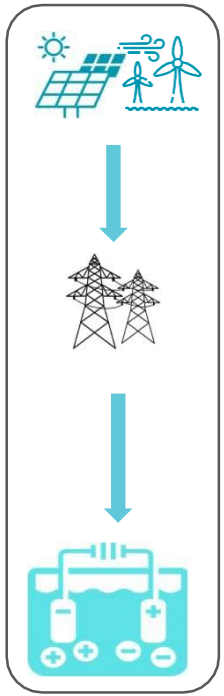
Off-grid connected



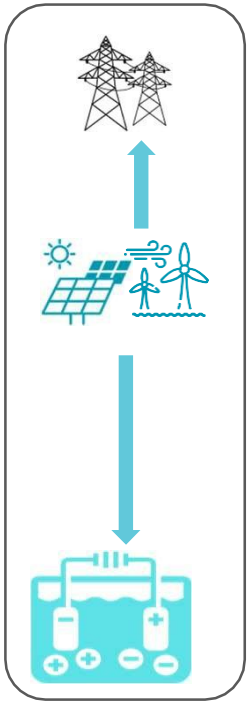
Grid connected



Connected via grid (Wheeling)



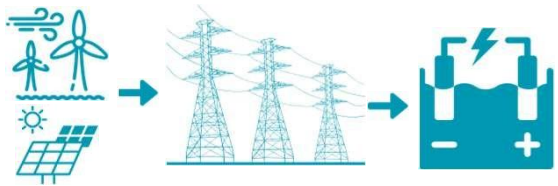
Direct connected with import/export possibilities



Intersection energy security and GH2/PtX

- Grid electricity demand
- Transmission & distribution infra
- System operation
- Energy imports
- Greenhouse gas emissions
- Promotion/shift in investments

2. Power transmission and distribution infrastructure



1 **Increased load and stress**

Higher demand: GH2 facilities require huge amounts of electricity, placing extra stress on transmission lines, transformers, and substations not designed for such loads

Equipment stress: the intermittency nature of RE sources may lead to more operational cycles for grid components, leading to quicker degradation

2 **Grid congestion and bottlenecks**

Congestion: the demand from GH2 facilities can create congestion in specific areas of the grid, particularly where the existing infrastructure is not designed to handle high loads.

Bottlenecks: this congestion can lead to bottlenecks, where the transmission capacity is insufficient to meet the electricity needs of GH2 facilities while also supplying other consumers

Geographical correlation principle

Definition of the optimal proximity (distance) of the electrolyser to the renewable energy source

3. Power system operation: stability and flexibility

Frequency regulation

- **Load adjustments:** in real-time power consumption adjustment to balance supply and demand
- **Frequency stability:** ramping up or down the production to correct frequency deviations

Demand response

- **Load management:** adjustment of power usage during peak demand or supply fluctuations
- **Mitigating peak loads:** shifting operations to off-peak times or absorbing excess energy during low demand

Voltage support

- **Reactive power control:** provision or absorption of reactive power in response to voltage fluctuations
- **Fault ride-through capability:** ability to stay connected to the grid during and after disturbances, such as voltage dips from fault

Energy storage

- **Conversion** of excess electricity into GH2 and reconversion of GH2 to electricity, when needed

Black start

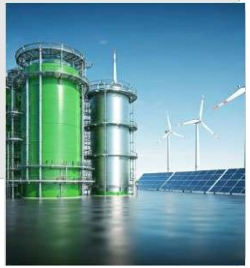
- **Grid restoration:** supply of power to restart generators and restore grid operations after a blackout, enhancing overall system resilience

RE integration support

- **Reduced power curtailment:** GH2 facilities can absorb excess power from RE plants, improving grid integration of RE

4. Energy import/export

Vulnerability reduction
Transitioning to domestic GH2 production could significantly reduce South Africa's dependence on imported fossil fuels, enhancing energy security and decreasing exposure to price fluctuations and geopolitical risks.



Improved energy security: decreased reliance on foreign energy sources

Economic opportunities: job creation and attracting foreign investment

Technology transfer: advancement in GH2 and related technologies

Export prospects: value-added products like synthetic fuels

5. Greenhouse gas emissions and GH2/PtX

1

Power sector decarbonization

- South Africa aims for net-zero emissions by 2050, with the energy sector decarbonization being central to this goal
- GH2 will contribute by storing and releasing green electricity, reducing dependence on polluting fossil fuel-based peaking plants

2

Hard-to-abate sectors

- GH2/PtX technologies provide solutions for sectors challenging to electrify directly by converting RE into various green products.

3

EU CBAM Impact

- The EU Carbon Border Adjustment Mechanism is expected to drive further adoption of GH2 technologies in South African exports to meet emissions standards.

4

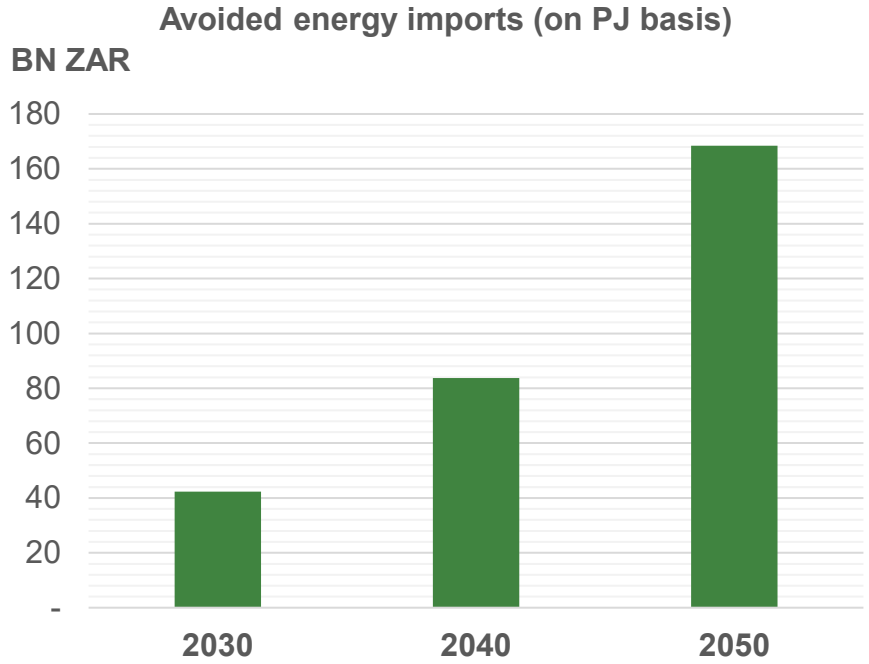
Business opportunities

- Increased demand for low-carbon products creates new markets for GH2 technologies (e.g., maritime decarbonization targets 2030/50)

5. Energy import substitution

- **Primary energy imports accounted for 21% of all commodity imports in 2022, up from 13% in 2020[1]**
- **The import value can be compared in terms of energy content to energy produced locally.**
- **GH2 offers a potential substitute in many thermal uses and the transport sector.**
- **The development of avoided energy imports can be estimated from long term estimates of oil prices being the basis of imported energy products.**

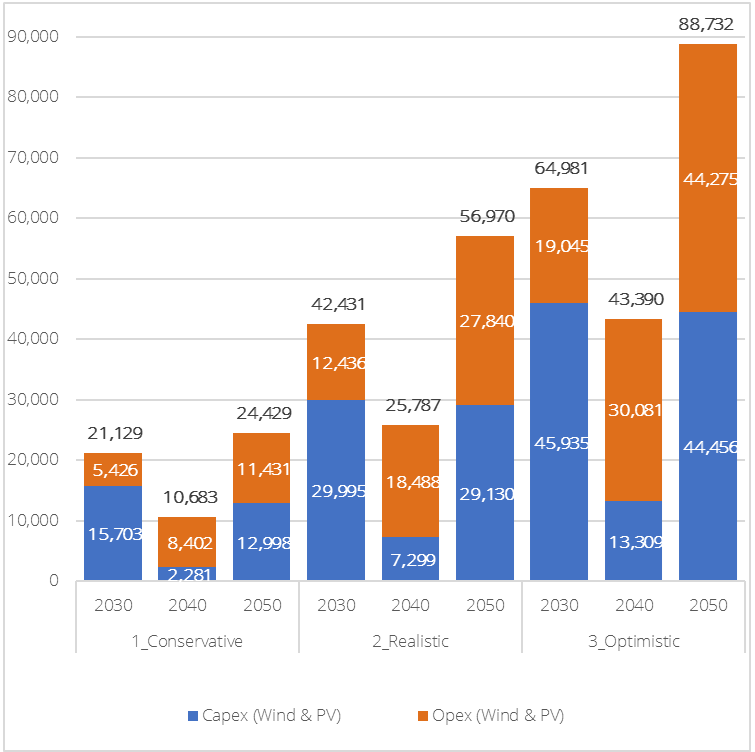
[1]UN Comtrade, 2022 International Trade Statistics Yearbook, Vol. I



Based on GH2 projections in PtX Business Opportunities in South Africa, GIZ 2023 – energy content in PJ and average long term oil price of 80 USD/bbl

6. Creation of qualified workforce for the energy sector

- Establishing a GH2 sector in South Africa promises significant job creation.
- Employment potential of GH2 spans the entire value chain.
- As the GH2 sector develops, jobs will emerge in construction, operation, and maintenance, alongside roles related to decommissioning.
- Full Time Equivalent (FTEs) job years are estimated based on Capital Expenditures (CAPEX) and Operating Expenditures (OPEX) to be spend[1].
- A valuation of job creation from GH2 can developed using the average salary in South Africa[2].
- Annual economic effect from FTE forecast is estimated at ZAR 7.2 billion in 2030 increasing to ZAR 23.3 billion by 2050

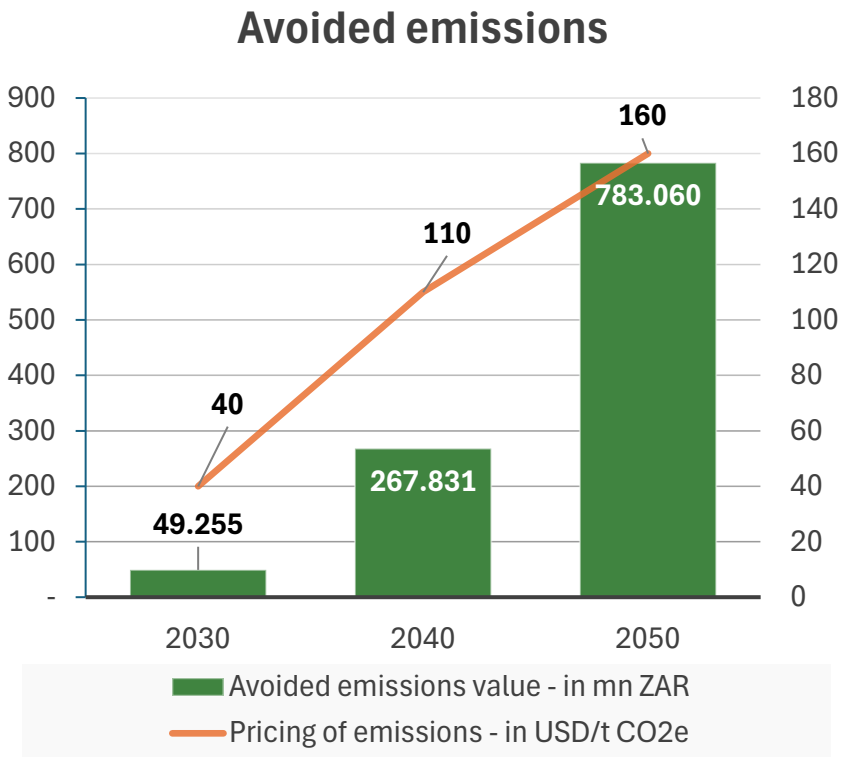


[1] Synergies between Green Hydrogen and Renewable Energy in South Africa - Renewable Hydrogen Market Potential and Value Chain Analysis, GIZ 2023

[2] ILO Stat explorer, South Africa - Avg. Monthly earning 2020

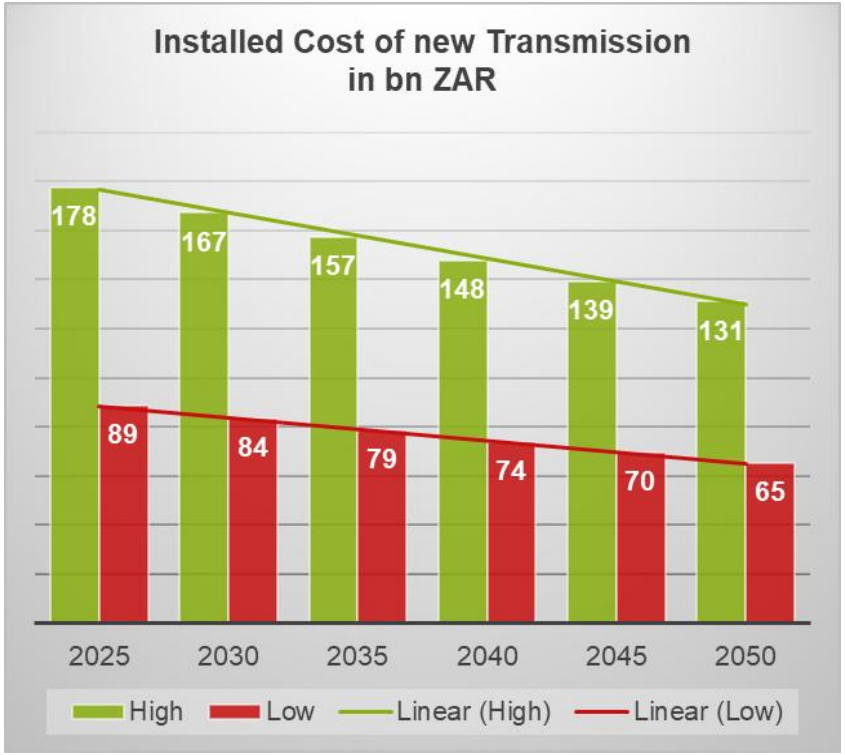
7. Greenhouse gas emissions

- GH2 offers a significant opportunity to decarbonise the South African economy.
- GH2 produced via electrolysis powered by renewable sources like wind and solar has inherently zero emissions.
- Emissions saved can be quantified using the grid emission factor for South Africa[1].
- Valuation of emissions saved can be estimated by applying long term price estimates of IEA's "Announced Pledges Scenario"[2].
- Annual economic effect from FTE forecast is estimated at ZAR 7.2 billion in 2030 increasing to ZAR 23.3 billion by 2050



[1] Department of Forestry, Fisheries and the Environment (DFFE)
[2] Global Energy and Climate Model Documentation – 2024, International Energy Agency

8. Required grid development & Private sector participation



Transmission Line Cost - based on Eskom cost estimates

- Establish a regulatory framework to encourage collaboration among government, development finance institutions, and private investors.
- Develop targeted policies for IPTs, facilitate concessional lending, and implement performance-based contracts.
- Enable credit enhancements for IPTs;
- Create attractive project sizes and pipelines to attract bidders.
- Integrate IPTs into GH2 hub initiatives for greater impact.

Thank You