African Green Hydrogen Report

Potential to Power:
Advancing Green Hydrogen Across Africa

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Africa Green Hydrogen Report
Foreword

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Minister of Electricity and Energy, Republic of South Africa
Chairperson, Africa Green Hydrogen

Africa stands on the cusp of a historic opportunity – an inflection point where our vast renewable endowments, our demographic dynamism, and our strategic commitment to sustainable industrialisation converge in the promise of a green hydrogen future.

This Africa Green Hydrogen Report, developed with the support of GIZ, offers the most comprehensive assessment to date of the continent's green hydrogen potential. More than a stocktake, it is a call to action. Drawing on a wealth of data and analysis and extensive stakeholder collaboration, the report underscores that Africa is not merely a site of opportunity – it is essential to the global energy transition.

Under the banner of the African Union's Agenda 2063 and South Africa's G20 Presidency, we are advancing a vision of energy that is just, inclusive, and transformative. This report aligns with our shared commitment to three pillars: energy sovereignty, social equity, and regional integration. These are not abstract ideals. They are the scaffolding for industrialisation, for employment, and for new continental value chains anchored in green hydrogen and its derivatives.

Africa's ambition must be matched by global partnership. This report is also an invitation – to investors, policymakers, technology developers, and off-takers across the world – to join us in shaping an energy future that works for all. Through a coordinated push on regulatory harmonisation, infrastructure planning, skills development, and market activation, Africa can lead – not follow – in this emerging sector.

Yet the path forward is not without complexity. We must confront issues of grid access, capital mobilisation, environmental sustainability, and the equitable allocation of benefits. But as the report shows, these are challenges we are already addressing – through strategic initiatives like the African Green Hydrogen Strategy, through regional corridors, and through our efforts to localise manufacturing and integrate African supply chains.

Green hydrogen is not simply a fuel. It is a vector for development. It is an enabler of green steel, fertiliser independence, low-carbon mobility, and energy resilience. For Africa, it is a bridge between our mineral wealth and our climate commitments. It is the anchor of a new economic architecture.

I urge us all – governments, financiers, researchers, and industrial leaders – to act with resolve and purpose. Let this report be our shared baseline. Let the investments and partnerships it catalyses mark the next chapter in Africa's energy renaissance.

Let us build an Africa that is not only green – but globally indispensable.

Africa Green Hydrogen Report
Foreword

Dr Petra Warnecke
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Green hydrogen is no longer a distant vision – it is a key pillar of the global energy future. For Africa, it represents a dual opportunity: to support climate goals by producing sustainable fuels at a global level, and to drive inclusive development. It is a landmark opportunity for economic transformation in Africa. With the right investments, partnerships, and policy frameworks, green hydrogen (GH_2) can power sustainable industrial growth across the continent.

The global demand for GH_2 and its derivatives, such as ammonia and synthetic fuels (Power to X, PtX), is accelerating. These energy carriers are pivotal in decarbonizing hard-to-abate sectors, including steel production, chemical manufacturing, and aviation. To meet international climate targets, many off-takers, notably in the European Union and Japan, are prepared to invest in long-term supply agreements, thereby stimulating the development of GH_2 and PtX markets.

African nations not only possess the natural resources necessary for large-scale renewable energy generation but also hold critical raw materials essential for the GH_2 economy. By leveraging these assets, African countries have the opportunity to become global leaders in green hydrogen production, advancing their own economic diversification and energy transition while contributing to global emission reductions.

Realizing this potential requires overcoming significant challenges such as accelerating investment in renewable energy infrastructure, the establishment of robust regulatory frameworks, and the cultivation of technical expertise. Each country‘s pathway will be unique, shaped by its specific context, ambitions, and capacities.

GIZ is proud to collaborate with African partners to support these transitions. Our efforts in more than a dozen African countries include:
- Advising on policy and regulatory frameworks to create conducive environments for GH_2 and PtX development.
- Facilitating access to finance and conducting pre-feasibility studies to attract investment.
- Building capacities within government institutions, industry, and academia to ensure the necessary skills and knowledge are in place.
- Promoting innovative technical solutions and pilot projects that demonstrate the viability of GH_2 and PtX applications.
- Ensuring that environmental and social considerations are integral to project planning and implementation.

This report provides a comprehensive overview of Africa’s readiness to develop a green hydrogen and PtX economy. It analyzes the global hydrogen landscape, engages with distinct regional and national contexts within Africa, and highlights opportunities and barriers across policy, technology, financing, and infrastructure. We trust it serves as a valuable resource for stakeholders committed to advancing sustainable energy solutions. Together, let us unlock the immense potential of green hydrogen in Africa, fostering a just and sustainable energy future for all.

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Acronyms

ACIL	Acil Allen Consulting
AEL	Alkaline Electrolysers
AEM	Anion Exchange Membrane
AEMEL	Anion Exchange Membranes Electrolyser
AfCFTA	African Continental Free Trade Area
AFD	Agence Française De Développement
AfDB	African Development Bank
Al	Aluminium
AMEA	Al Nowais Investments Middle East and Africa
AMSG	Africa Minerals Strategy Group
ARMSI	Africa Responsible Mineral Sourcing Initiative
AU	African Union
AWE	Alkaline Water Electrolyser
BASF	Baden Aniline and Soda Factory
BESS	Battery Energy Storage Systems
BH2	Blue Hydrogen
BMWK	Bundesministerium für Wirtschaft und Klimaschutz (Federal Ministry for Economic Affairs and Climate Action)
BMZ	Bundesministerium für wirtschaftliche Zusammenarbeit und Entwicklung (Federal Ministry for Economic Cooperation and Development)
BNEF	Bloomberg New Energy Finance
BoP	Balance-Of-Plant
BRI	Belt And Road Initiative

CAPEX	Capital Expenditures
CBAM	Carbon Border Adjustment Mechanism
CCS	Carbon Capture and Storage
CCUS	Carbon Capture, Utilisation and Storage
CDP	Cassa Depositi E Prestiti
CH3OH	Methanol
CHEM	Chemical Energy Corporation
CHP	Combined Heat and Power
CMB	Compagnie Maritime Belge
CO_2	Carbon Dioxide
CO_2e	Carbon Dioxide Equivalent
Cr	Chromium
CRMs	Critical Raw Materials
Cu	Copper
CUI	Common User Infrastructure
CWP	Clean Wind Power
DA	Delegated Act
DAs	Delegated Acts
DBSA	Development Bank of Southern Africa
DEFT	Divergent-Electrode-Flow-Through
DFC	Development Finance Corporation
DFIs	Development Finance Institution
DRC	Democratic Republic of Congo
DRI	Direct-Reduced Iron
DSI	Department Of Science and Innovation

EBIC	Egyptian Basic Industries Corporation
EBRD	European Bank for Reconstruction and Development
EC	European Commission
ECOWAS	Economic Community of West African States
EFSD	European Fund for Sustainable Development
EFTA	European Free Trade Association
EGH	Egypt Green Hydrogen
EGHDU	Green Hydrogen Development Unit
EIB	European Investment Bank
EIC	European Innovation Council
EKGs	Export Credit Guarantees
EoI	Expression Of Interest
EPO	European Patent Office
EPRA	Energy And Petroleum Regulatory Authority
ERBI	Equitable Resource-Based Industrialisation
ESG	Environmental, Social, And Governance
ESIA	Environment And Social Impact Assessment
ESMAP	Energy Sector Management Assistance Program
EU	European Union
FCEVs	Fuel Cell Electric Vehicles
FEED	Front End Engineering Design
FID	Final Investment Decision
FT	Fischer-Tropsch
GCF	Green Climate Fund
GDP	Gross Domestic Product

GGH2	Grey Or Grid-Supplied Green Hydrogen
GH_2	Green Hydrogen
GHCS	Green Hydrogen Commercialisation Strategy
GHF	Green Hydrogen Trust Fund
GHG	Greenhouse Gas
GHIC	Green Hydrogen Innovation Centre
GIZ	Deutsche Gesellschaft Für Internationale Zusammenarbeit
GOs	Guarantees Of Origin
GreenH2A	Green Hydrogen & Applications Park
GrH2	Grey Hydrogen
GRN	Government Of the Republic of Namibia
GW	Gigawatt
GWh	Gigawatt-Hour
H2uppp	International Hydrogen Ramp Up Program
HFCT	Hydrogen And Fuel Cell Technologies
Hintco	Hydrogen Intermediary Company
HPA	Hydrogen Purchase Agreement
HRS	Hydrogen Refuelling Station
HYENA	Hydrogen Energy Applications
HyIron	Hydrogen Iron
HyPlat	Hydrogen Platform
HySA	Hydrogen South Africa
IAO	Implementation Authority Office
ICT	Information And Communication Technology
IDC	Industrial Development Corporation

IEA	International Energy Agency
IEA’s	International Energy Agency
iFRL	International Funding Guideline for Hydrogen
IGB	Interfacial Engineering And Biotechnology
ILO	International Labour Organisation
IMHYPAC	Moroccan Institute of Hydrogen and Fuel Cell
IMO	International Maritime Organization
IPCEI	Important Projects of Common European Interest
IPFs	International Patent Families
IPHE	International Partnership for Hydrogen and Fuel Cells in the Economy
IPPs	Independent Power Producers
Ir	Iridium
IRA	Inflation Reduction Act
IRENA	International Re Agency
IRESEN	Research Institute for Solar Energy and New Energies
IRISEN	Institute For Solar Energy and New Energies
ISO	International Organization for Standardization
JCOI	Joint Communique of Intent
JET	Just Energy Transition
JET IP	Just Energy Transition Investment Plan
JSE	Johannesburg Stock Exchange
KfW	Kreditanstalt Für Wiederaufbau
$kgCO_2eq$	Kilograms Of Carbon Dioxide Equivalent Per Kilogram of Hydrogen
$kgCO_2eq/kgH2$	Kilograms Of Carbon Dioxide Equivalent Per Kilogram of Hydrogen
kW	Kilowatt

kWh	Kilowatt-Hour
kWh/kGH2	Kilowatt-Hours Per Kilogram of Hydrogen
La	Lanthanum
LCOG	Levelised Cost of Green Hydrogen
LCOH	Levelized Cost of Hydrogen
LH2	Liquid Hydrogen
LOHC	Liquid Organic Hydrogen Carrier
LOHCs	Liquid Organic Hydrogen Carriers
MASEN	Moroccan Agency for Sustainable Energy
MEA	Membrane Electrode Assembly
MEM	Ministry Of Energy and Mines
MeOH	Methanol
METI	Ministry Of Economy, Trade and Industry
MIGA	Political Risk Insurance and Credit Guarantees
MIME	Ministry Of Industry, Mines and Energy
Mn	Manganese
Mo	Molybdenum
MOTIE	Ministry Of Trade, Industry and Energy
MRV	Monitoring, Reporting and Verification
Mt	Megaton
MW	Megawatt
MWh	Megawatt-Hour
NCEDA	Northern Cape Economic Development, Trade, And Investment Promotion Agency
NGH2P	Namibia Green Hydrogen Programme
NGHRI	Namibia Green Hydrogen Research Institute

NH3	Ammonia
Ni	Nickel
NO_x	Nitrogen Oxides
NSI	Namibian Standards Institution
NZE	Net Zero Emissions
OCP	Office Chérifien Des Phosphates
OECD	Organisation For Economic Co-Operation and Development
OPEX	Operating Expenditures
PCC	Program Coordination Committee
PCCEL	Proton Conducting Ceramic Electrolyser
Pd	Palladium
PEM	Proton-Exchange Membrane
PEMEL	Proton Exchange Membrane Electrolyser
PESTLE	Political, Economic, Social, Technological, Legal, And Environmental
PGM	Platinum Group Metals
PGMs	Platinum Group Metals
PIC	Public Investment Corporation
PM	Particulate Matter
PNG	Piped Natural Gas
PPAs	Power Purchase Agreement
PPPs	Public-Private Partnerships
Pt	Platinum
PtX	Power-To-X
PV	Photovoltaic
PWC	PricewaterhouseCoopers

R&D	Research And Development
RDI	Research, Development, And Innovation
RE	Renewable Energy
RECs	Regional Economic Communities
RED	Renewable Energy Directive
REEs	Other Rare Earth Elements
REIPPP	Renewable Energy Independent Power Producer Procurement Program
RES4Africa	Renewable Energy Solutions for Africa Foundation
RFNBO	Renewable Fuels of Non-Biological Origin
RTA	Revealed Technological Advantage
RTFO	Renewable Transport Fuel Obligation
RWE	Rheinisch-Westphalian Power Plant
SADC	Southern African Development Community
SAF	Sustainable Aviation Fuels
SAREM	South African Re Masterplan
SASSCAL	Southern African Science Service Centre for Climate Change and Adaptive Land Management
SDGs	Sustainable Development Goals
SEZ	Special Economic Zone
SEZs	Special Economic Zones
SFA	Synthetic Fuels Act
Si	Silicon
SOEC	Solid Oxide Electrolyser Cell
SOEL	Solid Oxide or Oxide-Ceramic Electrolysers
SOFC	Solid Oxide Fuel Cell
SO_x	Sulphursulphur Oxides

TNPA	Transnet National Ports Authority
TVET	Technical And Vocational Education and Training
UCT	University Of Cape Town
UFK	Guarantees For Untied Financial Loans
UNCTAD	United Nations Trade and Development
WACC	Weighted Average Costs of Capital
Y	Yttrium
Zn	Zinc
Zr	Zirconium

Executive Summary

With global pressure to decarbonise hard-to-abate sectors and reduce emissions, green hydrogen (GH2) and its derivatives have emerged as vital clean energy solutions. With abundant RE resources, Africa is uniquely positioned to become a leader in the global GH2 market, offering a cost-competitive and sustainable supply that supports both international climate goals and the continent's own energy and industrial development.

This African Green Hydrogen Report presents a detailed assessment of Africa's potential and preparedness to build a competitive regional GH2 economy. This review evaluates current and planned projects, examines relevant policy and regulatory frameworks, and assesses institutional and technological readiness. Besides opportunities and best practice cases, the report will highlight key barriers and current bottlenecks and provide actionable recommendations to enhance regional cooperation and promote the growth of a GH2 economy in Africa.

Key findings and trends

Installed Electrolyser capacity and technology: Globally, capacity increased from 200 MW in 2019 to an estimated 5,200 MW by the end of 2024. In contrast to Africa's comparative potential, growth in the region has been only marginal: only three projects totalling 23.5 MW (15 MW – Egypt, 5 MW – Namibia and 3.5 MW – South Africa) are currently (by publication date) operational on the continent. Five further projects with a combined capacity of over 75 MW are under construction, and 39 projects totalling more than 40,000 MW are at the feasibility analysis stage. At the same time, 61 initiatives remain at the concept stage.

Export Potential: Several African countries are developing ambitious GH2 export strategies aimed at European and Asian markets. Combined, nations such as Tunisia, Namibia, Morocco, Egypt, and South Africa aim to have annual exports of more than 20 million tons of GH2 equivalent by 2050. However, these ambitions face critical constraints, particularly in infrastructure readiness. The current state of port facilities, pipeline networks, and transmission infrastructure remains underdeveloped, which could delay large-scale production and export. Significant investments, policy coordination, and capacity building are therefore required to bridge the infrastructure gap and ensure the timely realisation of export targets.

Domestic demand: The current domestic hydrogen demand in countries such as South Africa, Egypt, and Morocco exceeds 2 million tons annually. By 2030, total demand across Africa could rise to 3–4 million tons, with Egypt, South Africa, Kenya, and Morocco at the forefront. Looking ahead to 2050, projections estimate domestic demand could reach 6–10 million tons annually, depending on policy support and progress in industrial development and decarbonisation on the continent.

Priority sectors for domestic use: Domestic GH2 demand in Africa is expected to be driven by several key industries, including fertiliser production, steel and cement manufacturing, heavy-duty transport, mining, maritime applications (such as bunker fuels), and grid balancing. Fertiliser production is currently a significant source of hydrogen demand and is expected to become even more critical in the future, particularly in Morocco, Tunisia, Egypt, and Kenya. This is especially crucial, as African nations increasingly seek to reduce world market import dependencies and enhance domestic production and use of mineral fertiliser. Industrial decarbonisation, especially in steel and cement, is another priority, particularly in South Africa, Algeria, and Egypt. As things stand, direct-reduced iron (DRI) is gaining momentum in countries like Namibia, Mauritania, and South Africa. Simultaneously, heavy-duty transport, mining, and maritime uses are focus areas in, for example, South Africa and Namibia. Additionally, hydrogen is being explored for grid balancing and seasonal storage in Morocco and Algeria.

Job creation and contribution to Gross Domestic Product (GDP): In Morocco, Namibia, Tunisia, South Africa, Kenya, and Egypt, where data is available, the GH2 economy is expected to create around 1 million jobs by 2030. This will likely increase to 2.5 million by 2040 and 3.5–4.5 million by 2050. Its contribution to GDP is projected to reach $20–25 billion annually by 2030, $60–90 billion by 2040, and over $120–150 billion by 2050. These projections should, of course, be viewed with caution, as they are based on evolving market assumptions, policy frameworks, and investment trends. However, they offer a promising outlook on the potential socio-economic benefits of the GH2 sector for the continent.

Critical raw materials: Africa possesses significant reserves of critical raw materials (CRMs) essential for GH2 technologies, including electrolysers and fuel cells. Consequently, the continent has the potential to play a key role in supplying these upstream segments of the hydrogen value chain. Key resources are concentrated in countries such as South Africa, Mozambique, Zimbabwe, Zambia, and the Democratic Republic of Congo (DRC). This resource endowment positions African countries as indispensable players in the global GH2 supply chain, enhancing their strategic leverage in trade negotiations, infrastructure development, and industrial policy dialogues. By securing a foothold in these foundational segments of the GH2 ecosystem, African nations can not only capture greater value but also shape the terms of international cooperation and technology transfer.

Policy and regulation: By February 2025, eight African countries (Algeria, Egypt, Kenya, Mauritania, Morocco, Namibia, South Africa and Tunisia) have adopted hydrogen strategies and/or roadmaps, but lack the required comprehensive regulatory frameworks to translate these strategies into action. In the absence of such frameworks, GH2 project implementation may face significant delays, reduced investor confidence, and limited scalability.

Institutional capacity and labour market development: Institutional capacity across Africa varies widely. Countries like South Africa and Morocco have well-developed energy sectors and related industries, which increase their readiness to roll out GH2 at scale. Elsewhere, technical knowledge and skilled labour are more pressing concerns. Namibia, for example, anticipates a 130,000-worker gap by 2040 despite ongoing training efforts. Bridging these gaps will be critical to ensuring that the benefits of the GH2 transition are inclusive, sustainable, and equitably distributed across the continent.

Research, knowledge production, and technological innovation: Africa currently lags in hydrogen innovation, with only 20 patents registered. To address this, African countries are increasingly forming partnerships with global research institutions, technology developers, and intellectual property holders globally. These include at least 10 known university or research collaborations and over 20 public-private partnerships supporting technology transfer, joint research, and skills development in countries such as South Africa, Morocco, Namibia, and Kenya.

Financing projects: Almost 80% of the public funding for GH2 projects in Africa came from Europe, with Germany accounting for 13% of total funding, though over 90% remains undisbursed as of 2024. Worldwide, technically feasible GH2 megaprojects, often exceeding $1 billion, face financing challenges due to infrastructure gaps, regulatory uncertainty, and limited technical and project management capacity. Keeping with international trends, only a small fraction of announced large-scale African hydrogen projects have reached final investment decisions. Blended finance solutions are emerging, with initiatives like Namibia's SDG Namibia One Fund and South Africa's SA-H2 Fund, each aiming to mobilise $1 billion in investment.

Sustainability considerations: Electricity and water sustainability are key concerns for GH_2 projects, particularly in arid regions. As environmental standards evolve, emerging certification schemes (e.g., RED II, H2Global) demand strict water use, land access, and emissions compliance. At the same time, stronger social safeguards are needed to protect land rights, prevent forced resettlement, and ensure inclusive community engagement.

Strategic Recommendations

Based on the findings of this report, the following general recommendations have been formulated to support the development of a sustainable and competitive African GH2 sector:

Establish regional GH2 corridors: While some countries possess superior renewable energy (RE) resources, others have high industrial demand or strategic access to ports. A corridor-based approach to GH2 development would allow for the optimal use of these complementary assets, enabling economies of scale, cross-border infrastructure development, and improved continental competitiveness. The process should begin with joint feasibility studies and the implementation of pilot corridors within Regional Economic Communities (RECs).

Harmonize regulatory frameworks across regional blocs: Differing national standards create trade barriers, complicate project development, increase costs, and discourage international investment, especially for cross-border projects. This ultimately hinders the implementation of GH2 projects and the continent's progress toward a sustainable GH2 economy. By establishing unified regulations and certification schemes for GH2, Africa can create a conducive environment for seamless GH2 trade, attract international investment, and ensure the safe and efficient production, transport, and consumption of GH2.

Create a continental GH2 infrastructure plan: Many African countries currently face significant infrastructure gaps that limit their capacity for large-scale GH2 production, distribution, and export. Developing a continent-wide GH2 infrastructure plan would help address these shortcomings, minimize duplication of efforts, and align investments with projected long-term demand. Such a unified strategy would also strengthen Africa's preparedness for global GH2 trade, positioning the continent as a competitive actor in the international hydrogen economy. This plan should involve mapping existing infrastructure and prioritising strategic investments to support efficient trade and regional energy integration.

Develop regional financial instruments and risk mitigation mechanisms: Establish a GH2 Development Fund (potentially under the African Development Bank, AfDB) to provide blended financing, guarantees, and insurance instruments. These mechanisms will reduce investment risks and mobilize private capital for large-scale GH2 projects across Africa.

Foster cross-border industrial clusters and value chains: Leverage the diverse regional strengths of African countries by developing industrial clusters that span borders. These clusters should promote localised manufacturing, joint ventures, Special Economic Zones (SEZs), and interconnected regional supply chains to enhance competitiveness and innovation.

Establish a Pan-African GH2 knowledge and innovation hub: To support the growth of Africa's GH2 sector, a dedicated continental knowledge and innovation hub is proposed to address local challenges through research, innovation, and collaboration. This hub should link universities, start-ups, and industry partners to develop context-specific electrolysis, storage, and RE integration solutions. The hub would start by mapping existing African research institutions and linking them with global R&D partners, forming a network to drive research in cost-effective GH2 production, energy storage, and transport.

Coordinate talent development and workforce mobility: A skilled and adaptable workforce is crucial for the growth of Africa's GH2 sector, and developing high-quality talent will be key to meeting the rising demand across various segments of the GH2 economy, from R&D to construction, operations, and maintenance. This can be supported by developing a standardised technical and vocational curriculum and certification system for GH2 technologies, establishing regional training centres and promoting skilled labour mobility through frameworks aligned with the African Continental Free Trade Area (AfCFTA).

Align national and regional strategies with continental and global climate goals: Lack of alignment in national and regional strategies could undermine Africa's collective ability to transition to a GH2 economy. One of the key challenges to regional alignment and integration lies in the differing levels of progress across countries. While some have already developed dedicated GH2 strategies and roadmaps, others are still in the early stages and need to first establish national frameworks and adjust existing legal and regulatory systems accordingly. To address this, national and regional GH2 strategies should be progressively aligned with broader frameworks such as Agenda 2063, the African Green Stimulus Programme, and the Paris Agreement. Additionally, a continental GH2 roadmap and a robust Monitoring, Reporting and Verification (MRV) system should be established to track contributions to Sustainable Development Goals (SDGs) and climate targets.

Jointly implement environmental and social safeguards: Given that many GH2 projects will involve cross-border collaboration, it is essential for all stakeholders to follow common and shared environmental and social sustainability standards to avoid conflicts, support global sustainability objectives, and uphold the social license to operate. A harmonized approach can build trust among communities, investors, and project partners, minimizing the risk of opposition, protests, or delays. To support this, unified Environmental, Social, and Governance (ESG) guidelines and social impact assessment tools should be developed and applied across GH2 initiatives in Africa.

Promote diplomatic coordination and global advocacy: Establish a Pan-African GH2 Diplomacy group to represent African interests in global forums and influence the development of international standards, trade agreements, and certification systems. This group should advocate for equitable access to markets, technologies, and financing for GH2 development across the continent.

Conclusion

Africa possesses significant potential to become a key player in the global GH2 economy, driven by its abundant resources, growing project pipeline, and rising domestic and export demand. While the foundations are being established – with national strategies, critical mineral reserves, and emerging financing models – substantial gaps persist in regulatory frameworks, institutional capacity, innovation, and infrastructure. Targeted investments, stronger governance, and coordinated regional action will be crucial to translating this potential into inclusive, sustainable growth and positioning Africa as a global GH2 leader.

However, while these strategic recommendations provide a comprehensive framework to further a cohesive and competitive GH2 economy across Africa, their successful implementation and long-term impact will depend significantly on local realities. Technical readiness, political commitment, institutional capacity, and economic feasibility vary considerably among countries and regions, influencing the pace and viability of reforms. Therefore, each recommendation must be assessed and adapted to fit specific national and regional contexts, ensuring that initiatives are pragmatic and responsive to local development needs. This contextualisation is vital to transform continental ambition into actionable and sustainable progress.

2. Introduction

As part of the global effort to reach net-zero greenhouse gas (GHG) emissions by mid-century, many governments have set or are considering targets for transitioning from a fossil fuel-based economy to one powered by RE (RE). However, some industries, such as road transport, shipping, aviation, and chemicals, cannot easily transition from using fossil fuels to using RE (RE) directly. Fortunately, Power-to-X (PtX) bridges the gap by converting RE into green hydrogen (GH2) [1] and its derivatives that can be utilised in these sectors. PtX utilises green electricity (from RE sources such as wind, solar, hydro, and geothermal) to produce synthetic green molecules (such as hydrogen) via water electrolysis. This hydrogen is then combined with nitrogen to make ammonia or sustainable carbon dioxide (CO_2) to create hydrocarbons like green methane, methanol, diesel, or kerosene. These products present a significant opportunity to reduce global carbon footprints and are increasingly recognised as essential to achieve global net-zero GHG emissions. PtX products provide comparable or even superior energy content (MJ/kg) compared to their fossil fuel counterparts, while their production results in minimal or no GHG emissions.

As mentioned above, PtX products are particularly relevant for sectors where direct electrification is either technically difficult or economically unfeasible. Key industries such as steel, cement, chemicals, and long-distance transportation (including freight transport, aviation, and maritime shipping) can benefit from GH2 or its derivatives to decarbonise. Beyond its use as a fuel, GH2 serves as a versatile energy carrier and feedstock, providing solutions for energy storage, grid balancing, and the production of synthetic fuels and fertilisers.

Due to its abundant RE resources, Africa is poised to become a leader in the global GH2 market. The continent's vast potential for producing affordable and sustainable GH2 positions it as a key player in the global energy transition, while simultaneously addressing local energy challenges. GH2 potential, however, is country-specific and depends on local resources and policies. Different regions and countries in Africa are therefore expected to roll out GH2 at varying speeds and scales. Countries such as South Africa, Morocco, and Egypt are already spearheading large-scale projects aimed at producing and exporting GH2 to international markets. However, the potential for GH2 in Africa extends beyond export opportunities and could also drive substantial industrial growth across the continent, especially in energy-intensive sectors like steel, cement, and ammonia production. The potential thus exists in nearly all countries to create a GH2 industry through niche projects that can eventually be scaled and diversified.

The transition to GH2 offers the added benefit of generating new jobs, stimulating economic growth, and enhancing energy security while reducing reliance on fossil fuels. The development of GH2 infrastructure could foster greater regional cooperation, improve energy access, and align with Africa's broader climate resilience goals, positioning the continent as a global leader in sustainable energy and driving both environmental and economic transformation.

1 In this report renewable hydrogen and GH2 are used interchangeably

This report comprehensively analyses GH2 development in Africa, covering key aspects such as market trends, technological advancements, economic impacts, and decarbonisation. Additionally, the report includes an overview of current and planned GH2 and PtX projects, tracking their progress and outlining key challenges and opportunities.

2.1 Analysis methodology

The report is based on an extensive desktop study utilising secondary data sources such as government and international organisation reports, strategies, statistical data, and other relevant documents. This thorough literature review forms the foundation of the analysis and is supplemented by insights from key stakeholders involved in the GH2 sector. The methodology used in this report reflects the diverse stages of GH2 development across African countries. A tiered analytical framework was developed to account for these differences, categorising countries into three levels based on the maturity of their hydrogen initiatives and the availability of relevant data. Levels 1 and 2 are aligned with Germany's Non-EU bilateral hydrogen cooperation programmes, while Level 3 was established through an independent assessment of countries with GH2-specific interests.

- **Level 1: Existing GH2 agreements.** Countries in this category have made notable progress in GH2 development. They have published national GH2 strategies and/or roadmaps and have entered into formal bilateral agreements with international partners. This category includes Algeria, Egypt, Morocco, Namibia, South Africa, and Tunisia. Thanks to the availability of detailed and reliable data, the study provides an in-depth analysis of these countries.
- **Level 2: Other forms of collaboration.** These countries are involved in early-stage GH2 activities, such as prefeasibility studies, policy dialogues, and educational or technical partnerships. This category includes Angola, Burkina Faso, Côte d'Ivoire, Kenya, Nigeria, Mauritania, Senegal, and Togo. The study offers insights where sufficient data is available; however, given limited public access to credible information, not all countries at this level are covered.
- **Level 3: Other relevant players.** This group includes countries with key assets for the GH2 value chain, including abundant RE and critical raw materials, such as platinum group metals, copper, and nickel. Examples include the DRC, Mozambique, and Zambia. The analysis focuses on their long-term potential rather than existing project activity.

Figure 1: Considered Level 1&2 countries

Source: Extracted from BMWK (2024)

It is important to note that the classification framework adopted in this report one of several possible approaches to assessing the status of GH2 development across African countries. For instance, the H2Global Foundation's report *"Opportunities for Renewable Hydrogen Development in Africa: Insights from an Innovative Country Clustering Analysis"* introduces a distinct categorisation, grouping countries into: front runners, momentum builders, and strong foundation (H2Global, 2025). According to this framework, front runners (Egypt, Kenya, Mauritania, Morocco, Namibia, South Africa, and Tunisia) demonstrate the most advanced progress in GH2 development. Momentum builders, such as Algeria, Angola, Mozambique, Uganda, and Zimbabwe, are making strides but require further policy action and investment to maintain momentum. Meanwhile, strong foundation countries, including Cameroon, Nigeria, Senegal, and Tanzania, are at earlier stages, with nascent policy frameworks and emerging interest.

While differing in structure and terminology, both classification approaches aim to provide a nuanced understanding of specific country's position within the broader African GH2 landscape. They are rooted in the availability of data and the observable level of strategic, policy, and project activity.

2.2 Limitations

This report draws exclusively on secondary data and publicly available sources, including official government publications, international agency reports, academic research, and reputable databases. While efforts were made to gather the most accurate and up-to-date information, the availability, granularity, and reliability of data vary widely across countries. Some nations provide robust, detailed, and regularly updated documentation (e.g., national strategies, policy roadmaps, and market readiness assessments), while others offer only limited or outdated information. In certain instances, key documents were inaccessible due to restrictions or lack of publication.

As a result, the analysis presented herein should not be regarded as definitive or exhaustive. Instead, it represents a well-informed and conscientious attempt to synthesize and interpret the current landscape of GH2 sector in Africa based on the best data available at the time of writing. It is acknowledged that more comprehensive and recent information may exist that was beyond the scope or reach of this review. Accordingly, this report should be viewed as a foundational overview that offers initial insights and highlights broad trends and observations. It is intended to serve as a starting point for more in-depth research, stakeholder dialogue, and collaborative engagement. Further investigation and direct consultation with country stakeholders and sectoral experts are recommended to enrich the findings and to develop a more nuanced understanding of national contexts and strategic trajectories in the GH2 sector.

2.3 Report structure

The report is structured into ten chapters:

- **Chapter 2: Global GH2 landscape** – explores the worldwide GH2 market, policies, and technologies, highlighting growing demand, rising electrolyser capacities, and the evolving global regulatory and innovation landscape.
- **Chapter 3: African production and projects** – maps major GH2 projects in Africa, focusing on key countries and visual tools to support the presentation.
- **Chapter 4: Policy and regulatory environment** – analyses GH2 policies, identifying gaps and opportunities.
- **Chapter 5: Capacity and institutional development** – offers an overview of institutional capacity and required actions to build the necessary expertise, resources, and infrastructure for GH2 in Africa.
- **Chapter 6: Research, knowledge production, and technological innovation** – reviews ongoing research and technological innovations in the GH2 space, focusing on Africa-specific initiatives.
- **Chapter 7: Economic and environmental impacts** – assesses the economic and environmental benefits of GH2, including job creation, industrial growth, and reductions in carbon emissions.
- **Chapter 8: Financing of GH2 projects** – examines the financing landscape for GH2 projects in Africa, highlighting challenges and strategies for attracting investment.
- **Chapter 9: Sustainability considerations** – focuses on the role of GH2 in supporting sustainable development, with an emphasis on community engagement and the role of civil society.
- **Chapter 10: Key recommendations** – outlines actionable recommendations to enhance collaboration, aiming to position Africa competitively in the global GH2 market while promoting sustainable, inclusive development.
- **Chapter 11: Conclusion** – recaps the key findings and strategic recommendations for stakeholders, highlighting the critical actions needed to advance the GH2 sector in Africa.

3. Global Green Hydrogen landscape

In alignment with the Paris Agreement's aim to restrict global temperature rise to below 2°C, preferably 1.5°C, above pre-industrial levels by 2100, many nations have committed to achieving carbon neutrality, or Net Zero Emissions (NZE), within the 2050–2060 timeframe. A fundamental driver in achieving this goal is the large-scale adoption of GH2 and PtX. GH2 and PtX technologies are expected to play a crucial role in reducing greenhouse gas (GHG) emissions in sectors where direct electrification is either technically challenging or economically unfeasible, such as steel, cement, and chemical production, as well as long-haul trucking, maritime shipping, and aviation. GH2 and PtX are poised to support a more integrated and sustainable global energy system, thanks to their ability to allow intercontinental transportation of clean energy. This chapter comprehensively analyses the global GH2 landscape, focusing on market trends, policy frameworks, and technological advancements.

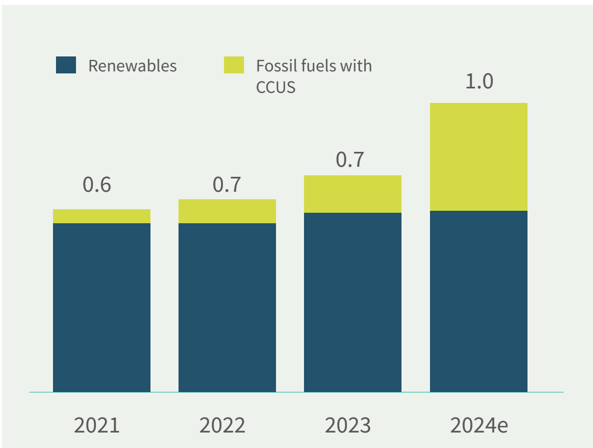
3.1 Global market overview

The GH2 market is expanding rapidly, driven by the global shift to clean energy, rising investments in electrolysis projects, and supportive policies. Demand for GH2 and blue hydrogen (BH2) is growing across continents and industries such as transportation, heavy industry, and power generation, with substantial market expansion expected over the next decade. Stakeholders are increasingly advancing electrolysis technology, storage, and distribution, further solidifying GH2's critical role in the energy transition. This section outlines the latest global trends in the GH2 market, examining production capacity growth, rising demand across industries, and the key players driving innovation.

3.1.1 Hydrogen Demand: Past, present and projections

Global hydrogen demand has steadily risen over the past two decades, increasing from approximately 60 Mt in 2000 to 90 Mt in 2020, reflecting a compound annual growth rate of 2% (IEA, 2021). This growth has been primarily driven by demand from the refining, chemical, and industrial sectors, where hydrogen is used for processes such as ammonia production, methanol synthesis, and hydrocracking in oil refineries. Since 2021, demand has accelerated significantly, reaching 94 Mt in 2021, 95 Mt in 2022, and over 97 Mt in 2023. Projections suggest it could approach 100 Mt in (IEA, 2024), representing an annual growth rate of 6% between 2021 and 2024.

Figure 2: Low emissions H2 production (Mt)



Source: IEA (2024)

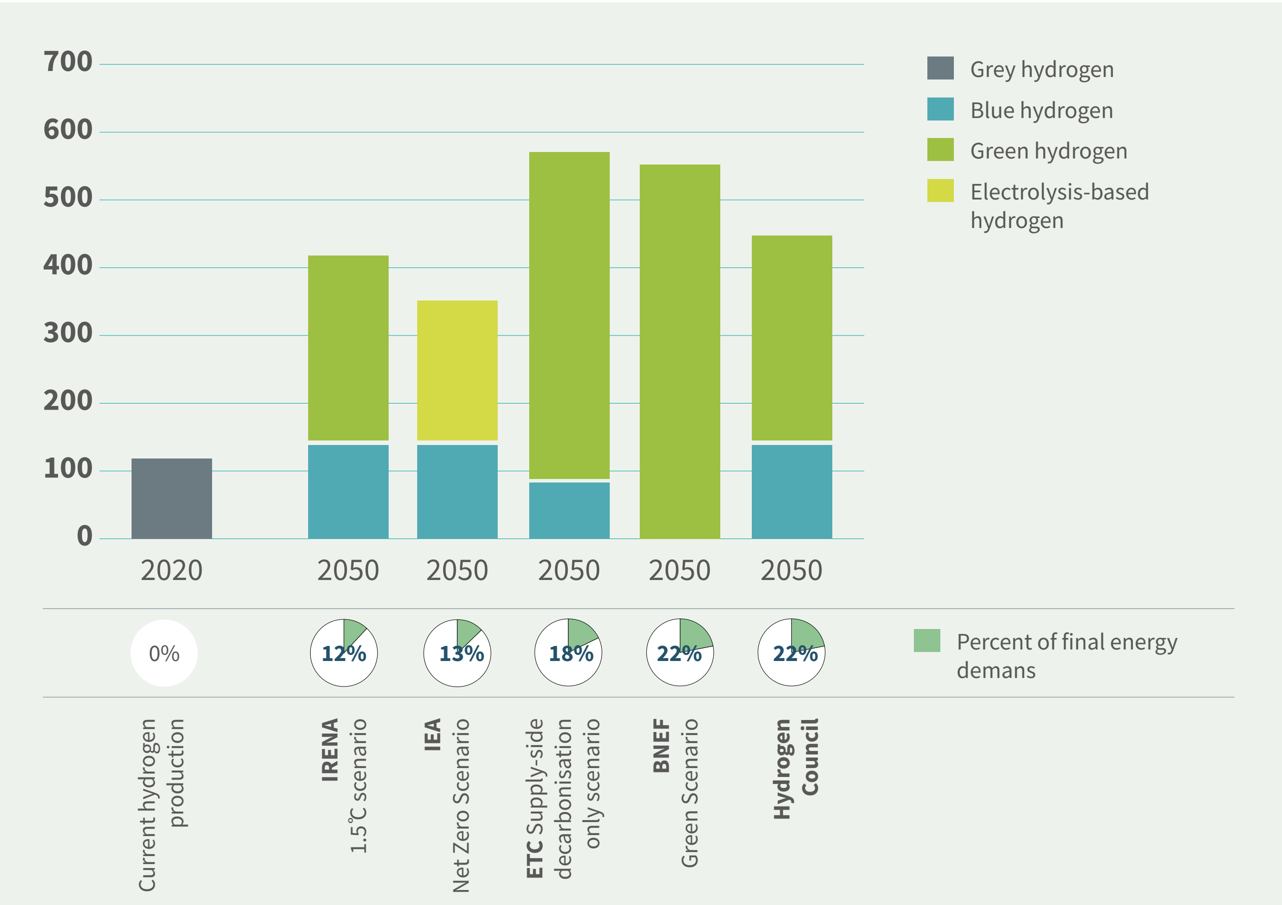
Nearly all supplied hydrogen is still produced using carbon-intensive methods, such as steam reforming of natural gas and coal gasification, without carbon capture and storage (CCS). A significant portion comes from by-products generated in facilities primarily designed for other industrial processes. In contrast, GH2 and BH2 account for less than 1 Mt, representing less than 1% of global hydrogen consumption.

Although GH2 still represents a small share of global hydrogen consumption, its demand is expanding rapidly (see Figure 2). This growth is driven by the increasing recognition of hydrogen's role in the global energy transition, alongside rising investments in hydrogen-based technologies. Sectors like transportation and industrial decarbonisation are seeing heightened interest, supported by government policies, financial incentives, and commitments to net-zero emissions.

Various projections highlight the crucial role of GH2 (and BH2) in achieving an NZE target by 2050, though estimates vary significantly across different scenarios (see Figure 3).

For instance, the International RE Agency (IRENA) forecasts a demand of approximately 613 Mt of green and low-carbon hydrogen, representing 12% of global final energy consumption by 2050 target (IRENA, 2021). In contrast, Bloomberg New Energy Finance (BNEF) projects a much higher demand of 1,318 Mt, or 22% of global final energy consumption (BNEF, 2021).

Figure 3: Estimates for global H2 demand in 2050



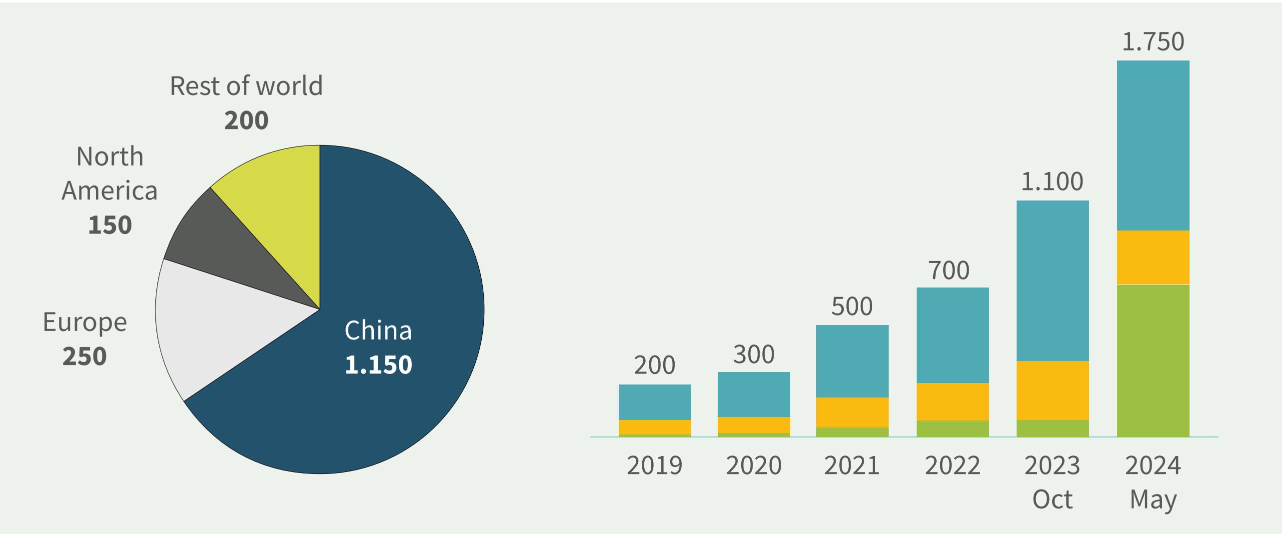
Source: IRENA (2022, 20)

As depicted in Figure 3, all projections point to the complete phase-out of grey hydrogen (GrH2) production by 2050. In its place, GH2 is anticipated to emerge as the dominant production method, driven by the increasing emphasis on sustainable and low-carbon energy sources. Blue hydrogen is expected to play a critical role during this transition, acting as a bridging technology to support the shift toward GH2. This transition is likely to be facilitated by advancements in technology, government policies, and market investments, all of which will help accelerate the adoption of GH2 while reducing reliance on GrH2.

3.1.2 Installed electrolyser capacity: Past, present and projections

In recent years, there has been a substantial increase in the installed capacity of electrolysers, driven by growing global demand for GH2 and the acceleration of the energy transition. As illustrated in Figure 4, the global installed capacity of electrolysers has experienced substantial growth, rising from just 200 MW in 2019 to an impressive 1,750 MW by May 2024 (Hydrogen Council , 2024). With numerous projects under construction and scheduled for commissioning by the end of the year, the total capacity was projected to reach approximately 5.2 GW (5,200 MW) by the end of 2024 (IEA, 2024). This rapid expansion highlights the increasing importance of electrolysis for producing GH2 in the global energy. The growth reflects a broader trend toward clean energy technologies as governments and industries worldwide intensify efforts to meet decarbonisation goals and reduce carbon emissions. Electrolyser capacity scaling is driven by public and private sector investments, advancements in electrolyser technology, and supportive policies aimed at fostering the hydrogen economy. This surge in installed capacity underscores the growing recognition of electrolysis as a key enabler of the transition to a sustainable energy future.

Figure 4: Global cumulative installed electrolysis capacity in MW



Source: Hydrogen Council (2024)

As illustrated in the figure above, China leads the world in installed hydrogen production capacity, accounting for 66% of the total, followed by Europe at 14% and North America at 9%. The remaining 11% is distributed across other regions. Among the total deployed electrolyser capacity, 60% have a specified technology, with alkaline electrolysers comprising 75% and proton-exchange membrane (PEM) electrolysers making up the remaining 25%.

3.1.3 Key players and drivers

The GH2 industry is rapidly expanding due to the global drive to decarbonise economies and shift towards cleaner energy. Four key player groups are shaping this transition: industries aiming to cut carbon emissions, electrolyser manufacturers scaling production to meet demand, financial institutions funding infrastructure projects, and public institutions (e.g., governments, regional organisations, and commissions) implementing supportive policies and regulations.

Industries heavily reliant on fossil fuels, such as steel, chemicals, refining, transportation, and power generation, are increasingly turning to GH2 to reduce their carbon footprint. This triggers technological innovation and large-scale adoption, as companies seek cost-effective and efficient hydrogen solutions. In response, electrolyser manufacturers are scaling production, focusing on cost reductions and improved efficiency. At the same time, financial institutions invest in infrastructure, facilitate public-private partnerships, and provide funding to accelerate deployment. Public institutions support the sector through policies, regulations, and incentives to ensure GH2's long-term viability as a key component of the clean energy transition.

Table 1 below provides an overview of the roles and major initiatives of selected key players that are driving the GH2 industry forward.

Table 1: Key players in the GH2 industry

Category	Players / initiatives	Description	Reference
Industries	Steel Industry (ArcelorMittal, SSAB, Thyssenkrupp)	Transitioning to hydrogen-based direct reduction methods for fossil-free steel	Hydrogen Europe
	Chemical Industry (BASF, Yara, Linde)	Utilizing GH2 for ammonia and methanol production	IEA – The Future of Hydrogen
	Oil & Gas Refining (Shell, BP, TotalEnergies)	Incorporating GH2 into desulfurization processes to reduce refinery emissions	IEA – Global Hydrogen Review 2023
	Heavy Transport (Daimler Truck, Volvo, Hyundai, Toyota)	Developing hydrogen-powered trucks, buses, and fuel cell vehicles	Hydrogen Council – Roadmap
	Maritime (Maersk, NYK Line)	Exploring hydrogen-based fuels for cleaner shipping	IEA – Global Hydrogen Review 2024
	Aviation (Airbus, ZeroAvia)	Developing hydrogen-powered aircraft for carbon-neutral aviation by 2050	Airbus – Hydrogen
	Energy Utilities (Iberdrola, RWE, Enel)	Producing and integrating GH2 into the energy grid for long-term storage and grid balancing	IEA – Global Hydrogen Review 2024

Category	Players / initiatives	Description	Reference
Electrolyser manufacturers	Siemens Energy (Germany)	Producing PEM electrolysers for industrial-scale hydrogen production	Siemens Energy – Hydrogen Solutions
	Nel ASA (Norway)	Specializing in alkaline and PEM electrolysers with cost-reduction strategies	Nel ASA – Electrolysers
	ITM Power (UK)	Partnering with Linde for gigawatt-scale PEM electrolyser production	ITM Power – Projects
	Thyssenkrupp Nucera (Germany)	Producing large-scale alkaline electrolysers for industrial GH2 projects	Thyssenkrupp Nucera – Electrolysis
	Plug Power (USA)	Manufacturing PEM electrolysers and fuel cells for large-scale hydrogen applications	Plug Power – Green Hydrogen
Financial Institutions	Public Investment Banks (EIB, JBIC, World Bank, ADB)	Providing large-scale financing for hydrogen infrastructure projects	EIB – Energy Lending Policy
	H2Global (Germany)	Facilitating global hydrogen trade with long-term contracts and subsidies	H2Global
	U.S. Inflation Reduction Act (IRA)	Offering tax credits and financial incentives for GH2 production	U.S. Department of Energy – IRA Benefits
	Hydrogen Power Purchase Agreements	Enabling long-term agreements between hydrogen producers and buyers to secure funding	IRENA – Hydrogen purchase agreements

Category	Players / initiatives	Description	Reference
Public institutions	European Union (EU Hydrogen Strategy)	Targeting 40 GW of electrolyser capacity by 2030	European Commission – Hydrogen Strategy
	United States (Hydrogen Hubs Program)	Investing $8 billion in regional hydrogen hubs	U.S. Department of Energy – Hydrogen Hubs
	Japan & South Korea Hydrogen Roadmaps	Setting ambitious hydrogen adoption targets for transport and industry	IEA – World Energy Investment 2024
	Hydrogen Corridors & Trade Agreements	Developing hydrogen transportation corridors and securing international supply agreements	Hydrogen Council – Global Hydrogen Flows
	Safety & Certification (EU CertifHy, ISO Hydrogen Safety Standards)	Ensuring the sustainability and safety of hydrogen production, storage, and transportation	CertifHy – Green Hydrogen Certification

3.2 Global Policy and Regulatory Framework

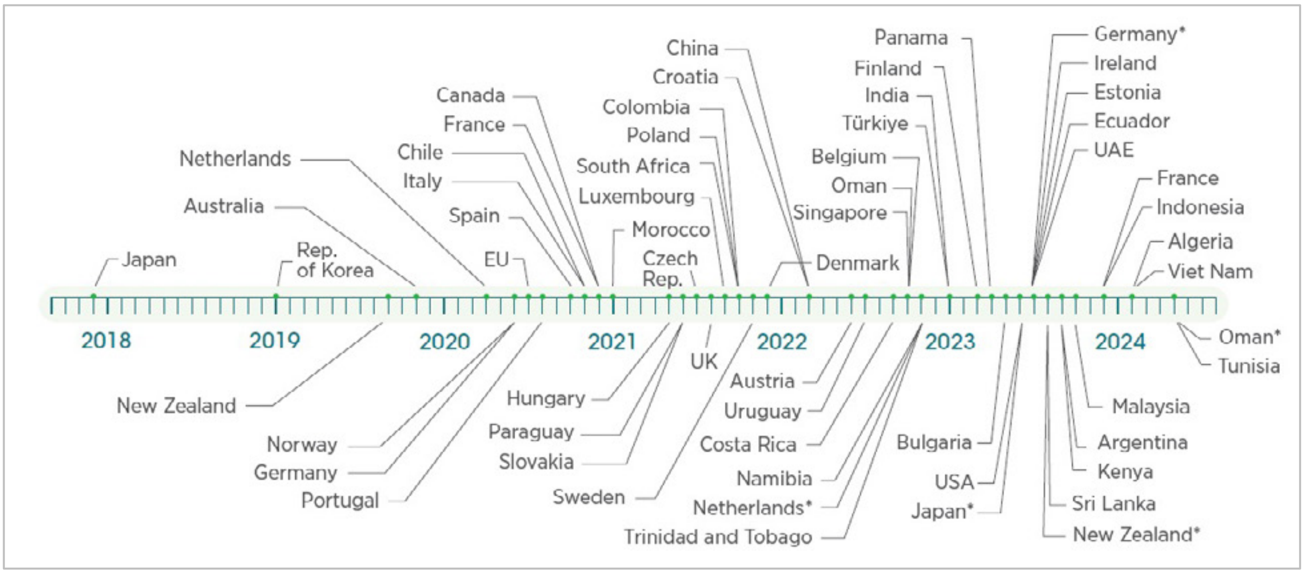
GH2 has emerged as a cornerstone for achieving global climate targets, with various policies, regulations, and incentives shaping the pathway for its development. These policy frameworks are pivotal in enabling the adoption of GH2, driving innovation, reducing costs, and creating a favourable investment environment. This section provides a global and regional overview of the policies, regulations, and incentives influencing the adoption of GH2, with a particular focus on Africa. It highlights these policies' positive and negative implications for the African continent and provides a tabulated summary of international incentives, subsidies, and support mechanisms for GH2 projects in Africa.

3.2.1 Global policies and strategies for GH2

Since 2018, countries and regions across the globe have been introducing policies, strategies and roadmaps to guide and drive the growth and adoption of GH2, establishing mechanisms to support its production, storage, and utilisation. As of May 2024, at least 74 countries were actively engaged in strategic planning for the green and blue hydrogen sector. This includes 46 national and supranational strategies, along with eight published hydrogen roadmaps, while at least 20 more countries were in the process of developing or releasing similar plans (IRENA, 2024).

The figure below displays the timeline of hydrogen strategies and roadmaps as of May 2024.

Figure 5: Timeline of hydrogen strategies and roadmaps (as of May 2024)



Source: IRENA (2024)

The table below provides an overview of these countries, including the titles of their respective GH2 documents, publication dates, and links to the full texts.

Table 2: African countries with hydrogen strategies/roadmaps as of May 2025

No.	Country	Document title	Date of publication	Link
1	Morroco	Feuille de Route de l'Hydrogène Vert (Green Hydrogen Roadmap)	01/2021	https://www.mem.gov.ma/Lists/Lst_rapports/Attachments/36/Feuille%20de%20route%20de%20hydrog%C3%A8ne%20vert.pdf
2	South Africa	Hydrogen Society Roadmap for South Africa 2021	10/2021	https://dst.gov.za/index.php/resource-center/reports/strategies-and-reports/3574
		Green Hydrogen Commercialisation Strategy for South Africa	10/2023	https://www.idc.co.za/wp-content/uploads/2023/11/GHCS-Full-Report-17Oct23-Public-Submission.pdf

3	Mauritania	Feuille de route pour l'industrie d'hydrogène à faible empreinte de carbone en Mauritanie	10/2021	https://www.energies-petrole.gov.mr/fr/feuille-de-route-hydrog%C3%A8ne-mauritanie
4	Namibia	Namibia Green Hydrogen and Derivatives Strategy	11/2022	https://allafrica.com/view/resource/main/main/id/00130863.html
5	Algeria	Stratégie Nationale de Développement de l'Hydrogène en Algérie (National Hydrogen Development Strategy in Algeria)	09/2023	www.energy.gov.dz/?article=stratgie-nationale-de-dveloppement-de-l-hydrogne-en-algrie-4
6	Kenya	The Green Hydrogen Strategy and Roadmap for Kenya	09/2023	www.eeas.europa.eu/delegations/kenya/green-hydrogen-strategy-and-road-map-kenya_en
7	Tunisia	La Stratégie Nationale pour le développement de l'Hydrogène Vert et de ses produits dérivés (The National Strategy for the development of GH2 and its derivatives)	05/2024	https://www.energiemines.gov.tn/fileadmin/docs-u1/Re%CC%81sume%CC%81_strat%C3%A9gie_Nationale_MIME_Franc%CC%A7ais___V_11-2024_.pdf https://www.energiemines.gov.tn/fileadmin/docs-u1/Re%CC%81sume%CC%81_strate%CC%81gie_nationale_MIME_Anglais.pdf
8	Egypt	National Low-Carbon Hydrogen Strategy	08/2024	https://greenhydrogen.gov.eg/static/media/pdf.6c00ad6b21bdc68bc522.pdf

Source: IRENA (2024) and IDC (2023)

These strategic planning documents provide a framework for developing and integrating hydrogen into national and regional economies, ensuring a coordinated approach to accelerating the GH2 sector while supporting decarbonisation and energy transition goals. They establish regulatory measures, incentives, and sustainability standards to foster a favourable market environment. Furthermore, the planning documents define key objectives, target sectors like industry, transport, and power generation, and outline strategies for infrastructure, technology, and international collaboration. Additionally, they set timelines with short-, medium-, and long-term milestones for policy implementation, investment, and market growth.

As countries and regions strive to procure the necessary GH2 to meet their targets, many will face challenges in producing sufficient GH2 due to limitations in domestic land availability and/or RE resources. As a result, these regions will need to import GH2 from areas with abundant RE resources, high availability factors, and ample land for large-scale production. Africa is particularly well-positioned to meet this demand, offering significant potential as a major exporter of GH2, which could boost its economy and create hundreds of thousands of jobs.

Africa's competitive advantage lies in its abundant RE resources, including solar, wind, and hydroelectric power, which provide a strong foundation for large-scale GH2 production. Additionally, its proximity to key international markets, such as Europe and Asia, further strengthens its appeal as a supplier.

The table below indicates the demand for GH2 exports from selected countries/regions.

Table 3: Export potential to selected countries/regions

Country/Region	Demand	Imports	Reference
EU	20 Mt in 2030	10 Mt in 2030	EC (2022)
Germany	2.8–3.9 Mt in 2030	1.4–2.7 Mt in 2030	Germany's GH2 strategy 2023 update
Japan	3 Mt (2030) / 20 Mt (2050)	2.5 Mt (2030) / 17 Mt (2050)	METI (2022) and ACIL Allen (2018)
South Korea	1.94 Mt (2030) 5.26 Mt (2040)	1.36 Mt (2030) 3.68 Mt (2040)	MOTIE (2019) and GoK (2019)

While they offer significant socioeconomic opportunities, both domestic and imported GH2/PtX are subject to specific conditions. Compliance with these conditions is typically verified through certification by accredited bodies, confirming adherence to key criteria. Details on the key regulatory requirements in selected countries and regions that could influence the production and export of GH2 and its derivatives from Africa are provided below.

3.2.2 Potential impacts of global policies on GH2 production in Africa

As highlighted in the selected examples above, key international markets, including the EU, Japan, South Korea, and the United Kingdom, have implemented stringent sustainability criteria to ensure that GH2/PtX products effectively contribute to global decarbonisation efforts. These regulations require both domestic producers and imports to meet specific environmental standards before entering these markets. For instance, the EU's RED II outlines strict criteria such as additionality and geographical and temporal correlation for the RE used to produce GH2. South Korea's clean hydrogen certification system sets a maximum GHG emissions threshold for hydrogen production, which could impact imports from regions like Africa. Japan is working on developing its clean hydrogen certification scheme, while the UK's RTFO includes requirements related to renewable electricity supply and guarantees of origin. Additionally, the EU's CBAM, which imposes carbon prices on certain imported goods (including cement, iron and steel, aluminium, fertilisers, and hydrogen), may encourage these sectors to adopt GH2/PtX in their production processes to meet the carbon intensity requirements. This could further stimulate the demand for GH2/PtX on the continent, creating opportunities for countries like Africa to supply GH2 while contributing to global decarbonisation efforts.

However, meeting these sustainability standards comes with challenges that can impact production costs for GH2. Ensuring compliance with regulations related to GHG emissions, RE sourcing, and carbon intensity thresholds will require substantial investment in both infrastructure and technology. For instance, producing GH2 from RE sources such as wind or solar energy requires significant upfront capital in RE installations and electrolysis infrastructure, which can elevate production costs. Additionally, complying with emission reduction requirements, such as those in the EU's RED II or South Korea's certification system, may require additional measures, such as CCS, further adding to the cost.

As Africa moves forward with its plans to capitalize on its competitive advantages, such as abundant RE resources, it will need to navigate these regulatory challenges and manage the associated costs effectively. By doing so, Africa can position itself as a leading exporter of clean hydrogen, supporting global decarbonisation while fostering economic growth and creating job opportunities on the continent. However, balancing these production costs with market access and competitiveness will be key to maximising the potential of Africa's GH2/PtX exports.

Another global policy instrument that may impact the production of GH2/PtX in Africa is the U.S. Inflation Reduction Act (IRA), which enhances the competitiveness of U.S.-based GH2 projects by providing substantial subsidies. These subsidies are likely to impact GH2 production in Africa both directly and indirectly significantly. Directly, the IRA offers financial incentives for establishing and expanding GH2 production facilities, as well as for manufacturing essential components. Indirectly, it supports investments in clean energy power plants and infrastructure, reducing electricity costs. Since electricity accounts for 60–80% of total GH2 production costs, these indirect subsidies further lower the cost of GH2 produced in U.S., which may shift investments away from Africa toward the American market. To remain competitive, African nations must implement supportive policies, attract international investment, and strengthen infrastructure to lower production costs and position themselves as key players in the global hydrogen economy. However, the future and scale of the IRA beyond the current budget cycle in the US are unclear.

3.2.3 International support mechanisms for African projects

Funding opportunities for GH2 projects are emerging globally, particularly in Africa, through various international initiatives. These initiatives support the development of GH2 infrastructure, production, and related technologies, offering grants, guarantees, and technical assistance to drive the transition to clean energy.

The table below presents potential funding options for H2/PtX projects in Africa.

Table 4: Selected funding mechanisms for GH2 projects

Instrument	Description	Amount of funding	Target countries / markets
Green Hydrogen Trust Fund (GHF)	The European Investment Bank (EIB) instrument supports GH2 infrastructure projects by offering strategic advice, capacity building, and partially funding project preparation, transaction structures, and advisory services to reduce capital costs (CAPEX).	The current funding includes €459 million in grants and €25 million for technical support. The German Federal Ministry of Economic Affairs and Climate Action (BMWK) is the main donor.	Developing and emerging economies are included on the OECD Development Assistance Committee's list of recipients of official development assistance.

European Fund for Sustainable Development (EFSD+) guarantees	The EFSD+ is part of the EU's guarantee platform, developed with EIB, AFD, KfW, and CDP. It provides global coverage for blending, partial risk guarantees, and financial operations to power producers, covering non-sovereign risk without a host government counter-guarantee.	€40 billion, with up to €13 billion allocated for the "EFSD+ open architecture" program. €26.7 billion supports the EIB's investments. Individual guarantees depend on project characteristics.	Lenders and investors for projects in Sub-Saharan Africa, the EU's Eastern Neighbourhood and Southern Neighbourhood.
PtX Development Fund (KfW)	The BMZ PtX Development Fund provides non-reimbursable grants (CAPEX) to industrial-scale projects at various stages along the GH2 value chain to make them bankable.	€270 million from BMZ, targeting sizes of €30 million	1st call for expression of interest for industrial scale GH2/PtX in Brazil, Egypt, Georgia, India, Kenya, Morocco, South Africa.
H2Global	H2Global is a German financing instrument designed to accelerate the market ramp-up of GH2/PtX through competitive bidding. Public grants cover the differential costs between higher purchase prices and lower sales prices. The Hydrogen Intermediary Company GmbH (Hintco) is the intermediary between the supply and demand sides of the supply chain.	BMWK allocated over €900 million in the first funding round for the initial funding period 2022–2024. For the second funding period (2025–2028), BMWK will provide €3.5 billion, with an additional €0.3 billion from the Netherlands.	Projects/companies from countries outside the EU and the European Free Trade Association (EFTA).
International Hydrogen Ramp up Program (H2uppp)	H2Uppp is a public-private partnership (PPP) project that supports companies in identifying, preparing, and implementing pilot projects for the production and use of GH2. The focus is thereby set on the early stage of project development.	The BMWE funds up to €2,000,000 to cover up to 50% of project costs.	Funding is provided for PPPs along the entire GH2 value chain in developing and emerging countries.
International Funding Guideline for Hydrogen (iFRL)	Funded by the German Federal Ministry of Education and Research, iFRL supports international projects related to GH2/PtX production, storage, transportation, as well as related research in alignment with the German National Hydrogen Strategy.	Up to €5 million for research projects and up to €15 million per applicant for GH2/PtX projects related to production, storage, transport, and industrial applications.	Projects in countries outside of the EU and EFTA.

Guarantees for untied financial loans (UFK)	The German Federal Government provides UFK and untied financial loans for corporate financing. These loans are granted for specific commercial projects abroad to protect against bad debt losses due to political and economic risks (OPEX). The financed projects must align with the special interests of the Federal Republic of Germany, such as raw material supply, GH2/PtX, battery technologies, and the chemical industry.	€60 billion for investment guarantees, UFK and loans from the EIB. As a rule, a deductible of 10% for each claim.	Worldwide projects with participation of German banks, branches of foreign banks based in Germany and, under certain conditions, foreign banks.
Foreign Direct Investment guarantees	Funded by the German Federal Government, Investment guarantees serve as long-term protection for investments against political risks (OPEX) such as war or expropriation in target countries with a risky market environment.	There are no upper or lower investment limits. Once the guarantee has been assumed, an annual fee of 0.5% of the hedged capital and any hedged income will be paid.	German companies investing in developing or newly industrialising countries.
Export credit guarantees (EKG)	The German Federal Government offers EKGs to protect exporters against economically or politically induced bad debt losses (OPEX). The guarantee covers the entire value chain of an export transaction – from production and delivery to payment of the final instalment.	5% own contribution for political, financial credit and manufacturing risks and 15% for non-payment risks. EKGs can be combined with UFKs.	Export companies and export-financing banks based in Germany operating in developing or newly industrialising countries.
Political risk insurance and credit guarantees (MIGA)	The Multilateral Investment Guarantee Agency (MIGA) is an international financial institution which offers credit guarantees for loans to the public and private sector as well as political risk insurance. Hydrogen is one of the institutions' priority areas.	Funding volume per company: Variable	182 eligible investor countries, 155+ eligible host countries with funding period of up to 15 to 20 years.

Source: H2 Business Alliance (2024)

3.3 Global technological developments

Technological advancements in GH2 production, storage, and transportation are accelerating its role as a clean feedstock and energy carrier. Innovations in electrolysis are improving efficiency and reducing costs, while new storage solutions, such as advanced compression, liquefaction, and chemical carriers, enhance GH2's viability.

Five years ago, electrolysers were considered unlikely to become larger than 10 MW; 20 to 50 MW configurations have now become the norm. A project with a 150 MW individual electrolyser unit is operational in China, and one with a 200 MW unit is being constructed in France (Collins, 2022; Air Liquide, 2024). Levelized cost of GH2 (LCOH) studies have multiplied recently (supported by the Hydrogen Council) and have shown a similar positive trend. Detailed LCOH ranges depend on the type of energy source and location-specific factors, but five years ago, GH2 was typically forecasted to cost around €6 to €8 / kg at best (IEA, 2020), while in 2024, notably in subtropical countries with a large demand and industrial capacities (India being a case in point), estimates indicate the LCOH may fall to below €3 / kg in future (Jindal, Shrimali, & Tiwary, 2024). Additionally, expanding pipeline networks and alternative transport methods are making large-scale hydrogen distribution more feasible, paving the way for broader adoption across industries.

3.3.1 Green hydrogen production

Water electrolysis is a process that uses electricity to split water into its fundamental components: hydrogen and oxygen. This process occurs inside an electrolyser, a device that facilitates the electrochemical reaction required for the separation. When an electrical current is passed through water, it causes the water molecules to break apart. There are several types of electrolysers, each utilising different technologies to achieve the electrolysis process. These electrolyser technologies are at various stages of development and commercialization. The four main types of electrolysers are:

- Proton Exchange Membrane or polymer-electrolyte membrane electrolyser (PEMEL);
- Alkaline electrolysers (AEL);
- Anion exchange membranes electrolyser (AEMEL), and
- Solid oxide or oxide-ceramic electrolysers (SOEL).

The table below summarises the primary features, along with the pros and cons, of each of these four electrolyser technologies:

Table 5: Comparison of the four main types of water electrolysers

Type	AEL	PEMEL	AEMEL	SOEL
Feature	• Operation temperature: 70–90°C • Catalyst: Nickel coated perforated stainless steel (both sides) • Efficiency: 50–78 kWh/kGH2 • Lifetime: 60,000 hours • Investments: € 450–900/kW • Commercial status: mature	• Operation temperature: 50–80°C • Catalyst: Iridium oxide (O2 side) and platinum (H2 side) • Efficiency: 50–83 kWh/kGH2 • Lifetime: 50,000–80,000 hours • Investments: € 600–1,200/kW • Commercial status: Commercial, fast growth	• Operation temperature: 40–60°C • Catalyst: nickel or NiFeCo alloys (O2 side) & nickel (H2 side) • Efficiency: 57–69 kWh/kGH2 • Lifetime: > 5,000 hours • Investments: – • Commercial status: demonstration plants	• Operation temperature: 700–850°C • Catalyst: perovskite-type such as LSCF and LSM (O2 side) and Ni/Yttria-stabilised zirconia (H2 side) • Efficiency: 45–55 kWh/kGH2 • Lifetime: < 20,000 hours • Commercial status: Limited deployment
PRO (+) and CONS (–)	+ Simple system design (established technology) + Delivery (supply chain already exists) + Cheap compared to PEM since it does not require platinum group metals (PGMs) – Slower dynamic response (10% minimum loading) – Less suited to variable RE	+ Rapid response time – tracks RES (can be loaded from 0%) + High H2 purity – Requires PGMs catalysts (platinum and iridium) – Delivery times (supply chain not well established)	+ No need for PGMs + The membrane is less expensive than that used for PEM	+ Can be operated in reverse mode as an FC + Electrolyses steam, not liquid water – Faster degradation (i.e., shorter lifetime) due to thermo-chemical cycling

Source: CIC energi Gune (2024)

As the hydrogen industry grows, manufacturers are positioning themselves to capitalize on the vast opportunities within this emerging market. The global demand for GH2 has spurred interest from both established companies and new entrants eager to secure a strong foothold in the sector, which holds significant growth potential in the coming decades.

As shown in the figure to the left, key players are concentrated in regions that are already making substantial investments in future-oriented technologies like batteries and RE systems. These regions include Europe, North America (with the USA at the forefront), and Asia, particularly China and Japan.

By the end of 2023, electrolyser manufacturing capacity reached 25 GW per year, nearly double that of 2022. China accounted for 60% of this capacity, with almost three-quarters of the new additions located there and is expected to maintain this dominant share in the near term.

3.3.2 Hydrogen storage and transportation

Hydrogen can be transported either in molecular form or as electrons. Molecular transport can be carried out via pipelines, ships or trucks. Electron transport is done through electrical transmission lines, with the electrolyser for hydrogen production installed at the end of the line.

Currently, pipelines and ships are the two primary methods for transporting large volumes of hydrogen over long distances. However, shipping hydrogen requires converting it into either Liquid Hydrogen (LH2), ammonia (NH3), methanol (CH3OH), kerosene, referred to as sustainable aviation fuel (SAF), or Liquid Organic Hydrogen Carriers (LOHCs).

The main characteristics of the key PtX products are outlined in the table below. The choice of transport method depends on distance, hydrogen volume, and end use. Pipelines are cost-effective up to 2,000 km, while ammonia shipping is preferable for distances between 5,000 and 15,000 km, depending on project size (IRENA, 2022).

Figure 6: Main electrolyser manufacturing firms

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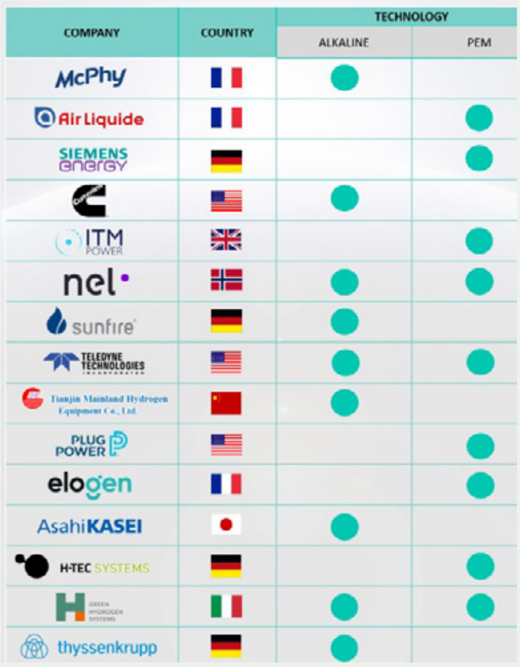


Source: CIC energi Gune (2024)

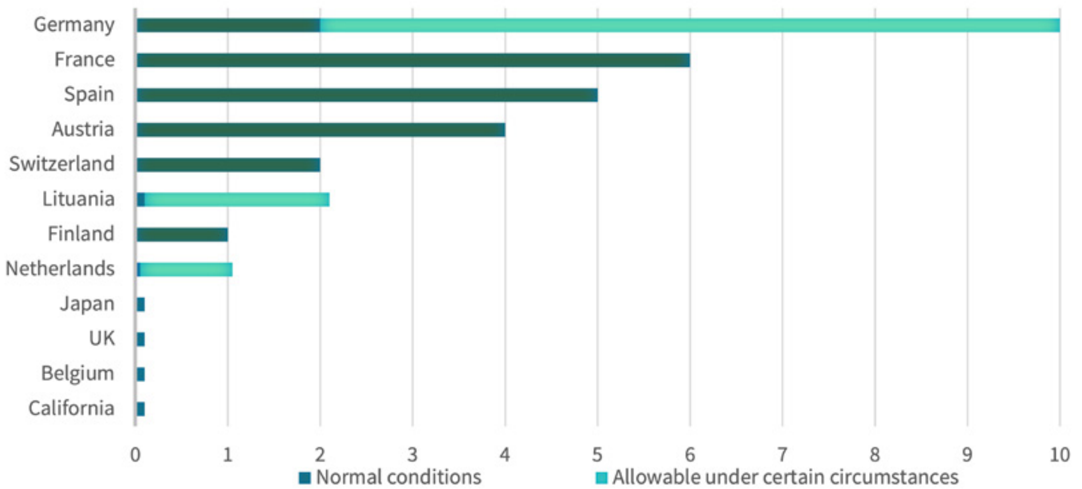
Table 6: Main physical and chemical properties of selected PtX products

No	Product	Density (kg/m³)	Specific energy[2] (MJ/kg)	Volumetric energy density (MJ/l)
1	Gaseous ammoniac gas, @ 25°C, 1 bar	0.69	18.6	0.013
2	Liquid ammoniac (–33°C)	681	18,6	12,7
3	Gaseous hydrogen gas (0°C)	0.09	120	0.0108
4	Liquid hydrogen (–253°C)	71	120	8,5
5	Kerosene / jet-fuel, @ 25°C, 1 bar	756	44.1	33,3
6	Methanol, @ 25°C, 1 bar	793	19.9	15,8

Source: EVOLEN (2023)

Pipeline: Gaseous hydrogen can be transported through dedicated hydrogen pipelines or blended with natural gas in existing gas pipelines. However, transporting hydrogen through existing infrastructure presents challenges such as hydrogen embrittlement[3] and alterations in gas composition affecting quality parameters like calorific value and Wobbe index[4], and the purity requirements of end-use equipment. Therefore, each gas network must be assessed on a case-by-case basis to determine the level of upgrade and repurposing required to ensure that H2 transportation in existing gas pipelines will not undermine the existing gas infrastructure, systems or end-use equipment. The proportion of hydrogen allowed in existing natural gas networks varies significantly in countries where hydrogen blending is permitted. The figure below presents current hydrogen blending limits in natural gas networks for selected countries.

Figure 7: Current limits on hydrogen blending in natural gas networks in selected countries



Source: IEA (2019)

2 The energy density considered for these fuels is the Lower Heating Value (LHV)

3 Chemical reactions between H2 and steel that can lead to fissures in pipelines

4 The Wobbe index is an indicator used to assess impact of changing fuels to power end-use equipment

As shown in the figure above, many regions limit hydrogen blending to a maximum of 2 percent, while a few allow between 4 and 6 percent. In Germany, a higher limit is allowed if there are no compressed natural gas filling stations connected to the network. In the Netherlands, the higher limit applies to high-calorific gas, and in Lithuania, it applies when pipeline pressure exceeds 16 bars (IEA, 2019).

Like natural gas, transporting hydrogen via pipelines requires compressing it to the pipeline‘s operating pressure. Depending on the pipeline‘s characteristics and local conditions, hydrogen may also need to be recompressed along the pipeline. Whether a pipeline can handle hydrogen depends on the materials used and the age of the pipeline, as older pipelines may be more susceptible to embrittlement by hydrogen.

Liquid Hydrogen: LH2 occupies less volume than compressed H2, but liquefying hydrogen requires cooling it to below -253°C, an energy-intensive process. Furthermore, maintaining LH2 in its liquid state during transportation requires highly insulated tanker ships to limit hydrogen boil-off to acceptable levels.

Ammonia: NH3 is considered one of the most promising hydrogen carriers due to its significantly higher energy density per unit volume compared to LH2 and compressed H2. Ammonia is already a well-established internationally traded commodity. However, the conversion of hydrogen into ammonia and the subsequent process of reconverting or cracking ammonia (NH3 → H2) are both energy-intensive, like the liquefaction of hydrogen. Additionally, the cracking process is not yet fully mature on an industrial scale.

Methanol: methanol is a chemically stable substance under normal conditions. It is colourless, water-soluble, and remains liquid at ambient temperature and atmospheric pressure. Its physicochemical properties differ significantly from those of conventional fuels, particularly its density of approximately 793 kg/m^3 at 20°C and its boiling point of around 65°C (IRENA, 2021). Like ammonia, methanol is regarded as a promising fuel for the maritime industry.

Kerosene: kerosene is insoluble in water and lighter than water, and though a flammable liquid, it is safer to handle than petrol (gasoline) as it is less volatile and has a higher flashpoint. It can be of fossil or renewable (synthetic) origin. Kerosene has a very high volumetric energy density (33.3 MJ/l), making it one of the best candidates for transporting PtX products as well as an excellent fuel for aviation.

Liquid Organic Hydrogen Carriers (LOHCs): LOHCs are organic compounds that can absorb and release hydrogen through chemical reactions. They can serve as both a storage and transportation medium for hydrogen without the need for further cooling. LOHCs are chemically similar to crude oil and petroleum products, meaning the existing oil transport infrastructure could potentially be adapted to transport LOHCs.

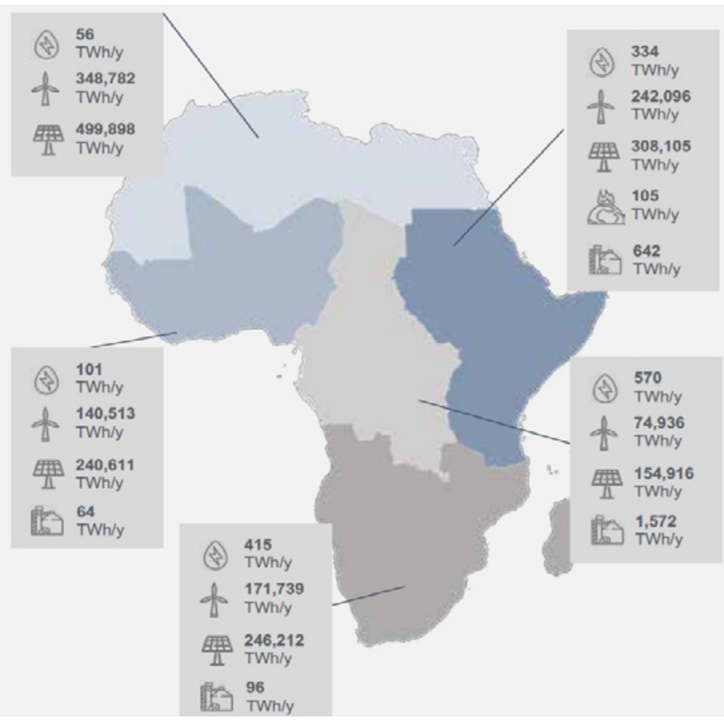
4. Africa's Green Hydrogen Potential

As the global energy transition accelerates, Africa is emerging as a key player in GH2 production and export. With abundant land and vast RE resources (particularly geothermal, hydropower, solar, and wind), the continent has the potential to become a competitive GH2 hub. Several African nations are advancing projects at various stages, from operational facilities to feasibility studies. Developing a robust value chain encompassing production, conversion, storage, transportation, and utilisation is essential to unlocking this potential for both export and domestic use. This chapter examines Africa's GH2 potential, current and upcoming projects, the continent's competitive strengths, and potential target markets, highlighting opportunities for both domestic use and international export.

4.1 Africa's RE potential

Africa is home to some of the world's richest RE resources, with abundant sunlight across the continent. In addition, specific regions like East Africa's Rift Valley have strong geothermal energy potential, while coastal areas and the Horn of Africa are ideal for wind power. The figure below illustrates the theoretical generation potential of different onshore RE technologies for Africa as a whole and by region.

Figure 8: Overview of theoretical onshore RE potential in Africa



Source: KfW, GIZ, and IRENA (2021)

The above RE potential of Africa was estimated as part of the study "The RE Transition in Africa – Powering Access, Resilience and Prosperity" commissioned by the German Federal Ministry for Economic Cooperation and Development (BMZ) and conducted in collaboration with the International RE Agency (IRENA), the German Development Bank (KfW), and the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ). This study estimated that Africa's theoretical onshore RE potential stands at a remarkable 2,431,765 TWh/year, where solar and wind energy alone account for over 95% of this vast potential (KfW, GIZ, IRENA, 2021).

Based on current estimates, Africa's RE potential is projected to be more than 1,000 times larger than its estimated electricity demand in 2040 (KfW, GIZ, IRENA, 2021). This highlights an immense surplus of RE resources, positioning the continent to meet its future energy needs and emerge as a major exporter of clean energy, making it a key player in the global energy transition. With the right investments in infrastructure, technology, and regulatory frameworks, the continent could see significant growth in RE projects, including the production of GH2 and its derivatives. These products hold the potential to replace fossil fuel exports such as coal, oil, and gas, enabling Africa to capitalise on its natural resources while contributing to global decarbonisation goals. By becoming a leader in RE and GH2, Africa could play a central role in the global shift toward sustainable energy, driving economic growth, creating jobs, and fostering energy security at national, regional and continent levels as well as globally.

4.2 African GH2 production and projects

The GH2 sector is expanding rapidly, with projects and initiatives continuously emerging across numerous African countries. This section summarises reported African projects based on publicly available sources, highlighting their focus, scale, and key milestones where applicable. Information on the projects is primarily extracted from the IEA's global hydrogen production and infrastructure projects database. The database includes commissioned, planned, and under-construction projects worldwide from 2000 to 2024. These projects focus on hydrogen production as an energy carrier and/or for climate change mitigation.

It is essential to highlight that while numerous hydrogen projects have been announced beyond the IEA database, many of these remain confidential or lack publicly available, verifiable information. Since this study was a desktop analysis relying solely on secondary data, the IEA hydrogen project database was selected as the primary source to ensure consistency, transparency, and comparability across all countries. This approach helped maintain the objectivity of the analysis by using a well-recognised and standardised dataset.

4.2.1 Status of GH2 projects in Africa

By October 2024, over 110 GH2-related projects were reported across Africa (IEA, 2024). However, despite these ambitious projections, Africa's hydrogen sector remains in its early stages, with most projects still in the concept and feasibility study phases, as shown in Figure 9.

The distribution of hydrogen projects across Africa is influenced by several factors, including RE potential, proximity to major markets, and industrial demand. Countries with abundant solar and wind resources, like Mauritania, are attracting significant interest, while those with established renewable infrastructure, such as Egypt and Morocco, are seeing a growing number of hydrogen projects (Koshikwinja, Cavana, Sechi, Bochiellini, & Leone, 2025).

North African nations, including Algeria, Morocco, and Egypt, hold a strategic advantage due to their proximity to Europe. Their geographical location supports integration into the European Hydrogen Backbone initiative [5], which seeks to convert existing gas pipelines for GH2 transport to Europe. In May 2024, Germany, Austria, and Italy confirmed their involvement in the South H2 Corridor project, an initiative focused on repurposing 3,300 km of gas infrastructure in North Africa to facilitate the export of 4 million tonnes of GH2 annually. A significant development in this effort is

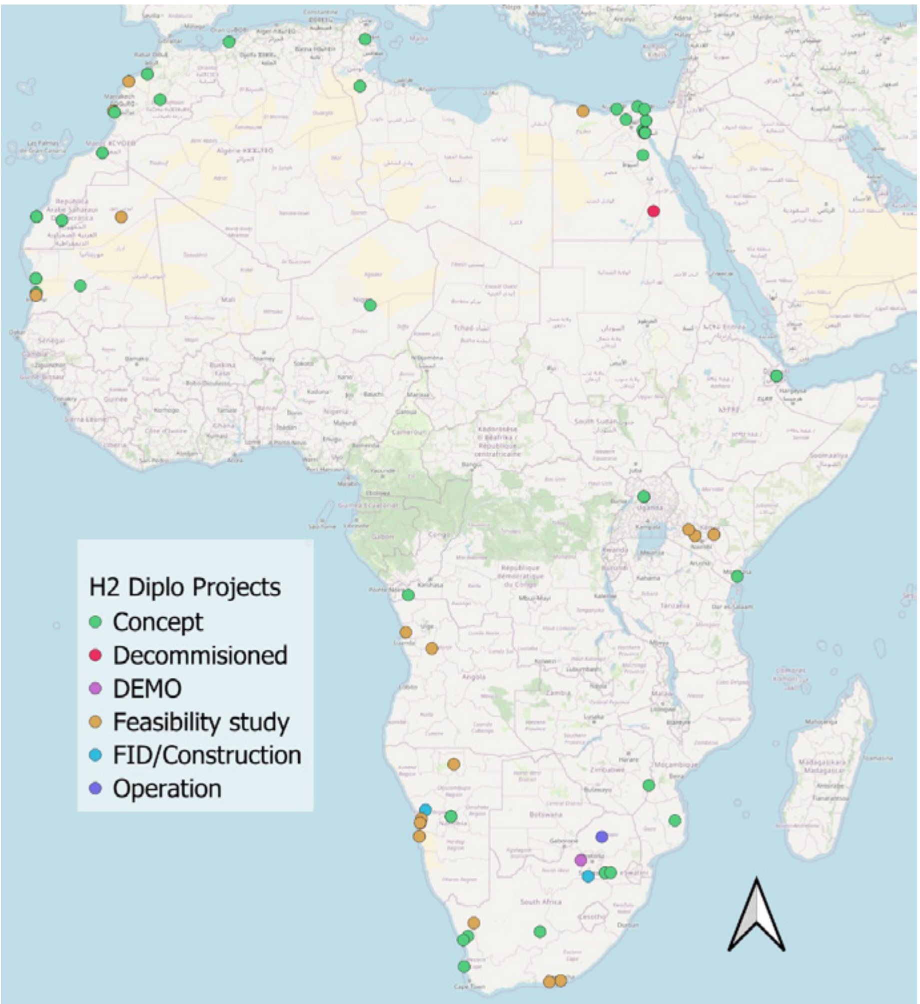
5 The European Hydrogen Backbone (EHB) initiative is a collaborative effort among 33 European energy infrastructure operators aiming to establish a pan-European hydrogen pipeline network. This network is envisioned to facilitate the transport of renewable and low-carbon hydrogen across Europe, thereby supporting the continent's decarbonization goals.

the Italian H2 Backbone project, a joint venture between Italy's Snam Rete Gas and Algeria's Eni, with an estimated import capacity of approximately 450 GWh per day (EIC, 2025)

Industrial hubs in countries like South Africa and Kenya are expected to play a crucial role in GH2 development. South Africa's Sasol is planning to leverage GH2 for synthetic fuel production, while Kenya is exploring hydrogen applications in fertiliser manufacturing, aligning with its agricultural and food security priorities (EIC, 2025).

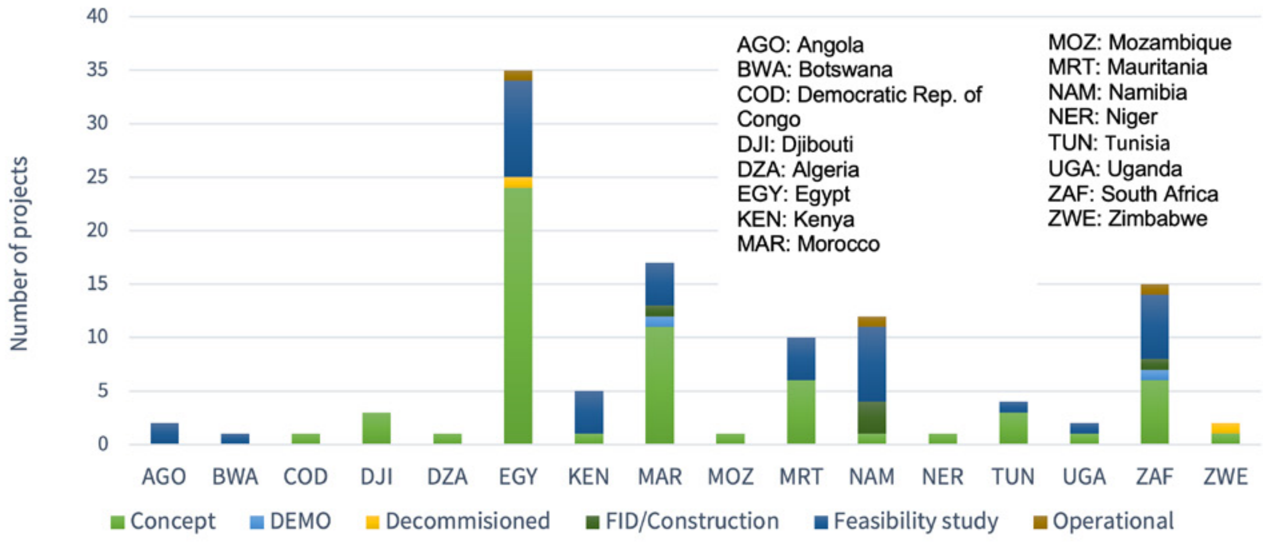
Regarding projects by country, Egypt leads with 24 concept-stage initiatives and nine feasibility studies, followed by Morocco with 11 concept-stage projects and Mauritania with six. Namibia (7) and South Africa (6) focus on feasibility assessments to evaluate commercial viability. The figure below shows the number of projects by country and their status as of October 2024.

Figure 9: Overview Distribution of Hydrogen Projects



Source: Own illustration based on data from the IEA (2024)

Figure 10: Hydrogen production projects in Africa as of October 2024

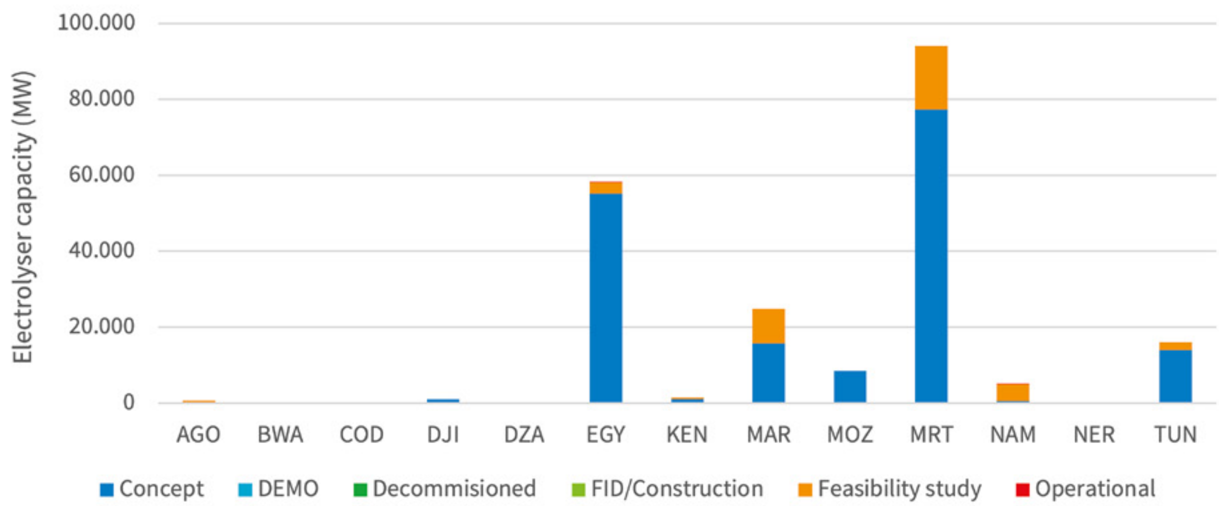


Source: Own illustration based on data from the IEA (2024)

As the above figure shows, only a few projects have progressed to the Final Investment Decision (FID) or construction phase. Namibia leads with three projects currently under construction, while Morocco and South Africa each have one project in this phase. Active projects remain few, with Egypt, Namibia, and South Africa each having a single operational GH2 facility.

While the number of GH2 projects is a key indicator of progress, the scale of production capacity provides a more comprehensive perspective on the state of the sector. The figure below illustrates the projected electrolyser capacities by country as of October 2024.

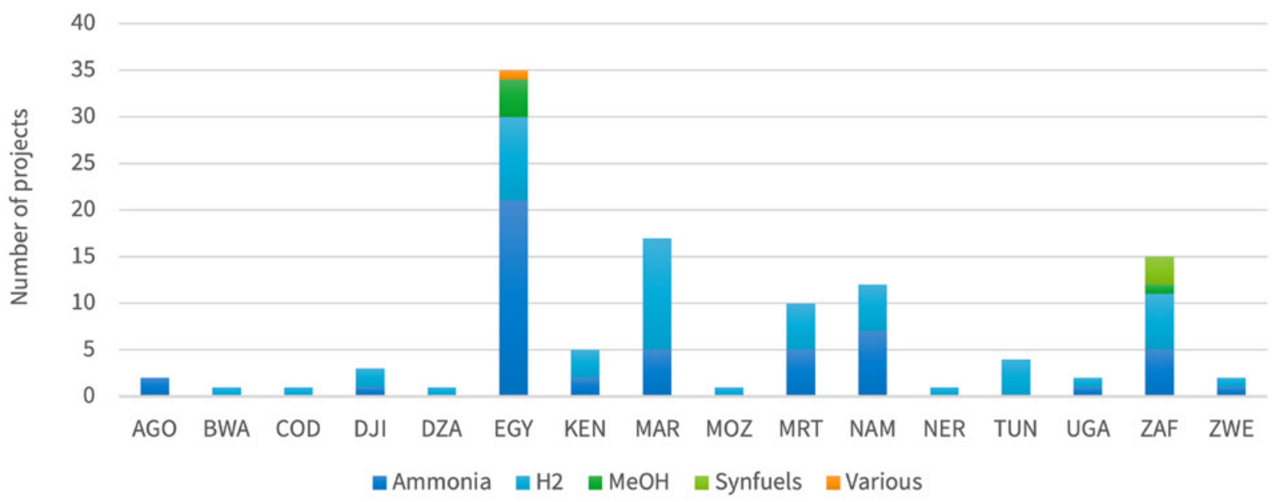
Figure 11: Announced electrolyser capacity per country and status



Source: Own illustration based on data from the IEA (2024)

As shown in the figure above, Mauritania leads in announced electrolyser capacity with nearly 94 GW, followed by Egypt with 58 GW, South Africa with 27 GW, Morocco with 25 GW, and Tunisia with 16 GW. The figure below presents the distribution of projects according to the envisaged PtX product. While projects in Africa vary by product, GH2 and ammonia are dominant.

Figure 12: Number of projects per country and per PtX product



Source: Own illustration based on data from the IEA (2024)

The distribution of projects by product differs across countries:

- **Green ammonia production:** Egypt leads with 21 projects, including the Ain Sokhna plant funded by H2Global (Green Hydrogen Organisation, 2025) [6]. Namibia, South Africa, and Mauritania also focus on ammonia production, while Tunisia, Uganda, and Morocco are exploring opportunities.
- **GH2 production:** Morocco hosts 12 projects, followed by Egypt with nine projects, South Africa with six projects and Mauritania with five.
- **Other GH2 derivatives:** Methanol (MeOH) production is being considered in Egypt and South Africa. South Africa is also at the forefront of synthetic fuels, emphasising GH2's role in diversified energy applications.

As discussed in later sections, the distribution of projects by product is driven by policy priorities. Egypt's hydrogen strategy, for example, is centred on ammonia production to support its fertiliser industry and, in turn, its agricultural sector. In South Africa, hydrogen is positioned to decarbonise heavy transport and energy-intensive industries, leading to an emphasis on synthetic fuels, methanol, and GH2 production. However, exports in the form of ammonia are seen as essential to enable the South African GH2 industry to scale and make cost-effective PtX products available to the local market.

6 The H2Global financed, auctioned production of green Ammonia for export to Germany between 2027 – 2033

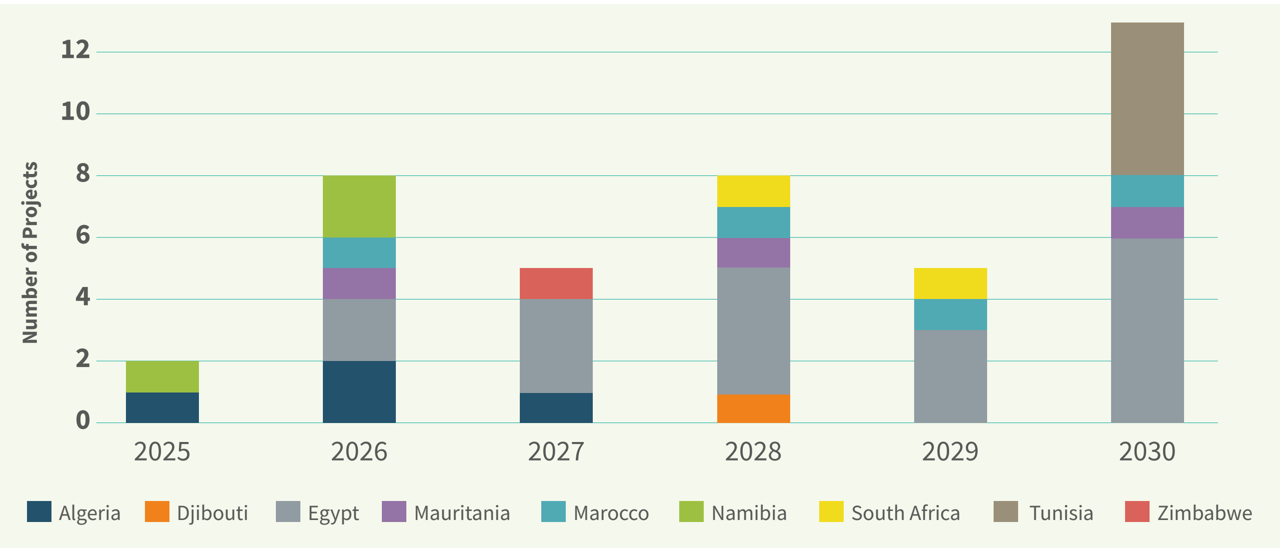
Summary key country-specific insights

- **Egypt** is the African country with the highest number of GH2 projects (24 concept projects, nine feasibility studies, and one operational project). The country's primary focus is on ammonia and hydrogen production.
- **Morocco** follows closely, with a mix of concept, feasibility, and construction-stage projects, predominantly centred on hydrogen and ammonia production.
- **Namibia** is making significant strides, with three projects currently in construction and one already operational. The country is home to some of the largest proposed hydrogen facilities in Africa.
- **South Africa** is focusing on diversified GH2 applications, incl. synthetic fuels, industrial GH2, and mobility solutions.
- **Mauritania** is emerging as a key GH2 player, with six concept-stage projects and four feasibility studies, including several large-scale production facilities.
- **Djibouti, Kenya, Tunisia** and **Algeria** are increasingly engaging in GH2 projects, reflecting their growing interest.

4.2.2 Africa's GH2 project outlook

The development of hydrogen projects across Africa is expected to accelerate, with a steady increase in projects coming online between 2025 and 2030 (see Figure 13). According to the Energy Industries Council (EIC, 2025), only 2 projects will come online in 2025 in Algeria and Namibia. From 2026 to 2030, however, the number of GH2 projects commencing operation annually will expand rapidly, with Egypt, Mauritania, and South Africa emerging as key players. In 2030, 13 projects are expected to come online, and by the end of the period, projects will be operating in nine countries. This sustained growth will lay a robust foundation for future large-scale GH2 production in Africa.

Figure 13: Annual projection of hydrogen projects coming online in Africa, by year



Source: EIC (2025)

4.3 Overview of African GH2 projects by status

This section focuses on individual projects by development status (e.g., operational, FID/construction, feasibility studies, concept, and demo). The information is mainly from the IEA's global hydrogen database, supplemented by insights from public strategic documents, including national hydrogen roadmaps and strategies, for projects in advanced stages of development.

4.3.1 Projects in operation

As of October 2024, only three GH2-related projects were operational in Africa, with a total electrolyser capacity of 23.5 MW. The table below lists these projects, detailing their installed electrolyser capacities, target production, and respective commissioning dates.

Table 7: GH2 projects in operation as of October 2024

No	Project name	Product	Electrolyser capacity (MW)	Electrolyser type	Production (kt H2/year)	Country	Commissioned
1	EBIC – Ammonia plant – Phase 1	Ammonia	15	PEM	2.2	Egypt	2022
2	Cleanergy Solutions Namibia HRS	H2	5	PEM	0.7	Namibia	2024
3	Anglo-American Mogalakwena mine	H2	3.5	ALK	0.6	South Africa	2022

Source: IEA's database (2024)

EBIC – Ammonia Plant Phase 1

The Egyptian Basic Industries Corporation (EBIC) ammonia plant in Ain Sokhna is a GH2 facility with a capacity of 15 MW, producing approximately 2.2 kt H2/y equivalent. It is one of Africa's first operational GH2 production plants, primarily focused on producing green ammonia. The project is part of a consortium led by Scatec, including partners OCI NV, Fertiglobe, The Sovereign Fund of Egypt, and Orascom Construction, with Plug Power providing the electrolyser technology.

The green ammonia produced is an effective GH2 carrier for storage and transportation and can support decarbonisation efforts across various sectors.

Cleanergy Solutions Namibia HRS

The Cleanergy Solutions Namibia Hydrogen Refuelling Station (HRS) is in Walvis Bay. It represents Africa's first public GH2 refuelling station with onsite production. It is a joint venture between the Ohlthaver & List Group and CMB.TECH and features a 10-hectare solar park, feeding a 5 MW PEM electrolyser, and a 5 MWh battery storage system. Its annual production capacity is approximately 0.7 kt H2/year (CMB.TECH, 2025).

As an integral part of the project, a Hydrogen Academy has been established to educate and train local individuals on hydrogen technology and its wide-ranging applications. The hydrogen station became fully operational by mid-2024. The site was developed to easily incorporate additional activities and technologies to support Cleanergy Solutions Namibia's goal to upskill locals to participate in the GH2 industry.

Anglo-American Mogalakwena Mine

The Anglo-American Mogalakwena mine (South Africa) operates a GH2 facility with a capacity of 3.5 MW, producing approximately 0.6 kt H2/year (Smith, 2023). This project involved retrofitting a 220-ton diesel mining haul truck (with a total laden weight of 510 tons) with a hybrid fuel cell system, utilising power from hydrogen fuel cells and a 1.2 MW lithium-ion battery pack (while also recovering energy through braking), to become a zero-emission truck.

Drawing from the experience and insights from this pilot project, Anglo American plans to progressively convert the entire haul truck fleet at the Mogalakwena mine from diesel to hydrogen-powered systems. Furthermore, Anglo American intends to expand the adoption of hydrogen-powered solutions across its global mining operations, aiming to significantly lower greenhouse gas emissions and advance cleaner, more energy-efficient mining practices worldwide.

4.3.2 Projects under construction

As of October 2024, four projects had reached the final investment decision (FID) stage and entered the construction phase. The table below provides an overview of these projects, highlighting their GH2 products and projected capacity.

Table 8: Projects that had reached FID and entered the construction phase by October 2024

No	Project name	Product	Electrolyser capacity (MW)	Production (kt H2/year)	Country	Expected date online
1	OCP Group demo project	Ammonia	4t NH3/day	Unknown	Morocco	Unknown
2	Daures Green Hydrogen Village, phase 1	Ammonia	0.25 MW – 18 t h2/y – 100 t NH3/y capacity	0.043	Namibia	2024
3	Oshivela DRI project, phase 1	H2	15 kt DRI/yeat	2.0	Namibia	2024
4	Sasolburg GH2 project	H2	60 MW	10.2	South Africa	2024

Source: IEA's database (2024)

OCP Group Demo Project (Morocco)

The OCP Group (Office Chérifien des Phosphates) is developing a GH2 demonstration project in Morocco to produce green ammonia. This project represents a significant step in Morocco's GH2 strategy, with the facility designed to produce approximately 4 tonnes of ammonia per day (Almouh, 2022). The primary purpose of this demonstration plant is to conduct technical and economic testing of production technologies for green ammonia.

The project is being developed as a collaboration between OCP Group, the Moroccan fertiliser company, and several research institutions, including the German research institute Fraunhofer (through its Institute for Interfacial Engineering and Biotechnology (IGB)), and the Green Energy Park platform of IRESEN (Research Institute for Solar Energy and New Energies).

OCP's motivation for this project stems from its position as one of the major importers of ammonia in the world, which it processes into various types of fertilisers. By implementing this project, the company aims to cover part of its ammonia demand with CO_2-neutral green ammonia in the medium term, reducing its carbon footprint. The project will test both electrolyser technologies and ammonia synthesis processes in a realistic intermittent operation on an industrial scale.

This demonstration project aligns with Morocco's broader GH2 roadmap, which identifies green ammonia production for the fertiliser industry as a priority area. In 2019, the country created a National Hydrogen Commission to develop a road map for deploying the GH2 strategy, and this project represents an important early implementation step in that strategy.

Daures Green Hydrogen Village, Phase 1

The Daures Green Hydrogen Village project is located in the Daures Constituency in Namibia's Erongo Region, the country's largest constituency. Phase 1 of this project involves the development of a proof-of-concept facility with a modest capacity of 0.25 MW, designed to produce approximately 18 tonnes of GH2 and 100 tons of green ammonia annually (Daures GH2 Consortium, 2024). The pilot project integrates solar energy as its primary power source, with the initial phase featuring a 0.74 MW solar installation alongside a 0.25 MW electrolyser. The demonstration facility was scheduled to be launched in Q1 2025 and will showcase a green circular economy and green industrialisation approach.

During its construction phase, the project provided employment opportunities for 376 Namibians and engaged 23 SMEs, contributing to local economic development. The project is being implemented in partnership with the Daure Daman Traditional Authority and Tsiseb Conservancy, ensuring local community participation. Research partners, including the University of Namibia and University of Stuttgart, will conduct on-site research with Namibian and international students.

Looking beyond the pilot phase, the firm is preparing to commence pre-FEED (Front End Engineering Design) and FEED for a more ambitious development. This expanded project envisions a hybrid 5.5 GW RE facility with a 2.5 GW electrolyser, with an estimated production in excess of 180 kt of GH2/year and 1 million tons of green ammonia per annum (Daures GH2 Consortium, 2024).

The Daures Green Hydrogen Village project follows a phased implementation approach. Subsequent phases include expanded GH2, green ammonia, and fertiliser production for local and regional consumption.

Oshivela DRI Project, Phase 1

The Oshivela DRI (Direct Reduced Iron) project in Namibia, whose name means „Iron" in the Oshiwambo language, is set to establish the first industrial production of zero-emission iron based on HyIron technology. Phase 1 of the project will have an annual output of 15,000 tonnes of Direct Reduced Iron (DRI) with approximately 12 MW of capacity, producing around 2.0 kt H2/year (HyIron, 2024). At this initial stage, the project is expected to avoid 27,000 CO_2 emissions per year, which is equivalent to 50% of the CO_2 emissions of Namibia's power industry.

The production process centres around an airtight rotary furnace supplied with GH2 and iron ore. The project will use RE to replace fossil fuels in the traditional production process. In Phase 1, a 20 MW solar PV installation will power a water electrolysis to produce GH2 needed for iron reduction. The hydrogen then reacts with the oxygen in the iron ore at ambient pressure, forming water that is reused in the process.

A key advantage of the HyIron technology is its modularity, which allows for rapid expansion of production capacities. A feasibility study is currently being conducted to evaluate the mid-term capacity expansion to 1 million tonnes of green iron per year, potentially reducing greenhouse gas emissions by 1.8 million tonnes CO_2e annually.

Namibia is considered an ideal location for this project due to its abundant RE resources, raw materials, robust infrastructure, skilled workforce, and favourable governance structures and legal frameworks. The project aligns with Namibia's ambition to become an important logistics hub for southern Africa.

Namibia at the Forefront of the GH2 Economy in Africa

- Three projects in FID or construction phase, driven by key advantages
- Exceptional RE potential, especially in coastal regions with wind capacity of 56–58%
- Strong international partnerships with the EU, Port of Rotterdam, and Germany
- Comprehensive infrastructure development through common use infrastructure (CUI) for GH2 projects
- “Three hydrogen valleys“ model ensures regional distribution of benefits, aiding social license
- Early successes like the Cleanergy Solutions Namibia hydrogen refueling station in Walvis Bay boost investor confidence
- Focus on skills development, including the Youth for Green Hydrogen Scholarships Program
- A unique environment that supports faster GH2 progress compared to other African nations

Sasolburg GH2 project

Sasol is implementing a GH2 project at its Sasolburg facility in South Africa, which involves powering existing 60 MW electrolysers with renewable electricity. This project is expected to have a capacity of approximately 10.2 kt H_2/year and was scheduled to be operational by 2024 (NRF, 2022). At the core of Sasol's RE strategy is the development of GH2 innovations, which the company sees as a key enabler in repurposing its existing assets in Sasolburg and Secunda.

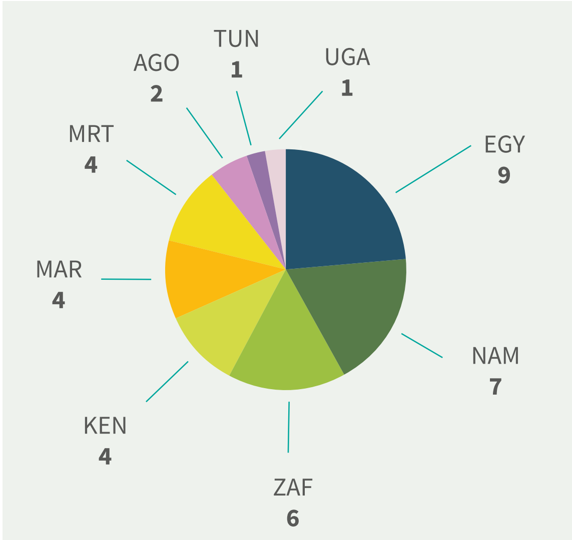
In recent years, Sasol has made significant strides to integrate renewables into its organisation's value chain and is targeting to procure 1200 MW of RE in tranches by 2030, beginning with 600 MW in partnership with Air Liquide. South Africa is considered to have all the elements needed to create a successful GH2 economy and associated value chains given its RE endowments, natural resources, platinum group metal resources, and industrial know-how in producing and managing hydrogen.

Through a partnership with the National Research Foundation (NRF), Sasol is advancing several projects to enable South Africa's energy transition and the development of the green economy. This includes funding for science and engineering projects related to CO_2 capture and utilisation, GH2, energy storage and fuel cells, RE, and other research areas critical to sustainable development.

4.3.3 Projects in feasibility assessment

In Sections 3.3.1 and 3.3.2, the report detailed individual projects due to their limited number. However, given the large number of projects under feasibility assessment (39 projects as of October 2024), this and the following sections offer a high-level summary by country rather than describing each project separately. The figure below shows the number of projects under feasibility assessment in various African countries.

Figure 14: Projects under feasibility assessment by country, October 2024



Source: own figure based on IEA's database (2024)

Egypt

Egypt has the most projects undergoing feasibility assessments (9). This reflects Egypt's strategic focus on developing its GH2 economy as part of its broader energy transition strategy. Major international partnerships drive these developments (see the Ain Sokhna project in section 3.3.1 as an example), In this mould, Petrofac is conducting a feasibility study with Mediterranean Energy Partners for a facility targeting 125,000 tonnes of green ammonia annually for export.

Other significant feasibility assessments include DEME's HYPORT project in the Port of Gargoub, targeting approximately 320 kt of green ammonia production annually in its first phase (Deme, 2024), and TAQA Arabia and Voltalia's 3.4 billion $ project with two 500 MW electrolyser phases (Voltalia, 2024). AMEA Power has also signed an agreement for a 1,000 MW project to produce 800 kt of green ammonia yearly at Ain Sokhna (AMEA Power, 2022).

Egypt's emphasis on GH2 is driven by its national strategy to become a GH2 hub, capitalising on its unique advantages. In line with its national low-carbon hydrogen strategy, the Egyptian government has set a target to produce 8% of globally tradable hydrogen, corresponding to a minimum of 114 GW of RE capacity and 76 GW of electrolysis capacity. The country is also actively pursuing decarbonisation of its economy, with an RE target of 42% by 2035 under its Integrated Sustainable Energy Strategy.

Egypt's leading position stems from several factors: abundant solar and wind resources ideal for GH2 production (as highlighted by industry leaders in the DEME and TAQA Arabia press releases), strategic geographic proximity to European markets, established ports and industrial infrastructure (particularly in the Suez Canal Economic Zone), and strong government policy support. Egypt's hosting of COP27 in 2022 further accelerated its GH2 ambitions, with several projects announced during the conference to showcase the country's commitment to becoming a regional GH2 hub.

Namibia

Namibia has seven GH2 projects undergoing feasibility assessment, ranking second in Africa. These include the Daures Green Hydrogen Development with 2.5 GW electrolyser capacity and the Cleanergy-CMB study for hydrogen infrastructure. As extensively discussed in the previous section, several projects have successfully progressed to FID and construction phases, making Namibia a standout example of effectively moving GH2 initiatives from concept to implementation.

South Africa

South Africa has six GH2 projects in the feasibility assessment phase. The country's projects showcase a strategic approach to diversifying its hydrogen applications across multiple sectors, focusing on decarbonising its carbon-intensive economy.

South Africa's portfolio of feasibility projects includes a variety of initiatives targeting domestic industrial decarbonisation alongside export opportunities. Notable examples include the Prieska Power Reserve in the Northern Cape, which secured project development funding through the Industrial Development Corporation (IDC) to produce 72,000 tons of green ammonia and 12,900 tons of GH2 annually from 2025 (Omarjee, 2022). Similarly, the Eastern Cape e-methanol plant project led by Earth and Wire, ENERTRAG South Africa, and 24Solutions will produce 120,000 t/y of zero-carbon e-methanol in Humansdorp using GH2 and locally sourced biomass (Creamer T. , 2021). Additionally, Sasol is exploring SAF production at its Secunda Synfuels plant with the LEN Consortium (Linde, ENERTRAG, and Navitas), leveraging its extensive Fischer-Tropsch (FT) technology expertise (Sasol, 2021).

South Africa's strong position in GH2 development is attributed to several key advantages outlined in its Hydrogen Society Roadmap. The country possesses world-class RE resources, vast land availability, and established industrial infrastructure that can be leveraged for GH2 projects. Most significantly, South Africa hosts the world's largest known concentration of PGM reserves, critical components for PEM electrolyser and fuel cell technologies, creating substantial opportunities for local value addition. This natural endowment positions South Africa to potentially double its current share of global hydrogen production from 2% to 4% by 2050. Additionally, the country has secured important bilateral partnerships with Japan, Germany, and the European Union, providing crucial technical collaboration and infrastructure financing.

Kenya

Kenya has emerged as a significant player in Africa's GH2 landscape, and several feasibility projects are underway. The country is strategically leveraging its RE resources, with approximately 90% of its electricity already coming from RE sources, particularly geothermal, which provides dispatchable power critical for stable hydrogen production. An ambitious project in feasibility assessment is Fortescue Future Industries' (FFI) initiative, which signed an MoU with the Kenya Private Sector Alliance (KEPSA) to assess an integrated large-scale GH2 and ammonia production facility (African Energy Portal, 2021).

Kenya's Green Hydrogen Strategy identifies several competitive advantages, including its significant RE potential with high solar radiation levels across the country and wind resources, especially in northern regions. The strategy outlines a phased approach, beginning with domestic market development (2023–2027), focusing on fertiliser and methanol production, and expanding into shipping fuels and regional exports (2028–2032). Kenya has also secured critical international partnerships to advance these projects, including with the European Union through the Global Gateway initiative that launched Kenya's Green Hydrogen Strategy and Roadmap in September 2023. The country's ambitious plans align with its National Climate Change Action Plans, which target a 32% reduction in emissions by 2030. They position Kenya as a potential leader in East Africa's hydrogen economy with domestic applications and export opportunities to nearby markets.

Morocco

Morocco has four significant projects currently in the feasibility assessment phase. Based on the data provided, these include the HEVO-Morocco project with a substantial capacity of 689.2 MW, producing 103,300 tonnes of hydrogen annually (Gupta, 2021), the Laayoune and Dakhla project with an impressive 8 GW capacity targeting 1,386,000 tonnes annually (Western Africa Resource Watch, 2023), the Guelmim-Oued Noun-Chbika project (phase 1) with a 400 MW capacity yielding 69,300 tonnes yearly, and the Masen-KfW project with a 100 MW capacity producing 17,300 tonnes annually (Masen, 2020). These projects represent Morocco's focus on both domestic applications and export opportunities to European markets.

Morocco's prominence in GH2 development stems from several strategic advantages outlined in the country's energy strategy. The nation possesses exceptional RE resources, with significant solar potential receiving more than 3,000 hours of sunshine per year and approximately 5 kWh/m²/day of solar irradiation, alongside substantial wind resources particularly in its southern regions. According to the German Fraunhofer Institute, Morocco has the potential to supply up to 5% of Europe's GH2 energy needs, benefiting from its geographic proximity to European markets and established trade relationships. The country's RE strategy targets 52% installed capacity by 2030, with plans to reach 70% by 2040 and 80% by 2050, creating the foundation for large-scale GH2 production. Morocco's „Morocco's Offer" framework also encompasses the entire GH2 value chain, allocating up to one million hectares for production and developing critical infrastructure such as ports, gas pipelines, and desalination plants, while offering tax and customs incentives to attract significant investment. According to the European Investment Bank, Morocco aims to produce 160 terawatt hours of GH2 by 2050, potentially capturing up to 4% of world demand.

In October 2024, Morocco's GH2 portfolio was further strengthened when TotalEnergies, through its joint venture TE H2, announced a significant partnership with the Kingdom of Morocco to develop the country's first GH2 production site. The „Chbika" project, located on Morocco's Atlantic coast, aims to deploy 1 GW of solar and wind capacity dedicated to producing GH2 through seawater electrolysis, with an annual production target of 200,000 tonnes of green ammonia (Dasgupta, 2024). TotalEnergies described this initiative as „the first phase of a development program aimed at creating a world-class GH2 production center," highlighting Morocco's competitive advantages in RE resources and its strategic proximity to European markets. Under the agreement, TE H2 (a joint venture between TotalEnergies and EREN Group) and Copenhagen Infrastructure Partners (CIP) will develop RE production, while A.P. Møller Capital will develop the port and associated infrastructure for transportation to the European continent. The project will involve a total investment of $10.69 billion, expected to be operational by 2025, with first production beginning in 2027 (Biogradlija, 2022).

Morocco has recently made significant strides in advancing its GH2 strategy through the „Offre Maroc" (Morocco Offer) initiative. On March 6, 2025, following a steering committee meeting chaired by the head of government, the country unveiled its selection of five investment consortia to develop six GH2 projects with a total investment value of 319 billion dirhams (Head of Government, Kingdom of Morocco, 2025). The selected investors include Ornx Green Hydrogen (a joint venture between American Ortus Power Resources, Spanish Acciona, and German Nordex), a Hispanic Emirati consortium comprising Taqa and Cepsa, Saudi ACWA Power, Moroccan company Nareva (a subsidiary of Al Mada holding), and a consortium of United Energy Group and China Three Gorges. These projects will be developed across strategic locations in southern Morocco, including Boujdour, Dakhla, and Laâyoune, with ACWA Power leveraging its existing RE expertise in the country. The initiative represents a structured approach to GH2 development, with investors first signing six-month land reservation contracts followed by detailed technical studies. The selection process evaluated financial and technical capabilities for both hydrogen production and associated infrastructure like ports, electrical networks, and desalination plants.

Mauritania

Mauritania is emerging as a promising player in Africa's GH2 landscape, with several significant projects currently in the feasibility assessment phase. The country's strategic position, abundant RE resources, and favourable policy environment have contributed to its prominence in feasibility studies. Mauritania is leveraging its considerable solar and wind potential, particularly in its northern regions, to develop what could become some of the world's largest GH2 projects.

Among the most significant initiatives is Project Nour, a partnership between Chariot Green Hydrogen and TotalEnergies H2 (TEH2) (Chariot, n.d.). This project spans approximately 5,000km² across northern Mauritania and has completed its feasibility study, confirming its „world class potential." The study outlined a phased development approach with a first phase RE capacity of 3 GW, powering up to 1.6 GW of electrolysis capacity to produce 150 kt of GH2 annually. Project Nour is notable for its dual focus on domestic applications (particularly green steel production) and exports (especially green ammonia), combining Mauritania's power-to-X potential with its established iron ore industry. The project benefits from geographical proximity to Europe and access to the deep-sea port at Nouadhibou

Another significant project under feasibility assessment is the Hynfra-MGA Ammonia plant, which plans to utilise 120-200 MWel of capacity to produce approximately 100 kt of ammonia annually, demonstrating Mauritania's growing portfolio of GH2 initiatives at various scales.

The AMAN project, developed by CWP Global, is even more ambitious, aiming to become one of the world's largest RE initiatives. This 30GW project will be located in northern Mauritania on a desert site of approximately 8,500 km² (Ministère du Pétrole, des Mines et de l'Energie, n.d.). The project's hybrid wind and solar generation benefits from a stable, high-capacity factor profile, promising low-cost clean energy ideal for massive-scale GH2 production. The government of Mauritania has demonstrated strong support for these projects, committing to accelerate progress on development and approvals processes. This institutional backing, combined with the country's exceptional RE resources and strategic location relative to European markets, positions Mauritania as a potential leader in Africa's GH2 sector, particularly for export-oriented production that could help meet the significant projected demand for GH2 in industries such as steel production, long-range shipping, and fertiliser manufacturing.

Angola

Angola has several projects under feasibility assessment. The country's state-owned energy company, Sonangol, is conducting conceptual and engineering studies in partnership with German companies Conjuncta GmbH and Gauff GmbH & Co Engineering KG. This $1.3 billion project aims to identify suitable locations for GH2 production facilities for both domestic consumption and export, with Germany being a key target market as early as 2025 (Oil Review Africa, 2022). Minbos Resource is assessing the feasibility of utilising 200 MW hydropower from the 520 MW Capanda dam in northern Angola to produce green ammonia for local fertiliser and mining explosives production (Oliveira, 2024). Angola's competitive advantages include its significant hydroelectric resources, particularly the Lauca dam on the Cuanza River, which currently operates at partial capacity (856 MW from four turbines) with the potential to exceed 2,000 MW (Moore, 2023). This existing renewable infrastructure should allow GH2 production without affecting local electricity supply. The initiatives form part of Angola's broader energy transition strategy, leveraging the country's abundant water resources and favourable geographic characteristics. The partnership with Germany is particularly strategic as Europe's largest economy seeks to diversify its RE sources beyond domestic solar and wind production, establishing Angola as part of Germany's international GH2 supply network alongside projects in Nigeria, Morocco, and Namibia.

Botswana

The Lesedi Power Project is currently undergoing feasibility assessment in Botswana. Tlou Energy has partnered with Synergen Met, a plasma torch and pyrolysis technology leader, to develop an innovative approach combining the country's established natural gas reserves with abundant solar energy to produce GH2. The project includes a prototype hydrogen production unit being designed and tested in Brisbane before deployment to Lesedi in 2022, with the potential to generate revenue ahead of the planned 10MW Power Purchase Agreement with Botswana Power Corporation (Biogradalija, 2021). This hybrid approach uses plasma technology for hydrogen production (a first for Sub-Saharan Africa) and plans to incorporate solar PV energy to achieve net-zero CO_2 emissions. The project's strategic advantage lies in its dual-production capability, generating both hydrogen and valuable solid carbon byproducts while creating multiple revenue streams. Beyond power generation, Tlou Energy is exploring using hydrogen for transportation fuel and leveraging Synergen Met's waste management technology to convert toxic waste to inert products. With transmission lines connecting Lesedi to the existing grid expected to be completed in 2023, Botswana is positioning itself as an innovative player in the region's hydrogen economy, focusing on cleaner power generation options.

Tunisia

In May 2024, TE H2 (a joint venture between TotalEnergies and EREN Groupe) and VERBUND (Austria's leading electricity company) signed a Memorandum of Understanding with the Republic of Tunisia to assess the feasibility of the ambitious „H2 Notos" project. The project utilises electrolysers powered by large onshore wind and solar installations and supplied with desalinated seawater. H2 Notos aims to generate 200,000 tons of GH2 annually in its initial phase, with potential to scale up to one million tons per year in South Tunisia (TotalEnergies H2, 2024). A key strategic advantage of the project is its planned connection to European markets through the „SoutH2 Corridor," a hydrogen pipeline project that will link North Africa to Italy, Austria, and Germany, expected to be commissioned around 2030. The Tunisian government views the project as a crucial element in the country's energy transition strategy, enhancing its attractiveness for foreign investment in renewable energies while creating significant local employment opportunities. The consortium, led by TE H2 and VERBUND, will oversee the entire value chain from green electricity production to hydrogen generation, with VERBUND coordinating transport to Central Europe. This project exemplifies Tunisia's potential to become a significant supplier of GH2 to Europe through favourable renewable resources and strategic geographical positioning.

Uganda

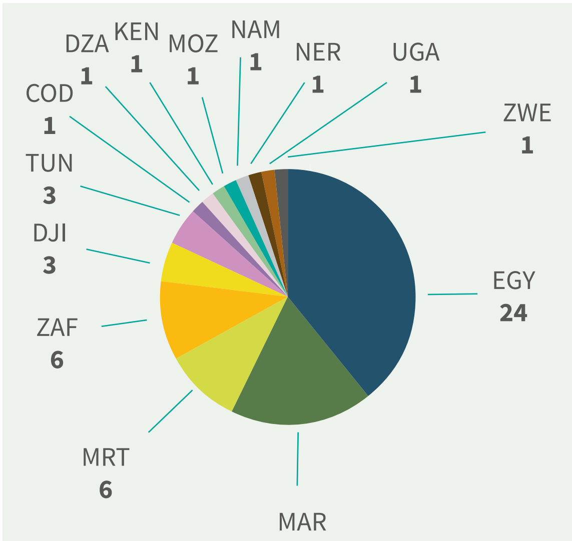
Uganda is emerging in Africa's GH2 landscape through a $400 million fertiliser project currently under feasibility assessment. In February 2024, the government signed a joint development agreement with Industrial Promotion Services (IPS) and Westgass Internasjonal, a Norwegian green energy company. The project will leverage Uganda's renewable resources, drawing 100 MW of hydroelectricity from the Karuma Hydro Power Station to produce GH2 through electrolysis (Martin P. , 2024). The hydrogen will be combined with nitrogen to produce green ammonia, which is further processed with dolomite or phosphates to make fertilisers, with a target of 200,000 tons annually. Financial backing comes from Norwegian institutions, with Norfund providing a convertible loan and Norad offering grant funding. The project's strategic advantages include reducing dependency on expensive fertiliser imports while avoiding greenhouse gas emissions, potentially preventing over 200,000 tons of CO_2 annually (Norfund, 2024). The initiative is expected to create 300 direct jobs and increase agricultural yields, positioning Uganda as a pioneer in green technology adoption in a region where fertiliser usage remains far below the sub-Saharan African average.

4.3.4 Projects in concept phase

The concept stage accounts for the largest share of GH2 projects across Africa, with numerous initiatives in early development. This extensive pipeline reflects the continent's increasing commitment to exploring hydrogen opportunities, despite being in the preliminary stages. Notably, these concept-stage projects are geographically diverse, spanning 15 African countries from North to Southern Africa and East to West. The figure below highlights GH2 initiatives in the concept phase, showcasing the widespread early-stage development efforts across the continent.

Unlike the more advanced project categories concentrated in a handful of nations, the wide distribution of concept-stage projects indicates broadening interest in GH2 development throughout the continent. This diversity suggests that numerous African countries recognize the potential of GH2 and are taking initial steps to participate in this emerging industry, even if they haven't yet progressed to more advanced development phases.

Figure 15: Projects that were under concept phase by October 2024



Source: own figure based on IEA's database (2024)

Egypt leads the continent with 24 concept-stage projects, followed by Morocco with 11, Mauritania with six, and South Africa with five projects, respectively. These four countries collectively account for nearly 70% of all African concept-stage initiatives, reinforcing their positions as the continent's GH2 frontrunners. As extensively discussed in the previous sections, these nations have established clear advantages in RE resources, policy frameworks, and strategic positioning that explain their dominance across all project development phases.

Djibouti is taking initial steps into the GH2 landscape with three concept-stage projects currently in early development. The most notable of these is the Amea Power Ammonia project, which plans to establish a 1 GW facility with a production capacity of approximately 173 kt of hydrogen annually (equivalent to 700 kt of green ammonia) (Atchison, 2022). The other two initiatives involve memoranda of understanding between the government and industry players: Fortescue Future Industries and CWP Global. The CWP Global agreement outlines plans for a 10 GW RE hub to support GH2 and derivative production while diversifying Djibouti’s energy mix.

These projects align with Djibouti’s „Vision 2035“ economic plan, which seeks to transform the country’s economy and leverage its RE resources. Currently dependent on electricity imports from neighbouring Ethiopia, Djibouti aims to use these GH2 initiatives to enhance energy security while developing new export opportunities. Situated at the mouth of the Red Sea, the country’s strategic location provides potential advantages for shipping GH2 derivatives to international markets. However, the projects remain in very early stages compared to more advanced initiatives elsewhere on the continent.

Tunisia has emerged as a key player in North Africa’s GH2 landscape with the signing of eight Memoranda of Understanding (MoUs) for GH2 production, with several international companies, including TotalH2 & Verbund, ACWA Power, the “TUNUR” consortium, “Aker Horizons” and “Verbund,” “Savanah Energy,” “Hydrogène de France,” “Amarenco” and “H2 Global,” as well as “DEME Hyport” and “Abo Energy.” These partnerships aim to implement Tunisia‘s national GH2 strategy, with total investment estimated at around 120 billion euros.

Three significant concept-stage projects are currently under development. The most substantial initiative is the H2Notos-Phase 2 project, which aims to establish a 10 GW facility capable of producing approximately 1,386 kt of hydrogen per year. This flagship project is complemented by two phases of the ACWA-Tunisia GH2 project: the first phase (2 GW) is designed to produce 200 kt of hydrogen annually, while phases 2-3 (4 GW) target an additional 400 kt yearly. Collectively, these projects represent a combined potential capacity of 14 GW of RE and 1,040 kt of hydrogen production annually, demonstrating Tunisia’s substantial commitment to GH2 development (ACWA Power, 2024).

The ACWA Power project exemplifies Tunisia’s ambitious approach to GH2. Under a memorandum of understanding signed with the Tunisian Ministry of Industry, Mines and Energy, ACWA Power will work to establish, operate, and maintain electricity generation units with a production capacity of up to 12 gigawatts of RE. The comprehensive development includes storage systems, transmission lines, water desalination facilities, electrolysis devices, and infrastructure projects to allow direct connection to the main pipeline. According to ACWA Power, the first phase will include installing four gigawatts of RE (along with battery storage facilities) and an electrolysis capacity of two gigawatts, to produce 200,000 tons of GH2 annually.

Tunisia’s strategic position in the Mediterranean enables exports to Europe. A key element of Tunisia’s export strategy is its integration with the „South 2“ hydrogen pipeline, an initiative by the European Network of Transmission System Operators for Electricity. Classified as a project of common interest by the EU, this pipeline will connect Tunisia with Italy, Austria, and Germany, creating a direct export route to major European markets. This infrastructure alignment is critical for Tunisia’s hydrogen ambitions and represents a strategic competitive advantage compared to more distant suppliers.

The country’s GH2 initiatives align with its national strategy announced in October 2023, which targets an annual production of 8.3 million tons of GH2 and by-products by 2050. As Tunisia’s Secretary of State for Energy Transition, Ouael Chouchene, emphasized, these projects leverage the country’s strategic geographic location, existing infrastructure, and skilled workforce to create a sustainable future. Marco Arcelli, CEO of ACWA Power, highlighted the potential of these projects to „build a bridge with Europe to help reach its decarbonisation targets“ while contributing significantly to Tunisia‘s economic growth and job creation. Through these concept-stage projects, Tunisia is positioning itself as a key player in the GH2 economy, with prospects to become a major supplier to the European market while advancing its sustainable development goals.

4.3.5 Demonstration projects

Two demonstration projects (see the table below) have been identified across the continent, serving as key testing grounds for innovative applications and production methods.

Table 9: Reported GH2 related demonstration projects in Africa

No	Project name	Product	Announced size	Capacity (MWel)	Capacity Kt H2/year	Country	Date online
1	Gaia-H2Pro Project	H2	10–20 MW	15	2,6	MAR	
2	H2 plant at Ironveld's Rustenburg smelter	H2	5kg H2/h		0,04	ZAF	2024

Source: IEA's database (2024)

The Gaia-H2Pro Project is a strategic partnership announced at COP27 (November 2022) between Moroccan RE developer Gaia Energy and Israeli company H2Pro. Under this agreement, Gaia will deploy 10–20 MW-scale H2Pro electrolyser technology for a demonstration project in Morocco, while exploring its application in a Gigawatt-scale system being developed within the Kingdom (GAIA Energy, 2022). The project utilises H2Pro's E-TAC (Electrochemical–Thermally Activated Chemical) technology, which reaches 95% efficiency by time-separating hydrogen and oxygen generation. This efficiency (compared to 60–70% for traditional methods) is achieved by avoiding the inefficient Oxygen Evolution Reaction, making it particularly suitable for Morocco's RE context.

BurnStar Technologies, in partnership with Turnkey Modular, is developing a 5 kg per hour Turquoise Hydrogen plant at Ironveld's Rustenburg smelting site in South Africa. Announced in November 2023, this facility represents BurnStar's first commercial Guilt-Free Hydrogen™ catalytic molten metal reforming plant, designed to showcase the process of introducing natural gas or LPG into a molten metal catalyst to produce hydrogen for CO_2-free Green Steel production (Burnstar, 2023). The plant was scheduled to be fully operational by the end of Q1 2024. Once established, Ironveld planned to evaluate hydrogen as a green reducing agent in its high-purity steel production process, substantially reducing carbon consumption. BurnStar indicated it had already begun development of a larger 5-ton per day unit and would incorporate learnings from this first commercial operation.

4.3.6 Project development outlook

The analysis of GH2 projects across Africa reveals a diverse landscape of development occurring at varying paces and scales across the continent, rather than a uniform continental approach. This heterogeneity reflects individual African nations' different capacities, resources, and strategic priorities. The operational projects section demonstrates that pioneering initiatives are already functioning in three countries – Egypt, Namibia, and South Africa – albeit at relatively modest scales ranging from 3.5 to 15 MW. These initial projects serve as critical proof-of-concept demonstrations that GH2 production is technically viable across different African contexts, from mining applications in South Africa to industrial ammonia production in Egypt and transportation infrastructure in Namibia.

Projects under construction or having reached FID show a concentration of activity in specific countries, with Namibia emerging as a continental leader with three of the five projects in this category. This suggests that certain countries are creating more conducive environments for advancing projects beyond planning stages, likely due to combinations of favourable RE resources, policy frameworks, infrastructure development, and international partnerships. The scale of these projects is also increasing significantly compared to operational ones, with Sasol's 60 MW project in South Africa indicating the transition toward industrial-scale implementation.

The feasibility assessment phase reveals a broader geographic distribution with significant activity in Egypt, Namibia, South Africa, Kenya, Morocco, Mauritania, and Tunisia. This wider participation demonstrates growing continental interest in GH2, with each country leveraging its unique advantages –whether Egypt's industrial base, Morocco's proximity to European markets, or South Africa's mining expertise. The substantial number of projects in this phase (approximately 30 across the continent) and their increasing scale suggest a potential acceleration in Africa's GH2 development in the coming years.

The concept phase represents the most geographically diverse category, spanning 15 countries from North Africa to Southern Africa and East to West, with Egypt, Morocco, Mauritania, and South Africa leading in project numbers. This widespread initial interest indicates a continental recognition of GH2's potential, though the significant drop-off between concept and operational phases highlights the challenges in advancing projects to completion. The geographical diversity at this early stage presents both an opportunity for inclusive development and a challenge in ensuring that more countries can overcome barriers to project implementation.

Demonstration projects, though limited in number, play a crucial role in testing innovative technologies and applications, such as H2Pro's E-TAC electrolyser technology in Morocco and BurnStar's catalytic molten metal reforming in South Africa. These projects are essential for adapting global technologies to African contexts and potentially developing locally optimised solutions that could reduce costs and increase feasibility across the continent.

This fragmented but vibrant landscape of GH2 development across Africa illustrates that the continent's potential is being realized through distinct national approaches rather than a unified strategy. Leading countries like Egypt, Namibia, Morocco, and South Africa are establishing precedents and developing expertise that could benefit neighbouring nations, while countries earlier in the GH2 journey have opportunities to learn from these experiences. The varying pace of development across countries underscores the importance of tailored approaches that account for local conditions, capacities, and priorities, rather than a one-size-fits-all continental model. As projects mature, increased regional cooperation and knowledge sharing will be essential to ensure that GH2 development benefits the broader African economy rather than remaining confined to a handful of resource-advantaged nations.

4.4 Value chain creation

Developing a robust GH2 value chain in Africa presents economic and environmental opportunities and could drive economic growth through job creation, infrastructure development, and export opportunities. Additionally, from an environmental perspective, GH2 offers a pathway to decarbonising industries, reducing reliance on fossil fuels, and enhancing energy security. However, challenges remain in ensuring cost competitiveness and developing policy frameworks to support market growth.

The GH2 value chain encompasses several interconnected stages. Industrial decarbonisation, energy sector integration, and transport applications depend on reliable supply chains from upstream and midstream investments. The availability of low-cost RE and water resources directly influences the scalability of GH2 production. Thereafter, effective compression, liquefaction, and conversion into carriers (e.g., ammonia and methanol) are essential for ensuring hydrogen reaches end users safely and efficiently. Infrastructure investments in pipelines, ports, and storage are critical enablers for domestic adoption and export market access.

The framework used to group and discuss the value chain segments in the following sections was developed by the PtX Hub in the build-up to the 2024 African Green Hydrogen Summit (see appendix in section 12.2). The framework groups activities into three stages: upstream, midstream and downstream. Within these three stages, examples from African countries are provided. The choice of examples was informed by the initial high-level assessment of African countries, where Tier 1 and, to some extent, Tier 2 countries (see the methodology section) have been prioritised, and are listed in alphabetical order.

4.4.1 Upstream: GH2 production

The upstream segment of the GH2 value chain involves the production of hydrogen through electrolysis, powered by RE sources. While Africa has abundant RE potential, grid constraints and water scarcity pose challenges for scaling GH2 production (GIZ, 2023c). The key segments of this value chain are illustrated in the figure below, with country-specific examples included thereafter:

Figure 16: Key components of the upstream GH2 value chain

RE infrastructure
The expansion of RE generation is essential for GH2 production, requiring significant investment in solar and wind farms

Desalination plants
Given Africa's water scarcity, desalination facilities will be crucial for ensuring a sustainable water supply for electrolysis

Electrolyser and fuel cell manufacturing
Localising the production of electrolysers and fuel cells can create economic opportunities, leveraging Africa's vast mineral resources

RE infrastructure – examples

Morocco: In 2024, Morocco's OCP Group and France's Engie signed a RE and desalination deal worth up to € 17 billion, aiming to support OCP's carbon neutrality by 2040. The agreement covers renewable power generation, energy storage, green ammonia production, electricity infrastructure, and water desalination. Projects will roll out between 2026 and 2032, aligning with Morocco's strategy to become a RE hub and support EU decarbonisation goals (Eljechtimi & Hernandez, 2024).

South Africa: South Africa has witnessed rapid and continued growth in RE capacity since regulatory changes and in response to the country's ongoing electricity supply crisis (DMRE, dtic, 2023; PtX Hub, 2023a). For instance, the City of Cape Town has commenced construction on a R200-million, 7 MW solar photovoltaic (PV) plant in Atlantis, expected to deliver electricity by the end of 2025 (Venter, 2024).

The RE Independent Power Producer Procurement Programme (REIPPPP) has been instrumental in attracting private investments for large-scale RE projects, while ensuring a competitive bidding process, and mandating local content requirements to stimulate the domestic industry (DMRE, dtic, 2023). The REIPPPP has facilitated the construction of numerous solar and wind farms, contributing to a diversified energy mix and reducing reliance on fossil fuels. Despite facing challenges and periods of uncertainty, the REIPPPP has played an important role in localising various components of RE projects, particularly in balance-of-plant (BoP) infrastructure and construction-related activities, including civil and electrical works (DMRE, dtic, 2023).

South Africa is also pursuing a broader strategy to establish a robust local RE value chain through the South African RE Masterplan (SAREM). This initiative aims to increase local manufacturing capabilities in solar PV panels, wind turbine components, and battery energy storage systems (BESS), ensuring that RE deployment aligns with industrial development and job creation goals (DMRE, dtic, 2023). BESS in particular are essential for managing the intermittency of RE sources (and ensuring a stable supply for GH2 production). While South Africa currently has small-scale battery manufacturing capabilities, plans are underway to expand domestic production capacity significantly. One notable development is a multimillion-dollar joint venture to establish the Giga-Africa 1 battery plant (Venter, 2025), which aims to enhance local battery production capacity and support the growing demand for energy storage solutions. Moreover, United Arab Emirates-based RE developer AMEA Power has secured two BESS projects in South Africa (Power Technology, 2025).

Egypt, Tunisia, Morocco, Mauritania: in 2022, AMEA Power's RE production from solar and wind projects had reached about 2,000 MW in 15 countries, including Egypt, Tunisia, Morocco and Mauritania (Reuters, 2022). However, integrating a high share of variable RE sources necessitates careful planning to maintain grid stability (Bulbulia, 2024). Therefore, upgrading existing infrastructure and implementing advanced grid management technologies are imperative.

Desalination plants – examples

Designing desalination plants with excess capacity to meet both the water requirements of electrolysers and the needs of nearby communities could contribute to securing a „social license to operate" (GFSE, 2021). However, it is essential to consider the environmental impact of desalination on marine ecosystems and coastal areas.

Egypt: Given Egypt's water scarcity, water from desalination is crucial for GH2 production. In 2022, Egypt began preparing for desalination in industrial areas such as the Suez Canal Zone (strategically positioned as a "green shipping hub") and Ain El Sokhna to incentivise GH2 investments (UNIDO, 2023). However, GH2 production requires a significant volume of high-purity water. Since Egypt relies on seawater, the purification process, at around 50% efficiency, means twice the volume of seawater is needed per unit of high-purity water (UNIDO, 2023).

Egypt plans to invest EGP 134.2 billion by 2050 to develop seawater desalination facilities, targeting 6.4 million cubic meters of drinkable water daily (Green Hydrogen Organisation, 2025). 20% of Egypt's planned desalinated seawater output will go towards GH2 production. The initiative consists of six five-year phases, with an initial EGP 45 billion allocated to build 47 desalination plants by 2025. The country aims to finalise contracts for 21 plants in this first phase.

Morocco: As mentioned above, the OCP Group and France's Engie signed a RE and desalination deal worth up to € 17 billion (Eljechtimi & Hernandez, 2024). RE projects are scheduled to commence in 2026, followed by the desalination and GH2 developments in 2028 and 2032, respectively.

Namibia: The blueprint for Namibia's green industrialisation recognises the investment requirements needed to construct the necessary desalination plants in the Northern, Central, and Southern Valleys (Government of the Republic of Namibia, 2024). The aim to for this to happen from 2027.

South Africa: Given the water needs for GH2 projects, most of the large-scale GH2 production facilities in South Africa are planned at the coast, so that desalination plants can be co-located with electrolyser plants.

Electrolyser and fuel cell manufacturing – examples

Morocco: In 2023, Belgian engineering firm John Cockerill announced plans to collaborate with a Moroccan energy company to establish an alkaline electrolyser manufacturing plant in Morocco (Smith T. , 2023). The partnership aims to create a Gigafactory that produces high-powered alkaline electrolysers (5MW+/Stack Electrolyser). The electrolyser plant is expected to bolster Morocco's RE ecosystem, aligning with the nation's objective to increase the share of RE in its total installed capacity to over 52% by 2030.

South Africa: The 2021 South African Hydrogen Society Roadmap has put forward a strategy to generate 500,000 tonnes of GH2 annually by 2030 (DSI, 2021), with plans to deploy 10 GW of electrolysis capacity in the Northern Cape region alone by the same year (increasing capacity to at least 15 GW by 2040). Within this context, electrolyser capacity requirements are projected to reach 10.9 GW by 2030, 16.2 GW by 2040, and 24.9 GW by 2050 (PtX Hub, 2024b).

Given South Africa's vast PGM resources (GIZ, 2024a), local electrolyser component manufacturing is gaining traction, with HySA/Catalysis – a University of Cape Town (UCT) affiliated initiative – developing catalysts and catalytic devices for fuel cell and electrolyser systems (UCT, 2025). Hydrox Holdings, a South African company based in Gauteng, is developing a membraneless divergent-electrode-flow-through (DEFT) alkaline electrolyser (PtX Hub, 2024c). This technology reduces production costs by eliminating the need for membranes or expensive electrodes. The company has collaborated with scientists from North-West University to test and validate this approach.

In addition, Mitochondria Energy Company is making strides with its solid oxide fuel cell (SOFC) technology (DBSA, 2020; Slater, 2022). Supported by funding from the Development Bank of Southern Africa (DBSA) and the Industrial Development Corporation (IDC), Mitochondria is developing a 250 kW SOFC system. Mitochondria's plans include constructing a manufacturing facility in the Vaal Special Economic Zone (SEZ) to produce these units ("Project Phoenix"), aiming to bolster local manufacturing and energy security (IDC, 2024). This will include manufacturing capacity to build units totalling 250 MW a year, with plans to ramp up to 1,000 MW a year eventually, depending on demand. Furthermore, at the end of 2024, Mitochondria entered into a collaboration with SolydEra (headquartered in Italy) to develop and commercialise a 50kW containerized SOFC system (SolydEra , 2024).

Lastly, Chem Energy South Africa, a Taiwanese conglomerate CHEM Corporation subsidiary, has established a $ 200million fuel cell production facility in KwaZulu-Natal's Dube TradePort SEZ. Initially focusing on GrH2GrH2, the company plans to transition to GH2 production (Engineering News, 2024; dtic, 2022). Currently, Chem Energy supplies fuel cells to power mobile phone towers, demonstrating practical applications of hydrogen technology. This development not only showcases the operational viability of hydrogen solutions but also opens avenues for technology transfer, given the company's international affiliations

4.4.2 Midstream: Conversion, storage and transportation

Once produced, GH2 needs to be stored, transported, or converted into derivative products such as ammonia, methanol, or sustainable aviation fuels (SAF). A country's ability to compete in the global GH2 economy will depend on scaling up its midstream infrastructure, including pipelines, port logistics, and hydrogen carriers. While the continent has strategic export ports, pipeline and storage infrastructure remain underdeveloped (GIZ, 2023c). The key segments of this value chain are illustrated in the figure below, with country-specific examples included thereafter:

Figure 17: Key components of the midstream GH2 value chain

Hydrogen compression and liquefaction
To store and transport GH2 efficiently, it must be either compressed to high pressures (up to 700 bar) or cooled to extremely low temperatures (around -253°C) to liquefy it

Pipeline and shipping infrastructure
Developing dedicated hydrogen pipelines for domestic distribution is critical to linking production hubs with industrial off-takers (domestic distribution and export)

Ammonia and methanol synthesis
Converting GH2 into green ammonia and methanol is essential for easier transportation and export

Hydrogen compression and liquefaction – examples

Liquefaction is energy-intensive, consuming about 30% of hydrogen's energy content, and requires specialised insulated containers to maintain these low temperatures (Hunt, et al., 2023).

Morocco: CWP Global and Hydrogenious LOHC Technologies are assessing the feasibility of transporting GH2 from Morocco to Europe using LOHC technology. The study examines the potential for daily transfers of 500 tons of GH2 (Morocco World News, 2023).

South Africa: Within this context, South Africa is exploring various storage and transport solutions to support large-scale hydrogen production, particularly in the Northern Cape, where the climate and geography favour RE generation for GH2 production (DSI, 2021). Notably, JSE-listed Anglo American Platinum and South Africa-linked AP Ventures are advancing industrial-scale GH2 value chains by supporting Hydrogenious LOHC Technologies, a German company developing LOHC technology to enable global hydrogen transport and trade, similarly to oil (Creamer M. , 2025).

Pipeline and shipping infrastructure – examples

Namibia: The blueprint for Namibia's green industrialisation recognises the need to expand port capacity at Walvis Bay and Lüderitz to accommodate enhanced regional trade flows and exploit green manufacturing industries (Government of the Republic of Namibia, 2024). This would ensure specialised deep-water capacity for GH2 industries and offshore oil/gas.

South Africa: South Africa's existing port infrastructure (e.g., Saldanha and Coega) provides a strategic advantage that can be leveraged in exporting hydrogen and its derivatives to international markets (GIZ, 2024a). However, significant enhancements and expansions are necessary to fully capitalise on this potential. While current ports provide a foundation, the specific requirements for hydrogen export, such as specialised storage facilities, pipelines, and loading systems, necessitate targeted upgrades (DSI, 2021). The existing infrastructure, however, requires modifications to handle hydrogen's unique properties safely and efficiently.

Recognising this, South Africa's state logistics company – Transnet National Ports Authority (TNPA) – has initiated plans for the development of a new deep-water port at Boegoebaai, identified as a potential hub for producing and exporting GH2 and its derivatives (Barradas, 2023). Additionally, South Africa's coastal ports provide a strategic advantage for exports. Major hubs like Saldanha Bay, Coega, and Richards Bay are being considered for hydrogen export infrastructure, with significant investment needed to develop liquefaction, storage, and specialised loading systems for hydrogen carriers like ammonia and methanol (DSI, 2021; GIZ, 2024a; GIZ, 2024a; GIZ, 2024a).

Namibia, South Africa: In a collaborative effort to enhance regional hydrogen infrastructure, Wesgro – the official tourism, trade, and investment agency for Cape Town and the Western Cape – has entered into a partnership with the Northern Cape Economic Development, Trade, and Investment Promotion Agency (NCEDA), Namibia's Environmental Investment Fund, Gasunie, and Climate Fund Managers (Wesgro, 2024). This partnership aims to explore the feasibility of constructing a GH2 pipeline connecting the Western Cape, Northern Cape, and Lüderitz/Windhoek regions in Namibia. The proposed pipeline, part of the Western SADC GH2 production corridor, seeks to stimulate economic growth by linking GH2 hubs, markets, and industries across these regions. The pre-feasibility study, which was expected to be completed by the end of 2024, will assess various aspects to determine the viability of establishing this GH2 corridor.

Algeria, Egypt, Morocco, Tunisia: Algeria (Medgaz and Transmed pipelines), Egypt (Arab gas pipeline), Morocco (Maghreb Europe gas pipeline and proposed Nigeria-Morocco Gas Pipeline), and Tunisia all possess extensive natural gas pipeline infrastructures, positioning them strategically for the development and export of GH2 (Zulin, 2024; Gómez, 2024; Muhsen, 2025; Hajbi, 2024). While adapting existing gas infrastructure to facilitate the transportation of hydrogen is a feasible venture, it does present additional technical and safety challenges due to the volatile properties of hydrogen (Ayuk, 2025). Moreover, the skills development and technology transfer requirements pose additional hurdles for these countries.

Tunisia: Tunisia has existing port infrastructure that can be leveraged for the export of GH2 and its derivatives, including five unloading ports for oil end products that could potentially be adapted for hydrogen-related products (GIZ, 2021; MIME, 2024; MIME, 2024). Tunisia's GH2 strategy includes plans to modify existing port facilities at strategic locations to handle GH2 derivatives, particularly ammonia and synthetic fuels, to facilitate exports. Moreover, the extensive natural gas infrastructure represents a strategic asset for hydrogen deployment. The Gabes pilot project features a network integration component to showcase hydrogen blending into the local natural gas distribution system (Bdioui, Touati, Ben Chiekh, & López-Agüera, 2024).

Angola: Angola is advancing its GH2 sector through two significant projects

- **Sonangol's Barra do Dande Project:** Angolan oil company Sonangol has partnered with German firms Gauff GmbH and Conjuctta GmbH to develop a GH2 project at the Barra do Dande ocean terminal (Green Hydrogen Organisation, 2025). The Barra do Dande project will utilise 600 MW of electricity (generated from hydroelectric sources) connected to a 400kV substation, to produce 1,200 tons of ammonia to export to the European market (Costa, 2024). Although unconfirmed, the hydroelectric power will likely be sourced from the Laúca Hydroelectric

Dam (2,070 MW), both of which are already integrated into the country's high-voltage transmission network. The Sonangol-led facility aims to produce 280 tonnes of GH2 and is strategically located near a new port, integrated with the country's oil and gas infrastructure. In this way, the project uses the country's natural endowments and existing storage and transportation infrastructure.

- **Minbos' Capanda Project:** Located within the Capanda Agro-Industrial Hub in Malanje Province, this project will leverage Angola's abundant hydroelectric resources, such as the Capanda Dam (520 MW capacity), to produce green ammonia (Thomas E. , 2023). Minbos Resources has secured a 60-year lease for the project site and access to 200 MW of zero-carbon hydroelectric power at highly competitive rates (Minbos, 2025).

Nigeria: Nigeria currently lacks dedicated hydrogen pipelines or large-scale hydrogen storage facilities (German-Nigerian Hydrogen Office, 2024). Instead, hydrogen is primarily produced on-site through steam methane reforming or electrolysis, as seen in Transcorp Ughelli and Egbin power plants, and is directly utilised within the facility via internal pipelines. When small quantities of hydrogen are needed but not produced on-site, they are delivered in pressurised steel or carbon fibre composite cylinders. The conversion of existing oil and gas pipelines for hydrogen transport is also under consideration. Given Nigeria's extensive pipeline network, repurposing these assets could facilitate the country's transition to hydrogen and other clean energy sources.

Additionally, Dangote Industries operates Africa's largest granulated urea fertiliser complex in the Lekki Free Trade Zone, Lagos, Nigeria (Dangote, 2025). The plant, built at a cost of $2.5 billion, has an annual production capacity of 3 million metric tonnes of urea. Here, hydrogen is produced via steam methane reforming of natural gas, a process classified as blue hydrogen when combined with carbon capture technologies. While this is not GH2, it illustrates Nigeria's capacity for large-scale hydrogen use in industry. With the integration of RE, such facilities could transition toward GH2 production and use.

Ammonia and methanol synthesis – examples

The transportation, distribution, and storage of hydrogen present significant technical and cost-related challenges, especially for large volumes (German-Nigerian Hydrogen Office, 2024). While hydrogen can be stored and transported as a gas or liquid, these methods remain complex and expensive. Alternative hydrogen carriers such as ammonia and methanol are being explored due to their established supply chain infrastructure to address this.

Given that converting GH2 into ammonia or methanol is essential for transportation and thus export (Torkington, 2024; Osman, Nasr, Lichtfouse, Farghali, & Rooney , 2024), green ammonia is a strong candidate for Africa's hydrogen export model. Amongst other reasons, ammonia can be cracked back into hydrogen at its destination, while also serving as a low-carbon shipping fuel (Jacobsen, 2024; Moeve Global, 2025).

Egypt: Fertiglobe, a UAE-based urea and ammonia exporter, finalised a € 397 million offtake agreement with Germany's H2Global program in July 2024 (Green Hydrogen Organisation, 2025). Under this deal, the company will supply green ammonia from its Egyptian facilities to the EU from 2027 to 2033, meeting 10% of Germany's annual demand. In December 2023, Fertiglobe delivered the first ISCC PLUS-certified green ammonia shipment to India from its electrolyser facility in Egypt's Suez Canal Economic Zone.

Morocco: Given their experience in fertiliser production, Morocco has identified the use of hydrogen as a feedstock in the local production of green ammonia as part of their GH2 National Strategy (Moroccan Ministry of Energy, Mines and Environment, 2021).

Namibia: Namibia will focus on the export of hydrogen derivatives, including ammonia, methanol, synthetic kerosene and hot-briquetted iron (Government of the Republic of Namibia, 2024). Focusing on ammonia, as industry and supply chains scale up, green ammonia costs are expected to fall below $500/ton. Namibia's ammonia production costs could fall to $420–460/ton by 2030 and to $320–360/ton by 2050 as technology improves, volumes increase, and standardisation drives learning rates and lowers equipment costs.

South Africa: South Africa has a long history of ammonia production for fertiliser manufacturing and chemical industries, and these existing facilities could be adapted for green ammonia production (Sasol, 2022; Sasol, 2021).

Green ammonia presents a significant opportunity for South Africa, not just for export markets (e.g., Europe and Japan) but also for domestic applications, such as clean fuel in maritime transport and hydrogen storage (DSI, 2021). Similarly, green methanol, a liquid at ambient temperature, offers an efficient alternative for hydrogen transport and is a potential feedstock for SAF, aligning with global aviation decarbonisation goals (Moeve Global, 2025).

Tunisia: Green ammonia production represents a key export opportunity, building on Tunisia's existing experience in the fertiliser sector (GIZ, 2021; MIME, 2024).

Angola: As mentioned above, the Barra do Dande project aims to utilise surplus capacity from existing hydroelectric power generation to produce GH2. This will then be combined with nitrogen to generate green ammonia, which can be used to decarbonise hard-to-abate industries (CWP Terra, 2024). Specifically, it can serve as a low-carbon fuel for international shipping, support green fertiliser production, or act as a carrier for transporting hydrogen energy to market. Additionally, Minbos' Capanda project plans to produce 112,000 tonnes of green ammonia annually, which will be used to manufacture 255,000 tonnes of high-density ammonium nitrate for fertilisers and mining explosives (Thomas E. , 2023). This initiative addresses Angola's agricultural needs by reducing reliance on imported fertilisers and supports the mining sector with locally produced explosives.

Nigeria: Given the costs and challenges, in Nigeria, ammonia is emerging as the most promising long-term solution for the storage and transportation of GH2, while methanol is preferred for short- and mid-term applications (German-Nigerian Hydrogen Office, 2024).

4.4.3 Downstream: Utilisation and market development

Downstream applications drive industrial decarbonisation, clean energy integration, and export market development. Within the downstream portion of the value chain, GH2 can be used in various sectors (see the sections 3.5 and 3.6 for more details) including:

Industrial applications: Africa's steel, aluminium, chemical, and mining industries are among the largest emitters of GHG emissions due to their reliance on coal-based energy and fossil fuel feedstocks. The use of GH2 as a clean alternative could drastically reduce emissions in these sectors (GIZ, 2024a). A noteworthy mention is Project Oshivela in Namibia by HyIron (HyIron, 2025).

Energy generation: GH2 can support Africa's RE transition by acting as an energy storage solution to balance intermittent solar and wind generation. In particular, GH2 can be integrated into African power grids to provide stable RE supply (GIZ, 2023c).

Transport sector: Africa's transport sector contributes significantly to carbon emissions, creating a strong case for hydrogen-powered transport, particularly in heavy-duty and commercial applications. Fuel cell vehicles (FCVs) and hydrogen-powered heavy transport are amongst the emerging applications being considered (PtX Hub, 2023b).

Exports and border markets: With increasing global demand for GH2, Africa is well-positioned to become a key supplier, particularly to regions such as Europe and Japan, which are investing in hydrogen imports and infrastructure (GIZ, 2024a). However, while heavy industry and export markets show demand, policy uncertainty and weak local incentives hinder widespread hydrogen (GIZ, 2023c). Additionally, maritime trade and international aviation must decarbonise to meet global emissions reduction targets (IEA, 2023), creating a market opportunity for hydrogen-derived fuels such as ammonia and SAF. These sectors require scalable, low-carbon energy solutions, further strengthening the case for Africa's GH2 exports.

4.4.4 Value chain integration

Developing a comprehensive and sustainable GH2 value chain in Africa will require coordinated efforts across the public and private sectors. Investments in RE, electrolyser manufacturing, infrastructure development, and market incentives are crucial to positioning Africa as a player in the global GH2 economy (GIZ, 2024a). Countries can leverage their natural advantages to drive a sustainable and competitive GH2 industry by addressing challenges such as costs, infrastructure gaps, and regulatory frameworks.

While Africa has an abundance of RE resources, scaling up hydrogen production and creating the necessary infrastructure for storage, transport, and distribution will require significant investment (Global Africa Network, 2025). Within this context, certain countries have integrated the concept of "Hydrogen Valleys" into their GH2 strategies, which essentially link the upstream, midstream, and downstream components of the GH2 value chain (Thomas & Plavina, 2022).

Hydrogen valleys or "hubs" serve as strategic hubs for GH2 production, integrating shared infrastructure to optimise costs, efficiency, and scalability (Thomas & Plavina, 2022). By clustering production, storage, and distribution within designated areas – often in Special Economic Zones (SEZs) – these valleys enable economies of scale, reducing investment risks for private sector players. Common infrastructure such as pipelines, electrolysis facilities, and RE sources fosters synergies among industries, facilitating local use while enhancing export potential. Co-locating hydrogen producers with industrial off-takers also streamlines logistics, minimises transmission losses, and supports sectoral decarbonisation. Hydrogen valleys can also attract international partnerships and funding when positioned along key transport corridors, further strengthening their role in the global GH2 economy. Some country-specific examples include:

Morocco: Morocco's GH2 strategy includes supporting the creation of industrial clusters, to create synergies for the utilisation of infrastructure (Green Hydrogen Morocco, 2025).

Namibia: Namibia's GH2 strategy envisions the development of three key valleys – Southern, Central, and Northern – each serving as a hub for green industrialisation and RE projects (GH2 Namibia, 2024; Government of the Republic of Namibia, 2024). These industrial zones are intended to avoid the risk of enclave industries with limited domestic value add, establish common user infrastructure to lower development cost and risk, and cluster industries to minimise footprint and maximise efficiencies. An overview of these valleys and the strategic projects include:

1. **Southern Valley:** Establishing a large-scale GH2 infrastructure and production facilities for common use, utilising the region's high solar and wind energy potential. Here, the Hyphen GH2 project is a flagship initiative aiming to produce GH2 and green ammonia (Hyphen, 2025).
2. **Central Valley:** Promote green industrialisation by integrating RE energy into existing industrial processes and developing new green industries. Here, the Project Oshivela by HyIron focuses on producing GH2 and green iron (HyIron, 2025).
3. **Northern Valley:** Integrate GH2 production with agricultural practices, enhancing energy access and promoting sustainable farming. Here, the Daures Hydrogen Village is a pilot project aiming to produce GH2 and green ammonia.

South Africa: South Africa's Hydrogen Society Roadmap envisions the creation of hydrogen hubs to bolster its energy transition and economic development (DSI, 2021). Three primary hubs have been identified:

1. **Johannesburg Hub:** Aimed at leveraging existing industrial infrastructure to integrate GH2 solutions.
2. **Durban Hub:** Focused on utilising the port's strategic location for hydrogen export and local industrial applications.
3. **Mogalakwena and Limpopo Hub:** Centred around the Mogalakwena platinum mine, this hub plans to use solar energy to produce GH2, power mining operations and support local communities.

Tunisia: Tunisia's GH2 strategy includes the development of hydrogen valleys, integrating ecosystems where GH2 production and demand are concentrated (GIZ, 2021; MIME, 2024; MIME, 2024). These valleys will be established within existing or future SEZs, acting as business opportunity hubs while covering the entire hydrogen value chain for both local use and export. Additionally, they can leverage international cooperation to enhance their impact if positioned along transport corridors.

Egypt: Egypt's National Low-Carbon Hydrogen Strategy outlines a phased approach to integrate the GH2 value chain, aiming to position the country as a global leader in the sector. The strategy leverages Egypt's strategic location, abundant RE resources, and existing infrastructure to develop a comprehensive hydrogen economy. Key initiatives include the establishment of the National Council for Green Hydrogen and its Derivatives to oversee implementation, and the identification of strategic sites such as the Suez Canal Economic Zone, which serves as a hub for multiple large-scale projects encompassing RE generation, electrolysis, ammonia synthesis, and export infrastructure for project development. The plan anticipates producing up to 5.6 million tonnes of low-carbon hydrogen annually by 2040, capturing 5–8% of the global market, and contributing an estimated $18 billion to GDP while creating over 100,000 jobs (GH2.org, 2025b).

4.5 Export opportunities for African GH2 production

Africa is strategically positioned to emerge as an important player in the global hydrogen economy, with estimates from the European Investment Bank (EIB) suggesting that the continent could generate up to 50 million tonnes of GH2 per annum by 2035 (EIB, 2023). The following subsections briefly highlight GH2 export opportunities for selected countries with high export potential, for which relevant information could be retrieved from the literature. By examining the export potential and strategic positioning of countries, an understanding the broader possibilities for African nations in the global hydrogen market emerges. Each country case demonstrates the unique strengths, challenges, and strategic pathways available to African countries seeking to become leading exporters in this emerging market.

4.5.1 Egypt

The export landscape for African GH2 presents significant opportunities for continental growth and global market participation. The following analysis details Egypt‘s approach to developing its export capabilities and international partnerships, providing insights into potential strategies for other African nations.

Strategic position and export potential

Egypt possesses a unique combination of natural resources, infrastructure, and strategic location that positions it favourably in the global GH2 landscape. These advantages create a strong foundation for developing a sustainable and globally competitive hydrogen export economy.

According to Egypt‘s National Low Carbon Hydrogen Strategy (Limited, 2024), the country has established ambitious targets for its hydrogen export sector, projecting significant growth over the coming decades:

- By 2030: 1.4 million tons of hydrogen for export (Central Scenario);
- By 2040: 3.75 million tons of hydrogen for export, representing 5% of the anticipated tradable market.

Under a more ambitious „Green Scenario,“ these export targets increase to:

- By 2030: 2.8 million tons of hydrogen for export;
- By 2040: 5.6 million tons of hydrogen for export, representing 8% of the global tradable market;
- Strategic Export Markets.

Egypt‘s hydrogen export strategy primarily focuses on the European market, which is expected to be the largest hydrogen import market. The European Union‘s REPowerEU Plan, unveiled in May 2022, sets a target of 10 million tonnes of renewable hydrogen imports by 2030 (European Commission, 2022), representing a significant opportunity for Egypt.

Green shipping gateway potential

Egypt‘s unique position along the Suez Canal creates a significant opportunity to develop a green shipping corridor that could advance global maritime decarbonisation goals and Egypt‘s hydrogen export ambitions. By establishing itself as a green refuelling station for ships travelling from Europe to Asia, Egypt could capture a substantial share of the emerging market for green shipping fuels.

The economics of developing this opportunity are promising, particularly compared to the alternative of exporting fuels for bunkering in European ports. If ships could bunker during their waiting time before entering the Suez Canal, the bunkering stop would require minimal additional time and operational costs, creating a compelling value proposition for shipping companies.

However, several economic challenges must be addressed to realise this potential fully:

1. **Regional Competition:** At the Red Sea, Saudi Arabia represents a potential regional competitor in producing green fuels and providing bunkering services. Saudi Arabia may be able to produce green fuels at lower costs due to lower weighted average capital costs. It already has the largest port with established bunkering infrastructure for conventional marine fuels in the Red Sea.
2. **Bunkering Patterns:** Current shipping logistics have large vessels on trunk lines bunkering at major hubs in Asia and Europe rather than Egypt. While the lower energy density of green fuels like ammonia and methanol could theoretically necessitate additional fuelling stations, the Suez Canal‘s position alone may not be sufficient to disrupt these established bunkering patterns without further incentives.
3. **Infrastructure Development:** Significant investment in bunkering facilities, fuel storage, and handling infrastructure would be needed to position Egyptian ports as competitive green fuel providers.

Strategic collaboration with global maritime hubs to establish green shipping routes will be critical in positioning Egypt and the Suez Canal as key players in decarbonising the shipping industry. Economic incentives such as reduced Suez Canal tolls for vessels using sustainable shipping fuels could accelerate adoption and route establishment. At the same time, the decarbonisation of port and canal infrastructure itself would set an example for the industry.

Natural and infrastructure assets supporting exports

Several key assets enhance Egypt‘s export potential:

- **RE resources:** Excellent solar and wind resources, with technical solar energy potential of approximately 20,000 GW of solar photovoltaic capacity and 6,000 GW of wind onshore capacity (Limited, 2024);
- **Strategic geographical position:** Proximity to European markets enhances potential as an export hub;
- **Well-established trade relationships:** Particularly with the European Union;
- **Existing and planned infrastructure:** Port facilities and gas infrastructure suitable for hydrogen and derivatives export;
- **Low production costs:** Egypt appears to be in the lower cost range of hydrogen production worldwide, according to the strategy document.

Industrial and technical export capabilities

Egypt holds significant advantages for export development through:

- **Strong chemical industry base:** Particularly in fertiliser production, providing expertise for hydrogen derivatives like ammonia;
- **Clear governmental commitment:** National strategy and governance framework supporting export development;
- **Track record in large-scale projects:** Established experience in developing large-scale energy projects;
- **Competitive renewable electricity costs:** Significantly low costs of RE production.

Strategic export products

The strategy identifies several key export products that Egypt will prioritise:

1. **Green Ammonia:** A primary focus given Egypt's existing ammonia production and export experience;
2. **Synthetic Fuels:** Including e-methanol and other Power-to-X products;
3. **Direct Hydrogen Export:** Through specialized carriers or pipelines as technology develops.

Export infrastructure and logistics

Egypt's export strategy considers three main possibilities for transporting hydrogen to markets:

1. **Pipeline Export:** Exporting hydrogen produced in Egypt through dedicated pipelines to Europe;
2. **Power Interconnection:** Interconnecting RE generation with power cables to Europe, producing hydrogen closer to final users;
3. **Maritime Shipping:** Transporting hydrogen derivatives (ammonia, methanol, liquid organic hydrogen carriers) via the Mediterranean Sea and Suez Canal.

To achieve the export targets, Egypt will develop substantial infrastructure. By 2030, the central scenario would require approximately 13 GW of electrolyser capacity supported by 19 GW of new RE capacity. By 2040, this would scale to 48 GW of electrolyser capacity supported by 72 GW of RE (Limited, 2024).

Associated infrastructure requirements include:

- Desalination plants for water supply;
- Production facilities for green ammonia and synthetic fuels;
- Port infrastructure upgrades for handling hydrogen carriers;
- Potentially dedicated hydrogen pipelines connecting to Europe;
- Economic Impact of Export Development.

The export-oriented hydrogen economy is expected to generate significant economic benefits for Egypt (Ringel, 2024):

- **GDP Growth:** Potential boost to Egypt's GDP in the order of 10–18 billion $ by 2040;
- **Employment Creation:** Over 100,000 jobs, with a high proportion being highly skilled;
- **Energy Security:** Increased domestic energy security through reduced reliance on petroleum imports;
- **Technology Transfer:** Development of local expertise and potential manufacturing capabilities

Egypt's strategic approach to hydrogen exports demonstrates how African countries can leverage their natural resources and geographical advantages to develop sustainable export industries that contribute to global decarbonisation while supporting local economic development.

International partnerships supporting exports

Egypt has been securing strategic partnerships to advance its hydrogen export potential:

- **Government-to-Government Export Partnerships**
- **EU-Egypt Renewable Hydrogen Partnership:** Signed during COP27, this partnership aims to establish hydrogen trade between Africa, Europe, and the Gulf. The partnership identifies Egypt as a strategic partner for EU hydrogen imports, working toward the EU's target of importing 10 million tonnes of renewable hydrogen by 2030. (European Commission, 2022)

- **Strategic and Comprehensive Partnership with the EU:** Signed in March 2024, the partnership led to agreements worth €40 billion covering RE and hydrogen projects, focusing on establishing Egypt as a clean energy export hub for Europe. (Habibic A. , 2024)
- **Germany-Egypt Hydrogen Partnership:** Germany signed a memorandum of understanding with Egypt to facilitate GH2 production in the lead-up to COP27, with implementation by the German Corporation for International Cooperation (GIZ) in collaboration with the German Chamber of Commerce. This partnership connects to Germany's H2Global mechanism, which provides long-term demand certainty for GH2 exports. (Gritz, 2024)
- **Mediterranean Green Hydrogen Partnership**: Discussions are underway to establish a broader partnership to facilitate hydrogen trade between Africa, Europe, and the Gulf countries. (European Commission, 2022)

International financial institution support for export infrastructure

- **European Bank for Reconstruction and Development (EBRD):** Providing technical assistance to develop Egypt's hydrogen strategy and export-focused regulatory framework, including advising on supply chains for storage, transportation, and export opportunities. (Limited, 2024)
- **European Investment Bank (EIB):** Supporting export-oriented hydrogen projects with long-term financing mechanisms designed to facilitate trade with European markets. (Habibic A. , 2024)
- **H2Global Foundation:** Established by the German government with €4.43 billion in funding to accelerate the emergence of international markets for clean hydrogen. In July 2024, the first H2Global auction resulted in an award to Fertiglobe, securing a 20-year green ammonia offtake agreement for exports from Egypt to Germany. (Scatec, 2024)
- **PtX Development Fund: E**stablished by the German Federal Ministry for Economic Cooperation and Development and KfW to support Power-to-X export projects in developing countries. In October 2024, it awarded a €30 million grant to support export-oriented hydrogen production in Egypt. (SCATEC, 2024)

Bilateral trade and export agreements

- **Japanese-Egyptian Cooperation:** Targeting Japan as a key export market, particularly for blending green ammonia into coal power stations, with an estimated demand of 500,000 tons per year into the 2040s. (Limited, 2024)
- **South Korean-Egyptian Market Development:** Establishing South Korea as another strategic market for Egyptian GH2 and ammonia exports. (Limited, 2024)

These international partnerships and agreements are critical to establishing Egypt as a leader in GH2 exports, providing the necessary market access guarantees, financing mechanisms, and trade infrastructure required to build a robust export sector.

4.5.2 South Africa

The following analysis details South Africa's approach to developing its export capabilities and international partnerships, providing insights into potential strategies for other African nations.

Strategic Position and Production Potential

South Africa possesses a unique combination of natural resources, infrastructure, and technical capabilities that positions it favourably in the global GH2 landscape. These competitive advantages create a strong foundation for developing a sustainable and globally competitive hydrogen economy. According to the country's GH2 Commercialisation Strategy (GHCS), South Africa's deep expertise in the FT process, combined with significant production capacity of critical minerals and existing infrastructure, positions the country to potentially double its current share of global hydrogen production from 2% to 4% by 2050. This transition is supported by the country's abundant RE resources, which could enable GH2 production at highly competitive costs, projected at $ 1.60 per kg by 2030 (DSTI, 2021), among the lowest worldwide.

Infrastructure assets

South Africa benefits from the following competitive advantages:

- Abundant RE resources: High solar and wind potential support cost-effective GH2 production;
- Established Industrial Infrastructure: A well-developed energy and industrial sector provide a strong foundation for hydrogen production and export;
- Strategic Geographic Location: Proximity to key global markets, including Europe and Asia, enhances export potential;
- Access to Ports and Logistics Networks: Well-equipped ports and trade routes facilitate efficient hydrogen transportation;
- Government Commitment and Policy Support: National strategies and incentives promote hydrogen development and international collaboration;
- Existing Expertise in Hydrogen-related Technologies: A history of hydrogen applications in industries like mining and fuel cell development supports rapid sector growth.

Industrial and technical capabilities

South Africa holds significant advantages for export development through:

- World's largest known concentration of PGM reserves, which are critical components of electrolyser and fuel cell technologies;
- Natural endowment creating significant opportunities for local beneficiation and value addition to raw materials;
- Industrial expertise anchored in deep FT process knowledge through Sasol and PetroSA;
- Established industrial base offering opportunities for decarbonisation;
- Strong research and development capabilities developed through the HySA program.

Growth Potential

The Hydrogen Society Roadmap outlines significant growth potential:

- Projected capacity to produce up to 3.9 million tonnes of GH2 per year by 2050;
- Emerging opportunities in the transport sector and power generation;
- Development of export-oriented infrastructure and capabilities;

International Collaboration Supporting Exports

South Africa has secured strategic bilateral partnerships with several key nations as summarised in the below table.

Table 10: International collaboration supporting South Africa's GH2/PtX exports

Partner/initiative	Project name	Product	Announced size
Japan	Green Hydrogen & Green Ammonia (via SATREPS) Technical collaboration and research	Co-hosted South Africa–Japan Workshop on Hydrogen Economy MoC on Hydrogen Collaboration signed by Minister Nzimande	Co-hosted South Africa–Japan Workshop on Hydrogen Economy MoC on Hydrogen Collaboration signed by Minister Nzimande Technology and knowledge transfer Support for R&D on hydrogen and ammonia
Germany	Strategic framework development Financing hydrogen infrastructure	€ 12.5 million project funding € 200 million programs through KfW Development Bank [7]	Establishment of enabling environment Capital injection to scale projects
European Union	Infrastructure enhancement GH2 value chain development	€ 7 million rand (≈ $ 7.8 million) for Transnet (railways, ports, pipelines) € 25 million (≈ $ 27.6 million) for GH2 & TA [8]	Infrastructure modernization Accelerated hydrogen value chain development
Other Key Partners (UK, Denmark, Netherlands)	Technical cooperation agreements Market development Strengthening SA's hydrogen ecosystem	Various bilateral and multilateral initiatives supporting hydrogen R&D, pilot projects, and market expansion	Broader market access Increased investment in skills and technology

Source: DSTI (2021)

7 IPHE Steering Committee. (2024). Strategy & roadmaps: South Africa update. IPHE Country Update.

8 Reuters. (2024, September 9). EU gives South Africa $35 mln in grants for GH2 plans.

4.5.3 Kenya

The following analysis details Kenya's approach to developing its export capabilities and international partnerships.

Strategic Position and Production Potential

Kenya possesses distinct advantages that position it favourably in the global GH2 landscape. These competitive advantages create a strong foundation for developing a sustainable and globally competitive hydrogen economy. According to the national strategy, Kenya's unique access to dispatchable geothermal energy, combined with significant solar and wind resources, positions the country to become a key player in GH2 production (EPRA, 2024). This transition is supported by the country's RE infrastructure and strategic geographic location.

Natural and Infrastructure Assets

Kenya benefits from:

- Exceptional RE potential, particularly through world-class geothermal resources in the Rift Valley, strong solar radiation levels across the country, and Significant wind resources, especially in northern regions;
- Nearly 90% RE in current electricity mix (European Commission, 2023);
- Strategic geographical position relative to key markets in Europe, Asia, and the Middle East;
- Access to major shipping routes through the Port of Mombasa;
- Extensive land availability for RE development;

Industrial and Technical Capabilities

Kenya holds significant advantages for export development through:

- Established industrial base and manufacturing capabilities;
- Strong agricultural sector providing immediate domestic demand;
- Existing fertiliser and chemical industry infrastructure;
- Advanced technical expertise in RE development;
- Strategic integration with regional trade networks;
- Strong research and development capabilities.

Growth Potential

The Green Hydrogen Strategy outlines significant growth potential:

- Initial production targets of 100,000 tonnes/year by 2025;
- Expansion to 300,000-400,000 tonnes/year by 2030;
- Development of green ammonia production facilities;
- Emerging opportunities in shipping fuel markets;
- Potential for regional market leadership;

International Collaboration Supporting Exports

Kenya has secured strategic bilateral partnerships with several key nations and organisations, including the European Union, Germany and various private entities.

Key collaborations include:

- Fortescue Future Industries (FFI) for large-scale production;
- International technology providers for technical expertise;
- Regional trade partners for market development;
- Shipping industry stakeholders for future fuel markets;

These international partnerships and funding arrangements contribute to:

- Technology transfer and knowledge sharing;
- Market development and access;
- Infrastructure development;
- Skills and capacity building;
- Research and development enhancement;
- Export capability development;

Table 11: International collaboration supporting Kenyan GH2/PtX exports

Partner/entity	Key focus	Main areas of support / activities	Overall contributions
European Union (EU)	Technical assistance and market facilitation	Technical guidance for GH2 development; Market access facilitation; Infrastructure development support; Capacity building	Helps Kenya build robust GH_2 capabilities, ensures infrastructure funding, and enhances integration into EU markets
Germany	Technology transfer and capacity building	Technical cooperation agreements; Technology transfer initiatives; Market development support; Training and capacity building	Accelerates GH_2 deployment, strengthens local skill sets, and expands market opportunities
Private Sector Partnerships	Large-scale production and export readiness	Fortescue Future Industries (FFI) for large-scale projects; International tech providers for expertise; Regional trade partners; Shipping industry stakeholders	Increases financing options, enables advanced technical expertise, and fosters GH_2 export infrastructure
Combined Contributions	Cross-cutting enablers	Technology transfer and knowledge sharing; Market development and access; Infrastructure development; Skills and capacity building; R&D enhancement; Export capability development	Broad-based benefits for Kenya's GH_2 industry, supporting both domestic growth and international market access

Source: European Commission (2023)

Export Infrastructure Development

Port Facility Enhancement

- Modernisation of Mombasa Port facilities
- Development of specialized handling capabilities
- Integration with transport networks
- Enhanced storage and distribution systems

Transport Network Development

- Pipeline infrastructure planning
- Rail network integration
- Road transport optimisation
- Regional connectivity enhancement

Storage and Distribution

- Development of storage facilities
- Distribution network optimisation
- Safety and handling protocols
- Quality assurance systems

Market Development Strategy

Phase 1 (2023–2027)

- Focus on domestic market development
- Initial export infrastructure development
- Regional market integration
- Technical capacity building

Phase 2 (2028–2032)

- Expansion of export capabilities
- International market development
- Infrastructure scaling
- Enhanced trade partnerships

These strategic initiatives and partnerships position Kenya to become a significant player in the global GH2 market, leveraging its natural resources and strategic location while building necessary infrastructure and capabilities for sustainable export growth.

4.5.4 Morocco

The following analysis details Morocco's approach to developing its export capabilities and international partnerships.

Strategic Position and Production Potential

According to the National Green Hydrogen Roadmap (Royaume du Maroc, 2021), Morocco has established ambitious targets for its GH2 sector, projecting significant growth over the coming decades. The country anticipates:

- By 2030: Local hydrogen market of 4 TWh and export market of 10 TWh (total 14 TWh);
- By 2040: Increased demand reaching approximately 67.9–132.8 TWh;
- By 2050: Total potential demand between 153.9–307.1 TWh.

These projections reflect both a reference scenario (minimum estimation) and an optimistic scenario (maximum estimation), providing a range of potential development pathways.

The World Energy Council study estimated the global market for GH2 and its derivatives at 20,000 TWh in 2050. Based on this assessment, Morocco's strategy assumes that the global market would represent approximately 600 TWh by 2030. Studies indicate that Morocco could capture up to 4% of this global demand by 2030, positioning the country as a significant player in the emerging GH2 market.

Natural and infrastructure assets

Morocco benefits from:

- Exceptional RE resources (Res4Africa and PwC, 2022). This includes significant solar energy potential with more than 3,000 hours of sunshine per year and an average solar irradiation of 5 kWh/m^2/day, technical solar energy potential of 49,000 TWh/yr, and technical offshore and onshore wind potential of 11,500 TWh/year, with some areas exceeding average annual wind speeds of 10 m/s.
- Strategic geographical position relative to European markets, potentially serving as an export hub.
- Well-established trade relationships with the European Union.
- Existing and planned port facilities and gas infrastructure suitable for hydrogen and derivatives.

According to studies presented in 2019, Morocco could cover its domestic demand more than 10 times with its solar sources alone. The RE technical potential includes approximately 20,000 GW of solar photovoltaic capacity and 6,000 GW of onshore wind capacity. Even utilising just 5% of this technical potential would yield 1,000 GW of solar power and 300 GW of wind power, far exceeding the country's projected needs (GIZ, 2021).

Industrial and Technical Capabilities

Morocco holds significant advantages for export development through:

- Strong chemical industry base, particularly in fertiliser production;
- Clear governmental commitment to developing the sector;
- Established track record in developing large-scale RE projects;
- Significantly low costs of solar PV production, with recent PV call for tenders at 12 Euro/MWh for all PV Power Purchase Agreements (PPAs);
- Highly competitive wind PPA contract tariffs.

Competitive Positioning in Global Markets

According to IEA studies, Morocco appears to be in the lower cost range of PtX production worldwide due to its significant RE resources. Electricity represents 60 to 75% of the cost of a green molecule. The global hydrogen market is estimated at approximately $100 billion, the ammonia market at $40 billion, and the methanol market at $50 billion, providing substantial market opportunities (GIZ, 2021).

Strategic Export Products

A Fraunhofer ISI study (Eichhamer, 2019) identifies synthetic green ammonia as a promising economic opportunity for Morocco. The country currently depends on imported ammonia as inputs to phosphor-based fertilisers (1–2 million tons imported annually), making ammonia replacement a logical first step in a GH2 strategy. The study suggests a three-stage approach for Morocco's green ammonia development:

1. To strengthen local fertiliser manufacturing, replace imported ammonia with domestically produced green ammonia, requiring approximately 3 GW of RE capacity to produce 1 Mt of green ammonia annually.
2. Export green ammonia to countries with stringent GHG reduction targets to replace fossil-based ammonia in their industrial processes. There is potential for 1–2 Mt of additional green ammonia exports by 2030.
3. Develop the capacity to export green ammonia for energy generation in importing countries beyond 2030.

The economics of GH2 production in Morocco presents a promising picture. According to Fraunhofer ISI analysis, by 2050, with 4,000 full load hours and optimistic RE costs, GH2 would become considerably cheaper than fossil hydrogen, particularly if carbon pricing reaches projected levels of 90 €/t CO_2 in importing markets.

The economics are further enhanced by the fact that PtX products are higher value products that maintain Morocco's comparative advantage of lower renewable electricity generation costs than Europe, as transport costs represent a smaller proportion of total costs for PtX exports than direct electricity exports.

Export Infrastructure and Logistics

For exporting hydrogen to Europe, Morocco is exploring three main possibilities:

1. Exporting hydrogen produced in Morocco through dedicated pipelines.
2. Interconnecting RE generation in North Africa with power cables, thus producing hydrogen in the EU, close to final users.
3. Shipping hydrogen, possibly after conversion into liquid derivatives (e.g., ammonia, liquid hydrogen organic carrier, methanol).

These solutions entail significant expenditures in infrastructure and require effective private-public partnerships to implement successfully.

To achieve the export targets, Morocco will need to develop substantial RE capacity and hydrogen production infrastructure (Royaume du Maroc, 2021):

- By 2030: Approximately 6 GW of new renewable capacity dedicated to GH2 production.
- By 2050: Scaled up to 78 GW of RE capacity in the reference scenario (potentially up to 131.5 GW in the optimistic scenario).

In terms of electrolyser capacity, the roadmap projects 2.8–5.2 GW of electrolyser capacity by 2030, 13.–-23.0 GW of electrolyser capacity by 2040, and 31.4-52.8 GW of electrolyser capacity by 2050.

Associated infrastructure requirements include:

- Desalination plants for water supply (4.4–7.0 million m^3 annually by 2030, increasing to 49.2–70.4 million m^3 by 2050).

- Production facilities for green ammonia (1.1–2.4 GW capacity by 2030, increasing to 10.7–19.2 GW by 2050).
- Synthetic fuel production facilities for Power-to-Liquid applications (0.4–0.8 GW capacity by 2030, increasing to 5.3–11.6 GW by 2050).

International Partnerships Supporting Exports

Morocco has secured strategic bilateral partnerships with several key nations to advance its GH2 export potential:

German-Moroccan Energy Partnership (PAREMA)

- A strategic partnership to advance GH2 development.
- The Germany-Morocco Hydrogen Agreement signed in Berlin in 2020 focuses on the joint development of GH2 production.
- Investment of €300 million pledged to enable future German sourcing of GH2 from Morocco
- KfW development bank providing support through a €270 million grant program for Power-to-X Development Fund.

European Union Free Trade Area

Morocco's free trade area with the EU and its proximity to European markets further enhance its export prospects, potentially enabling it to utilise existing infrastructure such as the Maghreb-Europe Gas Pipeline for future hydrogen transport.

CMMZE Invest UAE and Gaia Future Energy Project

This joint development agreement for a GH2 project in Guelmim, Morocco, includes:

- Plans to deploy a 200 MWe electrolyser capacity
- Utilisation of wind, solar, and battery storage to generate hydrogen.
- Export through the Port of Agadir.
- Anticipated completion date of 2025.

IRENA Partnership

In June 2021, the International Renewable Energy Agency (IRENA) and Morocco's Ministry of Energy, Mines and Environment signed a strategic partnership agreement focused on advancing the national GH2 economy, which includes:

- Joint development of technology and market outlook studies for GH2.
- Crafting public-private models of cooperation in the hydrogen sector.
- Exploring the development of new hydrogen value chains.
- Laying the groundwork for the trading of GH2 at national and regional levels.

These international partnerships and agreements are critical to establishing Morocco as a leader in GH2 exports. They provide the necessary technology transfer, market access, and funding to build a robust export sector.

4.5.5 Tunisia

The following analysis details Tunisia's approach to developing its export capabilities and international partnerships.

Strategic Position and Export Potential

Tunisia's combination of natural resources, geographical advantages, and strategic vision positions it favourably in the global GH2 landscape. The country's GH2 roadmap emphasises export markets as a primary economic and industrial development driver, with ambitious targets for hydrogen exports. This export-oriented approach is phased to grow strategically over time, and targets annual hydrogen exports to Europe of 300,000 tons by 2030, 1 million tons by 2035, and 6.4 million tons by 2050 (MIME, 2024), representing about 77% of its projected total production of 8.3 million tons.

Geographical and Resource Advantages

Tunisia's strategic position and natural resources create several competitive advantages for hydrogen exports.

- **Strategic Geographic Position.** Tunisia's proximity to Europe offers a substantial competitive advantage for exports via pipeline, reducing transportation costs and infrastructure requirements compared to more distant markets.
- **RE potential.** The country's vast RE potential, particularly solar and wind, is crucial for cost-effective GH2 production. However, it has struggled to convert this potential into RE generation. As of 2024, renewables are only contributing 5.6% of electricity production in the country, which has to clinch a key debate on subsidies. Some stakeholders fear that energy poverty will grow as subsidies might move to upstream capacity support.
- **Port infrastructure.** Tunisia has significant existing port infrastructure that can be leveraged for the export of hydrogen and its derivatives, including five unloading ports for oil end products that could potentially be adapted for hydrogen-related products (Eichhamer, 2019):
  - Skhira: Current capacity for petrol, gasoil, and fuel (with the deepest drafts at 47-50 feet at high tides);
  - Bizerte: Current capacity for LPG, petrol, gasoil, and fuel (with 35 feet at Dock A);
  - Radès: Current capacity for LPG, gasoil, jet aviation, and fuel;
  - Gabès: Current capacity for LPG;
  - Zarzis: Current capacity for petrol, gasoil, and jet aviation.

The Tunisian Hydrogen Backbone

A key component of Tunisia's export strategy is the development of a „Tunisian H_2 backbone" (MIME, 2024b) from the south of the country linked to the EU's hydrogen backbone in the north. This infrastructure will enable energy and economic optimisation of GH2 storage and transport by:

- Using existing gas infrastructure where possible.
- Developing new connections to supply local and export markets.
- Creating an efficient transport network connecting production centres with demand centres.

The strategy proposes three possible routing options for the Tunisian hydrogen backbone pipeline, focusing on leveraging existing infrastructure where possible while building new dedicated hydrogen transport capacity.

Priority Export Products

Tunisia's export strategy focuses not only on gaseous hydrogen but also on value-added derivatives:

1. **Pipeline Hydrogen Export:** The primary export strategy involves direct hydrogen export via pipeline to European markets through integration with the European Hydrogen Backbone.
2. **Green Ammonia:** Particularly in the early phases (2025–2035), green ammonia production represents a key export opportunity, building on Tunisia's existing experience in the fertiliser sector.
3. **International Bunkering of Synthetic Fuels:** From 2030 onward, Tunisia plans to develop synthetic fuels for maritime transport, creating export opportunities while also providing fuel for ships docking in Tunisian ports.
4. **Sustainable Aviation Fuel (SAF):** Identified as a longer-term potential export product (2040–2050).

International Partnerships and Market Access

Tunisia's export strategy recognises the importance of international cooperation to secure market access and support the development of export infrastructure. The approach includes:

- **Integration with European Markets:** Tunisia aims to position itself as a key supplier within the European Union's hydrogen import strategy, taking advantage of proximity and existing energy trade relationships.
- **Development of International Standards:** Participation in the development of international hydrogen certification standards to ensure Tunisian exports meet global requirements.
- **Trade Agreements:** Establishment of long-term purchase agreements with European buyers to secure investment in production capacity.

Export Infrastructure Development

To facilitate exports, Tunisia's strategy includes several key infrastructure developments:

- **Pipeline Infrastructure:** Development of the Tunisian Hydrogen Backbone with connection to European networks.
- **Port Adaptation:** Modification of existing port facilities at strategic locations such as Skhira and Bizerte to handle hydrogen derivatives, particularly ammonia and synthetic fuels.
- **Storage Capabilities:** Development of strategic storage facilities to manage supply fluctuations and ensure reliable export volumes.

Balancing export orientation and domestic energy security

While GH2 exports represent a significant economic opportunity for Tunisia, the strategy recognises the importance of balancing international market development with domestic energy security and transition goals. To ensure this balance:

- The 35% RE target by 2030, a cornerstone of Tunisia's climate commitments, will remain a priority alongside GH2 development.
- RE infrastructure for hydrogen production will be developed as additional capacity rather than diverting resources from the national energy transition.
- A portion of hydrogen will be allocated to decarbonise priority domestic sectors, including Tunisia's cement industry and transportation sector.
- GH2 development will complement rather than compete with other RE initiatives.
- Regular assessment of the strategy's impact on overall national energy transition goals will guide implementation decisions.

This balanced approach ensures that Tunisia's GH2 ambitions enhance rather than impede progress toward national energy independence and climate objectives.

Economic Benefits from Exports

The GH2 export sector is projected to have a significant positive impact on Tunisia's economy:

- **Trade Balance Impact:** The GH2 sector is projected to have a significant positive impact on Tunisia's trade balance:
  - Annual positive impact of approximately €2.1 billion by 2035;
  - Rising to €8.6 billion by 2050.
- **Investment Attraction:** The export strategy is expected to attract substantial foreign direct investment, estimated at approximately €120 billion through 2050
- **Employment Creation:** The export-oriented hydrogen sector will contribute significantly to job creation, where estimates suggest 19,000 jobs by 2030, ~64,000 jobs by 2035, ~116,000 jobs by 2040, and ~424,000 jobs by 2050 (GIZ, 2021).

Tunisia's export-oriented approach to GH2 development demonstrates a strategic vision that capitalizes on the country's natural advantages while addressing key challenges. By focusing on pipeline exports to nearby European markets and developing value-added derivatives, Tunisia aims to position itself as a significant player in the global hydrogen market while ensuring that export development supports rather than detracts from domestic energy transition goals. The phased approach allows for steady export capacity growth in line with market development and infrastructure capabilities, creating a sustainable path to becoming a major hydrogen exporter.

4.5.6 Namibia

The following analysis details Namibia's approach to developing its export capabilities and international partnerships.

Strategic Position and Export Potential

Namibia possesses a combination of natural resources, geographical advantages, and strategic vision that positions it favourably in the global GH2 landscape. The country's GH2 strategy emphasises export markets as a primary economic and industrial development driver, with ambitious targets for hydrogen exports.

By 2050, Namibia aims to produce approximately 10–12 million tonnes of hydrogen equivalent annually, with a significant portion designated for export. Namibia's GH2 production is expected to grow over time, with most of the production destined for export. The country expects to produce 1-2 million tonnes of GH2 annually by 2030, 5–7 million tonnes by 2040, and 10–12 million tonnes by 2050 (corresponding to 5-8% of expected international hydrogen equivalent trade volume).

In a net-zero scenario, the projected total hydrogen demand in the import markets where Namibia is optimally positioned is expected to reach approximately 13 Mtpa of hydrogen equivalent by 2030 and around 100 Mtpa by 2050, indicating substantial market opportunity for Namibian exports.

Geographical and Resource Advantages

Namibia's strategic position and natural resources create several competitive advantages for hydrogen exports:

- Strategic Geographic Position: Namibia's coastal location offers substantial advantages for overseas exports, with access to both Atlantic and potentially European markets.
- RE Potential: The country possesses vast RE resources, particularly solar and wind, which are crucial for cost-effective GH2 production. Wind capacity factors of about 56–58% along coastal regions are significantly higher than those of other potential exporters like Australia and South Africa.

- Port Infrastructure: Namibia has significant existing port infrastructure that can be leveraged for the export of hydrogen and its derivatives, with plans for further development:
  - › Lüderitz Port (Southern Region): Will be expanded and transformed into a state-of-the-art port for hydrogen export;
  - › Walvis Bay Port (Central Region): Already established and will be further developed for hydrogen and derivatives export;
  - › New Northern Port (Kunene Region): Planned development of a new deep-sea port.

International Partnerships and Market Access

Namibia's export strategy recognises the importance of international cooperation to secure market access and support the development of export infrastructure. The approach includes:

- **European Market Focus:** In 2022, Namibia signed a strategic partnership with the European Union (EU) to establish a renewable hydrogen market and promote new channels for investment and trade through a Memorandum of Understanding (MoU).
- **Port of Rotterdam Partnership:** The Namibian Ports Authority has signed an MoU with the Port of Rotterdam to establish a trading route for GH2 and derivatives to Europe, with Rotterdam seeking to import 20 Mt of hydrogen equivalent by 2050.
- **German Partnership:** Germany was the first country to sign a joint communiqué of intent with Namibia to develop the hydrogen market. In March 2024, Germany identified Hyphen Hydrogen Energy's ammonia project in Namibia as a „strategic foreign project".
- **Other European Partnerships:** Namibia has also signed MoUs with Belgium for cooperation on GH2 development and the Netherlands through port partnerships.
- **Asian Engagement:** Namibia has engaged with several Japanese companies, including Japan Oil, Gas and Metals National Corporation for the exchange of information on industry development.

Priority Export Products

Namibia's export strategy focuses not only on gaseous hydrogen but also on value-added derivatives:

1. **Green Ammonia:** The Hyphen project will produce GH2 for conversion to green ammonia (NH_3), with a target of 1.7 million tonnes of ammonia production annually
2. **Other Potential Derivatives:** Future phases may include:
   - › E-methanol for industrial applications.
   - › Sustainable aviation fuels.
   - › Other synthetic fuels for maritime and industrial applications.

Export Infrastructure Development

To facilitate exports, Namibia's strategy includes several key infrastructure developments:

- **Shared Infrastructure Development:** The Government of Namibia is establishing common use infrastructure (CUI) for large-scale hydrogen projects as part of the Southern Corridor Development Initiative, including:
  - › **Transmission Infrastructure:** Overland transmission lines to supply electricity from production sites to ports/processing facilities.
  - › **Water Infrastructure:** Desalination units and water pipelines to source water for electrolysis.
  - › **Hydrogen Transport:** Pipelines to pump hydrogen from production locations to ports for export.

› **Supporting Infrastructure:** Roads, fibre cables for internet connection, security services

› **Port Facilities: I**ndustrial port complexes with storage and production facilities for hydrogen derivatives, marine export and logistics facilities.

Economic Benefits from Exports

The GH2 export sector is projected to have a significant positive impact on Namibia's economy (Republic of Namibia, 2022):

- **GDP Impact:** By 2030, the hydrogen sector could add as much as $6 billion to GDP, representing a 30% increase compared to GDP projections without the hydrogen industry
- **Investment Attraction:** An estimated investment of $190 billion will be necessary by 2040 to establish Namibia's GH2 sector
  - › **Upstream Production and Infrastructure:** About $95 billion aimed at new upstream production and infrastructure.
  - › **Midstream Infrastructure:** Around $30 billion for midstream infrastructure such as derivative plants and ports.
- **Employment Creation:** The hydrogen industry would substantially expand the domestic labour market:
  - › Creating an estimated 280,000 jobs by 2030 and 600,000 jobs by 2040.
  - › About 30% would be direct (in the industry), 20% would be indirect (through goods and services), and the increase in household incomes would induce 50%.
- **Local Content Manufacturing:** Local content manufacturing of components required for hydrogen production will boost economic development:
  - › **RE Components:** Local tower and blade manufacturing could generate a $7 billion direct GDP impact in 2035-40 and create an additional 7,000 annual direct jobs.
  - › **Solar Manufacturing:** Localising solar cell and module manufacturing could generate a $4 billion direct GDP impact in 2035-40 and 4,000 direct jobs a year by 2040.
  - › **Electrolyser Components:** Localising stack (non-membrane) and BoP manufacturing could generate a $5 billion direct GDP impact in 2035-40 and create an additional 5,000 jobs.

Skills Development Strategy

Namibia has developed a three-phase strategy to address the skills gap for the hydrogen economy:

Table 12: Development plan for Skills Gap

Phase	Focus	Activities
Phase 1	Youth Development	Provision of scholarships as part of the Youth for Green Hydrogen Scholarships Programme
Phase 2	Stakeholder Engagement	Engaging with key stakeholders, including the Ministry of Higher Education, Training, Technology and Innovation to strategize and outline future education and research activities
Phase 3	Quality Assurance	The NGHP+ initiative ensures training providers meet international standards, including certification of training courses and providers to ensure employment readiness

Source: Namibia Green Hydrogen Council (2024)

The projected employment impact is substantial, as shown in the table below.

Table 13: Employment Impact of GH2 in Namibia

Category	By 2030	By 2040	Sectors
Direct Jobs	85,000	185,000	Construction, business services, transportation, and manufacturing
Indirect Jobs	60,000	130,000	Support industries and services
Talent Gap	55–60,000	120–130,000	To be addressed through skills development strategy

Source: Namibia Green Hydrogen Council (2024)

Regional Integration and Cross-Border Opportunities

Namibia aspires to establish an integrated, thriving green ecosystem across Southern Africa by creating synergies in shared infrastructure, manufacturing collaboration and power exports. This regional approach extends the economic benefits beyond Namibia's borders:

- **South Africa:** Shared infrastructure across the Northern Cape and Kharas regions to decrease costs and create low-carbon transportation corridors, facilitating excess power exports to the Southern Africa Power Pool (SAPP).
- **Botswana and Zambia:** Establishing transport corridors for hydrogen trains and trucks; identifying value chain/ manufacturing collaboration opportunities.
- **Angola:** Helping to valorise Angola's prime solar resources in its southern border region through cross-border transmission lines and/or pipelines.

These regional partnerships position Namibia to play an important role in increasing energy security and lowering the cost of energy for the Southern African Power Pool, advancing the decarbonisation agenda and the ideals of the African Continental Free Trade Area (AfCFTA).

Balancing Export Orientation and Domestic Development

While GH2 exports represent a significant economic opportunity for Namibia, the strategy recognises the importance of balancing international market development with domestic energy security and transition goals. To ensure this balance:

- The development of three hydrogen valleys ensures that benefits are distributed across different regions of Namibia.
- Manufacturing with local content, particularly in areas like RE components, promotes inclusive economic growth.
- Pilot projects explore domestic applications such as hydrogen in tugboats, hydrogen-powered regional trains, and hydrogen for mining vehicles.
- A portion of the produced hydrogen will be allocated to decarbonise priority domestic sectors, contributing to Namibia's target of 80% self-sufficiency in primary energy for power generation by 2029.

Namibia's export-oriented approach to GH2 development demonstrates a strategic vision that capitalizes on the country's natural advantages while addressing key challenges. By focusing on partnerships with European markets and developing value-added derivatives, Namibia aims to position itself as a significant player in the global hydrogen market while ensuring that export development supports rather than detracts from domestic energy transition goals.

The phased approach allows for steady export capacity growth in line with market development and infrastructure capabilities, creating a sustainable path to becoming a major hydrogen exporter while maximising domestic economic benefits.

4.5.7 Nigeria

Nigeria's potential to become an exporter of GH2 presents both opportunities and challenges within the global hydrogen market. As the country seeks to diversify its economy beyond traditional oil and gas exports, hydrogen and its derivatives offer a pathway for continued participation in global energy markets while transitioning toward sustainability.

Strategic Position and Production Potential

Nigeria's positioning in the global GH2 landscape is characterised by several factors (H2diplo, 2023a; H2diplo, 2023b):

- **RE Resources:** Nigeria has substantial RE potential, particularly solar energy in the northern regions, which could support competitive GH2 production. Solar PV potential ranges from 3.5-7.0 kWh/m²/day.
- **Production Costs:** According to modelling studies, by 2030, production costs for GH2 in Nigeria could reach around €3.5/kg in optimal locations, primarily in the north and central regions of the country. However, these costs are expected to be „10 to 20% higher compared to top international competitors like Mauritania, Saudi Arabia or Algeria."
- **Geographical Position:** Nigeria's location is less favourable for direct hydrogen exports to European markets than North African countries. The transport distance analysis indicates that „Nigeria's location tends not to be favourable" for supply chains sensitive to distance, such as pipelines, liquid hydrogen, and LOHCs.

Strategic Export Products

Given Nigeria's specific advantages and limitations, certain hydrogen derivatives and PtX products present more favourable export opportunities, as illustrated by quotes from the H2diplo sources referenced above:

- **PtX Products (Hydrogen Derivatives):** „For a possible export of 'green' energy, Nigeria should therefore focus on PtX products respectively hydrogen derivatives, whose supply costs are greatly influenced not only by hydrogen production costs, but also by other country-specific factors."
- **Green Hydrocarbons:** Particularly promising is the production of green hydrocarbons using Nigeria's biomass resources. „The production of 'green' hydrocarbons such as methanol and PtL fuels from hydrogen and renewable (biogenic) carbon could be a niche where Nigeria can exploit its advantages. Here, the long transport distance to potential sales markets plays a subordinate role."
- **Methanol:** Biomass-based methanol production is highlighted as particularly suitable, as the „availability of sustainable biomass as a source of green carbon could be a key advantage of Nigeria for the supply of green hydrocarbons (e.g., methanol)."

Export Infrastructure and Logistics

For exporting hydrogen and its derivatives, several supply chain options exist:

- **Maritime Transport:** For hydrogen derivatives like ammonia and methanol, tanker shipping represents a viable option, where Nigeria can leverage its existing port infrastructure.
- **Pipeline Infrastructure:** While direct hydrogen pipelines to European markets would be longer and more costly compared to North African routes, Nigeria has experience with pipeline infrastructure from its oil and gas industry that could be adapted.
- Supply Chain Analysis: Cost analysis of different supply chains indicates that liquid hydrogen, methanol (using biomass-sourced CO_2), and ammonia represent potentially viable export carriers.

Existing Industrial and Technical Capabilities

Nigeria possesses several advantages that could support hydrogen exports:

- **Oil and Gas Industry Experience:** „Existing infrastructure of the oil and gas industry as well as experience in realizing [sic] large-scale energy projects can help Nigeria to produce and export green PtX products.“
- **Natural Gas Infrastructure:** Nigeria has existing gas infrastructure, including 20,000 km of transmission lines, that could potentially be adapted for hydrogen-related purposes.
- **Port Facilities:** The country has established port facilities that could be used to export liquid hydrogen carriers.

Market Competitiveness Factors

Several factors influence Nigeria's competitiveness in the international hydrogen market:

1. **Onsite hydrogen production cost:** While production costs of around €3.5/kg are possible in the northern regions by 2030, they remain 10-20% higher than those of top competitors.
2. **Availability of sustainable, low-cost carbon:** Nigeria has a potential competitive advantage in biomass resources, which could provide sustainable carbon for producing green hydrocarbons like methanol.
3. **Proximity to import markets:** Nigeria's geographical position is less favourable than North African countries for supplying European markets, particularly for transport-sensitive carriers.
4. **Experience in the oil and gas industry:** Nigeria's extensive experience in the oil and gas sector provides valuable expertise and infrastructure that can be leveraged for hydrogen projects.

Strategic Export Products

Given Nigeria's specific advantages and geographical position, certain GH2 derivatives present more favourable export opportunities than others (GFA, 2022):

- **PtX Products/Hydrogen Derivatives:** Analysis shows that Nigeria should focus on hydrogen derivatives whose supply costs are influenced by hydrogen production costs and other country-specific factors. This approach would better leverage Nigeria's comparative advantages in the global hydrogen market.
- **Green Hydrocarbons:** The production of green hydrocarbons such as methanol and PtL (Power-to-Liquid) fuels from hydrogen and renewable biogenic carbon represents a promising niche for Nigeria. The relatively long transport distance to potential markets in Europe plays a subordinate role for these products.
- **Biomass-Based Methanol:** The availability of sustainable biomass as a source of green carbon could be a key advantage for Nigeria in supplying green hydrocarbons, particularly methanol. This approach leverages Nigeria's substantial biomass resources while creating higher-value export products.

Supply Chain Analysis and Export Infrastructure

For exporting hydrogen and its derivatives, several supply chains options have been evaluated:

- **Maritime Transport:** For hydrogen derivatives like ammonia and methanol, tanker shipping represents a viable option where Nigeria can leverage its existing port infrastructure. Analysis shows that transportation distance has minimal impact on supply costs when hydrogen is converted to chemical energy carriers like methanol or ammonia.
- **Pipeline Infrastructure:** While direct hydrogen pipelines to European markets would be longer and more costly compared to North African routes, Nigeria has experience with pipeline infrastructure from its oil and gas industry that could be adapted.
- **Liquid Hydrogen:** Liquid hydrogen-based supply chains show the lowest total costs (slightly under 6 €/kg H_2) in cost comparison analyses due to low hydrogen losses during transport, though liquefaction contributes significantly to the hydrogen supply costs (approximately 1.1 €/kg H_2).
- **LOHC (Liquid Organic Hydrogen Carriers):** LOHC-based hydrogen supply is strongly affected by transport distance, with costs ranging from 6.5 €/kg H_2 with external heat sources to almost 9 €/kgH_2 when heat must be provided internally (GFA Consulting Group, 2023).

Market Competitiveness Factors

Several key factors influence Nigeria's position in the international hydrogen market:

1. **Onsite Hydrogen Production Cost:** Production costs of around 3.5 €/kg in optimal northern regions are 10-20% higher than top international competitors like Mauritania, Saudi Arabia, or Algeria.
2. **Geographic Position:** Nigeria's location is less favourable for direct hydrogen exports to European markets than North African countries, particularly for transport methods sensitive to distance, such as pipelines and liquid hydrogen.
3. **Existing Industrial Capabilities:** Nigeria can leverage its experience in the oil and gas industry and utilise existing infrastructure to facilitate the production and export of green PtX products.
4. **Biomass Resources:** The country's significant biomass potential provides a competitive advantage for producing green hydrocarbons that require sustainable carbon sources, potentially offsetting other comparative disadvantages.

4.6 Domestic application and local offtake market

Developing domestic applications and local offtake markets represents a crucial complement to export-oriented GH2 strategies across Africa. While many countries prioritise hydrogen exports, developing robust domestic markets can accelerate decarbonisation efforts, enhance energy security, create new economic opportunities, and establish the foundation for wider hydrogen adoption across the continent.

This section examines how key African countries approach domestic hydrogen market development, highlighting their unique strategic approaches, priority sectors, implementation timelines, and expected economic benefits. Through comparative analysis, it provides insights into the diverse pathways being pursued to integrate GH2 into local economies and energy systems.

Table 14: Overview of GH2 Domestic Markets of various countries

Country	Current domestic h_2 demand	Key domestic focus areas	Implementation strategy	Domestic market target	Reference
South Africa	0.5 MTPA (2019)	Industry, transport, power generation	Three-phase roadmap (2021–2040)	500 kt/y by 2030, at least 15 GW by 2040	(DSTI, 2021)
Kenya	Limited direct imports (7 t/y), 5,000 t/y methanol	Agriculture, fertiliser, industrial applications	Two-phase strategy (2023–2032)	100,000 t/y NH_3 (2027), 400,000 t/y NH_3 (2032)	(EPRA, 2024)
Morocco	Import-dependent for NH_3 (1–2 Mt/y)	Fertiliser industry, power storage, transport	Three-phase strategy (2020-2050)	4 TWh by 2030, growing substantially by 2050	(Royaume du Maroc, 2021)
Tunisia	Import-dependent for NH_3	Fertiliser, maritime transport, industry, gas blending	Three-phase hydrogen blending (2025–2040)	1.9 Mt/y by 2050 (23% of total production)	(MIME, 2024)
Namibia	Limited current demand	Mining, domestic energy, transportation, industrial heat	Three hydrogen valleys model across regions	Focus on pilot projects and strategic domestic applications	(MME, 2022)
Egypt	~1.4 MTPA (fertilisers, refining, methanol)	Industry, steel, gas blending, transport	Three-phase strategy	0.1–0.4 MTPA by 2030, 2.0-3.6 MTPA by 2040	(Advisian Worley Group, 2024)
Algeria	Significant domestic gas consumption	Transport, steel industry, fertiliser, gas blending	80/20 split (export/domestic)	10 TWh/year by 2050 (20% of production)	(MEM, 2023)
Mauritania	Minimal current hydrogen use	Mining, water supply, power sector	Integration with export projects	Focus on infrastructure development	(IEA, 2023)
Senegal	No current hydrogen market	Cement, port operations, fertiliser, power	Potential for JETP-supported pilots	Early-stage market exploration	(IEA, 2024b)

Source: (MEM, 2023; MIME, 2024; Royaume du Maroc, 2021; Advisian Worley Group, 2024; DSTI, 2021)

4.6.1 Current Demand Profiles

African countries exhibit varying levels of existing hydrogen demand, primarily in the form of GH2 industrial applications. Understanding these baseline demand profiles is essential for developing targeted strategies to transition to GH2.

Table 15: Current Demand Profiles of various countries

Country	Total demand	Primary applications	Import dependencies	Sources	Reference
South Africa	~0.5 MTPA (2019)	Oil refining, chemical industries	Limited	Steam methane reforming	(DSTI, 2021)
Egypt	~1.4 MTPA	Fertiliser (~1 MTPA), oil refining (~0.14 MTPA), methanol (~0.27 MTPA)	Limited	Primarily fossil-based production	(Advisian Worley Group, 2024)
Morocco	Not quantified	Fertiliser production	1-2 Mt/y ammonia imports	Imported ammonia	(Royaume du Maroc, 2021)
Kenya	Limited direct H_2 imports (~7 t/y)	Chemical sector	5,000 t/y methanol (primarily from Egypt, Saudi Arabia), ammonia imports	Imports from India, South Africa, Egypt, Saudi Arabia	(EPRA, 2024)
Tunisia	Not quantified	Fertiliser production	All ammonia used in fertiliser production	Imports	(MIME, 2024)
Namibia	Minimal	Limited industrial applications	Depends on imported chemical products	Imports	(MME, 2022)
Algeria	Not quantified	Industrial processes, fertiliser production	Self-sufficient in natural gas	Domestic GrH2productionGrH2	(MEM, 2023)
Mauritania	Minimal	Mining operations	Depends on imported fuels for mining	Fossil fuel-based	(IEA, 2023)
Nigeria	Not quantified	Oil refining, ammonia for fertilisers	Limited	Domestic GrH2productionGrH2	(GFA, 2022)

Source: (MEM, 2023; MIME, 2024; Royaume du Maroc, 2021; Advisian Worley Group, 2024; DSTI, 2021)

Key Insights

- **Industrial Focus:** Across Africa, current hydrogen demand is concentrated in industrial applications, particularly fertiliser production, oil refining, and chemical industries. South Africa and Egypt have the most established industrial hydrogen usage, while countries like Namibia and Mauritania have minimal current demand.
- **Import Dependencies:** Several countries, including Morocco, Kenya, and Tunisia, currently depend heavily on imports of hydrogen-based products, particularly ammonia for fertiliser production. This import dependence creates a strong economic case for domestic GH2 production to enhance self-sufficiency.
- **Production Methods:** Existing hydrogen production is almost exclusively „grey" hydrogen derived from fossil fuels through processes like steam methane reforming, creating significant carbon emissions. The transition to GH2 production represents a major opportunity for emissions reduction.
- **Regional Variations:** North African countries (Egypt, Morocco, Algeria) generally have more established hydrogen consumption patterns due to their larger industrial bases, while sub-Saharan countries often have more limited current hydrogen applications. This baseline demand profile provides a foundation for understanding the potential transition pathways to GH2 across different African contexts. Countries with existing industrial hydrogen demand have natural starting points for GH2 substitution, while those with limited current demand may focus on developing new applications aligned with their economic development priorities.

4.6.2 Cost competitiveness analysis

The economic viability of domestic GH2 applications depends heavily on cost competitiveness compared to conventional alternatives. Table 16 compares GH2/PtX with their fossil-fuel-based homologues, while Table 22 presents the GH2 generation costs from selected countries.

Table 16: Cost competitive analysis for different applications

Application	Fossil baseline	Current cost gap	Timeline for cost-parity	Accelerating factors
Green ammonia	Coal-based ammonia	Significant	~2040	Carbon taxation, economies of scale
Green ammonia	Natural gas-based ammonia	Very large	~2045	Increasing gas prices, carbon pricing
Green steel	Traditional BF-BOF	Very large	~2050 or later	Carbon border adjustments, technology improvements
Green methanol	Fossil-based methanol	Very large	Beyond 2050 without interventions	Policy interventions, carbon pricing
SAF	Conventional jet fuel	Extremely large (~$2,000/t in 2025)	Beyond 2050 without interventions	Mandates, carbon taxation
Mining applications	Diesel equipment	Moderate	As early as 2026 in Namibia	Renewable cost declines, diesel price increases
Hydrogen Production	GrH2GrH2 (Egypt)	$1.25/kg (grey) vs. $2.57–3.73/kg (green optimal)	2030-2035 with optimal conditions	Renewable electricity below $25/MWh

Source: (MEM, 2023; MIME, 2024; Royaume du Maroc, 2021; Advisian Worley Group, 2024; DSTI, 2021)

Table 17: Regional GH2 cost factors

Country	Current GH2 cost estimates	Key cost advantages	Key cost challenges	Reference
South Africa	Projected at $1.60/kg by 2030	Exceptional RE resources, established industrial base	Grid constraints, logistics challenges	(DSTI, 2021)
Egypt	$5.55–6.69/kg (industrial electricity), $2.57–3.73/kg (optimal RE)	Solar resources, industrial clustering	Water constraints, grid limitations	(Advisian Worley Group, 2024)
Morocco	Not specifically quantified	World-class solar and wind resources	Water constraints, infrastructure needs	(Royaume du Maroc, 2021)
Namibia	Competitive with global leaders	Wind capacity factors of 56–58%	Distance to markets, infrastructure development	(MME, 2022)
Algeria	Not specifically quantified	Abundant gas resources for transition	Water constraints, infrastructure limitations	(MEM, 2023)

Source: (MEM, 2023; MIME, 2024; Royaume du Maroc, 2021; Advisian Worley Group, 2024; DSTI, 2021)

4.6.3 Priority sectors for domestic applications

African countries are targeting specific sectors for domestic GH2 applications based on their economic structures, decarbonisation priorities, and existing industrial capabilities. This section examines the prioritised sectors across countries.

Table 18: Priority Sectors for domestic applications

Sector	Key applications	Countries prioritising	Strategic rationale
Fertiliser Industry	Green ammonia production	Morocco, Egypt, Tunisia, Kenya, South Africa, Algeria, Senegal	Import substitution, agricultural productivity, existing infrastructure
Steel Industry	Direct reduced iron (DRI) with green H_2	South Africa, Egypt, Algeria, Mauritania	High emissions sector, export competitiveness (CBAM), value addition to minerals
Mining Sector	Mobile equipment, process heat	South Africa, Namibia, Mauritania	Emissions reduction, operational cost savings, strategic economic sector

Transportation	Heavy-duty vehicles, maritime applications, aviation	South Africa, Morocco, Namibia, Tunisia, Egypt, Nigeria	Difficult-to-electrify segment, high emissions, strategic corridors
Power Sector	Energy storage, grid balancing, microgrids	Morocco, Tunisia, Egypt, Namibia, Mauritania, Senegal	Renewable integration, energy access, grid stability
Gas Networks	Hydrogen blending	Tunisia, Egypt, Algeria	Leveraging existing infrastructure, gradual transition
Industrial Heat	Cement, chemicals, other manufacturing	South Africa, Morocco, Tunisia, Namibia, Nigeria, Senegal	Hard-to-electrify processes, high temperature requirements
Water Supply	Desalination powered by RE	Mauritania, Namibia, Morocco and Egypt	Water-energy nexus, addressing water scarcity

Source: (MEM, 2023; MIME, 2024; Royaume du Maroc, 2021; Advisian Worley Group, 2024; DSTI, 2021)

Key Insights

- **Common Priorities:** Fertiliser production through green ammonia emerges as the most consistently prioritised application across African countries, driven by agricultural needs and existing import dependencies. Industrial decarbonisation, particularly in hard-to-abate sectors like steel and cement, also features prominently.
- **Resource-Based Strategies:** Countries are leveraging their natural resources for targeted applications - Namibia's bush encroachment biomass for hybrid PtX pathways, Mauritania's mining sector for early adoption, and South Africa's industrial base for chemical applications.
- **Infrastructure Utilisation:** Several countries prioritise applications that can leverage existing infrastructure, such as Tunisia's gas network blending (targeting 15–20% hydrogen by 2040) and Morocco's integration with fertiliser production facilities.
- **Regional Variations:** North African countries (Morocco, Tunisia, Egypt, Algeria) tend to focus more on industrial applications and gas network integration, while sub-Saharan countries often prioritise mining applications and specific industrial processes aligned with their economic structures.
- **Phased Approaches:** Most countries adopt phased approaches, targeting low-hanging fruit in early phases (2025–2030) such as industrial hydrogen replacement, before expanding to more challenging applications like transportation and new industrial processes in later phases (2030–2050).
- The diversity of prioritised applications reflects African countries varied economic structures, resource endowments, and development priorities. This targeted approach allows countries to focus initial investments on the most economically viable and strategically important applications while building capacity for broader adoption.

4.6.4 Phased implementation approaches

African countries are adopting structured, multi-phase implementation strategies for developing their domestic GH2 market. These phased approaches allow for the gradual scaling of technology deployment, infrastructure development, and market adoption.

Table 19: Phased Implementation approaches for various countries

Country	Phase 1	Phase 2	Phase 3	Key targets	Reference
South Africa	2021–2024: Pilot projects, at least 1MW GH_2 production, 5 refuelling stations	2025–2030: 5GW under construction, 10GW deployed in Northern Cape, 1.7GW in H_2 Valley	2030–2040: Expansion to at least 15GW, full sector coupling	500kt H_2/year by 2030	(DSTI, 2021)
Kenya	2023–2027: 20% substitution of imported ammonia-based fertiliser (~100,000 t/y), 100% methanol substitution	2028–2032: 50% fertiliser import substitution (300-400,000 t/y), shipping fuels, regional exports	-	150-250 MW additional electrolyser capacity in Phase 2	(EPRA, 2024)
Morocco	2020–2030: Local raw material use, pilot projects, government support	2030–2040: Reduced costs, environmental regulations, electricity sector storage	2040-2050: Industrial heat, residential sectors, transport, aviation	4 TWh local market by 2030	(Royaume du Maroc, 2021)
Tunisia	2025–2030: Pilot projects with 5–10% H_2 blending, regulatory framework development	2030–2035: 10–15% blending in regional networks, REzone integration	2035–2040: 15–20% blending nationally, dedicated H_2 pipelines	10–15 kt/y → 50–70 kt/y → 150-200 kt/y H_2 demand	(MIME, 2024)
Egypt	2020s: Pilot phase using GH2 as industrial raw material	2030s: Scale-up phase, reduced costs, electricity sector applications	2040s: Full implementation across industry, transport, power	0.1-0.4 MTPA by 2030, 2.0-3.6 MTPA by 2040	(Advisian Worley Group, 2024)
Namibia	Current: Pilot demonstrations, three hydrogen valleys development	Medium-term: Mining applications, transport integration	Long-term: Full sector coupling, export integration	Focus on regional economic development	(MME, 2022)
Algeria	2023-2030: Pilot projects with decentralized production	2030-2040: Market scaling with increasing applications	2040-2050: Mature domestic market of ~10 TWh annually	80/20 split between export/ domestic use	(MEM, 2023)
Mauritania	Current: Integration with export project planning	Medium-term: Mining sector applications, water supply	Long-term: Power system transformation	Targeting mining sector decarbonisation	(IEA, 2023)

Nigeria[9]	By 2030: 33% blue hydrogen in ammonia production	By 2040: Hydrogen entering energy mix (9 GW capacity)	By 2060: Industrial heat applications, 65% blue H_2 in ammonia	5 GW electrolyser capacity by 2040, 22 GW by 2050	(GFA, 2022)

Source: (MEM, 2023; MIME, 2024; Royaume du Maroc, 2021; Advisian Worley Group, 2024; DSTI, 2021)

Key Insights

- **Consistent Three-Phase Structure:** Most countries adopt a three-phase approach spanning approximately 20-30 years: (1) pilot demonstration (2020s), (2) commercial scaling (2030s), and (3) mass deployment (2040s). This structured approach allows for gradual technology adoption while managing investment requirements.
- **Differentiated Timelines:** Implementation timelines vary based on current industrial capabilities and strategic priorities. Countries with existing hydrogen-consuming industries (South Africa, Egypt) often have more aggressive near-term targets, while countries building from a lower base (Mauritania, Senegal) focus on longer-term development.
- **Geographic Clustering:** Several countries employ a geographic clustering approach, such as Namibia's three hydrogen valleys model (Southern, Central, and Northern regions) and South Africa's Platinum Valley Initiative. This clustering creates integrated ecosystems that maximise infrastructure efficiency and knowledge sharing.
- **Infrastructure-Led Approaches:** Gas network blending represents a low-barrier entry point for several countries (Tunisia, Algeria, Egypt), with plans to gradually increase hydrogen concentrations from 5-10% to 15-20% over 15-20 years. This approach leverages existing assets while simultaneously building hydrogen-specific infrastructure.
- **Sector-Specific Sequencing:** Countries typically sequence adoption based on sector-specific economics and technical readiness, generally starting with industrial applications (ammonia, methanol) before expanding to transport and broader energy applications in later phases.
- **Integration with Export Development:** Most countries closely integrate domestic market development with export-oriented projects, particularly in early phases. This integration allows domestic applications to benefit from the infrastructure and economies of scale developed for export markets.
- The phased implementation approaches across African countries reflect a pragmatic recognition of hydrogen adoption's technical, economic, and institutional challenges. By sequencing deployment strategically, countries can manage risks while building the necessary capabilities and infrastructure for broader hydrogen integration.

4.6.5 Infrastructure Development for Domestic Applications

Developing appropriate infrastructure is critical for enabling domestic GH2 applications. Countries prioritise various infrastructure components based on their strategic application focus and existing assets.

9 Nigeria is currently developing a national H2 Policy with H2 implementation roadmap. Maybe this outlook can be added in a footnote

Table 20: GH2 infrastructure development

Infrastructure	Key components	Countries prioritising	Development timeline	Challenges
Production Facilities	Electrolysers co-located with industrial users	South Africa, Morocco, Egypt	Initial pilots by 2025, scaling 2025–2035	Capital costs, technical expertise
Refuelling Stations	Hydrogen dispensing infrastructure for transport	South Africa (5 by 2025), Namibia	First stations operational, scaling 2025–2030	Demand uncertainty, technical standards
Gas Network Integration	Blending facilities, pipeline modifications	Tunisia (15–20% by 2040), Algeria, Egypt	Gradual implementation 2025–2040	Materials compatibility, safety regulations
Water Infrastructure	Desalination plants, water pipelines	Morocco, Namibia, Mauritania	Early development with hydrogen projects	Energy requirements, brine disposal
Storage Systems	Compressed gas, liquid carriers, geological	South Africa, Egypt	Limited near-term development	Cost, technical complexity
Transport & Distribution	Dedicated pipelines, specialized vehicles	Medium-term development	2030–2040 for most countries	High capital cost, limited initial demand
Research Facilities	R&D centres, testing laboratories	Morocco (GreenH2A Platform), South Africa	Early-stage development	Knowledge gaps, funding requirements

Source: (MEM, 2023; MIME, 2024; Royaume du Maroc, 2021; Advisian Worley Group, 2024; DSTI, 2021)

Key Insights

- **Infrastructure Sharing Models:** Several countries are adopting shared infrastructure models where export-oriented projects develop oversized facilities that also serve domestic needs. Namibia's Common User Infrastructure (CUI) approach exemplifies this model, developing transmission lines, water infrastructure, and transport networks that benefit both hydrogen production and local communities.
- **Water-Energy Nexus:** Water infrastructure emerges as a critical component across most countries, with desalination facilities being developed for hydrogen production and to address broader water security challenges. Morocco's plans for 4.4 million m^3/year of desalination capacity by 2030, expanding to 49.2 million m^3/year by 2050, illustrate this dual-purpose approach.
- **Leveraging Existing Assets:** Countries with established gas networks (Tunisia, Algeria, Egypt) are prioritising hydrogen blending as a key initial infrastructure strategy, gradually increasing concentrations from 5-10% to 15-20% to minimize new infrastructure requirements in early phases.
- **Transportation Infrastructure:** South Africa leads in hydrogen transport infrastructure development, with plans for at least five refuelling stations by 2025 to support the deployment of 500 hydrogen-powered buses and trucks by 2030. Namibia has also made early progress with Africa's first hydrogen refuelling station at Walvis Bay.

- **Research Infrastructure:** Several countries are developing dedicated research facilities to support domestic technology development and adaptation. Morocco's GreenH2A Platform („Green Hydrogen & Applications Park") is a national research facility focused on the entire hydrogen value chain.
- **Regional Variations:** Infrastructure priorities reflect regional conditions and strategic focus – North African countries emphasize gas network integration and industrial facilities, while water-stressed regions like Namibia and Mauritania prioritise desalination infrastructure that serves both hydrogen production and community needs.

Developing appropriate infrastructure represents both a critical enabler and a significant challenge for domestic hydrogen adoption. The substantial capital requirements for hydrogen-specific infrastructure motivate integrated approaches that leverage existing assets and create multi-purpose facilities serving both hydrogen production and broader development needs.

4.6.6 Economic and social impacts of domestic applications

If properly developed, domestic GH2 applications could generate significant economic and social benefits across African countries, creating value beyond export revenues. The table below gives examples of expected impacts in selected countries.

Table 21: Examples of economic and social impacts of domestic applications

Country	Economic benefits	Employment impact	Social & environmental benefits	Regional development	Timeline	Reference
Morocco	Revenue potential: Up to 22 billion dirhams (2030), 330 billion dirhams (2050); Reduced ammonia imports (1–2 Mt/y)	15,000+ direct and indirect jobs by 2030	GHG reduction: 1–2.3 Mt CO_2e (2030), 10.6–20.6 Mt CO_2e (2050); Water security through desalination	Development in southern provinces; Regional employment in high-unemployment areas	Three phases: 2020–2030, 2030–2040, 2040–2050	(Royaume du Maroc, 2021)
South Africa	Contribution to decarbonisation targets (350-420 Mt CO_2e by 2030); Enhanced industrial competitiveness	Job creation in industrial corridor, PGM value addition	Air quality improvements; Just transition for coal workers; Industrial rehabilitation	Platinum Valley Initiative (Limpopo to Durban corridor), integrating mining and industry	Phased approach: 2021–2024 (pilots), 2025-2030 (scaling), 2030–2040 (expansion)	(DSTI, 2021)
Namibia	Mining sector cost savings; Energy self-sufficiency (80% target by 2029); Local manufacturing value	Portion of 280,000 jobs by 2030 serving domestic market; Skills development through hydrogen academy	Water security for communities; Off-grid electricity access (currently only 45% coverage); Bush encroachment management	Three hydrogen valleys model (Southern, Central, Northern) ensuring distributed benefits	Near-term pilot projects, medium-term scaling 2025–2030	(MME, 2022)

Mauritania	Mining decarbonisation (60–100% reduction in imported fuels); Potential 300–500% increase in mineral export value through processing	5,000–8,000 additional jobs from domestic applications	Agricultural productivity increase (15–25%) through water provision; Community resilience in water-stressed regions	Focus on Dakhlet Nouadhibou and Inchiri regions; Infrastructure development in underserved areas	Integration with export project timelines	(IEA, 2023)
Tunisia	Reduced energy imports; Fertiliser industry competitiveness; Gas network optimisation	19 000 jobs by 2030, 116 000 jobs by 2040 and 424 000 by 2050	Air quality benefits in industrial zones; Food security through local fertiliser production	Not specifically detailed	Phased hydrogen blending: 2025–2030, 2030–2035, 2035–2040	(MIME, 2024)
Egypt	Industrial competitiveness under carbon pricing; Fertiliser sector value addition; Natural gas savings	100,000 jobs by 20402040	Emissions reduction in hard-to-abate sectors; Urban air quality improvement	Industrial clusters in Suez Economic Zone; Port-centred development	Three phases: 2020s (pilots), 2030s (scaling), 2040s (integration)	(Advisian Worley Group, 2024; Limited, 2024)
Algeria	Natural gas conservation for export; Reduced energy imports; Industrial modernisation	Limited projections available	Contribution to NDC targets (7–22% emissions reduction by 2030); Energy security enhancement	Distributed development through a decentralised production model	2023–2030 (pilots), 2030–2040 (scaling), 2040–2050 (maturity)	(MEM, 2023)
Kenya	Import substitution (100,000+ t/y NH_3, 5,000+ t/y methanol); Agricultural productivity enhancement	Not specifically quantified	Food security improvement; Industrial air quality benefits	Integration with geothermal resources and agricultural centres	Two phases: 2023–2027 (substitution begins), 2028–2032 (expansion)	(EPRA, 2024)

Source: (MEM, 2023; MIME, 2024; Royaume du Maroc, 2021; Advisian Worley Group, 2024; DSTI, 2021)

Key Insights:

- **Multiple Value Streams:** Domestic hydrogen applications generate value beyond direct revenues through import substitution, industrial competitiveness enhancement, operational cost savings, and infrastructure development. Morocco projects up to 330 billion dirhams in annual revenue potential by 2050, while Mauritania could see a 300–500% increase in mineral export value through GH2-based processing.
- **Employment Generation:** Countries with advanced hydrogen strategies project significant job creation from domestic applications. Morocco expects 15,000+ direct and indirect jobs by 2030, and Namibia incorporates domestic applications within its broader projection of 280,000 jobs by 2030. Employment benefits extend beyond direct hydrogen production, including manufacturing, services, and infrastructure development.
- **Regional Development Strategies:** Several countries employ geographic development models to ensure distributed benefits, with Namibia's three hydrogen valleys approach and South Africa's Platinum Valley Initiative representing the most structured approaches. These models help address regional economic disparities while creating specialized hydrogen ecosystems tailored to local conditions.
- **Environmental-Social Nexus:** Domestic hydrogen applications create multiple environmental co-benefits with social implications, including improved air quality in industrial zones, water security through desalination infrastructure, and reduced environmental impacts from traditional fuel use. Morocco's strategy projects GHG reductions of 1–2.3 Mt CO_2e by 2030, increasing to 10.6–20.6 Mt CO_2e by 2050.
- **Integration with Development Priorities:** The most successful domestic hydrogen strategies align closely with broader national development priorities, addressing specific challenges in energy access, water security, industrial competitiveness, and economic diversification. Mauritania's approach to leveraging hydrogen desalination infrastructure to address water deficits represents a strong example of this integration.

4.6.7 Outlook and conclusion

African countries are developing differentiated approaches to domestic hydrogen markets based on their unique resource endowments, industrial capabilities, and development priorities. North African countries (Morocco, Egypt, Algeria, Tunisia) leverage their industrial base and proximity to European markets, while focusing on fertiliser production and gas network blending. East African nations like Kenya emphasize agricultural applications and industrial import substitution. Southern African countries (South Africa, Namibia) prioritise mining sector applications and industrial decarbonisation, while West African countries (Mauritania, Senegal) focus on infrastructure synergies and mineral value addition.

Despite these varied approaches, common elements emerge across successful strategies: phased implementation timelines, strategic sector prioritization based on economic viability, geographic clustering of hydrogen activities, and integration with broader development priorities. The most advanced strategies (South Africa, Morocco, Namibia) demonstrate how hydrogen development can simultaneously address multiple challenges, including energy security, industrial competitiveness, water scarcity, and regional economic disparities.

The development of domestic hydrogen markets faces several challenges, including cost competitiveness gaps, infrastructure requirements, technical capacity limitations, and policy frameworks. However, the potential benefits – including industrial decarbonisation, import substitution, employment creation, and enhanced resource security – provide compelling motivation for continued investment and policy support.

The successful development of domestic hydrogen applications will require integrated planning approaches that leverage synergies between export and domestic markets, strategic infrastructure investment, capacity-building initiatives, and supportive policy frameworks. Countries that successfully navigate these challenges stand to gain not just from hydrogen exports but from transforming their domestic energy systems and industrial base, contributing to economic development and climate goals.

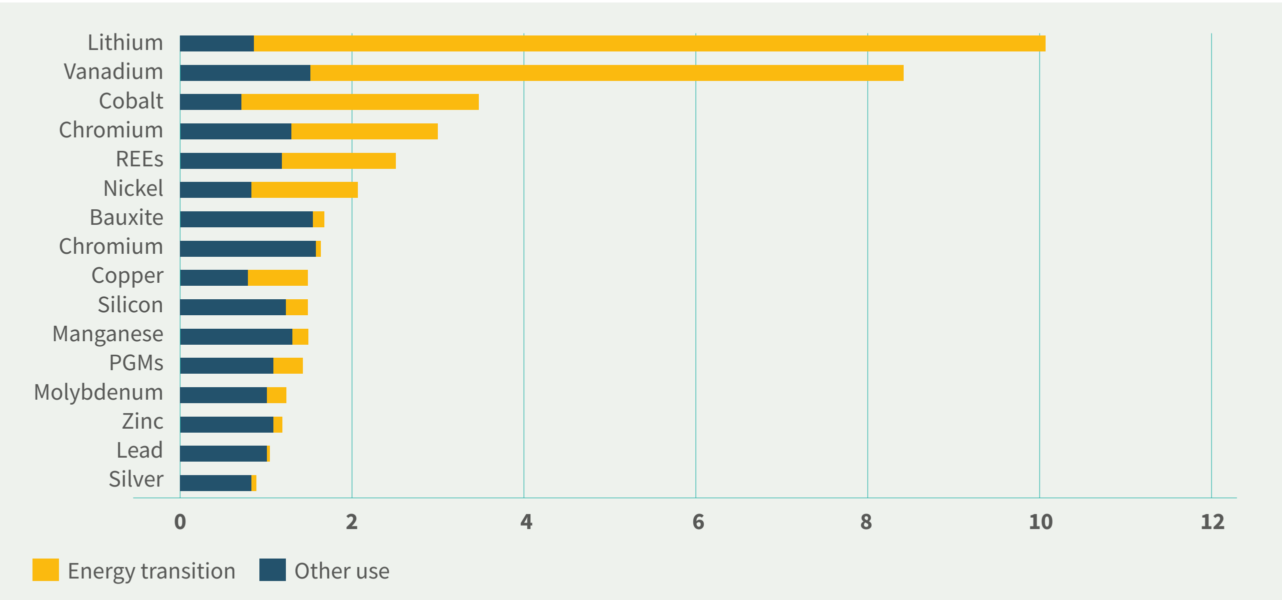
4.7 Critical Raw Materials

The energy transition will require a wide range of critical raw materials across the entire value chain, including copper, nickel, cobalt, aluminium, lithium, and others. This demand also applies to GH2/PtX development, particularly for PGMs, essential for manufacturing key technologies such as electrolysers and fuel cells. Ensuring a stable and sustainable supply of these materials will be crucial for scaling up hydrogen production and advancing the global energy transition.

4.7.1 Defining critical raw materials

The demand for mineral inputs into green technologies will increase significantly as the world decarbonises. The magnitude of demand increases by 2050 relative to current demand is shown in Figure 18. Increased demand is expected to lead to a significant shortage of many of these inputs by 2030 (IRENA, 2023).

Figure 18: Increase in Global Demand of Energy Minerals



Source: (IMF, 2024)

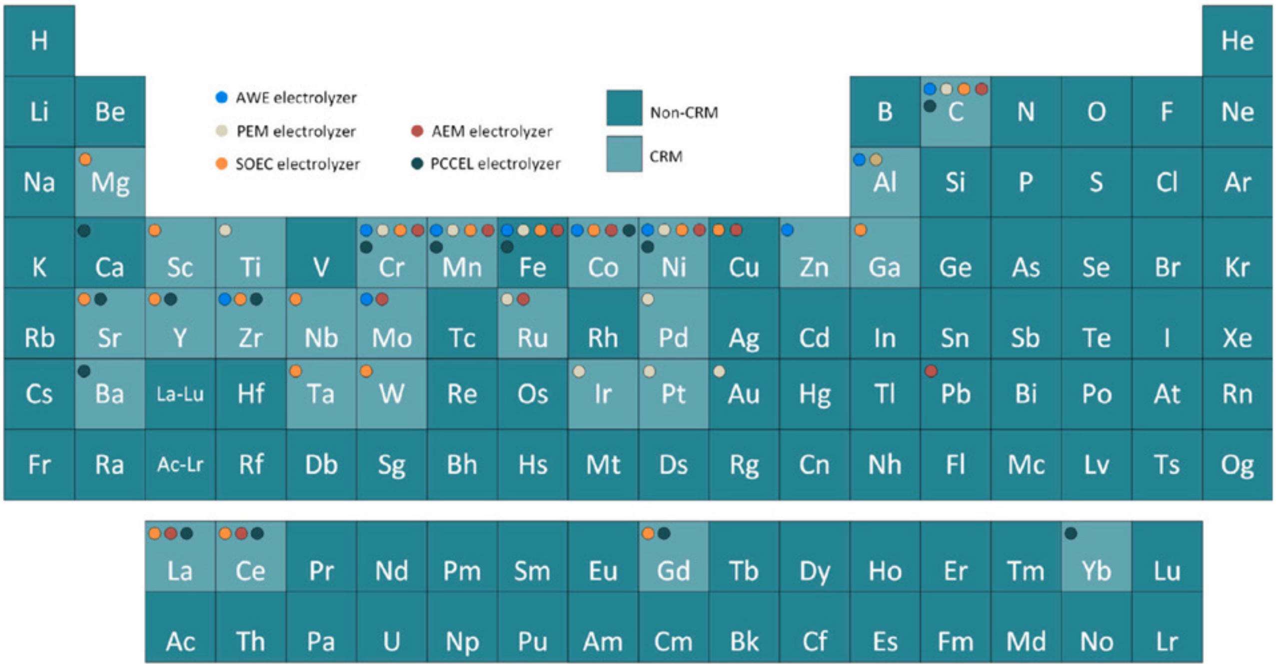
Note: The chart shows the IEA's projected increase in mineral demand (in quantity terms) broken down by sector as a ratio of 2050 to 2022 demand, under the IEA's net zero emissions transition scenario. REEs = Rare Earth Elements

There is no single definition of 'critical raw materials', the critical minerals required to support the energy transition and other low-carbon technologies. Countries and regions typically define critical minerals based on local conditions and needs. IRENA (2023) identified 51 materials included in at least one of 35 lists of critical minerals reviewed.

4.7.2 Minerals in GH2 value chains

Several electrolyser technologies are currently being developed and deployed internationally. Given that it is unclear whether or when these technologies may become dominant, there is significant uncertainty regarding which minerals will underpin the mass rollout of GH2. Eikeng, Makhsoos and Pollet (2024) consider the mineral requirements of five of the most promising electrolyser technologies and identify several vital minerals. The authors also consider whether the minerals have been listed as critical raw materials by the EU or the US Geological Survey. The results are shown in Figure 19.

Figure 19: Elements utilised in the production of different electrolyser technologies



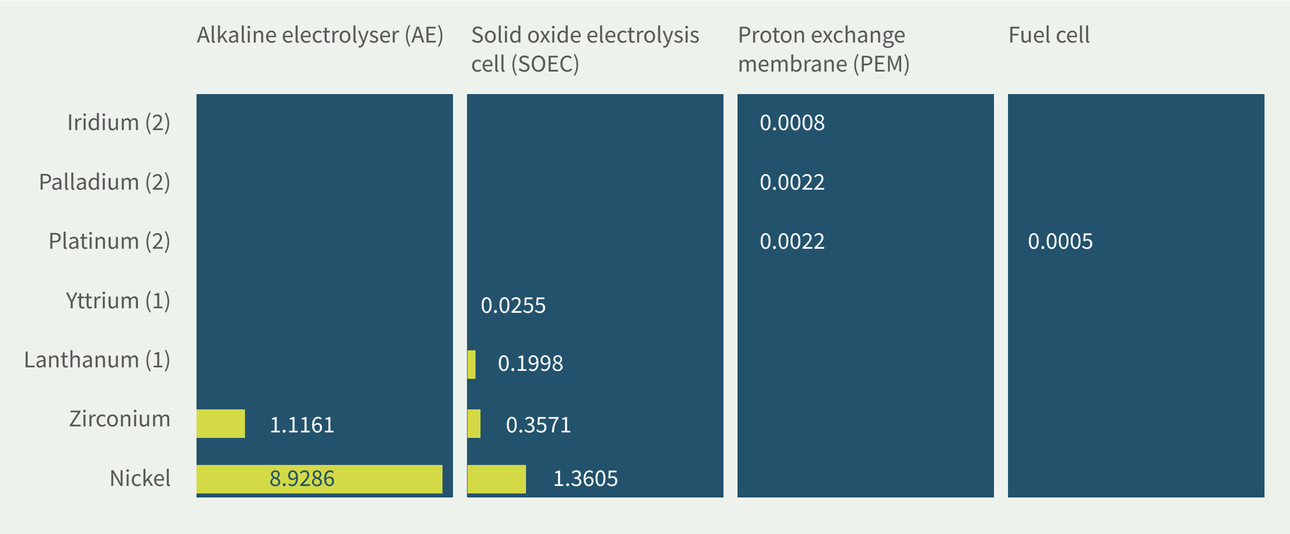
Source: (Eikeng, Makhsoos, & Pollet, 2024)

Elements: Calcium (Ca), Strontium (Sr), Barium (Ba), Scandium (Sc), Yttrium (Y), Titanium (Ti), Zirconium (Zr), Niobium (Nb), Tantalum (Ta), Chromium (Cr), Molybdenum (Mo), Tungsten (W), Manganese (Mn), Iron (Fe), Ruthenium (Ru), Cobalt (Co), Iridium (Ir), Nickel (Ni), Palladium (Pd), Platinum (Pt), Copper (Cu), Gold (Au), Zinc (Zn), Aluminium (Al), Gallium (Ga), Carbon (C), Lead (Pb), Lanthanum (La), Cerium (Ce), Gadolinium (Gd), Ytterbium (Yb)

Technologies: AWE: Alkaline water electrolyser, PEM: Proton exchange membrane, SOEC: Solid oxide electrolyser, PCCEL: Proton conducting ceramic electrolyser

Furthermore, as shown in Figure 20, the volume of minerals required by technology varies significantly. Greenwald, Zhao and Wicks (2024) considered the demand for critical minerals for electrolysers and related RE supply under a business-as-usual scenario (100 Mtpa GH2 demand), a net zero scenario (500 Mtpa GH2 demand) and a scenario where GH2 transforms the energy landscape (1000 Mtpa GH2 demand). The results are shown in Figure 21. The authors found supply constraints only evident for platinum group metals (PGMs), and in particular iridium, and one rare earth element (Yttrium) when considering electrolysers. More, and potentially more severe, mineral constraints were likely to impact the RE that would be required to supply the electrolysers. The tonnage of materials required for RE will be much greater than that for electrolysers. This is particularly true for PEM and SOECs, where the differential is several orders of magnitude (Greenwald, Zhao, & Wicks, 2024).

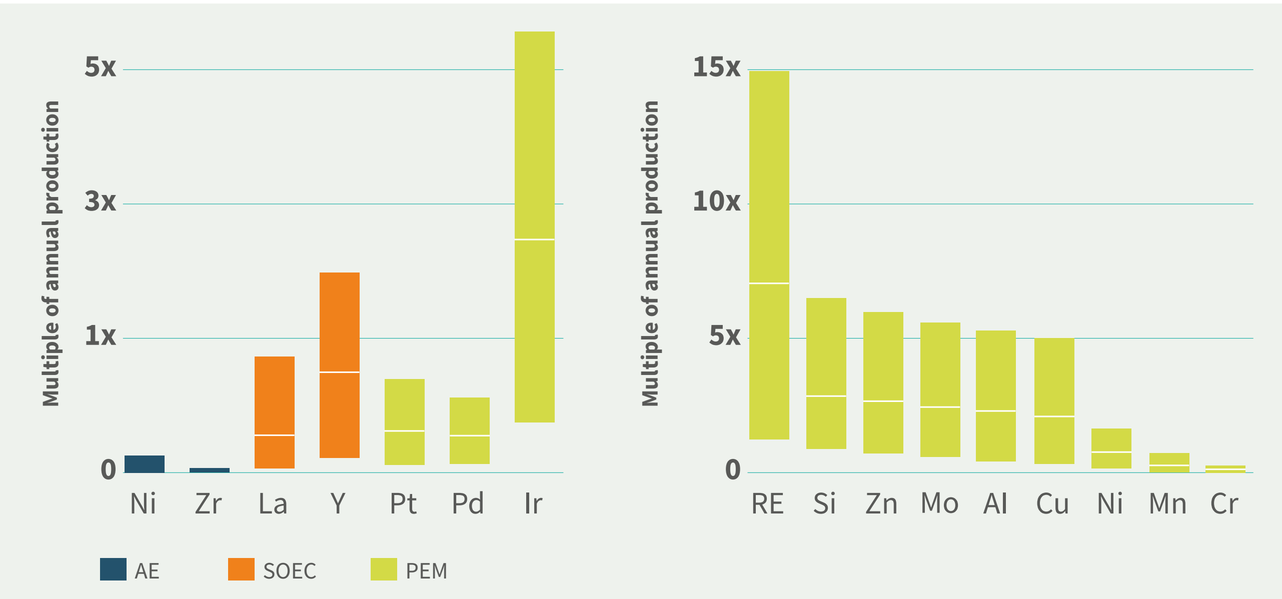
Figure 20: Mineral demand by type of electrolyser technology (kg per GWh output)



Source: Adapted from (IEA, 2021)

Note: (1) Rare earth elements (REEs) (2) Platinum Group Metals

Figure 21: Mineral demand from electrolyser and RE supply under different scenarios, 2050



Total mineral demand required to produce GH2 using different electrolyser technologies relative to the current annual production of minerals (by scenario)

Total mineral demand required to supply RE relative to the current annual production of minerals (by scenario)

Source: (Greenwald, Zhao, & Wicks, 2024)

Notes: Alkaline water electrolysers, AE (pink), solid oxide electrolysis cells, SOEC (blue) and proton exchange membranes, PEM (green). | For each floating bar, the lower and upper limits correspond to the GH2 required for the business-as-usual and transformative GH2 scenarios. Black lines correspond to the net zero scenario. | Renewables mix equally distributed between solar PV, onshore wind, and offshore wind | Other Rare Earth Elements (REEs) (RE), Silicon (Si), Zinc (Zn), Molybdenum (Mo), Aluminium (Al), Copper (Cu) Nickel (Ni), Manganese (Mn), Chromium (Cr), Zirconium (Zr), Lanthanum (REE) (La), Yttrium (REE) (Y), Platinum (PGM) (Pt), Palladium (PGM) (Pd), Iridium (PGM) (Ir)

Demand for PGMs could be increased by the deployment of fuel cells, and it is likely that GH2 production facilities will also increasingly include battery storage in future – which would increase demand for lithium (li), cobalt, graphite and fluorspar (Greenwald, Zhao, & Wicks, 2024; Lasley, 2024).[10]

While the extent to which expected demand for Iridium and Yttrium currently exceeds supply may be concerning at first glance, it is important to note that the minerals are required by different electrolyser technologies. Ferris (2023) believes that a GH2 market built around several electrolyser technologies, rather than one dominant technology, will help to avoid critical mineral shortages constraining industry growth. Mineral requirements are also likely to fall as current technologies mature, and new ones are developed – and shortages of critical minerals may incentive innovation as price of inputs start to increase (Ferris, 2023; Eikeng, Makhsoos, & Pollet, 2024; IEA, 2023c).

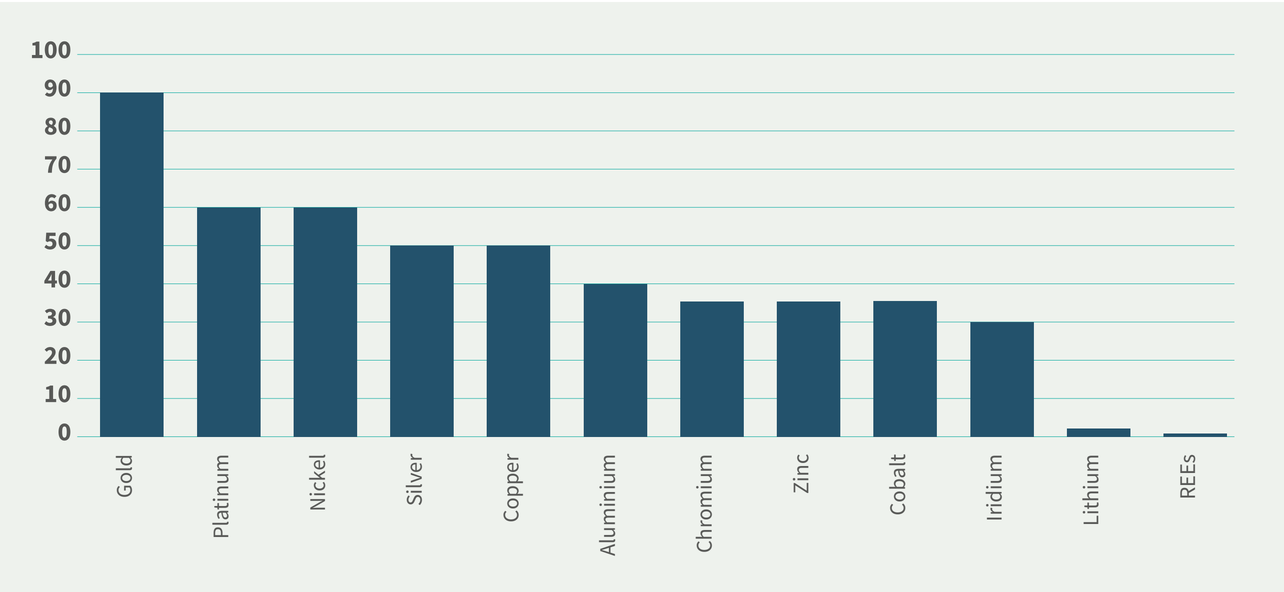
Eikeng, Makhsoos and Pollet (2024) emphasise that technological progress will be key to ensuring that material bottlenecks do not become a constraint to scaling the GH2 industry. They advocate several actions:

- Decrease the material requirements of existing electrolyser technologies;
- Develop and commercialise new technologies that are less reliant on critical materials;
- Improve the ability and extent of material recycling.

The Global Hydrogen Review (2024) mentions that the durability of PEM electrolysers with iridium-free catalysts have increased significantly, and highlights that Toshiba has developed a PEM technology that reduces iridium use by 90% and has partnered with Bekaert to commercialise it. Bekaert is also a partner in the EU-funded HyScale project that has developed and successfully tested a single stack 100 kW Anion Exchange Membrane (AEM) electrolyser prototype that uses no critical raw materials (Bekaert, 2025).

Doyle et al (2023) emphasise the importance of recycling to avoid supply chain disruptions and to reduce project costs. The authors also show that current recycling rates for critical materials are low, creating significant opportunities for future recycling and reuse (see Figure 22).

Figure 22: Recycling rates of key energy transition minerals, 2022



Source: (Doyle, Bernuy-Lopez, Krasowski, & Pries, 2023)

10 The discussion in this section focused on the minerals required in the GH2 value chain responsible for the bulk of physical demand. For a more complete discussion that includes all minerals relevant to electrolysers production and hydrogen transport, storage and separation, see Eikeng, Makhsoos and Pollet (2024).

4.7.3 Africa's critical mineral resource endowment

The African Union's Africa's Green Minerals Strategy Bank defines 15 core minerals and a further 20 minerals that may be included in future (watchlist minerals) (AMDC, 2024). Table 22 supplements the core minerals by six watchlist minerals and fluorspar, which is included in the critical minerals lists of the EU, US and China (IRENA, 2023).

Table 22: Critical minerals in Africa (2023 or latest available dates)

Minerals	World production	World reserve	Top African mcountries	Production (% of world)	Reserves (% of world)
Aluminium (smelter prod)	70 Mt		South Africa*	720 kt (1%)	
			Mozambique	314 kt (0.5%)	
			Egypt*	320 kt (0.5%)	
Alumina	140 Mt		Guinea	330 kt (0.3%)	
Bauxite	400 Mt	30Gt	Guinea	97 Mt 24.3%)	7.4 Gt 23.8%)
Chromium	41 Mt	560 Mt	South Africa*	18 Mt 43.9%)	200Mt 35.7%)
			Zimbabwe	1.4 Mt (3.4%)	
Cobalt	230 Mt	11 Mt	DRC	170 kt (73.9%)	6 Mt (54%)
Copper mine production	22 Mt	1 Gt	DRC	2.5 Mt (11.3%)	80 Mt (8%)
			Zambia	760kt (3.4%)	21 Mt (2.1%)
Copper refinery	27 Mt		DRC	1.9 Mt (7%)	
			Zambia	380 kt (1.3%)	
Fluorspar ≡	8.8 Mt	280 Mt	South Africa*	410 kt (4.7%)	41 Mt (14.6%)
Graphite - natural	1.6 Mt	280 Mt	Mozambique	96 kt (6%)	25 Mt (8.9%)
			Madagascar	100 kt (6.2%)	24 Mt (8.5%)
			Tanzania	6 kt (0.3%)	18 Mt (5.5%)
Iron & steel (raw steel)	1.9 Gt				
Iron ore (Fe cont.)	1.5 Gt	87 Gt	South Africa*	39 Mt (2.6%)	600 Mt (0.6%)
			Mauritania*	8.1 Mt (0.5%)	N/A

Lead∞	4.5 Mt	95 Mt	South Africa*	35 kt	
Lithium	180 Kt	28 Mt	Zimbabwe	3.4 kt (1.8%)	310 kt (1.1%)
			Mali*		834 kt (3.0%)
			Namibia*		230 kt (0.8%)
Manganese	20 Mt	1.9 Gt	South Africa*	7.2 Mt (36%)	600 Mt (31.5%)
			Gabon	4.6 Mt (23%)	61 Mt (3.2%)
			Ghana	840 kt (4.2%)	13 Mt (0.7%)
			Cote d'Ivoire*	390 kt (1.9%)	N/A
Molybdenum	260 kt	15 Mt			
Nickel	3.6 Mt	> 130 Mt			
Phosphate rock	220 Mt	74 Gt	Morocco*	35 Mt (16%)	50 Gt (67%)
			Egypt*	4.8 Mt (2.1%)	2.8 Gt (3.8%)
			Tunisia*	3.6 Mt (1.6%)	2.5 Gt (3.4%)
			Senegal*	2.5 Mt (1.1%)	50 Mt
			Algeria*	1.5 Mt (1.1%)	2.2 Gt (3%)
			South Africa*	1.6 Mt (0.7%)	30 Mt
			Togo*	1.5 Mt (0.6%)	1.5 Gt (2%)
PGMs (palladium+ Platinum)	390 t	1 Gt	South Africa*	191 t (49%)	63 kt (90%)
			Zimbabwe	34 t (8.7%)	1.2 kt (1.7%)
Iridium (PGM)	8.7t		South Africa*	6.7 (83.0%)	
Rare Earths	390 kt	>90 Mt	Angola*		>139 kt (0.2%)
			Mozambique	960 t (0.2%)	
			Madagascar	2 kt (0.5%)	
			South Africa*		860 kt (1.0%)
			Tanzania		890 kt (1.0%)
Silicon∞			South Africa*	51 kt	

Titanium∞		750 Mt	South Africa*	1.1 Mt (12%)	34.1 Mt (4.5%)
Vanadium		19 Mt	South Africa*	9.1 kt (9.1%)	750 kt (3.9%)
Zinc		220 Mt	South Africa*	230 kt (1.9%)	6.2 Mt (2.8%)
Zirconium		>70 Mt	South Africa*	300 kt (20%)	5.3 Mt (7.6%)
			Kenya*	20 kt (1.3%)	5 kt (<0.1%)
			Madagascar	30 kt (2.0%)	2.1 Mt (3.0%)
			Mozambique	160 kt (10.7%)	1.5 (Mt) (2.1%)
			Senegal*	60 kt (4.0%)	2.6 Mt (3.7%)
			Sierra Leone	20 kt (1.3%)	290 kt (0.4%)

Source: (AMDC, 2024) (Cornelissen, et al., 2024),Statista.com, (USGS, 2025), (Minerals Council, 2025), (IRENA, 2023) (Minerals Council, 2025b), (Eikeng, Makhsoos, & Pollet, 2024) (Pensana, 2025) (Kodal Minerals, 2025)

Notes: ∞ Africa Critical Minerals Strategy watchlist mineral ≡ Included in critical minerals list of US, EU and China
**Report focus countries (Tier 1, 2 or 3)*
Production and reserves values are not directly comparable. Output is typically denoted in gross weight and reserves in mineral content.

Table 22 shows that many countries that are developing GH2 industries, and particularly South Africa, are well-endowed with critical minerals. The table only shows countries with internationally significant levels of mineral production and/or reserve.

Boafo et al. (2024) consider the distribution of 15 critical minerals across Sub-Saharan Africa and shows that all but three are present in South Africa. South Africa beneficiates (processes resources locally to increase the economic value of exports) minerals like gold and platinum locally, and also has a large iron and steel and ferroalloys industry. Despite beneficiation being a policy objective in South Africa since the late 2000s (The dti, 2007), however, an electricity supply crisis, rapidly escalating electricity prices, and logistics bottlenecks have led to a reduction in the size of the iron and steel and ferroalloy industries, leading to more minerals being exported in unprocessed form (FAPA, 2022).

Furthermore, South Africa has historically been a mining powerhouse. Since the mid-2000s, however, South African mining production has been trending downwards as a result of the depreciation of South Africa’s gold mines, labour unrest, an electricity supply crisis and sharply increasing electricity costs, logistics bottlenecks, policy and regulatory uncertainty, and the lack of an efficient system for managing mining rights and applications (Cornelissen, et al., 2024; OECD, Undated). This led to South Africa‘s attractiveness as a mining location falling relative to other Sub-Saharan African countries, and its global share of exploration falling from a high of 5% during the early 2000s to around 1% currently (DMRE, 2022; Fabricius, 2024). The rapidly increasing demand for minerals to supply green energy technologies, coupled with South Africa’s rich endowment of many of these minerals and its extensive mineral extraction and processing experience, however, is seen as an opportunity to revitalise the South African mining industry (PWC, 2023). Emphasising the development potential of critical minerals to developing countries, President Cyril Ramaphosa included harnessing critical minerals for inclusive growth and sustainable development as one of his four priorities for South Africa’s presidency of the G20 in 2025. He also called for a G20 framework on green industrialisation and investment to promote the beneficiation of critical minerals close to their source of extraction (Moodley, 2025).

The processing of critical minerals to support the energy transition is currently concentrated mainly in China (IEA, 2024), but the distribution of critical minerals shows that Africa has an opportunity to grow its mining sector due to increased demand for GH2 and GH2-related renewables sector goods (including battery storage and transmission and distribution equipment).

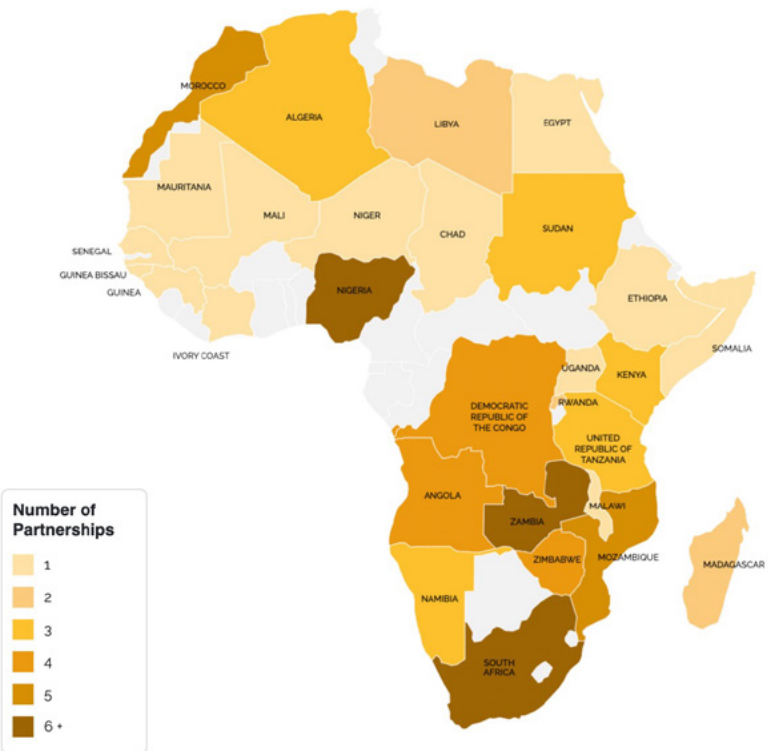
4.7.4 International relations and policies

Fear of shortages has led to critical raw materials gaining prominence in international diplomacy, and countries have increasingly entered into agreements and partnerships to secure the future supply of these materials. Two prominent examples of this are China's Belt and Road Initiative (BRI) and the EU's Global Gateway initiative. Until recently, however, Africa has been underrepresented in these endeavours. IRENA (2023) shows in 2022 only one African country, Botswana, was part of a multilateral alliance, namely the Energy Resource Governance Initiative driven by the United States. This is slowly changing.

In 2023, Angola, the DRC and Zambia created the Lobito Corridor in partnership with the EU and the US (European Commission, Undated), and in 2024, Egypt, Ethiopia and South Africa joined the BRICS Geological Platform (APRI, Undated). Also in 2024, 16 African nations founded the Africa Minerals Strategy Group (AMSG), an intergovernmental body established to support the mutually beneficial development of Africa's significant mineral reserves. The founding members included Nigeria and South Africa. The AMSG joined the Council for Critical Minerals Development in the Global South – a platform fostering collaboration between governments and other partners to develop equitable minerals value chains and technologies to support the energy transition (SEforALL , 2024). Furthermore, South Africa's ambassador to the UN co-chairs the UN Secretary-General's Panel on Critical Energy Transition Minerals. The Panel is developing a set of standard and voluntary principles covering equity, transparency, investment, sustainability and human rights during the extraction and processing of critical minerals to build trust and accelerate the low-carbon transition (UN, 2024).

Developed countries and fast-growing emerging economies like China increasingly enter bilateral agreements with African countries to gain preferential access to critical minerals. The prevalence of these agreements is shown in Figure 23 below.

Figure 23: Partnerships to access critical raw materials in Africa



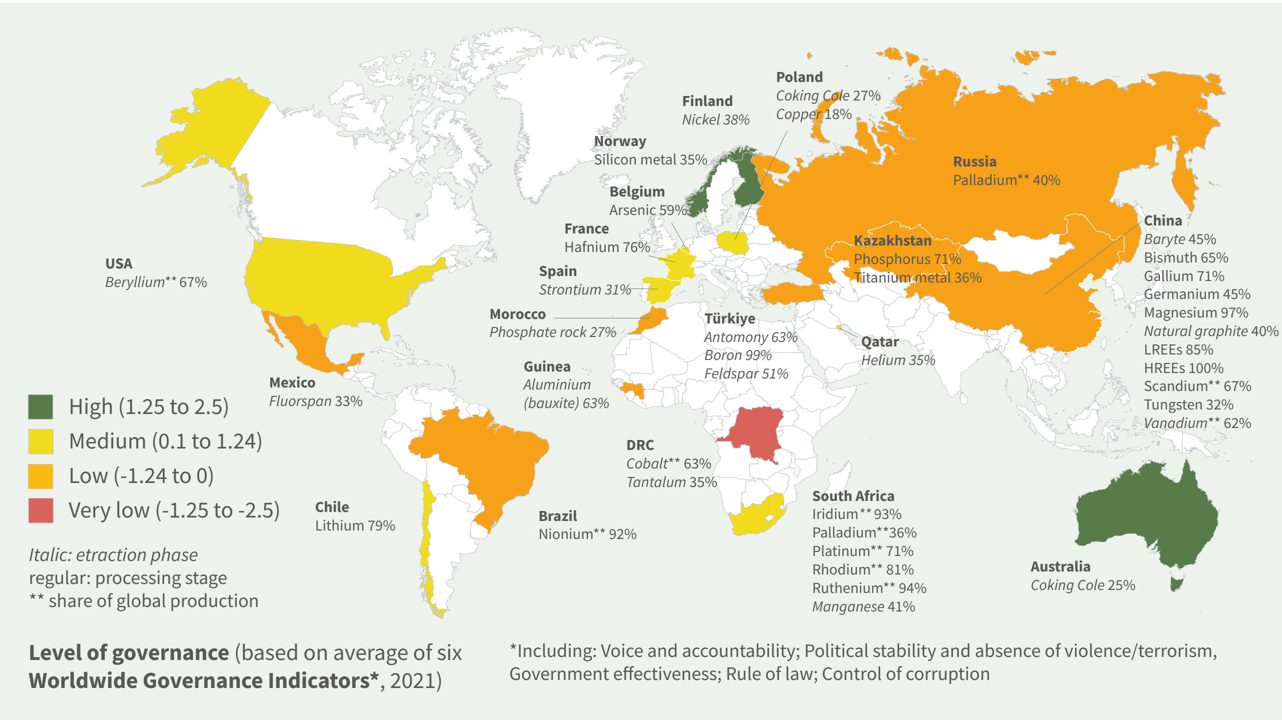
Source: (Beuter, Bhuee, Gabadadze, Gnanguênon, & Hofmeyr, 2024)

While several African countries have mining and even critical mineral strategies in place, only three had officially published lists of critical minerals by December 2023: DRC, Nigeria and South Africa (Garg & Vickers, 2024; IEA, 2023). South Africa's list was included in the Exploration Strategy for the Mining Industry of South Africa in 2022. The Strategy emphasises the importance of critical minerals to revitalise the mining industry (DMRE, 2022). South Africa is also currently developing a critical minerals strategy, which is expected to be launched, along with an updated critical minerals list, in 2025 (Minerals Council, 2025b).

4.7.5 Prospects

In addition to the increasing demand for critical raw materials, most developed countries and emerging economies are looking to diversify their supply chains in the face of recent supply chain disruptions linked to the COVID-19 pandemic and increasing geopolitical tensions. The G7, for example, issued a Five-Point Plan for Critical Minerals Security in 2023 that included a focus on supply chain "friend-shoring" and detailed ways to assist developing countries with value-added processing and manufacturing, supply chain integration and sustainable mining practices (Whyte, 2024). The EU and UK, in particular, are looking to diversify its supply of critical minerals away from China in favour locations with strong governance and practices that can address increasing concerns around the environmental and human rights impacts of critical minerals exploration in jurisdictions that lack strong ESG credentials (including China and many jurisdictions in Africa) (European Commission, 2023; Vandome, 2024). As Figure 24 shows, South Africa has relatively good governance. It also has a strong environmental, social, governance (ESG) reporting and regulation framework, which will be to its benefit given the increased focus on sustainability and responsible sourcing (Boafo, Obodai, Stemn, & Nkrumah, 2024; Cornelissen, et al., 2024; Pitron, 2024; Arnoldi, 2025; Creamer Media Reporter, 2025a). The South African mining industry is also increasingly turning to RE to avoid above-inflation grid electricity price increases, increase energy security in the face of ongoing loadshedding, and decarbonise its activities (Liedtke, 2024; BDO , 2025) (Liedtke, 2024; BDO, 2025). Other countries in Africa, however, have realised the importance of ESG factors, and Africa's Green Minerals Strategy emphasises the importance of mineral stewardship and ESG practices (AMDC, 2024). The AMSG launched the Africa Responsible Mineral Sourcing Initiative (ARMSI) to promote sustainable and ethical mining practices in 2024 and is developing Africa-specific responsible mineral sourcing guidelines following the OECD Due Diligence Guidance for Responsible Mineral Supply Chains (ASMG, 2025).

Figure 24: Global supply of critical minerals based on EU 2023 list by country and governance level



Source: (European Commission, 2023)

Several projects to recycle critical minerals are already operational in South Africa, and South Africa's long history of coal mining has generated significant volumes of coal discards from which rare earth elements can be extracted (Creamer M. , 2023; Cornelissen, et al., 2024). Large local coal miners, like Exxaro, are also seeing critical minerals as key to diversifying into more sustainable mining activities (Koppeschaar, 2025).

Examples of critical minerals projects or expansions currently under development in GH2-relevant African countries include (Bloomberg, 2023; Nhede, 2024; Sepfluor, Undated; Tucker, 2025; Energy Capital & Power, 2024):

- **Angola:** Longonjo Rare Earths Project - Various rare earths to form a rare earth carbonate
- **South Africa:**
  - Sishen Ultrahigh Dense-Media Separation Project - premium iron ore mining
  - KwaZulu Natal Titanium Beneficiation Complex - titanium pigment manufacture
  - Steelpoortdrift Vanadium Project - new vanadium mine
  - Platreef PGM Nickel Project - expansion of existing mining complex
  - Eland Mine Complex - new PGM mine
  - Thaba Joint Venture Project - new facility to extract PGMs from chrome ore tailings
  - Waterberg Project - new PGM mine
  - Sepchem Project - new fluorspar beneficiation plant
  - High Purity Manganese Sulphate Monohydrate (HP MSM) Project - expansion of manganese metal plant to produce HP MSM for battery applications
- **Mali:** Bougouni Lithium Mine and Goulamina Lithium Project
- **Nigeria:** China – Nigeria MOU to develop lithium, niobium, and tantalum deposits, French – Nigeria MOU to strengthen critical minerals value chains (targeting relaunch of 2,000 abandoned mining pits)
- **Various:** Q Global Commodities and F9 partnership - development of new mines for green metals in **South Africa**, Botswana, Zambia, Tanzania and **Namibia**

4.7.6 Recommendations

The African Green Minerals Strategy (AMDC, 2024) outlines four pillars to support the development of the continental critical energy minerals industry:

- **Create a conducive environment for minerals investment** by increasing geological knowledge, conducting feasibility studies, building infrastructure and creating a continent-wide Mineral Value Chain Investment Fund.
- **Enhance human and technological capabilities** by performing a green mineral skills and technologies audit and establishing institutions to develop the necessary skills and conduct coordinated research, development, and innovation activities.
- **Develop mineral value chains** to achieve equitable resource-based industrialisation (ERBI) by focusing on supply chain development, beneficiation, and value addition and strengthening regional and African-wide markets within the African Continental Free Trade Area.
- **Focus on mineral stewardship** to ensure positive environmental, social, and governance outcomes for green minerals and increase material reuse and recycling.

4.8 Development barriers and risks

In all the countries studied, the objectives for the dissemination of GH2 and the implementation of projects (production, PtX, value chain, etc.) are mainly derived from National Development Plans, national hydrogen strategies, linked to RE plans when they exist.

These technologies and projects will contribute to a triple objective. The first is to satisfy a growing electricity demand, induced by the economic and social transformation that the continent is experiencing, the second is to optimise and rationalise the use of this energy across all consumption profiles and uses, the third is to participate in the industrialisation of the continent, including the greening of exports in the context in particular of the European CBAM (logic of PtX, also decarbonisation of “hard to abate” sectors.

Furthermore, this implementation will significantly contribute to supporting the financial balance of the energy sector in the long term. It will be a very important source of direct and indirect job creation. Indeed, in the case of a large-scale implementation allowing new opportunities, particularly in solar energy, the combined effect of low-cost kWh production by solar and the optimisation of intermittent energy management will contribute to optimising the impact of subsidies and investment in general.

Africa is well-endowed with RE resources, including solar, wind, geothermal, and wave energy. Solar radiation, for example, can reach more than 2000 kWh/m 2 in all the countries studied and well beyond in some. Thus, Africa has significant potential to produce low-cost GH2 and PtX for its own markets and exports.

However, several obstacles complicate the development of a GH2 economy in Africa. While some issues are applicable to all countries, like the fact that GH2 is still significantly more expensive than fossil fuel-derived H2, factors relating to, for example, institutional and technical capacity and policy and regulatory frameworks are highly country-specific.

The table below summarises the main barriers to developing GH2 and the measures proposed to overcome them. While the barriers may seem daunting, many are linked to a lack of GH2 deployment at scale. As the market matures, familiarity with the technology increases, and business models evolve, most of these barriers will likely become less of a constraint to developing new PtX projects. The availability and cost of water, for example, were long thought to be severe constraints to developing new GH2 projects. Detailed financial modelling, however, has shown that the cost of providing a suitable water supply via desalination has a relatively insignificant impact on the total cost of GH2 projects (Roos & Wright, 2020).

Table 23: Main barriers to developing GH2

Barriers	Components of the barrier	Description of the type of barrier in the African context	Action to take to lift the barrier
Financial barriers	High initial costs	Although reduced in recent years, the cost of installing RE (including associated infrastructure) remains a significant barrier. Electrolysers remain expensive. A combination of RE, electrolysers, storage, etc, leads to PtX projects being capital-intensive mega-projects	To make RE and PtX installations more affordable, improve tax incentives and implement subsidies and financing mechanisms, such as tax credits, low-interest loans, and direct grants.
	Limited access to funding and high cost of funding	Financing mechanisms for H2V/ PtX projects are limited in Africa, hindering this technology's adoption.	Create financing programs specific to RE and/or PtX projects, including loan guarantees and dedicated development funds.

	Maintenance and operating costs	Although maintenance costs for upstream RE systems are low, they can be a barrier, especially in the absence of locally qualified technicians.	Train local technicians to maintain upstream solar systems and develop affordable and accessible maintenance contracts.
Institutional and regulatory barriers	Insufficient or inappropriate regulatory framework	Regulations for H2/ PtX in Africa are still developing, which may create uncertainty for investors and potential users.	Strengthen the regulatory framework by adopting H2-specific laws and guidelines. Additional laws and guidelines to facilitate the integration of RE into the national grid.
	Weak coordination between institutions	Lack of coordination between different government agencies can delay projects.	Create a national committee dedicated to RE to improve coordination between institutions and accelerate the implementation of GH2 and RE projects.
	Bureaucratic approval process	The administrative processes for obtaining the necessary permits for installing solar systems can be complex and lengthy.	Simplify and streamline administrative procedures, including creating a one-stop shop for permits.
	Lack of supportive policies	The lack of robust incentive policies for the development of GH2 and RE projects	Develop and implement a national strategy for developing PtX, with clear objectives and dedicated support measures.
Technical and environmental barriers	Insufficient support infrastructure	The lack of infrastructure, such as electricity grids suitable for integrating RE, limits the penetration of this technology and the locations suitable for PtX projects.	Invest in improving the electricity grid infrastructure to facilitate project integration.
	Lack of local technical skills	There is a shortage of qualified technicians to install and maintain technical systems.	Establish specialized technical training programs to develop a skilled workforce.
Market barriers	Lack of local RE suppliers and installers	The number of local suppliers and installers of RE equipment and electrolysers is limited. This can lead to higher costs and reduced availability, particularly if there is strong demand for RE from other sectors.	Through tax incentives and support programs, encourage the establishment of local suppliers, manufacturers, and installers of RE equipment or electrolysers.
	Low market demand	Demand for GH2 remains relatively low, partly due to high current costs and lack of awareness.	Stimulate demand through awareness programs, provide financial incentives for businesses, support projects to access subsidised international market mechanisms, and stimulate local demand through climate policies.

Source: Various sources, including (Komorowski & Grzywacz, 2024) (Dagnachew, Solf, Ibrahim, & de Boer, 2023) (AfriCGE, Undated) (Obanor, Dirisu, Kilanko, Salawu, & Ajayi, 2024) (Ayuk, 2025) (GIZ, 2024a) (GIZ, 2023d) and the authors' experience.

4.8.1 Financial barriers

The financial barriers to GH2 development in Africa are multifaceted and require comprehensive solutions. There is a critical need for dedicated production cost studies and scenarios at national, regional, and continental levels to accurately assess investment requirements (IEA, 2023). For a detailed discussion of the factors impacting the ability of PtX projects in Africa to access funding, see section 8.

The absence of comprehensive pan-African economic and financing studies represents a significant gap in understanding the full potential and requirements for various applications of GH2. In the fertiliser sector, for example, GH2 offers a promising Input for nitrogen fertiliser production via ammonia when accounting for external costs like transport and foreign exchange risks - but more research is needed to assess the competitiveness of GH2-derived fertiliser.

For higher-priced commodity production, GH2 and its derivatives (ammonia, methanol) could serve existing and new industrial processes in the short to medium term, with pilot projects potentially acting as catalysts for broader hydrogen development. Transport applications and large-scale industrial uses represent potential markets. GH2 or its derivatives could provide off-grid energy supply alternatives to diesel generators or PV-battery systems for isolated grids or free-standing applications (such as mobile network stations). Financial analyses of these options remain insufficient. Once this information is available, it could be used to develop incentives and financial support mechanisms to stimulate investment and market growth.

4.8.2 Institutional and regulatory barriers

Institutional frameworks for GH2 development across Africa face several key challenges that require concerted attention. The regulatory framework for off-grid self-consumption projects often lacks clear guidelines and procedures, and the rules governing right-of-way, accessing state-owned land, and private electricity transmission line provision are often opaque or missing. Accessing suitable land for GH2 projects and/or access to critical infrastructure is often challenging due to legal structures such as concessions or temporary occupation permits being unavailable in many countries. Coordination between ministries and responsible authorities or agencies involved in permitting, environmental authorisations, coastal protection, and industrial planning is often lacking.

Several critical capacity gaps hinder GH2 development across the continent:

- **Specialised Technical Expertise:** Limited experience with hydrogen technologies and their integration.
- **Regulatory Institution Adaptation:** Need for adaptation to accommodate hydrogen-specific requirements.
- **Industry-Research Collaboration:** Insufficient mechanisms for collaboration between sectors.
- **Project Development Capacity:** Limited experience with large-scale RE and hydrogen projects
- **Financing Expertise:** Gaps in specialized knowledge of blended finance and green financing mechanisms.

These gaps necessitate targeted capacity development initiatives, including technical training programs, regulatory capacity building, and project development support mechanisms. Coordination mechanisms establishing dedicated entities across government institutions, standards development for hydrogen-specific certification systems, infrastructure planning enhancement, and public awareness creation must also be addressed [11].

Concerning regulatory barriers, many African countries remain ill-equipped to handle GH2 development. Power sector legislation, for example, frequently does not deal with power production from hydrogen, requiring new provisions for hydrogen‘s role in self-generation or dedicated off-grid projects (Agyekum, 2024). Gas sector legislation in several countries still does not encompass hydrogen blending or dedicated hydrogen transport pipelines. Legal updates are necessary to define hydrogen‘s status within the national grid, set technical injection limits, and establish rights-of-way for private pipelines.

11 Institutional and capacity issues are discussed further in Chapter 5.

A legal definition of GH2 is often missing, creating fundamental challenges for project classification. The processes to obtain environmental, health and safety, permitting, and other authorisations for GH2 projects are often unclear and require updating beyond the simplistic "hazardous gas" approach usually applied. Safety standards for hydrogen production, transport, and storage represent another critical regulatory gap that must be addressed to ensure safe industry development.

4.8.3 Technical barriers

There are significant technical, technological and intellectual property barriers in many African countries that need to be overcome to enable large-scale GH2 development (see section 6). This will require significant international cooperation and domestic capacity building. International technology partnerships will be essential to access cutting-edge hydrogen technologies and best practices. Technical expertise exchange programs can help build a local knowledge base and capabilities in hydrogen production, storage, and application technologies.

Research and development collaboration between African institutions and international partners can address region-specific technical challenges and adaptations. Technology transfer agreements will be crucial to bringing established hydrogen technologies to African markets under terms that support local development. Local content development in hydrogen supply chains represents a vital opportunity to build domestic manufacturing and service capabilities while creating jobs. Skills and capacity-building programs targeting technical education, vocational training, and university curricula will be necessary to develop the specialized workforce required for a hydrogen economy.

4.8.4 Environmental barriers

Environmental considerations present both challenges and opportunities for GH2 development in Africa. Desalination is set to play a strategic role in water resource mobilization, with seawater desalination coupled with renewables representing a key nexus for national low-carbon development (Miltrup, 2024). However, water vulnerability remains a concern, as many potential hydrogen hubs rely on scarce water resources and must consider recycling or trucking alternatives to ensure a reliable supply for hydrogen production.

Water-Energy-Food Nexus coordination necessitates institutions to manage potential synergies where GH2 projects could offer a cost-effective water supply. Coordination mechanisms to support irrigation in water-stressed regions and stakeholder forums for comprehensive discussions with local communities will be vital to ensure sustainable development. The availability of sustainable, low-cost carbon represents another environmental consideration, as some countries may leverage competitive advantages in biomass resources as carbon sources for green hydrocarbons like methanol, although this requires verification against agriculture, forestry, and land sustainability standards.

Several key sustainability factors require attention in GH2 development:

- **RE Additionality:** GH2 production presupposes additional RE capacity separate from that needed for the electricity transition.
- **Land Use Management:** A Significant land area is needed for RE sources dedicated to the PtX industry.
- **Water Resource Optimisation:** Despite limited freshwater availability, coastal countries can utilise desalination.
- **Carbon Sourcing:** For carbon-containing synthetic fuels, Direct Air Capture technology is being prioritised for long-term sustainability.
- **Socioeconomic Development:** GH2 initiatives must contribute to sustainable economic growth through investment, poverty reduction, employment creation, and technology transfer.

4.8.5 Market barriers

Market development for GH2 in Africa faces several significant challenges. Market development support and access initiatives are needed to create viable commercial pathways for hydrogen products. Equipment supply agreements will be essential to ensure reliable access to necessary technologies at competitive prices. Local industry engagement represents a critical component of market development, encompassing supply chain development, manufacturing capability building, service sector development, and technical training programs.

In some countries, strategic hydrogen projects require significant RE capacity, sometimes exceeding existing National Low Carbon Strategy forecasts. This raises concerns regarding policy coherence, potential competition over RE resources, and economic distortions related to dedicated renewable capacity required for GH2 production (Imasiku, 2021).

The scale of investment required presents another market challenge. In some countries like Namibia, estimated capital costs for hydrogen projects approach the entire national gross domestic product, calling for continued assessment of feasibility and fundability (Lo, 2023). Port infrastructure development forms a critical bottleneck component of several coastal countries‘ hydrogen strategies, requiring significant investment.

International partnerships and agreements are critical to securing national strategies aimed at GH2 exports. They provide the necessary technology transfer, market access, and funding to build robust export sectors. Manufacturing with local content, particularly in RE components, can promote inclusive economic growth if a conducive environment can be created.

Geographic considerations affect market competitiveness, with some countries‘ positions less favourable than North African countries for supplying European markets, particularly transport-sensitive carriers like hydrogen and its derivatives. It will be important to identify suitable market opportunities and match these with the correct GH2 carriers to ensure export projects are cost-competitive.

Overcoming market barriers will require focused and consistent policymaking from African governments, and potentially the commitment of effort and funding to create a conducive GH2 investment climate. It will be essential to highlight the economic, social and environmental benefits discussed in section 7 to ensure broad-based support for these endeavours.

5. Policy and Regulatory Environment

Policies aimed at scaling up GH2 in Africa exist at the continental, regional and national levels. This section provides a comprehensive overview of these existing policies and regulations, analysing their scope, objectives, and potential impact on Africa's energy transition.

5.1 Continental and regional policy and regulatory landscape

Africa's GH2 policy and regulatory framework is rapidly evolving to drive the transition to a sustainable energy future. The African Union (AU) has adopted the African Green Hydrogen Strategy at the continental level, establishing a foundation for large-scale GH2 production, investment, and trade. Regionally, organisations such as ECOWAS are developing policies to integrate GH2 into their energy systems, ensuring alignment with national energy transition goals. These efforts focus on regulatory harmonization, infrastructure development, and investment incentives, positioning Africa as a key player in the global GH2 economy.

5.1.1 The AU African Green Hydrogen Strategy

In February 2025, the 38th African Union Summit adopted the African Green Hydrogen Strategy, a key initiative to accelerate the deployment of GH2 as a clean energy carrier and decarbonisation tool across the continent. The strategy aims to position Africa as a leader in the global GH2 economy by reducing reliance on conventional energy sources, enhancing energy security, and promoting sustainability. With its abundant RE resources, Africa is well-placed to harness GH2 for sustainable development and economic growth (African Union, 2025). By laying the foundation for active participation in the GH2 market, the strategy ensures that African nations benefit from financial investments and technological advancements in the sector. However, by the date of writing this report the strategy has not yet been published, therefore the strategy cannot be assessed in more detail in terms of objectives, institutional governance and regulatory instruments.

5.1.2 The ECOWAS GH2 Policy and Strategy Framework

In 2023, the Economic Community of West African States (ECOWAS) adopted a comprehensive Green Hydrogen Policy and Strategy Framework to drive the development of a regional GH2 industry. The framework's overarching objective is to establish West Africa as a key player in the global GH2 market by leveraging the region's abundant RE resources. It aims to promote economic growth, energy security, climate resilience, and industrial development while supporting the transition to sustainable energy systems. In the short term, the framework focuses on creating an enabling environment by raising awareness, building capacity, and developing a supportive legislative framework. Key priorities include launching GH2 demonstration projects, formulating a long-term roadmap for regional GH2 consumption, attracting investments, and fostering strategic partnerships with private and governmental entities for financing and technology transfer. In the long term, the framework envisions positioning West Africa as a leading global supplier of GH2, enhancing energy security, expanding the region's share of RE, and driving climate action and industrialisation.

Regarding production targets, the framework aims to scale GH2 production to 0.5 Mt annually by 2030 and increase output to 10 Mt annually by 2050. Implementation will follow a three-phase approach, with the first phase establishing the necessary institutional and regulatory framework. Institutionally, an ECOWAS Green Hydrogen Development Unit (EGHDU) and a working group will be created within the existing ECOWAS structure to address all issues related to GH2 development at the regional level. The EGHDU will be central to implementing the Green Hydrogen Policy and Strategy Framework across both regional and national levels within ECOWAS. Its responsibilities will include, among others, ensuring the establishment of the necessary regulatory framework for GH2.

At the regional level, the EGHDU will be responsible for, among other tasks:

- Developing a regional green certification mechanism that aligns with internationally accepted standards.
- Implementing pilot certification schemes and formulating a strategy for their scaling up.
- Establishing regional standards for the use, storage, and transportation of GH2, in line with internationally recognized standards.

Additionally, the EGHDU will assist ECOWAS member states in developing their national GH2 policies and regulatory frameworks or in making necessary amendments to existing frameworks. To achieve this, member states will closely collaborate with the EGHDU and identify appropriate national agencies to oversee the monitoring and implementation of these regulations.

5.2 Status of GH2/PtX regulatory environment in selected countries

Several African countries have committed to scaling up GH2 production. For example, Egypt, Morocco, Namibia, Kenya, Tunisia, Algeria, and South Africa have adopted targeted policies aimed at increasing GH2 output. However, to date, the necessary changes to create a robust regulatory framework for systematically scaling up GH2 projects have not yet been implemented in these countries. Until these regulatory frameworks are established, GH2 projects will need to be developed based on individually negotiated investment agreements and contractual frameworks.

5.2.1 Algeria

Algeria has established a clear policy framework for GH2. The key policy is the National Hydrogen Development Roadmap of Algeria (MIME, 2023). Whereas this document provides a clear policy framework for GH2 in Algeria, to date, a robust enabling regulatory framework for GH2 is not in place. Therefore, further efforts are required to adopt a clear, coherent and complete enabling legal and regulatory framework for GH2 in Algeria. Implementing the National Hydrogen Development Roadmap of Algeria consists of actions and measures to ensure the gradual integration of renewable and clean hydrogen into the national energy system. It focuses on short-, medium-, and long-term strategies while ensuring regulatory oversight of the entire hydrogen value chain. Notably, the strategy is not limited to GH2 but covers all types of hydrogen.

In institutional and regulatory terms, the roadmap envisages that the Ministry of Energy and Mines will develop a regulatory framework for GH2 production, storage, transportation, distribution, and usage, together with other relevant institutions. The roadmap in addition envisages that a national institution will be established to manage necessary approval and permitting processes, thereby supporting the deployment of hydrogen in Algeria and ensuring compliance of hydrogen operations with mandatory regulatory framework.

Specific regulatory priorities mentioned by the roadmap comprise hydrogen production by electrolysis, storage solutions, transport via tanks and cylinders, hydrogen distribution stations, hydrogen use in fuel cells and mobility, and hydrogen injection into natural gas pipelines. The roadmap also envisages that introduction of a certification system for GH2, and the adoption of a dedicated set of standards and procedures that will ensure the safe, reliable, and sustainable deployment of hydrogen as well as necessary health, safety and environmental standards to minimize hydrogen related risks.

Finally, the roadmap makes envisages that financial incentives and other types of governmental support will be made available for investors in the short-to medium-term. Hydrogen projects classified as strategic under the Algerian Investment Code will benefit from favourable tax rates, customs duties and other types of support. According to the roadmap projects are also expected to receive funding and technical assistance from the state, intergovernmental organisations, and European institutions.

In summary, whereas the National Hydrogen Development Roadmap of Algeria provides clear policy guidance for the hydrogen sector and on priority areas to be addressed to create a robust regulatory framework for GH2 in Algeria, to date, this guidance has not been transposed into regulatory action. Therefore, the government of Algeria should take targeted action to make the amendments in the existing regulatory framework conditions necessary to provide Algeria with a robust enabling regulatory framework for GH2. In the case of Algeria, with a mature legal framework in place for natural gas, the development of the necessary regulatory framework for GH2 is generally regarded to be of limited complexity compared to countries with no regulatory framework for natural gas. A high-level summary of key regulatory frameworks for production, storage, transport, domestic consumption and export of GH2 that should also guide the amendments to be made in Algeria‘s existing legal and regulatory framework is provided below. Until this regulatory framework is in place, GH2 projects in Algeria must be developed based on individually negotiated investment agreements and contractual frameworks, cognisant of existing regulatory conditions.

5.2.2 Morocco

Morocco has established a clear policy framework for GH2. The key policies are the Morocco Green Hydrogen Roadmap and the Morocco Green Hydrogen Offer. Although these policies provide a clear policy framework for GH2 in Morocco, a robust enabling regulatory framework for GH2 is not in place to date. Therefore, further efforts are required to adopt a clear, coherent, and complete enabling legal and regulatory framework for GH2 in Morocco.

The Morocco Green Hydrogen Roadmap was adopted by the Moroccan Ministry of Energy, Mines and Environment in 2021. The roadmap sets out a strategy and targets for the deployment of GH2 in Morocco. According to the roadmap, Morocco may produce up to 30.1 TWh by 2023 and more than 153.9 TWh of GH2 by 2050 (Royaume du Maroc, 2021b).

Regarding regulatory framework conditions, the Green Hydrogen Roadmap acknowledges that a regulatory framework for the entire GH2 supply chain, including for hydrogen export, presents a key condition for implementing the roadmap. In institutional terms, implementing the Green Hydrogen Roadmap was initially entrusted to the National Hydrogen Commission established in 2019. However, this commission was never established. The roadmap does not identify specific priority areas for the regulatory framework. The National Hydrogen Commission is entrusted to develop this regulatory framework. Amongst those currently contributing to the adoption of a Moroccan legal framework for GH2 is the Green Hydrogen Cluster.

The Morocco Green Hydrogen Offer was adopted in 2024 to facilitate the deployment of GH2 projects in Morocco by making available 300,000 hectares of land for the development of hydrogen projects and setting forth a framework for investments into GH2 projects on this land. The Moroccan Agency for Sustainable Energy (MASEN) is the key institution that will implement the Green Hydrogen Offer. In particular, MASEN is the central focal point for investors, providing information on relevant conditions, procedures, and available investment incentives, proposing available land plots, receiving applications for GH2 projects, and negotiating the investment terms thereof. Potential investors with adequate financial, legal and technical capacity and experience may submit a preliminary FEED study. The investors may sign an investment framework agreement with the Moroccan state if selected.

The governance of the Morocco Offer is designed to ensure strategic coordination, transparency, and efficient implementation of large-scale GH2 projects. It is structured around two main bodies:

1. Steering Committee (Comité de Pilotage)
   - Chaired by: The Head of Government.
   - Members: Key ministers (Energy Transition, Interior, Economy & Finance, Equipment, Investment, and others) and strategic institutions (e.g., AMEE, MASEN, ONEE, IRESEN).

  - Role: Provides high-level political direction, ensures inter-ministerial coordination, monitors overall program progress, and addresses strategic bottlenecks.

2. Investment Committee (Comité d'Investissement)
  - Led by: The Ministry of Investment, Convergence, and Evaluation of Public Policies.
  - Members: Representatives from relevant technical ministries and investment promotion agencies.
  - Role: Evaluates proposals received through the call for expressions of interest, validates selected projects, ensures alignment with national priorities, and facilitates administrative and financial procedures.

This dual-committee structure ensures that decisions related to GH2 development in Morocco are both strategically guided and technically sound, supporting the country's vision of becoming a regional and global leader in renewable hydrogen.

In March 2025, Morocco advanced its GH2 strategy by approving six major projects totalling approximately $32.5 billion in investment. These initiatives, selected through the „Morocco Offer" program, aim to produce green ammonia, synthetic fuels, and green steel, reinforcing the country's position as a regional leader in RE.

The selected projects involve a diverse group of international and domestic investors:

- ORNX Consortium: Comprising Ortus (USA), Acciona (Spain), and Nordex (Germany), this consortium will focus on green ammonia production.
- Taqa (UAE) and Cepsa (Spain): This partnership plans to produce green ammonia and synthetic fuels.
- Nareva (Morocco): The Moroccan company will invest in producing green ammonia, synthetic fuels, and green steel.
- ACWA Power (Saudi Arabia): This company will focus on green steel production.
- UEG and China Three Gorges (China): This consortium will develop green ammonia production facilities.

Each project will be allocated up to 30,000 hectares of land in Morocco's southern regions, with the government ensuring proper land use through contractual agreements. These projects are part of Morocco's broader strategy to leverage its RE potential, aiming to increase the share of renewables in its energy mix to 52% by 2030.

Morocco has also signed agreements with France's TotalEnergies and a partnership between OCP and ENGIE to further develop its GH2 infrastructure.

The selection process remains open to additional investors, reflecting Morocco's commitment to expanding its GH2 sector and contributing to global decarbonisation efforts.

The Green Hydrogen Roadmap and the Green Hydrogen Offer provide Morocco with a mature policy framework for GH2. Morocco also has a mature regulatory framework governing RE, gas, and public-private partnerships to support energy and infrastructure projects. However, a coherent regulatory framework for the entire GH2 sector is not in place in Morocco. To provide investors in GH2 with the necessary legal certainty and confidence in the GH2 sector, the government of Morocco will need to develop a dedicated regulatory framework for GH2. This regulatory framework should cover the entire GH2 supply chain, including production, storage, transportation by pipeline and other modes of transport, domestic consumption and export of GH2. To enable export of GH2, the regulatory framework should comprise an adequate GH2 certification system. A high-level summary of key regulatory frameworks for production, storage, transport, domestic consumption and export of GH2 that should also guide the amendments to be made in Morocco's existing legal and regulatory framework is provided below. Until this regulatory framework is in place, GH2 projects will have to be developed based on the investment conditions set forth by the Green Hydrogen Offer through individual investment contracts and contractual frameworks.

5.2.3 South Africa

South Africa has established a clear policy framework for GH2. The key policies are the Hydrogen Society Roadmap for South Africa (HSRM) and the Green Hydrogen Commercialisation Strategy (GHCS). While these documents create a clear policy framework for GH2 in South Africa, a robust enabling regulatory framework for GH2 is not in place to date.

The HSRM for South Africa was adopted upon initiative of the South African Department of Science and Innovation in 2021 to provide a framework for the integration of hydrogen-related technologies in various sectors of the South African economy, thereby contributing to growth and development of the South African economy and moving the country towards secure and low-cost sustainable energy in the medium-term. Whereas the primary focus of the roadmap lies on analysing the existing energy landscape of South Africa and identifying opportunities for South Africa to become a global GH2 player, the strategy also acknowledges the need to make the amendments in the existing legal and regulatory framework of South Africa that are necessary to create an adequate enabling legal and regulatory framework for GH2.

The GHCS builds upon the HSRM and aims to provide a strategy to position South Africa as a significant producer and exporter of GH2. The strategy, among other things, analyses the GH2 value chain and local opportunities, defines South Africa's strategic objectives in the field of GH2, and evaluates the attractiveness of a future South African GH2 market in the global GH2 economy.

The GHCS also acknowledges the importance of a coherent enabling regulatory framework to support the deployment of GH2 in South Africa and provides a high-level summary of the existing legal framework and some key areas that need to be amended to make the existing regulatory framework adequate for GH2. In addition, the strategy highlights the need for a certification/guarantee of origin system, the need for targeted incentives for GH2 projects, such as exemption from tax exemptions or the possibility to create special economic zones, and the need to provide targeted administrative support comprising instruments like a one-stop shop for GH2.

In addition, the Department of Mineral Resources and Energy published a Gas Act Amendment Bill in 2024. This bill aims to modernise the South African gas sector and expand the scope of the existing Gas Act to hydrogen, also covering GH2. If adopted as proposed, the Gas Act Amendment Bill will create a robust primary legal framework for GH2 in South Africa.

In summary, the HSRM and the GHCS provide clear policy guidance for the hydrogen sector and priority areas to be addressed to create a robust regulatory framework for GH2 in South Africa. South Africa can also be expected to have a robust primary legal framework for GH2 once the ongoing, advanced efforts to amend the Gas Act have been completed. However, further targeted efforts will be required to create a robust enabling regulatory framework for GH2 in South Africa. In addition to primary legislation, the necessary secondary regulations and specific GH2 technical standards covering the entire GH2 value chain will have to be developed and adopted. However, in the case of South Africa, with a mature regulatory framework and experience in in the field of natural gas, the development of the necessary detailed regulatory framework for GH2 can be expected to be to be of limited complexity in comparison to countries with no regulatory framework and experience in the field of natural gas. A high-level summary of key elements of regulatory frameworks for production, storage, transport, domestic consumption and export of GH2 that should also guide the amendments to be made in the existing legal and regulatory framework of South Africa is provided further below. Until this regulatory framework is in place, GH2 projects in South must be developed based on individually negotiated investment agreements, contractual frameworks, cognisant of existing regulatory conditions.

5.2.4 Namibia

Namibia has established a clear policy framework for GH2. The key policy is the Namibia Green Hydrogen and Derivatives Strategy. However, to date, a robust enabling regulatory framework for GH2 is not in place. Therefore, further efforts are required to adopt a clear, coherent, and complete enabling legal and regulatory framework for GH2 in Namibia.

In November 2022 the Namibian government published the Namibia Green Hydrogen and Derivatives Strategy which lays out an ambitious plan for Namibia to become a major hub of GH2-based industries ranging from hydrogen as direct export resource “packaged” for transport in the form of Ammonia, to hydrogen derivates which will be mostly synthetic fuels as well as e-Methane and further downstream activities such as Green Steel production plants using the HBI -process which relies on a stable low-cost supply of hydrogen.

According to the Namibia Green Hydrogen and Derivatives Strategy, the country aims to produce an output of 10-12Mt of RH2-equivalent by 2050, or just under 2% of world demand. This represents over 10% of the world’s estimated import demand, making the country a major player in this nascent market. To achieve this, the strategy foresees three special economic development zones dubbed “Hydrogen Valleys.”

In institutional terms, the strategy envisages that the implementation will be facilitated by a newly established Implementation Authority Office (IAO), which shall act as a one-stop shop to help deliver the projects as planned and agreed upon with the international investment community.

In regulatory terms, the strategy envisages that a new Synthetic Fuels Act (SFA) will provide a “fit-for-purpose” regulatory and institutional framework for GH2. According to the Green Hydrogen and Derivatives Strategy, the Synthetic Fuels Act, amongst others, will:

- Define standards that conform to international guidelines to reduce operational uncertainty for developers and set quality levels to comply with international export market requirements.
- Define clear oversight activities, including, among others, transparent access to land and permit processes for renewables and hydrogen that guarantee fair treatment to investors and local populations while protecting the environment and ensuring safety
- Advance development with private and public sector stakeholders, e.g., by modifying transmission and distribution fees for hydrogen producers to reflect ancillary services provided for the grid or introducing mechanisms to compensate developers for overbuilding RE capacity in a specific area.
- Introduce frameworks for pilot projects where regulation is not yet in place.

Finally, the Namibia Green Hydrogen and Derivatives Strategy envisages a Common Use Infrastructure (CUI) to de-risk projects and accelerate scale-up and encompass not only electricity grid and hydrogen pipelines but also water and desalination infrastructure, industrial port development and what is described as ancillary infrastructure.

Whereas the Namibia Green Hydrogen and Derivatives Strategy provides Namibia with a solid and ambitious policy framework for GH2, the existing regulatory framework is currently inadequate to achieve the policy objectives. In this respect, only mature enabling legal and regulatory conditions exist to date for the generation and transmission of electricity produced by renewable Independent Power Producers (IPPs), governed by the Electricity Act, the Electricity Regulations, and the Namibia Grid Code, which have been developed based on renewable energy auctions by NamPower. However, to date, neither the envisaged Synthetic Fuels Act nor a coherent regulatory framework comprising secondary rules, codes, and standards to enable the production, transport by pipeline or other means, domestic consumption, or export of GH2 exists in Namibia. Therefore, the Namibian government should develop and adopt an adequate enabling regulatory framework for GH2 production, storage, transport, and local consumption. A high-level summary of the key elements of regulatory frameworks for the production, storage, transport, domestic consumption, and export of GH2, which should also guide the amendments to be made in the existing legal and regulatory framework of Namibia, is provided further below. In terms of technical standards for GH2, the study entitled “A Roadmap identifying GH2 National Standards and establishing Namibian Standards Institution (NSI) Role in the GH2 Value Chain” that was commissioned by the H2 Business Alliance at the request of the Namibian Standards Institution (NSI) may serve as initial guidance for adopting the necessary standards. Until this regulatory framework is established, GH2 projects in Namibia must be developed based on individually negotiated investment agreements and contractual frameworks, cognisant of existing regulatory conditions.

5.2.5 Egypt

Egypt has established a clear policy framework for GH2. The key policy is the National Strategy for Low-Carbon Hydrogen. Egypt has also adopted the Green Hydrogen Projects Incentives Law. Whereas these documents provide a clear policy framework and incentives for GH2 projects, to date, a robust regulatory framework for GH2 is not in place in Egypt. Therefore, further efforts are required to adopt a clear, coherent, and complete enabling legal and regulatory framework for GH2 in Egypt.

The National Low Carbon Hydrogen Strategy sets ambitious targets for GH2 production for Egypt, seeking to position the country as a significant global player in the global GH2 market, and defines a strategy for attaining these objectives. According to the strategy, Egypt targets the production of 5.6 million tons of low-carbon hydrogen, reaching 8% of the global hydrogen market by 2040. This target shall be achieved through a three-phased approach. The foundations for developing the future low-carbon hydrogen economy, including the necessary regulatory framework, shall be established during the first phase of implementation of the strategy by 2030.

Regarding institutional governance, the National Low Carbon Hydrogen Strategy envisages that a National Council for Green Hydrogen and its Derivatives, duly supported by the Technical Secretariat, shall be responsible for its implementation. According to the strategy, this council shall be responsible for:

- Following up on the implementation of the national strategy for GH2.
- Proposing the update of the strategy in light of the international and national developments.
- Approving policies, plans and mechanisms necessary to implement and update the strategy.
- Coordinating between ministries and concerned authorities and proposing the necessary solutions to overcome investment obstacles in the field of GH2 and its derivatives.
- Reviewing the legislation, regulations and rules regulating the field of GH2 and its derivatives and proposing necessary updates.

In terms of the existing legal and regulatory framework, the National Low Carbon Hydrogen Strategy acknowledges the need to revise the existing legal and regulatory framework for GH2 in Egypt. It identifies a series of regulatory activities to be completed by 2030 during the first strategy implementation phase. These activities comprise:

- Preparing studies on enabling laws and regulations.
- Preparing and issuing of needed regulations for paving the way for investors and providing the enabling environment for the low-carbon hydrogen industry.
- Developing a national strategy for short-term and longer-term public support to be applied across the whole hydrogen value chain.
- Rolling out sustainable development laws and regulations to incentivise low-carbon hydrogen production.

The Green Hydrogen Incentives Law introduces specific incentives for GH2 and derivatives projects, as well as upstream and midstream facilities, provided that a minimum of 95% of their output is to service such projects, and for projects exclusively carrying out transportation, storage and distribution of GH2 and its derivatives in Egypt. Incentives comprise, amongst others, tax credits, VAT exemption on equipment, machinery and supplies, Zero VAT on exports, exemptions from real estate tax, certain stamp and customs duties and other incentives. To be eligible to benefit from the incentives within the scope of the Green Hydrogen Projects Incentives Law the relevant project must among others commence with the commercial operation within five years from the date of the project agreements and mandatorily source a minimum of local content from the Egyptian market to the extent available therein.

However, whereas the National Low Carbon Hydrogen Strategy and the Green Hydrogen Projects Incentives Law mark a significant step forward to provide Egypt with an adequate regulatory framework for GH2, further amendments in the existing regulatory framework will be necessary. The existing Gas Market Activity Regulation (Arab Republic of Egypt, 2017) provides a clear regulatory framework for the competitive functioning of the gas sector that in principle also applies to GH2, including a clear governance structure, a clear licensing framework for gas sector activities, clear rules regarding third party access to the gas system, clear framework rules for tariff setting, and a clear framework for regulatory oversight of gas sector activities in Egypt. However, further rules are required to create an adequate regulatory framework GH2 in Egypt. Key focus areas in this respect will among others be the development of a clear and effective permitting framework and specific licensing conditions for GH2 projects, the development of a clear regulatory framework comprising rules and technical regulations and standards for GH2 storage, hydrogen pipelines and for modes of hydrogen transport, a hydrogen certification scheme compatible with specific rules relevant hydrogen exports, such as i.e. the EU rules for guarantees of origin, as well the rules enabling the domestic consumption of GH2. A high-level summary of key elements of regulatory frameworks for production, storage, transport, domestic consumption and export of GH2 that should also guide the amendments to be made in the existing legal and regulatory framework of Egypt is provided below. Until this regulatory framework is in place, GH2 projects in Egypt must be developed based on individually negotiated investment agreements and contractual frameworks, cognisant of existing regulatory conditions.

5.2.6 Kenya

Kenya has established a clear policy framework for GH2. The key policies are the Green Hydrogen Strategy and Roadmap and the Guidelines on Green Hydrogen and its Derivatives (EPRA, 2024). Whereas these documents provide Kenya with a mature policy framework for GH2, to date a robust enabling regulatory framework for GH2 is not in place. Therefore, further efforts are required to adopt clear, coherent and complete enabling legal and regulatory framework for GH2 in Kenya.

The Green Hydrogen Strategy and Roadmap of Kenya was launched in 2023. The strategy aims to promote the development of a domestic GH2 market and GH2 exports and become a leading player in the global hydrogen market in the long term. It envisages a three-phase approach: establishing a domestic hydrogen market until 2027, gradually expanding production and export of GH2 by 2032, and fully integrating international hydrogen markets thereafter.

The Green Hydrogen Strategy and Roadmap also generally acknowledges the importance of a coherent enabling regulatory framework and incentives to support the deployment of GH2 in Kenya and provides a high-level assessment of some shortcomings in the existing legal and regulatory framework that need to be addressed to make the existing regulatory framework adequate for GH2. In addition, the strategy highlights the need for a certification/guarantee of origin system, the need for targeted incentives for GH2 projects, such as fiscal incentives, or the possibility of creating special economic zones.

The Guidelines on Green Hydrogen and its Derivatives provide further guidance for implementing the Green Hydrogen Strategy and Roadmap. The guidelines apply to GH2 developers and users and aim to stimulate a GH2 economy and hydrogen projects in Kenya by providing regulatory guidance enabling the development of GH2 projects.

According to the guidelines the implementation of the Green Hydrogen Strategy and Roadmap shall be overseen and monitored by the Green Hydrogen Program Coordination Committee (GH2-PCC), a multisectoral committee comprising government ministries and state agencies, private sector and civil society, that shall be duly supported by a Green Hydrogen Secretariat hosted by the Ministry of Energy and Petroleum.

According to the guidelines, the GH2-PCC, among others, is mandated to:

- Provide strategic leadership and oversight for the development of the GH2 industry in Kenya, setting the overall country vision, mission and project priorities for the development of the GH2 economy.
- Formulate policies, regulations, standards and certification mechanisms related to GH2, ensuring that they align with Kenya's national development goals and international commitments.
- Oversee the mobilisation of domestic and foreign resources through various instruments, including and not limited to green bonds, grants, climate finance and green fiscal incentives.
- Formulate joint sectoral strategic plans for existing and future human, institutional and infrastructure capacity needs across the GH2 value chain in Kenya.

The Green Hydrogen Secretariat, among other functions, must:

- Act as a one-stop-shop for information and guidance on GH2 project development regulatory processes, permits, financing options and other relevant aspects of project development.
- Coordinate communication and collaboration among stakeholders involved in the GH2 economy helping to streamline efforts and avoid duplication.
- Assist in the development and implementation of policies, regulations, standards and certification mechanisms for the GH2 sector, duly ensuring alignment of standards and certification mechanisms with those at regional and global levels.
- Provide capacity building by organising training programs, workshops and knowledge-sharing events related to GH2 technology and industry.

The guidelines further set forth a streamlined approval process to be followed by hydrogen project developers that aims to enhance investor confidence by providing regulatory certainty. According to the guidelines, project developers must initiate the approval process with the submission of an Expression of Interest (EoI) to the Ministry of Energy and Petroleum. This EoI must comprise a pre-feasibility study. If the EoI is approved, project developers must within 24 months submit a detailed feasibility study, comprising a Resource Assessment, a Technical Feasibility Study, an environmental and social impact assessment, details on project financing and off-take arrangement, a risk management plan, and an implementation plan.

The guidelines further require that any GH2 project comply with national and international standards to ensure safety, sustainability, and quality in GH2 production. Projects must adhere to Kenya's environmental, water, and energy regulations and global best practices, including ISO standards for hydrogen production, storage, and transportation and other applicable international standards. Developers must conduct environmental and social impact assessments (ESIAs) and implement risk mitigation measures.

Finally, the guidelines offer incentives to attract investment, including the option to endow areas designated as Special Economic Zones (SEZs) with tax benefits and regulatory advantages. These SEZs provide tax exemptions, customs duty waivers, and streamlined approvals. The guidelines also encourage public-private partnerships and local content participation to enhance skill development and technology transfer. Additionally, a structured approval process reduces bureaucratic delays. While direct subsidies are not specified, the framework aims to promote a business-friendly environment with regulatory flexibility and investment-friendly policies for GH2 projects in Kenya.

With the outlined elements, the Green Hydrogen Strategy and Roadmap and the Guidelines on Green Hydrogen and its Derivatives provide Kenya with a mature policy framework for GH2. However, to date, a coherent regulatory framework for the entire GH2 sector is not in place in Kenya. To provide investors in GH2 with the necessary legal certainty and confidence in the GH2 sector, the government of Kenya will need to develop a dedicated regulatory framework for GH2. This regulatory framework should cover the entire GH2 supply chain, including production, storage, transportation by pipeline and/or other modes of transport, domestic consumption and export of GH2. To enable export of GH2, the regulatory framework should comprise an adequate GH2 certification system. A high-level summary of key regulatory frameworks for production, storage, transport, domestic consumption and export of GH2 that should also guide the amendments to be made in Kenya‘s existing legal and regulatory framework is provided below. Until this regulatory framework is in place, GH2 projects in Kenya must be developed based on individually negotiated investment agreements and contractual frameworks, cognisant of existing regulatory conditions.

5.2.7 Tunisia

Tunisia has established a clear policy framework for GH2. The key policy relevant to GH2 in Tunisia is the National Strategy for the Development of Green Hydrogen and its Derivatives (MIME, 2024b). However, whereas this document provides Tunisia with a mature policy framework for GH2, to date a robust enabling regulatory framework for GH2 is not in place. Therefore, further efforts are required to adopt clear, coherent and complete enabling legal and regulatory framework for GH2 in Tunisia.

The National Strategy for the Development of Green Hydrogen and its Derivatives was launched in 2023 and aims to position Tunisia as a regional GH2 production and export hub. The strategy envisages that Tunisia becomes a net exported of GH2 that forms part of the EU hydrogen backbone, targeting to export 6.3mt of GH2 to the EU via pipeline per year by 2050 and supplying 2mt sets a target of producing 8.3 million tonnes of GH2 annually by 2050, allocating 2.3 million tonnes for domestic use and 6 million tonnes for export.

Whereas to date, no specific regulatory framework for GH2 has been adopted in Tunisia, the National Strategy for the Development of Green Hydrogen and its Derivatives acknowledges the importance of developing a robust institutional and regulatory framework for GH2 to implement the strategy. It identifies the key regulatory aspects to create the required regulatory framework. According to the strategy, these issues, among others, include introducing:

- A legal definition of GH2.
- Authorisation procedures for GH2 production projects, including the environmental and social impact assessment, simplified pre-approval processes at the national level, and reduced impact assessments to accelerate project evaluations compared to other initiatives.
- Criteria for determining electrolyser siting areas, establishing a land tenure system dedicated to GH2 projects, and allowing national and foreign investors to exploit designated land without prior administrative authorisation.
- Procedures for seawater use in desalination operations and occupation of the public maritime domain for installing necessary equipment
- Safety standards for hydrogen production, transport and storage, including the prerequisites for integrating hydrogen into the natural gas network.
- Conditions for developing GH2 valleys, including specific regulations for self-consumption of GH2
- Incentives and financial support mechanisms such as injection rights, feed-in tariffs and guarantees of origin (GOs) combined with purchase obligations.

However, whereas the National Strategy for the Development of Green Hydrogen and its Derivatives provides for clear policy guidance on priority areas to be addressed to create a robust regulatory framework for GH2 in Tunisia, this guidance has not been transposed into regulatory action. However, in the case of Tunisia, with a mature legal framework for renewable electricity and natural gas in place, the development of the necessary regulatory framework for GH2 is generally regarded to be of limited complexity compared to countries with no regulatory framework for natural gas. A high-level summary of key elements of regulatory frameworks for production, storage, transport, domestic consumption and export of GH2 that should also guide the amendments to be made in the existing legal and regulatory framework of Tunisia is provided further below. Until this regulatory framework is in place, GH2 projects in Tunisia will have to be developed based on individually negotiated investment agreements, contractual frameworks, cognisant of existing regulatory conditions.

5.3 Summary

Whereas some adequate policies to scale up GH2 in Africa exist at the continental, regional, and national levels, the regulatory frameworks to systematically scale up GH2 projects remain to be adopted.

At the continental level, AU adopted the African Green Hydrogen Strategy in 2025 to promote large-scale GH2 production, investment, and trade. While this policy signals strong political commitment, its details remain to be published. ECOWAS has taken a lead role at the regional level through its 2023 GH2 Policy and Strategy Framework. This framework outlines ambitious production targets of 0.5 Mt by 2030 and 10 Mt by 2050 and proposes a phased implementation approach. A dedicated ECOWAS Green Hydrogen Development Unit (EGHDU) is envisaged to oversee regional GH2 certification, technical standards, and regulatory harmonization. However, practical regulatory enforcement mechanisms remain to be developed. To date, no other policies for GH2 have been adopted at the African regional level.

Several African countries have developed robust GH2 policy frameworks at the national level but still lack comprehensive regulatory systems. Algeria's National Hydrogen Development Roadmap provides clear guidance, including plans for permitting, transport, and certification, but none of these provisions have been transposed into enforceable law. Similarly, Morocco has launched both a Green Hydrogen Roadmap and Green Hydrogen Offer, with support from MASEN and a national hydrogen cluster. However, it still lacks a legal framework covering the entire GH2 value chain. South Africa's Hydrogen Society Roadmap and Green Hydrogen Commercialisation Strategy are complemented by a Gas Act Amendment Bill pending adoption. This Amendment Bill explicitly covers hydrogen, providing South Africa with a robust primary legal framework for GH2 once adopted. However, secondary legislation and technical standards and norms for GH2 that comply with relevant international norms and standards will have to be adopted to provide South Africa with a robust enabling regulatory framework for GH2.

Namibia's Green Hydrogen and Derivatives Strategy is ambitious, among others, proposing hydrogen valleys and a synthetic fuels act. Yet, current regulations are limited to the power sector, and critical laws and regulations on hydrogen production, storage, transport, use and export remain to be developed. Egypt has adopted a Low Carbon Hydrogen Strategy and Incentives Law, offering fiscal benefits and governance structures. However, specific licensing and permitting rules, dedicated standards, and norms for GH2 projects do not exist. Kenya's Green Hydrogen Strategy and supporting guidelines outline a clear approval process and institutional roles, but lack formal regulation for production, certification, transport, and domestic use. Tunisia has also set high targets under its 2023 GH2 strategy and identified priority regulatory gaps, though no enabling regulatory framework has been created to date.

In summary, while some African countries have established solid policy foundations for GH2, robust regulatory frameworks covering production, storage, certification, transport, export, and domestic use are still largely absent. To date, GH2 projects are developed based on tailored case-by-case agreements and regulatory conditions. Although this may present a sufficient short-term option for developing some GH2 projects across Africa, systematically scaling up the deployment of GH2 initiatives will strongly depend on the establishment of robust enabling legal and regulatory frameworks for GH2 projects that appeal to investors at continental, regional, and national levels. Therefore, it is recommended that African continental, regional, and national institutions take targeted urgent action to progressively develop and adopt strong enabling regulatory frameworks to systematically scale up the deployment of GH2 projects across Africa. Ideally, these efforts should be coordinated by the AU and the Regional Economic Communities to achieve regulatory coherence for GH2 across Africa and set the conditions for regional GH2 networks and cross-border trade. However, realistically, in the short term, national governments will need to spearhead efforts to create the necessary enabling regulatory frameworks for scaling up the deployment of GH2 across Africa.

To understand the exact scope of changes required per country, an in-depth assessment of the existing national legal and regulatory conditions will be required for each country. Whereas some countries in the absence of a mature gas sector legal and regulatory frameworks will need to develop an entirely new legal framework, for other countries the focus will more likely lie on aligning existing primary sector legislation and regulations with the needs of GH2 and adopting specific norms and standards for GH2. The following table provides a non-exhaustive, high-level overview of recommended elements that guide robust national regulatory frameworks for GH2 across Africa.

Table 24: High level country assessment matrix for GH2 related policy, legal and regulatory frameworks

	High Level Indicators
Enabling legal, regulatory conditions for GH2 production, storage, transport and local use	Hydrogen Act or similar primary legislation (i.e., Gas Act) sets forth clear enabling legal framework for generation, distribution, transmission and storage of GH2: • Clear institutional structure for entire hydrogen sector, including GH2 • Clear framework for regulatory oversight of hydrogen sector, including GH2 • Clear licensing rules for hydrogen sector activities • Clear rules guaranteeing effective access to shared GH2 production and storage facilities • Clear rules guaranteeing effective connection and access of GH2 to hydrogen networks/pipelines
	Clear rules regarding environmental permitting and assessment of environmental impact of GH2 production and storage facilities/electrolysers and hydrogen networks/pipelines
	Secondary legislation and regulations enabling non-discriminatory access and use of shared/open-access GH2 production and storage facilities /electrolysers
	Secondary legislation and regulations enabling non-discriminatory condition for connection and access to hydrogen networks/pipelines (i.e., grid code)
	Safety Standards and Norms compliant with pertinent international standards and norms for GH2 production and storage facilities
	Safety Standards and Norms compliant with pertinent international standards and norms for GH2 pipelines
	Safety Standards and Norms compliant with pertinent international standards and norms for GH2 transport by train
	Safety Standards and Norms compliant with pertinent international standards and norms for GH2 transport by ship
	Safety Standards and Norms compliant with pertinent international standards and norms for GH2 transport by road
	Safety Standards and Norms compliant with pertinent international standards and norms for use of GH2 in different sectors

	High Level Indicators
Renewable electricity production, storage and Transport	Electricity Act or similar primary legislation sets forth coherent enabling legal framework for the generation, and storage of renewable electricity by IPPs, and for transmission and distribution of renewable electricity generated by IPPs: • Clear institutional structure for RE production and storage facilities • Clear framework for regulatory oversight of electricity sector • Clear licensing rules for RE production and storage facilities • Clear rules guaranteeing effective grid connection and access for renewable electricity • Detailed IPP Procurement Policy and Framework in place
	Clear rules regarding environmental permitting and environmental impact assessment of renewable electricity generation projects, as well as for distribution and transmission projects
	Clear rules guaranteeing effective grid integration of renewable electricity generated by IPPs (i.e., electricity grid code)
	Clear safety standards and norms compliant with pertinent international standards and norms for RE generation, transmission, distribution and storage

6. Capacity and Institutional Development

Capacity and institutional development are essential for driving GH2 economic development, as they establish the foundation for effective governance, regulatory clarity, and cross-sector coordination. Strong institutions enable the formulation and enforcement of sound policies, the attraction and management of investments, the planning and execution of critical infrastructure, and the enforcement of environmental and social safeguards. Moreover, building local technical and administrative capacity supports workforce development and inclusive growth, while enabling continuous monitoring, evaluation, and adaptive governance. Without these capabilities, GH2 strategies risk remaining unimplemented or unsustainable. This chapter presents the current status of institutional capacity, as well as the capacity requirements for GH2 development in Africa.

6.1 Status of institutional capacity in Africa

The countries that are looking to develop GH2 economies in Africa vary significantly in terms of levels of development, size of local economies, and industrial capabilities. This is illustrated by a range of indicators that measure the institutional capacity of GH2-relevant countries shown in Table 25. The indicators are drawn from the United Nations Trade and Development (UNCTAD) Productive Capacities Index (UNCTAD, Undatedb) and the World Bank Worldwide Governance Indicators (World Bank, Undated). The former indicators measure the "productive resources, entrepreneurial capabilities and production linkages, which together determine the capacity of a country to produce goods and services". In contrast, the latter are more general measures of the quality of governance within countries.

Table 25 shows that the quality of institutions varies significantly between countries in Africa. Whereas some countries like Morocco, Namibia, South Africa, and Tunisia have relatively strong indicators across the board, others like Angola, Mali, Mauritania and Niger have significant capacity gaps in several areas. Interestingly, while there are wide gaps in public sector capacity, most countries score relatively well regarding the vibrancy of the private sector. The worst value (for Angola) is about half the average G20 score, whereas the best value (for South Africa) is very near the G20 average.

Table 25: Selected Institutional capacity indicators for selected GH2-relevant African countries

	Human capital index^	Information and Communication Technology (ICT) index^	Institutions index^	Private sector index	Structural Change index^	Composite Productive capacities index^	Government effectiveness*	Regulatory quality*
Algeria	70	53	48	65	74	74	27	16
Angola	36	24	48	49	49	50	15	23
Burkina Faso	39	35	57	69	44	41	21	35
Côte d'Ivoire	37	54	59	80	63	63	37	49
Egypt	66	65	53	71	69	75	42	27
Kenya	53	49	58	69	64	64	39	38
Mali	26	43	41	75	30	37	13	26
Mauritania	40	48	50	55	84	62	25	15
Morocco	73	74	64	69	81	79	50	51
Namibia	56	50	82	85	62	70	53	51
Niger	27	24	52	62	50	29	29	21
Nigeria	36	36	42	60	60	54	20	17
Senegal	47	51	70	71	77	66	54	39
South Africa	65	66	74	95	84	89	41	44
Togo	52	41	55	75	50	62	30	34
Tunisia	80	66	67	73	71	81	39	29

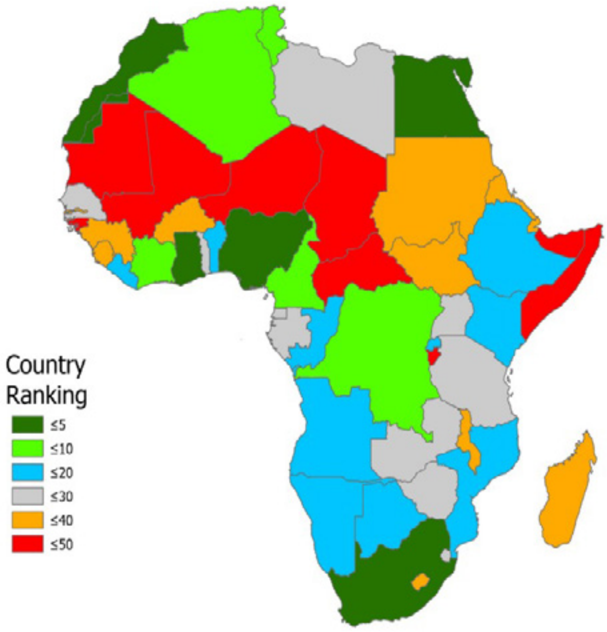
Sources: (UNCTAD, Undated), values are for 2022 * (World Bank, Undated), values are for 2023

Note: Composite Productive capacities index and sub-indices values are normalised as a percentage of the average G20 score. The Composite Productive Capacity Index also includes sub-indices for Energy, Natural Capital and Transport

**World Governance Indicators are shown as the percentile of all countries (with 0 worst and 100 best)*

Indicators of local capacity, policy, economic conditions and so forth can be combined into composite indicators to consider the capacity of countries to roll out GH2 projects. Lahnaoui et al. (2025), for example, consider a range of factors for ECOWAS and SADC countries and identify South Africa, Mozambique and Madagascar as the most attractive locations (all in SADC), followed by Senegal, Gambia, Cabo Verde and Burkina Faso (in ECOWAS) as the next most attractive locations. Mukelabai, Wijayantha and Blanchard (2022) use the political, economic, social, technological, legal, and environmental (PESTLE) framework to rank countries in Africa according to the likelihood that they will be able to successfully role out GH2. The results are shown in the below figure.

Figure 25: Capacity to deploy GH2 based on PESTLE analysis (ranking)



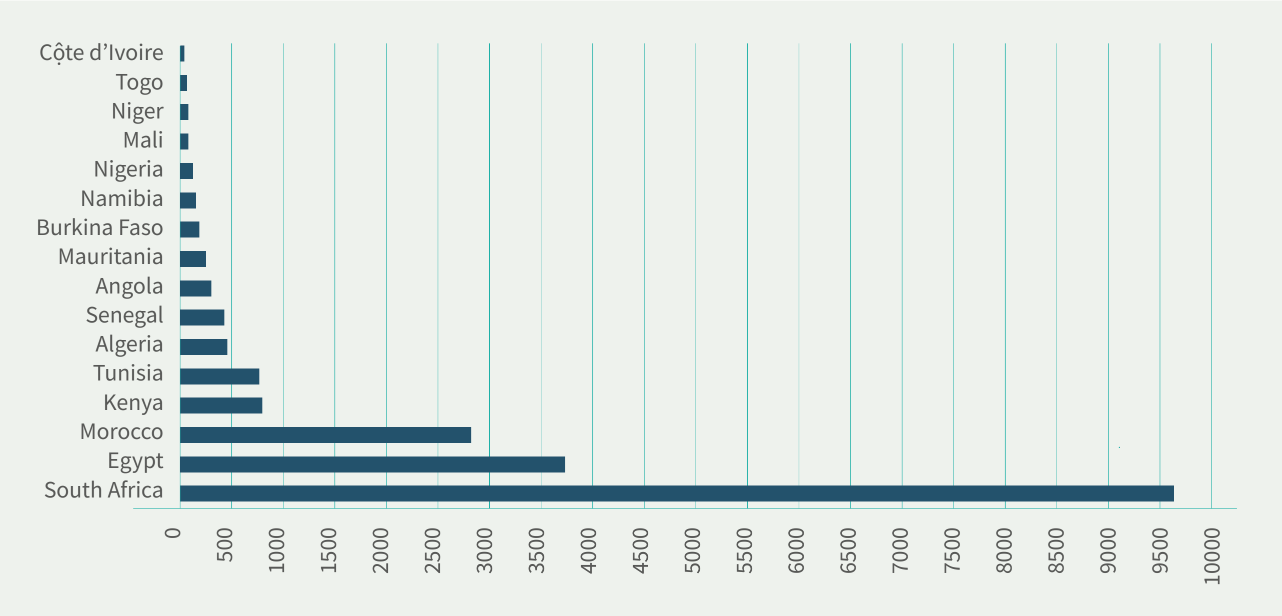
Source: (Mukelabai, Wijayantha and Blanchard 2022)

Note: 1 – 5 is most likely to succeed whereas 41-50 are least likely to succeed

However, a more accurate proxy for the capacity of institutions in African countries to develop GH2 projects is the amount of RE, particularly solar and wind energy, that countries have managed to roll out. Not only is RE a critical input into GH2 production and largely determines the cost competitiveness of GH2, but there are similarities in that RE is a relatively new area rolled out from a very low base. A conducive regulatory environment had to be created for RE, investors had to be coaxed into investing in what was locally perceived as a relatively new and risky sector, new skills and capabilities had to be created, significant investment in supporting infrastructure was required to roll the technology out at scale, and research was needed to cost-effectively roll out the technology locally (in terms of finding the best locations, the best configurations of plants, how to integrate it into the grid, etc).

Using RE deployment as a proxy for institutional capacity points towards a large gap in implementation capacity. Only three countries, Morocco, Egypt, and South Africa, have managed to roll out RE at scale. There are significant discrepancies even amongst the three successful countries. The scale at which RE has been rolled out in South Africa (the most successful country) is more than three times that of Morocco (the third most successful country) and more than double that of Egypt (the second most successful country).

Figure 26: Installed RE capacity (solar and wind), 2023 (MW)



Source: (IRENA, 2024a)

The countries also differ in terms of their experience with GH2. Countries like Angola, Algeria, Egypt, Morocco, Tunisia, Nigeria, and, to a lesser extent, South Africa have significant experience and/or infrastructure linked to natural gas production, transport or use that could be leveraged to support GH2 production. Tunisia, for example, has limited experience with the production or use of H2, but its natural gas experience has created the industrial capabilities needed to produce H2 (MIME, 2024; Muller & Eichhammer, 2023; Muller & Eichhammer, 2023).

Countries like Algeria, Egypt and South Africa have significant experience producing H2 from natural gas and coal. Egypt and South Africa also have experience of producing H2 via electrolysis. Other countries are looking to leverage existing industrial and technological expertise to produce GH2. This includes Morocco, which has a large chemical sector and significant fertiliser production, and Kenya, where experience attracting investment into the geothermal energy sector could benefit the nascent GH2 sector.

African countries are taking different approaches to kickstarting GH2 industries locally. Three different approaches are discussed by illustrating similar country experience.

6.1.1 Institutional capacity as a precursor to implementation capacity

Algeria published a national hydrogen development strategy in 2023 that covers GH2 and blue hydrogen. Aboushady et al (2024), however, believe that GH2 is not currently a policy priority in Algeria. There are several local challenges to overcome (e.g. the lack of a diversified economy, a weak private sector, and market regulations that aren't conducive to foreign investment), but the authors believe that political economy considerations linked to moving from a centralised fossil fuel-based economy to a more decentralised GH2-based economy are likely to be the main obstacle. This may lead to a policy focus on blue hydrogen to limit disruption to fossil fuel interests. A robust case for GH2 as an appropriate development option for Algeria will probably be required before serious efforts to build GH2-related institutional or implementation capacity can be undertaken.

Tunisia's national hydrogen strategy was only released in 2024. The strategy mentions several capacity gaps and capacity development priorities and proposes developing institutional capacity within the public and private sectors to address these shortcomings. Roadmap goals and interventions are proposed, but most are too high to drive implementation (MIME, 2024). Consequently, the immediate focus should be on creating the capacity to understand

and engage with challenges so that plans and interventions can be devised to overcome these challenges in future. Responsibility for moving the GH2 industry forward sits at the national government department level and is not clearly allocated to individual entities. Thus, while the technical capability to roll-out GH2 probably exists in Tunisia, institutional and planning capacity will likely be a challenge.

6.1.2 Public sector-driven GH2 development

Morocco created the National Hydrogen Commission in 2019 within the Ministry of Energy, Mines and Environment to act as the coordinating body for hydrogen development in Morocco. The same year the Moroccan Institute of Hydrogen and Fuel Cell (IMHYPAC) was created to support R&D and training on H2 technologies. It published the National Roadmap of H2 in Morocco in 2021. The roadmap set out the governance framework for H2 in Morocco and also led to the creation of a several entities tasked with driving the local development of GH2 (RES4Africa and PWC, 2022). These include the Green Hydrogen Cluster (supporting coordination, policy development, infrastructure planning, and innovation and capacity building at national level), the Moroccan Association for Hydrogen and Sustainable Development, and the GreenH2A Platform (a research platform formed by the Research Institute for Solar Energy and New Energies (IRISEN) and the Mohammed VI University Polytechnic). The main driver of the GH2 sector in Morocco, however, is the Morocco Offer, a scheme whereby developers compete for up to 30,000ha of industrial land that includes all the infrastructure and services (port facilities, hydrogen pipelines, electricity and water resources) required to develop integrated GH2 derivatives projects. The Morocco Offer also includes incentives and tax benefits (Clifford Chance, 2024). The Morocco Offer is being implemented by the Moroccan Agency for Sustainable Energy (MASEN).

Egypt only publicly released a summary version of the National Low Carbon Hydrogen Strategy in 2024, and the Strategy mentions that several studies, reviews and assessments will be undertaken by National Hydrogen Council working groups to identify capacity, planning, regulatory, and infrastructure gaps (Advisian, 2024). The National Council for Green Hydrogen was developed in 2023 to upscale GH2 production to drive sustainable development (UNIDO, Undated). At the start of 2024, however, the Egyptian government introduced a GH2 incentive law that made significant tax benefits, subsidised infrastructure and other direct incentives available to GH2 projects (Green Hydrogen Organisation, Undated). Egypt is also considering the development of blue hydrogen, which could divert attention and resources from the GH2 industry.

6.1.3 Public sector-enabled GH2 development

South Africa's then Department of Science and Technology launched the Hydrogen and Fuel Cell Technologies (HFCT) Research, Development, and Innovation (RDI) strategy in 2008 to support the beneficiation of the country's large resources. The resulting research programme was called Hydrogen South Africa (HySA) and comprised three Centres of Competence, as shown in

Table 26. The Department of Science and Innovation published the national strategy, Hydrogen Society Roadmap for South Africa, in 2021 this was followed by the Department of Trade, Industry and Competition's Green Hydrogen Commercialisation Strategy for South Africa in 2023. These documents list capacity gaps in areas like infrastructure, regulation and skills, but initiatives to address these issues have not been put in place yet. Responsibility for addressing these issues has largely been delegated to existing bodies, although a centre of excellence for the manufacturing of hydrogen products and fuel cell components is proposed in the Hydrogen Society Roadmap. South Africa also launched a GH2 blended finance investment fund, the SA-H2 fund, with support from the EU and the governments of the Netherlands and Denmark (DBSA, 2023; Krumpelmann, 2024). The fund is a partnership of private and public enterprises and international and domestic institutions and aims to raise $1bn to fund GH2 projects in South Africa. South Africa also listed its GH2 funding requirements as part of its Just Energy Transition Investment Plan (JET IP) (2023-2027) in support of the Just Energy Transition Partnership launched between South Africa and France, Germany, the United Kingdom, the European Union, and the United States in 2021. Environmental regulation, planning and economic development responsibilities are much more decentralised in South Africa than in the rest of the continent, with provincial (regional) and local (municipalities) governments having significant responsibilities

(Cloete & Kent, 2025). The Northern and Western Cape Provinces have published GH2 strategies, while the Eastern Cape Province has completed a draft strategy (ECSECC, 2024). No single entity currently coordinates GH2 activities or plans in South Africa, and the South African government has given strategic project status to several projects (Klagge, Walker, Kalvelage, & Greiner, 2025).

Table 26: Hydrogen South Africa (HySA) Centres of Competence and focus areas

Centre Name	Research Focus	Host InstituatioInstitutions
HySA Catalysis	Catalysts and catalytic devices for fuel cells and hydrogen production	University of Cape Town (UCT) South African Minerals Research Council (MINTEK)
HySA Infrastructure	Technologies for hydrogen, production, storage and distribution	North-West University (NWU) Council for Scientific and Industrial Research (CSIR)
HySA Systems	Systems integration and technology validation	University of the Western Cape (UWC)

Source: (DSI, 2021)

Namibia identified GH2 as a potential "transformative strategic industry" in its Harambee Prosperity Plan II development plan in 2021, and this led to the creation of an inter-ministerial Green Hydrogen Council later that year (Republic of Namibia, 2021; Republic of Namibia, 2022). In 2021 Namibia also signed a Joint Communique of Intent (JCOI) with the German Government to develop GH2 in Namibia. The JCOI included a capacity-building component, which supported the Namibia Green Hydrogen Research Institute (NGHRI) at the University of Namibia. Namibia's Green Hydrogen and Derivates Strategy was published in 2022 and identified regulatory, skills and other capacity gaps that must be addressed and provided an action plan outlining how this should happen. In 2022, Namibia also launched a first-of-its-kind GH2 blended finance investment fund, the SDG Namibia One fund, with support from the EU and the governments of the Netherlands and Denmark. The fund aims to raise $1bn in funds for GH2 projects and related infrastructure and served as a model for the South African SA-H2 fund launched in 2023 (Krumpelmann, 2024; DBSA, 2023). In 2023, the Implementation Authority Office was launched to manage GH2 projects located on state-owned lands (The Brief, 2023).

In 2024, the Namibia Green Hydrogen Programme (NGH2P) was formally stablished to drive the implementation of the GH2 strategy. The Programme commenced work on a GH2 Skills Development Strategy and Plan with the assistance of the World Bank and identified gaps in the policy and legislative environment to regulate GH2 and derivatives. It submitted a draft National Policy on Green Hydrogen and Derivatives for Ministerial consideration to kickstart the policymaking process. The Programme also started work to identify optimal Common User Infrastructure approaches to support the GH2 industry (Republic of Namibia, 2024). Also, in 2024, the Government issued a green industrialisation strategy that further outlined the infrastructure and other requirements to develop the GH2 market (in addition to other green industries) (Government of the Republic of Namibia, 2024). T

he Namibian approach to the development of the GH2 market is highly structured, and significant emphasis is placed on one very large flagship project, the Hyphen Hydrogen Energy's ammonia project, to develop a shared infrastructure backbone that can support several GH2 clusters (Republic of Namibia, 2022; Klagge, Walker, Kalvelage, & Greiner, 2025). Support for additional GH2 projects is, however, included in Namibia's green industrialisation strategy (Government of the Republic of Namibia, 2024).

6.2 Capacity Requirements

Countries' capacities to develop GH2 industries vary significantly within Africa. Given that the GH2 industry is still in its infancy globally, no country currently has the capacity to roll out GH2 at scale. Therefore, all countries are relying on partnerships with international project developers and funders to spread the risk and cost of developing GH2 ecosystems.

The Africa Green Hydrogen Alliance was created to support GH2 projects in Africa via support for public and regulatory policy, capacity building, financing, and certification to enable GH2 production for domestic use and export (Green Hydrogen Organisation, Undated). Current members include Angola, Djibouti, Egypt, Ethiopia, Kenya, Mauritania, Morocco, Namibia, Nigeria, and South Africa. The Alliance provides an opportunity for African GH2 producers to coordinate their activities and create African demand for GH2 to reduce reliance on international markets (Klagge, Walker, Kalvelage, & Greiner, 2025).

Internationally, GH2 projects have been slow to get off the ground, and Odenweller and Ueckerdt (2025) point out that only 7% of projects with an expected operational date of 2023 announced from 2021 to 2023 were operational by 2023. Despite the myriad of GH2 projects announced in Africa, only three projects with an annual GH2 production capacity of more than 1 kt were operational or under construction by November 2024 according to the IEA's Hydrogen Production Projects Interactive Map (IEA, 2024a). These projects were the EBIC Ammonia Plant in Egypt (which was awarded the only supply contract under the pilot H2Global auction), the Sasolburg GH2 project in South Africa, and the Oshivela DRI project in Namibia. In addition, projects from Egypt (Egypt Green Hydrogen (EGH)) and Morocco (Jorf Hydrogen Platform) received €30m non-refundable capital expenditure grants to increase the bankability of the projects (KfW and KGAL, 2025; Pearce, O, 2024).

Given this background, it is unsurprising that Klagge et al (2025) state that countries need to move beyond GH2 plans and roadmaps to financing and/or subsidy schemes and, eventually, contracts and investment decisions for stakeholders to believe that successful GH2 industries will develop. The authors mention that it is the extent to which commitments are binding that create expectations of large-scale GH2 deployment.

Thus, while creating the enabling conditions in terms of infrastructure, legislative and regulatory environment, and availability of skills is important to ensure GH2 industries can develop at scale, quick wins in terms of binding commitments linked to incentives, financing or offtake agreements could significantly speed up the speed at which GH2 industries develop. This is particularly true if projects focus on GH2 derivatives like green iron that is easy to transport without additional rules and regulations. That said, in circumstances where countries are not able to deliver financial commitments directly, a transparent, coherent and predictable policy agenda can help to build investor confidence. Clear government support and commitment action to support GH2 development in Namibia helped to overcome little experience in rolling out RE projects, a lack of technical capacity in hydrogen or iron production, limited iron ore mining experience, a small local market, and an incomplete policy environment to enable the rapid development of the first phase of Africa's first GH2-based iron plant (Lazarus, 2025; Martin P. , 2024). After commencing construction in 2023, the project signed an offtake agreement with a German steelmaker in 2024, produced its first GH2 in March 2025, and is set to produce its first green iron in April 2025.

Namibia and South Africa are looking to leverage the GH2 project development activity in both countries to develop the Western SADC GH2 corridor. This will allow capacity and experience to be shared between the countries and could also help to reduce the dependence of the two countries on demand from developed countries (Klagge, Walker, Kalvelage, & Greiner, 2025). Namibia's Environmental Investment Fund, Wesgro and NCEDA (the economic development agencies of South Africa's Western and Northern Cape Provinces), the Dutch energy network operator Gasunie and the Dutch investment manager Climate Fund Managers (which is part of the management of both the SDG Namibia One Fund and the South Africa-H2 Fund) signed a memorandum of understanding in 2024 to consider the feasibility of developing GH2 infrastructure to ling the Western Cape and Northern Cape regions of South Africa with the Lüderitz/Windhoek region in Namibia (Wesgro, 2024). The Eastern Cape Province has since joined the initiative as a partner in the Three Capes Alliance in South Africa (ECSECC, 2024a).

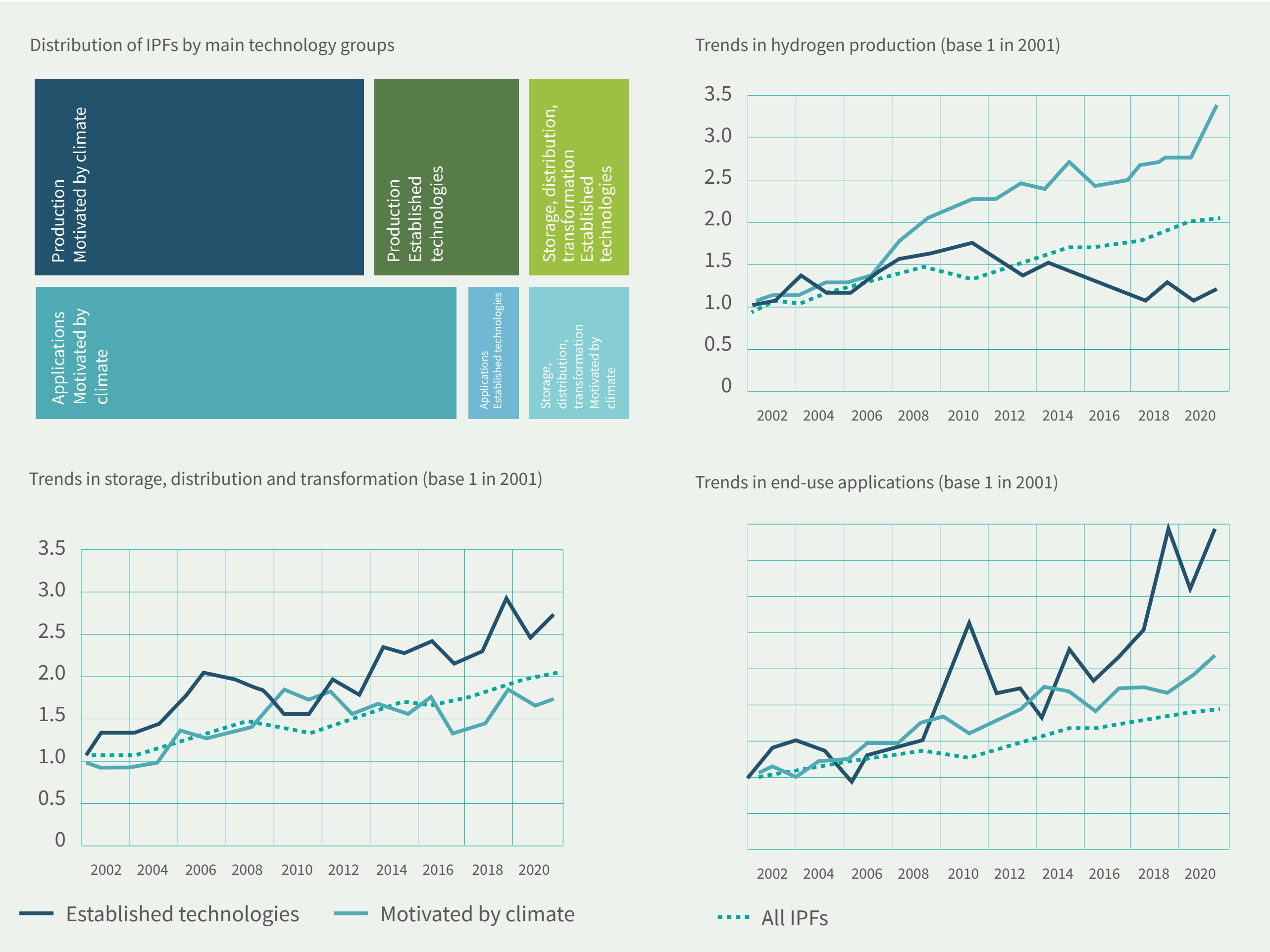
Summary insights

- **Institutional variation:** Institutional capacity varies widely across countries; South Africa and Morocco show stronger readiness.
- **Public sector roles:** Public actors can either drive GH2 development (e.g., lead implementation) or enable it (e.g., provide regulation and incentives).
- **Capacity gaps**: Key gaps exist in technical know-how, coordination between agencies, and understanding of GH2 technologies.
- **Training needs:** There is high demand for workforce training and upskilling to meet future project and regulatory needs.
- **Regional disparities:** Some regions lack even basic institutional frameworks for energy planning and hydrogen strategy.
- **Private sector support:** Governments need to build capacities to manage PPPs, tenders, and investor engagement effectively.
- **Knowledge transfer:** International cooperation and donor support are crucial for skills transfer and institutional strengthening.
- **Long-term vision:** Sustained investments in human capital and public governance systems are essential for scaling the GH2 sector.

7. Research, Knowledge Production and Technological Innovation

An analysis of patent applications indicates that H2-related research and knowledge production has shifted towards low emissions technologies. Figure 27 shows that this is the case for across the value chain and includes production, storage, distribution and transformation, and end use applications. The majority of new innovation is concentrated in H2 production and downstream utilisation.

Figure 27: Overview of patent trends in hydrogen technologies (2001–2020)



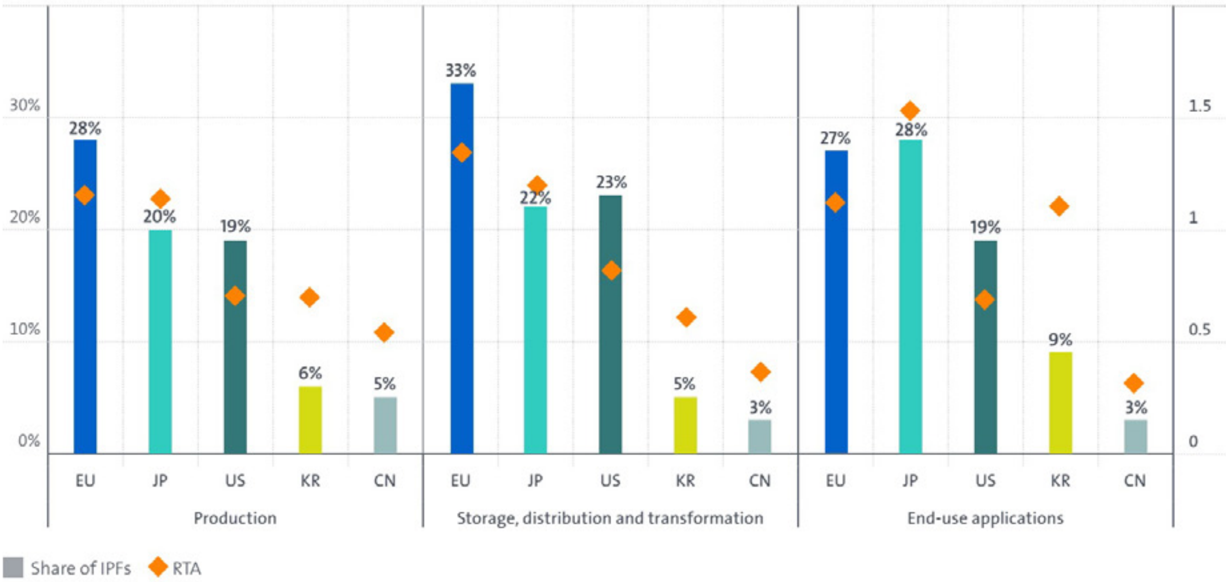
Source: (EPO and IEA, 2023) [12]

Note: Technologies related to CCUS and CO_2 acoidance in fossil-based hydrogen production, as well as technologies for vehicle refueling, are labelled in this chart as motivated by climate« to indicate that they would mostly not be pursued without the climate imperative

12 The research used data on international patent families (IPFs), which relate to patents filed and published at several international patent offices relating to a single invention. For more details, see EPO and IEA (2023).

The ownership of new technologies is highly concentrated in a few developed countries and China, as shown in the below figure.

Figure 28: Concentration of patents by main region and value chain segment (2011 – 2020)



Source: (EPO and IEA, 2023)

Note: RTA (righthand scale) indicates the extent to which a region or country specialises in H2 innovation and is calculated as a country's share of IPFs in H2 divided by the country's share of IPFs in all fields of technology. A value above one indicates a specialisation in H2 technologies.

The ownership of H2 patents is also concentrated amongst a relatively small number of entities (EPO and IEA, 2023). The entities in questions are shown in Figure 29. Africa is therefore expected to be largely a taker rather than a developer of owner of GH2 technologies. This is confirmed by an analysis of the IEA's Energy Technology Patents Database, which shows that between 2000 and 2023 South Africa was the only African country that registered patents related to H2 and fuel cells (17) or H2 fuel production (3) (IEA, 2024a). Over the period in question, however, 38,260 patents where registered related to H2 and fuel cells, and a further 4,442 related to H2 fuel production, internationally.

Despite holding relatively few patents, important technological developments are happening in South Africa. A GH2 research programme has been running in South Africa since 2008 and comprises three Centres of Competence, focussing on catalysts and catalytic devices (HySA Catalysis), production, storage and distribution (HySA Infrastructure) and systems integration and technology validation (HySA Systems) (see section 5.1.3). These centres are continuing to develop new technologies and generated most South Africa's GH2-related patents and patent applications. [13] Two companies have been created to commercialise GH2-related technologies developed via HySA programmes and at the University of Cape Town, namely Hydrogen Energy Applications (HYENA) and HyPlat (SANEDI, 2024; dtic, 2022). HYENA is deploying a fuel cell technology (HYENA, Undated; Royal Academy of Engineering, 2022) whereas HyPlat produces Membrane Electrode Assembly (MEA) components based on proprietary catalysts for the local market and export. South Africa company Hydrox holdings, supported by Shell's GameChanger programme, is commercialising a membrane-less Alkaline electrolyser system based on patented technology that won the Best Emerging Technology

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13 Details on research outputs are available at **www.hysasystems.com**, **https://hysainfrastructure.com** and **https://hysacatalysis.uct.ac.za/**

Award at the 2022 Monaco Hydrogen Alliance prize for Innovation in Renewable Hydrogen and Transportation (Hydrox Holdings, Undated).

Figure 29: Top applicants in hydrogen technologies (IPFs, 2011–2020)

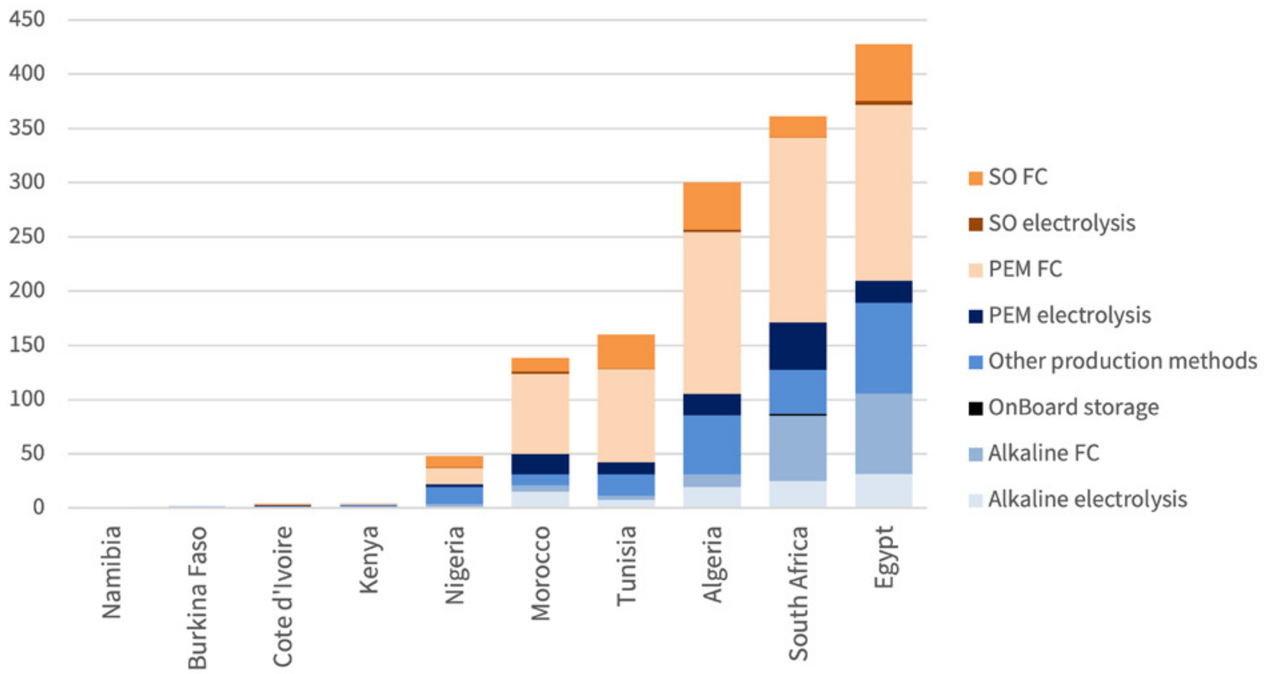
Source: (EPO and IEA, 2023)

Notes: IPFs have been allocated to the listed entities based on the identification of these entities as an individual or co-applicant of the related patents. Technologies related to CCUS and CO_2 avoidance in fossil fuel-based hydrogen production, as well as technologies for vehicle refuelling, are labelled in this chart as "motivated by climate". Ranking is based on the size of applicant portfolios of IPFs in established and climate-motivated hydrogen technologies. The sum of the applicants' IPFs reported in the chart may exceed the actual size of their portfolio due to some IPFs being counted as relevant to two or three different segments of the value chain

South African petrochemical firm Sasol's proprietary FT technology is one of relatively few technologies to produce PtX products that have been proven at scale. Sasol is attempting to use this technology and its experience in building and operating large-scale FT plants to license and/or deploy sustainable aviation fuel and green chemical plants internationally via its ecoFT business unit (dtic, 2022; Sasol, Undated). Sasol has started the process to form a joint venture with Danish green technology company Topsoe, and the two companies are partnering to deliver the largest e-fuels production research facility in the world at the German Aerospace Centre'slev Technology Platform Power-to-Liquid Fuels at the Leuna Chemical Complex in German. The €130 million facility is being funded by the German Federal Ministry for Digital and Transport (BMDV) and will utlise Sasol and Topsoe's proprietary G2L™ (Gas to Liquid) e-fuels technology which incorporates Sasol's LTFT™ (low-temperature FT) technology and Topsoe's eREACT™ and hydroprocessing technology (Sturgenor, 2023; Sasol, 2024).

Most of the GH2 technology deployed in Africa, however, is expected to come from international sources. Significant research is being undertaken into how to deploy GH2 technology in Africa. Figure 30 shows that scientific papers on GH2 has been published by researchers in several African countries. Despite not having registered any patents, Egyptian researchers have published more GH2 scientific papers than South African researchers since 2006. African GH2 research papers focused mostly on GH2 production and fuel cells but spanned a ranged of technologies.

Figure 30: GH2-related scientific publications by African countries (number of publications 2006 – Aug 2024)



Source: (European Hydrogen Obersvatory, 2025)

African countries are enabling access to the latest GH2 technologies via partnerships with research and development institutions and intellectual property owners in the developed world and China. Examples include:

Morocco. The partnership between the International RE Agency (IRENA) and Morocco's Ministry of Energy, Mines and Environment to advance the national GH2 economy (see section **Chyba! Nenalezen zdroj odkazů**). The Green Energy Park research and development platform's focus on partnering with foreign entities like Korea International Cooperation Agency, the Fraunhofer Centre for Silicon Photovoltaics, or the German Aerospace Centre The Belgium electrolyser manufacturer John Cockerill has announced plans to build a factory in Morocco via a joint venture, the Wuppertal Institute is planning Power-to-Liquid demonstration unit, and the PtX Hub in Morocco is implemented by GIZ in cooperation the German research bodies Agora Energiewende and DECHEMA. Other examples of international companies involved in the GH2 sector in Morocco include the Israeli company H2PRO (GH2 production pilot project), Serbian wind farm developer CWP Global and German Hydrogenious LOHC Technologies (exports via LOHC), Irish Fusion Fuel and French Total Energies (developing green ammonia plant), British Shell (green ammonia pilot projects) and Saudi company ACWA Power (RE project developer) (Weko, Farrand, Fakoussa, & Quitzow, 2023). BASF, one of the largest H2 patent holders, has chemical and recycling operations in Morocco (BASF, Undated). Al Mada Ventures, a Moroccan private equity fund, has invested in Supercritical Solutions Ltd, a UK based electrolyser technology developer (Supercritical, 2025).

Kenya: Australian mining company Fortescue, through its Fortescue Future Industries, has entered into an agreement with the Kenyan government to produce green ammonia in Kenya and grow the local green fertiliser supply chain (O'Farrell, 2022). The company also partnered with the Kenyan Strathmore University and Australian Curtin University to advance the GH2 economy in Kenya (Igadwah, 2023).

Namibia: Three Dutch state-owned companies, Port of Rotterdam, Gasunie (an energy network operators), and Invest International (a development finance institution) signed a memorandum of understanding with the Government of the Republic of Namibia (GRN), the Namibian Ports Authority (NamPort), NamPower (the national utility) and Hyphen Hydrogen Energy (the UK-based Nicholas Holdings and German Enertrag development vehicle), to support the development of the Hyphen vertically-integrated GH2 project (Habibic A. , 2023). This follows on from previous support by the UK and the EU to develop Namibia Green Hydrogen Research Institute as part of the University of Namibia to support research, innovation and the capacity to effectively engage in technology transfer. The Southern African Science Service Centre for Climate Change and Adaptive Land Management (SASSCAL), established in 2012 as a joint initiative of Angola, Botswana, Namibia, South Africa, Zambia, and Germany, is also supporting skills development to enable effective technology transfer in the GH2 industry in Namibia (Republic of Namibia, 2024). Air Liquide, one of the largest H2 patent holders, has a presence in Namibia (Air Liquide, 2022). The technology underpinning the HyIron plant in Namibia was first tested at a smaller scale in Germany by HyIron in partnership with RWE and BENTELER Steel/Tube (HyIron, Undated).

South Africa: Four of the largest H2 patent holders for GH2 production, Air Liquide, Linde, Air Products, and BASF have a significant presence in South Africa (Air Liquide, 2022; BASF, Undated; Bulbia, 2024a; Linde, Undated). Linde is a partner with Hive Energy UK in the Hive Hydrogen South Africa green ammonia project and, with Sasol and the German RE company Enertrag, a member of the HyShift consortium developing SAF via the FT process (Hive Energy, 2021; Sasol, 2022). Air Products is focused on rolling out GH2 mobility solutions in South Africa, and with Toyota and Sasol presented a on-road hydrogen mobility ecosystem proof-of-concept demonstration at a test track in South Africa in 2023. It is also collaborating with BMW on GH2 mobility solutions (Bulbia, 2024a).

Isondo Precious Metals manufacture fuel cell and electrolyser components in South Africa under license from the US-based Chemours Company (Cloete K. , 2016; Isondo Precious Metals, Undated). After initially licensing technology from UK-based Ceres Power to localise the production of Solid Oxide fuel cells, local fuel cell manufacturer Mitochondria Energy Systems has now concluded an agreement with Italian stack manufacturer to initially import and then locally produce a 50kW containerized Solid Oxide Fuel Cell system (Mitochondria, 2024). Chem Energy South Africa, a subsidiary of Taiwan-based CHEM Group, has established a $ 200-million fuel cell production facility in KwaZulu-Natal - initially focusing GrH2GrH2, the company plans to transition to GH2 production (Engineering News, 2024; dtic, 2022). CHEM Corporation, together with its partner Sunhydro China, is a global leader in H2 and fuel technology.

South African based Anglo-American Platinum was a seed investor in, and is continuing to invest in, the German company Hydrogenious LOHC Technologies and the UK based electrolyser technology developer Supercritical Solutions Ltd (Supercritical, 2025; Creamer M. , 2025). South Africa's Public Investment Corporation (PIC) is an investor in the UK-based AP Ventures venture capital firm which invests in PGM end use applications. This firm, which is also supported by the Japanese Mitsubishi Corporation and Mirai Creation Fund and the French automotive supplier OPmobility, also invested in Hydrogenious LOHC Technologies.

8. Economic and Environmental Impacts

GH2 offers a transformative opportunity for Africa, providing significant economic and environmental benefits. By harnessing its vast RE resources, the continent has the potential to establish itself as a major player in the global GH2 market. While the contributions of GH2 to economic growth, job creation, and industrial development have been extensively covered in Section 3.6.6, this chapter focuses on the environmental benefits of developing a GH2 economy.

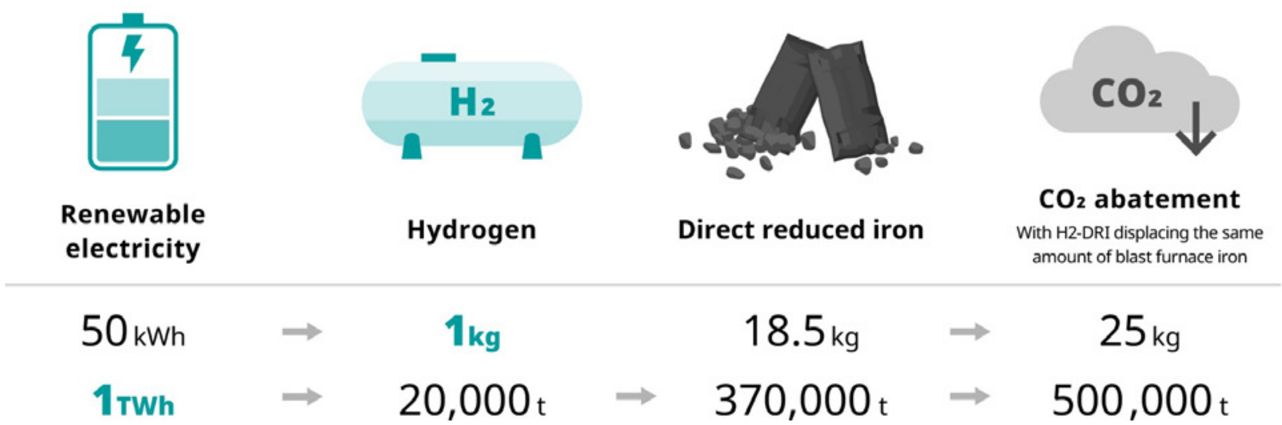
8.1 Environmental benefits

A GH2 economy offers substantial environmental and social benefits, notably through significant reductions in GHG emissions across various sectors. Below is a detailed analysis of these benefits, including quantifiable GHG reductions and their sources.

8.1.1 Iron and steel industry

The iron and steel industry is a major contributor to global carbon emissions, accounting for around 4% of anthropogenic CO_2 emissions in Europe and 9% globally, largely due to the extensive use of coal. Transitioning to GH2 presents a viable pathway to decarbonise this sector (European Parliament, 2020). GH2-based direct iron reduction (H_2-DRI) has the potential to cut emissions by nearly 2 tonnes of CO_2 per tonne of steel produced, enabling up to a 90% reduction in sector-wide emissions (SteelWatch, 2025). As illustrated in the figure below, replacing traditional blast furnaces with H_2-DRI can save over 500,000 tonnes of CO_2 per 1 TWh of renewable electricity consumed, making it a highly effective solution for reducing industrial carbon footprints.

Figure 31: CO_2 emissions reduction in steelmaking from using GH2 and/or renewable electricity



Source: SteelWatch (2025)

The technological feasibility of using GH2 as a replacement for coal is well understood, and ongoing pilot projects are proceeding worldwide to optimise these processes. While current hydrogen-based steelmaking would increase the price of steel by approximately one-third, this cost gap is expected to narrow significantly by 2030. This is due to rising carbon prices and the anticipated decline in GH2 production costs through economies of scale, advancements in electrolyser efficiency, and cheaper renewable electricity. Full decarbonisation would demand around 20% more electricity, highlighting the need for accelerated RE deployment (European Parliament, 2020).

8.1.2 Transport sector

The transport sector is one of the largest contributors to global GHG emissions, accounting for approximately 25% of total CO_2 emissions worldwide, primarily from fossil fuel combustion (IEA, 2023b). GH2 offers a viable pathway for deep decarbonisation, particularly in segments where battery-electric technology faces challenges, such as heavy-duty trucking, rail, shipping, and aviation. Hydrogen-powered fuel cell electric vehicles (FCEVs) produce zero tailpipe emissions, emitting only water vapor while significantly reducing nitrogen oxides (NO_x) and particulate matter compared to diesel-powered alternatives. The European Clean Hydrogen Alliance estimates that switching to GH2-powered trucks could cut CO_2 emissions by up to 80% per vehicle compared to conventional diesel engines (European Commission, 2022). A case study in Germany, where hydrogen trains were deployed in Lower Saxony, demonstrated the potential to eliminate approximately 700 tonnes of CO_2 emissions per year per train, replacing diesel-powered locomotives on non-electrified rail networks (Alstom, 2022).

In maritime and aviation sectors, GH_2-derived fuels such as green ammonia and e-kerosene provide viable pathways for substantial emission reductions. The International Maritime Organization (IMO) estimates that hydrogen-based fuels in shipping could eliminate up to 1 gigatonne of CO_2 emissions annually by 2050 (IMO, 2023). A case study from Maersk's adoption of green methanol, derived from hydrogen, revealed a potential reduction of 60-95% in lifecycle emissions compared to conventional marine fuels (Maersk, 2023). Similarly, Airbus has been developing hydrogen-powered aircraft, projecting that liquid hydrogen propulsion could tremendously reduce aviation its CO_2 emissions. Additionally, the deployment of hydrogen refuelling infrastructure will be crucial in scaling up adoption. As hydrogen production costs decline and refuelling networks expand, GH_2 is set to play a transformative role in achieving net-zero emissions in the transport sector.

8.1.3 Building and power generation

Power generation: Integrating GH2 into power generation presents a transformative opportunity for reducing reliance on fossil fuels while enhancing the resilience and stability of the electrical grid. GH2 serves as an energy carrier that can be stored and used for electricity generation, providing a flexible and sustainable alternative to coal, gas, and nuclear power plants. One of the key benefits of using GH2 in power generation is its ability to act as a buffer for fluctuations in RE generation. By converting excess renewable electricity into hydrogen during periods of high supply and low demand, it can be stored for later use, thus smoothing out the fluctuations in RE generation and ensuring a continuous and reliable energy supply. When needed, the stored hydrogen can be fed into power plants or fuel cells to produce electricity, thereby increasing grid stability and reducing the need for backup fossil fuel power plants.

Technological advancements in electrolyser technology have significantly improved efficiency, making the process of generating GH2 more economical and practical for large-scale power applications. These improvements not only lower the cost of hydrogen production but also make it a more viable option for decarbonising the power sector. In addition, hydrogen can play a crucial role in balancing the grid, as it can be deployed quickly in response to sudden changes in demand or when RE supply dips. Hydrogen's flexibility, coupled with its ability to store large amounts of energy, positions it as a key component in the transition to a net-zero carbon grid. As the costs of renewable electricity continue to fall, and electrolyser efficiency continues to rise, the adoption of GGH2 in power generation is expected to grow rapidly, contributing significantly to global emissions reductions.

Buildings and heating: The use of GH2 in heating systems offers a promising solution to the challenges associated with decarbonising the building sector, particularly in regions with colder climates or areas where electric heat pumps may not be as effective. In many countries, heating is a significant source of carbon emissions, especially when fossil fuels like natural gas are used. GH2 provides an alternative, carbon-free source of heat, and its integration into building heating systems can alleviate the strain on electrical grids. This is particularly important in regions where electricity demand peaks during cold weather months, as traditional electric heating systems may place excessive pressure on the grid, especially during the winter. By using hydrogen as a fuel in boilers or combined heat and power (CHP) systems, homes and commercial buildings can meet their heating needs without relying on grid electricity or fossil fuels.

Hydrogen-powered heating systems are particularly advantageous in areas where electric heat pumps are less effective, such as extremely cold climates. Heat pumps are efficient in milder conditions but struggle to provide sufficient heat in very cold temperatures, requiring additional electrical demand from the grid. In contrast, hydrogen boilers can provide a reliable and consistent heat source without the same limitations. This flexibility makes hydrogen an ideal solution for homes and industries that need high-temperature heating, such as in the food industry, manufacturing, and other industrial processes. Moreover, the use of hydrogen for heating can help reduce peak electricity demand, lowering the pressure on electrical grids during the winter months. As a result, it could reduce the need for additional investments in electricity grid infrastructure and improve overall grid reliability. With the right policies and investments in hydrogen infrastructure, including pipelines and refuelling stations, GH2 can be effectively integrated into residential and commercial heating systems, contributing to significant emissions reductions in the building sector.

8.2 Social benefits of GH2 economy

The transition to a GH_2 economy offers significant social benefits beyond environmental gains. It fosters innovation, creates high-quality jobs, enhances energy security, improves public health, and supports a more equitable energy transition for communities historically dependent on fossil fuels. While job creation and economic growth are covered in Section 3.6.6, this subsection focuses on energy independence, public health, and the fair distribution of energy resources.

8.2.1 Energy security

GH2 can significantly improve energy security by reducing a country‘s reliance on imported fossil fuels, which are subject to geopolitical risks and price volatility. The ability to produce hydrogen domestically using abundant RE resources enhances energy independence and supports more resilient energy systems. This decentralization of energy production is particularly crucial in countries that are heavily dependent on imported oil and gas, as it helps insulate national economies from fluctuations in global energy markets. The development of GH2 can help diversify energy sources and reduce reliance on a single supplier, improving energy security. Additionally, GH2 can help balance energy supply and demand. Hydrogen storage allows excess RE to be converted into hydrogen during times of high generation and stored for use during periods of low energy supply, reducing the need for fossil fuel-based backup power generation. Moreover, decentralized hydrogen production and distribution systems could facilitate energy access in remote or off-grid areas. For example, rural communities that may not have reliable access to a central grid could benefit from local hydrogen production, which would provide them with an alternative, clean, and cost-effective energy source. By reducing reliance on centralized, fossil-fuel-dependent energy systems, GH2 fosters a more resilient and adaptable energy infrastructure.

8.2.2 Health Improvements

The adoption of GH2 can significantly improve public health by reducing the harmful air pollutants associated with fossil fuel combustion. Transport, industrial activities, and power generation are major sources of pollutants such as nitrogen oxides (NO_x), particulate matter (PM), and sulphursulphur oxides (SO_x), all of which have detrimental effects on respiratory and cardiovascular health. By replacing fossil fuels with hydrogen, especially in sectors like transport and power generation, these harmful pollutants can be dramatically reduced, leading to significant public health benefits.

For example, hydrogen-powered fuel cell electric vehicles (FCEVs) produce only water vapor as a by-product, which results in cleaner air and reduces the incidence of diseases such as asthma, bronchitis, and other respiratory conditions. Similarly, hydrogen-powered industrial processes and power plants would emit zero CO_2 or harmful pollutants, offering a substantial improvement in air quality. Studies have shown that the transition to hydrogen-based energy systems could reduce premature deaths related to air pollution, particularly in urban areas where air quality is a significant concern. Additionally, reducing reliance on fossil fuels will help decrease noise pollution, which is another health hazard. In urban environments, noise pollution from vehicles, industrial operations, and power plants has been linked to increased stress, sleep disturbances, and cardiovascular diseases. Hydrogen-powered solutions, such as quiet fuel cell buses and trains, can mitigate this issue, promoting healthier living environments in cities.

8.2.3 Just transition and social equity

A key social benefit of GH2 is its ability to foster a just transition for workers and communities that are highly dependent on fossil fuel industries. As the global economy moves towards cleaner energy systems, there will inevitably be job losses and economic disruption in regions reliant on coal, oil, and gas extraction. However, GH2 offers the potential to revitalize these regions by creating new, sustainable employment opportunities in the hydrogen production, storage, and distribution sectors.

GH2 can also help address energy access and equity, particularly in developing regions where unreliable electricity limits economic growth and quality of life. By implementing local hydrogen production systems, these areas could access clean, affordable, and decentralized energy. This approach would help bridge the energy access gap, creating equitable development opportunities and reducing energy poverty. Moreover, investing in GH_2 ensures that the benefits of the energy transition are more evenly distributed. Unlike centralized fossil-fuel systems, GH_2 promotes a decentralized model that benefits both urban and rural communities by providing cleaner and more affordable energy options.

9. Financing Projects

Africa's attractive GH2 potential and its location relative to the international demand centres for GH2 have led to a myriad of projects being announced to supply local and international markets. Making these projects reality, however, has progressed relatively slowly. Section 3.2.1 showed that only 8 GH2 projects out of the more than 110 announced in Africa have reached a final moved beyond the final investment decision (FID). Furthermore, most of these projects are small-scale demonstration plants, with only 3 having an annual production capacity of more than 1 kt H2/year. This situation is not unique to Africa. The 2024 Global Hydrogen Review (IEA, 2024) shows that globally only 4% of announced projects have reached final investment decision. Advanced projects are clustered in two regions of the world, with more than 40% of the projects that reached FID during the year preceding the Review's publication located in China and 32% in the European Union.

While several factors contribute to the difficulty in getting GH2 projects off the ground (see Section 3.8), one of the most important is the cost and availability of finance (Lee & Saygin, 2023; Kigle, Schmidt-Achert, & Pérez, 2024; Taghizadeh-Hesary, et al., 2022; Hydrogen Council and McKinsey, 2024a; Rezaei, Akimov, & Gray, 2024). GH2 is a relatively new technology that is yet to be proven at scale. The production cost of GH2 is also still higher than that of fossil fuel-based hydrogen and, while this is expected to change in future, GH2 is therefore not currently commercially viable without subsidies.

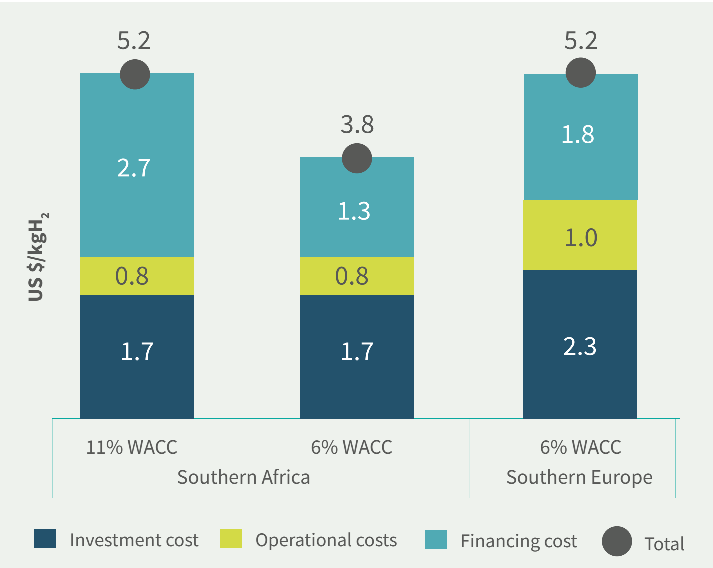
The European experience shows that creating a funding instrument focusing on strategic projects can help to get these to financial close. While about 8-10% of GH2 projects in Europe reached final investment decision since 2020, 21% of projects supported under the Important Projects of Common European Interest (IPCEI) framework for hydrogen received final investment decisions since 2020 (Hydrogen Europe, 2025b). IPCEI is the primary funding instrument in Europe bridging the gap between R&D and industrialisation. But even in the relatively well-resourced European context, there are significant differences between the funding outcomes by country and project area. While countries like Germany, France, and Italy have allocated funding to more than 75% of IPCEI projects based there, countries like Finland, Portugal and Poland have allocated funding to less than half of qualifying projects. Furthermore, only 9% of projects dealing with the production, supply and integration of GH2 into industry have reached final investment decision, largely due to the inability to obtain off-taker agreements.

GH2 projects are also large, capital intensive, and typically cost more than $1bn to develop because they involve RE, production, water provision and storage and/or transport infrastructure (Young & McGregor, 2024). Megaprojects come with their own set of complications, and less than 1% of these projects generate their expected benefits on time and within budget (The Economist, 2023). The combination of the GH2 industry being in its infancy internationally, the scale of projects, and the challenging operating environment in Africa, means that there is an important role for donor and development finance to increase the bankability of projects and assist with the development of GH2 value chains (Hydrogen Council and McKinsey, 2024a; Young & McGregor, 2024).

Hydrogen Council and McKinsey (2024a) mention that GH2 projects in developing markets like Africa carry additional risks that further increase financing costs. These risks origination from both the location and the execution of projects. Country-specific risks originate from legal uncertainty and political and monetary instability. These risks also create currency risk. Country-specific risks can be addressed by using insurance, hedging and foreign-currency contracting strategies, but these solutions tend to be costly. Project execution risk stems from a dearth of experienced contractors, limited availability and/or reliability of critical infrastructure, difficulty in securing the delivery of key hardware or services (like maintenance), and lack of local hydrogen industry skills and experience. While the capacity of African countries to undertake GH2 projects vary significantly (see sections 3.4 and 5), these issues are particularly prevalent in Africa given its poor state of infrastructure and relatively small and undiversified economies. Hydrogen Council and McKinsey (2024a) believes that higher financing cost is a key reason why fewer GH2 projects have moved beyond the early planning phase (5%) than is the case globally (20%).

To illustrate the impact of higher country risk premiums on the cost of GH2, Deloitte (2023) considered the impact of different weighted average costs of capital (WACC) on the LCOH in Southern Africa and Southern Europe. Figure 32 shows that while better conditions for renewables meant the capital investment and operational expenditure to produce GH2 were lower in Southern Africa than Southern Europe, the higher cost of capital in the former compared to the latter meant that the LCOG in 2023 was slightly higher in Southern African than in Southern Europe.

Figure 32: Impact of developing country WACC premium on the levelized cost of GH2 hydrogen, 2023

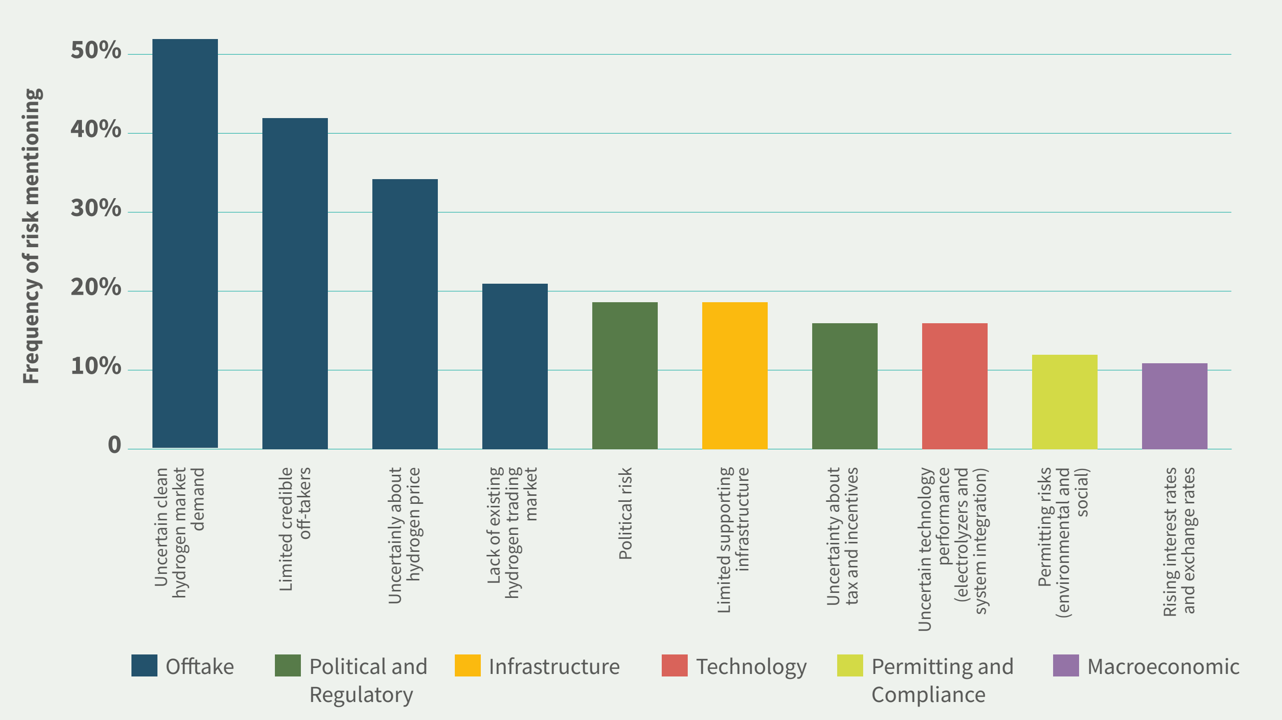


Source: (Deloitte, 2023)

The World Bank and the OECD surveyed global hydrogen stakeholders and identified more than 40 risks that affect the cost and availability of finance to clean [14] hydrogen projects (exceeding 100 MW of electrolysis capacity) (ESMAP, OECD, Global Infrastructure Facility, and Hydrogen Council, 2023). The risks that are most significant in limiting the availability of finance to clean hydrogen in emerging markets and developing countries are shown in Figure 33. Uncertainty around demand, price and trading opportunities, compounded by a lack of credible off-takers, translated into an inability to secure long-term offtake agreements being the main issue constraining the financing of clean hydrogen projects in the developing world.

14 Defined as GH2 and hydrogen produced using fossil fuel with safe and responsible carbon capture and storage.

Figure 33: Most important risks limiting the availability of clean energy finance in emerging markets and developing countries



Source: (ESMAP, OECD, Global Infrastructure Facility, and Hydrogen Council, 2023)

Lee and Saygin (2023) also analysed the results from the survey mentioned above, weighed the risks in terms of importance, and proposed measures to address the key risks, as shown in Table: 27.

Table 27: Key risks constraining clean hydrogen finance and potential policy or de-risking mechanisms

Risk factors	Weight	Examples of Mechaisms to address risk
Uncertain market demand	27%	Purchase obligations, public procurement.
Limited credible off-takers	23%	Long-term hydrogen purchase agreement (HPA), Partial risk/credit guarantees, export credit guarantees, and government guarantees especially for emerging markets and developing countries.
Uncertainty about hydrogen price	19%	Long-term hydrogen purchase agreement (HPA) and partial loan guarantee
Lack of existing hydrogen trading market	11%	Long-term hydrogen purchase agreement (HPA), De-risking through Guarantees of Origin could also strengthen market credibility

Political risk (Expropriation, Breach of Contracts, War, Currency Inconvertibility and Transfer Restriction)	10%	Political risk insurance, Partial risk/credit guarantees
Limited supporting infrastructure	10%	Hydrogen hubs
Total	**100%**	

Source: (Lee & Saygin, 2023)

The authors further mention that different policy measures are needed to unlock financing when markets for GH2 are still emerging and projects are being conceptualised, compared to once projects are ready to proceed to final investment decisions. During the first phase, smaller investments are needed to prepare and package a project while a **market is still being created**, but there is a high degree of risk. The final market for the project may not have been identified, and offtake agreements will not be in place. Given the nascent nature of GH2 market, a conducive policy and regulatory market is also unlikely to be in place in most countries during the development phase. Projects are typically equity-financed during the early stage of development, and investors look to earn 2-3 times their original capital outlay over about 3 years, at a weighted cost of capital of at least 20%. Policy measures aimed at creating a market for GH2 (like regulatory decarbonisation requirements), public procurement (e.g., the H2Global mechanism), revenue support (e.g., the Inflation Reduction Act in the US), and capital and project preparation grants, are particularly useful during this phase of market development (Lee & Saygin, 2023).

Investors require certainty with respect to offtake volumes and pricing before the final investment decision can be taken to enable significant project-linked capital expenditure. This typically involves offtake agreements to be in place, supported by some form of price support (feed-in tariffs, floor prices, etc) to be in place to bridge the gap between the cost of GH2 and fossil fuel-derived H2. **Once a market is established and ready for growth**, investors' weighted cost of capital expectations are reduced to between 10-20%, which is the norm for infrastructure projects (although, as discussed above, it is typically higher in developing countries). Once projects start reaching this point and the market becomes established, mechanisms like carbon pricing or performance standards can be used to grow the market (Lee & Saygin, 2023).

An overview of the most popular finance and de-risking instruments for each of the two market phases are shown in Figure 34, along with other measures that can be used to create and grow GH2 markets.

Figure 34: Policies and measures to facilitate GH2 market creation and growth

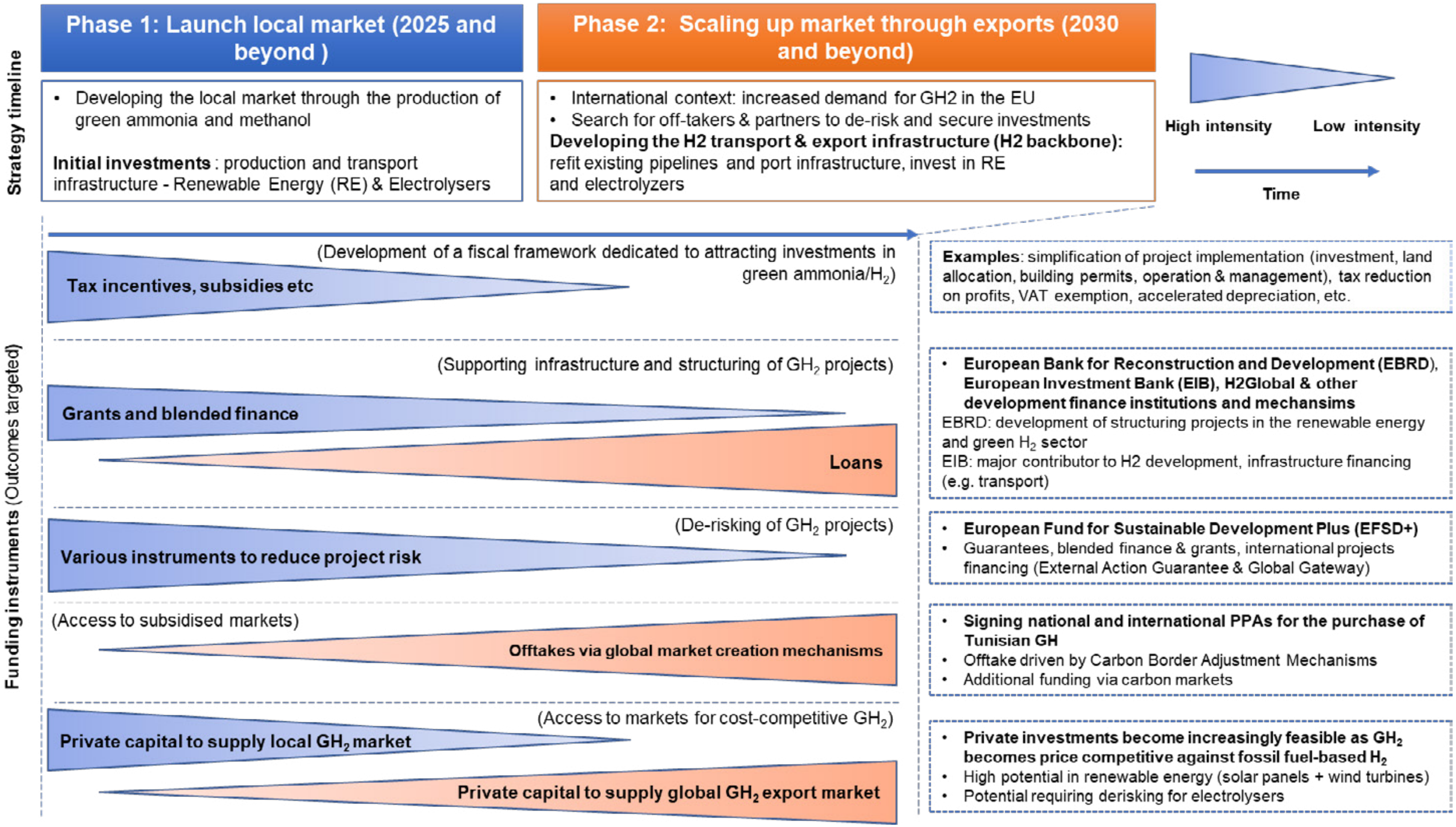
	Market creation			Market growth		
	Strategy, Governance, Standards	**Enabling market measures**	**De-risking instruments & Financing**	**Strategy, Governance, Standards**	**Enabling market measures**	**De-risking instruments & Financing**
Public sector (incl. DFIs)	Integrated energy roadmap including hydrogen targets and priority sectors	Land allocation	Feed-In tariffs / premiums	Lar-scale green hydrogen demonstration projects or hydrogen valleys	Guarantees of origin and tracking system	Regulated Asset Base model / Minimum Revenue Guarantee
	Infrastructures roadmap and investment planning (transport, storage, …)	Duty relief on Renewable Energy Assets / Electrolysers	Carbon Contract for Difference	Auctions	Consumption quotas / mandates	Credit enhancement mechanism
	Climate and renewable energy policies setting national targets	Fossil fuel subsidy reform	Grants / Viability Gap Fund		Tax relief for green products / Surcharge on end products	Subordinated debt
	Simple licensing process	Public Procurement	Simple licensing process			Blended FInance
International Organisations	Governance redommendations		Matching platforms between investors and developers	Sectoral Patforms and global technical KPIs tracking	KPI efficiency of public spending	Tracking financial flows
	Technical assistance / Capacity building / KNowledge Exchange			Green H2 certification and tracking schemes		
	Global targets based on scenarios			Trade and regional integration		
	Green H2 definition and assessment methodology			Define ecolabelling for green products		
Public sector (incl. DFIs)	Company zero pledges (Including Consumers)	Joint Venture / SPV / Asset Companies to deconsolidate green units	Equity investment (Front-runners)	Scale-up (Gigafactories, Port terminals, etc.)	Interoperability of systems (H2 quality, ports infrastructure, …)	Equity investment (All)
	Companies Green / Sustainable Finance Framework	Offtake agreements for H2	Green Bondsand Sustainability-Linked Investments	Certification and technical standards	Corporate PPAs / Water supply agreements	Green Bonds and Sustainability-Linked Investments
	Warranties, equipment performance, guarantees		Green premiums		Portfolio / Utility apporach to create scale	
Private financial institutions	Net Zero pledge	Risk assessment and risk measures insurance products	Issuance of Sustainability-Linked Products			Use of Proceeds of Sustainability Linked Investments
	Green / Sustainable FInance Framework					Traditional FInancing (mainly debt) and refinancing

Upstream Midstream Downstream Cross-cutting

Source: (Cordonnier & Saygin, 2022)

An example of how different mechanisms to unlock financing for GH2 projects can be deployed at different stages of the market development is included in **Tunisia**'s GH2 strategy (see Figure 35).

Figure 35: Chronology of Tunisia's GH2 financing strategy



Source: Adapted from (MIME, 2024b)

In developing countries, where there is a lot of general uncertainty, it is important to combine financial de-risking with policy de-risking to create the conditions where investors are comfortable committing large amounts of funding and reach the final investment decision on GH2 projects (ESMAP, OECD, Global Infrastructure Facility, and Hydrogen Council, 2023). Policy de-risking addresses the inherent risk present or perceived in developing countries via institutional capacity building and local skills development (see section 5 and section 6), the creation of robust legal and regulatory frameworks for GH2 (see section 4), and the prudent management of infrastructure assets.

The **Namibian** HyIron Oshivela Project is an example of where policy and financial de-risking combined to enable the world's first green iron from GH2 to be produced in 2025 in Namibia. The HyIron project benefited from focused and committed efforts from the Government of Namibia to create investor certainty and move forward GH2 projects forward (see section 5). It also benefitted from a €13,7 million grant from Germany's Federal Ministry for Economic Affairs and Climate Action (BMWK) (which amounted to 40% of the €30m cost of Phase 1 of the project) and an undisclosed amount of project development funding from the SDG Namibia One Fund (Climate Fund Managers, 2024; European Commission, 2025; De Jager, 2025).

The EU and the Government of the Netherlands have also committed to provide €12m of blended finance to Phase 2 of the project. The total cost of Phase 2, which is expected to start at the end of 2025, is €230m, whereas Phase 3, expected to commence in 2027, will require an additional investment of €2.3bn (De Jager, 2025).

The experience of the REIPPP in **South Africa** (see section 3.4.1) illustrated how a large-scale rollout of a technology supported by the public sector can reduce the cost of funding. Despite several false starts and significant uncertainty, the average cost of funding large-scale solar PV projects in South Africa is significantly lower than expected based on South Africa's country risk profile. This was achieved via government guarantees, efficient procurement methodologies, and increasing familiarity with the underlying technologies, allowing South Africa's sophisticated local financial markets to be tapped rather than having to rely on more costly international finance (Cloete & Kent, 2025). The success of the REIPPP programme has transformed the RE market in South Africa from predominantly led by public procurement (via the REIPPPP) to one largely driven by private demand facilitated by both smaller onsite solar PV installations and grid-scale solar PV and wind projects supplying corporate and industrial customers via wheeling across the national grid. The private demand for RE in South Africa currently outstrips supply due to a continuing electricity supply crisis in South Africa since 2007 that has led to intermittent electricity disruptions (referred to as 'loadshedding') to safeguard the integrity of the overall power grid. While additional supply coming online has reduced loadshedding, the cost of grid electricity has been rising much faster than inflation due to operational and financial management issues at the national power utility Eskom. RE is now at or below grid price parity in most areas of South Africa, and long-term PPAs are offering customers a greater degree of price certainty than grid electricity. The unmet demand for RE in South Africa has potentially reduced the risk of developing large-scale GH2 projects. If a project does not manage to secure an off-take agreement for the PtX element of a project, the RE component of the project can be broken up into smaller individual RE projects and sold to RE investors. This significant reduces the risk of sunk costs, and makes projects more attractive to financiers. Despite not having reach final investment decision yet, Hive Energy has, in addition to the RE projects it is co-developing with partners, entered into an agreement with a third-party RE developer to supply 372 MW of wind power to its Coega green ammonia project (Creamer M. , 2024; Energize, 2024).

Table 28 shows that apart from South Africa, Morocco and Egypt, it is unlikely that other African countries will be able to lower financing costs for GH2 projects by accessing domestic financial markets once local GH2 markets have been created and scaled. These countries are in the privileged position of having both financial institutions and financial markets that are close to or better developed than the average emerging market country. A country like Nigeria, for example, while having relatively well-developed financial markets, has financial institutions that are significantly weaker than the average emerging market country.

Table 28: Strength of the financial sector in GH2-relevant African countries, 2021

	Financial development index (aggregate)	Financial institutions index	Financial markets index
South Africa	0.55	0.58	0.49
Namibia	0.40	0.72	0.07
Morocco	0.35	0.43	0.26
Emerging markets average score	**0.33**	**0.45**	**0.20**
Egypt	0.31	0.32	0.29
Tunisia	0.23	0.41	0.06
Nigeria	0.22	0.24	0.20
Togo	0.18	0.25	0.10
Kenya	0.16	0.29	0.04
Algeria	0.14	0.27	0.00
Angola	0.14	0.25	0.02
Mauritania	0.13	0.26	0.01
Cote d`Ivoire	0.13	0.20	0.05
Burkina Faso	0.12	0.24	0.00
Mali	0.12	0.24	0.00
Senegal	0.12	0.22	0.01
Niger	0.11	0.21	0.01

Source: (IMF, 2023)

Note: The Financial Development Index is a relative ranking of countries on the depth, access, and efficiency of their financial institutions and financial markets. It is an aggregate of the Financial Institutions Index and the Financial Markets Index. [15]

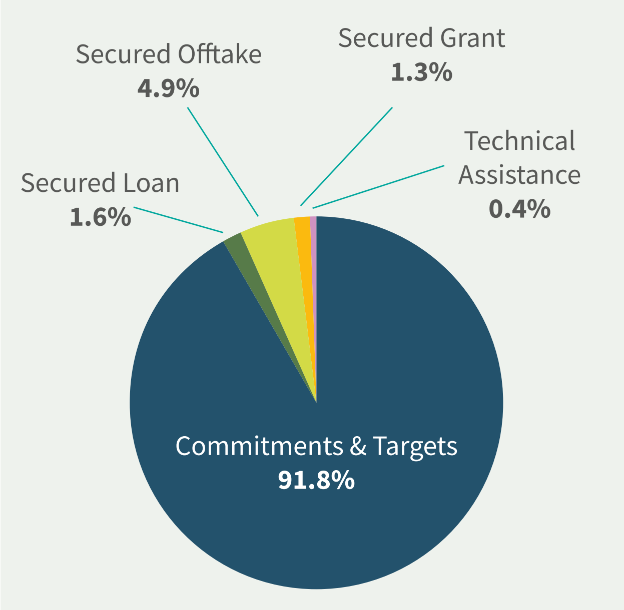
15 For a more detailed description of the indicators, see **https://legacydata.imf.org/?sk=f8032e80-b36c-43b1-ac26-493c5b1cd33b&sid=1480712464593https://legacydata.imf.org/?sk=f8032e80-b36c-43b1-ac26-493c5b1cd33b&sid=1480712464593**

Given the relative immaturity of GH2 markets, the price gap between GH2 and fossil fuel-derived H2, and the development of most African financial markets, it is unsurprising that to date public funding has driven investment in GH2 in Africa. By August 2024 almost 80% of the public funding for GH2 projects in Africa came from Europe, with Germany accounting for 13% of total funding (Tesfaye, 2024).

More than 90% of the public funding for African GH2 projects, have, however, not yet been disbursed as shown in the below table. This illustrates that significant effort is still required to create conditions that are conducive for GH2 projects in Africa. As highlighted above, financial and de-risking mechanisms alone will not be sufficient. Significant policy de-risking will also be required.

An overview of the available sources of finance, and the funding that have been committed and disbursed for GH2 projects in Africa, is shown in Table 29.

Figure 36: Type and status of public funding for GH2 projects in Africa (August 2024)



Source: (Tesfaye 2024)

Table 29: Funding for GH2 projects in Africa

Coverage Coverage	Funding institution / instrument	Funding country	Amount ($m)	Type of commitment	Funded country / region	Primary end-use	Funded project or program
Multi country	Africa Development Bank	AfDB	2,000.0	Commitment	Africa-wide	Local use	Africa Fertiliser Financing Mechanism
	European Investment Bank (EIB)	EU	4,400.0	Commitment	Africa-wide	Unspecified	Global Gateway Investment Package/ EU-Africa Green Energy Initiative
	KfW	Germany	297.0	Commitment	Egypt, Kenya, Morocco, South Africa, Brazil, Columbia	Export, Local Use	PtX Development Fund
	EIB	EU	27.5	Technical Assistance	Developing Countries	Unspecified	Green Hydrogen Fund

Coverage Coverage	Funding institution / instrument	Funding country	Amount ($m)	Type of commitment	Funded country / region	Primary end-use	Funded project or program
Country-specific	EIB	EU	2.0	Commitment	Kenya	Unspecified	General
	European Commission	EU	1,050.0	Commitment	Namibia	Unspecified	General
	European Commission	EU	12.9	Commitment	Kenya	Unspecified	Global Gateway Investment Package/ EU-Africa Green Energy Initiative
	French Development Agency (AFD)	France	0.9	Secured Grant	Morocco	Unspecified	Green Hydrogen Research
	KfW	Germany	27.5	Secured Grant	Tunisia	Unspecified	GH2 demonstration plants
	KfW	Germany	220.0	Commitment	South Africa	Export, Local Use	General
	Spanish Government	Spain	215.0	Commitment	Mauritania	Unspecified	General
	USAID	United States	1.0	Secured Grant	Namibia	Unspecified	Namibia Hydrogen Fund
	EU-South Africa Global Gateway Investment Package	EU	333.3	Commitment	South Africa	Various	Just Energy Transition (JET), incl. RE & GH2), connectivity infrastructure & pharmaceutical industry
	EU-South Africa Global Gateway Investment Package	EU	4,840.0	Leveraged development finance target	South Africa	Various	JET, incl. RE & GH2, connectivity infrastructure & pharmaceutical industry
	South Africa-UK PACT programme	UK	Unspecified	Technical Assistance	South Africa	Export	Feasibility study by multinational consortium (including Hive Hydrogen) to explore GH2 export corridor from Eastern Cape region to UK, Europe, and Japan

Coverage Coverage	Funding institution / instrument	Funding country	Amount ($m)	Type of commitment	Funded country / region	Primary end-use	Funded project or program
Project-specific	Development Finance Corporation (DFC)	United States	5.0	Technical Assistance	Egypt	Export	Globeleq Project
	IDC	South Africa	5.5	Commitment	South Africa	Export, Local Use	10 projects, early-stage funding
	EIB	EU	11.0	Secured Grant	Namibia	Local use	Renewstable Swakopmund Project
	European Bank for Reconstruction and Development (EBRD)	EU	1.1	Technical Assistance	Morocco	Export	Nador West Med Port for H2
	Development Finance Corporation (DFC)	United States	5.0	Technical Assistance	Egypt	Export	Egypt-Fertiglobe Project
	H2Global	Germany	437.3	Secured Offtake	Egypt	Export	Egypt-Fertiglobe Project
	EBRD	EU	80.0	Secured Loan	Egypt	Export	Egypt-Fertiglobe Project
	KfW	Germany	66.0	Secured Loan	Kenya	Local use	Olkaria Project
	German Federal Ministry of Education & Research	Germany	33.0	Secured Grant	Namibia	Pilot Projects	Multiple Renewable Hydrogen Pilot Projects
	KfW	Germany	22.0	Commitment	Algeria	Export	German-Algeria Pilot Project
	Federal Ministry for Economic Affairs and Climate Action of Germany (BMWK)	Germany	16.5	Secured Grant	South Africa	Export	Secunda/HyShift Project
	German Government	Germany	41.9	Commitment	Morocco	Unspecified	MASEN-Germany Project
	German Government	Germany	11.6	Secured Grant	Namibia	Local use	Daures Green Hydrogen project
	KfW	Germany	14.3	Secured Grant	Namibia	Export	HyIron Oshivela Project
	EU Global Gateway	EU, Netherlands	13.2	Committed blended-finance contribution	Namibia	Export	HyIron Oshivela Project (Phase 2)
	Development Bank of Southern Africa (DBSA)	South Africa	5.4	Secured Grant	Namibia	Export	Hyphen Project
	AFD	EU	7.7	Commitment	South Africa	Export, Local Use	Technical Assistance to Transnet (GH2 infrastructure)

Coverage Coverage	Funding institution / instrument	Funding country	Amount ($m)	Type of commitment	Funded country / region	Primary end-use	Funded project or program
Local funds	Egypt Sovereign Wealth Fund (Public-Private)	Egypt	12,000.0	Funds and Assets Under Management	Egypt		General
	South Africa-H2 Fund (Public-Private)	South Africa, Netherlands, Denmark	27.5	Equity	South Africa		General
	South Africa-H2 Fund (Public-Private)	South Africa, Netherlands, Denmark	1,100.0	Commitment	South Africa		General
	SDG Namibia One Fund (Public-Private)	Namibia, Netherlands	27.5	Equity	Namibia	Export	Hyphen Project
	SDG Namibia One Fund (Public-Private)	Namibia, Netherlands	1,100.0	Commitment	Namibia		General
	SDG Namibia One Fund (Public-Private)	Namibia, Netherlands	Unspecified	Development Funding Agreement	Namibia	Export	HyIron Oshivela Project
Private	Benteler	Germany	15 ktpa (2025) increasing to 2 Mtpa (2030) *	Offtake agreement	Namibia	Export	HyIron Oshivela Project
	Itochu Corp and partners	Japan	1,475.0	Equity (in negotiation)	South Africa	Export	Hive Hydrogen Ammonia Project
	Itochu Corp	Japan	Unspecified	Offtake agreement (in negotiation)	South Africa	Export	Hive Hydrogen Ammonia Project

Source: Adapted from (Tesfaye, 2024). Additional sources: (EU and DTIC, 2024; EU, 2025; Dakhling, 2024; PtX Development Fund, 2025; Martin P. , 2024; Hive Energy, 2024; European Commission, 2025)

*Notes: Publicly available data only. Some values have been converted using August 2024 exchange rate (1 € = 1.1 $) | *Tonnes of iron*

Overall, several factors are limiting the ability of African GH2 projects to access finance, including, amongst others:

- Inadequate market demand, rules and regulations due to emerging nature of GH2.
- Developing market risk premiums that increase financing cost and reduce price competitiveness.
- Lack of bankable off-take agreements linked to the GH2 price gap relative to fossil fuel-based H2.

Overcoming these barriers will require access to **grants and concessionary finance to be effectively delivered** to African projects. Given the relatively low level of financial development in many African countries, there should be a focus on building the capacity of local and regional financial institutions and DFIs to effectively disburse funds. Leveraging existing climate finance mechanisms, for example relying on institutions that are accredited with the Green Climate Fund (GCF), may help to address capacity constraints.

It is also important that the use of financial instruments to de-risk GH2 projects is supplemented by efforts to **create policy certainty and put in place the necessary physical and market infrastructure (including rules and regulations) required to enable projects to become bankable**. This will require targeted, focused and sustained efforts by local governments.

While the GH2 market is developing, international funding and mechanisms to overcome the GH2 and PtX price gap will be critical to enable African GH2 producers to develop the necessary expertise and scale to compete in international markets. **International cooperation and strengthening bi- and multilateral relationships** are therefore important.

Developing predictable and transparent programmes to support projects and facilitate access to available funding sources will be important to reduce relatively high-country risk premiums. **Targeting local and regional funder**s, investors and DFIs that are familiar with the local context will also help to reduce risk premiums.

Summary insights

- **Dominance of EU funding**: Almost 80% of public funding for African GH2 projects comes from Europe, with Germany contributing 13%.
- **Undisbursed funds:** Over 90% of allocated funding remains undisbursed as of 2024, indicating significant bottlenecks.
- **Scale of investments needed:** GH2 megaprojects often exceed $1 billion, facing high risk due to regulatory gaps and limited technical capacity.
- **Low FID rates:** Few large-scale African hydrogen projects have reached final investment decision (FID) stage.
- Blended finance emergence: Blended finance models are gaining traction to derisk projects and mobilize capital.
- **Flagship examples:** Namibia's SDG Namibia One Fund and South Africa's SA-H2 Fund each aim to mobilize $1 billion in investments.
- **Project management daps:** Technical and project management capacity constraints continue to hinder disbursement and execution.
- **Private capital mobilisation:** Risk mitigation tools and guarantees are essential to attract more private sector investment.
- **Alignment with global models:** Africa's financing strategies must integrate lessons from global models like H2Global and the IRA (USA).

10. Sustainability Considerations in Africa

Sustainability Considerations in Africa

Hydrogen production presents significant opportunities for Africa in industrial development, energy transition, and integration into emerging global markets. However, for GH2/PtX products to be considered truly "green," they must meet specific sustainability criteria. Various jurisdictions have established or are in the process of defining comprehensive standards that PtX producers must comply with to access these markets. These regulations, as briefly mentioned in Section 2.2.1., could significantly impact hydrogen production in Africa. The following section summarizes the current sustainability requirements for exporting GH2/PtX to the EU, Japan, and South Korea, which may shape production practices in Africa. While no globally harmonized PtX regulations exist, key criteria across different frameworks include the source of electricity, embedded greenhouse gas emissions, eligible carbon sources, water and land use considerations, and socio-economic factors.

10.1 Electricity Supply and feedstock

The quality of GH2/PtX is primarily a function of the quality of the electricity source used for its production. To ensure that the electricity used does not interfere with the existing power system and does not result in any competition between existing renewable electricity demands, various jurisdictions have set requirements that the electricity fed to the electrolyser must meet. In the EU area, for instance, the criteria for the production and use of PtX or renewable liquid and gaseous transport fuels of non-biological origin (RFNBO [16]) are stipulated in the **RE Directive II (RED II)**. The Directive RED II is supplemented by **Delegated Acts (DAs)** that set the rules for PtX production and specify the methodology to assess GHG emission from the production of PtX.

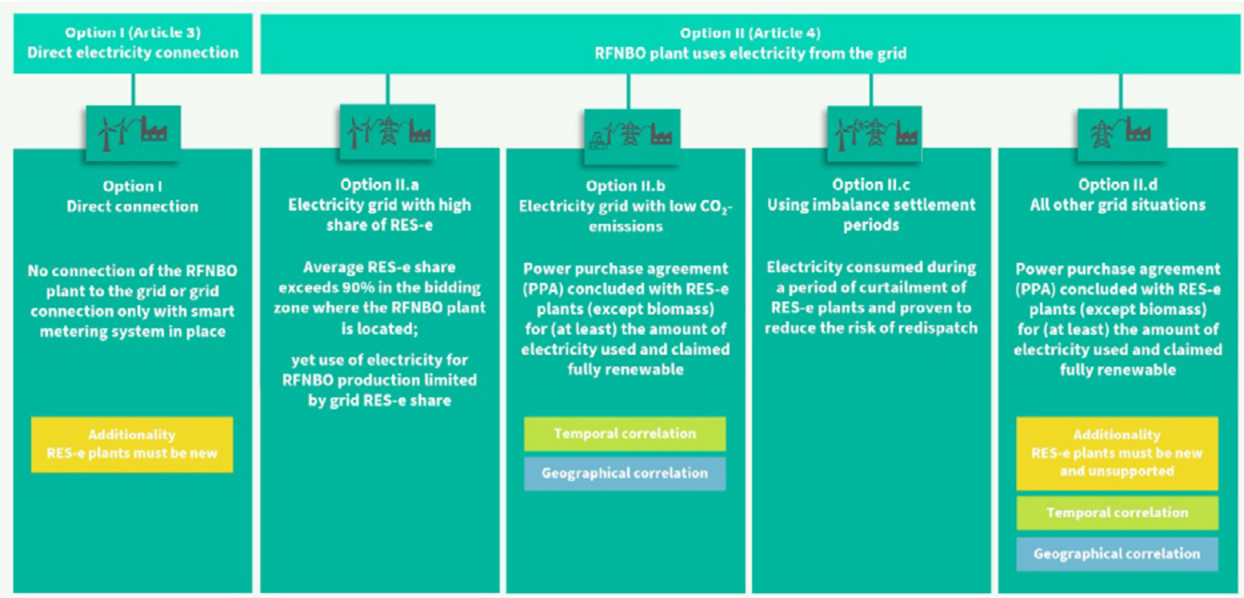
Key consideration for the electricity supplied to the electrolyser include:

- **Additionality:** the RE generation plant must be new (i.e., the plant came into operation no earlier than 36 months before the GH2/PtX plant) and unsupported, meaning that the RE generation plant has not received any operating or investment support.
- **Geographic correlation:** the location of the electrolyser and the RE installation supplying electricity to the electrolyser.
- **Temporal correlation:** the timeframe in which the RE plant's output and electrolyser power consumption need to match.

The figure below presents different conditions under which the consumed power by counts as RE.

16 In this report, the term "RFNBO" is used interchangeably with the term "GH2/PtX"

Figure 37: RE power supply requirements for GH2 production in the EU



Source: PtX Hub (2023)

Unlike EU, the Korean government considers „Clean Hydrogen“, to include hydrogen based on fossil fuels. The government's current draft for the Clean Hydrogen Certification System differentiates four tiers of clean hydrogen (Jeong, 2023):

- Tier 1 (≤0.1 kg CO_2eq/kgH2): domestic and overseas GH2 (100% RE for GH2 production).
- Tier 2 (0.1 – 1 kg CO_2eq/kgH2): domestic and overseas nuclear-produced hydrogen, and overseas GH2 utilising some grid power for hydrogen production (Some power mix utilisation for system stabilisation).
- Tier 3 (1 – 2 kgCO_2eq/kgH2): blue hydrogen from Piped Natural Gas (PNG) with 90%+ carbon capture and with other additional emissions reductions (reduction from raw material production, use of low-carbon electricity).
- Tier 4 (2 – 4 kgCO_2eq/kgH2): blue hydrogen produced with 90%+ carbon capture (utilising average gas field + grid power).

It is important to note that the above thresholds are currently exclusive of emissions from shipping, potential ammonia synthesis and cracking as well as the handling of carbon captured during a CCS process (Argus, 2023).

Similar to South Korea, Japan is also pursuing a clean hydrogen approach that is not linked to any particular production technology. By April 2024, Japan had neither a national certification scheme, nor a definition of clean hydrogen. However, a government committee has been created to establish a standard and certification scheme in Japan. By the end of 2023, Japan was still discussing both the establishment of a precise definition of clean hydrogen as well as the introduction of a certification and monitoring system (adelphi, 2023). The Aichi Prefecture was the only region in Japan which certifies GH2. The certification scheme, established in 2018, defines GH2 as hydrogen produced from dedicated RE installation or grid electricity accompanied by RE certificates. This scheme requires compliance with additionality criteria, meaning that renewable electricity installations that will be used for hydrogen production should be new or unused (dena, 2022).

10.2 Greenhouse gas threshold

GHG emissions resulting from the production of PtX have to fall within allowable limits. The allowable GHG emissions, GHG emission calculation methodologies and baselines vary from sector to sector and from jurisdiction to jurisdiction as shown in the below table.

Table 30: GHG emission reduction targets by regulatory frameworks and standards

Regulation / standard	Sector	Hydrogen type	Reduction target (%)	Reference baseline (gco2eq/ MJ) [17]	Threshold (gco2/ MJ)	Legal status	System boundaries
CertifHy (EU)	Transport	H2 from RE sources	60	91	36.4	Voluntary Scheme [18]	Well-to-Wheel [19]
LCFS [20] (USA)	Transport	H2 from water electrolysis & biomass	20	94	76.1	Regulatory framework	Well-to-Wheel
RED II (EU)	Transport	H2 from RE sources	70	94	28.2	Regulatory framework	Well-to-Wheel
RTFO (UK)	Transport	H2 (excl. biomass)	65	94	32.9	Regulatory framework	Well-to-Wheel
Germany	Transport	H2 (excl. electrolysis)	60	94 (Fossil fuels)	37.6	Voluntary Scheme	Well-to-Gate [21]
	All, except transport	H2 (excl. electrolysis)	60	89.7 (GrH2GrH2)	35.9	Voluntary Scheme	Well-to-Gate
	All	H2 from electrolysis	75	Fossil fuel/ GrH2 (depending on application)	23.5 – 22.42	Voluntary Scheme	Well-to-Gate

Source: (dena, 2022, pp. 25-26) and (UK Department of Transport, 2022)

17 To convert g CO_2eq/MJ into kg CO_2eq/kg H_2, the g CO_2eq/MJ value must be MULTIPLIED by hydrogen‘s lower heating value (LHV) of 120 MJ/kg H_2 to get g CO_2eq/kg H_2, then divided by 1000 to get kg CO_2eq/kg H_2.

18 Certification schemes that are officially recognized by the EC to mirror the requirements set by RED II

19 Well-to-Wheel system: from the electricity input to H2 usage (includes H2 transportation and distribution)

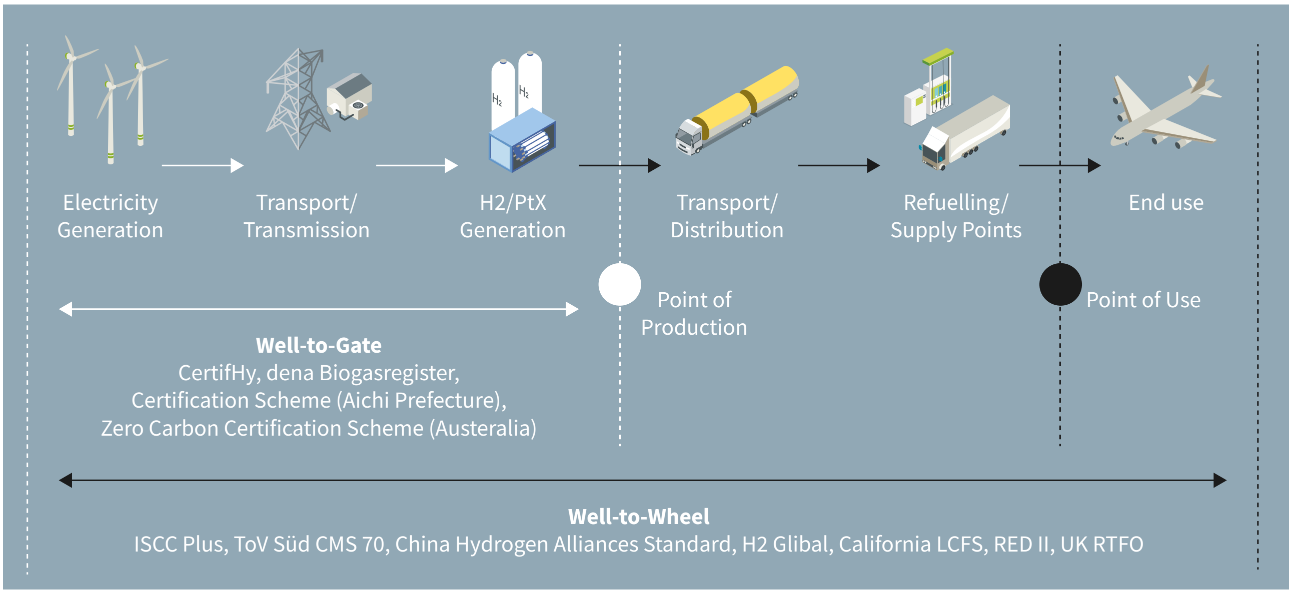
20 Low-carbon fuel standard

21 Well-to-Gate system: from the electricity input to output point of H2 production (excludes H2 transportation and distribution)

As it can be noticed from the above table, different certification schemes have different boundaries, which makes their harmonisation very challenging. While Dena Biogasregister, CertifHy and Zero Carbon Certification Scheme cover GHG system boundaries from Well-to-Gate, the RED II methodology, the Swiss MinöStV, RTFO (Renewable Transport Fuel Obligation), California LCFS, and TÜV Süd CMS 70 cover the system boundaries from the electricity input to hydrogen usage (Well-to-Wheel).

The below figure illustrates GHG accounting system boundaries for different certification schemes.

Figure 38: Carbon accounting system boundaries



Considering the anticipated global trade of GH2 and PtX products, there is a need for international consensus on GHG accounting standards concerning GH2/PtX production and distribution throughout the supply chain. To address this, the International Partnership for Hydrogen and Fuel Cells in the Economy (IPHE) has established a Hydrogen Production Analysis Task Force (H2PA TF) tasked with developing a methodology and analytical framework for assessing the GHG emissions associated with hydrogen production. While this methodology could form the basis of a certification program, it will not offer guidance on proposed GHG emissions intensity threshold values. Determining such thresholds will remain the responsibility of individual countries, although establishing common terminologies and thresholds could facilitate international GH2/PtX trade.

10.3 Carbon sources

CO_2 is necessary to synthesise hydrocarbon-based PtX products such as e-methanol, e-ethanol, e-kerosene, e-diesel, etc. To ensure that the production of these products do not lead to an increase in GHG emissions, different jurisdictions have set / are setting maximum threshold for GHG emissions savings. In the EU area, for instance, the threshold is set at least 70%, and Clause 11 of the Delegated Act (DA) to RED II Article 28(5) lists the following CO_2 sources as having the potential to reduce GHG emissions embedded in the PtX products:

- CO_2 captured from an activity listed in Annex I of Directive 2003/87/EC[22], which has been taken into account upstream in an effective carbon pricing and is incorporated in the chemical composition of the fuel before 2036, or.

22 https://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX:02003L0087-20230301&from=EN#tocId69

- CO_2 captured from the air using the emerging technology known as Direct Air Capture (DAC[23]), or.
- CO_2 captured from the production or combustion of biofuels, bioliquids or biomass fuels complying with the sustainability and GHG saving criteria, and the CO_2 capture did not receive credits for emission savings from CO_2 capture and replacement, set out in Annex V and VI of Directive (EU) 2018/2001, or.
- CO_2 captured from a geological CO_2 source where the CO_2 is being released naturally, with the exception of captured CO_2 stemming from a fuel that is deliberately combusted for the specific purpose of producing the CO_2, and CO_2 whose capture has received an emissions credit under other provisions of the law."

10.4 Other criteria

- **Criteria on water:** to avoid that hydrogen projects impair water quality and lead to any water scarcity, an environment and social impact assessment (ESIA) of water supply must be carried out, including water availability and scarcity as well as a water management plan. Article 30(4) of RED II highlights that national or international schemes setting standards for the production of GH2/PtX should contain accurate information on measures taken for the avoidance of excessive water consumption in areas where water is scarce. Ensuring the sustainability of water is also one of the key sustainability criteria to adhere to when applying for H2Global funding support (BMWK, 2022).
- **Land use criteria:** Article 30(4) of RED II requires a proof of measures taken for the restoration of degraded land and for certification of biofuels, bioliquids and biomass fuels with low indirect land-use change-risk. The German H2Global mechanism rules out forced resettlement and illegal land grabbing, as applicants/bidders must attest existence of contracts/records of land ownership or lease as well as records of stakeholder consultation.
- **Socio-economic impacts:** the development of hydrogen-related projects will lead to positive and negative impacts to the local people and their livelihoods such as local employment, health, and consumer choice, among others. In the EU, criteria covering the social impact are only implemented on a voluntary basis (dena, 2022), while the H2Global mechanism requires GH2 projects to comply with International Labour Organisation (ILO) standards, among others.

Summary insights

- **Electricity Supply & Feedstock:** Projects must use additional RE sources, not displace existing supply.
- **Water Use:** Water availability is critical; projects in arid zones should use desalination or non-potable water sources.
- **GHG Thresholds**: Projects must meet international lifecycle emissions standards, e.g., EU RED II.
- **Carbon Source Considerations:** CO_2 should be from biogenic or DAC sources to qualify as green.
- **Certification Readiness:** Prepare for certification schemes (e.g., H2Global, CertifHy) with robust emissions and sustainability reporting.
- **Land & Social Safeguards:** Ensure inclusive land-use agreements and avoid displacement or land grabbing.
- **Community Engagement:** Obtain FPIC from local communities.
- **Social & Environmental Impact:** Conduct thorough ESIAs before construction.
- **Safeguard Standards Alignment:** Align with IFC, World Bank, and AfDB safeguard standards for better funding access.

23 DAC technologies extract CO2 directly from the atmosphere.

11. Key Recommendations

Africa's diverse resources, infrastructure levels, and policies mean that working together regionally can lower costs, create synergies, and support shared growth. This section presents actionable recommendations to support regional collaboration, with the aim of positioning Africa as a competitive player in the global GH2 (GH2) market while promoting sustainable and inclusive development.

It is important to note that the African Union (AU) has formally adopted the African Green Hydrogen Strategy and Action Plan, marking a significant milestone in the continent's pursuit of sustainable energy solutions and economic transformation. This strategy was endorsed during the 38th AU Summit in February 2025, after being approved by African ministers of transport and energy in December 2024. The strategy's objective is to position Africa as a global leader in the GH2 economy by capitalizing on its abundant RE resources, mainly solar and wind power.

At the time of writing this report, however, the strategy had not yet been made publicly available; therefore, it is possible that some of the recommendations presented here may have already been addressed within the strategy itself.

11.1 Establish regional GH2 corridors

From a geographic perspective, Africa's diversity presents both opportunities and challenges for the development of a continent-wide GH2 economy. While some countries possess superior RE resources, others have high industrial demand or strategic access to ports. A corridor-based approach to GH2 development would allow for the optimal use of these complementary assets, enabling economies of scale and enhancing the overall competitiveness of the continent.

By establishing regional GH2 corridors, African nations can benefit from shared resources, joint investments, and an integrated market that fosters the development of a thriving, continent-wide GH2 economy. These corridors would connect RE-rich regions with industrial hubs, trade ports, and regional demand centres, creating an interconnected, efficient, and scalable infrastructure for GH2 production and trade. The corridor-based approach not only facilitates the internal African GH2 market but also opens up export opportunities, positioning Africa as a major player in the global GH2 economy. A compelling example of such an initiative is the planned GH2 pipeline traversing the Western Cape and Northern Cape in South Africa and extending into southern Namibia. This project exemplifies how a corridor can align abundant solar and wind resources with port access and industrial potential, reinforcing the feasibility of cross-border GH2 infrastructure.

The first step in establishing GH2 corridors would be to conduct comprehensive joint feasibility studies to identify the most suitable zones for GH2 production across the continent. These studies should assess RE resources, infrastructure availability, industrial demand, and logistical considerations for efficient transport and distribution. Then, pilot GH2 corridors can be established within specific regional economic communities (RECs). These pilot projects will serve as proof of concept and provide valuable insights into the challenges and opportunities of cross-border GH2 trade and infrastructure integration. Finally, the development of cross-border pipelines and transmission lines would follow to enable the efficient transport of GH2 from production sites to demand centres and export terminals.

11.2 Harmonise regulatory frameworks across regional blocs

The establishment of GH2 markets across Africa faces a significant challenge due to the inexistence and lack of harmonised regulations between nations. Differing national standards can create barriers to trade, complicate project development, and increase costs, ultimately hindering the continent's progress toward a sustainable GH2 economy. These inconsistencies often discourage international investors and slow down the implementation of GH2 projects.

By developing unified regulations, Africa can create a conducive environment for seamless GH2 trade, attract international investment, and ensure the safe and efficient production, transport, and consumption of GH2. A harmonised regulatory framework will lower entry barriers for new businesses and promote cross-border collaboration, making Africa a more attractive hub for GH2 investments. Furthermore, a uniform regulatory approach will also promote safety and quality assurance across the industry.

By adopting common standards, African countries can ensure that GH2 production and its associated infrastructure meet internationally recognised levels of quality, safety, and environmental sustainability. Furthermore, standardisation can facilitate easier integration with global markets, enhancing Africa's competitiveness on the international stage. This can be achieved by each REC setting up a Regional Hydrogen Task Force to lead the process of harmonising regulations across member states. These task forces will play a central role in developing/updating the technical standards, safety protocols, and certification schemes needed for GH2 production, transportation, and trade.

In line with the "African Green Hydrogen Strategy and Action Plan", the Hydrogen Task Forces would operate under and collaborate closely with the African Union Commission and the African Continental Free Trade Area (AfCFTA) Secretariat to Develop Continental Certification and Traceability Standards in order to facilitate intra-continental trade and ensure consistent quality. These standards will allow African countries to certify that their hydrogen meets agreed-upon criteria, which is essential for the development of a unified market across the continent.

To position Africa among global leaders in GH2, it is also essential to align African standards with international norms. Engaging with international organisations such as the European Union (EU), the International Energy Agency (IEA), and the International Organization for Standardization (ISO) will allow African countries to harmonize their regulations with global best practices and ensure that their GH2 industry can integrate smoothly with the global market. A compelling example of this approach is the EU–Namibia strategic partnership, signed in November 2022. The agreement focuses on developing sustainable raw materials and GH2 value chains, with a strong emphasis on aligning Namibia's GH2 with EU standards. This cooperation positions Namibia to supply certified GH2 to the European market while simultaneously advancing its own economic development and industrialization goals.

11.3 Create a continental GH2 infrastructure plan

Another key challenge to the development of a GH2 economy in Africa is the infrastructure gap. The successful production, storage, transport, and trade of GH2 depend on robust, interconnected infrastructure. However, many African countries currently lack the necessary infrastructure for large-scale GH2 production, distribution, and export. By creating a continental GH2 infrastructure plan, Africa can address these gaps, reduce redundancy in infrastructure development, and ensure that investments are aligned with long-term demand.

A unified plan will also enhance Africa's readiness to export GH2 to global markets, positioning the continent as a competitive player in the international GH2 economy. Furthermore, coordinated infrastructure development will promote regional integration, improve energy access, and contribute to sustainable development across the continent. The plan would focus on identifying key infrastructure needs, prioritising investment in strategic projects, and ensuring that infrastructure development aligns with regional and continental energy goals. This includes both the physical assets (e.g., pipelines, storage facilities, transport systems) and the necessary policy frameworks that support cross-border cooperation and long-term planning.

The first step in creating a comprehensive infrastructure plan is to conduct an assessment of the current infrastructure landscape across Africa, identifying existing assets and infrastructure gaps. This mapping exercise should cover

RE generation, power and gas transport and distribution networks, storage, refuelling infrastructure and water desalination requirements, as well as general connective infrastructure such as roads, railways, and ports. Moreover, it should examine the availability of education and training facilities needed to build a skilled workforce, and review existing or planned infrastructure near urban centres or industrial zones where GH2 projects are being considered. A holistic approach will ensure that GH_2 infrastructure development is not only technically viable but also socially and economically integrated into the broader development context. Results from this assessment would form the basis of the GH2 infrastructure master plan. As highlighted above, this may have been considered in the African Green Hydrogen Strategy and Action Plan.

11.4 Develop regional financial instruments and risk mitigation mechanisms

The development of large-scale GH2 projects is capital-intensive and involves significant risks, including political instability, regulatory uncertainty, and market volatility. These risks can deter private sector investment, which is crucial for scaling up the GH2 sector. To attract private capital and ensure the viability of GH2 projects, it is necessary to develop financial instruments and risk mitigation mechanisms that can de-risk investments and make them more attractive to investors.

By pooling resources at the regional level, Africa can enhance the creditworthiness of projects, improve their financial sustainability, and enable access to international capital markets. Additionally, regional financial instruments will facilitate the efficient allocation of resources, enhance the development of GH2 projects across multiple countries, and provide consistent support for large-scale infrastructure investments. A combination of blended finance facilities, risk guarantees, and innovative financial mechanisms, such as green bonds and carbon credit markets, can help unlock the financing needed for GH2 projects while addressing the unique challenges of the sector.

To accelerate the development of GH2 across Africa, the establishment of a Green Hydrogen Development Fund under the African Development Bank (AfDB) could be highly instrumental. This fund would pool resources from RECs and sovereign wealth funds to provide concessional loans, grants, and equity for GH2 infrastructure, including RE, storage, and transport systems. The fund's blended finance approach would reduce capital costs and incentivize project development.

In addition, the establishment of regional guarantees and insurance schemes is crucial to mitigate perceived political and regulatory risks. These should include political risk insurance to safeguard investors from instability and expropriation, as well as regulatory guarantees to protect them from sudden policy changes. Furthermore, Public-Private Partnerships (PPPs) should be encouraged and promoted in the development of these guarantees, with the public sector underwriting part of the risk to reduce private sector exposure, thereby increasing investment willingness in large-scale GH2 projects. One example of a strategic risk-sharing framework relevant in this context is Chile's US$1 billion Green Hydrogen Facility, designed to accelerate domestic GH_2 development by de-risking investments, mobilizing private finance, and enhancing the enabling environment to strengthen global competitiveness. This underscores the need for Africa to establish similar regional risk-sharing mechanisms and public-private investment frameworks to unlock large-scale green hydrogen investment and enhance the continent's global competitiveness.

11.5 Foster cross-border industrial clusters and value chains

The establishment of cross-border industrial clusters is a strategic approach to maximizing the potential of GH2 production and its associated industries. Africa's diverse resource endowments, including abundant RE resources in certain regions and manufacturing capabilities in others, present an opportunity to build integrated value chains. By creating industrial clusters that span national borders, Africa can exploit these complementary strengths, reduce input costs, improve the efficiency of production processes, localize technology manufacturing, and boost competitiveness in the global market. Such clusters would also foster innovation, encourage knowledge-sharing, and create synergies that facilitate the growth of GH2 and its associated industries (e.g., ammonia, e-methanol, electrolyser production).

Developing industrial hubs that focus on GH2 will also enable African nations to capture a larger share of the global value chain by fostering local manufacturing of critical components (such as electrolysers, batteries and solar panels) and value-added products (such as ammonia or synthetic fuels). Furthermore, by creating interconnected, cross-border value chains, Africa can attract significant investments, create jobs, and strengthen regional economic integration.

To develop cross-border industrial clusters for GH2, it is essential to first identify opportunities for regional production of key GH2 inputs and derivatives. This includes evaluating the feasibility of manufacturing key equipment such as electrolysers and solar panels in countries with industrial capabilities, while leveraging renewable-rich regions for GH2 production. In parallel, nations with access to existing infrastructure could initiate production of PtX products, leveraging on existing assets. In this regard, a value chain analysis will be crucial to determine the most efficient locations for various components and ensure supply chain integration from RE generation to export.

To support these efforts, governments should establish SEZs, such as those in countries like Kenya and South Africa, linked by strategic transport corridors and harmonized customs frameworks to promote the efficient cross-border movement of materials and products. These SEZs would house GH2-related industries and facilitate logistics through pipelines, rail, and highways. Additionally, fostering cross-border joint ventures and technology transfer partnerships with international firms will drive innovation and capacity building. Joint ventures and PPPs can provide African companies with access to capital, advanced technologies, and international markets, while technology transfer initiatives will help develop local manufacturing and technical expertise, securing long-term sustainability of the continent's GH2 industry.

11.6 Establish a Pan-African GH2 knowledge and innovation hub

To enable Africa's GH2 sector to thrive, there is a pressing need for targeted technological solutions and coordinated research efforts to address the continent's unique challenges. A continental GH2 knowledge and innovation hub can provide a central platform for research, innovation, and collaboration among academia, industry, and government entities. This hub would serve as a collaborative space for researchers, start-ups, and technology developers to share knowledge, develop new technologies, and solve critical problems in the GH2 value chain.

The establishment of this hub would foster innovation by concentrating efforts in areas where Africa can have a competitive advantage, such as in developing water-efficient electrolysis technologies, optimizing storage solutions, and improving the integration of hydrogen with RE grids. Additionally, it will provide an avenue for Africa to develop homegrown technological solutions that meet local challenges while promoting sustainable development.

The establishment of this hub would begin with mapping existing research institutions, universities, and innovation centres across Africa, creating a network that connects them with global R&D partners. This ecosystem will serve as the foundation for ongoing research into critical areas such as cost-reduction technologies for hydrogen production, energy storage, and transportation systems. Additionally, the hub would provide programs and funding opportunities to stimulate innovation, support entrepreneurs, and promote cross-border collaborations. Africa's GH2 sector will greatly benefit from the development of context-relevant solutions that can be scaled across different countries and regions, driving economic growth and technological advancement. The establishment of a Pan-African GH2 knowledge and innovation hub could, for example, take inspiration from the Green Hydrogen Innovation Centre (GHIC) of the International Solar Alliance, which serves as a global platform to connect experts, support startups, and accelerate innovation through training and knowledge sharing.

11.7 Coordinate talent development and workforce mobility

A skilled and adaptable workforce is vital for the growth of Africa's GH2 sector. To meet the rising demand for skilled professionals across various segments of the GH2 economy (from R&D to construction, operations, and maintenance), Africa should ensure the development of a high-quality workforce. Additionally, the free movement of skilled labour across borders will be key to realizing the continent's GH2 potential. Efforts to train, certify, and retain skilled labour should be integrated with the AfCFTA to foster workforce mobility and ease labour market integration.

To address these needs, a coordinated talent development strategy must be designed to enhance both the quantity and quality of the workforce. Standardized technical training programs and certification schemes should be implemented to provide relevant skills in GH2 technology, green energy systems, and related industries. Aligning these programs with industry needs will ensure that the workforce is capable of meeting the demands of a growing GH2 sector.

This strategy should begin with the development of a standardized curriculum for technical and vocational education and training (TVET) institutions. This curriculum should focus on emerging fields such as electrolysis technology, RE systems, hydrogen storage solutions, and fuel cells. Regional and continental training hubs can also be established to provide specialized education in GH2 technologies, supported by public and private sector partnerships. Furthermore, a mutual recognition framework for certifications and qualifications under AfCFTA would promote the mobility of skilled workers, helping to address labour shortages in high-demand regions.

Regional collaborations and exchange programs can also be promoted to increase workforce mobility, allowing professionals from across Africa to work on projects in different countries and gain practical experience. Training programs should focus on not only technical skills but also leadership and entrepreneurship, ensuring that Africa has the management talent required to guide GH2 projects to success.

11.8 Align national and regional strategies with continental and global climate goals

Fragmented strategies at the national and regional levels could undermine Africa's collective ability to transition to a GH2 economy. To optimise the potential of GH2 for sustainable development, it is crucial to align national and regional strategies with continental frameworks, such as Agenda 2063 and the African Green Stimulus Programme, as well as the global climate goals outlined in the Paris Agreement. This alignment will ensure that Africa's GH2 projects are harmonized with broader goals, such as reducing carbon emissions, improving energy access, and fostering economic development. Furthermore, aligning strategies will enhance the continent‘s negotiating position in international climate discussions and improve access to climate financing.

To achieve this alignment, governments and regional organisations should carry out joint assessments to identify the potential role of GH2 in advancing low-carbon development across key sectors such as energy, transport, and industry. A comprehensive continental hydrogen roadmap should be developed, outlining a shared vision and action plan for realizing the full potential of GH2 across Africa. This roadmap should emphasize the integration of GH2 into national energy systems, the decarbonisation of hard-to-abate sectors, and the promotion of circular economies.

The AUC could lead the development of the roadmap, drawing on the expertise and leadership of countries like South Africa, Morocco, and Kenya. With their ambitious climate commitments, established green hydrogen initiatives, and robust institutional frameworks, these countries are well-positioned to provide valuable input and serve as regional champions for strategic alignment, policy harmonization, and knowledge sharing across the continent.

A comprehensive monitoring, reporting, and verification system should be established at the continental level to evaluate progress toward climate goals, measure how GH2 projects contribute to key Sustainable Development Goals such as energy access, job creation, and climate action, and support consistent reporting to ensure transparency and accountability across national, regional, and continental levels.

11.9 Jointly Implement Environmental and Social Safeguards

As many GH_2 projects will span multiple countries, it is crucial that all stakeholders adhere to common environmental and social sustainability standards to prevent conflicts, ensure alignment with global sustainability goals, and maintain the social license to operate. A coordinated approach will foster trust among stakeholders, communities, and investors, reducing the risk of protests, opposition, and project delays. To achieve this, shared Environmental, Social, and Governance (ESG) guidelines and social impact assessment tools should be developed and implemented for GH_2 projects across Africa.

The AU should lead the development of a regional ESG framework that outlines common principles for GH2 projects. This framework will cover key areas such as land acquisition, water management, environmental preservation, labor standards, community relations, and equitable benefit-sharing. It must be flexible enough to accommodate Africa‘s diverse contexts while aligning with international standards like the United Nations Sustainable Development Goals (SDGs) and the Paris Agreement. The AU could also facilitate the creation of a regional ESG certification program to verify that GH_2 projects meet sustainability standards, enhancing investor confidence and attracting funding from sustainability-focused sources.

In addition to the ESG framework, robust community engagement strategies must be integrated into all cross-border GH_2 projects. Local communities, often directly impacted by these developments, should be involved early in the planning process through public consultations and grievance mechanisms. Encouraging community participation—via job creation, skills training, and economic opportunities—will build stronger support for projects and reduce opposition. Addressing social risks such as displacement and livelihood loss with mitigation plans and compensation will ensure that the benefits of GH2 projects are distributed equitably and adverse effects are minimized. Advanced technologies like satellite imagery and AI should be employed to monitor land use, water stress, and biodiversity impacts in real time, ensuring that projects avoid ecologically sensitive areas and use resources sustainably. This data can be integrated into a regional monitoring system to ensure continuous oversight and quick responses to environmental challenges.

11.10 Promote diplomatic coordination and global advocacy

To fully capitalize on the opportunities in the global GH2 market, Africa should pursue diplomatic collaboration to influence the development of international hydrogen trade and certification standards, secure favourable trade agreements, and advocate for greater access to global technologies and financing mechanisms. As GH2 becomes an increasingly important part of the global energy transition, it is essential for African countries to present a united position in international forums. Through strategic diplomatic coordination, the continent can ensure that its interests are represented and that it gains meaningful access to the global GH2 supply chain.

As a foundational move in this diplomatic effort, a Pan-African Green Hydrogen Diplomacy Group should be established, bringing together representatives from the African Union, Regional Economic Communities, national governments, and the private sector. This group would coordinate Africa‘s participation in global hydrogen discussions and engage actively in key international forums such as the COP climate talks, the G20, and the IPHE. Through proactive involvement in shaping international policy and trade frameworks, Africa can secure favourable terms for GH2 exports and ensure its GH2 is recognized as both credible and market-ready.

In addition to shaping global policy, Africa should pursue preferential trade agreements with key hydrogen importers such as the European Union, Gulf Cooperation Council, and Asia-Pacific countries. These agreements would aim to secure long-term off-take arrangements, reduce trade barriers, and promote equitable access to global hydrogen markets. Moreover, Africa can play an active role in advocating for the creation of international certification systems that align with its GH2 standards, enabling producers on the continent to meet global expectations for traceability, carbon footprint reduction, and quality assurance.

Overall, the recommendations outlined above reflect the need for a comprehensive and coordinated approach to unlock the full potential of GH2 in Africa. From creating knowledge hubs and developing skilled talent to aligning national and regional strategies with global climate objectives, each measure represents a vital step toward building a sustainable and inclusive GH2 economy. Africa’s abundant renewable resources and strategic geographic position offer a strong foundation for becoming a global leader in GH2 production and export, while simultaneously advancing domestic energy access and climate resilience.

Achieving these ambitions will require close collaboration among African nations, supported by strategic partnerships with the international community. Success depends on harmonized policy frameworks, strengthened cross-border cooperation, and the effective mobilization of both public and private investments. By actively implementing these recommendations, Africa can harness the opportunity to lead a GH2 revolution that promotes economic growth, stimulates innovation, generates jobs, and places the continent at the forefront of the global clean energy transition.

12. Conclusion

Africa is poised to seize a transformative opportunity by leveraging its abundant RE resources for large-scale GH2 production and use. This report has demonstrated Africa's potential to emerge as a global GH2 leader while simultaneously addressing domestic development priorities including industrial decarbonisation, energy security, job creation, and regional integration.

The analysis yields the following key findings and insights:

- **Global trends and national alignment:** Africa's GH2 ambitions align with global decarbonisation goals and emerging international hydrogen markets. The continent is already engaged through strategic partnerships and policy commitments across various nations including South Africa, Morocco, Egypt, Namibia, and Kenya.
- **Diverse national strategies:** countries are adopting differentiated approaches based on local strengths, with North Africa emphasizing industrial exports, East Africa prioritising fertiliser production and energy imports substitution, while Southern and West Africa focusing on mining, infrastructure synergies, and regional integration.
- **Value chain development:** Africa's GH2 value chain is expanding, with increasing electrolyser capacity, growing project pipelines, and rising investments. Still, integration across the value chain, from upstream production to downstream applications, requires greater institutional capacity and coordination.
- **Domestic market potential:** beyond exports, domestic hydrogen markets offer substantial socio-economic and environmental benefits. Applications include fertilisers, green ammonia, industrial applications, and heavy-duty transport. These uses support agricultural productivity, import substitution, emissions reduction, and rural development.
- **Critical raw materials and innovation:** Africa possesses many critical minerals essential for GH2 technologies. However, the continent remains a technology taker rather than an innovator, necessitating investments in local research, technological adaptation, and manufacturing capacity.
- **Institutional and regulatory gaps:** the development of GH2 is constrained by policy uncertainty, weak institutional capacity, limited infrastructure, and fragmented regulatory frameworks. Capacity building in government institutions, clear regulatory environments, and enabling investment frameworks are prerequisites for long-term success.

Key strategic recommendations for stakeholders include:

- **Develop integrated regional GH2 corridors and harmonized regulatory frameworks**
  Africa should build cross-border GH2 corridors that connect renewable-rich regions with industrial hubs and export ports. This requires joint feasibility studies, infrastructure master planning, and harmonized technical and safety standards across countries. Regional Hydrogen Task Forces can guide alignment, while coordination with the African Union and AfCFTA will help establish a unified, trade-ready hydrogen market.

- **Mobilise regional financing and de-risk investments to scale GH2 infrastructure**
  Establishing a Green Hydrogen Development Fund under the AfDB, coupled with blended finance tools, risk guarantees, and green bonds, can attract private investment for large-scale GH2 projects. Pooling resources at the regional level will enhance project bankability and financial resilience, while enabling strategic infrastructure and value chain development across borders.

- **Foster industrial clusters, local innovation, and a skilled GH2 workforce**
  Africa should promote GH2-linked industrial zones and value chains through SEZs, technology transfer, and local manufacturing of electrolysers and PtX products. A Pan-African GH2 knowledge and innovation hub should drive R&D, while harmonized TVET programs and mutual recognition of certifications will build a mobile, technically skilled workforce ready to meet the sector‘s demands.

In summary, the GH2 sector offers Africa a rare dual opportunity: to secure a strong position in the global hydrogen market while driving inclusive, low-carbon economic growth. Realising this vision will require strategic, coordinated efforts across governments, the private sector, and international partners. With the right investments, policies, and partnerships, Africa can emerge as a resilient and sustainable hub for GH2 innovation. With this approach, the continent can ignite a new era of clean energy development, delivering enduring economic and environmental benefits for future generations.

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14. Appendices

14.1 Appendix 1: List of African GH2 project as of October 2024

NO.	PROJECT NAME	COUNTRY	STATUS	PRODUCT	ANNOUNCED SIZE	CAPACITY (MWEL)	CAPACITY (KT H2/ YEAR)
1	EBIC - Ammonia plant -phase 1	Egypt	Operational	Ammonia	15MW	15	2.2
2	Cleanergy Solutions Namibia HRS	Namibia	Operational	H2	5MW	5.0	0.7
3	Anglo-American Mogalakwena mine	South Africa	Operational	H2	3.5MW	3.5	0.6
4	OCP Group demo project	Morocco	FID/ Construction	Ammonia	4t NH3/day		
5	O&L group - CMB.TECH hydrogen hub	Namibia	FID/ Construction	H2	4MW	4	0.7
6	Daures Green Hydrogen Village, phase 1	Namibia	FID/ Construction	Ammonia	0.25 MW - 18 t h2/y - 100 t NH3/y	0.25	0.043
7	Oshivela DRI project, phase 1	Namibia	FID/ Construction	H2	15 kt DRI/y (production)	12.0	2.0
8	Sasolburg GH2 project (existing electrolysers to be powered with renewables)	South Africa	FID/ Construction	H2	60MW	60	10.2
9	Sonangol	Angola	Feasibility study	Ammonia	400MW or 280 kt Nh3/y	400	69.3
10	Capanda Green Ammonia	Angola	Feasibility study	Ammonia	112 kt NH3/y	204.2	35
11	Lesedi Power Project	Botswana	Feasibility study	H2			
12	Votalia - Taqa Arabia -phase 1	Egypt	Feasibility study	H2	500MW	500	86.6
13	Ain Sokhna plant, Suez Canal Economic Zone (SCZone), phase 1	Egypt	Feasibility study	Ammonia	140kt NH3/y using 25kt H2/y	288.6	50
14	Ain Sokhna ammonia project - Phase I	Egypt	Feasibility study	Ammonia	500 MW	500	86.6

15	Masdar Hassan Allam GH2, phase 1	Egypt	Feasibility study	MeOH	100 kt MeOH/y	193.7	34
16	Waste-to-hydrogen East Port Said	Egypt	Feasibility study	H2	300 kt H2/y		300
17	Petrofac Ain Sokhna Ammonia project	Egypt	Feasibility study	Ammonia	125 kt NH3/y	259.8	45
18	EBIC - Ammonia plant - phase 2	Egypt	Feasibility study	Ammonia	100MW	85	14.7
19	C2X Green Methanol Plant	Egypt	Feasibility study	MeOH	300 kt MeOH/y	662.6	115
20	HYPORT Gargoub project	Egypt	Feasibility study	Ammonia	500MW	500	86.6
21	Kenya Private Sector Alliance - FFI MoU, phase 1	Kenya	Feasibility study	Ammonia	300MW	300	52.0
22	Kenya Electricity Generating Company pilot shceme	Kenya	Feasibility study	Ammonia	5MW	5	0.9
23	Renewstable Kwale Kenya (RKK)	Kenya	Feasibility study	H2	64MW	64	11.1
24	Renewstable WM1	Kenya	Feasibility study	H2	50MW	50	8.7
25	HEVO-Morocco	Morocco	Feasibility study	Ammonia	31kt H2/y, 183 kt NH3/y	689.2	103.3
26	Masen - KfW	Morocco	Feasibility study	H2	100MW	100	17.3
27	Guelmim-Oued Noun - Chbika project - phase 1	Morocco	Feasibility study	Ammonia	400 Mwel	400	69.3
28	Western Sahara hydrogen project	Morocco	Feasibility study	H2	8GW	8000.0	1386.0
29	Aman - Green Hydrogen Project - phase 1	Mauritania	Feasibility study	Ammonia	2.5GW	2500	433.1
30	Project Nour - Phase 1	Mauritania	Feasibility study	H2	1650 Mwel - 150 kt H2/y	1650	285.9
31	Aman - Green Hydrogen Project - phase 2	Mauritania	Feasibility study	Ammonia	15GW	12500	2165.7
32	Hynfra-MGA Ammonia plant	Mauritania	Feasibility study	Ammonia	120-200 MWel - 100 kt NH3/y	160	27.7
33	Hyphen Hydrogen Energy - phase I	Namibia	Feasibility study	Ammonia	0.7 Mt NH3/y - 120 kt H2/y - 1 GW	1000	173.3
34	Hyphen Hydrogen Energy - phase II	Namibia	Feasibility study	Ammonia	2 Mt NH3/y - 350 kt H2/y - 3GW	2000	346.5

35	Renewstable Swakopmund	Namibia	Feasibility study	H2	24MW	24	4.2
36	Daures Green Hydrogen Village, phase 2	Namibia	Feasibility study	Ammonia	5 MW - .62 kt H2/y - 35 kt NH3/y	4.75	0.8
37	Daures Green Hydrogen Village, phase 3	Namibia	Feasibility study	Ammonia	420 MW- 121 kt H2/y - 352 kt NH3/y	415.25	71.9
38	Oshivela DRI project, phase 2	Namibia	Feasibility study	H2			
39	PV2Fuel	Namibia	Feasibility study	Ammonia	250kt NH3/y	1039.4	180
40	H2Notos- Phase 1	Tunisia	Feasibility study	H2	2 GW - 200 kt H2/y	2000	347
41	Ugandanda H2-based fertiliser project	Uganda	Feasibility study	H2	11.4 kt H2/y	115.4	20
42	Boegoebaai GH2	South Africa	Feasibility study	H2	400kt H2/y	2308.8	400
43	Coega, Nelson Mandela Bay green ammonia plant, phase 1	South Africa	Feasibility study	Ammonia	156kt NH3/y	540.5	93.6
44	Coega, Nelson Mandela Bay green ammonia plant, phase 2	South Africa	Feasibility study	Ammonia	780kt NH3/y	2161.9	374.5
45	Secunda SAF Project - Phase I	South Africa	Feasibility study	Synfuels	15000 t synfuels/y	89.0	15.4
46	Prieska ammonia project, phase 1	South Africa	Feasibility study	Ammonia	72 kt NH3/y - 12.9 kt H2/y	148.9	26
47	Eastern Cape MeOH plant	South Africa	Feasibility study	MeOH	120MW	120	20.8
48	Gaia-H2Pro Project	Morocco	DEMO	H2	10- 20 MW	15	2.6
49	H2 plant at Ironveld's Rustenburg smelter	South Africa	DEMO	H2	5kg H2/h		0.04
50	Grand Inga hydroelectric power project	DRC	Concept	H2			
51	MoU Fortescue Future Industries-Djiboutibouti	Djibouti	Concept	H2		0	
52	MoU CWP - Ministry of Energy and Natural Resources	Djibouti	Concept	H2		0	
53	Amea Power - Ammonia project	Djibouti	Concept	Ammonia	1 GW or 700 kt NH3/y	1000	173
54	Sonatrach - Oran	Algeria	Concept	H2	50MW	50	9.0

55	Ra Green Ammonia project	Egypt	Concept	H2	100-200 MW	150	26.0
56	Ain Sokhna plant, Suez Canal Economic Zone (SCZone), phase 2	Egypt	Concept	Ammonia	350kt NH3/y	432.9	75
57	Masdar Hassan Allam GH2, phase 2	Egypt	Concept	Ammonia	4GW electrolysis, 2.3 Mt NH3/y, 0.48 Mt H2/y	3806.3	659.4
58	ReNew Power - Egypt MoU, Hydrogen, phase 1	Egypt	Concept	H2	20 t H2/y	230.9	40
59	ReNew Power - Egypt MoU, Hydrogen, phase 2	Egypt	Concept	H2	200 kt H2/y	2077.9	360
60	ReNew Power - Egypt MoU, Ammonia phase 1	Egypt	Concept	Ammonia	100 kt NH3/y	207.9	36.0
61	ReNew Power - Egypt MoU, Ammonia phase 2	Egypt	Concept	Ammonia	1.1 Mt NH3/y	2078.7	360.1
62	Scatec e-Methanol - first project	Egypt	Concept	MeOH	60 MW electrolyser - 40 kt MeOH/y	60	10.4
63	Jindal - Suez Canal Economic Zone authority green steel project	Egypt	Concept	H2	5 Mt steel/y	3623.0	628
64	Fortescue Future Industries - Egypt	Egypt	Concept	H2	2.98 GW,330 kt H2/y and 1550kt NH3/y	2980	516.3
65	Votalia - Taqa Arabia -phase 2	Egypt	Concept	H2	1GW	500	86.6
66	ACME SCZONE Green Ammonia Plant	Egypt	Concept	Ammonia	2.2 Mt H2/y	25396.3	4400
67	Globeleq GH2 project, phase 1	Egypt	Concept	Ammonia	100 kt NH3/y	103.9	18
68	Globeleq GH2 project, phase 2	Egypt	Concept	H2	3.6GW	3500	606.4
69	Suez Green Ammonia site	Egypt	Concept	Ammonia	1.2 Mt NH3/y (production)	2494.5	432.2
70	Scatec e-Methanol - second project	Egypt	Concept	MeOH	190MW - 100 kt MeOH/y	190.0	32.9
71	ACWA Power - Green Hydrogen Project	Egypt	Concept	Ammonia	600 kt NH3/y	623.6	108.0
72	Alfanar Egypt	Egypt	Concept	Ammonia	500 kt NH3/y	1039.4	180
73	Actis project	Egypt	Concept	Ammonia	200 kt NH3/y,	415.7	72
74	Ain Sokhna ammonia project - Phase II	Egypt	Concept	Ammonia	1 GW - 800 kt NH3/y	500	86.6

75	Phelan Green Energy - Egypt	Egypt	Concept	Ammonia	2500 kt NH3/y	2598.4	450
76	SMoroccotenergy Green H2 Project	Egypt	Concept	Ammonia	1 GW - 150 kt H2/y - 830 kt NH3/y	1000	173.3
77	SK Ecoplant-CSCEC Consortium Green H2 project	Egypt	Concept	Various	250MW or 50 kt H2/y converted to 250 kt NH3/y	250.0	51.3
78	Abu Qir Fertilisers Green Ammonia Project	Egypt	Concept	Ammonia	2.4 kt NH3/d	910.5	158
79	H2 project - Port of Mombasa	Kenya	Concept	H2	1 GW	1000	173
80	Saipem and Alboran Hydrogen (1 plant)	Morocco	Concept	H2			
81	Amun, phase 1	Morocco	Concept	H2			
82	Amun, phase 2	Morocco	Concept	H2			
83	OCP Group Ammonia project	Morocco	Concept	Ammonia	1 Mt NH3/y	2078.7	360
84	White Dunes - Western Sahara hydrogen project -phase 1	Morocco	Concept	H2	1GW	1000.0	173.3
85	White Dunes - Western Sahara hydrogen project -phase 2	Morocco	Concept	H2	8GW	7000.0	1212.8
86	Gaia-Ajlan Bros Green H2 Project	Morocco	Concept	H2	320 kt H2/y - 1400 kt NH3/y	1847.0	320
87	Dakhla-Atlantic International Green Moleucle Hub	Morocco	Concept	H2			
88	S2H2+Bm Green H2 Project - Phase I	Morocco	Concept	H2	3.1 MW	3.1	0.5
89	S2H2+Bm Green H2 Project - Phase II	Morocco	Concept	H2	500 kt H2/y	2882.8	499
90	Guelmim-Oued Noun - Chbika project - phase 1	Morocco	Concept	Ammonia	800 Mwel additional	800	138.6
91	Solar-to-hydrogen Inhambane province	MOZ	Concept	H2	4kt H2/d	8427.0	1460
92	Mauritania - Green Ammonia project - phase 1	Mauritania	Concept	Ammonia	400MW or 0,28-0,3 Mt NH3	400	69.3
93	Mauritania - Green Ammonia project - phase 2	Mauritania	Concept	Ammonia	10GW or 8 Mt NH3	9600	1663.2

94	Mauritania & BP- Nassim project	Mauritania	Concept	H2	10 Mt NH3	20787.1	3601.4
95	Megaton Moon	Mauritania	Concept	H2	35 GWel	35000.0	6063.9
96	Project Nour - Phase 2	Mauritania	Concept	H2	8.5 Gwel additional	8500	1472.7
97	AMEA- Mauritania project	Mauritania	Concept	H2	3 GW	3000	519.8
98	Daures Green Hydrogen Village, phase 4	Namibia	Concept	Ammonia	840MW - 240 kt H2/y - 700 kt NH3/y	424.75	73.6
99	MoU EEC-Niger	Niger	Concept	H2		0	
100	H2Notos- Phase 2	Tunisia	Concept	H2	10 GW	8000	1386
101	ACWA-Tunisiaisia MoU GH2 project, phase 1	Tunisia	Concept	H2	2 GW - 200 kt H2/y	2000	347
102	ACWA-Tunisiaisia MoU GH2 project, phases 2-3	Tunisia	Concept	H2	4 GW - 400 kt H2/y	4000	693
103	Industrial Promotion Services-Ugandanda MoU	Uganda	Concept	Ammonia			
104	Secunda SAF Project - Phase II	South Africa	Concept	Synfuels	2.5 Mt synfuels/y	14825.1	2568.5
105	Prieska ammonia project, phase 2	South Africa	Concept	Ammonia	500 kt NH3/y	5623.0	974
106	Omnia - WKN Windcurrent green ammonia plant	South Africa	Concept	Ammonia	100 kt NH3/y	207.9	36
107	E-fuels project in South Africa	South Africa	Concept	Synfuels	1GW or 500 kt synfuels/y	1000	173.3
108	Renewstable Mpumalanga	South Africa	Concept	H2	18 kt H2/y	346.3	60
109	Atlanthia Green Hydrogen	South Africa	Concept	H2	44 MW el - 7 kt H2/y	44	7.6
110	HDF MSR-Zimbawe (Manicaland)	Zimbabwe	Concept	H2	1.15 kt H2/y	22.1	3.8

Source: IEA (2024)

14.2 Appendix 2: The GH2 value chain

Figure 39: GH2 value chain (PtX Hub, 2024c)