South Africa's Green Hydrogen Roadmap: Promises, Progress and Policy Gaps

[1] Mohit Dalal; [2] Dr. Harpreet Kaur; [3] Dr. Kavita Singh
[1] PhD Research Scholar, Department of African Studies, University of Delhi, India
[2] Principal, Mata Sundri College, University of Delhi, India
[3] Assistant Professor, Department of Environmental Studies, Mata Sundri College for Women, University of Delhi, India
[1] ORCID: 0009-0005-7926-5347

Abstract: South Africa is emerging as a leader in clean energy efforts among African countries. The country is well-positioned with world-class solar and wind energy potential. Also, it is becoming a major hub for green hydrogen production. At the same time, it faces the dual challenge of reducing greenhouse gas emissions while addressing widespread poverty and inequality. According to the Emissions Database for Global Atmospheric Research (EDGAR), South Africa is the largest emitter of greenhouse gases in Africa. This places it under significant pressure to meet climate goals without compromising economic development. Green hydrogen presents a practical and promising solution to this dilemma. The Hydrogen Society Roadmap, released in 2022 by the Department of Science and Innovation, supports this direction. It sets a target of producing five lakh tonnes of green hydrogen annually by 2030. Also, it outlines plans to install ten gigawatts of hydrogen production capacity, with a strong focus on the Northern Cape. This research tries to takes a close look at the Hydrogen Society Roadmap released by the Department of Science and Innovation in February 2022. Similarly, the study will analyse on policy documents released by UN onglobal energy plans, and project data from South Africa's Department of Trade, Industry and Competition which releases data on commercialisation strategy and data from Science and Innovation Ministry. From the data analysis, research will put emphasis on its two-foldoutcomes. One that while the roadmap marks an important step, it needs stronger planning, fair benefit sharing, and secondly it will provide better links with job creation. By looking at both achievements and gaps, the study will try to offer new insights into how South Africa can build a fair and lasting green hydrogen sector. It will help future research by providing a factual study of how clean energy plans can be shaped by local needs, policy choices, and global climate goals.

Keywords: Energy sector, Hydrogen Society Roadmap, South Africa, Green Hydrogen, Just Energy Transition Investment Plan.

Introduction

South Africa is situated at the southern tip of the African continent, where the Atlantic and Indian Oceans meet. The geographic location of South Africais diverse. It has access to rich solar and wind resources. This provides great potential to procure renewable energy projects like solar farms, wind parks, and green hydrogen production facilities. Economically, South Africa is among the continent's most developed countries, with a strong industrial base, well-established infrastructure, and major ports that link it to the global markets. It is an emerging economy whose energy sector has long been dominated by coal, making it Africa's top greenhouse gas emitter. But on the other side of the coin, as global warming and climate change are intensifying, South Africa faces severe challenges like rising temperatures, prolonged droughts, and increased frequency of extreme weather events. All these combined challenges hamper its economic growth as resources are split between pursuing economic growth and addressing the rising, escalating costs of climate-related disasters.In the global climate context, South Africa is a signatory to the Paris Agreement and is committed to reducing its carbon emissions and transitioning to a low-carbon economy. It stands at a turning phase in its energy transition, with green hydrogen emerging as a crucial element in its strategy to achieve net-zero emissions by 2050.

Green hydrogen, which is produced through electrolysis powered by renewable energy, offers a versatile solution for decarbonizing carbon-intensivesectors such as heavy industry, transport, and power generation. South Africa is the world's largest producer of Platinum Group Metals (PGMs), which are a critical component in green hydrogen production. Due to the abundant availability of PGMs, South Africa is uniquely positioned to become a global leader in green hydrogen production and export. The Hydrogen Society Roadmap (HSRM), launched in 2022 by the Department of Science and Innovation, Government of South Africa, articulates a vision for a hydrogen-based economy that drives economic growth, creates jobs, and supports a just transition from non-renewable to renewable sources of energy. The Green Hydrogen Commercialisation Strategy (GHCS), approved in 2023 by the government of South Africa, further outlines a path for commercializing hydrogen technologies. This research critically evaluates the promises, progress, and policy gaps in South Africa's green hydrogen roadmap, assessing its viability as a cornerstone of the country's net-zero pathway.

Methodology

Thisarticle is based on a comprehensive review of publicly available documents, reports, and news articles related to South Africa's green hydrogen initiatives. Sources include the Hydrogen Society Roadmap (HSRM), the Green Hydrogen Commercialisation Strategy (GHCS), feasibility studies on the Hydrogen Valley project, and announcements from government departments such as the Department of Science and Innovation (DSI) and the Department of Trade, Industry, and

Competition (DTIC) of South Africa. Additional insights were drawn from international partnerships and funding agreements, as well as expert analyses from organizations like the Centre for Strategic and International Studies (CSIS) and the African Development Bank (AfDB). The analysis critically examines the promises and progress of South Africa's green hydrogen roadmap while highlighting policy gaps and challenges.

Findings

South Africa is the largest greenhouse gas emitter in Africa. Its greenhouse gas emissions in 2023 were 522.12 million tonnes of carbon dioxide equivalent (Mt CO_2-eq)(Crippa, 2024). Coal is still the largest source of electricity generation in South Africa. It accounts for 82 percent of total electricity generation. (International Energy Agency, Crippa, 2024). The country has to transition to renewable sources of energy to achieve its goal of Net-Zero emissions by 2050. The country is pursuing an ambitious green hydrogen strategy to transition from its coal-dependent economy to a cleaner, sustainable future.It also aims to produce 500,000 tonnes of green hydrogen annually by 2030 to ensure its transition to a low-carbon economy. (Department of Science and Innovation, 2022).

Understanding Green Hydrogen: A Clean Energy Alternative

Green hydrogen is a clean energy carrier produced through a process called electrolysis, where electricity is used to split water into hydrogen and oxygen. It's called 'green' because the electricity used to produce it comes entirely from renewable sources like solar and wind which ensures a carbon-free process.Unlike grey hydrogen, which is derived from fossil fuels and emits substantial carbon dioxide, or blue hydrogen, which uses carbon capture to partially reduce emissions, green hydrogen is completely emission-free. As it is the most sustainable method of hydrogen production, it helps address both climate and energy security challenges.Green hydrogen opens up new pathways for economic diversification in South Africa as it has the potential to drive export-oriented growth.Understanding green hydrogenand how it uniquely fits South Africa's geography, industrial base, and climate obligationsis the key to evaluating the country's roadmap. It is more than a clean fuel; it is a strategic national opportunity for a resilient, inclusive, and low-carbon future.

South Africa's Green Hydrogen Roadmap and Policy

South Africa's aspirations for a green hydrogen economy are closely knit into the broader vision for aJust Energy Transition. It is a part of its commitment to reduce greenhouse gas emissions, diversify its energy mix, and drive inclusive economic growth. Central to this is the Hydrogen Society Roadmap (HSRM), launched by the Department of Science and Innovation in 2022. The roadmap outlines six high-level goals: decarbonizing heavy transport sectors, industrial emissions, strengthening the

power grid, establishing a Centre of Excellence for manufacturing hydrogen components, creating a green hydrogen export market, and scaling up hydrogen generation and distribution within national energy systems. Specifically, it aims to build 10 gigawatts (GW) of electrolyser capacity and produce 500 kilotons of hydrogen by 2030, scaling to 15 GW by 2040,with the promise of creating around 30,000 jobs per year(IEA, 2023). By laying out these measurable targets, the HSRM sets a clear foundation for both public and private action.

The Just Energy Transition Investment Plan (JET-IP) launched at COP26 complements the roadmap. It outlines a strategic plan to mobilize funding across critical sectors, including electricity, new energy vehicles, green hydrogen, municipal capacity, and skills development. Among these, green hydrogen has been given special focus, receiving one of the largest allocations of grant funding across all portfolios. A total of USD 141 million (ZAR 2.5 billion)has been committed specifically to support the development, commercialization, and export readiness of green hydrogen, reflecting its importance in South Africa's low-carbon transition and its potential as a future economic growth driver (JET Project Management Unit, 2025).South Africa's Just Energy Transition Partnership (JETP) has seen increased international financial pledges, growing from USD 8.5 billion (ZAR 150.45 billion) in 2021 to USD 12.9 billion (ZAR 228.33 billion) by March 2025 (JET Project Management Unit, 2025). However, the United States withdrew from the partnership in February 2025, cancelling USD 56 million in grants and USD 1 billion in potential commercial investment (JET Project Management Unit, 2025). These funds are expected to catalyse nearly US$100 billion in public and private investments. Key government strategies include using blended finance mechanisms, green bonds, and concessional loans to cover funding gaps and manage debt risks.To build the green hydrogen sector, South Africa is accelerating policy reforms in energy and industrial planning.It is integrating its key sectors to align with its green hydrogen vision by coordinating energy reform, industrial policy and infrastructure development.

The energy sector is expanding renewable generation to power electrolysis which uses electrical power to split water into hydrogen and oxygen, while industrial planning includes manufacturing electrolysers, fuel cells, and green steel. Through the Hydrogen Society Roadmap, government institutions are working with partners to build supply chains, enable export infrastructure, and promote skills development. The transport and mining sectors are also being transitioned to adopt hydrogen technologies. This cross-sectoral approach ensures that green hydrogen becomes central to both decarbonization and long-term economic diversification.

On the policy front, South Africa is creating incentives to spur domestic demand for green hydrogen. Tax rebates for electric and hydrogen vehicles (effective March 2026) aim to boost uptake in the transport sector. It haspassed a law offering a 150% tax deduction on capital investments for manufacturers of electric and hydrogen vehicles. This incentiveaims to boost local production, attract investment, and support

the country's transition to cleaner transport. It covers machinery, equipment, and new facilities used in producing EVs and hydrogen fuel cell vehicles (Green Building Africa, 2025). Also, it is building strategic global cooperation. In September 2024, it signed a memorandum of understanding with Namibia for a cross-border hydrogen pipeline, aiming to strengthen regional integration and scale production.The Africa Green Hydrogen Alliance (AGHA) brings together leading African nations,includingEgypt, Kenya, Mauritania, Morocco, Namibia, and South Africa.AGHA serves as a platform to accelerate the deployment of green hydrogen by promoting collaboration across African nations.The Alliance aims to leverage Africa's vast renewable energy potential to produce up to 60 million tonnes of green hydrogen equivalent by 2050, potentially generating $66–126 billion in GDP and creating 2–4 million jobs across member states (Africa Green Hydrogen Alliance (AGHA).

South Africa has actively engaged in AGHA's strategic dialogues, including regional forums in Nairobi and a ministerial summit in Cape Town, where it advocated for regulatory harmonization and investment-readiness of hydrogen hubs.It launched itsGreen Hydrogen Commercialisation Strategy (GHCS) with the primary goal of positioning the country as a global exporter of green hydrogen and its derivatives. The government developed this strategy to tap into the rising international demand for clean fuels and to drive national economic transformation. Themajor objectives of GHCS are, it aims to position South Africa as a global leader in green hydrogen exports, targeting international markets such as the EU, Japan, and Korea.Second, it seeks to stimulate economic growth by building a competitive and inclusive low-carbon economy through green hydrogen investment, job creation, and industrialisation. Third, the strategy focuses on decarbonising hard-to-abate sectors like steel, cement, aviation, fertiliser production, and heavy-duty transport, where electrification alone is insufficient (DSI, 2023). The GHCS intends to improve national energy security by integrating hydrogen into the energy mix, especially to support grid stability and reduce reliance on coal for energy generation.It promotes the local manufacturing of hydrogen technologies, such as electrolysers and fuel cells, leveraging South Africa's dominance in PGMs. It also stresses the importance of creating enablinghydrogen hubs and export corridors.

Current Status of Green Hydrogen in South Africa

South Africa's green hydrogen ambitions are supported by its unique natural resources and strategic position in the global energy transition. The country has world-class solar and wind resources,mostregions stand on average more than 2500 hours of sunshine per year, and average solar-radiation levels range between 4.5 and 6.5kWh/m2 (Department of Mineral Resources and Energy (DMRE)and wind speeds averaging 7-8 m/s in coastal areas, making it ideal for large-scale renewable energy production which is essential for green hydrogen production.Additionally, South Africa is the world's largest producer of platinum group metals (PGMs), which

constitute over 70% of global supply and are critical components in hydrogen fuel cells and electrolysers (Salma &Tsafos, 2022).

The HSRM outlines a vision to produce 500,000 tonnes of green hydrogen annually by 2030, create at least 20,000 jobs annually by 2030, and contribute USD5 billion to GDP by 2050 (Department of Science and Innovation, 2022). In this context, South Africa's Hydrogen Society Roadmap (HSRM) positions hydrogen as a driver of decarbonisation and industrial growth. It focuses on six main outcomes: reducing emissions from transport and heavy industries, building a green hydrogen export market, and supporting power sector reform. The roadmap also focuses on creating local manufacturing capacity for hydrogen technologies and expanding infrastructure for hydrogen production, storage, and use. Importantly, it aims to transition away from grey and blue hydrogen toward greener options, aligning with its goal to achieve net zero by 2050. These priorities reflect South Africa's intent to use its renewable energy strengths for both domestic benefit and global competitiveness (Department of Science and Innovation, 2022).

Gaps and Challenges in Scaling up South Africa's Green Hydrogen Roadmap

South Africa has immense potential for producing green hydrogen, as it has all the key inputs required to do so. But there are obstacles in scaling up its green hydrogen sector. One of the biggest challenges is the high cost of production of green hydrogen as compared to its fossil fuel counterparts.The cost of producing green hydrogen is currently nearly twice moreas grey hydrogen. According to the Hydrogen Valley Feasibility Study, green hydrogen production costs in South Africa are estimated at approximately $3.70 to $4.08 per kilogram, while grey hydrogen which is produced from coal or natural gas, costs between $1.90 to $2.40 per kilogram, depending on the location where it is produced (Department of Science and Innovation, 2021, p. 53).This stark cost difference is largely due to the high price of electrolyser technology and the high cost of renewable electricity, which is not yet cheap or abundant enough, whereas grey hydrogen still benefits from already established fossil-fuel infrastructure. Such a steep cost gap makes green hydrogen economically uncompetitive in the absence of substantial subsidies, carbon pricing, or regulatory incentives.

This cost disparity between the price of green hydrogen and other sources of energy presents a major hurdle for South Africa's green hydrogen ambitions. Without strong subsidies and a well-designed carbon pricing mechanism, or international "off-take agreements", green hydrogen will struggle to compete with existing fossil-based hydrogen in industrial markets. As a result, investors remain cautious and demand remains limited.The Investment to develop green hydrogen and scale up its production is lacking, as private players find a lack of commercial viability in it, as the domestic demand for green hydrogen is less due to its high cost. Most global green hydrogen projects lack "long-term off-take agreements", meaning buyers aren't yet

committing to purchase hydrogen at scale. This creates a perpetual loop where Investors won't invest without buyers, and buyers won't commit until green hydrogen becomes cheaper.However, with targeted policy support and declining renewable energy costs, the price gap could shrink over time.

According to the Hydrogen Valley Feasibility Study (Department of Science and Innovation, 2021, p. 53), the price of green hydrogen in South Africa is expected to decrease by approximately 25% by 2030 compared to 2025 levels. It will make green hydrogen more viable and competitive for domestic use and export. Still, until these reductions are achieved, the sector remains financially risky and highly dependent on public-private partnerships and global climate financing. To develop its green hydrogen economy, South Africa requires extensive infrastructure upgrades across multiple sectors. Despite rich renewable energy potential, South Africa lacks the foundational infrastructure required to translate its green hydrogen ambition into reality, as the infrastructure to support this ambition remains severely underdeveloped. It needs to develop its ports, railways, transmission grid, and pipelines.

Transmission Grid Constraints

At the heart of South Africa's hydrogen strategy lies the need for renewable electricity. Electrolysis, which is the process of producing green hydrogen, requires massive quantities of electricity, ideally from solar and wind. The country's national grid is in a precarious state. Eskom, which is a South African electricity public utility,faces mounting challenges in maintaining, upgrading, and expanding transmission lines. The GHCS estimates a need for an additional 25 to 39 GW of renewable electricity generation by 2035 just to support green hydrogen projects. However, Eskom's current Transmission Development Plan (2023–2032) does not account for this demand in its investment pipeline (Department of Science and Innovation, 2022).To bridge this gap, the grid needs over R370 billion in upgrades by 2035 (Department of Science and Innovation, 2022). Without urgent investment and structural reforms, Eskom's limitations pose a serious bottleneck due to limited transmission capacity. Without substantial and rapid upgrades, hydrogen projects risk being stranded due to a lack of connectivity.

Port Infrastructure Challenges

Another critical piece in the green hydrogen export is port readiness. Green hydrogen and its derivatives like ammoniarequire specialised facilities for handling, storage, and loading. While ports like Boegoebaai, Saldanha, and Coega have been earmarked as export hubs, they face serious capacity and planning issues.Boegoebaai port lacks existing logistics networks and poses high capital and operational costs. All these ports also need desalination plants, power generation, and storage facilities,

without which hydrogen handling at scale is impossible (Department of Science and Innovation, 2022).

Pipeline and Transport Deficiencies

Moving hydrogen from inland production zones to coastal export hubs or domestic industrial zones presents another hurdle. South Africa's current gas pipeline infrastructure, which is primarily the Mozambique-Secunda pipeline and the Transnet Gas Pipeline Network, was never designed for hydrogen. While blending hydrogen with natural gas up to 20% is technically possible, anything beyond that requires completely new infrastructure (Department of Science and Innovation, 2022).Constructing new hydrogen-dedicated pipelines is expensive. Moreover, most proposed hydrogen hubs, like the Northern Cape, are isolated from existing pipeline networks. That means either long-distance trucking or rail transport of hydrogen, both of which will inflate costs and increase emissions unless decarbonized.Unlike countries such as Germany or Japan, which already have hydrogen corridors and transport networks, South Africa must build infrastructure from the ground.

The Water Factor

Hydrogen electrolysis demands large amounts of purified water, which is often an overlooked input. South Africa is a water-scarce country. Many of the proposed hydrogen zones are already drought-prone. Coastal desalination is being considered, but it adds yet another infrastructure cost layer and raises sustainability concerns.

Comparison: South Africa vs. Global Peers

When compared with peers like Australia the United Arab Emirates, and Japan, South Africa lags in critical infrastructure. Australia's Pilbara region hosts several advanced-stage hydrogen projects such as the Asian Renewable Energy Hub (AREH)**.** Australia has already established renewable energy zones, invested heavily in transmission upgrades, and aligned its regulatory framework to support large-scale green hydrogen exports. Australia benefits from strong port infrastructure and proximity to Asian markets, giving it a competitive edge in export logistics. The UAE, backed by sovereign wealth funds and an oil-exporting legacy, has pumped billions into hydrogen infrastructure. In contrast, South Africa is struggling to fund basic energy transmission upgrades.This infrastructural lag not only increases project costs but also makes South Africa less competitive in global green hydrogen markets. Transport costs to Europe or Asia are already high due to distance. Add inefficient ports, congested railways, and weak pipelines, and South Africa's hydrogen could price itself out of key markets unless these issues are tackled head-on.

Is South Africa's Hydrogen Vision Overhyped?

There is mounting scepticism that South Africa's hydrogen vision, while technically sound, is politically overpromised. Its strategy paints a picture of job creation, decarbonization, and export windfalls, but it downplays the complexity, cost, and time required to build out the necessary infrastructure. Without the backbone of functioning infrastructure, South Africa's goal of green hydrogen looks more like rhetoric than reality.As it stands, most of South Africa's green hydrogen projects remain in the Memorandum of Understanding (MoU) or pre-feasibility stage, which means they are still in the early planning and conceptual phases.The real-world bottlenecks, like grid congestion, weak ports, and inadequate pipelines, are not addressed with the urgency or scale needed.An MoU is a non-binding agreement between the stakeholders,such as the government, private investors, or international partners. It outlines shared intentions to collaborate on a project. While these agreements show interest and political will, they do not guarantee actual investment, construction, or operation.On the other hand, pre-feasibilityrefers to the stage where the technicaland financial viability of a project is being assessed.Its green hydrogen industry is still largely aspirational, with many announcements made but few projects breaking ground. Until these projects move into the implementation phasewith infrastructure, regulatory clarity, and actual hydrogen production.It remains difficult to measure the country's real progress beyond paper commitments.

Funding constraints

South Africa is actively seeking international partnerships to advance its green hydrogen sector. In September 2024, the European Union pledged two grants totalling €32 million to support the creation of a regional green hydrogen hub in Southern Africa (European union,2024). These grants are intended to catalyse further investment, particularly in upgrading essential infrastructure such as ports, railways, and pipelines. However, this contribution is minimal, accounting for less than 0.2% of the estimated ZAR 410 billion ($21.9 billion) required to meet South Africa's ambitious goal of producing one million tonnes of green hydrogen annually by 2030 (South African Agricultural Industry, 2023; Young, 2024). Green hydrogen has been identified as one of three strategic pillars under South Africa's Just Energy Transition Investment Plan (JET-IP). While some of the plan's resources are already supporting initiatives like the Hydrogen Valley, funding remains a critical challenge. Notably, only 4% of the JET-IP's total budget consists of grant funding, with the overwhelming majority structured as loans. This reliance on debt-based financing raises serious concerns about the long-term sustainability of the green hydrogen programme, particularly in the context of South Africa's already constrained fiscal position.South Africa has secured international grants to develop its green hydrogen plans. In September 2024, the European Union pledged two grants to the sum of R628mil (€32 mil) in support of South Africa's green hydrogen agenda (European Union, 2024).

Conclusion

South Africa's green hydrogen roadmap represents an ambitious vision that positions the country as a potential global leader in clean energy production. It has the potential of solar and wind resources. It has access to critical minerals like platinum, which gives it an edge as the country holds several natural and strategic advantages. The Green Hydrogen Commercialisation Strategy, Hydrogen Society Roadmap, and Just Energy Transition Investment Plan collectively provide the foundational policy architecture needed to support a green hydrogen economy. On paper, the direction is clear, and the potential benefits are considerable, like job creation, industrial growth, energy security, and long-term decarbonisation.However, when the policy ambitions are measured against current realities, a different picture emerges. Most green hydrogen projects are still in the early planning stages, either within pre-feasibility or bound by non-binding MOUs. Infrastructure gaps remain a serious barrier. Ports are congested, railway logistics are weak, and the transmission grid in key provinces like the Northern and Western Capecannot integrate the large-scale renewable energy needed to power electrolysis. Water constraints, land access issues, and inadequate community consultation further complicate the rollout of projects, especially in regions earmarked for hydrogen hubs.Moreover, the cost of green hydrogen in South Africa is currently nearly double that of grey hydrogen, making it commercially uncompetitive without significant subsidies, carbon pricing mechanisms, or international offtake agreements. While some foreign investment has been pledged, actual disbursement and execution remain slow. Public finance is heavily tilted towards loans, not grants, raising concerns about long-term debt burdens for a country already grappling with fiscal pressure. The absence of a detailed regulatory framework for safety, certification, pricing, and domestic offtake also adds uncertainty for investors. The hydrogen narrative of the country is often pitched as a game-changer for both domestic transformation and international climate leadership. But without the necessary infrastructure, regulatory certainty, and financing models tailored for a developing economy, the promise of a thriving hydrogen industry may remain out of reach. The country cannot afford to build its energy transition on hope and headline announcements alone. Instead, it must focus on hard groundwork: upgrading infrastructure, aligning domestic industrial policy with hydrogen demands, and ensuring inclusive participation from communities and local businesses.It is also crucial for South Africa to define its hydrogen strategy in terms of domestic benefit, not only in serving export markets. Green hydrogen must become more than just a commodity for European buyers; rather, it should help decarbonise local industry, provide clean fuels for transport, and address internal energy security challenges. For this, the hydrogen roadmap must be grounded in socio-economic realities, supported by long-term planning, and protected from short-term political cycles.In conclusion, South Africa has a genuine opportunity to lead the green hydrogen transition, but to

do so, it must move from aspiration to action, from plans to projects, and from vision to tangible value.

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