HYDROGEN INSIGHTS

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CDH's Key Messages

BY JACKWELL FERIS, MARGO-ANN WERNER, CLARICE WAMBUA AND NJERI WAGACHA

Clean hydrogen is the missing piece of the puzzle for effective decarbonisation of the global economy – and Africa cannot be left behind.

There are enormous opportunities for Africa to be a key player in the clean hydrogen value chain, with several areas on the continent having the potential to be developed into major export hubs for hydrogen and Power to X (PtX) products.

Industrial players across the value chain are willing and eager to invest in and scale hydrogen to achieve cost parity with carbon intense fuels, with governments around the world recognising hydrogen's critical contribution to decarbonisation.

Africa must develop a continental hydrogen roadmap to clearly identify the opportunities hydrogen holds for intra-Africa trade.

The right policy and regulatory framework in African jurisdictions actively seeking to play a leading role in the clean hydrogen economy are imperative for the deployment of significant capital investment for the development of large-scale infrastructure.

The policies must include directives, mandates and robust carbon pricing, and must provide targeted support and de-risking for the significant initial investments required for large-scale infrastructure for the production of hydrogen.

Uniform regional industrial policies will need to be developed that speak to how the barriers to a hydrogen economy will be addressed on a regional level.

Countries such as Morocco and Namibia have been earmarked to become major exporters of green hydrogen and need to follow and adopt a collaborative policy approach as exporters of clean hydrogen

South Africa

As one of the biggest contributors to greenhouse gas (GHG) emissions on the continent, South Africa is uniquely poised to harness hydrogen, and therefore carbon-free fuel, to facilitate South Africa's just transition and fulfil its international climate change commitments.

There are several hydrogen policy development processes underway, and South Africa released its Hydrogen Society Roadmap for South Africa (HSRM) 2021 on 17 February 2022. The HSRM sets ambitious goals for hydrogen to contribute to just and inclusive net-zero carbon economic growth for South Africa by 2050.

South Africa has a suite of legal and policy interventions, such as the Climate Change Bill, the Low Emissions Development Strategy, and the National Climate Change Adaptation Strategy, and updated its Nationally Determined Contribution (NDC) under the Paris Agreement in September 2021.

South Africa has a robust environmental legislative framework that encourages the development of hydrogen and PtX products. One of the key criteria prescribed by the 2014 environmental impact assessment (EIA) regulations (EIA Regulations) is the consideration of alternatives – such as the development or expansion of infrastructure to produce sustainable fuels. In addition, climate change impacts and associated mitigation measures has become a necessary factor to consider as part of the EIA process.

Environmental, social and governance (ESG) standards are becoming an increasingly tangible and vital custom in corporate society, capable of swaying investor appetite and developer innovations towards *"greener"* and more socially responsible and sustainable projects. For investment decisions in hydrogen projects, ESG will be an important factor to consider throughout the project lifecycle.

Kenya

Kenya has begun its path towards a green hydrogen future and in 2021 conducted a, as yet unpublished, baseline study on green hydrogen production and utilisation in the country.

A national green hydrogen working group made up of stakeholders from both the public and private sectors has been set up and a roadmap on the future of green hydrogen is being developed.

In addition green hydrogen pilot projects are planned in the country to demonstrate the suitability of this technology and identify lessons for the development of larger installations.

Kenya is well placed to produce green hydrogen, which will contribute to the country's goal to reduce emissions to 32% by 2030, as outlined in Kenya's Updated NDC, submitted to the United Nations Framework Convention on Climate Change (UNFCCC) in December 2020.

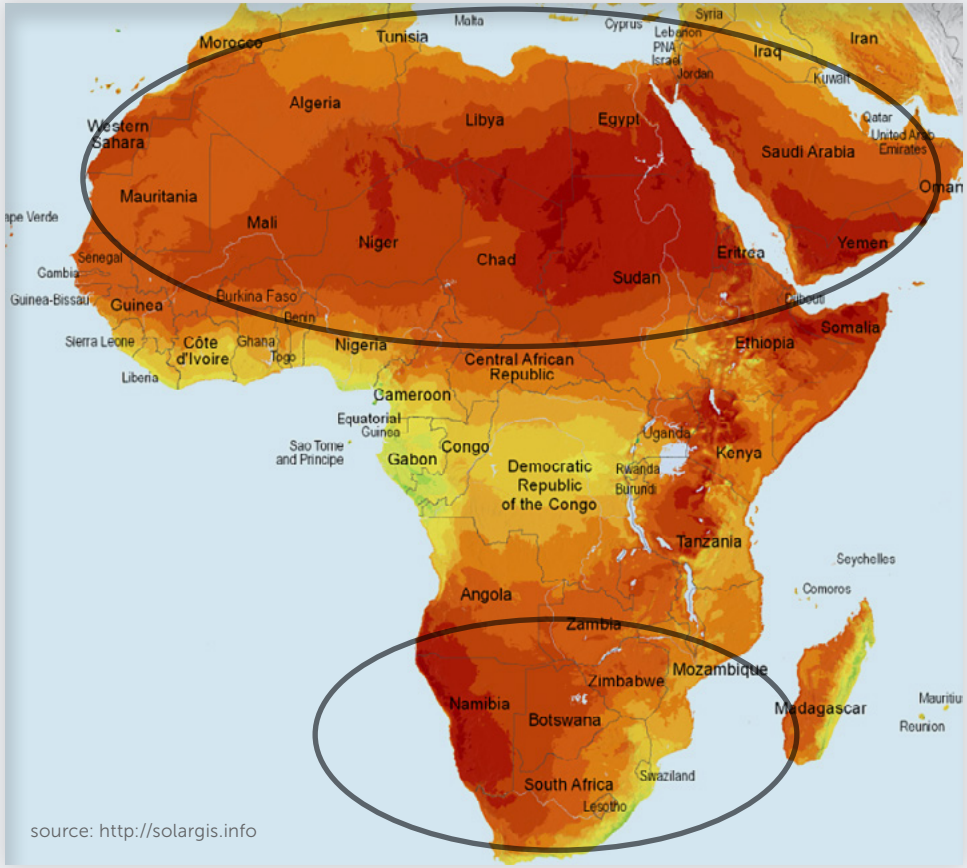
AFRICA AND THE GLOBAL HYDROGEN ECONOMY

BY JACKWELL FERIS

As critical as clean hydrogen[1] is for the decarbonisation of the global economy by 2050, it must also form a key part of Africa's industrialisation efforts. Africa cannot afford to be left behind or to be merely a spectator in the new age of net zero industrialisation that will be necessary to achieve global climate change targets. With Africa being the continent with by far the lowest CO2 and GHG emissions, accounting for between 2% to 3% of global GHG emissions (with South Africa accounting for about 33% of all GHG emissions in Sub-Saharan Africa), clean hydrogen presents a chance for Africa to be catapulted into prosperity through investment in the entire value chain of clean hydrogen.

This includes the production of green hydrogen from renewal sources; the production of PtX products from green hydrogen (ammonia, methanol etc); the production of hydrogen from repurposed existing fossil-fuel intense infrastructure; the development of storage and handling facilities for hydrogen; and the transportation infrastructure (pipelines, vessels) for conveying hydrogen products, including to end-use applications in existing and future industries (electric fuel cell vehicles, refuelling stations, and so on).

The development of the hydrogen economy in Africa will support effective, broad global decarbonisation, allow countries to meet their climate goals, and create sustainable economic growth for African countries and the rest of the world. There are enormous opportunities for Africa to be a key player in the clean hydrogen value chain, with several regions having the potential to develop into major global export hubs for hydrogen and other areas with the potential to provide domestic demand for end-use applications of hydrogen. Northern and Southern Africa have very favourable solar conditions for the production of green hydrogen, and countries in these regions (such as Namibia and South Africa in the south) are ideally situated to become export hubs for green hydrogen and PtX products.



[1] Clean hydrogen is hydrogen produced from a) fossil fuels with carbon-captured storage of the GHG emissions (so-called blue hydrogen) or b) electrolysers powered by renewable electricity (so-called green hydrogen).

However, for that to happen African governments must make a concerted effort to ensure they have suitable policy and regulatory frameworks in place that make investment of significant capital in projects along the hydrogen value chain enticing. Clean hydrogen is considered to be the only scalable and cost-efficient energy vector to decarbonise hard to abate sectors (heavy industries, transportation and mobility) that require clean molecules as fuel or feedstock to substitute petroleum products and coal.

Hydrogen holds the promise to decarbonize hard to abate sectors

Upstream

How will existing value chains be disrupted?

H2 Production

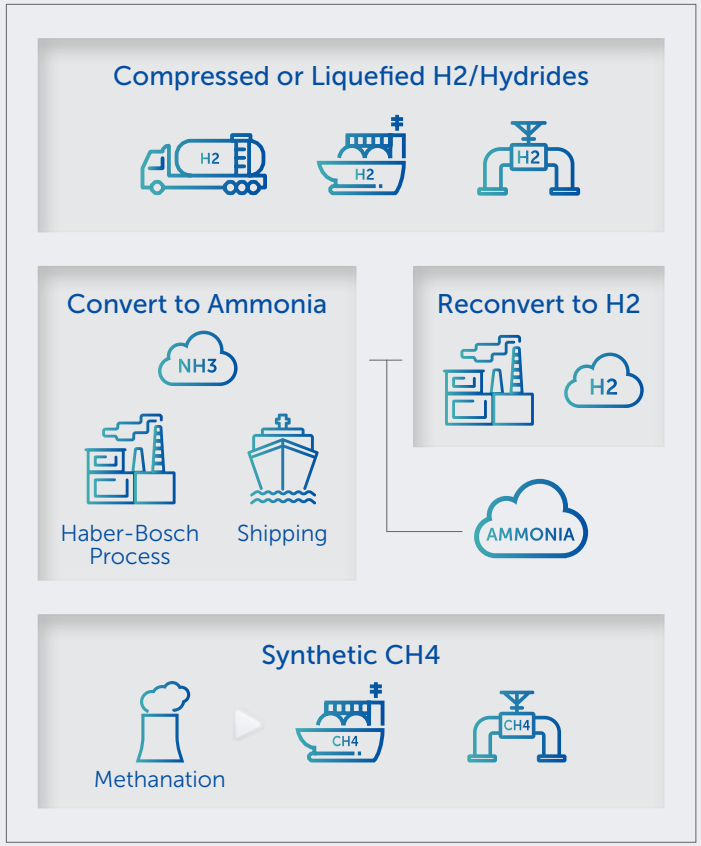
How competitive will each type of H2 be?

Storage, Transport, Distribution

What will the future supply chains look like and what are the economics?

End Use

What is the size of the future market H2?



CHEMICALS
- Methanol
- Ammonia
- Chemical products

INDUSTRY
- Refineries
- Steel
- Cement

RESIDENTIAL/COMMERCIAL
- H2 blending to gas systems
- CHP

MOBILITY/TRANSPORT
- Fuel cell EVs
- Filling stations
- Marine fuels

Globally, industrial players across the value chain are willing and eager to invest in and scale hydrogen to achieve cost parity with carbon intense fuels, with governments across the world recognising hydrogen's critical contribution to decarbonisation. As of 31 October 2021[2] more than 30 countries have developed or were preparing hydrogen strategies. South Africa launched its HSRM on 17 February 2022, with several other Africa countries planning to release their hydrogen strategies sometime during 2022, while others, such as Kenya, are in the early stages of developing theirs.

Countries like Morocco and Namibia have been identified as potential major exporters of green hydrogen. The Moroccan and Namibian Governments, with support from the private sector (foreign and domestic), have put in concerted efforts to make that a reality. Judging by the strategies and growing bilateral agreements Namibia has concluded with Germany, the Netherlands and Belgium, the Namibian Government is serious about positioning the country as a green hydrogen export hub. South Africa also has the ability to become an exporter of green hydrogen (from the Boegoe Bay region) using its domestic industrial and manufacturing base as the catalyst for the development of a clean hydrogen economy, as outlined in the HSRM. The South African domestic market also has the potential to provide sufficient demand for the development of a robust hydrogen value chain (as highlighted in the Hydrogen Valley Feasibility Report released in September 2021 and the HSRM). In this publication we unpack South Africa's position around the hydrogen economy looking at:

- South Africa's international climate change commitments, COP26, and their link to hydrogen;
- an overview of South Africa's legal framework as an enabler of hydrogen project development;
- environmental permit requirements and potential hurdles;
- environmental benefits, opportunities and risks related to hydrogen production, use and distribution; and
- ESG objectives and green financing in relation to hydrogen opportunities.

In addition to these regions in Africa that are actively pursuing the development of hydrogen strategies for future policy and regulatory development, the entire continent must benefit from the hydrogen economy. In that regard, in this publication we also look at the efforts in Kenya where we consider the following:

- Kenya's potential for green hydrogen production; and
- Kenya's steps towards green hydrogen production.

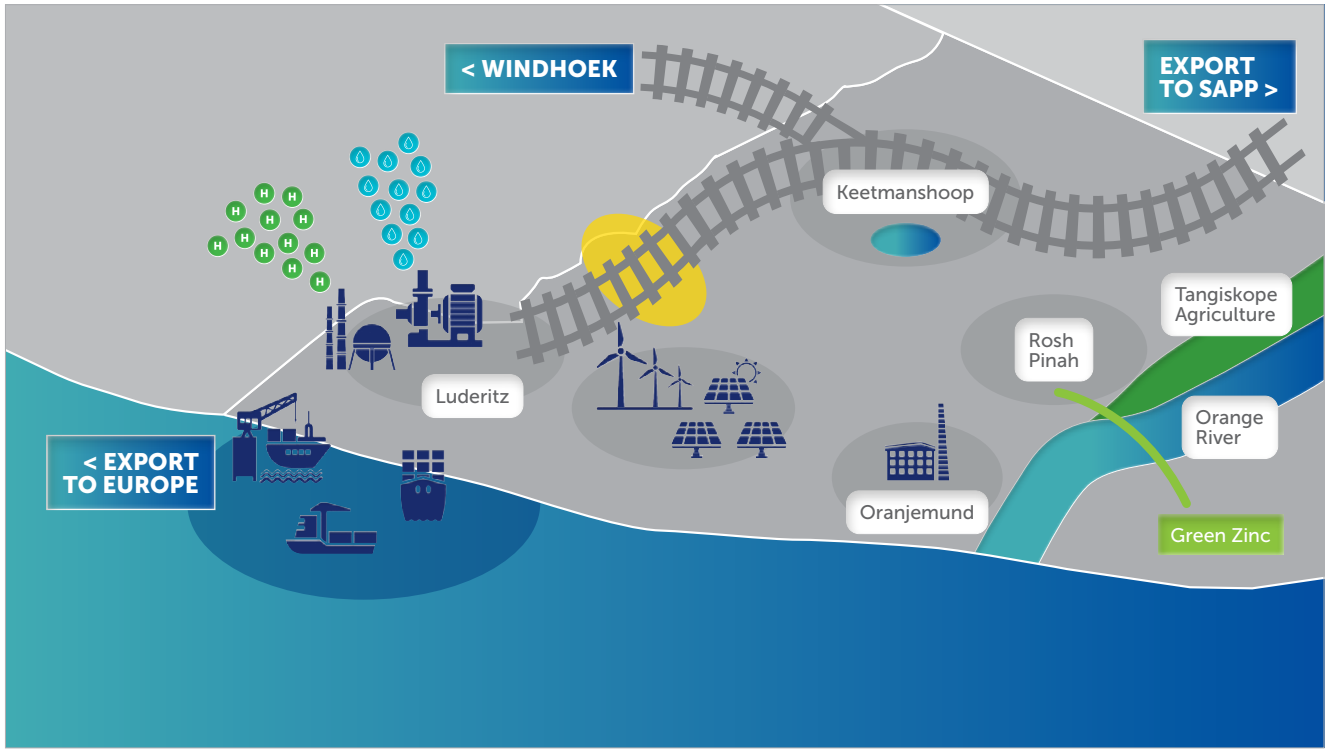
As such, it is imperative that Africa develops a continental hydrogen roadmap (similar to what Europe has done) that identifies the opportunities hydrogen holds for intra-Africa trade in order to facilitate the harmonisation of regional and domestic economic strategies, policies and regulatory frameworks around hydrogen to mitigate against the risk of developing a fragmented hydrogen value chain in Africa. A hydrogen roadmap for Africa will need to consider:

- Northern and Southern Africa becoming cost-competitive exporters of green hydrogen to regions such as Europe and Asia. Morocco and Namibia could achieve this by 2030, with countries like South Africa also potentially developing as a hedge market for green hydrogen exports, with the ability to serve both exports and domestic demand.
- Being self-sufficient to supply the growing African market and the developing of linkages (intra-Africa transportation, storage and handling), and other necessary infrastructure in various regions on the continent that allows for private sector investors and traders to take full advantage of the African Continental Free Trade Area (AfCFTA) in the production, supply and sale of clean hydrogen and PtX goods on a cost-competitive basis to existing and future African heavy industries (chemicals, automotive, aviation, steel and cement). For that, the development of integrated infrastructure for the transportation, storage and handling of hydrogen and PtX products in all the regions in Africa will be critical.

[2] International Renewable Energy Agency: Geopolitics of the Energy Transformation – The Hydrogen Factor, January 2022.

With the world's eyes firmly on clean hydrogen, the time to focus on the development of hydrogen projects in the entire value chain is now. The following are the most important levers to fully unlock the hydrogen economy:

- Creating demand for clean hydrogen. For countries geared towards exports, like Namibia, the demand will initially come from European industrial users and the initiatives driven by the Namibian government with countries such as Germany, the Netherlands and Belgium. There is potential to also supply industries in South Africa. For South Africa, there is local demand through industries that must decarbonise and a potential export market in the Northern Cape for green hydrogen.
- Creating access for clean hydrogen to reach the demand centres. Investment in infrastructure in the form of deep-water ports, rail, renewal electricity installations, electrolysers and desalination plants must be developed to enable end-user access to hydrogen. The Southern Corridor project, in Lüderitz, Namibia is one of the Namibian Government's most ambitious green hydrogen export projects and involves the planned development of an integrated hydrogen production facility for, amongst other things, exporting to Europe.



- Lower the cost of production of hydrogen. Over time green hydrogen production will become cost competitive, however that can only be achieved by accelerating the scaling up of clean hydrogen deployment globally. The planned projects in Morocco, Egypt, Namibia and South Africa will contribute to the cost-competitiveness of clean hydrogen.

The right policy and regulatory framework in African jurisdictions actively seeking to play a leading role in the clean hydrogen economy are imperative for the deployment of significant capital investment for the development of large-scale infrastructure focused on the hydrogen economy to unlock the international trade of green hydrogen and PtX products. In the next section we explore what it means to have the right policy and regulatory framework.

What are the factors african states must take into account when developing the right policy and regulatory framework for a clean hydrogen economy?

BY JACKWELL FERIS

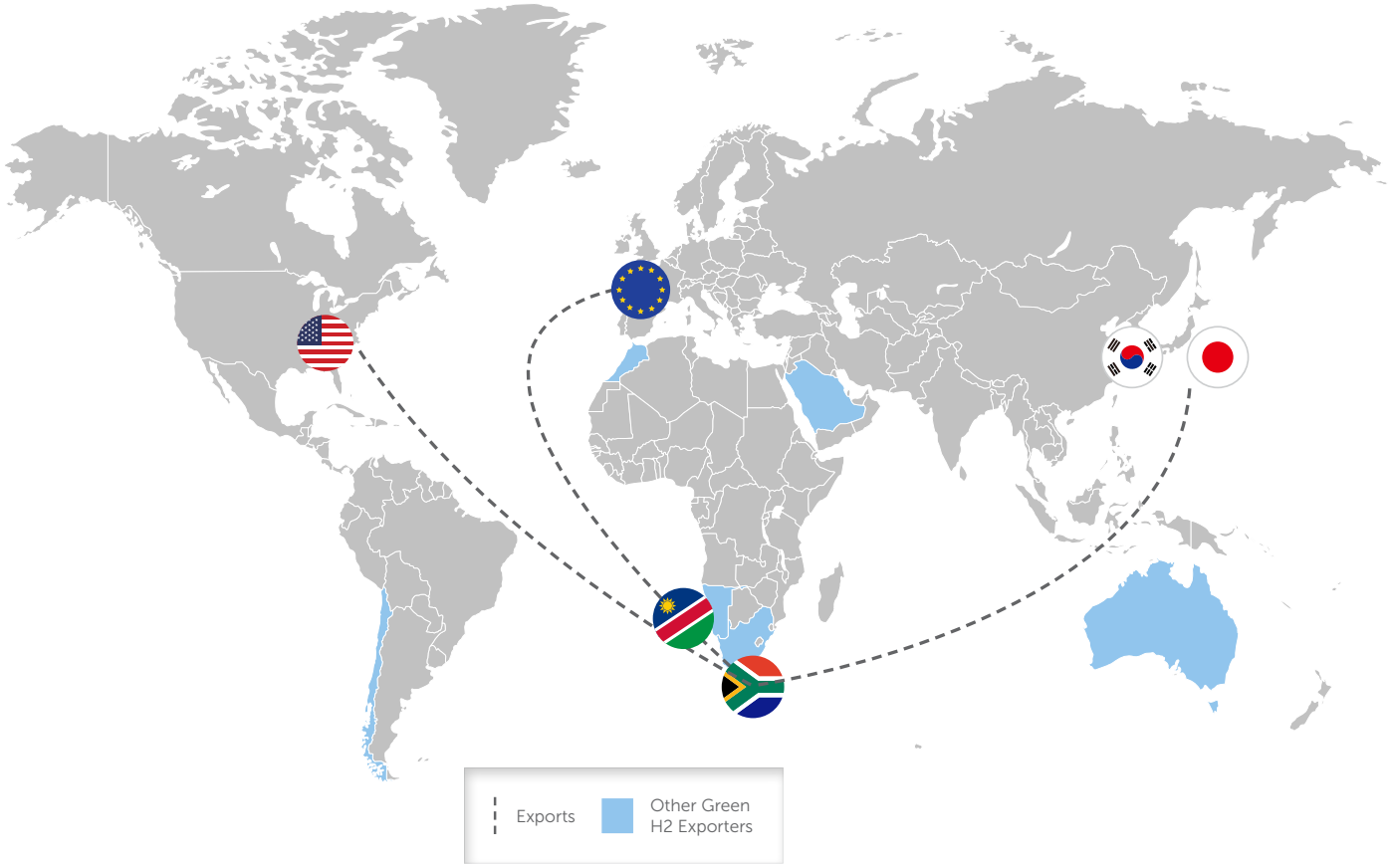
What does it mean to have the right policy and regulatory framework for investors to invest in a country to unlock its hydrogen economy? The policy imperatives that have been broadly identified are that a country's policies must include directives, mandates and robust carbon pricing, and they must provide targeted support and de-risking for the significant initial investments required for large-scale infrastructure for the production of hydrogen.

What countries in Africa must also fundamentally understand is that there will be a need for a mind shift in the development of policies that incentivise investment in hydrogen projects. One of the biggest differences is that the production and supply of clean hydrogen is a conversion (manufacturing) process, not an extractive business like oil and gas, and as such has the potential to be produced competitively in many places around the globe. This limits the possibilities of capturing economic rents akin to those generated by fossil fuels. Further, as the costs of green hydrogen fall over time, new and diverse participants will enter the market, making hydrogen even more competitive. So, as a starting point, African states will have to be cognisant of this distinction and appreciate the long-term risk associated with hydrogen.

Another important consideration for Africa governments planning to make hydrogen an economic catalyst is the grouping within which each country may fall. The Hydrogen Council has classified three country groups in the global hydrogen economy. These are:

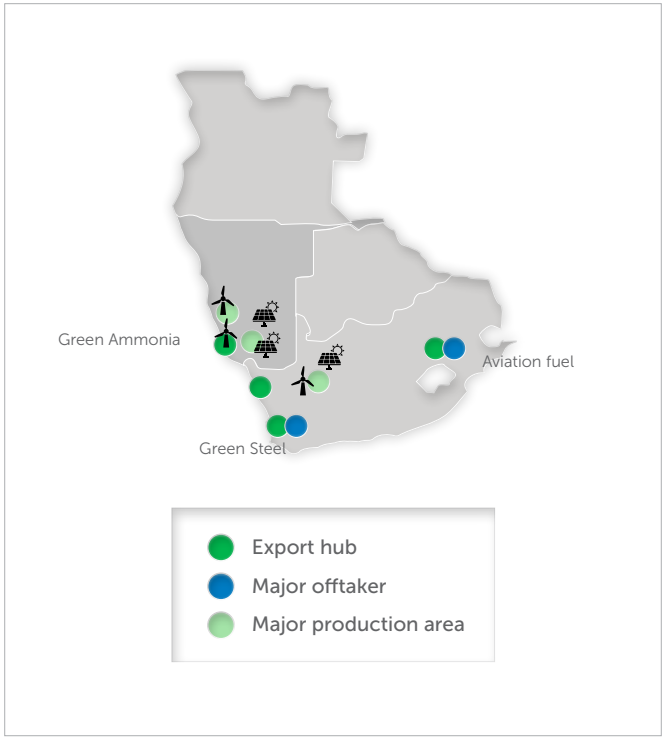
- **Self-sufficient countries:** These are countries that aim to produce and consume hydrogen within their respective jurisdictions. These states would need to create the entire value chain from upstream supply, midstream transmission and storage, distribution, and downstream demand.
- **Exporters:** These countries would need to focus on the development of export infrastructure and ensure that project locations are optimised to create export hubs in a manner that contributes to the development of the local (and regional) hydrogen economy.
- **Importers:** These countries would need to focus on developing import infrastructure, working with exporters to ensure they get access to affordable clean hydrogen, and developing downstream applications to ensure they have control over where hydrogen is used.

Southern Africa is geographically well positioned to be a major green exporter



Source: Sasol

A few countries in North Africa, notably Morocco, and in Southern Africa, notably Namibia and South Africa, would need to follow and adopt policy approaches as exporters of green hydrogen. For South Africa this would need to be a fine balance between local industry demands and the export market, but ultimately, it should aim to be a net exporter of cost-competitive green hydrogen. Southern African can develop both as an export hub and supply green hydrogen to the heavy industries situated in South Africa.



While only a few countries in Africa have the potential to become competitive hydrogen exporters, several others may develop into net importers of hydrogen (i.e. producing green hydrogen locally and importing additional green hydrogen to meet domestic demand).

In order to plan for the various scenarios and created a harmonised approach to the development of the hydrogen economy in Africa, it is essential to have a hydrogen roadmap for Africa that will ensure economic and infrastructure integration. For African countries that are part of the AfCFTA, developing national industrial policies in isolation without regard for regional and continental integration of industries will negate the benefits of the AfCFTA for deeper economic growth. As such, uniform regional policies will need to be developed that address how the barriers to a hydrogen economy will be dealt with on a regional level. As South Africa and Namibia are both considered markets that have significant prospects of becoming export hubs of green hydrogen, deeper co-operation between these two countries is important. Regional co-operation in the development of sound legal principles, the nature and type of incentives, infrastructure, and industry standards and certification should inform regional policies and filter into domestic laws. This is imperative for continental economic integration and for private sector parties to be in a position to take full advantage of the benefits under the AfCFTA's the protocols on goods and services. Regional value chains supported by robust and integrated regional policies that nurture emerging industries are imperative for Africa to realise the economic growth required to achieve Agenda 2063. As one of its action items under "*Hydrogen Export*" the HSRM does emphasise that regional co-operation/partnership on green hydrogen must be expanded. It is encouraging to see that the HSRM recognises the value of regional co-operation, as the economic potential for a regional and continental approach to the hydrogen economy will have a profound impact on the economic development of the continent.

Having said that, what is the right policy and regulatory framework to attract investors and unlock a country's hydrogen economy? The Hydrogen Council has identified six pillars for efficient policy design for clean hydrogen:

- **Make use of local strengths and benefit from cross-border co-operation:** Leveraging local strengths is an important starting point in policy design and should be complemented by cross-border co-operation and trade to unlock efficiency gains. In cases like Namibia and South Africa, which can be anchors for regional and continental development, it is imperative that uniform policy and regulatory frameworks be developed.

- **Create certainty through targets and commitment:** To drive down costs and attract investment, governments can help create certainty by developing legislation that reduces policy risks and market uncertainty. In establishing robust policies there must be learnings from other sectors to avoid future disputes with investors.
- **Provide hydrogen-specific support across the value chain:** To catalyse and grow new markets, hydrogen-specific support is required in production, midstream infrastructure, and end-use sectors like industry and transport.
- **Support robust carbon pricing:** Robust regional carbon pricing mechanisms should be built up from existing schemes, and work together with hydrogen-specific support, to drive efficient and effective uptake in the longer term, while mitigating carbon leakage.
- **Adopt harmonised certification schemes:** International standards and robust certification systems play a crucial role in the development of the hydrogen economy, enabling cross-border trade in hydrogen.
- **Factor in societal value and values:** Societal value and values can be factored into policy decisions. Well-designed hydrogen policies can make a positive contribution to several UN Sustainability Development Goals. As such, ESG standards are imperative. We consider this in more detail under the South African segment.

In framing and developing national policies and the necessary regulatory framework to attract investments, it will be important to put in place the six pillars identified by the Hydrogen Council. However, in doing so, it is also important for governments to be cognisant of the legal consequences that certain commitments or guarantees could have as a result of future economic, social or political changes in their countries. As such, the investment agreement concluded with investors must be carefully negotiated to mitigate against unforeseen risk. The investment frameworks of the country should also take into account existing (and future) investment commitments under bilateral or multilateral agreements that deal with issues such as:

- who qualifies to be an investor;
- what constitute an investment;
- expropriation, in particular the extent of the guarantees be provided (i.e. does it extent to indirect expropriation);
- whether fair and equitable treatment guarantees should be provided and, if so, the extent thereof (having regard to states' differing positions on fair and equitable treatment guarantees as provided for under the Draft Pan African Investment Code, which is understood to serve as a guide for the negotiation of the AfCFTA Investment Protocol);
- the extent of the most favoured nation guarantee to be provided, including issues around national treatment and full protection and security;
- investor obligations in relation the issues such ESG; and
- the legal recourse the state will provide in the event of a dispute, in particular access to investor state dispute settlement mechanisms in the form of consent to arbitration under the auspices of the International Centre for the Settlement of Investment Disputes

There are sound lessons to be learnt from the investor-state disputes in the extractive and energy sectors. If incorporated and properly balanced, these learnings would mitigate against the risk associated with large-scale capital investments. To attract capital investment for large-scale hydrogen infrastructure projects will require states to compromise as they are competing with other states, but this should not be a reason to not incorporate sound legal principles that, amongst other things, guarantee regulatory freedom for the state and balance the rights and obligations of the investor and state.

There is thus a delicate balance required in the policies, regulatory framework, investment guarantees and commitment a state provides to attract investments in hydrogen projects. In doing that, states must be cognisant that green hydrogen production and supply will become more competitive and be less lucrative than hydrocarbon (coal, oil and gas) production and supply in future, as it can be produced in any part of the world. For Africa, hydrogen could be a game changer if approached regionally, as it has the potential to materially impact Africa's industrialisation, allowing for investment in heavy industries such as the automotive industry, steelmaking, ammonia production and other complimentary downstream industries at net zero. With hydrogen, Africa could industrialise at net zero without compromising the climate and achieving sustainable development, thereby contributing to the realisation of Agenda 2063.

South Africa's Road to a Hydrogen Economy

BY MARGO-ANN WERNER, JACKWELL FERIS, LAURA WILSON AND ANTON ACKERMANN

Part 1: The global movement towards green economies and greener technology solutions

The year 2021 saw *"green hydrogen"* emerging as a popular buzzword associated with solutions to address climate change. Although the full realisation of a hydrogen economy, and green hydrogen specifically, will take time, the potential of hydrogen and the role that South Africa could play in its production and distribution are becoming a reality with several pilot projects already on the go. An exciting development in the green hydrogen space was the recent news of the confirmation of the German Government's proposed injection of €12,5 million to fund South Africa's green hydrogen development initiatives. This was announced by the Minister in the Presidency Party Mondli Gungubele on 17 January 2022 during a stakeholder engagement session in the Northern Cape, which is envisioned to be South Africa's new green hydrogen production hub with Gauteng being the domestic demand hub. These provinces will be the site of catalytic green hydrogen projects that can be realised with Germany's financial support, particularly in respect of South Africa's potential to produce sustainable aviation fuel for global export. Closely linked to green hydrogen production is the announcement of South Africa's first green ammonia project with the proposed establishment of a R75 billion green ammonia export plant in Nelson Mandela Bay in the Eastern Cape.

The kick-starting of South Africa's hydrogen roadmap, together with ongoing global initiatives to explore hydrogen technologies, could not be more critical in the context of increasing climate change concerns. A key outcome of COP26 was that the world is currently on the path to reach between 1,8 to 2,4ºC heating by 2030. In the same vein, the UN Secretary-General termed the Intergovernmental Panel on Climate Change Report published amid the global COVID-19 pandemic as a *"code red for humanity"*, with the pandemic having highlighted the climate change crisis and the impacts to vulnerable members of society.

In the context of this global crisis, one of the key enablers of a green economy is a clean energy and greener fuel transition. Sustainable energy in Africa is multifaceted, with financial, technical, political, legal, and practical issues to consider. In this regard, a just transition away from fossil fuels is a material consideration in the African context, and especially the South African context, where measures need to be put in place to ensure that those who are vulnerable and dependent on the fossil-fuel value chain are not burdened by the continent's clean energy transition.

In the imperative to move away from fossil fuel electrification and reliance by energy-intense large industry, thereon the implementation and expansion of renewable energy production is crucial. Over and above the need for cleaner energy production, there are energy end-uses that themselves require alternatives to fossil-fuel inputs, such as fuelling long-haul aviation and heavy freight transport. A key intervention that allows for a realistic transition from fossil-fuel reliance and still sees the use and sustainable upgrade of existing infrastructure is the advent of hydrogen.

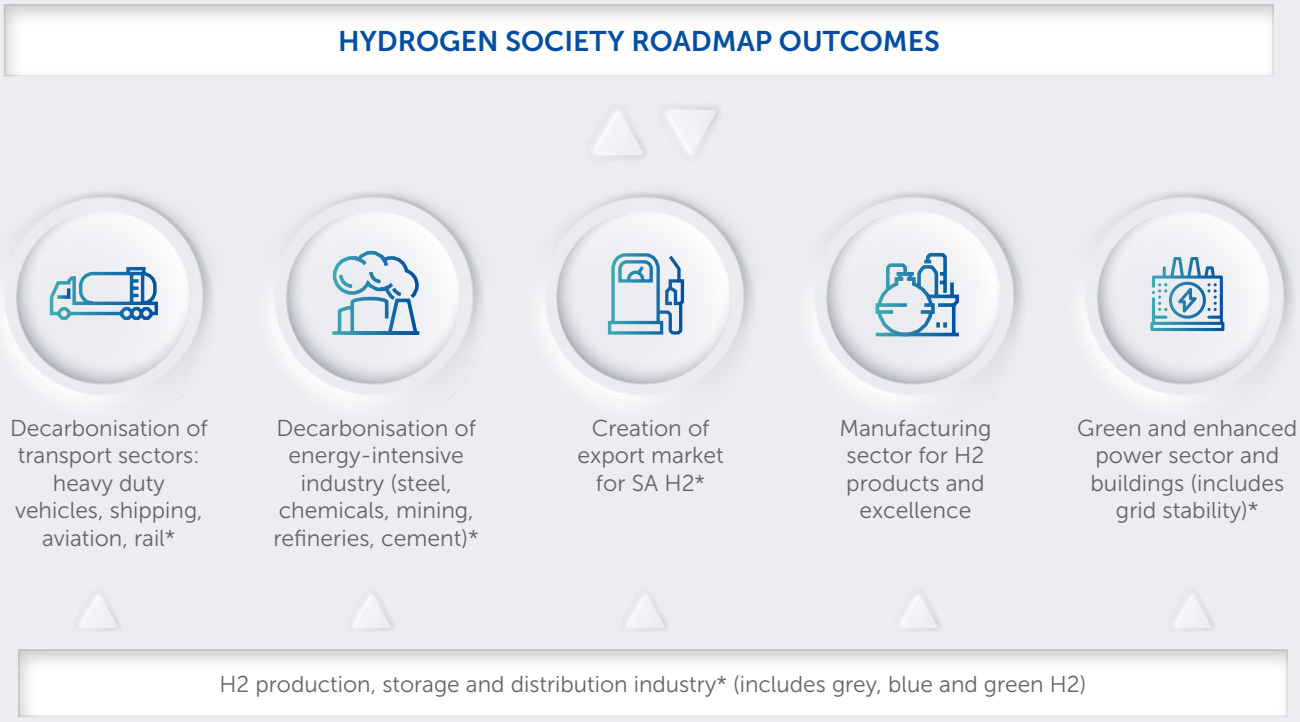
South Africa is well endowed with available land, wind, and solar resources to provide the energy sources for green hydrogen production and has the makings of suitable distribution infrastructure. Existing South African infrastructure will allow for the production of blue, grey, black, and brown hydrogen, with the possibility of pink hydrogen arising in light of existing plans for nuclear power projects. As such, South Africa is in a unique position to gain a competitive advantage in harnessing hydrogen with the added benefit of expanding the green hydrogen opportunities, and therefore carbon-free fuel, to assist in addressing South Africa's energy crisis and to fulfil South Africa's international climate change commitments.

Part 2: The road to unlocking the hydrogen economy in South Africa with the HSRM

The HSRM set out the South African Government's official strategy to unlock the hydrogen economy through the following high-level outcomes:

- Decarbonisation of heavy-duty transport.
- Decarbonisation of energy-intensive industry (cement, steel, mining, refineries).
- Enhanced and green power sector (main and micro-grids).
- Centre of Excellence in Manufacturing for hydrogen products and fuel cell components.
- Creating an export market for South African green hydrogen.
- Increasing the role of hydrogen (grey, blue, turquoise and green) in the South African energy system in line with the move towards a net-zero economy.

Goal: Just and inclusive net-zero carbon economic growth for societal wellbeing by 2050 (NDP)



Should the HSRM be successfully implemented in South Africa it is expected that the country could achieve just and inclusive net-zero carbon economic growth by 2050. A total of 70 priority actions have been identified and classified according to the high-level outcomes. As a lever for the change that will facilitate the realisation of these outcomes the following has been identified as imperative to deal with:

- Local and international demand for green hydrogen and green products.
- Compliance and regulation.
- Enabling infrastructure and policy that support hydrogen adoption and dis-incentivise alternatives.
- Attractive investment environment.
- Cost competitiveness with a focus on the levelised cost of green hydrogen.
- Corporate targets (e.g. carbon budgets).
- International commitments.
- Innovative culture and skilled workforce.

The must be achieved change through the following:

- Market development/business cases.
- Favourable and integrated policy, fiscal measures and regulatory environment.
- Financial framework that provides access to capital markets.
- Raw material availability, ranging from platinum group metals to water.
- National and international partnerships.
- Demonstration of pilot projects including industrial clusters.
- Research, development and innovation.
- Skills development.

HSRM has also outlined how South Africa intends to achieve its goals:

HYDROGEN PRODUCTION, STORAGE, DISTRIBUTION

Establish targets and policy signals

- Finalise Green Hydrogen Commercialisation Strategy to support HSRM.
- Revise NDCs taking into accound GH2 to support a move towards a net-zero economy especially in hard-to-abate sectors.
- Complete feasibility study on water resource availability and desalination.
- Complete feasibility studies on new H2 corrdors and valleys in SA.
- Finalise just Transition Framework.
- Develop grey H2 phase-out plan if green H2 reaches parity.

Mitigate investment risk

- Gazette Strategic Integrated Infrastructure Project on Hydrogen.
- Revise Critical Infrastructure Programme Framewok.

Harmonise standards and remove barriers

- Improvement of grey H2 infrastructure including technology upgrade.

Skills development and public awareness

- Establish an overarching body to coordinate relevant players in the quadruple helix around hydrogen economy.
- Develop a communication plan to promote awareness of hydrogen across all sectors.
- Develop framework for reskilling people and preserving jobs in sectors affected by transistion.
- Establish international partnership to scale up training required for hydrogen economy.
- Develop a skills development roadmap which spans across TVETs, UoTs and universities.

Promote RDI

- Develop RDI Strategy to support HSRM.
- Establish international partnership to support electrolyser research.
- Call for proposals on improving cost and efficiency of hydrogen solutions.

Strategic demonstration and development projects

- Pilot CCUS in Mpumalanga Priority Area.
- Pilot CCUS on a national scale.

Support demand creation

- Implement catalytic projects such as Boegoesbai SEZ, Platinum Vallery Initiative (SA's Hydrogen Valley) CoalCO.
- Demonstration and SAF project.

CREATION OF EXPORT MARKET FOR SA GREEN HYDROGEN

Establish targets and policy signals

- Develop hydrogen export strategy to inform business case for green H2 (including derivatives) export.

Mitigate investment risk

- Conduct market analysis identifying export opportunities, obstacles and gaps including potential partners and investors.
- Put in place international partnerships with key countries willing to purchase GH2.
- Expand regional cooperation/partnerships on GH2.
- Integrate H2 exports into existing natinal port and rail strategies.
- Invest in rail and port infrastructure to support GH2 export.

Harmonise standards and remove barriers

- Participate in relevant task teams on hydrogen certification and hydrogen trade rules of the IPHE.
- Review, develop and publish harmonized policy, regulations, codes to ensure GH2 export by 2024.

Promote RDI

- Invest in RDI focused on the most efficient generation, storage and shipping methods to make SA green H2 cost competitive.
- Continue to invest in RDI focused on the most efficient generation, storage and shipping methods to make SA green H2 cost competitive.
- Continue to innovate to remain globally competitive for GH2 export.

DECARBONISATION OF INDUSTRY

Establish targets and policy signals

- Develop policies and strategies that stimulate demand for hydrogen-related applications in the energy-intensive industries (mining, cement, steel, refineries).
- Align Steel Masterplan to the HSRM.

Mitigate investment risk

- Develop local market framework with incentives that support domestic consumption of GH2 and ammonia in industry.
- Feasibility studies on developing hydrogen industrial hubs at South African ports that link with shipping truck and aviation routes.
- Provide incentives for companies to start using GH2 and ammonia for power generation to create domestic demand.

Harmonise standards and remove barriers

- Reduce the administrative timelines required for approval for self-generation projects.

Skills development and public awareness

- Establish a national Hydrogen Industry Association tasked with advocacy for hydrogen and stimulating investment in the industrial sector.

Strategic demonstration and deployment projects

- Convert heavy goods vehicles (HGVs) for mining into the hydrogen fuel cell powered vehicles as part of showing proof of concept.

DECARBONISATION OF TRANSPORT SECTORS

Mitigate investment risk

- Create an enabling environment for investment in refueling infrastructure.
- Classification of hydrogen as a transport fuel.

Harmonise standards and remove barriers

- Develop policy and regulatory framework that incentivizes or rewards transport users that use hydrogen as a fuel to generate scale.
- Develop regulations, codes, and standards of hydrogen refueling.
- Develop regulatory framework to support zero emission transport across all modes (roads, rail, ship).

Support demand creation

- Conduct feasibility studies to develop demand-driven business cases for municipal transport, heavy good vehicles, buses and taxis.
- Scale up conversion of government fleets and municipal vehicles to use hydrogen as a fuel.

Strategic demonstration and deployment projects

- Implement refueling station pilots for buses, heavy goods vehicles and taxis.

CENTRE OF EXCELLENCE IN MANUFACTURING

Establish targets and policy signals

- Finalise Beneficiation Masterplan.
- Conduct study and develop export strategy for H2 products and PC components.
- Develop GH2 product and component manufacturing strategy and business cases aligned with Automotive Masterplan and Minerals Masterplan.

Harmonise standards and remove barriers

- Adopt and implement regulatory framework including establishing independent H2 product and component testing and verification facilities.

Support demand creation

- Develop a policy framework that incentivizes the use of locally manufactured components in various applications (PC vehicles, stationary PCs, electrolysers).

Mitigate investment risk

- Develop and implement RDI strategy to support H2 product and component manufacture.

Skills development and public awareness

- Identify skills needed to support the implementation of the manufacturing strategy and develop a skills development roadmap.

ENHANCED AND GREEN POWER SECTOR

Establish targets and policy signals

- National electrification plan to be divided into main and micro-grids.
- Finalise the Renewable Energy Masterplan.
- Update the NDCs to align with HSRM with a specific focus on the power generation sector.
- Prepare a position paper to specifically fund H2 use in subsectors (building, micro-grids).

Harmonise standards and remove barriers

- Develop a national set of standards on energy within the built environment to enable use of H2 in buildings.
- Incorporate and couple H2 production into existing PPA.
- Revise IRP to include hydrogen gas for power generation.

Support demand creation

- Subsidies to telco applications for PC deployment to scale up.
- Use public procurement to stimulate hydrogen and PC demand in public buildings sector.
- Adopt hydrogen and PCs to power critical infrastructure.
- Connect households to either main or micro-grids PCs.

Promote RDI

- Solar Research Facility plan approved for funding.

Strategic demonstration and development projects

- Pilot CCUS in Mpumalanga Priority Area.
- Pilot CCUS on a national scale.

Skills development and public awareness

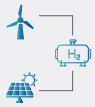
- Create awareness of hydrogen economy through different building-ralated bodies around H2 and HFCT in buildings.
- Create a marketing and advocacy plan for hydrogen use in the electricity sector (main, micro-grid).

The envisaged road to 2050 for South Africa:

2021-2024

Production

- Small scale electrolysis production.
- At least 1MW GH2 production piloted.



Use

- At least 100 buses and trucks powered by H2 by 2025.
- At least 20 forklifts converted to fuel cell power by 2025.
- At least five refueling stations deployed by 2025.
- Demonstration in power generation and stationary fuel cells in public buildings.
- Industry demonstration including SAFs.

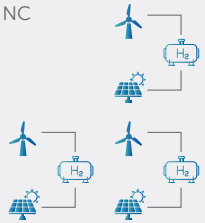
Jobs

- Upscaling of training and reskilling for new jobs.

2025-2030

Production

- 5GW electrolysis capacity under construction in NC.
- 10GW electrolysis capacity deployed in NC by 2030.
- 1,7GW electrolyser capacity deployed in H2 Valley by 2030.
- At least 500kt H2 produced annually by 2030.



Use

- At least 500 buses and trucks powered by H2 by 2030.
- Power generation in turbines using H2 and ammonia.
- Sector coupling and use in transport, industry.

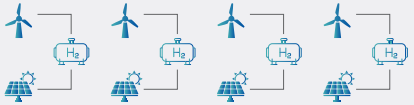
Jobs

- At least 20,000 jobs created annually by 2030.

2030-2040

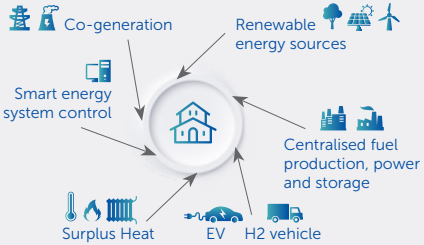
Production

- Increase electrolysis capacity to at least 15GW by 2040.



Use

- Sector coupling and full use in transport, industry and power.



Jobs

- At least 30,000 jobs created annually by 2040.

Establish targets and policy signals

Support demand creation

Mitigate investment risk

Harmonise standards and remove barriers

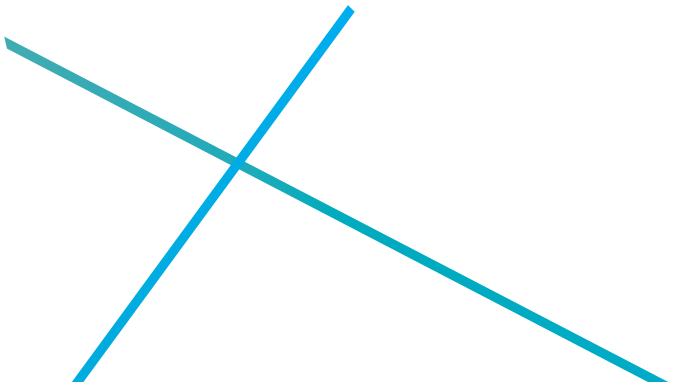
Promote research, development and innovation

Strategic demonstration and deployment projects

Skills development and public awareness

Part 3: South Africa's international climate change commitments, COP26, and their link to hydrogen

South Africa is a signatory to the Paris Agreement, which was the first universal, legally binding global climate deal that seeks to accelerate the reduction in global GHG emissions. South Africa has set its nationally determined contribution (NDC) under the Paris Agreement. The first NDC under the Paris Agreement was published in September 2021, with a 2025 target range that allows for the implementation of South Africa's national mitigation system that includes the Climate Change Bill, the Integrated Resource Plan, 2019 and a national recovery from COVID-19. The latest updated draft NDC published in March 2021 sets out South Africa's GHG emission targets, finance support requirements and long-term decarbonisation plans, and makes provision for the implementation of National Climate Change Adaptation Strategy interventions for certain priority sectors. The suite of legal and policy interventions includes the Climate Change Bill, the Low Emissions Development Strategy, and the National Climate Change Adaptation Strategy.



The creation of the Presidential Climate Change Co-ordinating Commission as well as work on climate finance were all done in preparation for COP26, during which South Africa committed to net-zero carbon emissions by 2050. Some of the key outcomes of the conference were the Paris Agreement Work Programme, an annual mitigation ambition work programme, and the Just Transition Partnership, which was set up to balance the need to transition to a low carbon economy by South Africa with France, Germany, the UK, the US, and the European Union (EU). The partnership mobilised an offer of R131 billion to support a just transition over the next three to five years, although the offer remains to be finalised.

The commitments from COP26 implicating green financing will significantly impact South Africa and the rest of the African continent. Considering the land availability and renewable energy potential on the continent, along with the aging existing infrastructure in South Africa, including old mines and coal-fired power stations nearing the end of their lives, hydrogen has significant potential to attract green finance from developed nations. In this regard, Namibia and Germany have already entered a hydrogen partnership where, through co-operation, green hydrogen technologies can be explored in locations where hydrogen technologies already exist. The German Development Bank KfW and the German Government have similarly recognised that South Africa has comparable competitive advantages, which has resulted in their funding of South Africa's green hydrogen development initiatives in the Northern Cape and Gauteng.

Part 4: An overview of South Africa's environmental legal framework as an enabler of hydrogen development

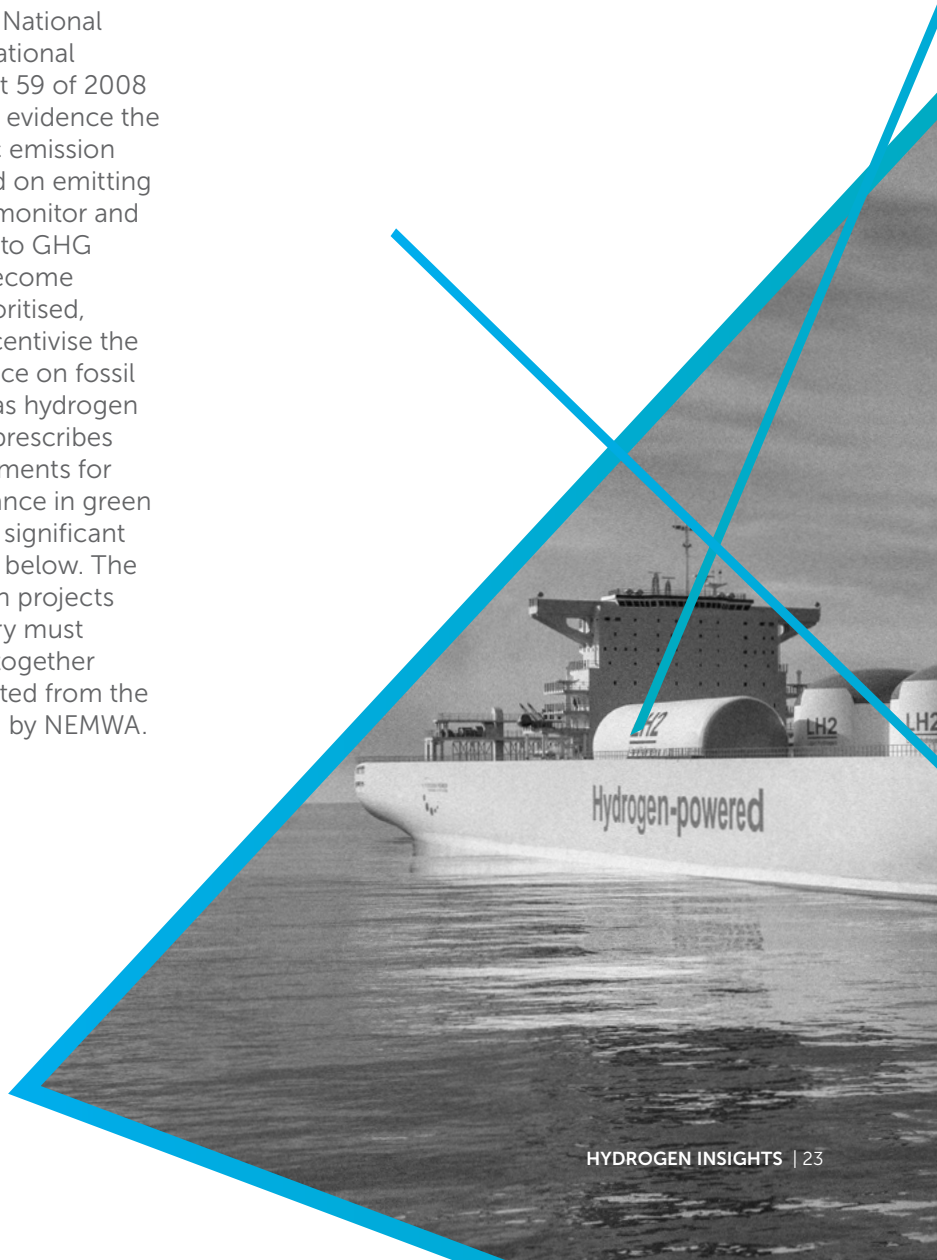
The National Environmental Management Act 107 of 1998 (NEMA), South Africa's primary environmental statute, provides for various principles that align with just transition objectives and its move towards a green economy. The pursuit of environmental justice, equitable access to environmental resources for historically disadvantaged people, and the promotion of community well-being and empowerment are but a few of the principles highlighting the social pillar of sustainable development and what makes a transition "*just*", along with the constitutional right to an environment that is not harmful to health and well-being.

The following fundamental principles contained in NEMA are of relevance. First, the "*polluter pays principle*" provides that the costs of remedying, preventing, controlling, or minimising pollution and environmental degradation must be paid for by those responsible for harming the environment. Second, NEMA places a general duty of care on any person who causes, has caused, or may cause significant environmental pollution or degradation, to take reasonable measures to prevent, minimise and rectify the pollution or degradation. Third, NEMA gives effect to a cautious approach to the assessment and management of environmental risks, known as the precautionary principle. Specifically, NEMA provides that sustainable development requires a consideration of all relevant factors, including that a risk-averse and cautious approach must be applied considering the limits of current

knowledge about the consequences of decisions and actions. The introduction of hydrogen production, which will: be used in place of fossil fuels; stimulate renewable energy production and sustainable repurposing of existing infrastructure; and result in the minimisation of atmospheric emissions and GHG emissions, amounts to an observance of the precautionary principle, and a failure to take such precautions in the context of the protection of environmental rights will violate the NEMA duty of care and trigger the polluter pays principle.

The EIA Regulations published in terms of NEMA set out criteria that must be considered in applications for an environmental authorisation (EA), which is a licence that must be obtained if certain listed activities which have been recognised to have a detrimental impact on the environment are triggered by a project (EA Listed Activities). One of the key criteria prescribed by the EIA Regulations is the consideration of alternatives. This criterion encourages hydrogen development as a feasible fuel alternative. In the role hydrogen has in the renewable energy sector, a complementary dynamic arises where, in one vein, a demand for green hydrogen will drive the development of more renewable energy projects required for green hydrogen production and, in another vein, a hydrogen-based electricity storage system can be relied on that allows for the storage of renewable generated energy. In this regard storage technologies involving lithium batteries and pressurised hydrogen tanks are being explored, as well as solely hydrogen-based storage solutions which have a far greater storage capacity than batteries.

There are also various Specific Environmental Management Acts (SEMAs) and their associated suite of legislation that further the NEMA principles and support sustainable hydrogen solutions. The National Environmental Management Act: Air Quality Act 39 of 2004 (NEMAQA), the National Water Act 36 of 1998 (NWA) and the National Environmental Management: Waste Act 59 of 2008 (NEMWA). NEMAQA and its regulations evidence the importance of minimising atmospheric emission generation and the requirement placed on emitting entities to accurately and consistently monitor and report on them, particularly in relation to GHG emissions. As compliance standards become more stringent and enforcement is prioritised, penalties for noncompliance will disincentivise the continuation of existing emitters' reliance on fossil fuels and incentivise alternatives such as hydrogen production and use. The NWA, which prescribes permissible water uses and the requirements for authorisations and licences, is of relevance in green hydrogen projects which currently use significant amounts of water, as discussed further below. The high water demands of green hydrogen projects in the context of a water-scarce country must therefore be given due consideration, together with the management of waste generated from the production process, which is regulated by NEMWA.



Climate change has become a relevant factor forming part of the EIA process. The Minister of DFFE published the Draft National Guideline for Consideration of Climate Change Implications to be relied on in applications for EAs, atmospheric emission licences, and waste management licences. The guideline will create a consistent approach to climate change impact assessments in all sectors. Although it functions as a guide to best practice, as opposed to being an enforceable statute, it sets out the minimum requirements and generic principles for involving climate change specialists in the EIA process; defines the roles of the environmental assessment practitioner, specialists, and other stakeholders; and outlines the extent and content of climate change impact assessments, and, to this end, it plays an important role in climate change mitigation practices.

The Climate Change Bill forms an integral part of the legislature's commitment to fostering a green economy and seeks to prescribe climate change mitigation and adaptation measures. The bill, a version of which was first published in 2018 (2018 CC Bill) and further iterations published in 2021 and 2022 (2022 CC Bill), provides for the Minister's publication of a notice setting out a list of GHGs that are reasonably believed to cause or are likely to cause or exacerbate climate change, as well as a list of activities that emit one or more of the listed GHGs. This notice is envisioned to further determine quantitative GHG thresholds expressed in a "*carbon dioxide equivalent*" to identify the entities to which a carbon budget must be assigned, who must annually report on the progress against their carbon budget, and the entities that are required to submit GHG mitigation plans. Notably, provisions in the 2018 CC Bill allowing for an extension for carbon budget compliance have been removed in the 2022 CC Bill, which previously envisioned that companies "*under extreme circumstances*" would be permitted to apply to the Minister to extend the compliance timeframes of their allocated carbon budgets. The 2022 CC Bill prescribes penalties for noncompliance with, amongst other things, greenhouse gas mitigation plan requirements, and if an entity's GHG emissions exceed the maximum emissions prescribed in its allocated carbon budget during the applicable period, it will be subjected to a higher carbon tax rate on the exceeded emissions as provided for in the Carbon Tax Act 15 of 2019 (Carbon Tax Act). The Climate Change Bill will therefore need to be read together and implemented (once promulgated) with the Carbon Tax Act, NEMA, NEMAQA and the various other SEMAs to achieve a just transition, and points to the integrated nature of South Africa's environmental legislative framework that will need to be considered during hydrogen project development.

In order to support the creation of demand for clean hydrogen in South Africa, the HSRM proposes that a robust approach be adopted that provides for stringent emissions standards, under NEMAQA, to enable the rapid introduction of clean hydrogen production technologies across the economy and in particular for diesel vehicles, which predominate in heavy-duty transport and have a direct impact on local air quality. With that there must also be linkages between stringent environmental regulations as an incentive for people to buy electric vehicles (e.g. hydrogen fuel cell electric vehicles) in South Africa. Automobile manufacturers in South Africa should also be incentivised to move from exporting of internal-combustion vehicles to exporting electric vehicles for key markets for South Africa (EU, the UK and North America) based on the planned reduction/ceasing of such imports by 2030 by these markets in response to climate change requirements.

With the increase in climate change related laws and policies, there is a greater regulatory burden on high emitters and the general use of fossil fuels. It is expected that the onus of the burden will incentivise a low-carbon economy transition and associated initiatives, with green hydrogen presenting an opportunity to create financial benefits and cost savings from the transition. Notwithstanding that South Africa's regulatory framework provides an enabling platform for these and other benefits, there are certain regulatory hurdles to consider when looking toward green hydrogen project development.

Part 5: Environmental permit requirements and potential hurdles

The potential legal hurdles in relation to green hydrogen projects will be dependent on the nature of the project, the intended product, and the location, which will require comprehensive project-specific impact assessments. As noted above, the EIA Regulations require that an EA is obtained before the commencement of EA Listed Activities. Various activities associated with the production of green hydrogen will likely trigger the need for an EA, and given the scale of green hydrogen projects, which are significantly larger than renewable energy generation facilities, the EAs issued for green hydrogen projects might include onerous conditions that hamper implementation.

The production of green hydrogen by way of electrolysis will likely require a water use licence (WUL) in accordance with the NWA, as the production requires large volumes of water, and could trigger a number of water uses such as the abstraction and storage of water, and the disposal of waste or water containing waste. The time delays associated with the approval and issuing of WULs also presents a hurdle, although the time constraints may be addressed through the DFFE's new truncated decision-making period of 90 days. Further, as hydrogen is explosive, it will attract numerous requirements prescribed by national, provincial, and municipal legislation that are associated with the use and storage of hazardous flammable substances.

Depending on the location, type and volume of water used, licences may be required for the treatment of wastewater for inland projects. Coastal desalination projects would require permits triggered by desalination activities, additional zoning requirements, and a coastal water discharge permit in terms of the National Environmental Management: Integrated Coastal Management Act 24 of 2008. Over and above the material environmental permit requirements that will be applicable, other ancillary but important consents will also be applicable which relate to the transportation of dangerous goods and substances by road, as well as permits prescribed by municipal bylaws.

Fossil-fuel related projects such as the development of coal-fired and gas-powered energy facilities as well as exploratory activities such as seismic surveys, are and will continue to be subject to public and private scrutiny and legal challenges. Environmental permitting is particularly susceptible to legal challenges as without these material consents, development cannot be realised. This is not to say that hydrogen related projects won't face challenges, but their very development is already an observance of preventative measures being observed. Impact assessments and especially the requirement for meaningful public participation will play a vital role in mitigating any challenges and working closely with impacted stakeholders.

Part 6: Environmental benefits, opportunities and risks related to hydrogen production, use and distribution

Novel hydrogen technologies bring new challenges to developers, investors, lenders, environmental assessment practitioners and regulators as the risks and impacts associated with hydrogen production, and specifically green hydrogen, requires further research. Hydrogen is extremely flammable and must be stored in high pressure tanks. Storage requirements are also limiting as hydrogen cannot be transported as easily as petroleum products and gas, and the transporting of hydrogen also presents significant safety risks, particularly in the context of collisions. Further, the production of hydrogen presents unique environmental challenges because it is a water-intensive process that not only requires large volumes of water, but also high-quality treated water. The use of water treatment plants may result in significant brine discharge. The desalination of sea water is considered a viable water resource option for

hydrogen production and offers an opportunity not only for further infrastructure development but possible opportunity to mitigate South Africa's water shortages. One significant by-product associated with desalination, however, is the salt-rich effluent (brine) produced during the process, which is then discharged into the ocean and this effluent generation will need to be weighed up in the impact assessments. The construction of a desalination plant may trigger an EA Listed Activity, subject to the production capacity, while the discharge of the brine may also trigger the coastal water discharge permits mentioned above. The movement to green hydrogen will also allow the desalination process to be powered by renewable energy from which the hydrogen itself is generated, allowing for a clean circular process.

In the move towards green economies, it has become apparent that there is a need to not only introduce new emission reduction technologies and "*green*" energy sources, but also to find solutions and adopt new practices that allow our existing infrastructure to be repurposed, and which work in parallel with and bolster other green energy generation models. Considering that South Africa has one of the highest renewable energy generation potentials in the world and with existing infrastructure in place, the opportunity exists to invest in electrolysis technology. This would also support the platinum sector as platinum is a required raw material for both fuel cell and electrolyser manufacturing. Given that South Africa holds most of the world's platinum reserves, and is the world's largest producer of platinum, there is an opportunity for it to be a leading contributor in the manufacturing of the underlying technology. In terms of repurposing, establishing hydrogen production facilities at existing mines and coal-fired power stations, for instance, may offer the opportunity to treat wastewater and contribute to combatting acid mine drainage where treated contaminated water can be used for green hydrogen production.

The use of hydrogen will play a critical role in the transition of the transport sector, which currently accounts for more than 20% of global carbon emissions. In this regard, hydrogen can be used as fuel for long-haul aviation, maritime shipping, certain road vehicles and heavy freight transportation. Further, hydrogen can be used as an intervention in other industries such as steel production and in cement making; it can be used as a cleaned-up chemical feedstock in processes such as fertilizer production; it can contribute, as mentioned above, to the flexible dispatch and long-duration storage needs of a high-renewables electricity grid; and it can support context-specific decarbonization requirements.

A notable practical benefit to green hydrogen usage is that its distribution and storage can be linked to that of natural gas, as hydrogen can be stored in aboveground tanks and transported in gaseous form via pipelines, liquified for shipment, or even converted into denser forms such as ammonia. Establishing widescale pipeline distribution is key to enabling a high-penetration hydrogen economy. In this regard South Africa's establishment of and upgrades to national and provincial pipeline infrastructure remain a priority as pipelines are conducive to hydrogen distribution, which can be carried out in a manner similar to, and potentially together with, the existing distribution and use of natural gas. Again, this presents an exciting opportunity in terms of infrastructure expansion and development.

Part 7: Environmental social and governance objectives and green financing in relation to hydrogen opportunities

While ESG standards may initially have seemed somewhat abstract, ESG is becoming an increasingly tangible and vital custom in corporate society, capable of swaying investor appetite and developer innovations towards "*greener*" and more socially responsible projects. The more investment capital is reserved for "*greener*" developments, the more developers will focus on projects that align accordingly.

ESG has become the foremost investment consideration and financial institutions are required to weigh up short-term costs (which are often extensive) with long-term benefits (that may likely be unquantifiable). Further, institutions need to design and implement ESG strategies that amount to the "*tools*" to practically implement ESG objectives, without which the objections may remain nebulous and ineffectual. Considering hydrogen's versatile application and its emission-reducing potential, it could form a key component of impactful ESG strategies and stimulate investment in hydrogen projects for their ESG potential.

For example, hydrogen could be incorporated into projects with high revenue-generation potential to make them appealing targets for impact investing, which is one of the more common ESG strategies. Examples of such projects include algae farming in South Africa's coastal waters, as algae growth produces hydrogen as a (green) by-product, or repurposing existing gas transmission infrastructure for green hydrogen distribution. Another strategy is improved data analysis, as one of the main barriers to companies implementing ESG initiatives is the lack of data available regarding its (mainly financial) benefit. By improving data analysis techniques, companies will be better equipped to introduce tailored ESG objectives that also result in financial gains, including those involving hydrogen.

While hydrogen has major potential in terms of technology innovation, sustainable repurposing existing infrastructure, job creation, economic recovery, and overall contribution to reducing GHG emissions, the extent of the potential, the cost, and implementation constraints all require further investigation. By bettering and increasing research and investigation into ESG motivated projects such as hydrogen technology and development, companies can confidently develop and hopefully easily access investment in green hydrogen projects that will bolster their ESG ratings that actually, and not superficially, reflect meaningful impacts.

Although the application of ESG criteria appears to primarily feature at the investment decision level, it also plays a vital role in any company's day-to-day operations. Offering a competitive advantage, ESG observance at business level will naturally also be more attractive to ESG-committed investors and lenders. ESG implementation may have reputational benefits and risks risk of reputational harm if the ESG goals or outcomes are overstated or otherwise misrepresented. To tie back to the need to be conscious of the appetite for increased civil challenges against the environmental impacts of infrastructure development, stakeholders, including environmental and community interest groups, are already holding investors and corporates accountable, scrutinising environmental and social monitoring reports, publicly criticising failures to provide transparent disclosures and instituting ESG related litigation. In South Africa in particular, with its development needs and just transition approach, these challenges are likely to arise irrespective of the robustness of an ESG-led investment decision.

Ultimately, in all ESG initiatives there needs to be a balance between responsibility and profitability, but there also needs to be a mindset shift to where costs are viewed as investments. The introduction of green hydrogen production technologies will be extremely capital intensive and will not be without challenges and barriers, particularly in the context of South Africa's economic, political, and social constraints. That notwithstanding, hydrogen presents a key opportunity to synergise sustainability and profitability and is therefore perfectly aligned with South Africa's just transition goals.

The Road to Green Hydrogen in Kenya

BY CLARICE WAMBUA, NJERI WAGACHA AND JOHNSTONE ODEYA

As discussed earlier in the publication, green hydrogen is currently viewed as the next big thing in energy, a game changer for meeting the world's growing energy demands. As a clean alternative to fossil fuels, green hydrogen also offers significant opportunity for the decarbonisation of important sectors for Kenya and the East African region.

Kenya's potential for green hydrogen production

Kenya benefits from having an abundance of the elements required to develop green hydrogen: electricity, water, wind and solar.

According to 2021 data from the Energy and Petroleum Regulatory Authority (EPRA), about 73% of the country's land mass experiences an average wind speed of about 6m/s or higher at a 100m above ground level. The average wind speeds on about 28228km^2 range between 7,5 and 8,5m/s while about 2825km^2 experiences wind speeds ranging between 8,5 and 9,5m/s. As such, Kenya has great potential to produce electricity from wind.

With regards to hydro power, Kenya is endowed with various water resources.

According to EPRA, Kenya's currently installed large hydropower capacity is 826,23MW. This is in addition to small hydro potential with an estimated capacity of 3000MW. Of this, less than 30MW has been exploited and about 15MW supplies the national grid. This further shows that there is great untapped potential that Kenya could exploit to generate hydropower for the purpose of producing green hydrogen.

EPRA also reports that in addition to abundant wind and water resources, Kenya's daily insolation is 4 to 6kWh/m^2. Despite this great potential, only a small portion (1% of the country's energy mix) has been utilised. The estimated solar potential in Kenya is about 15000MW. Of this, the installed capacity is 100MW. The northern part of Kenya experiences the highest solar intensity. Therefore, taking advantage of all these resources would go a long way in supplying sufficient electricity to produce green hydrogen in the country.

Currently, electricity generation sources in Kenya are mainly renewable, with geothermal, which generates over 40% of Kenya's power, being the main source of energy. Hydro, wind and solar also contribute significantly at 34,22%, 14,05% and 0,73% respectively, according to Kenya Power and Lighting Company's 2021 Annual Report.

However, the production of green hydrogen does not solely rely on the availability of renewable sources of energy. In its 2020 Guide to Policymaking on Green Hydrogen, the International Renewable Energy Agency (IRENA) highlights that the production of green hydrogen requires a dedicated transport infrastructure, capital to manage the high production costs, and a reliable market, among other factors.

While developing and middle-income countries like Kenya do not as yet have all the essential ingredients to drive a hydrogen economy, political will and interest in green hydrogen is high.

For example, in his speech at COP26 in Glasgow, President Uhuru Kenyatta affirmed Kenya's commitment to fully transition to clean energy by 2030. To achieve this, the President indicated that the Kenyan Government intends to tap into other sources of clean energy, such as green hydrogen.

To affirm its commitment, at COP26, Kenya was among 42 countries that endorsed the ground-breaking Glasgow Breakthrough Agenda, an international clean technology plan to help achieve the Paris Agreement of 2015 where world leaders at COP21 agreed to take steps to limit the increase in global temperature to 1,5 degrees Celsius. The Glasgow agenda set out common targets known as "*Glasgow Breakthroughs*" for 2030 to accelerate the innovation and deployment of clean technologies in five key sectors of global economies, including hydrogen.

Kenya's steps towards green hydrogen production

Kenya has begun its journey towards a green hydrogen future and in 2021 conducted a yet unpublished baseline study on green hydrogen production and utilisation in the country. There are also plans underway for the piloting of green hydrogen projects to assess the feasibility of large-scale green hydrogen production in Kenya. To drive the process towards a green hydrogen economy, a national green hydrogen working group made up of stakeholders from both the public and private sectors, has been set up and planning has begun for a roadmap on the future of green hydrogen in the country that will be used in formulating policy on the subject.

While there are no laws or policies regulating the production, storage, and distribution of green hydrogen in Kenya, the existing general legal framework supports the adoption and utilisation of clean energy in the country.

One example can be found in Kenya's taxation framework. Under the Value Added Tax, 2013, the importation of windmills is not subject to import duty or value-added tax (VAT) while hydraulic turbines and water wheels do not attract any import duty but 16% VAT. Furthermore, the Finance Act 2021 reinstated VAT exemptions on renewable energy equipment, such as solar and wind generation equipment, by scrapping the imposition of 14% VAT on the equipment which had been introduced by the Finance Act, 2020. These tax reliefs are critical for persons seeking to invest in green hydrogen since its production relies on wind, solar, and water generated electricity.

In order for the country to implement real change in this sector and meet its obligations in this respect, Kenya must address the issues that hinder the production of green hydrogen. These include the high cost of production, the lack of an enabling infrastructure, and the lack of market, among other factors. The first critical steps Kenya should take are outlined below.

The development of a stand-alone green hydrogen policy and strategy

The IRENA guide on developing policy on green hydrogen advises that some of the key pillars of a green hydrogen policy are a national hydrogen strategy that outlines the support required for producing and using green hydrogen; a set of priorities with regards to the production and use of green hydrogen; and a policy which establishes a governance system and a mechanism to integrate green hydrogen into the larger energy framework. In developing its policy, Kenya should consider all these pillars and use the examples set by other countries such as France and Namibia.

France has developed a Green Hydrogen Plan 2020–2030 setting out the country's long-term plan to achieve mass production of green hydrogen by 2030. Some of the target sectors in the plan are transport, heavy metal industries, aviation, and other energy intensive sectors. In addition to identifying target sectors, the plan also sets a target of green hydrogen production capacity at 6,5GW, which would save 6MT CO2 emissions by 2030. Moreover, the plan identifies various market opportunities including large group energy suppliers, start-ups and small and medium enterprises, and the public sector.

In addition, France has a national hydrogen strategy that focuses on three areas: French electrolysis, production of hydrogen-controlled vehicles, and support for research and innovation on green hydrogen, while at the same time recognising the role of the private sector in the production of green hydrogen.

Due to its clear plan and strategy on green hydrogen production, France has attracted private sector players who have shown interest in investing in green hydrogen production. For instance, Total Energies and Engie signed an agreement to design, develop, build, and operate France's largest renewable energy production pilot project at Châteauneuf-les-Martigues in the Provence-Alpes-Côte d'Azur region in the south of the country. The 40MW electrolyser will produce about 5 tonnes of green hydrogen daily.

Closer to home, Namibia broadly has a green hydrogen policy and strategy that identifies private sector players as key in the implementation of its green hydrogen production. Furthermore, the policy identifies both local and international markets for green hydrogen exports. These provisions have attracted international players to partner with Namibia's government in the production of green hydrogen, solidifying the African country's forerunner status in green hydrogen.

The exploration of regional and international collaborations

The process of producing, storing, and using green hydrogen is capital intensive. As such, funding from collaborative efforts between countries and governments can assist in spearheading Kenya's investment in green hydrogen. This approach is being applied in Egypt and Namibia in their pilot green hydrogen production projects with the signing memoranda of understanding.

There is scope for Kenya to collaborate with countries that have demonstrated interest in supporting green hydrogen development projects in developing countries. Besides collaborations with international players, regional collaborations on the African continent would be beneficial. These could be within the East African community to support the development of green hydrogen transportation system to access regional markets. Kenya may also consider partnerships fronted by trading blocks. For instance, the Common Market for Eastern and Southern Africa collaborating with the Southern African Development Community. The AfCFTA would also help Kenya to access a wider market.

The implementation and learning from pilot projects

Pilot projects play a crucial role in promoting the development of green hydrogen. Essentially, pilot projects test the viability of implementing a project on a full scale.

Outcomes from a pilot project inform policymakers about issues such as licencing, electrolyser capacity targets, transportation, and storage of green hydrogen. Further, a pilot project would assist in developing infrastructure and identifying potential market targets to explore. Private sector players would also be motivated to invest in green hydrogen following the outcomes of a pilot project.

The pilot projects that Kenya is considering are therefore a good opportunity to introduce and promote the production and use of green hydrogen, including developing storage and transportation infrastructure for both local and international markets and creating awareness about the use of green hydrogen locally.

Conclusion

Kenya is well placed to produce green hydrogen, which will contribute to the country's goal to reduce emissions to 32% by 2030, as outlined in Kenya's updated NDC, submitted to the UNFCCC in December 2020. Local high emission sectors such as the industrial processing sector and the transport sector, among others, would benefit greatly from green hydrogen production.

In addition to reducing emissions and providing energy security, the production and use of green hydrogen would provide job opportunities for local populations along the production and distribution value chain.

Should the push for hydrogen gain significant momentum in the country, it also offers an opportunity for Kenya to potentially become a hydrogen exporter by developing export-oriented hydrogen projects. It has been said that nothing is more powerful than an idea whose time has come, and Kenya is embarking on the path towards a green hydrogen future aware of the opportunities that abound and needing more clarity on how to fully embrace these for a more sustainable future.

Snapshot: Major Green Hydrogen Projects In Southern Africa

BY STEFAN ZIMMERMAN AND JACKWELL FERIS

Southern Namibia Hydrogen Plant

Namibia is seizing the economic opportunity presented by the production and distribution of green hydrogen and PtX products to several global markets, notably Europe. The south of Namibia has a competitive advantage in the production of green hydrogen due to the quantity of days that it has natural sunlight and wind, which are key factors for generating cost-competitive renewable energy. Namibia was one of the first Southern African countries to recognise this potential and has entered into strategic bilateral agreements with several countries, including Germany, the Netherlands and Belgium, to develop its green hydrogen export potential.

The coastal town of Lüderitz in southwestern Namibia has been identified as a major development zone for the production of hydrogen and the first large-scale vertically integrated green hydrogen project is planned to be developed in the Tsau //Khaeb National Park, subject to a feasibility study. The Tsau //Khaeb National Park has been identified as being among the top five locations in the world for the production of cost-competitive green hydrogen, benefitting from a combination of co-located onshore wind and solar resources near sea and land export routes to the global market. The Namibian Government has issued a notice of award to appoint Hyphen Hydrogen Energy (Hyphen) as the preferred bidder to develop the vertically integrated green hydrogen project. This project is estimated at USD 9,4 billion and will ultimately produce 300,000 tonnes per year of green hydrogen for regional and global markets, either as pure green hydrogen or in derivative form (green ammonia). The agreement with Hyphen will afford it the right to construct and operate the project for a 40-year period following the conclusion of the feasibility study and sign-off from the Government.

The first phase of the project, which is expected to begin in 2026, will see the creation of 2GW of renewable electricity generation capacity to produce green hydrogen for conversion into green ammonia, at an estimated capital cost of USD 4,4 billion. Further expansion phases in the late 2020s will increase the combined renewable energy generation capacity to 5GW and 3GW of electrolyser capacity, increasing the combined investment to USD 9,4 billion.

Once the plant is fully developed, the project will provide a significant boost to the Namibian economy in terms of foreign direct investment and job creation. The USD 9,4 billion investment amounts to the same magnitude of the country's current GDP, and the project will see the creation of nearly 15,000 direct permanent jobs during the operational phase. Further, in addition to taxes, Hyphen will pay concession fess, royalties, a sovereign wealth fund contribution and an environmental levy to the Namibian Government.

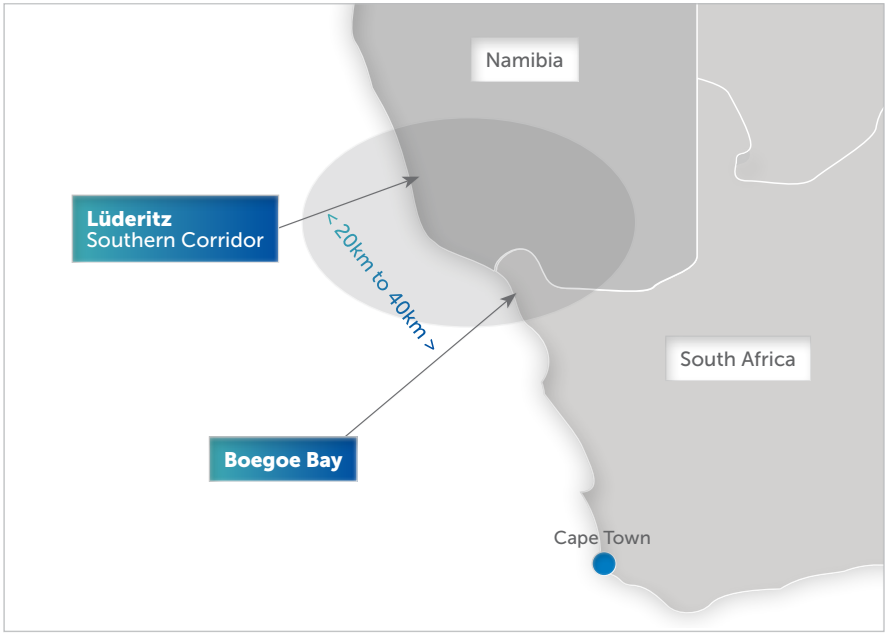
In addition to the hydrogen plant, the Namibia is planning to fund, via a private-public partnership, the development of a new deep-water port to export its hydrogen via sea freight to the global market.

South African hydrogen production

Sasol is the leading player in future of hydrogen production in South Africa and has announced the development of the Boegoe Bay green hydrogen project which, similar to the proposed Namibian project, will be a mega green hydrogen project. The Boegoe Bay green hydrogen development has been designated a Strategic Integrated Project in the South African National Development Plan and is located in the Namakwa Special Economic Zone.

Sasol has been engaging with the Infrastructure and Investment Office of the Presidency to develop a hydrogen economy in South Africa. The company has signed a memorandum of agreement with the Northern Cape Development Agency to lead the feasibility study to explore the potential for Boegoe Bay to be an export hub for green hydrogen and ammonia. This study is expected to take approximately 24 months. The outcome of this feasibility study will determine the next steps for the Government.

Sasol has estimated that the Boegoe Bay project has the potential to create up to 400 kilotonnes of green hydrogen per year, but would require 9 gigatonnes of renewable energy to do so, which is 20% of South Africa's current installed capacity. Sasol has further estimated that green hydrogen could bring in R100 billion per year to the economy and create employment and improve skills.



Due to the location of both the proposed Southern Corridor green hydrogen project in Namibia and the proposed Boegoe Bay green hydrogen project in South Africa, literally within a 20km to 40km radius of one another, it will be important for South Africa and Namibian to collaborate in order to develop uniform policies and regulatory frameworks. Both Lüderitz and Boegoe Bay are earmarked as strategic export hubs of green hydrogen and PtX products.

Bird's eye view of global clean hydrogen developments: strategy, policy and legislation

BY STEFAN ZIMMERMAN AND JACKWELL FERIS

The policy and legislative landscape around hydrogen is rapidly changing in several jurisdictions around the world. There are countries that have been leading the call for greater decarbonisation of the global economy, with these countries having adopted hydrogen strategies (or being in the process of doing so) as part of their respective commitments to achieve their GHG emissions targets and goals by 2030 and 2050.

This is a high-level bird's eye view of what is happening with the development of policies and the regulatory frameworks for clean hydrogen in several jurisdictions.

United Kingdom

The UK has released a Hydrogen Strategy as part of its commitment to reaching net-zero carbon emissions by 2050. The document sets out detailed plans to achieve a goal of 5GW of clean hydrogen by 2030.

Key takeaways

Hydrogen targets: The UK has maintained its existing target of 5GW of hydrogen production by 2030. It will launch a €240 million Net Zero Hydrogen fund in early 2022 with a series of competitions at intervals. It plans to finalise the Hydrogen Business Model in 2022, aiming to award contracts in 2033.

Contractual support model: The UK Government has proposed a contractual support model to incentivise hydrogen production, borrowing heavily from the UK's Contract for Difference (CfD) regime for renewables. By using a contractual support mechanism similar to the CfD regime for renewables, the UK Government hopes that it will see a clean hydrogen revolution, akin to the success and rapid expansion of renewable power generation in the UK. Under this model, the UK Government has sought to mitigate two key risks: (i) market

price risk (the risk that production costs are high compared to the market price achieved); and (ii) volume risk (the risk that producers cannot sell enough hydrogen to cover their costs).

Market price risk: The UK has considered three methods for dealing with price risk, its preferred option appears to be the *"variable premium"* model. Similar to the CfD regime for renewables, the proposed *"variable premium"* model will aim to mitigate market price risk by topping-up producers' revenue up to an agreed *"strike price"*. Where the hydrogen reference price exceeds the *"strike price"*, producers will be required to repay revenues down to the *"strike price"*. The effect of this is to provide producers with a stable revenue stream.

Volume support: The UK Government has considered a number of volume support options, including (i) availability-based payments, or (ii) acting as a backstop purchaser of last resort where a producer has been unable to sell minimum quantities due to low demand. The UK Government's preferred approach to provide volume support is through sliding scale price support. This would involve higher price support where volumes sold are low. Sliding scale support would divide production levels into tranches, with different price support levels for each tranche, the aim being to achieve a minimum economic return at lower volumes sold.

Demand focused policies: the UK is considering a range of policies to create demand for hydrogen production, including:

- **Carbon pricing** – by strengthening the UK Emissions Trading Scheme pricing, the UK Government hopes to promote investment in low carbon technologies, including clean hydrogen.
- **Creation of a low-carbon hydrogen standard** – to support the demand for low carbon hydrogen by providing confidence to end users that the hydrogen purchased is a low carbon alternative to existing fuels.
- **Sector-specific policies** – for example, the Renewable Transport Fuel Obligation in transport, the Capacity Market in the power sector, and the Industrial Energy Transformation Fund in industry.

Broad regulatory regime: Further clarity is yet to be provided on licencing requirements and roles, for example, whether hydrogen production, storage and transportation will require a licence, and whether the national grid's role as the gas transmission operator will be extended to encompass hydrogen, or whether a new regulated entity will be created. A review of the Gas Act of 1986 will also be launched to consider the future regulation of a gas industry that includes hydrogen.

Hydrogen storage: The strategy acknowledges the need to increase hydrogen storage infrastructure and to assess whether regulatory interventions are required.

Japan

On 26 December 2017, Japan adopted a basic hydrogen strategy to represent its direction and vision for realising a hydrogen-based society and provides an action plan to achieve this.

Key takeaways

By 2030, Japan aims to produce commercial-scale supply chains to generate 300,000 tonnes of hydrogen annually and reduce the cost of hydrogen.

From 2030 Japan aims to target international supply chains and produce hydrogen at a competitive international price.

To promote regulatory reform, the Government has identified technological development and co-operation with the private sector in the strategic development of hydrogen stations as important for increasing supply and reducing supply costs. This includes:

- Discussions about accelerating current initiatives based on the Regulatory Reform Implementation Plan, and considering a regulatory system based on the realities of hydrogen.
- Government to support hydrogen stations and other players in the market to reduce upfront investment costs and effectively promote the optimum location of hydrogen stations based on simulated demand.

Government and private sector to create standards for hydrogen station infrastructure and relevant equipment development and ensure that they are compatible.

To increase the significance of hydrogen use in the mobility sector and provide users with incentives for using hydrogen, the Government will consider a system to visualise the environmental value of hydrogen assessment and certification.

Australia

Existing regulations already apply to industrial applications of hydrogen, however there is a need to prepare a legal framework for large-scale production and use of hydrogen as an energy carrier.

Key takeaways

Currently, there is no targeted regulation for hydrogen production facilities in Australia. There is an existing framework of technical regulation (e.g. for the transport of gaseous materials) that provides broad coverage regarding the use of hydrogen and related technologies. Any hydrogen production facility will be governed by existing energy, water, gas and environmental regulations. However, given the increasing attention given to hydrogen by political parties and the renewable energy industry, regulatory reform is likely to occur in the near future. Considering this, and depending on the intended end-use application of the hydrogen produced by a facility, it is important to understand the current regulatory frameworks applying to: the export of hydrogen and related substances in Australia and the destination country; and, participation in the domestic gas market. While they are yet to be any introduced in Australia, hydrogen-specific standards are being developed internationally through organisations such as the International Organisation for Standardization and the International Electro-technical Commission. These standards remain voluntary unless codified as Australian law. However, it is important to consider these technical standards when developing a hydrogen project as equivalent specifications between Australia and potential export markets can simplify processes and help to reduce costs.

Directly applicable laws include those applicable to hydrogen production, transport to market, use as a fuel, use in gas networks, safety, project approvals, environmental protection and economic effects of the industry.

The first stage would be for the Government to review existing legislation, standards, and regulations to determine whether their legal frameworks can support hydrogen safety and hydrogen industry development.

Government needs to agree on co-ordinated reviews of the existing legal framework to:

- Support the development of technical safety standards for the hydrogen industry, taking into account the role of Standards of Australia.
- Consider and evaluate, with the aim of developing a nationally consistent approach as far as practicable, a regulatory model to address and support both hydrogen safety and hydrogen development.
- Where necessary, amend existing legislation and regulations or draft new legislation to address hydrogen safety and support hydrogen industry development.

The Australian Government will follow the Council of Australian Governments' Principles of Best Practice Regulation for any new regulations associated with hydrogen.

The following factors have been noted regarding industry growth:

- **Collaboration** – aligning national and international regulations, considering the broader regulatory ecosystem. Governments should share expertise to promote consistent frameworks.
- **Fit for purpose** – taking a systems approach to regulation, focusing on outcomes and performance. Governments should ensure regulation is consistent with strategic objectives.
- **Flexibility** – recognising that, as the industry evolves, regulatory frameworks may require continuous adjustments. Governments should us adaptive, iterative approaches, and use standards, codes of conduct and other tools to allow flexibility.
- **Innovation** – fostering innovation and using models such as regulatory sandboxes and accelerators to test new ideas. Governments should be open to experimentation and new approaches to frameworks appropriate for an emerging industry.

Environmental regulatory considerations, should include:

- if the facility will engage any activity that may have a *"significant impact"* on a *"matter of environmental significance"* and whether the project requires approval under the Environment Protection and Biodiversity Conservation Act of 1999;
- whether any licences are required under federal and state legislation, e.g. an environment protection licence; and
- if reporting to the National Pollutant Inventory is required and any relevant reporting obligations which may apply.

Storage and transport regulatory considerations: On-site storage of hydrogen post-production and subsequent transport off site is governed by multiple laws, regulations and codes at both the federal and state levels. Substances other than hydrogen may be present during the production process and these may also be subject to such regulatory requirements. Key considerations regarding compliance, licensing and reporting obligations include:

- the presence of any *"dangerous goods or substances"* at a facility as prescribed under the Australian Dangerous Goods Code;
- which licences are required (if any) to store or transport any relevant dangerous goods or substances; and
- any technical standards which may apply to storage and transportation depending on the type and volume of any dangerous goods or substances, e.g. permissible types and specifications for storage conditions or tanks.

Water for hydrogen electrolysis: The production of *"green"* hydrogen requires water for the electrolysis process. A key challenge of production is sourcing and securing a sufficient volume of quality water. Relevant considerations include:

- any licensing or approval requirements for connecting to the relevant water network in the state or territory where the facility is located; and
- if using seawater, the relevant state licensing requirements regarding the operation of a desalination facility (including limitations on water temperature increases at the point of discharge, and brine management and disposal).

Hydrogen project approval requirements: As the current hydrogen projects are pilot projects, the approvals requirements have been regulated on a case-by-case basis by the relevant authorities under feasibility study, demonstration or pilot project regimes, enabling smaller-scale proof-of-concept testing without the need for lengthy formal assessments and approval processes. If the technology is proven, it is most likely that regulations will be amended to introduce a new category of energy specific projects and approval guidelines will be developed (as has happened for wind and solar projects).

Regardless of the regulatory approval pathway, given the potential for significant environmental and safety risks it is likely that these projects will be subject to comprehensive environmental assessments and public consultation regimes.

Taxes and levies: Most energy commodities produced are subject to taxation, excises, fees or levies. Hydrogen is not explicitly considered as an energy source in these regimes. As hydrogen production and use grows, appropriate taxation, excises, fees or levies could help ensure that the community shares in the economic benefits from developing a hydrogen industry. The Australian Government recognises the importance of the Australian public receiving a share of future benefits from a hydrogen industry and for investors to have certainty about future revenue arrangements.

Canada

Canada has adopted a hydrogen strategy which lays out the hydrogen opportunity in Canada and an action plan to achieve certain targets by 2050.

Key takeaways

The strategy notes that policy and regulation are a specific challenge because:

- There is a lack of comprehensive, long-term policy and regulatory frameworks that include hydrogen.
- Where certain policies are in place they are not consistent across regions, which slows down their adoption.
- The strategy states that a radical transformation of the energy sector requires a clear and co-ordinated regulatory and policy effort.

Certain policies should be implemented, including:

- Policies and regulations that encourage the use of hydrogen technologies such as low carbon fuel regulations, carbon pollution pricing, vehicle emissions regulations, zero emissions regulations, zero emission vehicle mandates, creation of emission free zones, and renewable gas mandates in natural gas networks.
- Codes and standards relating to hydrogen production and best practices need to be implemented across all regions. Such codes need to meet international standards in order to facilitate growth in the export and trade markets.
- There also needs to be implementation of codes and practices regarding blending hydrogen into the natural gas system.
- Canada is also working with countries around the world to develop and align codes and standards through efforts like the Canada-US Regulatory Cooperation Council.

Germany

The legal and regulatory framework for hydrogen in Germany is not yet comprehensive. There is no consistent and complete framework covering the hydrogen value chain in the country. Regulations and definitions are lacking or unclear. A framework for carbon capture and storage necessary for the market launch of "*blue*" hydrogen is lacking completely. Even the fundamental question of whether and, if so, how the established regulatory system for gas should apply to hydrogen is still waiting for a reply. All of this will have to be tackled within the context of the implementation of the National Hydrogen Strategy.

Key takeaways

Construction of hydrogen production facilities: The construction and operation of a hydrogen production facility such as a power-to-gas plant requires the execution of an authorisation procedure pursuant to the Federal Emission Control Act. This encompasses a preliminary audit under the Environmental Impact Assessment Act. The requirements of the Hazardous Incident Ordinance also have to be fulfilled.

Transportation: The definition of "*gas*" in the Energy Act encompasses hydrogen as long as it is produced by electrolysis (power-to-gas).

Hydrogen produced by electrolysis also falls within the definition of "*biogas*" in the Energy Act, thereby profiting from the privileges for biogas concerning preferential network connection, network access and balancing.

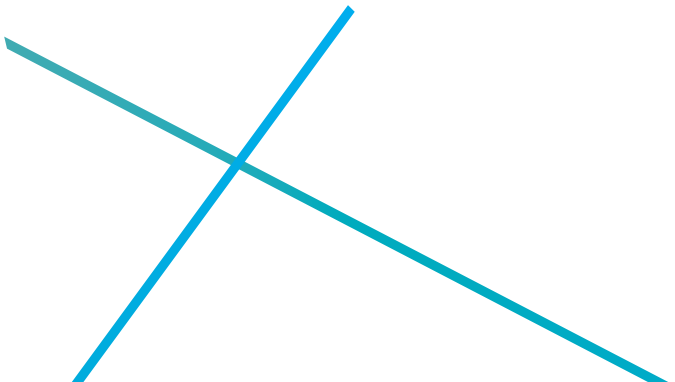
Since hydrogen produced from electrolysis is defined as gas, pipelines transporting such hydrogen would qualify as gas supply networks under the Energy Act. To make things difficult, this applies to only distribution networks, since the definition of gas transmission in the Energy Act refers to the transmission of natural gas, thereby excluding hydrogen of any type.

Other types of hydrogen like blue hydrogen are not covered by these definitions at all. Consequently, they fall outside the scope of the Energy Act and its related regulations.

Pure hydrogen transmission networks are not covered by the existing regulatory framework.

As of today, a maximum of 10% hydrogen can be blended into the natural gas grid. According to the reports from the Technical Gas Association this share may be increased up to 20%.

As part of Germany's National Development Plan the TSOs have announced their intention to completely convert existing pipeline sections to hydrogen and to build new hydrogen trunklines.



Network tariffs: Under the Network Access Regulation, the injection of biogas (and hence hydrogen produced from electrolysis) into the gas transmission grid is free of charge. Under the regulation, the injection of gas (and hence hydrogen produced from electrolysis) into the local gas distribution network is free of charge.

Generally, facilities producing hydrogen from electrolysis are exempted from network access charges under the Energy Act.

Draft Amendment to Energy Act Regarding the Regulation of Hydrogen Networks: On 10 February 2021, the German Government passed the draft of an amendment to the Energy Act which contains new provisions for the regulation of hydrogen networks. The purpose of the amendment to the Energy Act is to gradually build up a hydrogen infrastructure in Germany. The provisions are intended as a transitional solution until corresponding European guidelines are available. The EU Commission has announced that it will present proposals on this by the end of 2021. Implementation into German law is expected from 2025 onwards.

So far there are only a few hydrogen pipelines in Germany that are not regulated as they are direct pipelines used for industrial purposes. According to the explanatory notes on the legislation, in view of this, there is no intention to subject existing or future hydrogen pipelines to mandatory regulation. Instead, this decision is to be left up to the pipeline operators. However, the German Government presumes that as more and more interconnected hydrogen networks are developed, there will be a need to subject them to comprehensive regulation.

The draft provides for the following framework conditions:

- In the definition of the term *"energy"* in section 3(14) of the Energy Act, hydrogen is fundamentally categorised as an independent energy carrier alongside gas. However, this is only intended to apply to pure hydrogen pipelines. For the blending of hydrogen into the natural gas network, the existing legal framework continues to apply on the basis that hydrogen produced by electrolysis falls under the definition of gas.
- According to section 3(39)(a) of the Energy Act, a hydrogen network is a network for the purpose of supplying customers with hydrogen which, in terms of its size, is not designed from the outset to supply specific customers or customers which are specifiable at the time when the network is constructed but which is, in principle, open for the supply of all customers. Industrial pipelines which connect a generation plant with dedicated individual consumption sites are therefore not covered by the Energy Act by their very definition.
- Section 28(j) of the Energy Act gives operators of existing networks and newly constructed networks a unique and irrevocable right to choose whether they want to be subject to the newly introduced regulation of hydrogen networks or not. This also applies to the conversion of natural gas pipelines to hydrogen. The right to choose applies to the operator in general and not to individual pipelines. Those who choose not to be regulated will not be covered by the requirements regarding network access, tariffication and unbundling as explained below.

According to section 28(n) of the Energy Act, network operators are required to grant access and connection to their hydrogen networks based on the principle of negotiated network access. The standardised contracts for regulated network access to the natural gas network, which have been continuously developed since 2006, therefore do not apply. Whether a correspondingly uniform contractual practice will nevertheless emerge remains to be seen.

Section 28(o) of the Energy Act provides for cost-based tariffication which is largely in line with the current legal situation. The conditions and tariffs must be reasonable, non-discriminatory and transparent. Application of the Ordinance on the Incentive Regulation of Energy Supply Networks is not planned but has not been completely ruled out. This is logical as benchmarking between network operators would not make sense in the beginning with only few operators to compare. A prerequisite for cost recognition is a positive needs assessment of the hydrogen infrastructure in accordance with section 28(p) of the Energy Act.

According to section 28(k) of the Energy Act, the operators of hydrogen networks must carry out separate accounting and bookkeeping for their networks (unbundling of accounts). This serves to avoid cross-subsidisation and discrimination. Particularly in the case of simultaneous operation of long-distance gas networks, the aim is to prevent costs for the hydrogen infrastructure being included in the transmission tariffs.

In accordance with section 28(m) of the Energy Act, hydrogen network operators may not construct, operate or own facilities for the production, storage or distribution of hydrogen. The requirements on informational unbundling also apply in the sense that the operator of a hydrogen network must be separated from an energy supply company in terms of its legal form is not prescribed.

Section 113(a) of the Energy Act regulates the transfer and continued application of rights of way and easements for gas pipelines. Under this provision, these also apply to the operation of these pipelines with hydrogen. This also applies, as a matter of principle, to concession agreements. This is intended to facilitate the transition from gas pipelines to hydrogen.

Transmission system operators can identify pipelines that could be converted to hydrogen in the framework of the Gas Network Development Plan in accordance with section 113b of the Energy Act. It must be ensured in this respect that the remaining network can meet the capacity requirements.

An independent Network Development Plan is to be drawn up for the hydrogen networks. The target year for this is 2035. This rejects the idea of joint network planning with the natural gas network.

United States

There is currently no comprehensive hydrogen regulatory regime for the US. However, the US Department of Energy's (DOE) Hydrogen Program Plan suggests that it is starting with one in earnest.

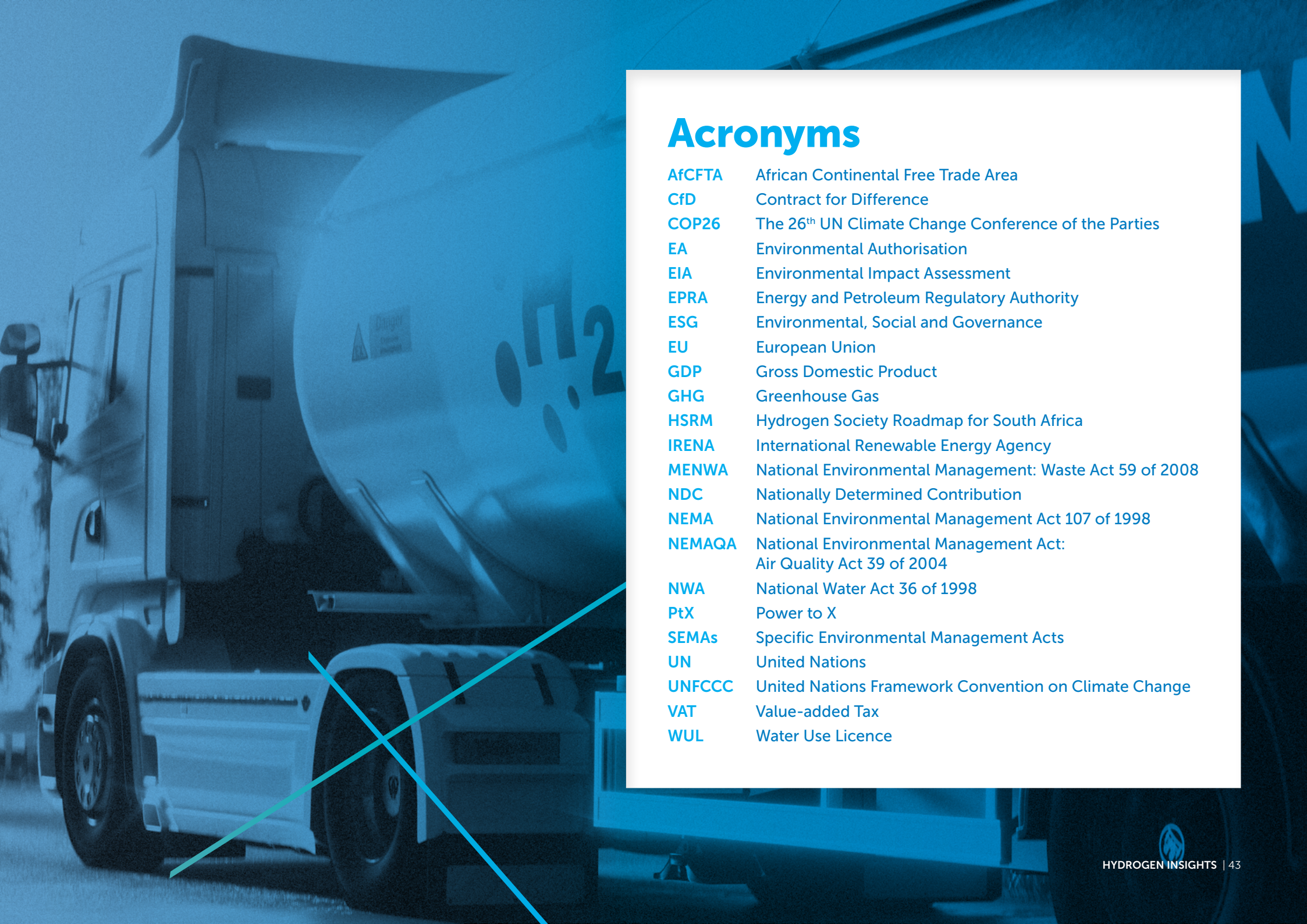
Key takeaways

The US Federal Government's major initiative regarding hydrogen as a fuel source has been to incentivise research in the area, including by funds made available through programmes in multiple agencies. One of the most important is the DOE's $100 million pledge, which reflects its intention to invest up to this amount in two new DOE National Laboratory-led consortia to advance hydrogen and fuel cells technology research, development, and demonstration over the next five years. One consortium will develop affordable, commercial-sale electrolysers, which use electricity to divide water into hydrogen and oxygen, and the other consortium will assist in accelerating the development of fuel cells for vehicles, specifically for long-haul trucks.

In November 2020, DOE released its updated Hydrogen Program Plan, which underscores the DOE's department-wide commitment to facilitating the growth of hydrogen as a source of energy and provides a *"strategic framework for the department's hydrogen activities"*.

This is an important aspect of developing the hydrogen economy, however the Federal Government will need to incorporate hydrogen into its broader regulatory scheme for hydrogen to truly become part of the energy infrastructure in the US. Much of this may fall on agencies other than DOE. Several federal agencies already address hydrogen in their regulations; however, they only address it incidentally, as one of the many substances regulated under their regimes. For example, most environmental regulations on hydrogen deal with hydrogen's properties, such as its flammability/explosivity (which often requires it to be regulated as a hazardous substance). These regulations are scattered throughout the Code of Federal Regulations and are not organised to address hydrogen in a cohesive manner. Instead, disparate regulations touch upon a portion of the hydrogen industry or issues related to the characteristics of hydrogen itself, but do not focus on regulation of the hydrogen industry as a whole.

Currently, the federal agencies with the most extensive regulation of hydrogen are the Occupational Safety and Health Administration, EPA, and PHMSA. Hydrogen regulations are not a central part of these agencies' missions, but the agencies will continue to play an important role as hydrogen becomes more prevalent and technologies advance and change.



Acronyms

AfCFTA	African Continental Free Trade Area
CfD	Contract for Difference
COP26	The 26th UN Climate Change Conference of the Parties
EA	Environmental Authorisation
EIA	Environmental Impact Assessment
EPRA	Energy and Petroleum Regulatory Authority
ESG	Environmental, Social and Governance
EU	European Union
GDP	Gross Domestic Product
GHG	Greenhouse Gas
HSRM	Hydrogen Society Roadmap for South Africa
IRENA	International Renewable Energy Agency
MENWA	National Environmental Management: Waste Act 59 of 2008
NDC	Nationally Determined Contribution
NEMA	National Environmental Management Act 107 of 1998
NEMAQA	National Environmental Management Act: Air Quality Act 39 of 2004
NWA	National Water Act 36 of 1998
PtX	Power to X
SEMAs	Specific Environmental Management Acts
UN	United Nations
UNFCCC	United Nations Framework Convention on Climate Change
VAT	Value-added Tax
WUL	Water Use Licence

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