



FOCUS ON HYDROGEN: A NEW ENERGY FRONTIER FOR AFRICA

As African economies continue to further their green ambitions, clean hydrogen is increasingly viewed as an important pathway to reducing imports of fossil-based fuels and chemicals. In this briefing, we examine why Africa is well-placed for the development of a green hydrogen economy, and provide an overview on the various initiatives, strategies and partnerships in play across the continent.

With extensive solar and wind resources and a growing interest in hydrogen technology, Africa can have a solid claim to a 'seat at the table' in the new hydrogen economy. Through strong partnerships, African nations stand to benefit economically, environmentally and socially from the rapid development of new hydrogen technology.

WHAT IS CLEAN HYDROGEN?

Clean hydrogen refers to the extraction of hydrogen from more complex substances using 'clean' (zero carbon) processes. Most hydrogen production currently relies on the extraction of hydrogen from fossil fuels leading to large carbon emissions (**grey hydrogen**). This process can be made cleaner, for example when carbon capture technology is used to store the greenhouse gases which are released (**blue hydrogen**). The cleanest form of hydrogen extraction, however, uses electrolysis to split water molecules into their component parts. When this process is powered by electricity from renewable energy sources, the emissions are reduced to zero. This is known as **green (or clean) hydrogen**.

Clean hydrogen has gained widespread attention in recent years as the need to find eco-friendly energy alternatives intensifies. Green hydrogen's versatile application – be it as a replacement for fossil fuels in chemical and fuel production, a means of storing and transporting renewable electricity or even as a fuel powering vehicles and non-electrified trains – makes it an obvious solution to the carbon crisis of our times. Nonetheless, electrolytic hydrogen makes up only 4% of global hydrogen production. For clean hydrogen to become a real competitor to the fossil fuel industry, it will need to be scaled up and rapidly.

Key points

- Africa's extensive renewable energy sector makes it well-suited to the growth of a green hydrogen economy
- Efforts to develop the industry can be seen on a governmental level across the continent, including in Morocco and South Africa
- European countries, Germany in particular, are turning to the continent as a potential source of green hydrogen
- Interregional initiatives are appearing to support green hydrogen technology, including the African Hydrogen Partnership

Why Africa?

Although hydrogen production is by no means limited to Africa, the continent is well-placed for the development of a green hydrogen economy:

- **Abundance of resources:** Africa's diverse wealth of natural resources and ever-growing solar and wind projects means that renewable electricity can often be produced at a significantly lower cost than in other parts of the world. In addition, green hydrogen's capacity to act as a storage system for excess renewable energy can help overcome the irregularities and current weaknesses in renewable energy supply and provide remote communities with permanent energy access.
- **Supportive governments and achieving national targets:** African governments, including South Africa and Morocco, have voiced support for and are actively pursuing more environmental policies. Green hydrogen offers governments a sustainable route to achieve national energy and decarbonisation goals.
- **Existing technology:** Unlike Europe and other parts of the world, many African nations are not trapped in existing technology industries and so large-scale devaluations and exit risks pose less of an issue.
- **Energy security:** A clean hydrogen economy would help reduce exposure to geopolitical and oil price instability and would generally reduce the cost of energy for countries relying on diesel.
- **Development and investment opportunities:** With its long value chain, a hydrogen economy offers significant potential of job creation and would help attract international investment into the region.

Why now?

With rapidly improving technology and decreasing costs for electrolyzers and fuel cells, green hydrogen is becoming a more appealing alternative to fossil-fuel based hydrogen. Coupled with the ever-increasing pressure to find environmentally sustainable alternatives and to decarbonise our industries, green hydrogen is drawing more attention day by day. This trend is taking shape in different parts of Africa, each moving at its own pace on the hydrogen path.

LOOKING INWARDS

Clean hydrogen initiatives have been appearing across the continent.

African Hydrogen Partnership (AHP)

A recent development is the establishment of the African Hydrogen Partnership (AHP). AHP advocates for the establishment of renewable hydrogen economies to offer solutions to many of the social, economic and environmental issues faced by African nations. It has laid out a framework for its vision of the hydrogen economy in Africa, beginning with the construction of power-to-gas renewable energy hubs in large metropolitan areas, ports and mining centres along important trans-African highways. These hubs would service a multitude of industries, from fuel-cell transport to industrial and chemical production, as well as support small-scale businesses and even supply electricity to consumers' homes.

Yet political will, government support and considerable investment remain essential to propel such an ambitious vision forward, even on a continent with abundant potential, such as Africa.

National hydrogen initiatives

Morocco

The Moroccan government entered into a partnership with Germany to develop the first green hydrogen plant in Africa last year. The partnership intends to reduce carbon dioxide emissions by 100,000 tonnes. See "A Closer Look" for more detail on this initiative.

South Africa

The South African government, through its initiative, "Hydrogen South Africa" (**HySA**), is working to expand local knowledge and innovation in hydrogen technology to bring about, among other things, tangible benefits to the local economy through job creation and increased wealth. One of HySA's objectives includes introducing fuel cells to help expand the provision of clean energy to remote communities to avoid the prolongation of energy poverty. See "A Closer Look" for more detail on this initiative.

Nigeria

The Federal Government of Nigeria has also expressed general interest in the development of hydrogen energy to supplement the country's energy demand through the National Energy Policy 2018, which details a short, medium and long-term strategy towards the incorporation of hydrogen energy in the country.

Other initiatives

Other initiatives in the region have relied on public-private partnerships to ensure the provision of green hydrogen to underserved communities. For example, in Uganda, the Rural Electrification Agency partnered with the Belgian company Tiger Power to provide solar power to three villages in the Kyenjojo District. The project uses hydrogen batteries to store the excess energy produced by the solar panels in the day to provide the villages with a constant supply of electricity through the night.

Developing local expertise

A 'domestic' hydrogen economy can only be sustainable in the long run if societies grow local expertise to develop and maintain it. A step in this direction is the development of theoretical and applied research into green hydrogen at universities throughout Africa.

Examples of academic initiatives include the Ecole Supérieure des Métiers des Energies Renouvelables (**ESMER**) in Benin, which has developed both a research programme in hydrogen technology and a training programme for future engineers, focusing particularly on hydrogen vehicles and the storage of energy through hydrogen. Research is being carried out on a large-scale by the German-funded West African Science Service Centre on Climate Change and Adapted Land Use (**WASCAL**), who are collecting information from partnership universities on the amount of water available in each country for the production of hydrogen by electrolysis. See "Europe's Hydrogen Ambitions for Africa" for more detail on this research initiative.

TURNING OUTWARDS

The appeal of hydrogen is not limited to the domestic benefits it offers. Several initiatives have been launched with the intention of expanding hydrogen production in Africa for export internationally.

Europe's hydrogen ambitions for Africa

As European nations struggle to procure the territorial capacity for the production of all of their renewable energy domestically, many European governments and institutions are turning to African nations as potential partners to help them achieve the green future they have committed to under the Paris Agreement on Climate Change.

EU Hydrogen Strategy

The EU's Hydrogen Strategy, published in 2020, sets out an ambitious roadmap for a significant shift towards green hydrogen by the year 2050. The Strategy highlights Africa's abundant renewables potential noting that in particular North Africa, due to its geographic proximity, is a potential supplier of cost-competitive renewable hydrogen to the EU.

Hydrogen Europe, an umbrella business organisation, has advocated using existing natural gas infrastructure to transport renewable hydrogen from North Africa directly to Europe. Currently, only Spain is interconnected with Morocco via two submarine power cables of approximately 800MW capacity, while Algeria and Libya export natural gas through several pipeline connections to Spain and Italy of more than 60GW capacity.

2020 also saw the EU publish a joint communication, "*Towards a Comprehensive Strategy with Africa*" which called for investments to be directed towards enabling African countries to pursue a low-carbon, climate resilient and green growth trajectory, including deployment of renewable energy sources and hydrogen production.

EU support for hydrogen projects in Africa

Given the above, it is likely that EU funding opportunities will be available for hydrogen projects across Africa. Funding could come from various sources:

- The **Connecting Europe Facility (CEF)** - an EU funding instrument focused on promoting growth through targeted infrastructure investment. The CEF generally makes funds available to Projects of Common Interest (**PCIs**). PCIs are governed by the legislation on the Trans European Energy Networks (TEN-E Regulation) which is currently being updated to focus on hydrogen and may provide additional opportunities to fund projects with third countries. Currently, the only PCI involving an African country is the electricity interconnection between Italy and Tunisia (ELMED).
- A new **Neighbourhood, Development and International Cooperation Instrument (NDICI)**. The NDICI will have a total budget of just under €80 billion for the period 2021-2027, with a focus on climate objectives, and at least €30 billion has been earmarked for sub-Saharan Africa.
- As noted in its Hydrogen Strategy, the Commission will also consider potential projects through the **European Fund for Sustainable Development**, which supports investments in Africa and the EU's neighbouring countries to help achieve the UN 2030 Agenda, its

Sustainable Development Goals and the Paris Agreement on Climate Change.

In addition, in 2020, the European Investment Bank (EIB) provided more than €3 billion of new financing across Africa which will include financing for climate related investment and sustainable development.

Germany

Within Europe, Germany is among those at the forefront of green hydrogen efforts in Africa. In 2020, Germany signed a memorandum of understanding with the Democratic Republic of Congo in relation to the production of clean fuel. This forms part of Germany's plans to explore Congo as a potential supplier of green hydrogen, including building a hydrogen plant on Congo's coast to ship fuel from the future Inga III dam to Germany. In addition, the German development agency, *Deutsche Gesellschaft für Internationale Zusammenarbeit GmbH (GIZ)*, is developing a project with countries including South Africa and Morocco to develop decarbonised fuel, generated from renewable energy, for export to Europe.

Germany's efforts also extend to the enhancement of research on sustainable development in the region. In 2020, Germany's Federal Ministry of Education and Research (**BMBF**) provided funding to the University of Cape Town's Electrolyser Research Group (within the HySA initiative) to encourage study into electrolyser catalyst-coated membranes used in hydrogen production.

BMBF also provided funding towards the H2 Atlas Africa project (**H2 Atlas Africa**). H2 Atlas Africa is working to identify locations in Western and Southern Africa that are particularly suited to green hydrogen production. In order to make these determinations, H2 Atlas Africa will examine, across a total of 31 sub-Saharan countries, a range of factors, including available renewable energy and water resources, land available for the production of green hydrogen, cost-efficiency of hydrogen production, local energy demand and energy infrastructure and social and socio-political framework conditions.

H2 Atlas Africa then intends to map out these locations on an interactive atlas, showing hydrogen production hotspots. The project will subsequently demonstrate through pilot projects how the production of green hydrogen, its export and its distribution can be realised in an economically efficient manner. In doing so, the pilot concepts will be designed in such a way that they improve the local economy as well as demonstrating possibilities for an economically viable hydrogen supply chain.

In order to provide the necessary data, H2 Atlas Africa will establish its own panels of regional experts as well as collaborating with two existing partnerships sponsored by the German government to enhance research efforts into sustainable development, namely WASCAL and the Southern Africa Science Center for Climate Change and Adaptive Land Management (**SASSCAL**).

A CLOSER LOOK

Morocco

Since 2009, Morocco has positioned itself as a leader in the renewables space. The Kingdom has adopted a successful national renewable energy strategy which serves as its roadmap to a low-carbon energy system that reconciles development, economic, social and environmental goals.

Morocco-Germany agreement

On 10 June 2020, Morocco and Germany signed an agreement on the development of the green hydrogen production sector, under which the two countries will join efforts to establish two projects:

- **Power-to-X:** a reference to the umbrella term used to refer to the different ways of generating energy (e.g. power-to-gas, power-to-liquid, power-to-fuel, power-to-chemicals and power-to-heat), will focus on the production of green hydrogen, proposed by the Moroccan Agency for Sustainable Energy (**MASEN**). This innovative mega-project, to be co-financed by KfW, is expected to give rise to the first hydrogen production unit in Africa and involves the construction of a hybrid photovoltaic/wind power plant to supply a green hydrogen plant with an electrolysis capacity of c.100MW. The project should be awarded in 2022 for a commercial operation date scheduled between 2024 and 2025; and
- **Power-to-X research:** the second project consists of the establishment of a research platform on Power-to-X, knowledge transfer, and the strengthening of related skills in partnership with the Moroccan Research Institute for Solar Energy and New Energies (**IRESSEN**).

Morocco's potential for green hydrogen

Green hydrogen presents considerable opportunities for Morocco for a number of reasons:

- **Production of green ammonia:** Morocco currently imports 1-2 million tonnes of fossil-based ammonia every year to be used as a basic ingredient together with phosphate in the production of fertilisers. Green ammonia, produced using green hydrogen, could be used to replace imported grey ammonia, reducing carbon emissions and costs. It is anticipated that by 2030, Morocco could be producing the same amount of ammonia as it currently imports, but in a carbon-neutral way, while also exporting a similar amount on top of this.
- **Stabilise the grid:** As the share of variable renewable sources in the electricity mix grows, consistency of supply becomes a greater challenge. Solar and wind power are increasingly popular sources of energy, but they are at the whim of the elements – if there is no wind or sunlight, there is no electricity. Green hydrogen, with its capacity to store excess energy, provides a reliable solution to these fluctuations. Although conventional power can manage this imbalance when renewables represent a 50% share of the electricity mix, it is estimated that, if renewables reach 100%, up to 20% of green hydrogen will be needed to stabilise the grid. If Morocco continues to grow the share of renewable energy in the electricity mix, larger amounts of green hydrogen will be needed.
- **Export potential:** Using the existing gas infrastructure, hydrogen can be transported via pipeline and connected to the European gas grid, making Morocco a potential 'Hydrogen Landing Zone' and allowing it to serve as a connecting point to other African nations.

Thanks to its strategic geographical position and exceptional wind and solar energy and even water potential, Morocco could capture a significant share of Power-to-X demand, estimated at 2-4% of global demand in 2030. Morocco has the potential to develop a world-leading hydrogen economy for domestic demand and for export and become a leader in the renewables space and a benchmark for other African states.

South Africa

Like Morocco, South Africa boasts a strong renewables offering. Its abundance of sun, wind and land make it well-suited to the production of green hydrogen. South Africa is also endowed with a wealth of platinum group metals (PGMs) - with platinum reserves representing up to 90% of known PGM reserves worldwide. PGM catalysts are used in the electrolyzers that produce hydrogen as well as in fuel cells, which can be used to power transport, generate power, and even produce heat in steel and other metal plants. Platinum therefore has an important role in the development of clean hydrogen technology, making South Africa a potentially indispensable player in the growth of a green hydrogen economy in Africa.

The South African government is already on board with the move to green hydrogen and has been for a while. With the establishment of HySA in 2008, the South African government has shown its willingness to explore the potential clean hydrogen offers in a variety of sectors. One such sector is healthcare and emergency relief. In 2020, the South African Government partnered with the Bambili Energy Group, Horizon Fuel Cell Technologies, Element 1 and PowerCell Sweden to provide hydrogen fuel cell units at 1 Military Hospital in Pretoria to help with the fight against coronavirus. The portable nature of containerised hydrogen fuel-cells made them a valuable asset to assist in this moment of national crisis.

The South African government has also been looking at potential export opportunities for clean hydrogen, with countries like Japan and Germany as potential offtakers. The HySA Infrastructure team have already been tasked with looking into the cost of transporting hydrogen by land and sea, including by ship to Japan. With Japan announcing its intention to import up to 800,000 tonnes of hydrogen per year by 2030, this could be a profitable partnership for the nation.

AP Ventures LLP, a venture capitalist fund focused on investing in technologies and applications for PGMs, is concentrating on the ways that green hydrogen can assist in decarbonising sectors of South Africa's economy, including the mining industry. Anglo American (one of AP Ventures' investors) is testing this theory at one of its mines in Limpopo, where it has approved an investment to trial a fuel-cell powered electric mining truck. The PGM mining company Impala Platinum introduced fuel-cell technology into its mining processes with its fuel-cell engine forklift fleet at its Spings refinery.

Green hydrogen offers huge potential for South Africa, a nation that has traditionally been dependent on import for its energy needs. Clean hydrogen provides South Africa with the opportunity to leverage its wealth of natural resources and PGM reserves to establish a clean energy industry that can both service the country and provide a prosperous export economy.

CHALLENGES FOR HYDROGEN PRODUCTION

Despite its numerous advantages, there are many challenges in implementing green hydrogen on a wide scale across the continent.

One such difficulty is its cost. A great deal of upfront investment is required in order to establish the infrastructure needed to produce and transport green hydrogen. Combine this with high tariffs for electricity and it is clear that green hydrogen is expensive to produce. However, investing in electrolyzers in locations where renewable energy sources are in abundance (and there are many such locations in Africa) means that electricity can be provided at a

more competitive rate reducing the cost of hydrogen production. This is particularly important given that the cost of electricity can make up to 60% of the total cost of hydrogen production. Moreover, work currently being done on clean hydrogen ecosystems in the EU shows that such lower electricity prices, combined with scaling up of electrolysis, can deliver competitively priced clean hydrogen.

Although a great deal of hydrogen's potential in Africa lies in export opportunities, the logistics of transporting hydrogen to far-away markets may also prove challenging. In order to be transported by ship, hydrogen must be pressurised, chilled to a temperature of -253°C and either liquefied or converted into ammonia or another form of carrier. Energy is often lost in the conversion and re-conversion process, which in turn increases costs. However, shipping is not the only method of transporting hydrogen. One of the most cost-effective options could prove to be repurposing natural gas pipelines for the transportation of hydrogen, for example from Tunisia or Morocco to Europe. While such reconversion is still to be done at scale, the energy company E.ON has recently undertaken to trial the conversion of a natural gas pipeline in Germany to test the technical viability of this process. It should only be a matter of time.

Despite such challenges to green hydrogen development in Africa, the growing momentum, interest and investment in clean hydrogen on the continent suggest that these challenges should not yet be deemed insurmountable and the potential domestic benefits from the development of a hydrogen economy on the continent are undeniable.

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ABOUT

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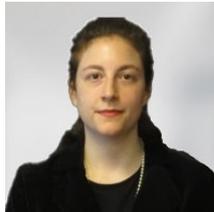


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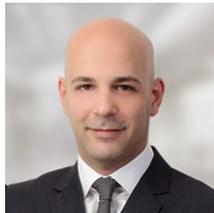


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