Integrated Africa Power

Africa's place in the emerging hydrogen economy

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1. Introduction

Hydrogen, as an energy carrier, is not new in Africa and around the world. It has a long history of uses, particularly in the metal, chemical and fertilizer industries. So far, hydrogen is mainly extracted from fossil fuel resources via a process known as steam methane reforming, leading to significant CO2 and fugitive methane emissions (so-called grey hydrogen). However, as the global pursuit of carbon-neutrality targets intensifies, the production of 'clean' hydrogen, has emerged as a key pillar for fostering a transition to climate-neutrality. Clean hydrogen development is seen as a pathway for reducing the carbon footprint of today's CO2-intensive hydrogen production. It is also envisaged to serve as a catalyst for further decarbonization of other hard-to-abate sectors and as a possible long-term storage medium in a future energy system dominated by variable renewable energy sources.

The production of clean hydrogen requires the extraction of hydrogen using new processes: through the splitting of water molecules into its component parts using renewable electricity (so-called green hydrogen) or through steam methane reforming combined with carbon capture and storage (CCS) technologies (so-called blue hydrogen). The latter results in significant residual emissions during the stages of natural gas extraction, transport and CO2 storage. Hence, it is not considered a viable option to meet the long-term target of net-zero emissions but is being considered as a temporary option within the pathway to climate neutrality. The former is emission-free but implies large additional renewable energy capacities to meet projected hydrogen demand over the next decades, placing additional pressure on scarce renewable energy resources.

2. Abundant natural resources offer potential for green and blue hydrogen production and export

The abundant availability of energy resources in many parts of Africa position the continent as an important potential location for the production and export of green and blue hydrogen. Several African countries, especially around the Northern and Southern Tropics, have excellent solar (average daily potential of 4.49kWh/kWp[1]) and wind resources (180,000 TWh per year[2]) for potential green hydrogen production.

Africa also has large untapped hydropower potential, estimated at over 250 GW, mainly located along the Congo and Nile rivers. Furthermore, countries like Nigeria, Algeria and Angola have some of the largest gas reserves in the world, at 203.16 trillion, 159 trillion, and 343 million cubic feet, respectively[3]. Blue hydrogen could offer these countries an alternative export product, as they seek to diversify their fossil-fuel dependent economies. Finally, countries like South Africa and the DRC have an abundance of mineral resources essential for producing clean hydrogen and other renewable energy technologies. South Africa's unique endowment in platinum group metals (PGMs) – an important mineral for manufacturing electrolysers – gives it a particular advantage in the growing green hydrogen market.

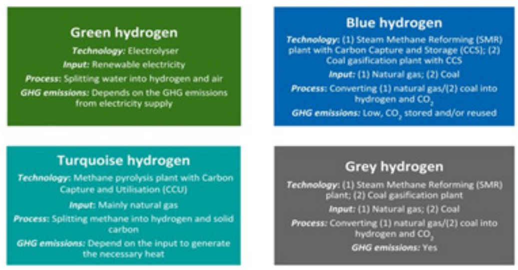

Figure 1: Forms of Hydrogen (FSR 2020)

Despite these abundant resources, Africa still faces daunting energy-related challenges. More than 640 million Africans have no access to electricity, placing the electricity access rate on the continent at just over 40 percent – the lowest in the world[4]. Per capita consumption of energy in sub-Saharan Africa (excluding South Africa) stands at just 180 kWh, compared to 13,000 kWh per capita in the US and 6,500 kWh in Europe[5]. Moreover, renewables remain at an early stage of development, accounting for only 20 percent of the African power mix (consisting of 15 percent hydropower and 5 percent from other renewable energy sources)[6]. Given this reality, any capacity additions for the production of green hydrogen raise the question of whether they are coming at the expense of expanding access to renewable energy supply for local users, both to meet socio-economic needs and enable clean industrial development on the continent. Furthermore, the production of green hydrogen comes with a significant demand for water. Given the increasing levels of water scarcity across large parts of Africa, this raises additional questions regarding the sustainability of green hydrogen production in these regions.[7]

3. The economics and politics of hydrogen exports

As countries in Europe and Asia with insufficient local renewable resources for hydrogen production consider the prospects of hydrogen imports from the African continent, additional questions regarding the economic feasibility of such export scenarios come into play. The production of clean hydrogen in some of the most promising locations in Africa would be highly competitive in terms of production cost. It is estimated that West Africa alone could produce approximately 120,000TWh per year at a cost-competitive price of less than €2.50 per kg, assuming no water constraint. Transporting hydrogen could add significantly to this, however. Maritime shipping, considered the most cost-effective for distances over 3000km, would add an estimated cost of approximately €1 – €2,50 per kg[8]. For shorter distances, the cost of pipeline transport could be considerably lower, estimated at €0,16 per kg per 1000km for new hydrogen pipelines and €0,07 for retrofitted gas pipelines[9].

Figure 1: Technical Potentials of Green Hydrogen Production, with Sub-Saharan Africa and MENA region taking lead. (IRENA 2020)

Currently, international pipeline infrastructure in Africa mainly consists of pipelines transporting natural gas from Northern African countries to the European market via Spain and Italy and inter-connections between Egypt and the Middle East. In addition, there is the West African Gas Pipeline (WAGP) network which currently transports gas from Nigeria to neighboring countries Benin, Togo and Ghana. The WAGP represents the starting point for the recently launched Nigeria-Morocco Pipeline project.

It is planned to extend from along the West African coast to Morocco, through the construction of additional pipeline segments over the next 25 years. Eventually, the pipeline could also link to the European continent via Spain. If constructed as 'hydrogen-ready', the WAGP could eventually be converted to enable the export of hydrogen from Nigeria. For now, however, it remains aimed at supplying Morocco and other West African countries with Nigerian natural gas. In the medium-term, the production of blue hydrogen from the Nigerian natural gas might offer a low-carbon alternative, with the possibility of transitioning to green hydrogen export over time. This could be supplemented with green hydrogen production from other West African countries along the pipeline route. Whether it can be repurposed for transporting hydrogen will largely depend on the interests of Nigerian and Moroccan governments, the major stakeholders in the pipeline construction. While Morocco is likely to prioritize meeting its domestic energy security needs, Nigeria is likely to remain committed to capture additional revenues from its natural gas resources.

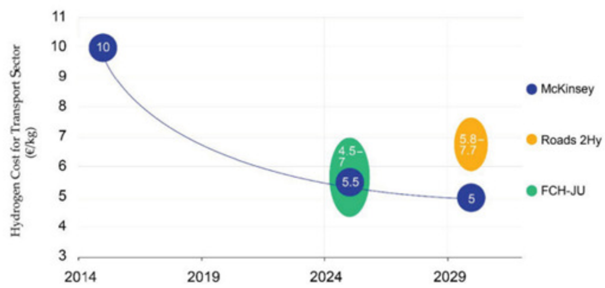

Fig 3: Hydrogen cost development from 2015 to 2030 (Jovan and Dolanc 2020)[10]

4. Local applications and industrial policy ambitions

Despite the uncertainty regarding viable export routes, green hydrogen has increasingly garnered interest across the African continent, with high-level conferences and forums and the formation of new alliances, such as the African Hydrogen Partnership (AHP). Most tangibly, activities are emerging around local applications of green hydrogen and related industrial development opportunities.

One important avenue for this is the production of ammonia using green hydrogen (green ammonia) to replace the widely used fossil-based ammonia in fertilizer production. Morocco, a major exporter of fertilizers, plans to replace imports of conventional ammonia with locally produced green ammonia, positioning it as a player in a future global market for green fertilizers, with its first project to start construction in 2022. Similarly, in Egypt, the Egyptian Sovereign Fund is supporting Fertiglobe and Norwegian Scatec to build a 50-100MW green hydrogen plant for the production of green ammonia. In Uganda, the role of hydrogen is being explored as a component within renewable-based mini-grid applications. A solar-hydrogen powered mini-grid has already been successfully deployed to power 3,000 rural households and businesses in the town of Kyenjojo, becoming the world's first project with such technology.

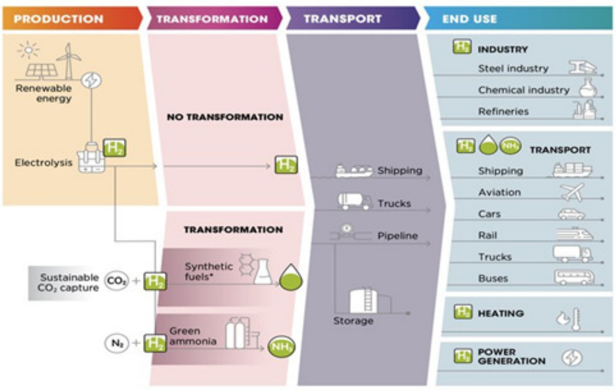

Fig 4: Green hydrogen value-chain, processes and various uses (IRENA, 2020).

The most ambitious efforts are emerging in South Africa. It has launched a strategy aimed not only the production of hydrogen and related derivatives, but for building a manufacturing base in the field of hydrogen-related technologies, such as hydrogen fuel cells and electrolysers. Building on its endowment in PGMs, the South African government has partnered with Anglo American Platinum to launch a feasibility study for a 'Hydrogen Valley'. The concept targets the promotion of an industrial cluster along a corridor stretching from Mokopane in Limpopo, a PGM mining region, through Johannesburg's industrial district to Durban. Furthermore, the country's chemicals and energy giant, Sasol, has launched an initiative with the Northern Cape and Gauteng province governments to conduct a two-year feasibility study for landmark green hydrogen projects.

These projects are geared towards the production, transport and possibly export of green hydrogen as well as projects aimed at greening existing materials and chemical value chains.

5. External drivers of green hydrogen development

In addition to these applications in the industrial and power sectors, Africa's hydrogen economy has also spurred political dialogue with a number of European countries on the possibilities of green hydrogen exports. The German government has been the most active in this regard, launching cooperation with a number of African countries. To assess the potential for green hydrogen production across the continent, Germany's Federal Ministry of Education and Research (BMBF) has partnered with several African partners to launch the Hydrogen Potential Atlas project[11]. In addition, Germany recently committed $45.7million[12] to the National Green Hydrogen Development Strategy of Namibia in 2021. This includes plans to build water desalination plants to meet the water demand for running potential electrolyzers for the production of green hydrogen. Furthermore, Germany and the DRC have taken up discussions on an energy partnership that could see the central African country relaunch the controversial Inga Dam III project, in spite of significant environmental, social and governance-related concerns. With a total potential capacity of 44GW, the dam could provide electricity both for green hydrogen exports and domestic uses. Finally, Germany's Foreign Office has set-up so-called Hydrogen Office in Angola and Nigeria to facilitate dialogue with these fossil-fuel exporting economies.

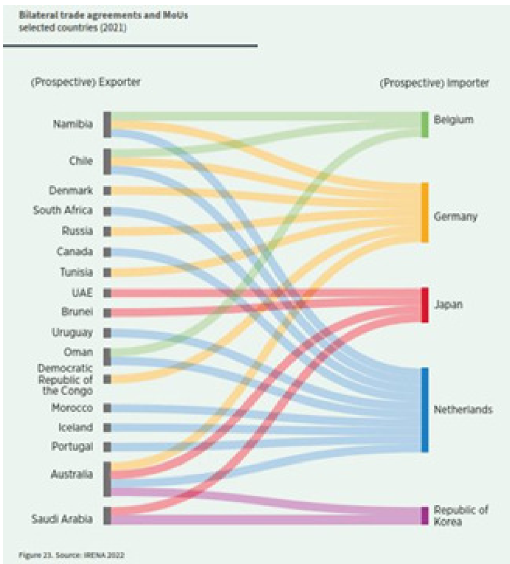

Fig 4: Bilateral trade agreements and MoUs (IRENA 2021)

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