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# Powering Africa's Future:

## Unleashing Green Hydrogen Opportunities

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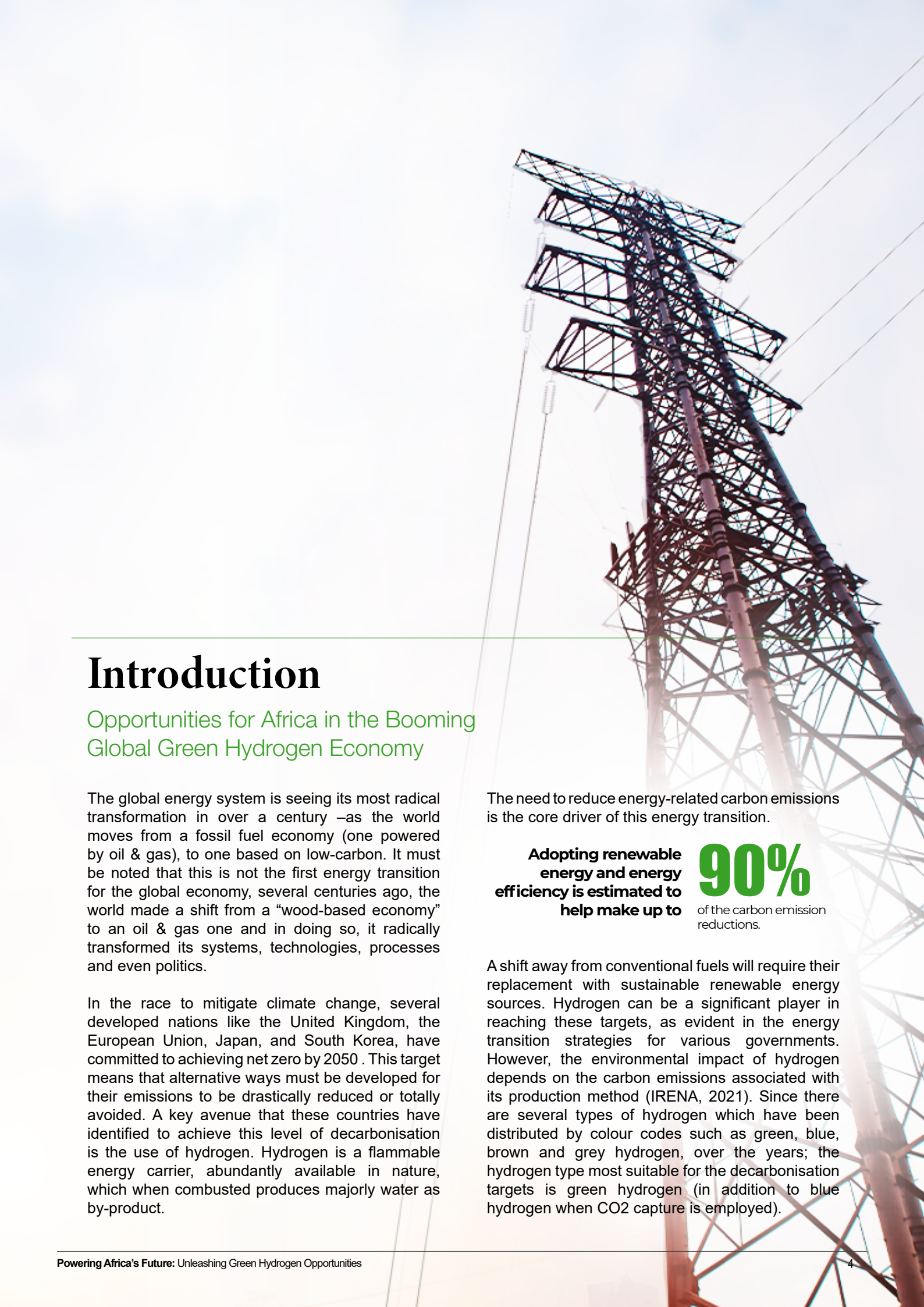


# Introduction

## Opportunities for Africa in the Booming Global Green Hydrogen Economy

The global energy system is seeing its most radical transformation in over a century –as the world moves from a fossil fuel economy (one powered by oil & gas), to one based on low-carbon. It must be noted that this is not the first energy transition for the global economy, several centuries ago, the world made a shift from a “wood-based economy” to an oil & gas one and in doing so, it radically transformed its systems, technologies, processes and even politics.

In the race to mitigate climate change, several developed nations like the United Kingdom, the European Union, Japan, and South Korea, have committed to achieving net zero by 2050 . This target means that alternative ways must be developed for their emissions to be drastically reduced or totally avoided. A key avenue that these countries have identified to achieve this level of decarbonisation is the use of hydrogen. Hydrogen is a flammable energy carrier, abundantly available in nature, which when combusted produces majorly water as by-product.

The need to reduce energy-related carbon emissions is the core driver of this energy transition.

**Adopting renewable energy and energy efficiency is estimated to help make up to** **90%** of the carbon emission reductions.

A shift away from conventional fuels will require their replacement with sustainable renewable energy sources. Hydrogen can be a significant player in reaching these targets, as evident in the energy transition strategies for various governments. However, the environmental impact of hydrogen depends on the carbon emissions associated with its production method (IRENA, 2021). Since there are several types of hydrogen which have been distributed by colour codes such as green, blue, brown and grey hydrogen, over the years; the hydrogen type most suitable for the decarbonisation targets is green hydrogen (in addition to blue hydrogen when CO2 capture is employed).

Green hydrogen is a term used to describe hydrogen produced with clean energy sources. Renewable sources such as wind and solar are used to power large electrolysers that separate hydrogen and oxygen molecules from water. This hydrogen can subsequently be converted to other dense forms , pressurised or liquified for storage and later use. Blue hydrogen is hydrogen produced through a process known as Steam Methane Reforming (SMR) or AutoThermal Reforming (ATR). In the SMR case, methane (or other hydrocarbons) are used in the production process, mixed with high temperature steam alongside a catalyst, with the resultant product being hydrogen and carbon monoxide (syngas). The carbon monoxide can be converted into carbon dioxide by adding more water which leads to more hydrogen being produced (this process is called water-gas shift reaction). A distinctive fact of blue hydrogen is the use of carbon capture and sequestration as a way of curtailing carbon emissions in the hydrogen production process.

With an abundance of renewable energy resources (such as wind, solar, hydro) and natural gas, Africa is blessed with the required raw resources to be a stand-out player in the global hydrogen economy. If properly harnessed, there is a chance for the continent's resources to become a springboard of economic development and strategic trade with European and Asian countries. This could shift the dynamics of the global energy landscape, making immediate impacts on commerce and industry in the African continent. Green hydrogen production presents various possibilities. Hydrogen holds the huge potential of helping Africa become a global player in the future clean energy trade sector. This advantage stems from its energy storage capacity,energy security advantage and reliability. Other areas of benefits include energy grid re-structuring through the implementation of mini-grids, and providing strategic partnerships for the continent's economic development.

***In Africa, countries such as Egypt, Namibia, Morocco, Mauritania and South Africa are gearing efforts to become net exporters of green hydrogen through evolving and relatively established pathways that enable production.***

These countries have taken critical action to create their national hydrogen development strategies/ roadmaps and are already signing Memorandums of Understanding (MoUs) with other countries and international organisations. For example, in 2021, the government of Namibia and Belgium signed an MoU at COP26 to partner on the development of a hydrogen refuelling station, industrial hydrogen applications and a medium-sized solar power plant, which will produce one million tonnes of green hydrogen annually by 2026. Elsewhere, an agreement was signed between Egypt's Sovereign Fund, Norway's Scatec, the Fertiglobe company owned by the Dutch "Orascom", and Abu Dhabi's National Oil Company. The agreement will see Scatec build, operate and own most of the plant while EBIC, a subsidiary of Fertiglobe, will serve as the product off-taker. These agreements attest to many benefits of hydrogen development in Africa, not just to Africa but to the global economy.

With hydrogen, especially green hydrogen, beginning to gain more traction in the African energy landscape, there are still some challenges that pose heavy constraints to its growth and adoption. Currently, there is a twin issue of a comfortable dependence on fossil fuels and the unwillingness to invest in hydrogen. Some African countries boast large fossil reserves, and proponents of "local content consumption" believe that Africa must consume what it has in abundance. The reason for this is not far-fetched. The infrastructure for oil and gas is settling into maturity stages, and government investments have gone a long way toward accelerating the sector's growth over the years. This, therefore, brings an unwillingness to direct a new round of investment into a new technology that is perceived as "untested", "unproven" and "more globally ubiquitous".

Furthermore, like most nascent industries, policies play a critical role in driving mass adoption. As such, there is a need for adequate government/ political support to drive the growth of the sector into maturity. For a hydrogen economy to flourish, proper regulatory frameworks will need to be put into place.

Hydrogen promises great dividends for Africa. Beyond its nexus with electrification, a hydrogen boom anchored in Africa would lead to rapid economic development as several other aspects of the economy will experience accelerated growth. However, for Africa to position itself strategically and take advantage of the current financing opportunities, geopolitical landscape and increased global appetite, it will have to move quickly to take advantage of the rapidly shaping global market, leveraging its nous, long-standing partnerships, credibility and establish position as an energy supplier.

# Strategic Role of Africa's Renewable Energy Endowments

Africa's incredible wind speeds and solar irradiation, coupled with its mineral endowments, gas reserves and proximity to key markets makes it a competitive partner in the low-carbon hydrogen race. And as such, it has the potential of becoming a global hub for both the production of hydrogen and a business hotspot for its trading.

Africa is gifted with a significant amount of solar, wind, hydro and geothermal resources, and as such its potential for renewable energy generation is unrivalled. And as such, it has the opportunity to become a global hub for both the production of hydrogen and a business hotspot for the sale of the fuel. Note that globally, there are yet to exist fully functioning trading spots for hydrogen (akin to the Henry Hub in the USA). Could this be an opportunity for Africa to take the lead in domesticating the production and trading of hydrogen?

In Africa, the majority of the countries enjoy year-round sunshine, and as such, the continenthas the capacity to produce up to 10 terawatts of solar energy by 2050. This is more than twice the continent's current electricity consumption, according to the International Renewable Energy Agency (IRENA). In the same vein, there is a lot of wind energy potential throughout Africa, especially near the coast and in hilly regions.

**By 2050, the continent could produce up to** **170 GW** of wind energy

With several large rivers, like the Congo, Nile, and Zambezi, offering great potential for electricity generation, hydropower is another prominent renewable energy source in Africa. Some nations, including Kenya and Ethiopia, have tremendous geothermal energy potential.

Suppose Africa's renewable energy capacity is well developed, the continent can be a leader in the green hydrogen economy, supplying hydrogen for both domestic and international needs.

> ***Projects such as the 6,450 MW Grand Ethiopian Renaissance Dam in Ethiopia, the 580 MW Noor Ouarzazate Solar complex in Morocco, and the 310 MW Lake Turkana wind farm in Kenya are just some of the continent's most significant renewable energy developments.***

By using new and existing renewable projects to accelerate green hydrogen development, Africa serves to significantly benefit from a green energy future.

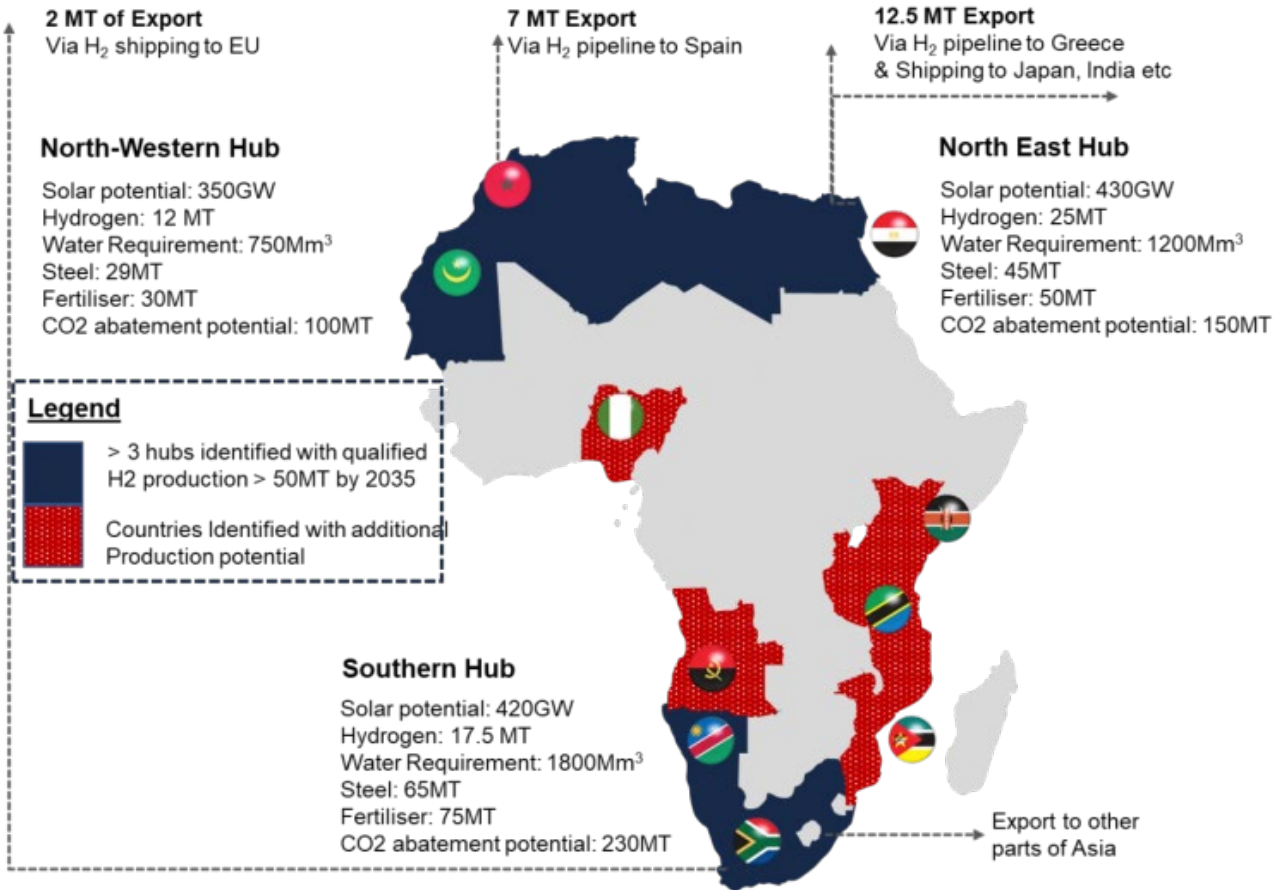
The development of hydrogen is expanding, yet some challenges are still being encountered on the continent. Some of them include the development of hydrogen infrastructure. This is a challenge holding back widespread adoption. There is a need for local production of necessary equipment (like electrolysers, batteries) for the hydrogen economy. Unfortunately, in this regard much of the continent's critical minerals needed to make these systems are taken away in raw form and manufactured elsewhere –ferrying away value from the local economies. Still on the challenges that need to be surmounted, upgraded pipelines and efficient shipping infrastructure (ports, jetties, berths, etc.,) require further development. Any of these infrastructure are in derelict, old and desolate and not fit for such a large industry.

Also, a lack of fit-for-purpose regulatory structures still limit the development of a clean hydrogen industry. It is important for governments and industries to work together to ensure that existing regulations do not become unnecessary barriers to investments.

**This point is rather important because Africa has** **90%** of the world's proven platinum supplies (used to make proton-exchange-membrane electrolyers).

It also has over 30% of proven lithium supplies – an important component for battery manufacture. And as such, developing this value chain in Africa to capture the economic value will help to advance the continent.

# Key green hydrogen hotspots in Africa



**A number of significant hydrogen hubs are emerging in Africa. Here are a few examples:**

- **Egypt:** Egypt has vast renewable energy resources, including wind and solar power, and is also exploring the potential of blue hydrogen production using its significant natural gas reserves. The country has established a Hydrogen Alliance to promote the development of a local hydrogen industry. Among the hydrogen projects that are being implemented in the country is the "Green Hydrogen for Egypt" project which is aimed at establishing a green hydrogen production plant in the North of the country. With an estimated cost of 4 billion USD, the project is expected to have production capacity of 1 GW, the project was jointly initiated by the German government and the Egyptian Ministry of Electricity and Renewable Energy. Renewable energy sources such as solar and wind will supply the energy needed by the plant for the production of green hydrogen, using electrolysis. Also, Egypt's Sovereign Fund, Norway's Scatec, and Abu Dhabi's National Oil Company, signed an agreement to build and operate a hydrogen plant.

- **Mauritania:** Mauritania is rich in wind and solar resources, making it a sweet spot for the production of green hydrogen. There is a 30 GW AMAN green hydrogen project that is being developed in partnership with CWP Global. The project alone is expected to raise Mauritania's Gross Domestic Product (GDP) by 50% by 2030. Several other green hydrogen projects like the 10 GW NOUR gren hydrogen project and the BP-Mauritania Large-Scale green hydrogen projects are also at play in the country.

- **Morocco:** Because of its plentiful sun and wind resources, Morocco has a tremendous potential for producing green hydrogen. The nation already has a number of sizable renewable energy projects under construction, and it has created a Green Hydrogen Alliance to support the growth of a regional hydrogen industry. The country has also announced several green hydrogen projects, one of which is a green hydrogen plant to be constructed in Laayoune. The project is to be developed by a consortium made up of Moroccan and German companies. The project is expected to have a capacity of 100 MW and is estimated to cost around €500 million (approximately $600 million USD). Another is the Hydrogen-powered train project in the country. In collaboration with Alstom, the French train manufacturer, Morocco will establish the project as part of its efforts to reduce its dependence on fossil fuels in the transportation sector.

- **Namibia:** In a report by the European Investment Bank on the state of hydrogen and the potential of solar in Africa, Namibia was identified as a significant could-be-player if the country's abundant solar resources are harnessed towards the production of green hydrogen. Based on the report, a southern African Hydrogen hub can be established due to the activities from the neighbouring country of South Africa.

  Namibia in 2021 announced a green hydrogen project with an estimated value of USD 9.6 billion. The project is expected to commence commercial operations by 2026. In its initial phase, it should generate 2 gigawatts of renewable electricity for regional and global markets. Another is the Green Hydrogen and Ammonia Production Facility in Walvis Bay. The Industrial Development Corporation of South Africa and the Development Bank of Namibia are the project's partners. It is aimed at producing green hydrogen and ammonia which will be exported to other countries.

  In addition, the country plans the following:
  - 5GW of renewable energy capacity by 2030
  - 30% SMEs and local companies
  - 90% Namibian employees
  - 20% youth participation
  - N330,000,000 land rentals per year during operations
  - Royalties, government participation and taxes.

- **Nigeria:** Nigeria is one of the largest producers of crude oil in Africa and is exploring the potential of using its oil and gas resources to produce hydrogen. The country has established a National Energy Policy that includes the development of a hydrogen economy as a key priority. Even though Nigeria is yet to announce feasible hydrogen projects, there have been activities in the country suggesting its interest in hydrogen. In 2022, the German government and Nigeria launched the German-Nigerian Hydrogen office which is tasked with understanding the needs and pathways for the development and export of hydrogen in Nigeria.

- **South Africa:** The majority of the planet's platinum, a crucial component for making proton exchange membrane (PEM) electrolysers and fuel cells, are found in South Africa. Also, the nation is home to a number of sizable renewable energy projects, making it a potential major player in the world's hydrogen economy. The feasibility study for the creation of a hydrogen valley in South Africa has now been completed. As at the end of 2022, 19 green hydrogen projects were registered in the country, at varying levels of development. In the same year, the President of South Africa, Cyril

Ramaphosa, initiated the country's Green Hydrogen National Programme with an investment pipeline worth R300 billion (€15 billion). Other hydrogen development projects in the country include the Platinum Valley Special Economic Zone (SEZ) in the North West Province which is being developed as a hub for the hydrogen and fuel cell industry. The SEZ will include a hydrogen refuelling station, a manufacturing plant for fuel cell components, and a training facility. Another is the Gauteng Industrial Development Zone (GIDZ) which is exploring opportunities to develop a hydrogen hub in the province. The proposed hub would include a hydrogen refuelling station, a hydrogen production plant, and facilities for research and development.

- **Tunisia:** Tunisia has a significant potential for green hydrogen production, particularly through the development of solar power. The country is already home to several large-scale renewable energy projects and has established a Hydrogen Alliance to promote the development of a local hydrogen industry. Countries like Germany and Italy have all shown interests in investing into the development of green hydrogen in the country. In 2022, Germany made a €31 million donation towards the implementation of a green hydrogen test plant to the country. Also, TSK Electronica y Electridad, a Spanish company, in 2021, engaged the Tunisian National Agency for Energy Conservation, signing an MoU towards the production of green hydrogen in the country.

# Green Hydrogen and Its Potential to Industrialise African Economies

It is common knowledge that the European Union over the last two decades established a carbon taxation scheme (i.e., the emissions trading system – ETS). The scheme, which is mainly for companies domiciled in the EU, came into effect in 2005 and has seen many companies pay tens of millions per year in proportion to their emissions.

In Sept 2022, the EU released an update to the prior guidance on the emissions trading system, (under a new framework known as the Carbon Border Adjustment Mechanism - CBAM). Under this new framework, non-EU nations (e.g., African countries) who access EU markets will be subject to the same carbon tax via the EU ETS –which risks seeing their profits wiped-off or losing their competitive position. As such, it has become imperative for African countries who access EU markets to seek ways to decarbonise their operations.

Green hydrogen promises more than a lever for African countries to decarbonise. With the burgeoning hydrogen industry, and its nexus with renewable energy, this can serve as a catalyst for transitioning African nations from energy poverty to energy sufficiency . The critical path to do this is by setting up the right frameworks, policies and environments to make investment into stand-alone distributed generation solar and centralised large solar & wind farms possible. Any such investments will serve as precursor for larger scale investments into multi-gigawatt hydrogen projects.

A 2019 report by the International Energy Agency (IEA) showed that steel and cement production in Africa is projected to grow from 13.1 million tonnes, to about 25.4 million tonnes by 2040. Going with this outlook and other projects which show significant growth in GDP across the African continent, it is

clear that the current decade and the next will be periods of massive development in the African steel and cement production industry.
Globally, cement and steel have been identified as major players in the hard-to-abate emission sectors with hydrogen proving to be a worthy solution to their emissions. With the projected increase in steel and cement production, Africa has a unique opportunity to satisfy its local energy demand for this energy-intensive production process by utilising locally produced hydrogen. The rise in steel and cement production would be stimulated by a corresponding increase in demand. Therefore, at the base level of these increases would be an increase in population and urbanisation. With these in mind, Africa is expected to experience major economic and infrastructural growth within these periods.

# Implications for Africa: Opportunities for Exports and International Trade

In 2013, the African Union (AU) Heads of State, as part of its Agenda 2063 endorsed the African Integrated High-Speed Railway Network which is targeted at receiving and establishing a modern railways system across the African continent. With this very welcomed development, there is an increased demand and use-case opportunity for hydrogen in Africa.

The project is aimed at interconnecting sixteen African landlocked countries to major seaports and neighbouring countries will establish interoperability of railways across different regions, create East-West/North-South land-bridges and interconnect African capitals. This will enable the interconnection of major commercial and economic hubs to boost economic growth and intra-African free trade, as well as complement the African Continental Free-Trade Area. This development also opens up an opportunity for international trade of hydrogen though several routes on the African border and, therefore, great development for the continent.

The most obvious market for African low-carbon hydrogen export is Europe. As already announced in the European Union “Fit-for-55” strategy, Europe has set and committed to ambitious targets to reduce greenhouse gas emissions, and low-carbon hydrogen is a vital component to achieve this target. African countries, who are next door to Europe, like Morocco, Egypt and Tunisia, with their favourable renewable energy conditions, have the potential to produce green hydrogen at a competitive cost, making them attractive suppliers to the EU market.

Additionally, other obvious markets for African hydrogen are in Asia, specifically South Korea, Japan and Singapore, which have limited energy resources or capability to produce hydrogen and as such are incredibly dependent on energy imports. Low-carbon hydrogen from key African countries can become important to these economies, ultimately deepening trade partnerships.

Other benefits that African nations can realise in the quest to being the leading low-carbon hydrogen suppliers, is establishing strong and lasting partnerships. These play a very important role in making the export of a commodity like hydrogen happen. Typically, MOUs will be signed with key governments, companies, academic institutions and OEMs in order to develop the necessary infrastructure, technology and policies for establishing a hydrogen value chain. Partnerships will offer benefits including knowledge transfer, risk mitigation, investment, capacity building for the establishing the nascent industry in Africa.

Furthermore, with the already established African Continental Free Trade Agreement (AfCFTA), African countries can leverage this existing framework, to promote intra-African trade of green hydrogen. Perhaps even set up a hydrogen trading system (which is functional for the continent). This will without a doubt create a regional market for African green hydrogen, driving economic growth, job creation, and sustainable development.

# Next Steps: How Africa Can Win in the Green Hydrogen Game

Africa is at a critical time in its relation to the global economy and hydrogen production, based on the continent's vast amount of natural resources, is a key leverage. Africa needs to locally develop its local minerals, especially those useful in the hydrogen economy. For example, Cobalt is a critical material in the production of hydrogen fuel cells and DR Congo has one of the largest deposits of the important resource globally. Also, South Africa, Zimbabwe and Madagascar have large deposits of Nickel, an important catalyst in the SMR process for the production of blue hydrogen. Platinum Group Metals (PGMs) such as platinum, palladium, and rhodium are used in hydrogen fuel cells as catalysts. South Africa is one of the world's leading producers of PGMs.

Therefore, it is clear that Africa remains home to critical ingredients for the advancement of the hydrogen economy and must now situate itself properly to harness its potential in the most pragmatic manner. Some important steps to take are highlighted below:

1. Invest in research and development: African countries should invest in research and development to develop new technologies and processes for producing hydrogen more efficiently and at a lower cost. This will help to increase the competitiveness of African-produced hydrogen in the global market.

2. Develop a favourable policy and regulatory environment: African countries should create a conducive policy and regulatory environment to attract investment in the green hydrogen industry. This includes setting clear targets and policies for the development of the industry, providing incentives for investors, and establishing clear regulatory frameworks to govern the production, transportation, and use of hydrogen.

3. Leverage the continent's abundant renewable energy resources: Africa has abundant renewable energy resources, including solar and wind power, that can be used to produce green hydrogen. By developing these resources, African countries can reduce the cost of producing hydrogen and gain a competitive advantage in the global market.

4. Build strategic partnerships: African countries should build strategic partnerships with other countries and companies to help develop the green hydrogen industry. This includes partnerships for technology transfer, financing, and market access.

5. Develop local skills and expertise: African countries should invest in building local skills and expertise in the green hydrogen industry. This includes training programs for engineers, technicians, and other professionals, as well as programs to support entrepreneurship and innovation in the industry.

By taking these steps, Africa can position itself to become a major player in the green hydrogen industry and capture a share of the growing global market.

In conclusion, Africa has a significant opportunity to play a leading role in the global hydrogen economy. The continent's abundance of renewable energy resources, critical ingredients for hydrogen production, and potential for investment make it a prime location for the development of the green hydrogen industry. By investing in research and development, creating a favourable policy and regulatory environment, leveraging renewable energy resources, building strategic partnerships, and developing local skills and expertise, Africa can harness its potential in the most pragmatic manner and become a major player in the growing global hydrogen market. The time is ripe for African countries to take bold steps towards this goal and unlock the full potential of the hydrogen economy for the benefit of the continent and the world.

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