The Green Hydrogen Pathway for Nigeria

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Accelerating the Growth of Green Hydrogen in Africa: Opportunities, Challenges, and Solutions

The Great Potential of GHRU, ABUAD

- Hydrogen includes hydrogen in molecular form (pure hydrogen) and other hydrogen derivatives such as synthetic methane (CH_4), ammonia (NH_3)…

- At its core, green hydrogen is simple. It's hydrogen, the universe's most abundant element, produced environmentally friendly

- Green hydrogen is generated via electrolysis, which splits water into hydrogen and oxygen using electricity. But for the hydrogen to be 'green', the electricity must come from renewable sources, like wind or solar power. The only byproduct is oxygen, a harmless gas we breathe every day.

The Rise Of Green Hydrogen In Africa

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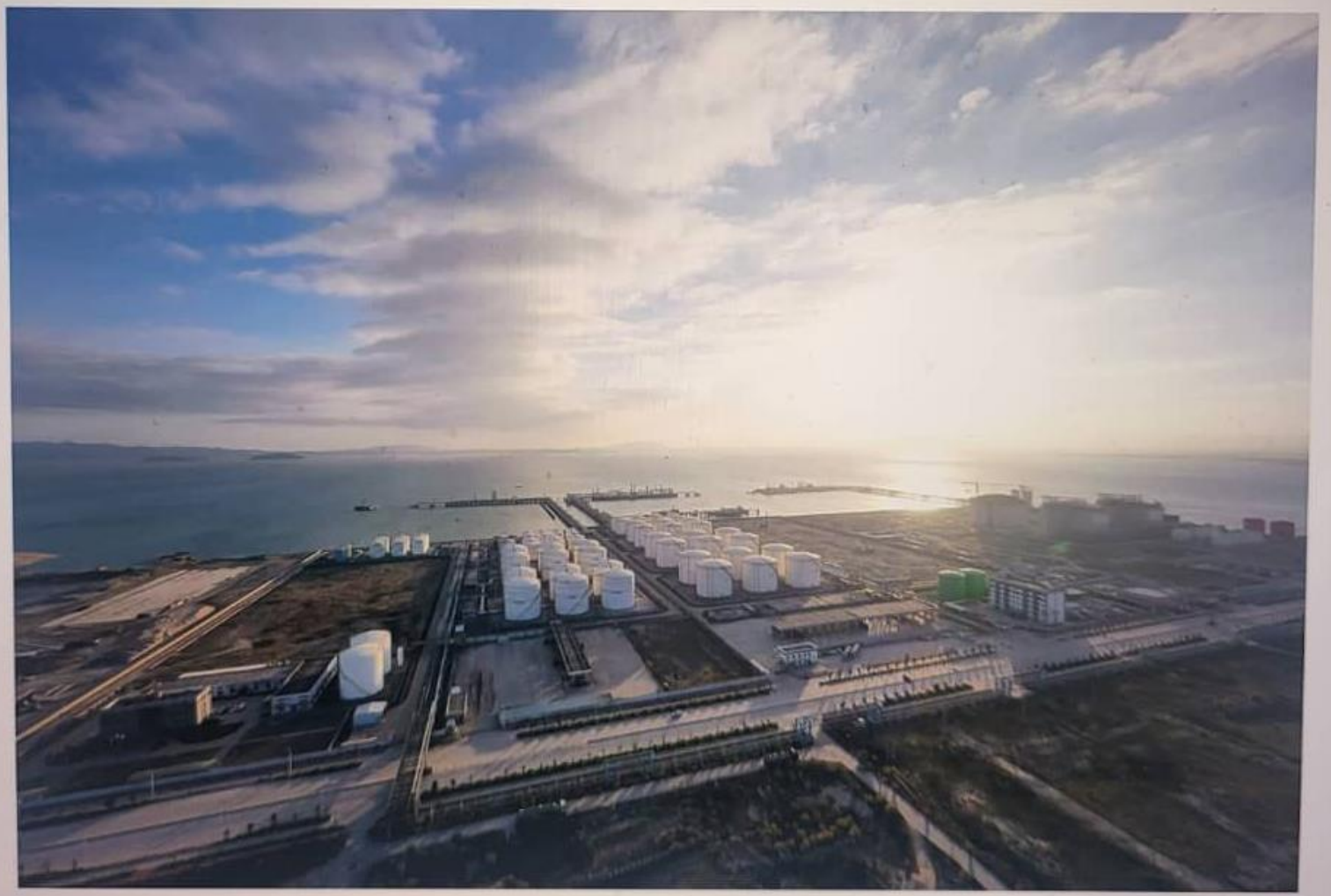
By Yeshiel Panchia



Africa's secret weapon in the global energy race – green hydrogen. The continent has the potential to flip the script, transitioning from a fossil fuel consumer to a green energy titan.

INTRODUCTION

Green Hydrogen – The Game Changer?

Policy and profitability

- A confluence of factors is propelling the growth of green hydrogen in Africa. The continent's abundant natural resources, particularly sunlight and wind, provide an ideal setting for green hydrogen production. The advent of green hydrogen presents a substantial opportunity for job creation across the African continent.

- With Africa positioned as a potential global exporter of green hydrogen, the sector could become a significant contributor to the continent's GDP. Moreover, the revenues generated from green hydrogen exports could be reinvested into local communities, improving infrastructure, education, and healthcare etc

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The global energy transition has a burgeoning champion – green hydrogen. Often overshadowed by solar and wind, this renewable resource is increasingly crucial for a sustainable future.

The current global hydrogen market is over $130 billion. The World Bank predicts an annual growth of over 9%. Although the surge is likely niche until 2030, the growing demand for renewable energy means that green hydrogen could accelerate rapidly thereafter. Regions with low-cost markets and abundant renewable resources, like Africa, become attractive production markets.

Green Hydrogen is a tool for survival

As the world stands on the brink of a pivotal moment in its fight against climate change, green hydrogen emerges as a powerful ally. As a clean, carbon-free source of energy, green hydrogen can replace fossil fuels in various sectors, leading to a dramatic reduction in greenhouse gas emissions.

In Africa, where climate change threatens both people and ecosystems, investing in green hydrogen will not only enable nations to contribute to global emission reductions but also helps them build resilience against climate change impacts at home.

Even though Africa is responsible for only a fraction of global carbon emissions, the continent is actively taking steps to reduce its carbon.

Classification of Hydrogen:

- Brown hydrogen, Pink hydrogen, yellow hydrogen, multi-coloured hydrogen…
- Grey hydrogen: produced by splitting natural gas into hydrogen and CO2, but the CO2 is not being captured and is released into the atmosphere.
- Blue hydrogen: produced by splitting natural gas into hydrogen and CO2, but the CO2 is captured and then stored.
- Green hydrogen: produced by splitting water by electrolysis this process to make green hydrogen is powered by renewable energy sources, such as wind or solar.

Production Output of selected crops in Niger State (2016-2018)

Color	Primary Feedstock	Primary Energy Source	Primary Poduction Process	Carbon Impact (kg CO_2/kg H_2)
Brown	Coal or Lignite	Chemical Energy in Feedstock	Gasification & Reformation	18 to 20
Gray	Natural Gas	Chemical Energy in Feedstock	Gasification (SMR)	10 to 12
Blue	Coal, Lignite, or Natural Gas	Chemical Energy in Feedstock	Gasification with Carbon Capture and Sequestration	0.6 to 3.5
Green	Biomass or Biogas	Chemical Energy in Feedstock	Gasification and Reformation	
	Water	Zero Carbon Electricity	Electrolysis	0

Hydrogen Production Methods:

- Most methods of producing hydrogen involve splitting water (H2O) into its component parts of hydrogen (H2) and oxygen (O). The most common method involves steam reforming of methane (from natural gas), although there are several other methods….
- Steam reforming converts methane (and other hydrocarbons in natural gas) into hydrogen and carbon monoxide by reaction with steam over a nickel catalyst
- Electrolysis uses electrical current to split water into hydrogen at the cathode (+) and oxygen at the anode (-)

Hydrogen Production Methods:

- Steam electrolysis (a variation on conventional electrolysis) uses heat, instead of electricity, to provide some of the energy needed to split water, making the process more energy-efficient
- Thermochemical water splitting uses chemicals and heat in multiple steps to split water into its component parts
- Photoelectrochemical systems use semi-conducting materials (like photovoltaics) to split water using only sunlight

Hydrogen Production Methods:

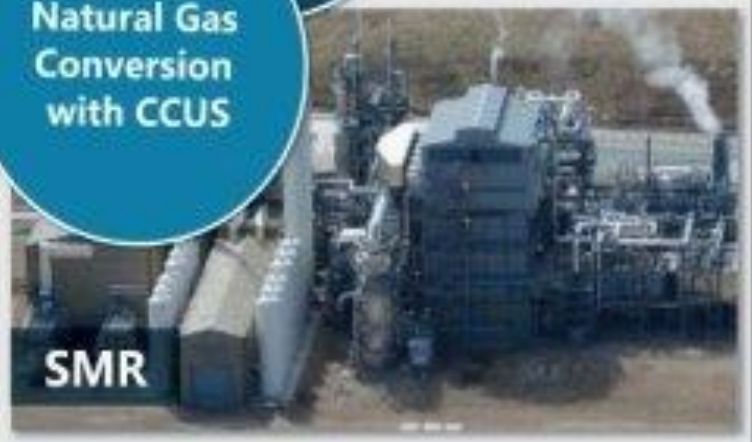
- Photobiological systems use microorganisms to split water using sunlight
- Biological systems use microbes to break down a variety of biomass feedstocks into hydrogen
- Thermal water splitting uses a very high temperature (approximately 1000°C) to split water
- Gasification uses heat to break down biomass or coal into a gas from which pure hydrogen can be generated.

FOSSIL RESOURCES

- Low-cost, large-scale hydrogen production with CCUS
- New options include byproduct production, such as solid carbon

Coal Gasification with CCUS

Natural Gas Conversion with CCUS



BIOMASS/WASTE

- Options include biogas reforming and fermentation of waste streams
- Byproduct benefits include clean water, electricity, and chemicals

Biomass Conversion

Waste to Energy

H_2O SPLITTING

- Electrolyzers can be grid-tied, or directly coupled with renewables
- New direct water-splitting technologies offer longer-term options

Direct-Solar

High Temp. Electrolysis

Low Temp. Electrolysis

CCUS: carbon capture, utilization, and storage; SMR: steam methane reforming; ADG: anaerobic digester gas; STCH: solar thermochemical hydrogen; PEC: photoelectrochemical)

Green hydrogen can transform how we power Nigeria and create vibrant clean energy economies with sustainable local jobs

Agriculture

Industrial applications

Natural Gas

Power

Transportation

Mining

Energy Storage

Pathways for Nigeria

Domesticate
The H2 ATLAS-AFRICA project
https://www.h2atlas.de/en/

H2 ATLAS project is focused on assessing the potential of generating hydrogen in sub-Saharan Africa from the renewable energy resources in the region

Nigeria should carry out:
Critical Analysis of the Potentials, Infrastructure and Other Enabling Framework Conditions for Hydrogen/Green Hydrogen Development

Detailed Feasibility/Comparison Analysis of the Different Pathways

Agriculture

Industrial applications

Natural Gas

Power

Transportation

Mining

Energy Storage

Nigeria should develop High-Level Regulatory and Policy Roadmap - Work needs to start NOW to resolve issues for ALL pathways

Nigeria should As a matter of urgency develop a Strategic In Capacity Building Programme in Green Hydrogen/Renewable Energy Development In Nigeria

Suggested Pathways for Nigeria

- Help create alignment with key stakeholders including labor and environmental justice groups
- Help study and provide vision for accelerating transformation of existing assets and skilled jobs: repurposing gas and oil assets, natural gas pipeline conversion, sectoral convergence
- Improve regional modelling of optimal portfolios - electric and gas sector optimization connecting green hydrogen industrial hubs.

Suggested Pathways for Nigeria

- Accelerate green hydrogen industrial hub development: nexus of green ammonia for shipping and agriculture; electrolytic tariff design; expand industrial applications

- Needed RD&D: production, transport, blending and injection demonstrations, underground geologic storage (aquifers, retired oil wells, retired natural gas caverns)

Suggested Pathways for Nigeria

Leverage existing pipeline infrastructure to bring low-cost green hydrogen to the basin

- ❑ Utilize existing natural gas pipeline through injection
- ❑ Utilize pipeline right of ways for new, exclusively hydrogen pipelines
- ❑ Repurpose existing natural gas pipelines

Pathways for Nigeria

Leverage existing transmission infrastructure and capacity to produce green hydrogen locally through electrolysis

- ❑ Utilize excess transmission capacity to import low-cost renewable electricity for electrolysis
- ❑ Maximize local rooftop solar

Pathways for Nigeria

- Create green hydrogen locally through gasification

- Divert organic municipal solid waste and non-recyclable paper and ocean plastic from landfills to thermochemically produce green and low-carbon

THANK YOU