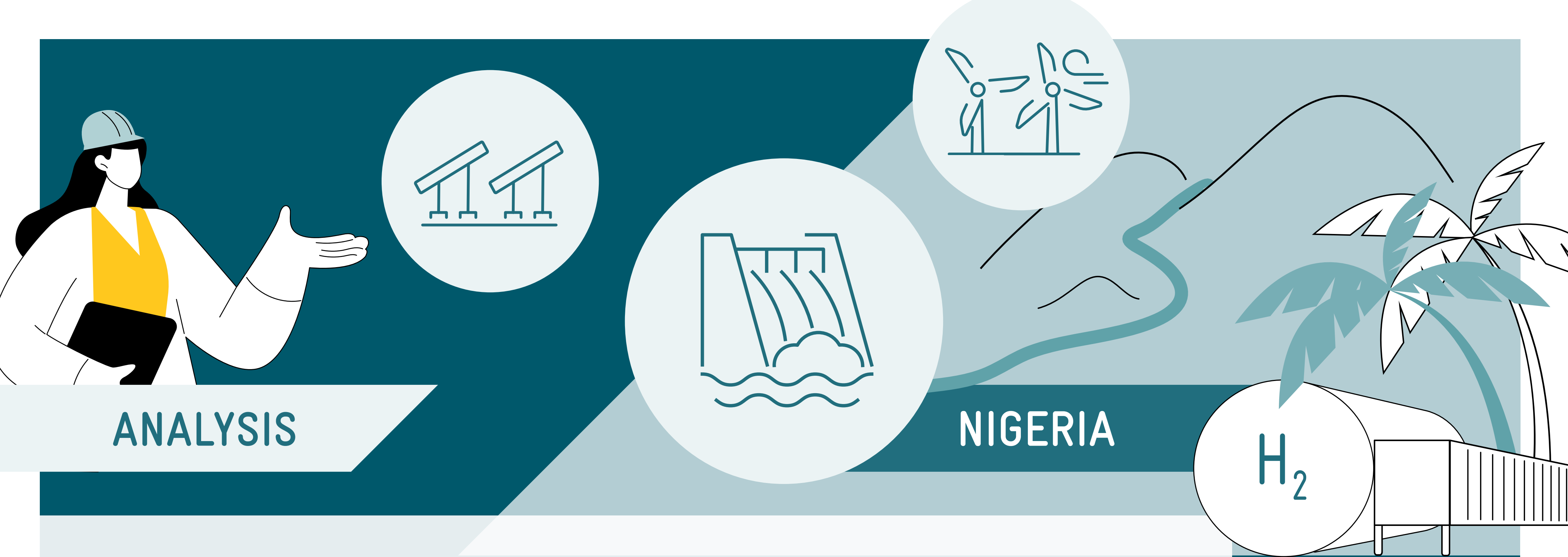

Sector Analysis Nigeria

Green Hydrogen for the C&I Sector

Deutsche Gesellschaft
für Internationale
Zusammenarbeit (GIZ) GmbH

This publication was commissioned by the German
Energy Solutions Initiative of the German Federal
Ministry for Economic Affairs and Energy (BMWE)

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Currency units

NGN	Nigerian Naira
USD	United States dollar

Currency units and conversion rate as of 05.09.2024

EUR 1 = NGN 0.0005649
NGN 1 = EUR 1,770.28

EUR 1 = USD 0.92275
USD 1 = EUR 1.0838

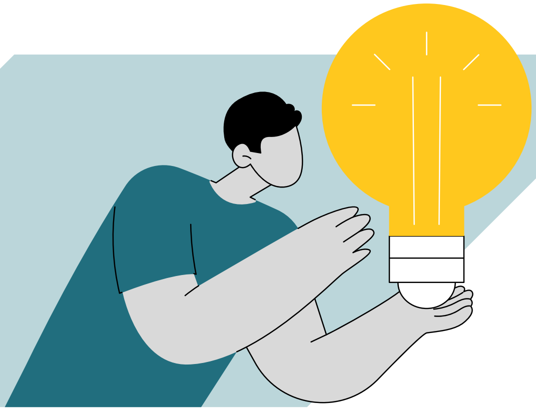
Source: Exchange-Rates.org, 2024

Technical units

bbl	Barrels (plural)
Boe	Barrels of oil equivalent
EJ	Exajoules (10^6 TJ)
GW	Gigawatt
GWh	Gigawatt-hour
kTPA	Thousand (metric) tons per annum
Mt	Million (metric) tons
MTPA	Million (metric) tons per annum
MW	Megawatt
MWh	Megawatt-hour
PJ	Petajoule (10^3 TJ)
TJ	Terajoule (10^12 Joule)
kboed	Thousand barrels of oil equivalent per day

Abbreviations/acronyms

AEC	Alkaline electrolysis
AEMEC	Anion exchange membrane electrolysis cell
AN	Ammonium nitrate
AS	Ammonium sulphate
ASU	Air separation unit
BMWE	Bundesministerium für Wirtschaft und Energie (German Federal Ministry for Economic Affairs and Energy (BMWE))
BT	Benzyltoluene
CAN	Calcium ammonium nitrate
CCU	Carbon capture and utilisation
CH_2	Compressed hydrogen
CHP	Combined heat and power
CO_2	Carbon dioxide
DAC	Direct air capture
DAP	Diammonium phosphate
DBP	Domestic base price
DME	Dimethyl ether
DMT	Dimethyl terephthalate
DRI	Direct reduced iron
EAF	Electric Arc Finance
ECOWAS	Economic Community of West African States
ETP	Energy Transition Plan
ETS	Emission trading scheme
EU	European Union
FTZ	Free Trade Zone
GDP	Gross domestic product
GH_2	Green hydrogen
GHG	Greenhouse gas
GHI	Global horizontal radiation
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit (German federal enterprise in the field of international cooperation for sustainable development)
HB	Haber-Bosch
IEA	International Energy Agency
LH_2	Liquid hydrogen
LOHC	Liquid organic hydrogen carriers
MAP	Monoammonium phosphate
MCH	Methylcyclohexane
MeOH	Methanol
MTBE	Methyl tertiary butyl ether
MTG	Methanol-to-gasoline
MTO	Methanol-to-olefins
n/a	not applicable
NDC	National Determined Contribution
NH_3	Ammonia
NMDPRA	Nigerian Midstream and Downstream Petroleum Regulatory Authority
NNPC	Nigerian National Petroleum Company
NPV	Net present value
NREC	Nigerian Electricity Regulatory Commission
OEM	Original equipment manufacturer
PEMEC	Proton membrane electrolysis cell
PFI	Presidential Fertilizer Initiative
PPA	Power Purchase Agreement
PPP	Public-private partnerships
PSA	Pressure swing absorption
PtX	Power-to-X (anything)
PV	Photovoltaic
R&D	Research and development
RES	Renewable energy sources
SBT	Service-based tariff
SDG	Sustainable Development Goals
SME	Small and medium-sized enterprises
SMR	Steam methane reforming
SOEC	Solid oxide electrolysis cell
UAN	Urea ammonium nitrate
VAT	Value-added tax
WACC	Weighted average cost of capital



ENERGY SOLUTIONS – MADE IN GERMANY The German Energy Solutions Initiative

The German Energy Solutions Initiative of the German Federal Ministry for Economic Affairs and Energy (BMWE) aims to globalise German technologies and expertise in climate-friendly energy solutions.

Years of promoting smart and sustainable energy solutions in Germany have led to a thriving industry known for world-class technologies. Thousands of specialised small and medium-sized enterprises (SMEs) focus on developing renewable energy systems, energy efficiency solutions, smart grids, and storage technologies. Cutting-edge energy solutions are also built on emerging technologies such as power-to-gas, fuel cells, and green hydrogen. The initiative's strategy is shaped around ongoing collaboration with the German business community.

The initiative creates benefits for Germany and the partner countries by:

- boosting global interest in sustainable energy solutions
- encouraging the use of renewables, energy efficiency technologies, smart grids, and storage technologies, while facilitating knowledge exchange and capacity building
- enhancing economic, technical and business cooperation between Germany and partner countries

THE PROJECT DEVELOPMENT PROGRAMME (PDP)

PDP is a key pillar of the German Energy Solutions Initiative and is implemented by the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH. It connects development cooperation with private-sector engagement and supports climate-friendly energy solutions in selected developing and emerging countries, enabling local businesses to adopt solutions in energy efficiency, electricity and heat supply, and hydrogen, while facilitating market access for German solution providers.

Developing and emerging economies offer promising business potential for climate-friendly energy solutions but also pose challenges for international business partners. The PDP team works closely with local industries to develop financially viable projects by providing technical expertise, financial guidance, and networking opportunities.

It identifies project leads, collects and analyses energy consumption data, and assesses projects from both a technical and economic perspective. This includes outlining the business case, calculating payback periods, and evaluating profitability. Companies can then choose to finance projects using their own funds or explore leasing and other financing options. PDP provides cost-free advice to local companies and connects them with German solution providers for project implementation.

Additionally, by offering training, organising reference project visits, and publishing studies on the potential of climate-friendly solutions and on navigating regulatory frameworks, the programme supports market development and fosters private-sector cooperation.

Executive summary

GREEN HYDROGEN FOR NIGERIAS'S C&I SECTOR

The 'H_2 Sector Analysis for Nigeria' aims to assess the potential for green hydrogen production in the country, providing a foundation for future reference projects. This study is part of series to deliver key market insights and support pre-development efforts to attract both local and international interest in the green hydrogen economy.

The analysis explores the feasibility of transitioning from grey to green hydrogen within Nigeria's commercial and industrial sectors, evaluating specific use cases and providing techno-economic estimates for stakeholders - particularly companies based in Germany. The objective is to identify opportunities, highlight key challenges and outline a pathway for green hydrogen integration in Nigeria's energy and industrial landscape.

Nigeria is Africa's fourth-largest economy and most populous country, offering a significant potential market for green hydrogen applications. The country has vast renewable energy resources, particularly solar potential in its northern regions, as well as a large industrial base that could serve as a foundation for green hydrogen adoption. However, energy security remains a challenge, with an unstable electricity supply and heavy reliance on diesel generators affecting industrial operations.

Zusammenfassung

GRÜNER WASSERSTOFF FÜR DEN C&I-SEKTOR NIGERIAS

In der vorliegenden „H_2-Sektorstudie für Nigeria" wird das Potenzial für die Produktion grünen Wasserstoffs in Nigeria untersucht. Damit wird die Grundlage für zukünftige Referenzprojekte gebildet. Die Analyse ist Teil einer Serie, die darauf abzielt, zentrale Markteinblicke zu liefern und Vorentwicklungsmaßnahmen zu unterstützen, um sowohl lokales als auch internationales Interesse an einer Grüner-Wasserstoff-Wirtschaft zu fördern.

Im Fokus der Analyse steht die Frage, wie der Übergang von grauem zu grünem Wasserstoff in Nigerias Industrie- und Gewerbesektor gelingen kann. Dazu werden konkrete Anwendungsfälle geprüft und technoökonomische Einschätzungen für verschiedene Akteure bereitgestellt – insbesondere für Unternehmen mit Sitz in Deutschland. Ziel der Analyse ist es, Chancen aufzuzeigen, zentrale Herausforderungen zu benennen und einen möglichen Fahrplan für die Integration grünen Wasserstoffs in Nigerias Energie- und Industriestruktur zu skizzieren.

Nigeria ist die viertgrößte Volkswirtschaft Afrikas und das bevölkerungsreichste Land des Kontinents – und damit ein potenziell attraktiver Markt für Anwendungen aus dem Bereich des grünen Wasserstoffs. Das Land verfügt über große Erneuerbare-Energie-Potenziale, insbesondere im Bereich der Solarenergie im Norden, sowie über eine breite industrielle Basis, die als Ausgangspunkt für die Einführung von Lösungen mit grünem Wasserstoff dienen könnte. Gleichzeitig bleibt die Energiesicherheit eine zentrale Herausforderung: Eine instabile Stromversorgung und die große Abhängigkeit von Dieselgeneratoren erschweren derzeit vielerorts den industriellen Betrieb.

Despite these challenges, green hydrogen could play a complementary role in Nigeria's broader energy transition by:

- Supporting industrial decarbonisation, particularly in oil refining, ammonia production and fertilisers
- Leveraging existing gas infrastructure to enable hydrogen blending and transport
- Enhancing energy security by reducing reliance on imported refined fuels

Additionally, Nigeria's strategic location and well-developed trade networks position it as a potential hub for regional hydrogen exports, further strengthening its long-term market potential.

BUSINESS OPPORTUNITIES FOR GERMAN SOLUTION PROVIDERS

Nigeria's evolving energy landscape presents several business opportunities for German SMEs, particularly in renewable energy, electrolysis, industrial applications and infrastructure development.

Key advantages for SMEs:

- **Renewable energy potential:** Nigeria's vast solar resources, particularly in the northern regions, create a strong basis for green hydrogen production. German companies specialising in solar photovoltaic (PV), hybrid systems and energy storage can play a key role in developing decentralised hydrogen solutions.

Trotz solcher Herausforderungen kann grüner Wasserstoff eine ergänzende Rolle in Nigerias übergeordneter Energiewende spielen, insbesondere durch die

- Unterstützung der Dekarbonisierung industrieller Prozesse, etwa in der Ölraffination, der Ammoniakherstellung und der Düngemittelproduktion;
- Nutzung der Gasinfrastruktur für die Beimischung und den Transport von Wasserstoff;
- Stärkung der Energiesicherheit durch die Verringerung der Abhängigkeit von importierten raffinierten Brennstoffen.

Darüber hinaus positionieren seine strategische Lage und gut entwickelte Handelsnetzwerke Nigeria als potenzielles Drehkreuz für den regionalen Wasserstoffexport. Dieser Aspekt erhöht das langfristige Marktpotenzial zusätzlich.

GESCHÄFTSMÖGLICHKEITEN FÜR DEUTSCHE LÖSUNGSANBIETER

Das sich wandelnde Energiesystem des Landes eröffnet deutschen KMU Geschäftschancen, insbesondere in den Bereichen der erneuerbaren Energien, Elektrolyse, industriellen Anwendungen und Infrastrukturentwicklung.

Zentrale Vorteile für KMU:

- **Potenzial für erneuerbare Energien**: Nigerias große Solarressourcen – vor allem im Norden – bieten eine starke Grundlage für die Produktion grünen Wasserstoffs. Deutsche Unternehmen mit Expertise zu Photovoltaik, Hybridsystemen und Energiespeichern können eine Schlüsselrolle beim Aufbau dezentraler Wasserstofflösungen spielen.

- **Industrial integration:** Nigeria's existing gas infrastructure, refinery operations and fertiliser production provide a clear pathway for early hydrogen applications. German firms with expertise in industrial hydrogen use and process optimisation can support pilot projects and industrial-scale deployment.
- **Export and trade potential:** As one of Africa's largest economies with strong regional trade ties, Nigeria could develop into a hydrogen export hub. German companies involved in logistics, port infrastructure and industrial zones could benefit from early-stage investments in hydrogen supply chains.
- **Energy diversification and security:** Green hydrogen could complement Nigeria's efforts to diversify its energy mix and reduce dependence on imported refined fuels. German firms specialising in hydrogen storage, fuel cells and distributed energy systems could support the country's long-term energy transition.

CHALLENGES ON THE PATH TO A HYDROGEN ECONOMY

While the potential is significant, Nigeria faces several hurdles:

- **Economic challenges:** High production costs, low initial demand and the availability of cheap natural gas make green hydrogen less competitive in the short term. Investments in cost-effective technologies and policy support will be essential for market development.

- **Industrielle Integration:** Bestehende Gasinfrastrukturen, Raffinerien und Düngemittelwerke bieten Anknüpfungspunkte für erste Wasserstoffanwendungen. Deutsche Firmen mit Erfahrung mit der industriellen Nutzung von Wasserstoff und der Optimierung von Prozessen können Pilotprojekte und den großtechnischen Einsatz unterstützen.
- **Export- und Handelschancen:** Als eine der größten Volkswirtschaften Afrikas mit engen regionalen Handelsverbindungen hat Nigeria das Potenzial, sich zu einem Exportzentrum für Wasserstoff zu entwickeln. Deutsche Unternehmen aus den Bereichen der Logistik, Hafeninfrastruktur und Industrieparks könnten von frühzeitigen Investitionen in Wasserstoff-Wertschöpfungsketten profitieren.
- **Diversifizierung und Energiesicherheit:** Grüner Wasserstoff kann Nigerias Bestrebungen nach Diversifizierung des Energiemixes und der Verringerung der Abhängigkeit von importierten Kraftstoffen sinnvoll ergänzen. Deutsche Anbieter von Wasserstoffspeichern, Brennstoffzellen und dezentralen Energiesystemen können die langfristige Energiewende des Landes mitgestalten.

HERAUSFORDERUNGEN AUF DEM WEG ZUR WASSERSTOFFWIRTSCHAFT

Trotz des erheblichen Potenzials steht Nigeria vor mehreren Herausforderungen:

- **Wirtschaftliche Hürden:** Hohe Produktionskosten, geringe Anfangsnachfrage und der vergleichsweise günstige Zugang zu Erdgas machen grünen Wasserstoff kurzfristig weniger wettbewerbsfähig. Investitionen in kosteneffiziente Technologien sowie politische Unterstützung sind entscheidend für die Entwicklung des Marktes.

- **Energy and infrastructure gaps:** Nigeria's unreliable power grid and aging infrastructure pose challenges for large-scale hydrogen production. Off-grid, decentralised energy solutions may be required to enable early adoption.
- **Regulatory and policy uncertainty:** A clear hydrogen policy framework is needed to attract investment, ensure safety standards and facilitate market development. Aligning Nigeria's energy policies with international standards will be key to unlocking growth.

OPPORTUNITIES FOR GREEN HYDROGEN PROJECTS

Nigeria's large economy, industrial potential and renewable energy resources create early opportunities for German companies to engage in hydrogen-related projects. While challenges exist, a coordinated approach involving policy advocacy, technological innovation and strategic investment can help establish a foothold in this emerging market. By contributing to Nigeria's energy diversification and industrial modernisation, German companies can position themselves as key players in the country's green hydrogen transition, driving both commercial success and sustainable development.

- **Lücken in Energieversorgung und Infrastruktur:** Eine unzuverlässige Stromversorgung und veraltete Infrastruktur erschweren die großflächige Produktion von Wasserstoff. Dezentrale, netzunabhängige Energielösungen könnten notwendig sein, um erste Anwendungen zu ermöglichen.
- **Regulatorische und politische Unsicherheiten:** Ein klarer politischer Rahmen für Wasserstoff ist erforderlich, um Investitionen anzuziehen, Sicherheitsstandards zu gewährleisten und die Marktentwicklung zu fördern. Die Angleichung der nigerianischen Energiepolitik an internationale Standards wird eine zentrale Rolle für das Marktwachstum spielen.

POTENZIALE FÜR GRÜNE WASSERSTOFFPROJEKTE

Nigerias große Volkswirtschaft, das industrielle Potenzial und die reichlich vorhandenen Ressourcen der erneuerbaren Energien eröffnen frühzeitig Chancen für deutsche Unternehmen, sich in wasserstoffbezogenen Projekten zu engagieren. Trotz bestehender Herausforderungen kann ein koordinierter Ansatz aus politischer Begleitung, technologischer Innovation und strategischen Investitionen dazu beitragen, dass KMU in diesem aufstrebenden Markt Fuß fassen. Indem europäische Unternehmen zur Diversifizierung der Energieversorgung und zur Modernisierung der Industrie in Nigeria beitragen, können sie sich als zentrale Akteure im Sektor des grünen Wasserstoffs positionieren – und dabei sowohl wirtschaftlichen Erfolg als auch nachhaltige Entwicklung vorantreiben.

1

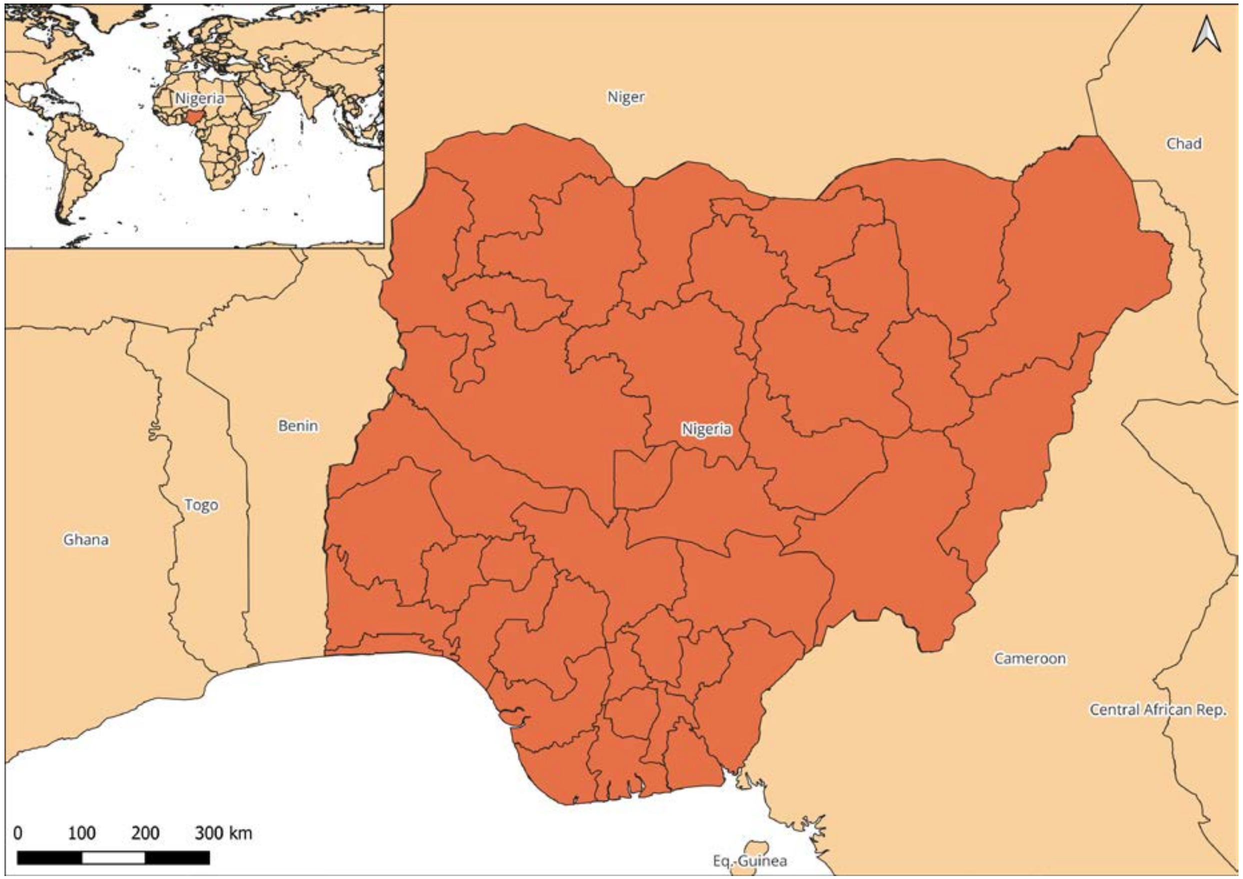
Outline of the current context

1.1 General country information

Nigeria is located in West Africa (see Figure 1). The country has an area of approx. 910,770 km^2 and a population of about 224 million as of 2023 (World Bank, 2024). Its economy is one of the largest in Africa, driven primarily by its oil and gas sector. In 2023, Nigeria's gross domestic product (GDP) reached USD 363 billion equating to USD 1,621 per capita. In 2022, in urban areas ~90% of citizens had access to electricity as opposed to only 25% in rural areas (World Bank, 2024). This corresponds to a national average of ~60% with access to electricity.

Nigeria's economy strongly depends on exporting mineral fuels, mineral oils and oil products (88.2%) and fertilisers (2.8%). From an import perspective, mineral fuels, mineral oils and oil products also represent a major share at 31.4%, while machinery, mechanical appliances and parts and electrical machinery and electronics make up a similar share of 8% and 7% respectively. The fact that one sector is the main contributor to both exports and imports shows that Nigeria exports large amounts of crude oil while, at the same time, importing large volumes of refined oil products. In 2022, the total export and import volumes reached a sum of USD 70.7 billion and USD 67.6 billion respectively.

FIGURE 1. Location of Nigeria



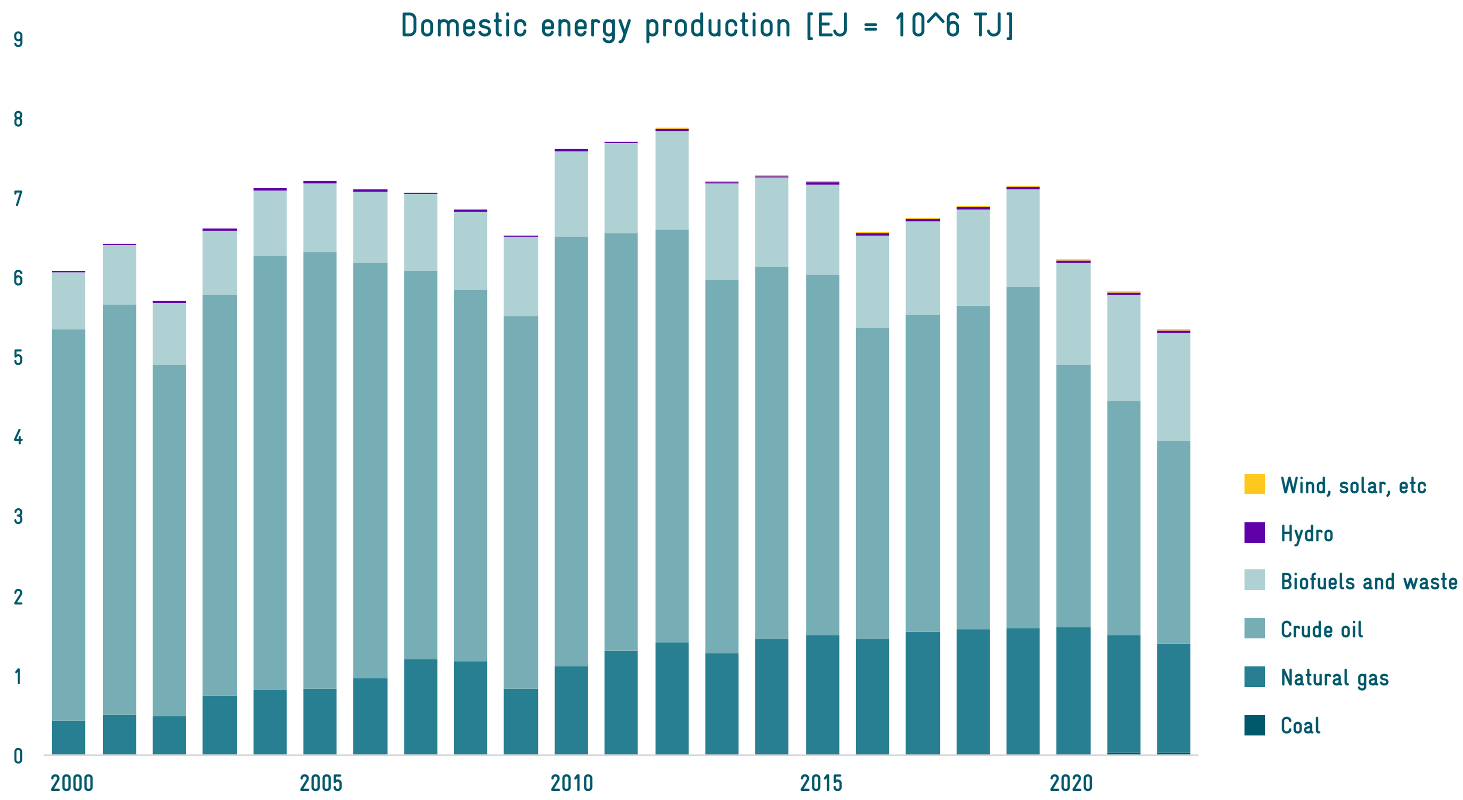
Source: Authors' own compilation, Fichtner (2024) based on (OpenStreetMap, 2024)

1.2 National energy sector analysis

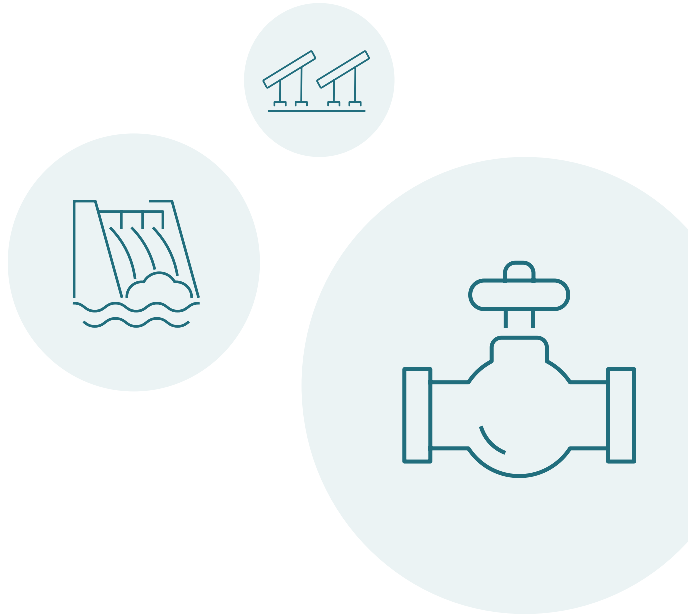
1.2.1 Evolution of the energy sector to date

Figure 2 shows the evolution of Nigeria's energy production (in exajoules, EJ = 10^6 TJ), with fossil fuels being the major sources. Energy production includes any exploration of fossil fuels, which can be burned to produce electricity or heat or used directly, e.g. as fuels. It also includes energy produced by nuclear fission and renewable energy sources (RES), e.g. biomass, solar PV, wind, geothermal and hydropower, if relevant. Energy production in Nigeria is strongly dominated by crude oil (48%) and natural gas (26%). Its oil reserves are the second largest in Africa, after Libya, and among the tenth-largest in the world, also ranking 8th globally for gas reserves (OPEC, 2023). Nonetheless, crude oil production started to decrease in 2010 and was reduced by half in 2022, resulting in a 30% decrease in the total domestic energy production from 2010 to 2022. While natural gas production has fluctuated, an increase of 20% was achieved from 2010 to 2022. Biofuels and waste also play an important role in domestic energy production, representing 25% and being primarily based on traditional use of biomass. Hydropower plays a minor role at around 1%, while solar photovoltaics (PV) still plays a negligible role but has been in use since 2012.

FIGURE 2. Evolution of domestic energy production in Nigeria since 2000 (in EJ)

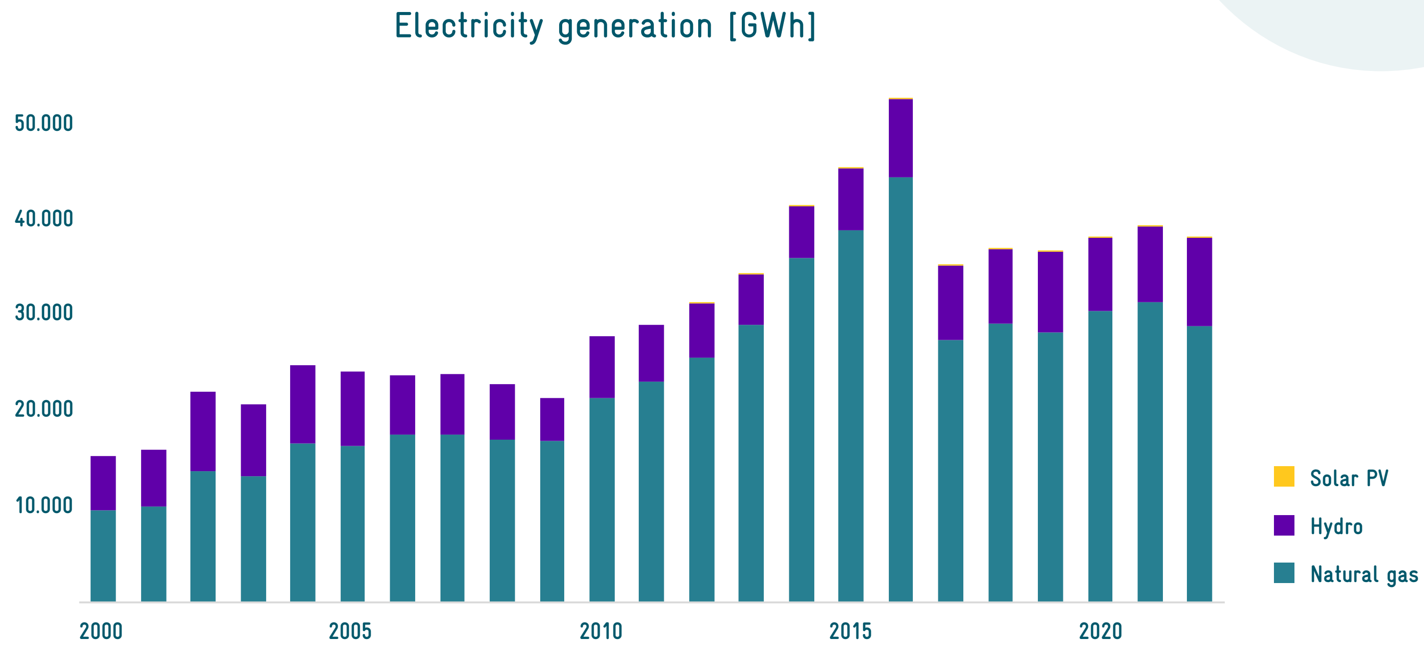


Source: Authors' own compilation, Fichtner (2025) based on (IEA, 2024a)



As shown in Figure 3, electricity generation is based mainly on natural gas. For a total electricity generation of 37,915 gigawatt-hours (GWh) in 2022, natural gas represents almost 76% and hydropower 24%. A minor share of 0.3% of electricity is generated by solar PV. The country reached its highest electricity production in 2016 with around 52,000 GWh; nonetheless, in 2017 this amount was reduced by some 30% to approx. 35,000 GWh and has remained more or less constant at this level since then. Before 2016, there were improvements in infrastructure and other investments that increased the availability of the power plants. By 2017 there were disruptions in gas supply, which directly affected generation, as well as some attacks on pipelines and infrastructure that also diminished the generation and distribution capacity. It must be highlighted that Nigeria is still struggling with a range of issues in the power sector leading to an unreliable system with frequent blackouts. Since this affects daily life and economic activities, many end users rely on alternative power sources, such as diesel and petrol generators.

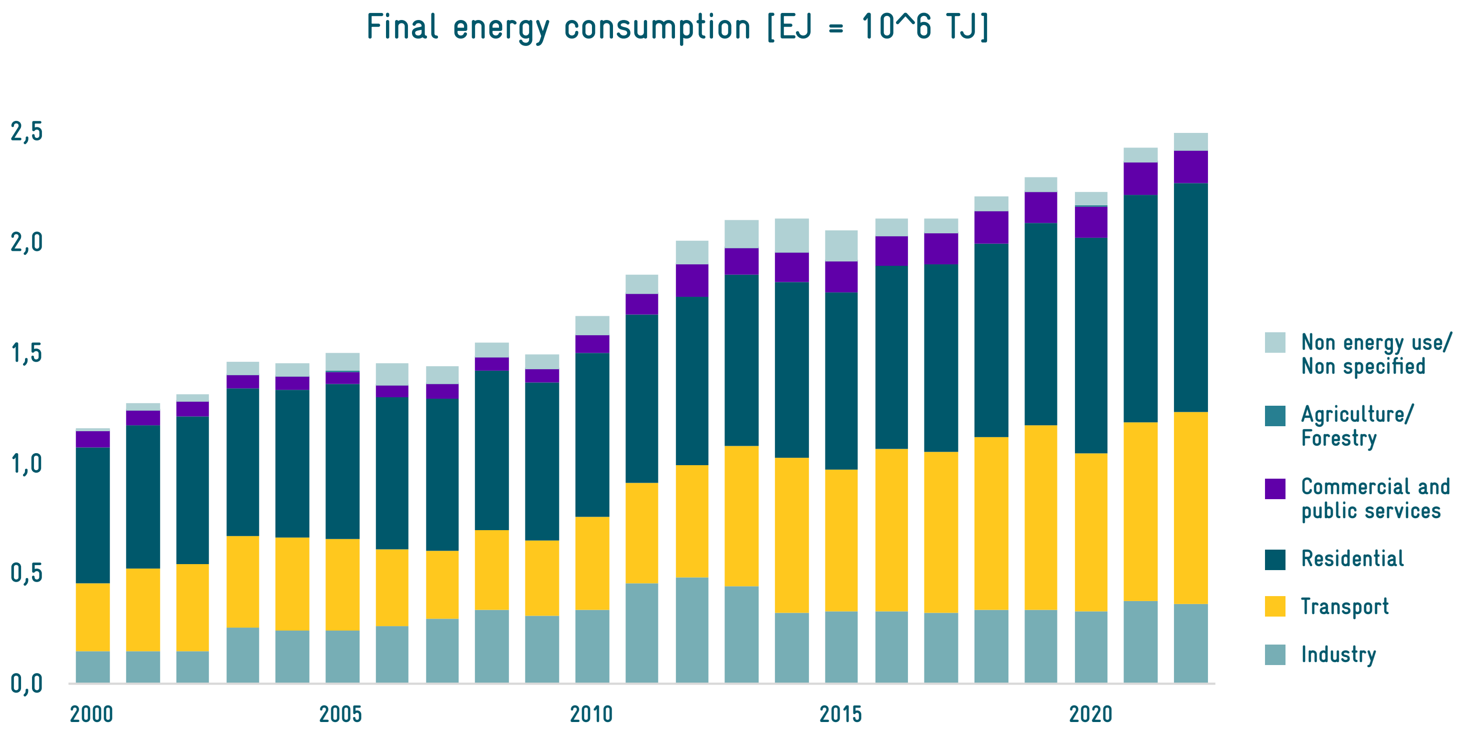
FIGURE 3. Evolution of electricity generation by sources in Nigeria since 2000 (in GWh)



Source: Authors' own compilation, Fichtner (2025) based on (IEA, 2024a)

Regarding final energy consumption (in exajoules, EJ = 10^6 TJ), Figure 4 shows that it has more than doubled since 2000, reaching about 2.5 EJ in 2022. The main consumption sectors are residential (42%) and transport (35%). Residential energy consumption has increased by around 70% since 2000, while consumption in the transport sector has almost tripled. The industry sector, which consumes 14% of final energy, has more than doubled its consumption since 2000. Other sectors include commercial and public services, agriculture and forestry and non-specified or non-energy uses; together they make up 9% of final energy consumption, showing a more constant level of consumption for the same timeframe.

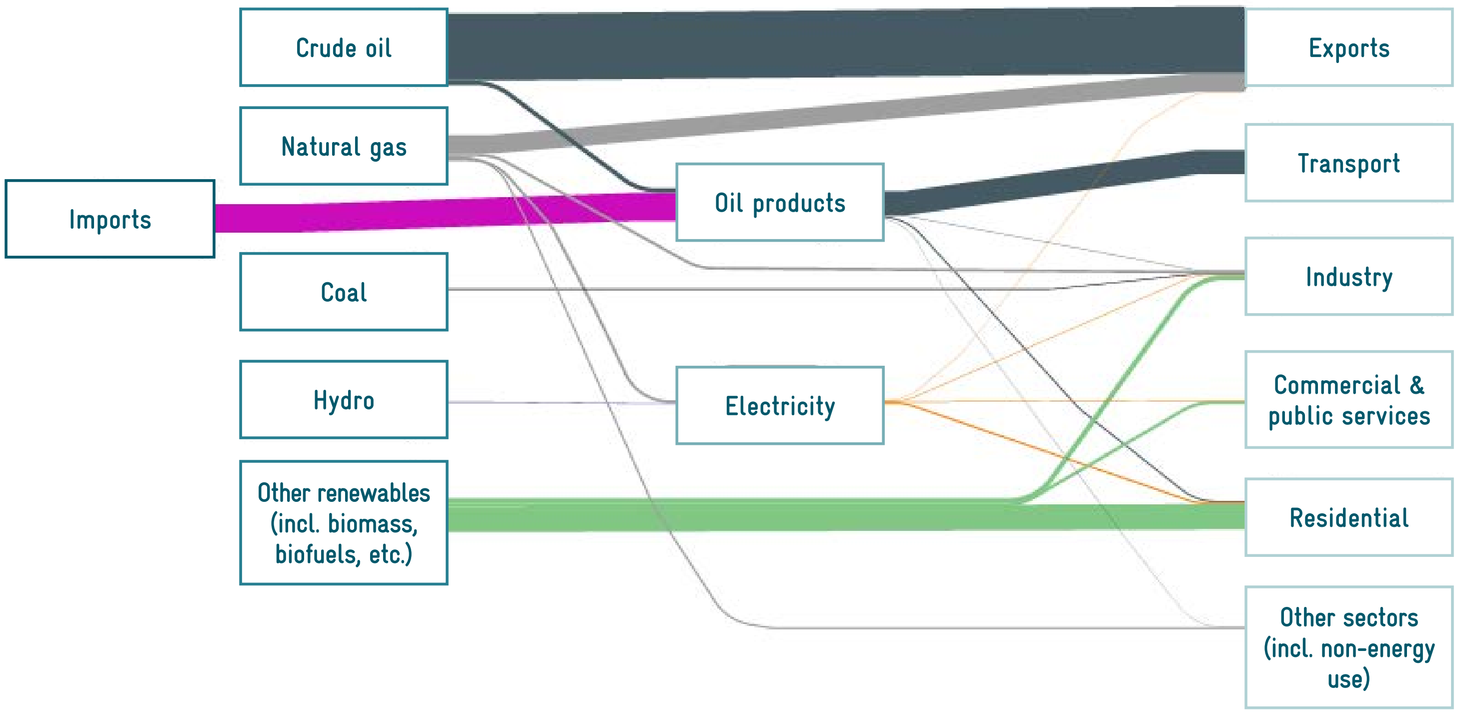
FIGURE 4. Evolution of final energy consumption by sector in Nigeria since 2000 (in EJ)



Source: Authors' own compilation, Fichtner (2025) based on (IEA, 2024a)

The Sankey diagram in Figure 5 is based on IEA statistics (IEA, 2024a). It summarises the energy flows from primary energy sources to secondary sources and to different end users' sectors for 2022. The total primary energy available was 21.3 EJ. The main primary sources were crude oil (48%), natural gas (26%) and other renewables (incl. biomass, biofuels, etc.) (25%). Most of the crude oil and natural gas is exported, while large volumes of oil products are imported. Final energy consumption is led by the transport sector, relying exclusively on oil products. This is followed by the residential sector, with a consumption that relies almost exclusively on biomass, waste and biofuels, representing the traditional use of biomass. Industry as the third consumer sector presents a mix of sources with other renewables (incl. biomass, biofuels, etc.) covering some 50% of total consumption.

FIGURE 5. Energy flow in Nigeria in 2022



Source: Authors' own compilation, Fichtner (2025) based on (IEA, 2024a)

As also indicated in the previous Sankey diagram, Nigeria is a net exporter of energy, with crude oil as the main product (78%), followed by natural gas (22%). A small amount of electricity is also exported to neighbouring countries – around 2,316 GWh in 2022 (IEA, 2024a). On the other hand, Nigeria has imported almost all oil products since 2000, reaching the highest imported volume in 2022 with 1,008,852 TJ (IEA, 2024a). Refining capacity in the country has drastically reduced from 472,772 TJ (peak reached in 2001) to 9,831 TJ in 2022 (IEA, 2024a). Nonetheless, given that Dangote Petroleum Refinery recently started operation with a capacity to process 650,000 barrels of crude oil per day, a reduction in the import of oil products may be expected.

Energy prices

Indicative current energy prices for the main energy sources are listed in Table 1. The prices serve only as an initial indication of the current levels since there will be regional variations across the country and over time. In Nigeria, neither a carbon tax nor an emission trading scheme (ETS) have been put in place. Biomass still plays a very significant role for households and is used especially for cooking. This traditional use implies that no market is applicable. Electricity tariffs are set by the Nigerian Electricity Regulatory Commission (NERC) based on a service-based tariff (SBT) scheme, reflecting the number of hours of electricity supply available per day, from Band A with a minimum of 20 hours to Band E with a minimum of 4 hours in steps of 4 hours (NREC, 2023). While Band A tariffs are cost-reflective and adjusted monthly based on inflation and the exchange rate for contracts based on USD, for example, tariffs for Bands B (at least 16 hours daily) to E (at least 4 hours daily) remain unchanged to give all connected residential customers access to electricity (stears, 2024). Electricity prices for large industrial consumers are commonly fixed by bilateral agreements and, therefore, not published. The pricing mechanism for natural gas is implemented by the Nigerian Midstream and Downstream Petroleum Regulatory Authority (NMDPRA), a domestic base price (DBP) is fixed for the power sector and an additional tariff for commercial users (Premium Times, 2024).

TABLE 1. Indicative energy prices for Nigeria

Energy source		Price [NGN]	Price [USD]	Unit	Date
Coal	Steam coal	229,882	140.8	/ t	25 Oct. 2024
Crude oil	Bonny Light	129,702	79.4	/ bbl	8 Oct. 2024
Natural gas	DBP (power sector)	13,395	8.3	/ MWh	1 April 2024
	Commercial	16,335	10.0	/ MWh	1 April 2024
Electricity	All users Band A	72,300 209,500	44.3 128.3	/ MWh / MWh	Up to Mar 2024 July 2024
	Residential and small commercial Bands B – E	min. 31,240 max. 68,560	19.1 42.0	/ MWh / MWh	July 2024
	Commercial and small industrial Bands B – E	min. 43,270 max. 76,150	26.5 46.6	/ MWh / MWh	July 2024

bbl	barrels
DBP	Domestic Base Price

Source: Authors' own compilation, Fichtner (2024) based on (Coal Price, 2024), (Statista, 2024b), (Premium Times, 2024), (stears, 2024)

1.2.2 Current infrastructure

Nigeria's infrastructure presents significant challenges across key sectors. The road network includes well-developed highways as well as poorly maintained rural roads, while rail transport remains underdeveloped and underutilised. Main ports in the country include Apapa Port and Tin Can Island Port (both in Lagos), Port Harcourt Port and Onne Port (both in Rivers State), and Calabar Port (in Cross River State). The Lagos Free Trade Zone (FZE) provides a special zone that supports international trade through fewer restrictions and tax benefits. The power sector struggles with inconsistent electricity supply due to aging infrastructure, gas supply issues and congestion within the grid, necessitating substantial investment for improvement. Although Nigeria is one of Africa's largest oil and gas producers, its pipeline network faces frequent vandalism and leaks, impacting production and the environment. Gas distribution infrastructure is underdeveloped, complicating delivery to end users. Water scarcity is severe in the northern regions, exacerbated by seasonal variations and rising demand, while flooding and pollution from industrial activities further threaten water quality and access to safe drinking water.

1.2.3 Forecast evolution of the energy sector

In 2022, Nigeria presented its Energy Transition Plan (ETP) (Nigeria, 2022), where key targets in five different sectors (power, transport, oil and gas, cooking and industry) were established to achieve carbon neutrality by 2060. The power sector expects centralised electricity demand to grow from 61 TWh in 2020 to 138 TWh by 2030 and to 532 TWh by 2050, mainly driven by households and industry sectors. In order to cover this demand, centralised production capacity has to grow from 33 GW in 2020 to 44 GW by 2030 and to 258 GW by 2050. After 2030, the growth in production capacity is expected to be driven by solar PV, increasing from 8 GW in 2030 to 197 GW by 2050. Hydrogen production is expected to have an installed electrolyser capacity of 9 GW by 2040 and 34 GW by 2050.

With regard to the refining sector, the country is expected to increase refining volumes, which were almost non-existent in 2020, to 273 million barrels oil equivalent (BOE) by 2030 and to 422 million BOE by 2050. By 2030, 4% of the refining capacity is expected to include carbon capture and storage (CCS), which is to be implemented in all refineries by 2050.

The transport sector, which by 2020 had a fleet comprising only gasoline/diesel vehicles, is expected to have a small share of 3% hybrid and electric vehicles by 2030 and 60% of electric vehicles and 20% of hybrid vehicles by 2050, while 20% will still be fuelled by gasoline and/or diesel. In order to achieve these targets, approximately 3,000 electric vehicle charging stations are to be installed each year, starting in 2030.

Finally, the industry sector aims to replace grey hydrogen in ammonia production by 2050, with a share of 50% blue hydrogen and 35% green hydrogen. By 2060, high-temperature heating processes are expected to use 100% hydrogen and low- and mid- temperature heating is expected to be fully electrified.

The targets set in Nigeria's ETP are aligned with global decarbonisation efforts and should allow the country to have a modern and reliable energy system. Nonetheless, it will be challenging to mobilise the huge investments required in the short term, which calls for a suitable investment environment with stable political and social conditions.

1.3 Legislative and regulatory framework

Nigeria's legislative and regulatory framework for renewable energy, climate change and emerging sectors such as green hydrogen (GH_2) is developing in response to domestic energy challenges and the need to meet international climate commitments. Key national laws and regulations guiding Nigeria's energy transition are outlined below.

Renewable Energy Master Plan (2005) (Energy Commission of Nigeria, 2005)

OVERVIEW:

This plan aims to promote the use of renewable energy sources in Nigeria's energy mix. The last update was published in 2021.

KEY PROVISIONS:

- **Targets:** To increase the participation of renewable sources in electricity generation from 13% in 2015 to 23% in 2025 and 36% by 2030. Foreseen installed capacity by 2025 includes 2,000 MW small hydropower, 500 MW solar, 400 MW biomass and 40 MW wind power. Electrification rates should increase from 42% in 2005 to 60% in 2015 and 75% by 2025.
- **Incentives**: Fiscal and financial incentives are to be proposed for renewable energy projects, including tax exemptions and low-interest loans. The Plan also underlines the need for the creation of a specialised funding agency, the Nigerian Rural Electrification Agency (NREA).
- **Capacity building:** Training and education to build local expertise in renewable energy technologies.

Nationally Determined Contribution (NDC) (2021) (Federal Ministry of Environment, 2021b)

OVERVIEW:

Nigeria's updated NDC outlines its climate targets under the Paris Agreement.

KEY PROVISIONS:

- **Greenhouse gas (GHG) emissions reduction target:** Commitment to reduce GHG emissions by 20-30% unconditionally or up to 47% conditionally by 2030 relative to a business-as-usual scenario.
- **Sectoral focus:** Prioritises actions in the energy, transport and agriculture sectors, with tailored strategies for each sector to reduce emissions and enhance resilience.
- **Investment in renewable energy:** Aiming to increase access to clean energy and reduce reliance on fossil fuels.
- **International cooperation:** Recognition of the importance of global partnerships and support in achieving targets, especially in technology transfer and financing.

Climate Change Policy 2021-2030 (Federal Ministry of Environment, 2021a)

OVERVIEW:

Nigeria's Climate Change Policy (2021-2030) builds on the 2012 policy, aiming to strengthen resilience to climate change impacts while promoting sustainable development. It aligns with the Paris Agreement and integrates climate considerations into national development plans.

KEY PROVISIONS:

- **Enhanced mitigation targets:** Targets aligned with Nigeria's NDC 2021.
- **Adaptation strategies:** Focus on community resilience and addressing sectoral vulnerabilities (e.g. agriculture, water, health).
- **Sectoral approach:** Address specific challenges and opportunities in energy, transportation, forestry, and waste management.
- **Capacity building and awareness:** Emphasises education, capacity building and public awareness to drive climate action at all societal levels.

- **Financing mechanisms:** identification of new financial instruments and partnerships, including public-private partnerships and international climate finance.
- **Collaboration and stakeholder engagement:** Strengthens partnerships with local communities, civil society and the private sector, to foster collaboration in climate action.

Nigeria Energy Transition Plan (ETP) (Nigeria, 2022)

Overview:

The plan emphasises promoting sustainable energy development and reducing the country's reliance on fossil fuels.

Key provisions:

- **Diversification of energy sources:** Focuses on renewable energy sources such as solar, wind and hydropower to diversify the energy mix.
- **Infrastructure development:** Investments in grid expansion and energy storage technologies to support renewable energy generation.
- **Access to energy:** Aims for universal energy access, especially in rural areas, via off-grid solutions and decentralised energy systems by 2030, targeting 42 GW operational grid capacity and 6.3 GW of decentralised renewable energy.
- **Energy efficiency:** Promotes energy efficiency measures to reduce overall energy demand and improve sustainability across sectors.
- **Policy and regulatory framework:** Establishes supportive policies and regulations to attract investment in renewable energy and enhance energy governance.
- **Capacity building:** Focuses on developing human capital and technical skills in renewable energy sectors to support the transition and create jobs.
- **Climate commitments:** Aligns with international climate goals, such as the Paris Agreement, to reduce GHG emissions and promote sustainable development.
- **Public-private partnerships:** Promote collaboration between government and private sectors to mobilise funding and drive innovation in the energy sector.
- **Hydrogen as clean energy alternative:** Introduces measures for deployment of a hydrogen economy (mainly GH_2), including production, investment in research & development (R&D), pilot projects and creating a domestic and export market.

Nigeria's legislative and regulatory framework is fostering the renewable energy transition and climate change mitigation through ambitious targets and supportive policies aimed at attracting investment, promoting clean energy and enhancing energy access. Despite progress in energy supply, challenges such as unachieved goals (e.g. electrification rates) persist. While Nigeria is advancing its renewable energy goals, certain regions face challenges related to political instability and safety, which may affect project implementation. These circumstances highlight the need for tailored strategies to ensure equitable industrial development across the country and foster resilience in affected areas. International support will be essential for successful implementation, offering opportunities for domestic and international companies to contribute to sustainable development.

2

Industrial applications of hydrogen

Global hydrogen demand reached 97 million tons per annum (MTPA) in 2023 and remains concentrated in traditional uses such as refining and industry applications, mainly ammonia and methanol production and steel manufacturing (IEA, 2024b). Considering current (or traditional) and potential new uses of hydrogen as a decarbonisation solution, this demand is expected to increase significantly to 200-600 MTPA by 2050, depending on the analysis and scenario selected, and should be covered, primarily, by clean hydrogen (produced either by electrolysis powered by renewable energies, so-called green hydrogen, or by fossil fuels reforming combined with CCS, referred to as blue hydrogen).

2.1 Hydrogen production methods

Hydrogen can be produced through different processes according to the energy source and technology used as summarised in Table 2. The hydrogen used to cover the current demand comes almost exclusively from processing fossil fuels (natural gas and coal) within methane reforming and coal gasification.

TABLE 2. Production methods of hydrogen

Production process	Energy source	Technology options	Products	CO_2 emissions
Methane reforming	Natural gas	• Steam methane reforming (SMR) • Autothermal reforming (ATR)	H_2, CO, CO_2, N_2	• High CO_2 emissions • Potential combination with CCS to reduce CO_2 emissions
Coal gasification	Coal	• Gasification/reaction with O_2 and steam at high pressure and temperatures	H_2, CO, CO_2, N_2	
Methane pyrolysis	Natural gas	• Thermal decomposition at high temperatures without O_2	H_2, CO, CO_2	
Biomass gasification	Biomass	• Heating with limited oxygen	H_2, CO, CO_2	• Low to none CO_2 emissions
Electrolysis	Electricity	• Electrolysis (AEC, PEMEC, SOEC, AEMEC)	H_2, O_2	• CO_2 emissions depend on electricity source • Low to none for renewable energy sources

CCS	Carbon capture and storage
AEC	Alkaline electrolysis cell
PEMEC	Proton exchange membrane electrolysis cell
SOEC	Solid oxide electrolysis cell
AEMEC	Anion exchange membrane electrolysis cell

Source: Authors' own compilation, Fichtner (2025)

2.2 Hydrogen uses

Hydrogen is a key component of the global energy and industrial landscape, with similar applications worldwide. The data presented in this section reflect the global context of hydrogen and are location-independent.

Given a hydrogen demand of 97 MTPA in 2023, the largest consumers of hydrogen are refining (44%), ammonia production (33%) and methanol production (17%). Some 5% of hydrogen is used for direct reduced iron (DRI) in the iron and steel sector and small amounts are used in other segments such as glassmaking, electronics and metal processing, accounting for 1 MTPA or 1% of current global hydrogen demand (IEA, 2024b). Main current hydrogen uses are listed in Annex 1.

Other minor current uses of hydrogen include aerospace, as a propellant, and energy storage for balancing renewable energy supply and demand.

Additionally, hydrogen is produced by different production processes as a by-product.

In 2023, some 25% of hydrogen was produced as a by-product in refineries and petrochemicals production (IEA, 2024b). Main products that generate hydrogen as a by-product are listed in Table 3.

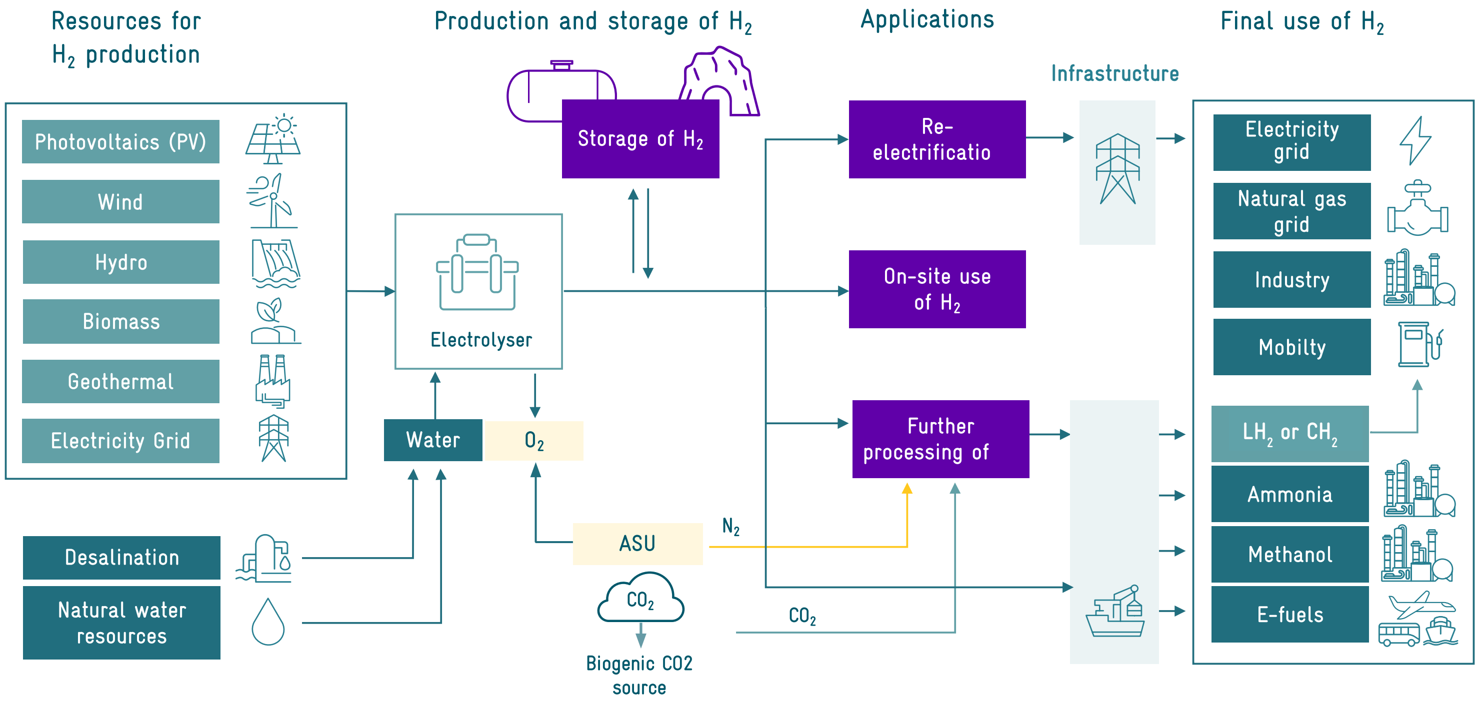
TABLE 3. Hydrogen generation as a by-product

Final product	Typical use of H_2 by-product	Specific H_2 generation
Ethylene	• On site as feedstock for other processes	190 Nm³ H_2/tonne ethylene (11 kg H_2/tonne ethylene)
Styrene		220 Nm³ H_2/tonne styrene (20 kg H_2/tonne styrene)
Chlorine (via chlor-alkali process)	• Fuel for heat boilers and/or combined heat and power (CHP) units	270–300 Nm³ H_2/tonne chlorine (24–27 kg H_2/tonne chlorine
Acetylene	• On site as feedstock for other processes	3,400–3,740 Nm³ H_2/tonne acetylene (305–336 kg H_2/tonne acetylene)
Cyanide		2,470 Nm³ H_2/tonne cyanide (222 kg H_2/tonne cyanide)

Source: Authors' own compilation, Fichtner (2025) based on (Fuel Cells and Hydrogen Observatory, 2021)

Even if the demand for hydrogen has been concentrated in refining and some industrial applications, the adoption of clean hydrogen in new applications will play a key role in the energy transition; this will include the replacement of current hydrogen demand for example by green hydrogen produced via electrolysis (as shown in Figure 6) but also new areas of use such as mobility (road, air and maritime transport), electricity generation, production of synthetic fuels (e-fuels) and high-temperature heat generation, among others. The switch from conventional production processes to electrolysis for hydrogen generation will require additional feedstocks for derivatives production, including a nitrogen source for ammonia production and a sustainable CO_2 source for methanol and synthetic fuel production.

FIGURE 6. Value chain of potential applications of green hydrogen



Storage: In tanks or geological.

H_2	Hydrogen
LH_2	Liquefied hydrogen
CH_2	Compressed hydrogen
ASU	Air separation unit

Source: Authors' own compilation, Fichtner (2025)

These applications provide an initial indication of how green hydrogen might be used in the future. Which applications gain traction will largely depend on possible alternative technologies with which hydrogen will have to compete, on national and international decarbonisation targets and commitments, as well as on available energy sources in the individual countries.

Furthermore, the production of hydrogen by electrolysis generates 8 kg oxygen (O_2)/kg H_2 as a by-product. Some typical applications for high-purity liquified oxygen include water treatment, medical purposes and industry (metallurgy, pulp & paper, chemical, etc.). Nonetheless, taking into consideration that current technologies for oxygen production (air separation unit (ASU), pressure swing absorption (PSA)) are mature, easily scalable and applicable to on-site oxygen generation, the economically feasible use of oxygen generated by electrolysis is quite restricted and very location-dependent.

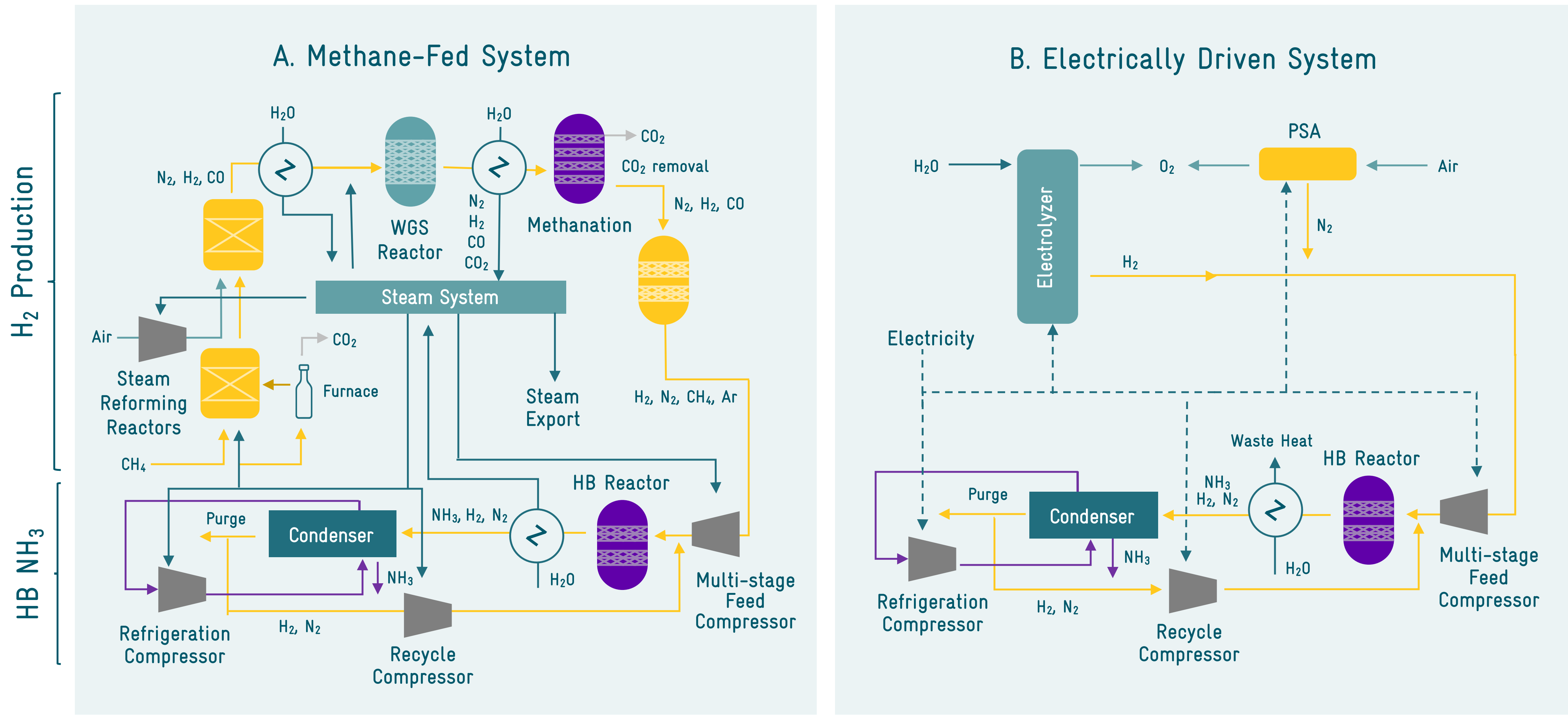
2.3 Most common hydrogen downstream products

2.3.1 Ammonia and fertilisers

Ammonia production is the second-largest current use of hydrogen with 33% of total hydrogen demand. Ammonia is a key precursor in the industry and is mainly used for nitrogen-based fertilisers (around 70-80%) and other industrial applications such as plastics and explosives production.

Ammonia is synthesised via the Haber-Bosch (HB) process, in which hydrogen (H_2) reacts with nitrogen (N_2) to form ammonia (NH_3) under high pressures and at high temperatures. Figure 7 shows a schematic of the conventional HB process as well as a green hydrogen-based process. Conventional ammonia production is based on steam methane reforming (SMR), which involves using steam and nitrogen from the air. For the green ammonia option, an external source of nitrogen is required (for example from air through an ASU) and the compressors that are steam-driven in the conventional process are mainly electrically driven. Little to no steam is used in this green ammonia production process.

FIGURE 7. Schematic of conventional (A) and green (B) Haber-Bosch process



Source: Smith, 2019

Ammonia is a key ingredient in nitrogen fertilisers and as such critical for crop growth. The following table presents an overview of some commonly used fertilisers.

It should be noted that the production processes of some of the fertilisers need a carbon source, which needs to be sustainable in order to obtain green fertilisers. Possible solutions are direct air capture (DAC), carbon capture and use (CCU) from industrial unavoidable sources or biomass treatment processes. Globally, only few industrial or commercial scale projects are currently available for sustainable carbon sourcing.

TABLE 4. Key nitrogen fertilisers

Fertilisers	Production process	Specific H_2 requirement (stochiometric)	Global production [MTPA]
Ammonia (NH_3)	Haber-Bosch process $N_2 + 3H_2 \rightarrow 2NH_3$	177 kg H_2/t NH_3	145
Urea	NH_3 and CO_2 from HB fed into a high-pressure reactor (or urea reactor) $2NH_3 + CO_2 \rightarrow CH_4N_2O + H_2O$	100 kg H_2/t urea	234
Ammonium nitrate (AN)	Neutralisation process in which NH_3 (gas) is mixed with HNO_3 (liquid) in neutraliser $NH_3 + HNO_3 \rightarrow NH_4NO_3$	40 kg H_2/t AN	45
Calcium ammonium nitrate (CAN)	Blending of AN (solution) with limestone (calcium carbonate) in a mixing unit and granulation of product $NH_4NO_3 + CaCO_3 \rightarrow Ca(NO_3)_2 + NH_4 + CO_2 + H_2O$	50 kg H_2/t CAN	13
Urea ammonium nitrate (UAN)	Mixing solutions of urea and AN and dilution with water	7 kg H_2/t UAN	23
Ammonium sulphate (AS)	By-product of caprolactam production (raw material for nylon) $2NH_3 + H_2SO_4 \rightarrow (NH_4)_2SO_4$	50 kg H_2/t AS	30
Diammonium phosphate (DAP)	Reaction of NH_3 with phosphoric acid and posterior granulation $H_3PO_4 + 2NH_3 \rightarrow (NH_4)_2PO_4$	46 kg H_2/t DAP	28
Monoammonium phosphate (MAP)	Reaction of NH_3 with phosphoric acid and posterior granulation $H_3PO_4 + NH_3 \rightarrow NH_4H_2PO_4$	26 kg H_2/t MAP	29

Source: Authors' own compilation, Fichtner (2025). Global annual production in 2022 based on (Statista, 2024a) and (Chemanalyst, 2023)

2.3.2 Methanol

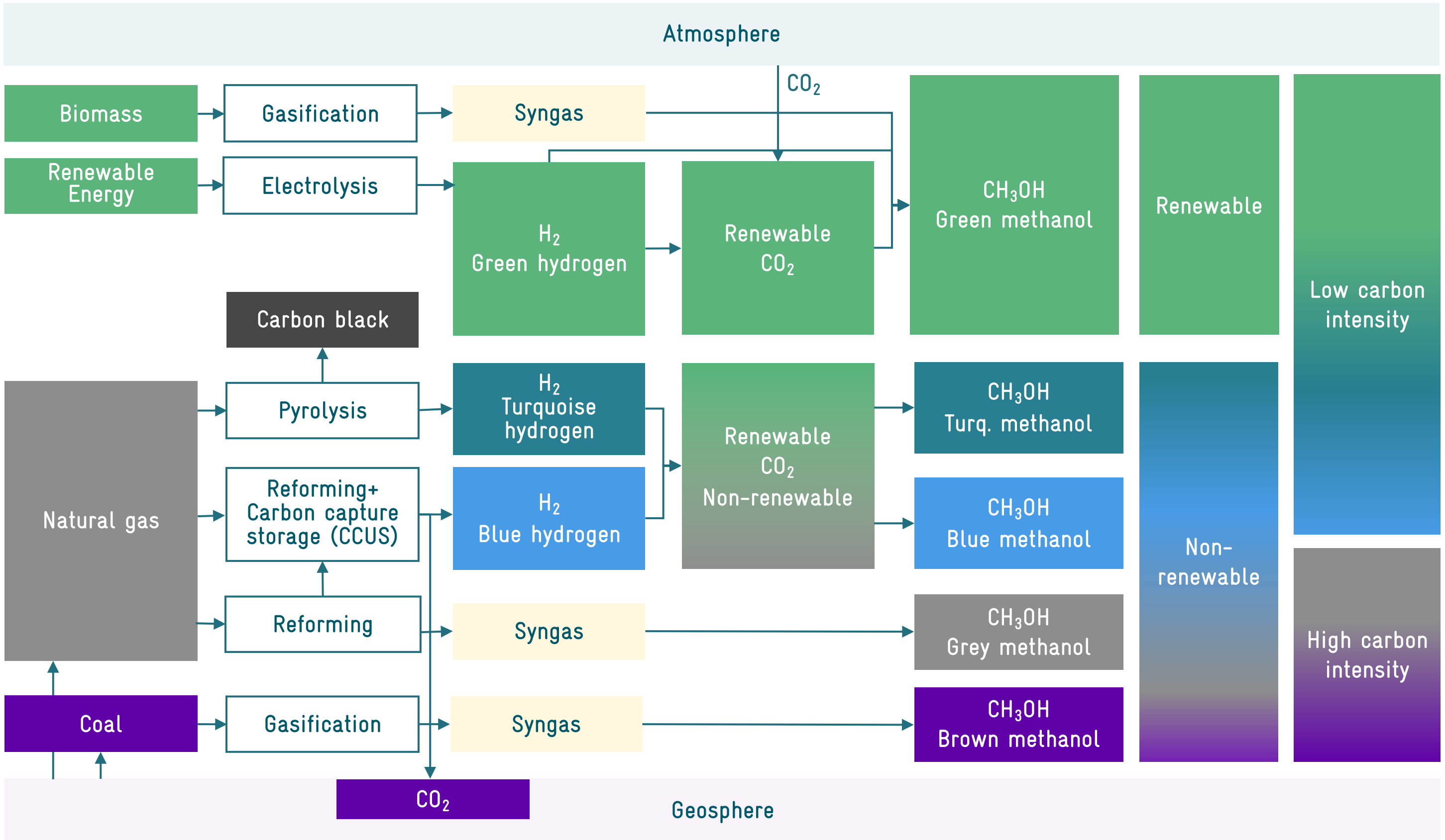
Methanol production is another major current use of hydrogen, accounting for 17% of hydrogen demand. Methanol is a widely used chemical whose main uses include the production of basic chemicals (e.g. formaldehyde, acetic acid; 52%), olefins (e.g. polyethylene; 31%) and fuels/fuel additives (e.g. dimethyl ether (DME); 17%) (Methanol Institute, 2024).

Today's methanol production depends mainly on natural gas consumption to produce hydrogen as well as the necessary CO_2 (see Figure 8). The mixture of hydrogen, CO_2 and CO generated in a steam methane reforming (SMR) reactor is passed over a catalyst at high pressure and moderate temperatures, with two key reactions:

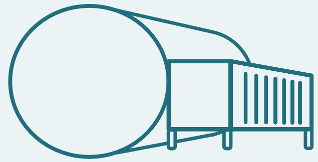
$CO + 2H_2 \rightarrow CH_3OH$ and
$CO_2 + 3H_2 \rightarrow CH_3OH + H_2O$

In the case of green methanol, the hydrogen is generated by electrolysis and an additional source of carbon is required for the synthesis process. The sourcing of sustainable carbon and the large-scale deployment of technologies such as DAC or CCU might be limiting factors. Annex 1 offers an overview of the main uses of methanol.

FIGURE 8. Pathways of methanol production



Source: Authors' own compilation, Fichtner (2025) based on (IRENA, 2021)



2.4 The hydrogen industry in Nigeria

2.4.1 Overview of the national industry

The hydrogen demand in Nigeria is mainly concentrated in refining, ammonia (as the final product or for applications other than urea) and urea production. Methanol production facilities that are currently under construction will then become another large consumer of hydrogen. Smaller consumers include the petrochemical and chemical sectors, glassmaking and the food industry, among others.

Since hydrogen is typically produced on site, no hydrogen trading takes place. For the main derivatives, Nigeria imported 2.3 kTPA of ammonia at a total value of approx. USD 1.5 million and 25 kTPA of methanol at USD 21.2 million (WITS, 2025b).

Currently, no official hydrogen statistics are available for Nigeria. To provide an overview of the country's hydrogen industry, the existing hydrogen demand for key industrial products has been estimated based on the known production capacities of major industries, combined with typical hydrogen consumption ratios per unit of the final product, assuming continuous full-load operation of the plants. Consequently, this estimation represents the maximum theoretical hydrogen demand in Nigeria, while the actual annual demand is likely to be lower. The results of these estimations are shown in Table 5. Further details are provided in the following sections.

The estimated current hydrogen demand for large applications is about 2.15 MTPA. This demand is likely to increase in the future, for example with the commissioning of new methanol plants that are under construction or the expansion of the local refining capacity by some 1.4 MTPA. Even if the demand for small consumer sectors has not been considered, the total hydrogen demand in the country will remain in the estimated order of magnitude as it is mostly determined by the large consumers.

TABLE 5. Estimated local hydrogen demand for main sectors

Product	Specific H_2 demand [t_{H2}/t product]	Local capacity [kTPA]	Potential H_2 demand [kTPA]
Ammonia	0.177	5.5	0.98
Urea	0.100	7.7	0.77
Refining	0.012	34	0.40
Total	-	-	2.15

Source: Authors' own compilation, Fichtner (2025)

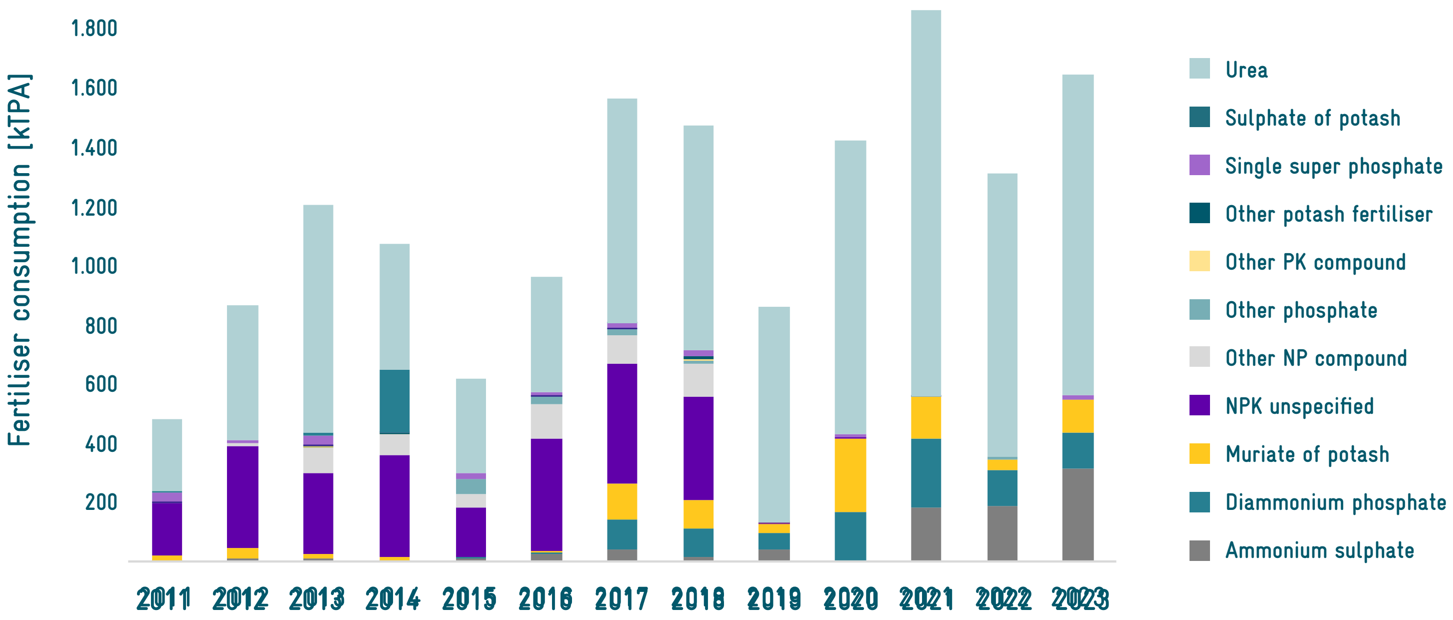
2.4.2 The fertiliser industry

Nigeria is one of the world's leading producers of nitrogenous fertilisers and exports to Brazil, USA, EU and African countries, among others. Fertiliser consumption in Nigeria has experienced fluctuations due to various economic, policy and supply chain factors. In recent years, consumption has generally increased, driven by policies such as the Presidential Fertilizer Initiative (PFI) that aim to make fertilisers, especially nitrogen-rich ones like urea, more affordable and accessible for farmers. In 2021, Nigeria's fertiliser consumption was estimated at about 1.8 MTPA, with urea being the most important fertiliser product (> 60%). Figure 9 shows the consumption of fertilisers in Nigeria since 2010. Fertiliser consumption is very volatile and depends heavily on fertiliser prices in the market.

In Nigeria there are three ammonia production locations with a combined production capacity of 5.5 MTPA. Table 6 shows their location, production capacities and estimated hydrogen demand. All production locations currently use coal gasification, methane reformation and the Haber-Bosch process as production technologies (GIZ, 2024).

Furthermore, in Nigeria there are three main urea production companies with a combined production capacity of 6.2 MTPA. Table 7 shows their location, production capacities and estimated hydrogen demand.

FIGURE 9. Fertiliser consumption in Nigeria



Source: Authors' own compilation, Fichtner (2025) based on (AfricaFertilizer, 2024)

In 2023, Nigeria's urea production was approximately 3.7 MTPA (AfricaFertilizer, 2024). This indicates that the plants do not operate at full capacity. The hydrogen demand for this amount of urea would be around 370 kTPA, lower than the estimated total of 766 kTPA at full production capacity. The country exported approximately 2.6 MTPA of urea in 2023 (AfricaFertilizer, 2024).

Nigeria has 91 fertiliser processing and blending plants with a combined capacity of 42 MTPA (AfricaFertilizer, 2024). These facilities do not produce fertilisers themselves but instead focus on blending imported fertiliser components with domestically produced urea to create various NPK fertiliser grades. The plants are distributed across the country, playing a crucial role in meeting agricultural demand.

In 2023, Nigeria imported approx. 534 kTPA of fertiliser, comprising ammonium sulfate (67%), diammonium phosphate (16%), muriate of potash (14%) and others (3%). Around 630 kTPA of NPK fertilisers were blended domestically.

TABLE 6. Main ammonia production companies in Nigeria

Company	Location	Capacity [kTPA]	Estimated hydrogen demand [kTPA][1]
		Ammonia	Hydrogen
Dangote Fertiliser Plant	Lekki Free Trade Zone, Lagos	1,496	265
OCP Fertilizer Bulk Blending Plant*	Kaduna	653	116
Brass Fertilizer & Petrochemical Company	Bayelsa	3,400	602

* OCP Fertilizer Bulk Blending has two additional locations in Ogun and Sokoto, but with unknown production capacity.

Source: Authors' own compilation, Fichtner (2025) based on (GIZ, 2024)

TABLE 7. Main urea production companies in Nigeria

Company	Location	Capacity [kTPA]	Estimated hydrogen demand [kTPA][2]
		Urea	Hydrogen
Notore Chemical Industries	Port Harcourt	400	40
Indorama Eleme Fertilizers & Chemicals	Port Harcourt	2,800	280
Dangote Fertiliser	Lekki Free Trade Zone, Lagos	3,000	300
Stanch Fertiliser FZE	Eastern Obolo, Akwa Ibom State	1,460	146

Source: Authors' own compilation, Fichtner (2025) based on (AfricaFertilizer, 2024), (GIZ, 2023) and (StanchFertilizer, 2025)

1 The estimations are indicative, as these do not consider process efficiencies or part load operation. Specific requirements of 0.177 t_{H2}/t_{NH3} have been considered.

2 The estimations are indicative, as these do not consider process efficiencies or part load operation. Specific requirements of 0.1 t_{H2}/t_{urea} have been considered.

2.4.3 The chemical industry

The country's chemical requirements have to be covered mainly by imports, for example products such as hydrogen peroxide or cyclohexane. Local companies usually play a role in the supply chain, but primally in the distribution of the chemical products and not in their production. Brenntag Chemicals Nigeria Limited, GMAS Chemicals and Reliant Overseas Limited are examples of such companies. Nonetheless, some chemicals are produced locally by companies that manufacture ammonia and ammonia-based products. For example, Notore Chemical Industries (Port Harcourt) also manufactures oxo-alcohols. Table 8 gives an overview of imports of the main chemical products that require hydrogen.

In the methanol sector, recent announcements highlight plans for local production. The Brass Fertilizer and Petrochemical Company is currently constructing a methanol plant in Bayelsa State. The facility is expected to produce 10,000 metric tons of methanol per day (Brass Fertilizer, 2025). To secure a steady feedstock supply, a gas supply agreement has been finalised with the government (Fertilizer Daily, 2024).

Once the methanol plants become operational, the sector will require around 1.0 MTPA of hydrogen, making it one of the country's largest hydrogen consumers.

TABLE 8. Imports of main hydrogen-dependent chemical products in Nigeria in 2023

Product	Volume [kTPA]	Value [USD million]
Hydrogen peroxide	3.5	4.7
Cyclohexane	3.6	5.8
Methanol	52	21.2

Source: Authors' own compilation, Fichtner (2025) based on (WITS, 2025b)

TABLE 9. Planned methanol plants in Nigeria

Company	Location	Capacity [kTPA]	Estimated hydrogen demand [kTPA][3]
Brass Fertilizer and Petrochemical Company	Bayelsa State	3,650	690
Blackrose Methanol Plant	Akwa Ibom	1,800	340

Source: Authors' own compilation, Fichtner (2025) based on (Brass Fertilizer, 2025), (Africa Finance Corporation, 2024)

3 The estimations are indicative, as these do not consider process efficiencies or part load operation. Specific requirements of 0.189 t_{H2}/t_{MeOH} have been considered.

2.4.4 The steel and metallurgy industry

Steel manufacturing is a sector with substantial potential in Nigeria, given its abundant iron ore reserves. Nigeria has 74 established steel plants and fabricators with a combined installed capacity of 11 MTPA but many of them are not operational (NSRMEA, 2022). According to the World Steel Association, the total production of crude steel in Nigeria was 1.2 MTPA in 2023 (World Steel Association, 2024). This results in a need for imports to cover the domestic demand. The imported amount of steel has been around 2 MTPA since 2020 (WITS, 2025a).

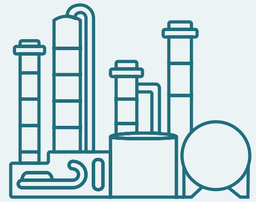
The following table summarises the key players and their production capacities as well as their current operational status.

The first two listed companies are steel producers, while the others specialise in steel processing and cutting. Delta Steel Company operates a DRI furnace, presenting an opportunity for a future transition to green hydrogen as refurbishment or expansion plans are considered. If the DRI furnace were to operate at full capacity (which is currently not the case), its estimated hydrogen demand would be around 60 kTPA. The potential for green hydrogen use in the sector could further increase in the long term, particularly if Nigeria's steel industry expands to fully utilise local resources of iron ore, although the exact demand remains uncertain at this stage.

TABLE 10. Main steel and metallurgy companies in Nigeria

Company	Location	Status	Capacity [kTPA]
			Steel
Ajaokuta Steel Company	Ajaokuta	Non-operational	1,300
Delta Steel Company	Aladja	Partially operational	1,000
African Foundries Limited	Ogijo	Operational	500
Company	**Location**	**Status**	**Capacity [kTPA]**
			Aluminium
Aluminium Smelter Company of Nigeria (ALSCON)	Ikot-Abasi, Akwa Ibom State	Non-operational	193

Source: Authors' own compilation, Fichtner (2025) based on (GIZ, 2024), (BPE, 2006), (Punch, 2023), (234intel, 2024), (The Nation, 2017), (ALCSON, 2024)



2.4.5 The oil and mining industry

Table 11 presents a list of the main refineries in the country, with their locations, production capacity and estimated hydrogen demand. The largest refinery in the country belongs to the Dangote Group, while four other state-owned refineries are currently not in operation. Significant rehabilitation projects are being carried out in all of them. In addition, there are further privately owned refineries that are currently planned or under construction.

The estimated hydrogen demand for the operational refineries is mainly driven by the Dangote refinery and amounts to 398 kTPA. Considering the total capacity (operational, non-operational and under construction), the hydrogen demand would almost double and reach 782 kTPA.

TABLE 11. Main oil refineries in Nigeria

Company	Location	Status	Capacity [bbl/d]	Estimated hydrogen demand[4] [kTPA]
Dangote group	Lagos, Lekki	Operational	650,000	379
Warri Refinery and Petrochemical Plant	Warri	Non-operational	125,000	73
New & Old Port Harcourt Refinery	Port Harcourt	Non-operational	210,000	123
Akwa-Ibom *	Akwa Ibom	Under construction	200,000	117

* Probable commissioning in 2025 (arise news, 2025)
** Mechanical completion expected in 2024 and commercial operation in 2025 (This Day, 2024)
*** Plans for phase II with a capacity of 25,000 bbl/d and phase III with 20,000 bbl/d (Waltersmith, 2023)

Source: Authors' own compilation, Fichtner (2025) based on (Dangote, 2024) and (NNPC, 2024), (GIZ, 2024), (GIZ, 2023), (AIPCC, 2024), (OPAC, 2024)

4 An estimate of the hydrogen demand for these refineries is calculated based on a specific consumption of 12 kg of hydrogen per metric ton of refined product. This value is only indicative and can vary significantly depending on the type (quality) of crude oil and the refinery specific technologies and processes. Furthermore, the estimated hydrogen demand assumes full operation throughout the year.

2.4.6 The food industry

Nigeria's food industry is one of the largest in Africa, driven by its vast population of over 200 million people and a strong demand for processed and packaged foods. The sector spans agriculture, food processing and retail, with key industries including flour milling, dairy, beverages, confectionery and packaged foods. Hydrogen requirements in the sector will be mostly driven by the hydrogenation of oils and fats. Table 12 presents a list of key companies from the food industry that have a potential need for hydrogen in the hydrogenation of oils.

Compared to key hydrogen-consuming industries such as refining and ammonia production, hydrogen usage in the food sector remains relatively low. The sector's diverse range of processes and products makes it difficult to estimate hydrogen requirements accurately. However, based on a production capacity of 684 kTPA for the listed palm oil processing companies, hydrogen demand could range from 3 kTPA to 68 kTPA, if hydrogenation processes were in place.

2.4.7 Other industries

Hydrogen is increasingly recognised as a key solution for decarbonising industries that are difficult to electrify, particularly those requiring high-temperature processes. The transition to green hydrogen in sectors such as cement, glass and ceramics will likely be gradual, depending on technological advancements and process adaptations. Nevertheless, its potential role in these industries should be carefully evaluated as part of long-term decarbonisation strategies.

TABLE 12. Main food industry companies in Nigeria

Company	Location	Capacity / Product
PZ Wilmar (Devon King)	Ajao Estate, Lagos	365 kTPA crude palm oil
Golden Oil Industries Ltd	Ilpeju Lagos and Onitsha Anambra	100 kTPA crude palm oil
Olam Global Agri (Ruyat Oil Ltd)	Lagos	73 kTPA crude palm oil
FMN (Premium Edible Oils Ltd)	Ibadan, Oyo Estate	146 kTPA refined palm oil, fatty acids

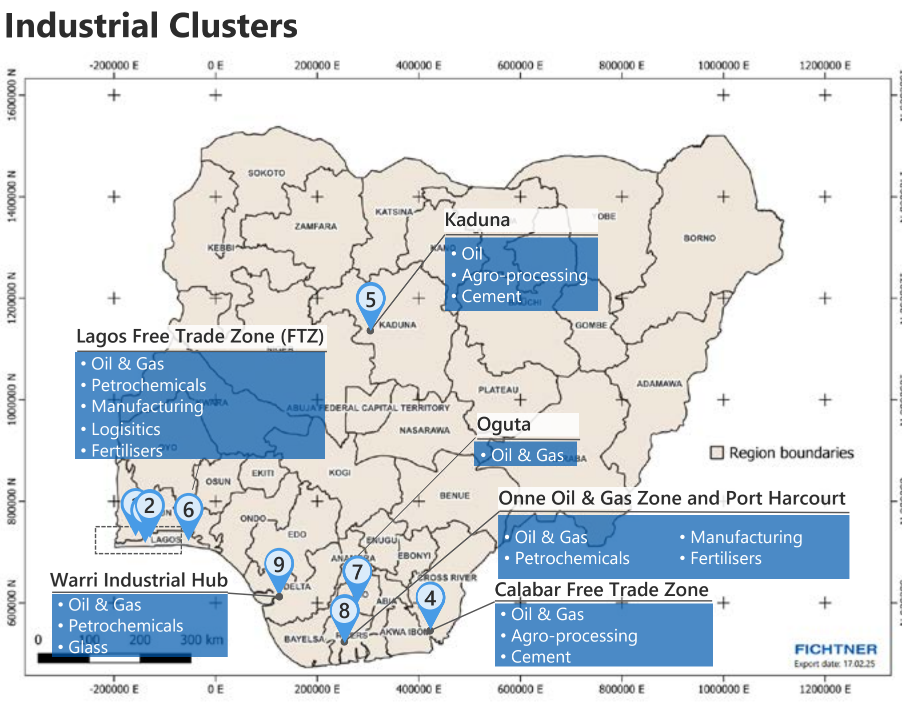
Source: Authors' own compilation, Fichtner (2025) based on (pzWilmar, 2024), (RSPO, 2024), (Olam Agri, 2024), (RSPO, 2025)

2.5 Industrial clusters and enabling infrastructure

The main existing industrial clusters in Nigeria with a higher likelihood of hydrogen use are depicted in Figure 10. In these clusters, one or more of the following sectors have been identified: petroleum refining, fertiliser production, petrochemicals and palm oil processing. Further details on the industrial clusters are listed in Annex 2 Details on industrial clusters.

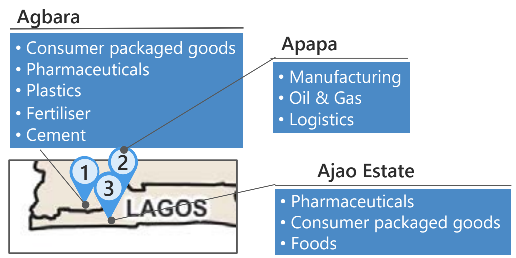
Identifying these clusters is the first step in assessing the short-term feasibility of transitioning from grey to green hydrogen. Key insights for each cluster are as follows:

FIGURE 10. Main industrial clusters in Nigeria



Key Companies

	Company	[kTPA]
1	**Dangote Cement** (Cement)	12
2	**PZ Wilmar** (Vegetable oil) **Golden Oil Industries** (Vegetable oil)	365 100
5	**OCP Bulk Blending Plant** (Fertiliser) **Kaduna Refinery** (Refinery)	653 -
6	**Dangote Fertilizer Plant** (Ammonia) **Dangote** (Refinery)	1,496 650,000 [bbl/d]
8	**Notore Chemical Industries** (Urea) **Indorama Eleme** (Fertiliser)	400 2,800



Source: Authors' own compilation, Fichtner (2025)

- Clusters with petroleum refining: From a technical perspective, a switch from grey to green hydrogen is deemed possible. Nonetheless, the operational challenges in several plants might represent a barrier. Large refineries will require significant investments if a total switch is strived for; alternatively, smaller projects for a partial substitution of hydrogen can be considered at an early stage.
- Clusters with fertiliser production and palm oil processing have high potential for a short-term switch from grey to green hydrogen.
- Clusters with other products and processes, such as iron and steel or cement, might still have or develop a demand for hydrogen. In these sectors the current technologies might require major adaptations to current processes, and, in some cases, technological readiness still has to be proved.

Most industrial clusters in Nigeria are concentrated in the western part of the country and near the coastline. Existing industrial clusters can be expected to have basic infrastructure in place, albeit of varying standards:

- **Grid connection:** The clusters are connected to the grid. Specific challenges related to supply reliability are found in some areas. In Bayelsa, for example, vandalism affected the electricity supply for several months in 2024 (Nigerian Tribune, 2024). In general, large and well-established clusters such as Calabar, Lagos free trade zone (FTZ) or Port Harcourt have a more reliable energy supply.
- **Water supply:** Water supply systems are in place in all industrial clusters. The future implementation of seawater desalination projects on the coast and the development of a water pipeline network might benefit most of the industrial clusters located near the coastline, improving water access and reducing the stress on water bodies in the country.
- **Transport infrastructure:** Road conditions influence transport capacities and related costs, and are a key driver of competitiveness for the clusters. In general, there is a good road network in the clusters, with less developed networks in Oguta.
- **Ports:** Most of the clusters have access to ports located in the same state or nearby. Some clusters without direct port access include Agbara (Ogun State) and Oguta (Imo State). Port access for the clusters can be covered mainly through Apapa Port, Port Harcourt Port, Onne Port, Calabar Port and Lekki Deepsea Port (integrated in the Lagos Free Trade Zone).

2.6 Pilot projects

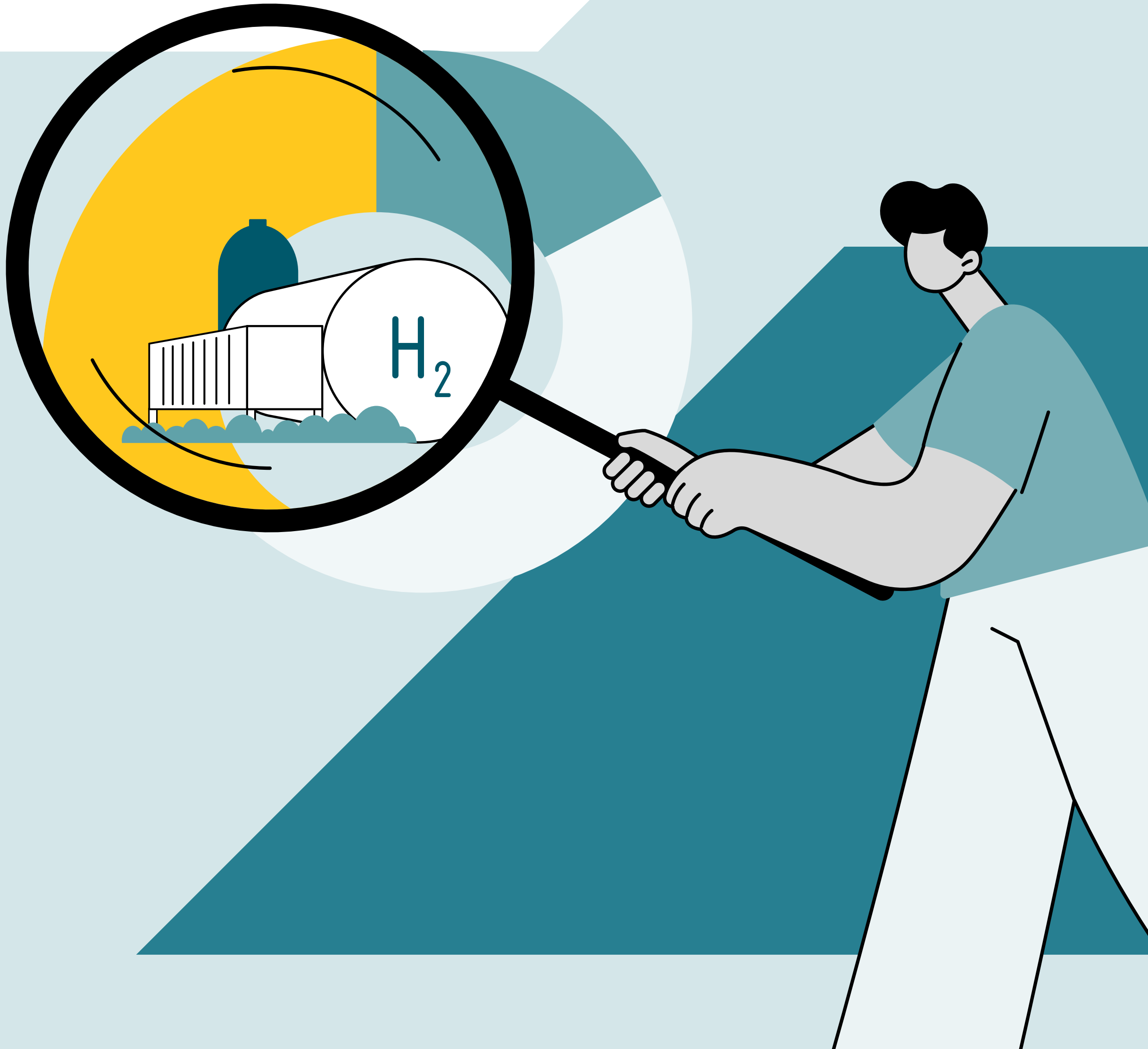
Nigeria is promoting green electricity and hydrogen initiatives with multinational corporations such as Shell and Total Energies but has not realised any pilot projects because the development of the hydrogen industry is still in its infancy there. In addition, Nigeria is considering blue hydrogen in the short term based on local natural gas resources (Nigeria, 2022). In the long term, green hydrogen might have also its place within Nigeria.

In 2023, FuelCell Energy signed a memorandum of understanding with OCEL to build a green hydrogen plant in Nigeria. This collaboration aims to explore the commercial deployment of FuelCell Energy's technologies in the country (Renewables Now, 2023).

In 2024, the Nigerian company Alternative Petroleum & Power Limited (APPL) announced the development of a Power-to-X (PtX) project situated at Liberty Oil & Gas Free Zone, Ibeno Local Government Area of Akwa Ibom State, Nigeria. The APPL plant should produce 1.2 MTPA of green ammonia and 520 MTPA of renewable methanol (green and blue). It is expected to be fully operational by January 2029 (Econnect, 2024).

3

Green hydrogen potential in Nigeria and use cases



Nigeria has the potential to emerge as a key player in the global hydrogen economy, driven by its abundant solar energy resources, strong industrial base and strategic export infrastructure. With existing hydrogen demand in oil refining and fertiliser production, as well as coastal access to international markets, the country is well-positioned to develop a thriving green hydrogen industry. However, challenges such as grid instability, regional water scarcity, regulatory uncertainties and financing constraints must be addressed in order to unlock this potential. By expanding renewable energy capacity, modernising infrastructure and establishing clear hydrogen policies, Nigeria can support both domestic decarbonisation efforts and global hydrogen markets.

3.1 Renewable resource potential within Nigeria

Nigeria possesses a diverse range of renewable energy resources that can be leveraged for green hydrogen production. Among the most promising sources are solar energy, hydropower and wind energy, though their development varies across the country:

- **Solar resources:** Nigeria has some of the highest solar irradiation levels in Africa, particularly in the northern regions, where solar PV projects can achieve high capacity factors. With average global horizontal irradiation (GHI) exceeding 5.5 kWh/m^2/day in many areas, solar energy represents the most viable option for powering electrolysis-based hydrogen production.
- **Hydropower:** While large-scale hydropower already contributes to Nigeria's electricity mix, seasonal variability in river flows, particularly during dry seasons, affect hydropower reliability. Nonetheless, small and medium-sized hydropower projects could provide a complementary power source for green hydrogen production.
- **Wind resources:** Wind energy potential in Nigeria is moderate compared to solar. Coastal and northern regions, particularly along the Sokoto and Katsina wind corridors, exhibit wind speeds suitable for utility-scale wind farms. However, large-scale deployment is still at an early stage, and further investments are needed to establish wind energy as a major contributor to Nigeria's energy mix.

The solar and wind resources for Nigeria are displayed in Figure 11.

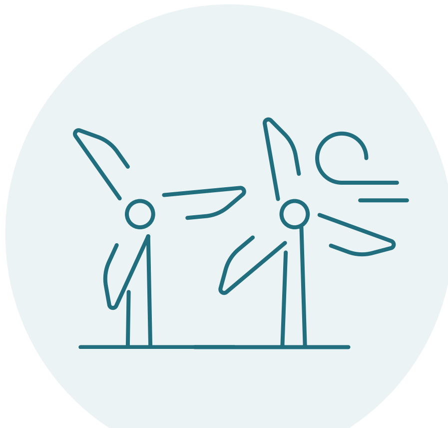
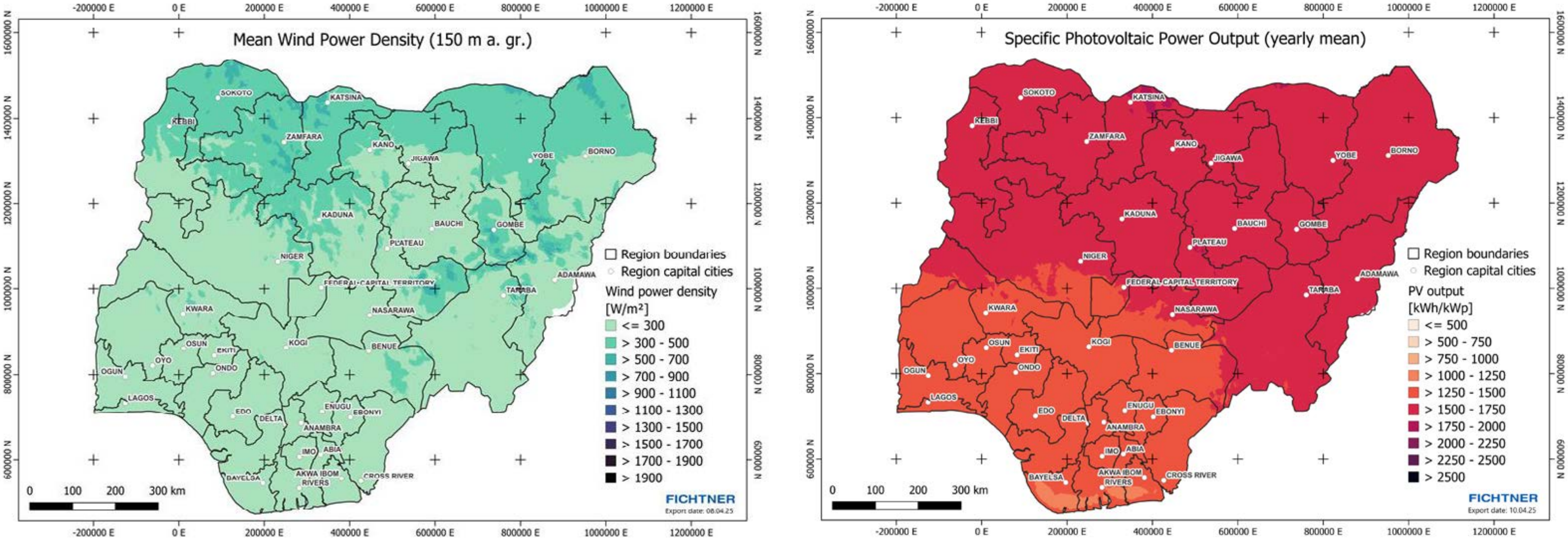


FIGURE 11. Mean wind power density and specific photovoltaic power output for Nigeria



Source: Authors' own compilation, Fichtner (2025) based on (Neil N. Davis, 2024)[5]

Source: Authors' own compilation, Fichtner (2025) based on (Global Solar Atlas, 2024)[6]

5 Data obtained from the Global Wind Atlas version 3.3, a free, web-based application developed, owned and operated by the Technical University of Denmark (DTU). The Global Wind Atlas version 3.3 is released in partnership with the World Bank Group, utilising data provided by Vortex and funding provided by the Energy Sector Management Assistance Program (ESMAP). For additional information: https://globalwindatlas.info

6 Data obtained from the Global Solar Atlas 2.0, a free, web-based application is developed and operated by the company Solargis s.r.o. on behalf of the World Bank Group, utilising Solargis data, with funding provided by the Energy Sector Management Assistance Program (ESMAP). For additional information: https://globalsolaratlas.info

Water availability is another key consideration for hydrogen production. Although Nigeria has abundant freshwater resources from rivers such as the Niger and Benue, localised water scarcity and competing demands for agricultural and domestic use could pose challenges. In coastal regions, desalination may be necessary to provide a reliable water supply for electrolysis without impacting freshwater availability. However, desalination costs contribute minimally to the overall levelised cost of hydrogen and are not expected to be a showstopper. Investments in transmission infrastructure, energy storage and grid stability will be essential to fully harness these resources and ensure reliable power supply for large-scale hydrogen production.

3.2 Potential use cases

Nigeria's growing industrial landscape offers opportunities for green hydrogen integration. The country's primary hydrogen demand is concentrated in oil refining, ammonia and urea production, and, in the near future, methanol production. Additional smaller consumers include the petrochemical, chemical, glass and food industries. As the hydrogen industry expands, applications in steel, cement and transportation may emerge, further increasing hydrogen demand. These potential use cases can be classified into **small-scale and large-scale applications**, reflecting global trends in the early development of hydrogen markets.

Small-scale use cases (electrolyser capacity: 1+ MW)

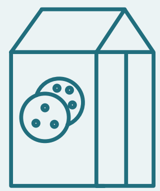
Small-scale green hydrogen projects serve industries with moderate hydrogen demand or decentralised production needs. These setups prioritise on-site or near-site generation to minimise logistics costs and seamlessly integrate with existing processes.

Electrolysers will then be typically powered by local wind or solar PV plants, supported by battery energy storage or hydrogen storage to manage fluctuations in electricity supply and hydrogen demand. In most cases, the hydrogen is consumed directly on-site, ensuring efficiency and reliability.

Typical small-scale applications include electronics, specialty glass production, welding processes and the food industry - either for hydrogenation or as a protective gas in food packaging. In Nigeria, potential applications are currently limited but possible targets include:

1. **Food industry**

   Hydrogen plays a crucial role in the hydrogenation of vegetable oils and fatty acids, a process used to improve the stability, shelf life and texture of edible oils and fats. This process is widely applied in the production of margarine, shortening and other processed foods that require a semi-solid fat consistency. Nigeria has a large vegetable oil industry, with major players involved in palm oil, soybean oil and groundnut oil processing. Currently, the hydrogen used in these processes is derived from fossil fuels, but switching to green hydrogen could help reduce emissions and support the country's climate and sustainability goals. The industry is concentrated around Lagos, Ogun and Anambra States, where companies such as Devon King's Cooking Oil, Golden Oil Industries and PZ Wilmar operate large-scale processing facilities. These facilities could benefit from on-site green hydrogen production to replace conventional hydrogen sources, enhancing energy security and sustainability in the sector.



2. Glass and specialty chemical manufacturing

Glass manufacturing and specialty chemical production are two additional sectors where hydrogen is used in high-temperature processing and chemical reactions.

- **Glass industry:** Hydrogen is used in glassmaking for its heat transfer properties and as a reducing agent in high-temperature furnaces. In Nigeria, the container glass and float glass industries are growing, with Beta Glass, Glassforce and Nigeria Glass Group among the key producers. Companies that produce float glass could integrate on-site green hydrogen production.
- **Specialty chemicals:** The Nigerian chemical industry primarily depends on imports, but local production could be gradually expanded. Hydrogen is required in the production of ammonia-based chemicals, oxo-alcohols and hydrogen peroxide, among others. Companies such as Notore Chemical Industries manufacture some of these products, and adopting green hydrogen could improve their competitiveness in the global market by offering low-carbon alternatives.

Large-scale use cases (electrolyser capacity: 10 MW and above)

Large-scale green hydrogen projects serve industries with high and continuous hydrogen demand, maximising economies of scale through larger electrolyser installations and the utilisation of optimal wind and solar resources.

These projects typically feature large renewable energy facilities paired with nearby large-scale electrolysers, supported by infrastructure for electricity transmission, water supply, wastewater management and hydrogen storage and transport to off-takers or ports. Extensive hydrogen storage is essential either to balance production fluctuations without disrupting downstream processes or to accommodate the periodic nature of maritime transport for export-oriented projects.

Unlike smaller-scale projects, large electrolysers are housed in dedicated buildings, as containerised solutions are more common for smaller installations. In some cases, desalination units may be required to ensure a sustainable water supply, depending on local availability.

Typical large-scale applications include ammonia and fertiliser production, chemicals (including methanol) and crude oil refining. In the future, iron & steel and cement may also emerge as major hydrogen consumers.

In Nigeria, the primary opportunities include:

1. Ammonia and fertiliser production

- Nigeria is a leading producer of nitrogen-based fertilisers and one of Africa's major ammonia and urea exporters.
- The country's ammonia production is concentrated in Dangote Fertiliser Plant (Lagos), Brass Fertilizer & Petrochemical Company (Bayelsa), and OCP Fertilizer Bulk Blending Plant (Kaduna).
- The global market for lower-carbon fertilisers is growing, driven by sustainability trends. Implementing green fertiliser production can enhance Nigeria's competitiveness in agricultural exports, aligning with increasing demand for sustainably sourced products.

2. Oil refining and petrochemicals

- Nigeria's refining industry is expanding, with the Dangote Refinery in Lagos being the largest in Africa. Other refineries, including those in Warri, Kaduna and Port Harcourt, are undergoing rehabilitation.
- Refineries require hydrogen for hydrotreating and hydrocracking, processes essential for removing sulphur and improving fuel quality.

3. Steel and metallurgy industry

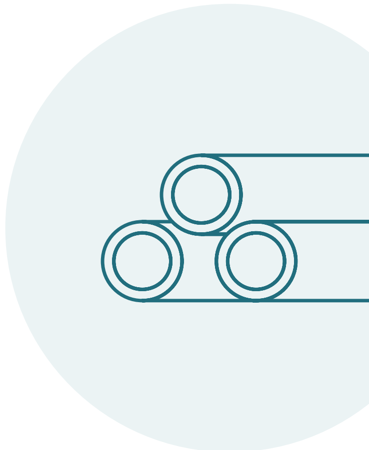
- Nigeria's steel industry has significant untapped potential due to its large iron ore reserves and existing but underutilised production capacity.
- Ajaokuta Steel Company and Delta Steel Company are potential candidates for hydrogen-based direct reduced iron (DRI) steelmaking, an emerging low-emission technology.
- As global steel markets increasingly prioritise low-emission products, this shift could drive higher willingness to pay among off-takers, potentially opening up new exports for green steel.

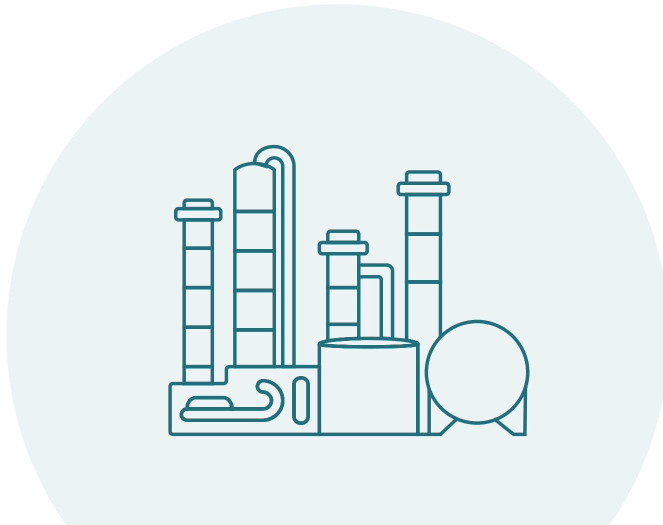
4. Cement industry

- Nigeria's cement industry, led by Dangote Cement, BUA Cement, and Lafarge Africa, is one of the largest in Africa, with an installed capacity of around 70 MTPA.
- Cement production is highly energy-intensive, and in future hydrogen could be used as a low-emission fuel for high-temperature kilns.

5. Methanol production

- With the construction of new methanol plants, such as Brass Fertilizer and Petrochemical Company (Bayelsa) and Blackrose Methanol Plant (Akwa Ibom), Nigeria's hydrogen demand for methanol is expected to significantly increase.
- Methanol is a key feedstock for chemical production and clean fuel applications, and shifting to green hydrogen-based methanol production enables Nigeria to supply low-carbon methanol to international markets.





Techno-economic calculations of the use cases

Based on the previous analysis, potential use cases for hydrogen in Nigeria will currently primarily focus on small-scale applications or ammonia production for fertilisers.

To provide a preliminary indication of the techno-economic feasibility for projects of varying scales, three different scenarios have been assessed for direct hydrogen use at a location in Lagos, one of the main industrial clusters of the country with different potential applications. Here, a transition to green hydrogen could be considered in the short-term. For these selected cases, the analysis examined the optimal renewable energy mix, including PV and wind, necessary to meet the given annual hydrogen demand using different electrolyser sizes (1 MW and 8 MW). The main results of these three cases are summarised in the following table. These results are considering exemplary renewable profiles at the location (6° 27' 14.65" N, 3° 23' 40.81" E). It is to be noted that the results may vary significantly if industries in other parts of the country with, for example, different wind resources nearby are chosen or if utility-scale projects with significantly larger component sizing are planned.

TABLE 13. Techno-economic calculations for direct hydrogen use cases

Case	Small-scale H_2 (wind & PV)	Small-scale H_2 (PV only)	Large-scale H_2 (wind & PV)
Demand (H_2) in metric tons/a	45	45	450
Installed RE (capacity) in MW	PV: 1.9 Wind: 0.5	PV: 2.9	PV: 40 Wind: 4
Electrolyser size in MW	0.9	1.0	8.3
WACC in %	15.3	15.3	15.3
Total investment in USD million	5.5	6.1	44.4
Oxygen sales in million kg	0.33	0.36	3.5
Excess RE sales/consumed in GWh[7]	0.6	1.0	8.5
LCOH grey in USD/kg	6.8	6.8	6.8
LCOH proposed case/green in USD/kg	19.4	18.6	13.0
Project IRR in %	2.4	3.5	6.1
Net present value in USD million	–3.3	–3.3	–19.5
Finance gap in USD/kg	12.7	11.9	6.3

Source: Analyses performed by GIZ (2025)

7 Excess RE are calculated for the value chain including ammonia. If only H_2 is to be produced, the amount of excess renewables can be increased by ~5%.

The complete assumptions, sizing, cost breakdown, financial parameters and results are detailed in Annex 3 Techno-economic calculations. Based on the results presented in the table above, the following can be concluded:

- **Resource utilisation and cost analysis:** The analysis reveals that wind resources at the selected location are insufficient for effective electricity generation[8], as indicated by the lower LCOH for green hydrogen in the 'Small-scale H_2 (PV only)' case compared to the 'Small-scale H_2 (wind & PV)' case. The green LCOH for the 'Small-scale H_2 (PV only)' and 'Large-scale H_2 (wind & PV)' cases are approximately 170% and 90% higher than the current grey hydrogen costs, respectively.
- **Financial viability:** With an LCOH for grey hydrogen of 6.8 USD/kg, which results from considering external supply by a third party (no own production), among the analysed scenarios, the 'Large-scale H_2 (wind & PV)' case shows the lowest finance gap at USD 5.78 per kg of hydrogen and the highest IRR (6.1%), suggesting it as the most financially feasible option for implementation based on these estimates. Lower LCOHs for grey hydrogen will correspondingly increase the finance gap.[9] By leveraging one or a mix of the funding sources described further in Section 4.3, the finance gap might be closed to make the project economically feasible.

8 Capacity factors of wind: 5% for small scale and 9% for large scale.
9 Defining finance gap as the difference between LCOH for green hydrogen and LCOH for grey hydrogen.

Given that current hydrogen use in Nigeria is highly depending on ammonia and ammonia-based fertiliser production, a complementary techno-economic analysis has been conducted for three ammonia use cases that align with the hydrogen use cases presented above. The results are summarised in the following table.

TABLE 14. Techno-economic calculations for ammonia use cases

Case	Small-scale NH_3 (wind & PV)	Small-scale NH_3 (PV only)	Large-scale NH_3 (wind & PV)
Demand (NH_3) in metric tons	270	270	2,700
Installed RE (capacity) in MW	PV: 1.9 Wind: 0.5	PV: 2.9	PV: 40 Wind: 4.0
Electrolyser size in MW	0.9	1.0	8.3
WACC	15.3	15.3	15.3
Total investment in USD million	6.3	6.8	48.8
LCOA grey (USD/kg)	1.2	1.2	1.2
LCOA proposed case (USD/kg)	4.2	3.9	2.8
Oxygen sales (m kg)	0.33	0.36	3.5
Excess RE sales/consumed in GWh	0.6	1.0	8.5
Project IRR in %	0.7	2	4.5
Net present value in USD million	-4.0	-4.1	-24.9
Finance gap (USD/kg)	3.0	1.6	2.7

Source: Analyses performed by GIZ (2025)

Based on these results, the following can be concluded:

- **Cost-competitiveness:** Among the cases, the 'Large-scale NH_3 (wind & PV)' scenario presents the lowest green LCOA at USD 2.8 per kg, making it more competitive than the alternatives.
- **Financial feasibility:** Despite having large finance gaps and negative net present values in all scenarios, the 'Large-scale NH_3 (wind & PV)' case has the smallest finance gap at USD 2.7 per kg of ammonia, highlighting its potential for large-scale implementation. As with hydrogen, the remaining gap might be closed by leveraging funding mechanisms.
- **Investment returns:** Although the project IRR is modest across all cases, the 'Large-scale NH_3 (wind & PV)' scenario offers the highest return at 4.5%.

Overall and under current assumptions, the results show the general rationale of larger projects being more cost-efficient than small-scale projects. Nevertheless, they also require higher initial investment, which the lower LCOH is still not enough to compensate and to reach a positive NPV. It is therefore clear that these projects are not economically feasible in the short-term without intensive funding. From a funding perspective it might be more feasible to go for small-scale projects as the funding required to set up these projects is lower in absolute terms, but this depends to a large extent on the funding scheme to be used.

It is important to note that the aforementioned options provide an estimate of potential green hydrogen and ammonia costs; however, costs should be evaluated on a project-by-project basis as factors such as the local renewable profile and the required industry's offtake profile (the analysis above is based on a constant profile) can significantly influence the levelised cost, particularly due to their impact on the sizing of the electrolyser and storage system required. This effect is smaller for ammonia than hydrogen as the first has significantly smaller storage costs. Additionally, securing an off-taker for the produced oxygen can be challenging, as revenue from the sale of this by-product generally does not justify investment in extensive transport infrastructure. The calculation further assumes that the full amount of renewable electricity generated can be sold to the industry attached for a price of USD 150/MWh. It is likely that the industries will be interested in purchasing the otherwise curtailed renewable electricity, but this might not always be the case and without the sales of excess renewables, the implementation of battery storage might become an option. In certain scenarios, it may be further feasible to derive additional benefits from using the electrolyser's waste heat for applications such as district heating or industrial pre-heating processes and to conclude a PPA with other renewables to make use, for example, of the constant renewable profile of existing hydropower assets.

3.3 Analysis of hydrogen production potential

For large-scale hydrogen production, the availability of renewable energy resources, water supply, industrial demand, export infrastructure and regulatory frameworks plays a crucial role. In Nigeria, abundant solar energy presents the greatest opportunity for green hydrogen production, particularly in the northern regions. While hydropower is already part of the energy mix, wind resources exist but will play a more limited role in Nigeria's energy mix. However, hybrid renewable energy solutions, integrating solar with other renewables or storage systems, are beneficial in order to enhance grid stability and limit the cost of hydrogen production.

Nigeria's industrial base creates strong domestic demand for hydrogen, particularly in ammonia and fertiliser production, oil refining and methanol synthesis. The country's coastal infrastructure and export capabilities further strengthen its position as a potential green hydrogen supplier, allowing Nigeria to export hydrogen or derivatives to Europe and North America via its ports in Lagos, Port Harcourt and Warri.

Conversely, small-scale hydrogen projects require proximity to industrial end-users in order to minimise transportation costs and ensure economic viability. Nigeria's industrial centres, including Lagos, Ogun, Port Harcourt and Kaduna, offer strategic locations for pilot hydrogen projects. These regions benefit from existing energy and water infrastructure, as well as a concentration of industries - such as food processing, glass manufacturing and petrochemicals - that could integrate green hydrogen into their operations. Leveraging these established industrial clusters can reduce capital expenditure and accelerate project deployment, making it easier to enable small-scale projects and scale up hydrogen adoption in key sectors.

Nigeria's existing oil and gas infrastructure presents a unique advantage in the hydrogen economy. The country's extensive pipeline network, LNG terminals and petrochemical processing facilities could be repurposed for hydrogen transport and storage, reducing the need for entirely new infrastructure. Moreover, projects such as the Trans-Saharan Gas Pipeline, which is planned to transport natural gas to North Africa and Europe, could be adapted to carry hydrogen in future. This infrastructure, combined with Nigeria's geographical advantage as a gateway between West Africa and global markets, positions the country as a key contender for hydrogen exports.

However, challenges remain. Nigeria's power sector struggles with grid instability, which could impact the reliability of small-scale, grid-connected electrolysis. Additionally, while water resources are abundant overall, regional water scarcity - particularly in the north - may require investments in desalination infrastructure for coastal-based hydrogen production.

Moreover, most industrial zones, and therefore the primary hydrogen demand, are concentrated in the southern region, where renewable energy conditions are the least favourable nationwide. This diminishes the economic viability of small-scale onsite projects, shifting the focus toward large-scale hydrogen production.

3.4 Multi-criteria assessment for small-scale hydrogen projects

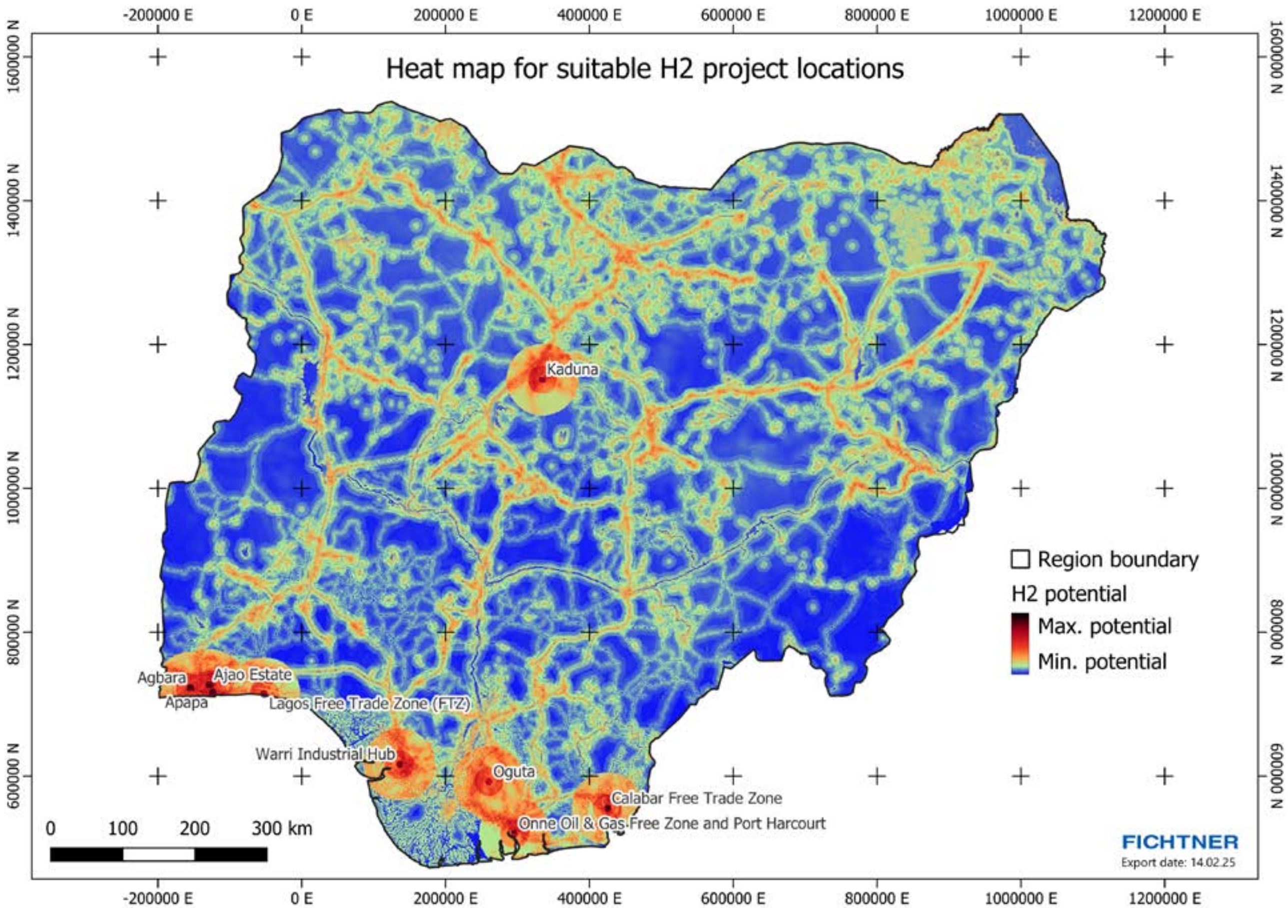
A multi-criteria assessment (MCA) was applied to identify optimal locations for small-scale hydrogen projects. The evaluation considered:

- Renewable energy availability (wind and solar potential)
- Proximity to industrial clusters (potential off-takers)
- Access to water resources (for electrolysis)
- Connection to existing energy and transport infrastructure

Each criterion was assigned specific scoring thresholds based on factors such as distance to off-takers, high-voltage grid connections, water sources, roads and port facilities. Industrial proximity received the highest weighting, followed by grid access, renewable resource quality and water availability. Transportation infrastructure (roads and ports) was also factored in to assess export feasibility.

The results of the MCA are visually represented in Figure 12, highlighting high-potential areas in red as prime locations for engaging industrial off-takers and initiating project development. Areas with less favourable conditions are marked in blue, indicating higher development challenges.

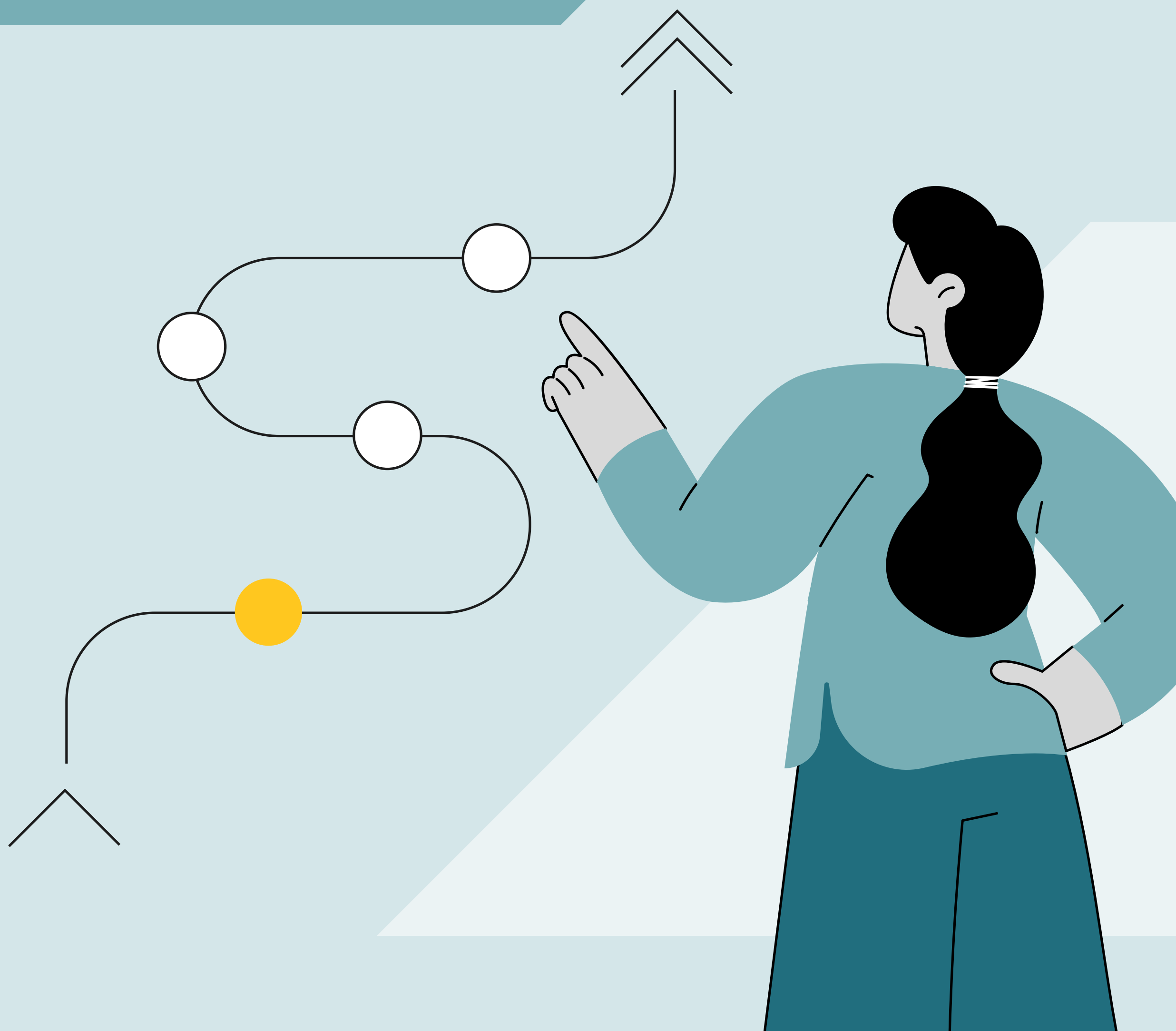
FIGURE 12. Country heat map indicating potential locations for green hydrogen pilot projects



Source: Authors' own compilation, Fichtner (2025)

4

The way forward



Nigeria's energy sector presents both opportunities and challenges for green hydrogen adoption. While the country has abundant natural gas and oil reserves, its renewable energy potential, particularly in wind and solar PV, remains underdeveloped. Future hydrogen applications could emerge in hard-to-abate sectors such as refining, cement and steel production, driven by rising energy demand, but structural challenges are likely to hinder near-term adoption. Additionally, the dominance of fossil fuels and weak environmental enforcement limit the economic incentives for green hydrogen, while safety and regulatory uncertainties pose further obstacles to large-scale deployment.

This section explores Nigeria's potential role in the hydrogen sector, considering its renewable energy resources, opportunities for integrating hydrogen into industrial processes and contributions toward long-term decarbonisation goals. It also highlights the key challenges - policy gaps, infrastructure limitations and economic hurdles - that need to be addressed in order to support the sustainable development of a hydrogen market in the country.

4.1 Opportunities and supporting frameworks

Nigeria has substantial energy resources, a growing industrial base and a large domestic market, all of which provide a strong foundation for the development of a hydrogen economy. While fossil fuels currently dominate the country's energy mix, incorporating green hydrogen could support industrial diversification, reduce emissions and improve energy security. Moreover, Nigeria's strategic location and trade networks position it to play a key role in regional hydrogen markets.

- **Renewable energy potential for green hydrogen production:** Nigeria's vast solar energy potential, particularly in the northern regions, offers an opportunity to generate the renewable electricity needed for large-scale electrolysis. Though renewable energy development is still in its early stages, targeted investments in solar PV and hybrid systems could enable green hydrogen production while simultaneously improving electricity access for industries and communities.
- **Industrial applications for green hydrogen:** Nigeria's existing gas infrastructure, coupled with its numerous potential off-take industries and robust port facilities, provides a basic foundation for the initial development of supply-scale hydrogen infrastructure. Key sectors such as oil refining, steel and ammonia production could benefit from green hydrogen adoption, either as a fuel or feedstock. The refining sector, for instance, could leverage hydrogen to produce cleaner fuels, supporting Nigeria's emission reduction goals in line with global decarbonisation efforts.
- **Strategic position for regional energy trade:** As one of Africa's largest economies, Nigeria's strong trade connections make it a potential exporter of green hydrogen and its derivatives to regional and international markets. Investments in infrastructure, particularly in ports and industrial zones, could support future export opportunities.
- **Enhancing energy security and diversification:** Integrating green hydrogen into Nigeria's energy mix could help diversify its energy sources, reduce dependence on imported refined fuels and enhance domestic energy resilience. Over time, hydrogen storage and fuel-cell applications could complement existing electrification efforts, offering new pathways for a reliable and sustainable energy supply.

For Nigeria to fully capitalise on these opportunities, it will require a well-defined supporting framework that includes clear policies, regulatory mechanisms and investment incentives to attract both local and international stakeholders. The key elements of this framework should include:

- **Policy framework:** Clear government policies are needed to define the role of green hydrogen in the national energy mix, alongside measurable targets for production and consumption. Policies should incentivise renewable energy projects and the industrial adoption of hydrogen technologies, while also fostering investment in hydrogen infrastructure. In this regard, Nigeria's ETP considers hydrogen as a clean energy alternative and foresees a generation capacity of 34 GW by 2050. Nigeria's existing renewable energy goals could serve as a reference point for further hydrogen-related policy developments.
- **Regulatory framework:** Nigeria has existing regulations in renewable energy, climate goals and climate change that provide a foundation for incorporating green hydrogen. However, hydrogen should be formally recognised as an energy source within energy laws such as the Renewable Energy Master Plan. Specific regulations governing hydrogen production, storage, transportation and quality should be developed, aligned with international standards to enable cross-border trade. Financial support mechanisms, such as tax breaks and subsidies, have not yet been defined but would help attract both local and foreign investment in the sector.
- **Technology framework:** Green hydrogen production in Nigeria presents a valuable opportunity to boost the country's large-scale renewable energy sector, which has faced challenges due to government fiscal constraints and tariff issues. However, to implement large-scale green hydrogen projects, significant upgrades to existing infrastructure, such as expanding the electricity grid, will be necessary. Nigeria's diverse industrial landscape provides opportunities for green hydrogen to be utilised across various applications, supporting economies of scale. Smaller-scale pilot projects that focus on specific industrial clusters would be beneficial for evaluating the integration of green hydrogen into current processes and testing its scalability for larger deployments.

By establishing a comprehensive supporting framework, Nigeria can position itself as a competitive player in the green hydrogen economy, driving industrial growth, energy security and environmental sustainability.

4.2 Challenges and considerations

Despite its potential, Nigeria faces several challenges across economic, technical and regulatory domains that must be addressed to facilitate the successful adoption of green hydrogen technologies. Key barriers include a lack of clear regulatory frameworks, insufficient financial incentives and the uncertain willingness of off-takers to pay a premium for green hydrogen. Technological limitations may slow the deployment of hydrogen technologies, while infrastructure issues - especially concerning electricity access and grid capacity - pose critical challenges. These obstacles must be overcome to enable Nigeria's transition to a green hydrogen economy.

- **Economic challenges:** High production costs remain a significant barrier to green hydrogen adoption in Nigeria. While there are large industries with potential demand, the local availability of fossil resources such as natural gas hampers the competitiveness of green hydrogen. The willingness of industrial off-takers to pay a premium for green hydrogen remains unclear, further complicating the situation. Without large-scale, committed consumers, it will be difficult to achieve economies of scale. Moreover, more immediate priorities, such as addressing energy access and upgrading the grid, may delay the focus on green hydrogen, making it challenging to attract the necessary investment in the short term.

- **Technical challenges:** Nigeria faces several technical challenges that could hinder the widespread adoption of green hydrogen. The country's unreliable electricity grid, reliance on diesel generators and limited renewable energy generation capacity make it difficult to rely on the grid for hydrogen production. This will require decentralised, off-grid solutions for hydrogen production. Additionally, Nigeria's existing gas pipeline infrastructure is outdated and frequently damaged, limiting the possibility of using or repurposing it for transporting hydrogen without substantial upgrades. Water availability is another critical issue for electrolysis-based hydrogen production. Nigeria is classified as a high-water-stress country, and a significant portion of its population faces challenges accessing clean and reliable water. Local water infrastructure cannot be relied upon for hydrogen production since it would exacerbate competition, creating additional challenges for scaling up the sector.
- **Regulatory challenges:** Nigeria's regulatory landscape for green hydrogen is still developing. While the country has established some regulations related to renewable energy, climate change and sustainability, there is a lack of specific targets or policies related to hydrogen. To create a viable hydrogen economy, Nigeria must integrate hydrogen into its energy strategy, ensuring it is recognised as a key energy source. This should be accompanied by targeted regulations for hydrogen production, storage and transport. Political stability is also a critical factor in attracting investment; while Nigeria boasts a large industrial base, political risk perceptions may deter investors. A stable and predictable policy environment will be essential to support long-term investment in the hydrogen sector.

While Nigeria faces numerous challenges in the path towards adopting green hydrogen, the country also has significant opportunities to become a leader in the regional hydrogen market. By addressing key challenges in policy, infrastructure and financing, Nigeria can unlock the potential of its renewable energy resources and industrial base.

4.3 Green hydrogen financing opportunities for German companies

The green hydrogen sector requires substantial financial investments to overcome high initial costs and infrastructure challenges. Several funding mechanisms exist to support hydrogen projects globally, particularly in emerging markets. These mechanisms are designed to reduce investment risks, facilitate project development and encourage public-private partnerships. Detail on different founding mechanism can be found in Annex 4.

4.4 Stakeholder mapping and institutional overview

The development of Nigeria's green hydrogen sector will require the collaboration of various stakeholders, including government agencies, regulatory authorities, academic institutions, private sector players, non-governmental organisations and international partners. Each of these groups will play a crucial role in shaping the policy landscape, advancing pilot projects and developing the necessary regulations to enable the widespread adoption of hydrogen technologies. This collaborative effort is essential not only for building a thriving domestic hydrogen economy but also for positioning Nigeria as a key partner for European and global companies looking to expand their green hydrogen operations in West Africa. Key stakeholders involved in this process and their role related to hydrogen are listed in Annex 5.

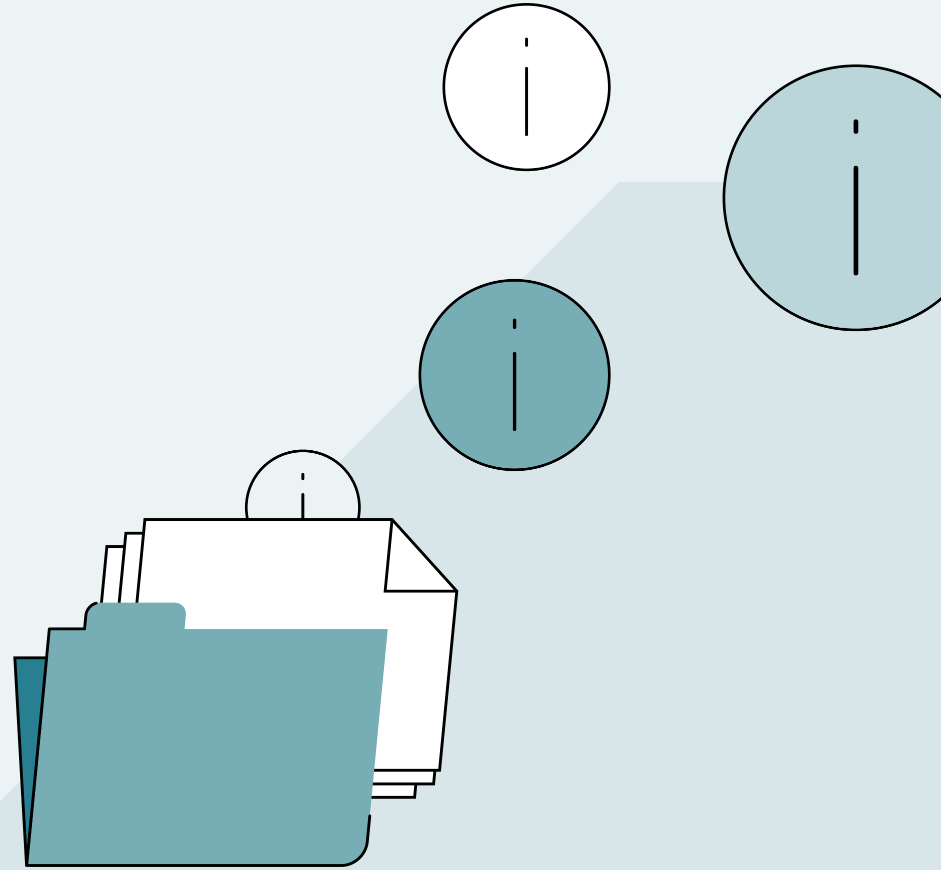
4.5 Next steps for German companies

Nigeria offers some opportunities for green hydrogen development, backed by abundant renewable energy resources and its strategic position in West Africa. To take advantage of these opportunities, German companies should:

1. **Engage with local stakeholders:** build partnerships with Nigerian government agencies such as the Federal Ministry of Power, Energy Commission of Nigeria (ECN) and key state-owned enterprises (such as NNPC) to stay informed about regulatory developments, investment opportunities and national hydrogen strategies.
2. **Leverage funding mechanisms:** explore financing options through international initiatives such as H2Global and the Green Hydrogen Trust Fund. Additionally, consider multilateral support from institutions such as the World Bank and the African Development Bank (AfDB) for project funding and risk mitigation.
3. **Assess market viability and infrastructure:** evaluate the feasibility of green hydrogen production based on Nigeria's renewable energy resources, particularly solar and wind, to a lesser extent. Target key industries (e.g. oil refining and fertilisers) as initial hydrogen off-takers. Consider pilot projects that demonstrate scalability and potential demand.
4. **Monitor regulatory developments:** keep track of evolving policies such as the National Renewable Energy and Energy Efficiency Policy (NREEEP), Energy Transition Plan and future hydrogen-specific regulations. Advocate for supportive frameworks such as tax incentives and streamlined permits to foster a more attractive investment environment.
5. **Collaborate on R&D and technology:** partner with local universities, research institutions and private sectors to develop and test hydrogen technologies, ensuring compliance with international standards and contributing to technology transfer and innovation.
6. **Explore regional export opportunities:** Nigeria's location and growing industrial base offer potential for hydrogen exports to neighbouring countries in West Africa. Explore possibilities for regional hydrogen trade, as well as Europe.

By taking these steps, German companies can tap into Nigeria's green hydrogen market, contributing to the country's energy transition while positioning themselves as key players in Africa's emerging hydrogen economy.

Annexes



Annex 1 Current key uses of hydrogen and methanol

TABLE 15. Current uses of hydrogen

Current uses	Main processes / products	Specific requirements
Refining[10]	• Hydrocracking, hydrotreating and desulfurisation	• Depends on refinery complexity and oil quality: 8-14 kg hydrogen/ton refined product
Ammonia	• Fertiliser production • Chemical production: e.g. nitric acid, amines, explosives • Refrigeration	• Stochiometric: 178 kg H_2/ton ammonia
Methanol	• Fuel: Methyl tertiary butyl ether (MTBE) • Solvent • Antifreeze • Chemical feedstock: e.g. formaldehyde, acetic acid	• Stochiometric: CO_2 hydrogenation: 189 kg H_2/ton methanol CO hydrogenation: 126 kg H_2/ton methanol
Chemical industry	• Oxo alcohols	• Depends on olefin, process and product, stoichiometrically between 10-30 kg H_2/ton oxo alcohol
	• Fatty alcohols	• Depends on production process and product, stoichiometrically between 10-20 kg H_2/ton fatty alcohol
	• Hydrogen peroxide (H_2O_2)	• Stochiometric: 59 kg H_2/ton H_2O_2
	• Cyclohexane (C_6H_{12})	• Stochiometric: 71 kg H_2/ton cyclohexane
	• Hydrochloric acid (HCl)	• Stochiometric: 55 kg H_2/ton HCl
	• Caprolactam	• Depends on the production process, between 30-50 kg H_2/ton caprolactam
	• Phenol production*	• Depends on the production process, between 10-30 kg H_2/ton phenol
	• Acetone production* via hydrogenation of isopropyl alcohol	• Stochiometric: 34 kg H_2/ton acetone
	• 1,4-butanediol (BDO)	• Stochiometric: 23 kg H_2/ton BDO
	• Fine chemicals and pharmaceuticals as reducing agent	• Depends on processes and products

10 In refineries, hydrogen is required for hydrocracking and hydrotreating, but it is also generated, mainly during catalytic reformulation: 18 kg of hydrogen / ton of crude oil (Fuel Cells and Hydrogen Observatory, 2021).

* The most common production process for phenol and acetone is the cumene process. This process does not require hydrogen directly, but it can be required for refining acetone (removal of impurities).

Current uses	Main processes / products	Specific requirements
Iron and steel	• As reducing agent in direct reduced iron (DRI) • As reducing atmosphere in annealing process in steel roll mills	• Depends on iron ore quality: ~60 kg H_2/ton steel
Glass	• Glass melting as reducing agent to improve quality • Specialty glasses to control optical properties • Alternative fuel or furnaces to replace e.g. natural gas	• As reducing agent: 0.4 kg H_2/ton float glass
Electronics	• Chemical vapor deposition, mainly, e.g. for semiconductor manufacturing and LED production. • Reduction agent	• 45-90 kg H_2/ton semiconductor
Food industry	• Hydrogenation of oils (fats) and fatty acids	• Depends on oil/fat, required product and process: 5-100 kg H_2/ton unsaturated fat processed
Metal processing	• Pure or in a mixture as shielding gas for welding processes	• Depends on process

Source: Authors' own compilation, Fichtner (2025) based on (Bressan, L. et all, 2009), (Fuel Cells and Hydrogen Observatory, 2021), (Wasserstoff Kompass, 2022), (Semiconductor Digest, 2018)

TABLE 16. Key methanol uses

Application	Precursors
Fuel	As a fuel, either directly or blended with gasoline. Methanol fuel cells are a promising technology.
Solvent	As a solvent in various industrial processes, including paint thinners and adhesives.
Formaldehyde	Formaldehyde production, which is used in resins, plastics and textiles.
Acetic acid	Acetic acid production, which is used in the production of vinegar, plastics and synthetic fibres.
Methyl tertiary butyl ether (MTBE)	MTBE production, which is used as an oxygenate added to gasoline to reduce emissions.
Biodiesel	Used in the transesterification process to produce biodiesel from vegetable oils or animal fats as a substitute for conventional diesel.
Methanol-to-olefins (MTO)	Conversion into light olefins such as ethylene and propylene, for the production of plastics and synthetic fibres.
Methanol-to-gasoline (MTG)	Transformation into high-octane gasoline through a series of catalytic reactions.
Dimethyl ether (DME)	Dehydration to form DME, which can be used as a substitute for diesel.

Source: Authors' own compilation, Fichtner (2025)

Annex 2 Details on industrial clusters

Table 17 shows the main existing industrial clusters across the country, which have been selected focusing on identified current or potential hydrogen demand. In these clusters one or more of the following sectors have been identified: petroleum refining, fertiliser production, petrochemicals and palm oil processing. The table is ordered alphabetically and includes the location of the clusters, the main sectors, key products and main companies in each cluster.

TABLE 17. Main industrial clusters in Nigeria

Industrial cluster	Location	Main sectors	Key products/main companies
1 Agbara	Agbara, Ogun State	Consumer packaged goods, pharmaceuticals, plastics, fertiliser, cement, building materials	Beverages, pharmaceuticals, plastic products, packaged goods, fertilisers, cement, building materials Nestlé, PZ Cussons, Fidson, Unilever, Reckitt, Benckiser, Suntory, PharmaDeko, Beta Glass, Nigerian Breweries, OCP Fertilizer Bulk Blending Plant, Dangote Cement, Lafarge Africa Plc
2 Ajao Estate	Ajao Estate, Lagos State	Pharmaceuticals, consumer packaged goods, foods	Pharmaceuticals, foods, beverages, palm oil processing EMZOR, CHI, Devon King's Cooking Oil, Golden Oil Industries Ltd
3 Apapa	Apapa, Lagos State	Manufacturing, oil & gas, logistics	Refined petroleum, packaged foods, flour Flour Mills of Nigeria, NIPCO, MRS Oil Nigeria
4 Calabar Free Trade Zone	Calabar, Cross River State	Oil & gas, agro-processing, cement	Biodiesel, processed foods, refined petroleum, cement Dangote Flour Mills, Fynefield Petroleum FZE, Dozzy Oil and Gas, Lafarge cement
5 Kaduna	Kaduna, Kaduna State	Agro-processing, oil, cement	Automotive assembly, construction materials, cotton fabrics, beer, cement, fertiliser blending, oil refining Dangote Cement, Kaduna Fertilizer Company, OCP Fertilizer Bulk Blending Plant, Kaduna Refinery
6 Lagos Free Trade Zone (FTZ)	Lekki, Lagos State	Oil & gas, petrochemicals, manufacturing, logistics, fertilisers	Petrochemicals, ammonia, urea, plastics, construction materials, vegetable oil processing* Dangote Refinery and Dangote Fertiliser Plant, Petrolex, Peugeot, Stallion Group, Nestlé, Olam International, BASF, PZ Wilmar*, Golden Oil Industries*, Ruyat Oil Ltd*
7 Oguta	Oguta, Imo State	Oil & gas	Oil refining Addax Petroleum, Waltersmith Refinery

* Located in Lagos, outside Lagos FTZ

Industrial cluster	Location	Main sectors	Key products/main companies
8 Onne Oil & Gas Free Zone and Port Harcourt	Onne & Port Harcourt, Rivers State	Oil & gas, petrochemicals, manufacturing, fertilisers	Oilfield services, oil refining, petrochemicals, construction materials, equipment, ammonia, fertilisers Shell, Indorama Eleme Fertilizers & Chemicals, Notore Chemical Industries, New/Old Port Harcourt Refinery, Niger Delta Petroleum Resources (NDPR), Schlumberger, TotalEn-ergies, Shell, Indorama Element Fertilizers & Chemicals
9 Warri Industrial Hub	Warri, Delta State	Oil & gas, petrochemicals, glass	Oil refining, petrochemicals, glass products Warri Refinery, Chevron, Julius Berger, Warri Glassworks

Source: Authors' own compilation, Fichtner (2025)

Annex 3 Techno-economic calculations

Parameter	Value
Equity cost (%)	17
Debt interest rate (%)	13
Debt tenor (years)	10
Debt-to-Equity ratio (%/%)	35/65
Project lifetime (years)	25
Electricity price (Feed in tariff) (USD/kWh)	0.16
Water cost (USD/metric tons)	2.15
Grey hydrogen benchmark price (USD/kg)	4.30
Oxygen selling price (USD/kg)	0.16
Ammonia price (USD/kg)	0.75
Corporate tax rate (%)	30

Source: Analyses performed by GIZ (2025)

Annex 4 Funding mechanisms

German instruments for investment in the international market

- **H2 Global** (H2Global Stiftung, 2025): A reverse auction-based mechanism to support green hydrogen market development, offering 10-year purchase agreements. No project size or investment limitations; non-EU hydrogen producers can participate, meeting EU sustainability standards.
- **PtX Development Fund** (KfW, 2025): Set up by the German Government and KfW Group. Provides non-reimbursable grants for large-scale projects in emerging economies, with no specific investment thresholds. Eligible countries include Brazil, Colombia, Egypt, India, Kenya, Morocco and South Africa (PtX Development Fund, 2025). As of now, Nigeria is not listed among the eligible countries. However, eligibility criteria and target countries may evolve in future funding rounds.
- **International Hydrogen Ramp-up Programme** (H2Upp) (BMWK, 2025) Supports early-stage public-private partnerships for pilot projects, with a minimum public contribution of EUR 100,000 and total project costs of at least EUR 200,000. Companies must contribute at least 50%. Applications are currently open until March 2025 (PtX Hub, 2025), though the overall programme is expected to continue until 2026 (BMWK, 2024).
- **UFK Untied Loan Guarantees** (UFK-Garantien.de, 2025): Provides loan guarantees to reduce political and economic risks in target countries. Green hydrogen projects may be eligible if they align with Germany's energy strategy.

European instruments for investment in the international market

- **Green Hydrogen Trust Fund (GHF)** (European Investment Bank, 2025): The European Investment Bank (EIB) established this fund to support large-scale green hydrogen infrastructure projects with substantial (million-US dollar) investments, requiring a 30-40% contribution from applicants. Nigeria may be eligible based on specific criteria.
- **Clean Hydrogen Partnership** (European Union, 2025) (CHP) primarily supports the development and commercialisation of clean hydrogen technologies. No fixed limitations on project size or investment, but large, impactful projects are prioritised. Third countries may participate through specific agreements.
- **GET.Invest Nigeria** (GET.invest, 2025): established in October 2024. Supports sustainable energy projects, including green hydrogen, offering advisory services, financing facilitation and capacity-building for Nigerian projects.

Multilateral instruments

- **African Development Bank** (Sustainable Energy Fund for Africa, 2025): SEFA provides grants and concessional finance for renewable energy projects, including green hydrogen, in Africa. Nigeria could benefit from SEFA to develop hydrogen infrastructure.
- **MIGA (Multilateral Investment Guarantee Agency)** (MIGA, 2025) Offers political risk insurance and credit guarantees for hydrogen investments in developing countries, with a focus on projects with significant development impact. There is no strict minimum investment amount, but larger projects, especially those aligned with national development priorities, are likely to be prioritised.
- **Global Environment Facility (GEF)** (Green Climate Fund, 2025): Provides grants and concessional loans for renewable energy projects, including green hydrogen, to achieve decarbonisation and environmental goals.
- **World Bank loans:** The World Bank promotes the implementation of renewable energies incl. hydrogen through different programmes and initiatives. In 2023, for example, the bank announced that it had approved USD 1.6 billion in funding for renewable hydrogen loans in that year (World Bank, 2023). The World Bank had invested over USD 2 billion in the Nigerian power sector over the last five years.

Private finance

- **Hydrogen One Capital** (HydrogenOne, 2025): A private venture fund specialising in direct or indirect investments in hydrogen infrastructure and technology.
- **Breakthrough Energy Ventures** (Breakthrough Energy, 2022): Through different programmes, Breakthrough Energy supports cutting-edge research and development by investing in companies with clean products to accelerate the clean energy transition.
- **Green Bonds:** These bonds are fixed-income financial instruments designed to fund sustainable projects such as renewable energies or clean transportation. There are different standards that can be applied, two of the most commonly used being the Green Bond Principles issued by the International Capital Market Association (ICMA, 2025) or the Climate Bond Standards (Climate Bonds, 2025).

These mechanisms provide diverse funding options tailored to different stages of hydrogen project development, ensuring both public and private contributions to the sector's growth.

Annex 5 Key Nigerian stakeholders for hydrogen development

Institution	Role related to hydrogen
PUBLIC	
Office of the Vice President (OVP) / Energy Transition Office (ETO)	Oversees the coordination of Nigeria's energy development and transition plans, ensuring alignment with national climate and energy goals, including green hydrogen integration.
Ministry of Petroleum Resources (MPR)	Formulates and implements policies for the oil and gas sector, including regulations for the development and transition to cleaner energy, such as hydrogen.
Federal Ministry of Finance, Budget and National Planning (FMFBNP)	Provides funding for infrastructure development, including electricity and gas, and facilitates financial incentives for green hydrogen projects.
Energy Commission of Nigeria (ECN)	Develops and coordinates national energy policies, including strategic planning for integrating green hydrogen into Nigeria's energy mix.
Federal Ministry of Water Resources (FMWR)	Oversees water licensing and permits, essential for hydrogen production through electrolysis, which requires significant water resources.
Federal Ministry of Environment (FMEnv)	Coordinates the implementation of Nigeria's Energy Transition Plan (ETP), develops policies for renewable energy, and regulates environmental and social impact assessments (ESIA) for hydrogen projects.
National Council on Climate Change (NCCC)	Develops climate change policies and coordinates efforts related to climate goals, including hydrogen-related initiatives as part of the Energy Transition Plan and Emissions Trading Scheme.
Nigerian Electricity Regulatory Commission (NERC)	Regulates electricity generation, transmission, distribution, and sales, and oversees the development of regulations for integrating green hydrogen into the power sector.
Nigerian Upstream Petroleum Regulatory Commission (NUPRC)	Regulates oil and gas production, including technical, operational, and commercial activities, which may intersect with hydrogen production from natural gas (e.g. blue hydrogen).

Institution	Role related to hydrogen
Standard Organisation of Nigeria (SON)	Sets and enforces standards for the quality of hydrogen products, equipment and infrastructure to ensure safety, compliance and market acceptance.
Nigerian Electricity Management Services Agency (NEMSA)	Ensures compliance with NERC's technical standards, inspecting electricity infrastructure that may be used for hydrogen production and distribution systems.
Nigerian Export Promotion Council (NEPC)	Promotes and develops export opportunities, including green hydrogen and hydrogen derivatives, to international markets.
Nigerian Investment Promotion Commission (NIPC)	Assists companies in obtaining necessary registrations and licences, fostering investment opportunities for hydrogen and other renewable energy sectors.
Federal Ministry of Industry, Trade, and Investment (FMITI)	Develops industrial policies and incentives for renewable energy technologies, including green hydrogen production, and supports the commercialisation of hydrogen technologies.
Federal Ministry of Science, Technology and Innovation (FMSTI)	Leads research and development (R&D) in all energy sectors, including hydrogen, and integrates hydrogen technologies into educational and training programmes.
Federal Ministry of Power (FMP)	Coordinates policies and strategies for Nigeria's power supply, including the necessary transmission infrastructure for renewable energy-powered hydrogen production.
NGO	
Nigerian Environmental Study/Action Team (NEST)	Advocacy for environmental sustainability, including renewable energy solutions and policy recommendations on climate change and energy transition.

Institution	Role related to hydrogen
Clean Technology Hub (CTH)	Promotes clean technologies, including hydrogen, through advocacy, research and collaboration with industry stakeholders.
PRIVATE	
Nigerian Gas Association (NGA)	Represents stakeholders in the Nigerian gas sector, including natural gas companies. It could play a key role in integrating green hydrogen into Nigeria's energy transition.
Renewable Energy Association of Nigerian (REAN)	Focuses on the promotion of renewable energy, including hydrogen, supporting both policy development and implementation.
Lagos Chamber of Commerce and Industry (LCCI)	Acts as a hub for businesses in Nigeria, promoting sustainable and green energy solutions. It could facilitate partnerships for the development and scaling up of green hydrogen projects.
University of Lagos (UNILAG)	Conducts research into energy transition technologies, including renewable energy and hydrogen production. The university can provide scientific and technological expertise, fostering innovation in green hydrogen production.
Ahmadu Bello University (ABU)	Engages in energy research and renewable energy technology development, including hydrogen. It could play a role in developing local expertise and solutions for green hydrogen production.
Nigerian Institute of Science and Technology (NIST)	A key player in research and development related to energy technology, it can support innovation in hydrogen production, storage and utilisation.

Source: Author's own compilation, Fichtner (2025)

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As a federally owned enterprise, GIZ supports the German Government in achieving its objectives in the field of international cooperation for sustainable development.

Published by
Deutsche Gesellschaft für
Internationale Zusammenarbeit (GIZ) GmbH

Registered offices
Bonn and Eschborn, Germany

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Design/Layout
DITHO Design GmbH, Cologne

On behalf of
German Energy Solutions Initiative of the
German Federal Ministry for Economic Affairs and
Energy (BMWE), Berlin
Department VB4 German Energy Solutions Initiative, Market Entry
Programme Berlin

Berlin, 2025

Deutsche Gesellschaft für
Internationale Zusammenarbeit (GIZ) GmbH

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