Gas for Africa

ASSESSING THE POTENTIAL FOR ENERGISING AFRICA

IGU
INTERNATIONAL GAS UNION
UNION INTERNATIONALE DU GAZ

Hawilti

Endorsed by

AFREC
AFRICAN UNION ENERGY
African Energy Commission
Commission Africaine de l'Energie

Africa Finance Corporation

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The report is based on market research, publicly available data, and research interviews conducted by Hawilti Ltd. with various public- and private-sector executives across Africa. It engaged the African Union's African Energy Commission (AFREC) and the Africa Finance Corporation (AFC), which have provided critical insights and endorsed the report's key findings and conclusions.

We received valuable inputs from numerous experts whose contributions and review helped to develop and shape this report, including:

- Rashid Ali Abdallah, Executive Director, African Energy Commission (AU-AFREC);
- Taiwo Okwor, Vice President Natural Resources, Africa Finance Corporation (AFC);
- Halima Abba, Associate Vice President, Africa Finance Corporation (AFC);
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- Jean Craven, CEO, Barak Fund Management;
- Karim Shaaban, Managing Director, Rosetta Energy;
- Audrey Joe-Ezigbo, Co-Founder & Deputy Managing Director, Falcon Corporation;
- Sumeet Singh, CEO, Powergas Nigeria;
- Jamal Akinade, Founder & CEO, Bridport Energy;
- Hassana Mbeirick, CEO, Meen & Meen.

Welcome

We are delighted to welcome you to this important report, produced jointly by the International Gas Union with Hawilti Ltd.

Africa is home to every fifth human on the planet; it has the youngest and fastest growing population with the lowest energy access level in the world. It also has close to one tenth of the world's proven natural gas reserves.

Gas can play a major role in delivering a secure and sustainable energy future for Africa and can enable a just energy transition, which starts with energy access. Access to modern energy in Africa is imperative for its development, its ability to respond to climate change, and for gradually decarbonising its economies. Gas is one of the keys to unlocking this access, and it is also a key source of flexibility and reserve energy needed for integrating large amounts of variable renewables. Using its gas resources together with renewable energy technologies, Africa can build energy systems compatible with a climate- or carbon-neutral future and underpin the continent's sustainable economic development.

Most of the gas developed in Africa to date has been exported. While several African countries with the most advanced energy networks have been successfully using natural gas to produce electricity and serve other key energy needs, most Africans still have no way to access Africa's gas. The lack of delivery, storage, and access infrastructure, together with small, remote, and often rural demand centres without established energy markets, form a set of complex challenges for gasification. However, as complex as the challenges are, there are achievable solutions, many of which have been demonstrated successful local examples, some of which are explored in this report.

It is also imperative that Africa's gas industry is future-ready, which means minimising or eliminating value chain emissions of natural gas and applying infrastructure designs today which are ready for decarbonisation in the future. There are clear opportunities to future-proof new projects and maximise the sustainability value of existing natural gas projects, including actions to eliminate flaring and methane emissions.

Finally, for gas opportunities to be realised, domestic cooperation and local leadership will be critical, and we are most grateful for the invaluable endorsements of this report's findings by the African Union's African Energy Commission and the Africa Finance Corporation. The analysis presented in the subsequent sections assesses key drivers, potential, barriers, and solutions for developing natural gas value chains in Africa. We hope that readers will find it valuable and that this report will play an important role in enriching the understanding of the scale of domestic and global opportunity for Africa's gas and future gas markets.

Li Yalan
President
International Gas Union

Amel Grabsi
Partner & Head of West Africa
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Foreword

Role of Natural Gas in Africa's Just Energy Transition

The African Union attaches great importance to the implementation of ambitious energy goals designed to build resilient energy infrastructure on the continent. The 41st Ordinary Session of the Executive Council adopted the African Common Position on Energy Access and Just Energy Transition, on the 15th of July 2022, a comprehensive approach that charts Africa's short-, medium-, and long-term energy development pathways to accelerate universal energy access and transition without compromising its development imperatives.

Therefore, the African Common Position encourages striking a balance between ensuring access to electricity to catalysing much-needed socio-economic growth in Africa and smoothly transitioning towards an energy system based on renewable and clean energy sources matching the ambitions of Agenda 2063. This is in recognition that access to energy currently stands low in Africa compared to other regions, with almost 600 million Africans living without electricity services while almost 1 billion lack access to clean cooking facilities. Natural gas is a resource that has a significant role to play in bringing about socio-economic development and mitigating climate change through its ability to reduce greenhouse gas emissions when substituting coal, oil and biomass.

Proven natural gas reserves in Africa are estimated to be at least 18 Tcm, about 8.8% of the world's total. They are considerable in Northern (45%) and Western (32%) Africa especially, and commercial quantities of natural gas have been found in many African countries[1]. The huge reserves of gas can play a significant role in energy transition for the fact that natural gas has much less carbon footprint than oil and coal. Natural gas can be used as an energy source to assist certain regions and countries with power generation, transport, and cooking. Sub-Saharan Africa should be prioritised, accounting for three-quarters of the global energy access deficit. Several countries, including Mozambique, Tanzania, Mauritania, and Senegal, are actively marketing the use of natural gas to capitalise on recent discoveries. Gas is therefore an ideal baseload fuel that complements the rapid uptake of renewables. Thus, as part of a just transition, Africa requires gas. When non-African advocates call for an immediate end to all fossil fuel utilisation and global capital investors stop funding gas projects, developing countries in Africa will suffer economically and socially.

Africa's wealth of gas resources provides the economic foundations for the sustainable development of many African countries, while the discovery and development of new natural gas fields continue to provide economic leverage through trade and investment. It is therefore essential to foster intra-African trade relationships and build infrastructure to facilitate trade on Africa's natural gas market. Through regional integration, African countries have the opportunity to exploit regional value chains and expand their markets, which would otherwise be small and fragmented. In turn, regional value chains are important anchors for industrialisation and broader economic transformation. The expansion of continental and regional gas markets in Africa will offer stakeholders with broad actions for consideration within the framework of the AfCFTA as a key vehicle to facilitate Africa's energy integration and cross-border trading.

Rashid Ali Abdallah
Executive Director
African Energy Commission (AU-AFREC)

[1] *Africa and Just Energy Transition, Considerations for the expansion of Africa Oil and Gas Domestic Market, AFREC, 2022*

Foreword

It gives me great pleasure to welcome this timely study on the state of gas in Africa. For far too long Africa has suffered from widespread energy poverty in the midst of abundant natural gas reserves and correcting this incongruity must become mission critical if the continent is to meet its development aspirations.

The global energy market is in an unprecedented state of flux. Conflict in Ukraine is driving a desperate search to diversify sources of gas supplies to Europe, opening significant opportunities for exploration and logistics in Africa. At the same time, gas is key to helping Africa overcome its crippling energy deficit, as well as play its part in the global energy transition. At the Africa Finance Corporation, we hold the view that gas is critical not only to Africa's energy security, but also holds the key to a pragmatic and just energy transition. Only gas has the potential to end Africa's energy deficit quickly and affordably – lifting hundreds of millions out of poverty while generating needed export revenue for re-investment in renewable solutions.

In the transition towards wind, solar and hydro, gas is by far the next cleanest alternative. In fact, if the continent were to use an additional 90 bcm/y by 2030, or 50% more than it does today, the resulting emissions would only raise Africa's cumulative contribution to global CO2 emissions to 3.5%, according to the International Energy Agency (IEA). Crucially, harnessing Africa's natural gas could provide the baseload power needed to boost Africa's capacity to process its raw materials locally, rather than the continent's current practice of shipping them halfway across the world at a great cost to the climate. At the same time, Africa's biggest contribution to global net zero could derive from arresting the pace of deforestation. How do we achieve this? By offering the roughly 63% of African households that rely on woodfuel for cooking, a cleaner cooking alternative.

It is for these reasons that AFC works to develop the infrastructure instrumental to producing gas and connect multiple countries through new and expanded corridors, assisted with time by the African Continental Free Trade Area agreement. A case in point is Senegal. The West African nation is heavily reliant on expensive fuel oil imports for generation of electricity, with 83% of its energy generated from HFO. With our partners and the Government of Senegal, we are building a 300-MW gas-fired plant that will will increase the generation capacity of the country by a third. Senegal's economy is poised for 8% economic growth this year and 10.5% in 2024, according to the World Bank, due in no small part to gas import substitution and the export of gas.

As Africa develops, it is essential that we utilise our resources to their fullest potential. This report is a valuable tool in understanding the opportunities that abundant reserves offer for Africa's future. It should catalyse discussion and action. The world is waiting.

Samaila Zubairu
President & CEO
Africa Finance Corporation

Contents

Executive Summary

This report assesses key drivers, potential, barriers, and solutions of developing natural gas value chains in Africa to fight energy poverty and enable a just energy transition. In doing so, it looks at how gas can play a major role in delivering a secure and sustainable energy future for the continent – economically, socially, and environmentally.

Picture: Savannah Energy

Despite holding over 8% of the world's proven reserves of natural gas, Africa remains the most energy-poor continent. Industries rely on expensive, inefficient, and polluting sources of energy, and hundreds of millions of households lack modern energy access. Instead of helping to meet growing domestic energy needs, the development of Africa's abundant domestic gas resources has remained reserved mostly for the export market. While African gas has been fueling economies and supporting decarbonisation and jobs abroad, most of the African continent has no access to infrastructure to benefit from its resources. Domestic gas markets remain under-developed or non-existent, especially south of the Sahara.

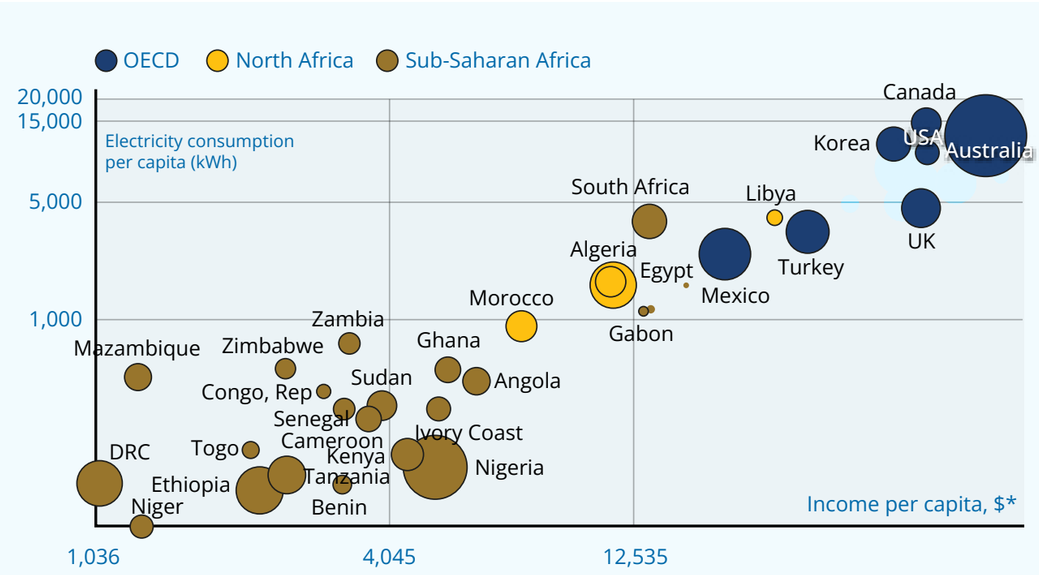
Picture: Globeleq

Africa's energy poverty is rising and directly impacts the continent's development potential and response to climate change.

This report first looks at the current reality of energy access in Africa, which remains largely insufficient to support the continent's growing economies and populations. In light of Africa's rapid population growth and post COVID-19 economic downturn, we find that efforts to increase energy access are slowing down. Almost 600 million Africans do not have access to electricity, and almost 1 billion currently lack access to clean cooking.

Given the lack of energy access and low industrialisation levels, Africa has the lowest primary energy consumption per capita in the world, estimated at 14.6 gigajoules (Gj) – or five times less than

Figure 1: Understanding energy poverty



There is a direct correlation between income and energy consumption. High-income countries are all high-energy, while low-income countries are all low-energy. The threshold of 1,000 kWh of electricity consumption/capita marks the Modern Energy Minimum set by the Energy for Growth Hub.

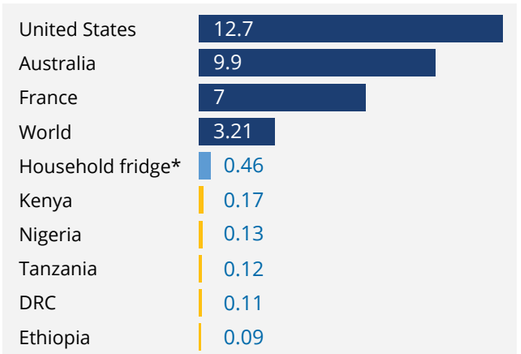
* Lower middle-income economies are those with a GNI per capita between $1,036 and $4,045; followed by upper middle-income economies with a GNI per capita between $4,046 and $12,535; and high-income economies with a GNI per capita above $12,535.

Source: IMF, World Bank

the world average (75.6 Gj), seven times less than China (109.1 Gj), 16 times less than Belgium (235.8 Gj), and almost 20 times less than the US (279.9 Gj)[2].

Electricity consumption is also very low, averaging 534.6 kWh/capita on the continent in 2020, against a global average of 3,210 kWh[3]. Most people in sub-Saharan Africa have an electricity consumption that is below that of an average US fridge[4].

Figure 2: Low energy
Electricity consumption, MWh/capita (2020)



** US average*

Source: IEA, Energy for Growth Hub

Energy poverty is preventing the industrial and commercial development of Africa and making the development of competitive and modern economies, as well as implementing climate change mitigation measures, impossible.

Natural gas has become a critical component of Africa's quest for modern, affordable, and reliable energy.

Africa wants to leverage its proven reserves of natural gas – some 18 tcm, or 8.8% of the world's total discovered reserves[5] – to meet its vast and growing energy needs. Adopting gas has become increasingly relevant, considering sustained constraints on hydropower capacity due to droughts, and the declining use of heavy fuel oil HFO/diesel because of their heavy pollutant emissions. In its quest for greater gas adoption, the continent seeks to reorient gas towards domestic markets and find the appropriate balance between lucrative export revenues and pressing needs for local development. By adopting gas locally, Africa can notably achieve the following:

a) Promote gas-based industrialisation to create jobs, expand supply-chains with the production of fertilizer and petrochemicals, and diversify economies with the growth of energy-intensive industries such as cement, steel, and desalination among others.

b) Generate baseload electricity in countries with no alternatives like hydropower or geothermal, and ultimately strengthen national and regional power systems to enable the integration of increasingly affordable renewable energies (wind, solar).

c) Provide cleaner and more affordable energy to households and industries by displacing wood, biomass, charcoal, and diesel.

d) Switch coal and diesel-fired power plants to gas to begin decarbonising the electricity mix.

e) Develop receiving and processing infrastructure that can monetise associated gas, thereby eliminating routine flaring while making additional energy available for homes and industries.

f) Build gas systems that are decarbonisable with the use of renewable gas, hydrogen, and carbon capture technologies, and can therefore provide energy today while anchoring the continent's future low-carbon power systems.

Successful African case studies demonstrate that while the challenges are complex, local solutions for achieving gasification and emissions reductions can be developed. These cases include the successful monetisation of domestic gas use in Tanzania, growth of LNG exports in Nigeria, and flare reduction initiatives in Angola, Nigeria, and Cameroon.

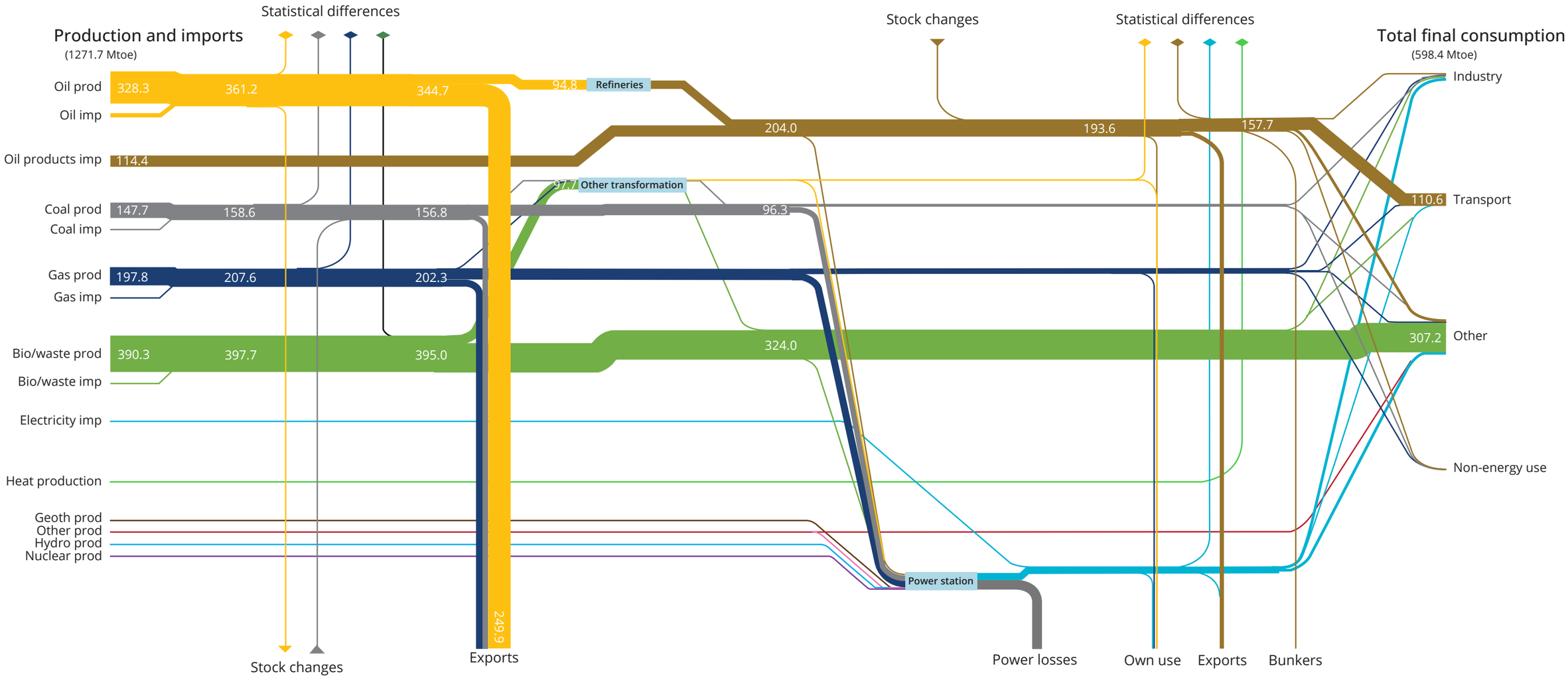
View of the Coral Sul FLNG
Picture:Eni

[2] *bp Statistical Review of World Energy, 2022*
[3] *International Energy Agency (IEA)*
[4] *"Africa will remain poor unless it uses more energy", 3 November 2022, The Economist*
[5] *Annual Statistical Bulletin 2022, Organisation of Petroleum Exporting Countries (OPEC)*

Executive Summary

Figure 3: Africa's energy balance 2020 in millions of tonnes of oil equivalent

The International Energy Agency's Sankey diagram on Africa's energy balance reveals that most of Africa's final consumption in energy is biomass and imports, while two-thirds of its oil and much of its gas are exported. The scale of fuel in power losses is another striking detail revealed by the diagram.



Source: IEA

Gas is a solution to building resilient and sustainable energy systems that can help Africa decarbonise in the short and long term.

We give a brief overview of Africa's current energy mix, dominated by highly emitting and polluting traditional sources, such as biomass, wood, and charcoal with negative impacts on public health and the environment.

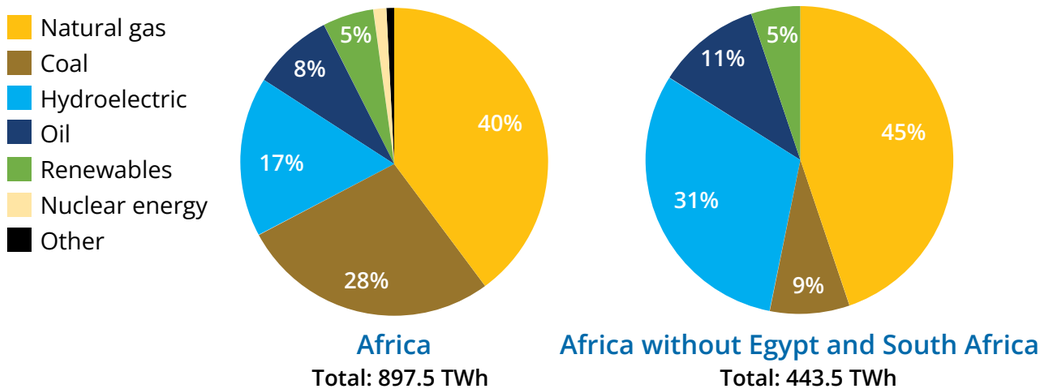
We particularly look at the electricity mix, which is dominated by coal, oil, and natural gas. The shares of coal and natural gas are the most important but vary heavily from country to country. Most coal-fired electricity is located in South Africa while gas-fired electricity is produced largely in Egypt and Algeria.

On the other side, Sub-Saharan Africa relies heavily on oil to support its decentralised power generation industry, which consists of sparse captive power plants and diesel generators, with distributed diesel capacity alone estimated to be anywhere between 45GW[5] and 100 GW[6].

Natural gas provides an immediate emissions reductions benefit when it replaces coal or oil fuel, both in greenhouse gases and especially in air pollutants. For this reason, several African countries, including Ghana, South Africa, and Senegal, are planning to switch to gas to lower their emissions and improve air quality.

Gas adoption also comes with a big affordability benefit as gas is often a lot cheaper in power, industry, and transport

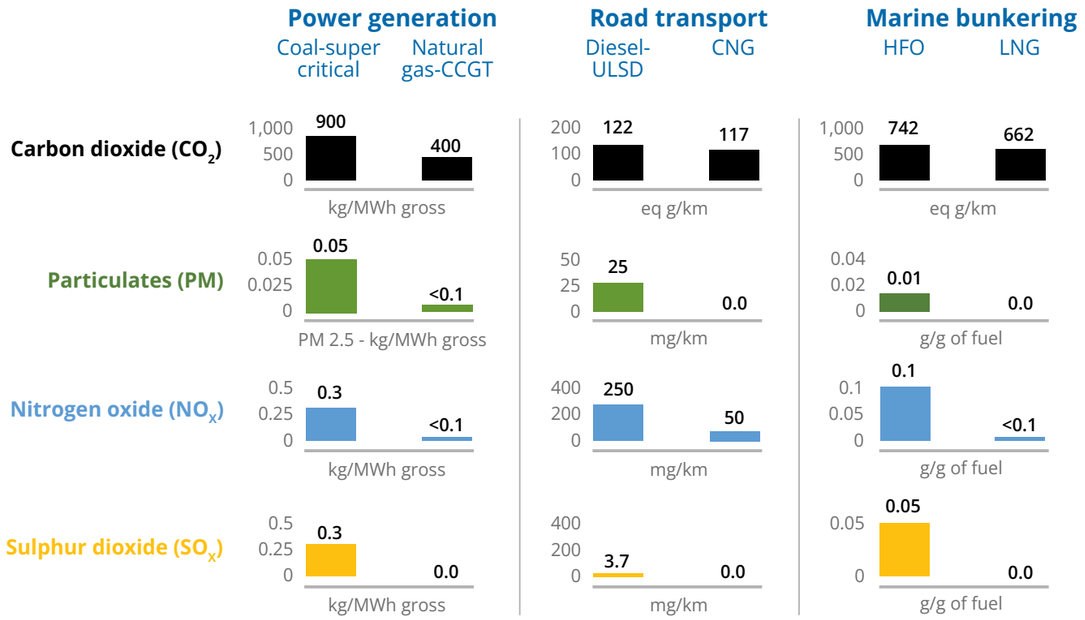
Figure 4: Africa's electricity mix (2021)



Source: bp Statistical Review of World Energy, 2022

[5] *Africa Energy Outlook 2022, IEA*
[6] *"Utility evolution in Africa to reshape global electricity demand", 17 March 2022, Wood Mackenzie*

Figure 5: Emissions factors for natural gas vs. coal and oil



Source: NETL, EEA, OIES, BCG analysis

than imported diesel. This has been demonstrated in Nigeria for instance where between 2020 and 2022, CNG was between two to four times cheaper than diesel.

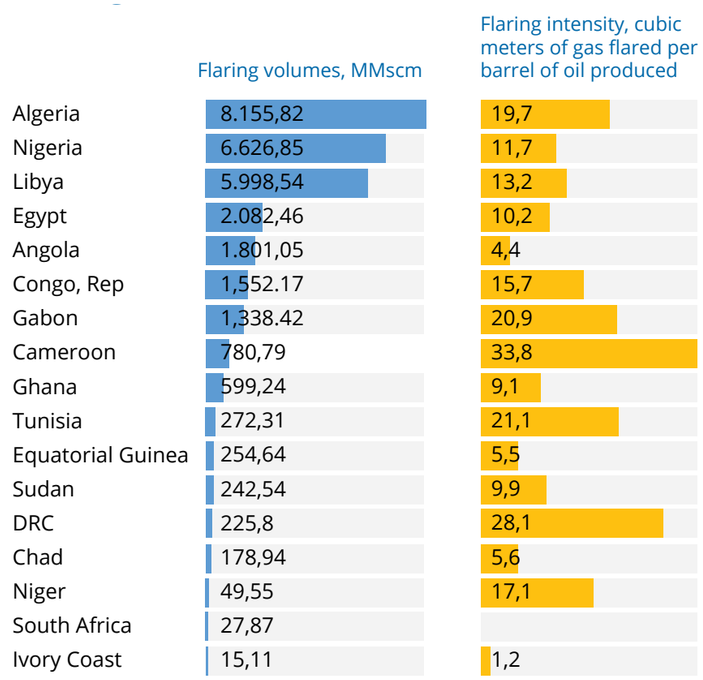
Developing gas infrastructure and markets in Africa should also go hand in hand with further decarbonisation of the fuel supply in the medium and long-term. This includes supporting the integration of variable renewable generation, and planning for carbon capture, renewable gases, and hydrogen integration.

The report also looks at the potential of a broader penetration of gas across industry and transport by using CNG, LNG, and LPG.

Picture: Eni

In terms of the green house gas (GHG) emissions impact in the short to medium-term, adoption of natural gas in Africa will have a very muted impact on global emissions, given its minis-cule starting point. The IEA estimates that using an additional 90 Bcm per year of African gas by 2030 for the fertilizer, steel, cement, and water desalination industries would generate cumulative CO2 emissions of 10 Gt[7]. This would take Africa's share of global emissions from only 3% today to 3.5% by 2050

Figure 6: Flaring in Africa (2021)



Source: Global Flaring Reduction Partnership (GFRP), World Bank

Sustainability improvements will be vital for the gas value chain in Africa to ensure its global competitiveness.

It will be vital for the future of Africa's gas industry to ensure state-of-the-art management of the gas supply chain, necessary to progressively minimise GHG emissions, including methane. This will have a major impact not just on the industry's environmental footprint, but also very prominently on the attractiveness of the African gas sector for investments.

Methane emissions management and flaring reduction projects can contribute to emissions reduction in the short-term, while making Africa's resource base more competitive and providing more energy to growing African economies.

The Methane Guiding Principles provide a valuable reference for implementing good industry practices for methane management in Africa[8].

Flaring reduction is another critically important element for Africa's gas future.

[7] *Africa Energy Outlook 2022, IEA*
[8] *https://methaneguidingprinciples.org*

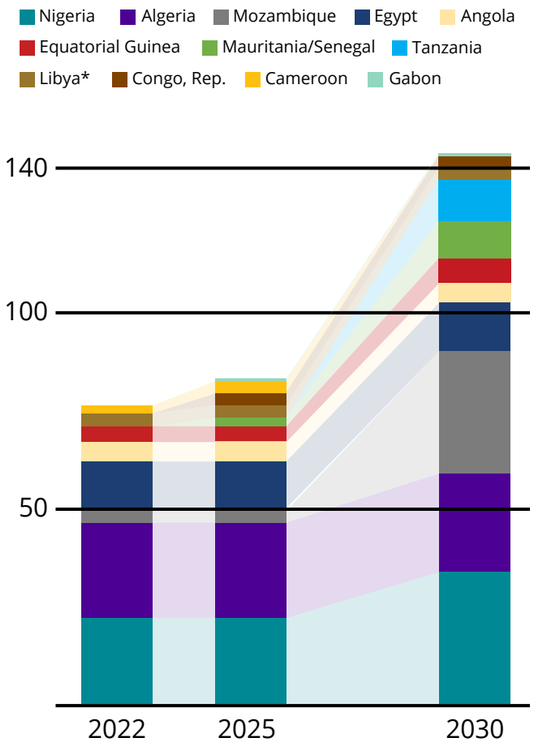
Africa has had some degree of success in cutting flaring; however, the results have stagnated. Case studies in Angola, Nigeria, and the Gulf of Guinea offer some lessons to be applied by regulators and operators to successfully capture and use their associated gas. They demonstrate that while penalty mechanisms have proven useful, they fall short of offering solutions for small and scattered flare sites where gas is in low-pressure and low volumes.

Africa can better use its export industry to develop local markets, while further contributing to fuelling the global energy transition and enhancing energy security.

The overall growth trend of global LNG demand over the past decade has enabled African countries to monetise gas in lucrative export markets and gave birth to several LNG export terminals on the continent. Still, Africa's export capacity has remained relatively small compared to its potential. With the current market fundamentals signaling the strong need for investments in new LNG supply, the continent has a new window of opportunity to position itself as a strategic and reliable global gas supply hub. However, this window is not exclusive to Africa, nor will it stay open forever.

By 2025, Africa's LNG export capacity will already have increased from 77.6 mtpa today to 83 mtpa with new countries joining the club of African gas exporters, such as Senegal, Mauritania, or Congo. Much more potential exists based on projects currently being proposed, with a total proposed project pipeline totalling over 55 mtpa.

Figure 7: African LNG export capacity, mtpa (2022-2030)



Best-case scenario projections based on approved and pre-FID projects.
* Libyan capacity is unoperational

Source: IGU, Hawiliti Research

To realise this vast potential and benefit from lucrative sector investments, a pragmatic approach, a sense of urgency, and a focus on competitiveness to attract the billions of dollars that will be injected into LNG projects this decade.

Equally important, the further development of export projects needs to translate into better value for local economies. The report considers the opportunity to use export infrastructure to anchor domestic gas projects (Mozambique, Mauritania, Senegal, Morocco, Nigeria) and the role of LNG export terminals in boosting domestic supplies of gas liquids.

To maximise its gas potential and foster sustainable economic development, African stakeholders should seek to address several barriers.

First, financing capital-intensive energy projects in Africa faces two major challenges: African states' growing debt burden and global asset managers' divestment from all hydrocarbons. Securing capital for gas ventures is as ever more challenging, as it is ever more needed, and it calls for (1) futureproofing projects to reassure global investors of sustainability and climate value, and (2) unlocking additional sources of capital, especially domestically.

The second barrier is the lack of infrastructure for the processing, storage, and distribution of natural gas. Investing in African gas infrastructure remains perceived as risky and uneconomical, especially considering small and scattered demand centers in Sub-Saharan Africa. To grow gas penetration, this report suggests exploring several avenues, notably including developing industrial clusters, reforming electricity markets, promoting regionalisation, and encouraging the adoption of small-scale technologies.

Finally, there is a pressing challenge to develop an enabling environment and decrease risks associated with investing in Africa. Policy certainty and physical security are imperative in Africa to provide a positive environment and grow gas value chains.

In light of the long-term global demand uncertainties and the intensifying competition within the broader energy transition, it is important to address these barriers with a sense of urgency, before Africa's window of opportunity begins to close.

Picture: Sahara Group

Figure 8: Key principles to supercharge the development of Africa's gas markets

For full details on our 8 guiding principles, please refer to Section 4.

1. Futureproof by Design	Alignment of future gas development plans with the just energy transition; guarantees of environmental sustainability and compatibility with the goals of the Paris Agreement.
2. Financial Innovation	Look inward and promote domestic financing mechanisms that can tap into vast pools of institutional money, especially for domestic projects.
3. Good Business Climate	Safe and stable investment climate will be pivotal to ensuring that the continent is globally competitive.
4. Regionalisation	Sub-regional and regional gas and energy networks can support economies of scale and infrastructure investments.
5. Cluster and Ecosystem Investing	Industrialisation plans can focus on creating manufacturing clusters located next to gas fields to benefit from a cheap source of electricity and energy.
6. Gradual Scaling	Small-scale projects have proven as a winning strategy to pre-develop gas markets and unlock suppressed demand.
7. Build Electricity Markets	Reforms are needed to restructure electricity markets and increase liquidity, while improving operational efficiencies.
8. Price Emissions	Externalising the cost of emissions is an effective way to invest in emission reductions projects and incentivise switching from coal and oil to natural gas.

1 / Africa's Energy Context

An energy-poor continent where access to energy is the lowest in the world, expensive, and polluting

Despite holding over 8% of the world's proven reserves of natural gas, Africa remains the most energy-poor continent. Industries rely on expensive, inefficient, and polluting sources of energy, and hundreds of millions of households lack modern energy access. Instead of helping to meet growing domestic energy needs, the development of Africa's abundant domestic gas resources has remained reserved in large part for the export market. While African gas has been fueling economies and supporting decarbonisation and jobs abroad, most of the African continent has no access to infrastructure to benefit from its resources. Domestic gas markets remain under-developed or non-existent, especially south of the Sahara.

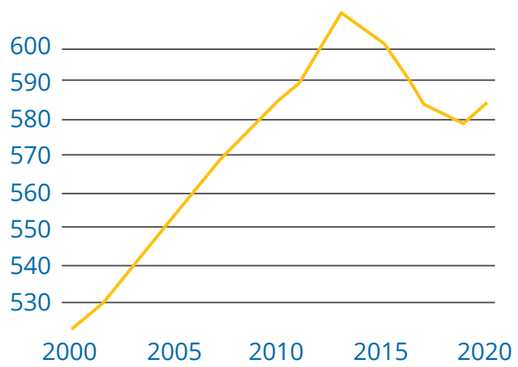
1.1 Coming to terms with the reality of energy poverty

Africa has the lowest primary energy consumption per capita in the world and the lowest share of the world's greenhouse gas emissions by population.

As a result of continuous population growth and recent setbacks in infrastructure, the number of Africans without access to electricity is back on the rise, reaching almost 600 million in 2020[9]. With a current population of some 1.4 billion people, Africa has the lowest primary energy consumption per capita in the world, estimated at 14.6 gigajoules[10]. This is 10 times less than Europe (122 gigajoules), and four times lower than other developing countries in Latin America or Asia.

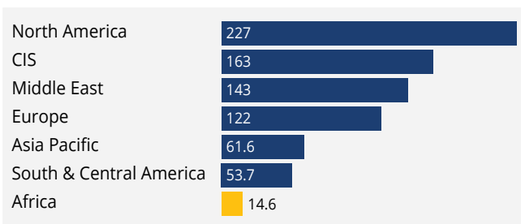
Limited access to reliable and affordable energy continues to hamper Africa's development and keeps industrialisation rates low. Most of the continent's commodities are still

Figure 9: African populations without access to electricity, millions (2000-2020)



Source: IEA SDG 7 database

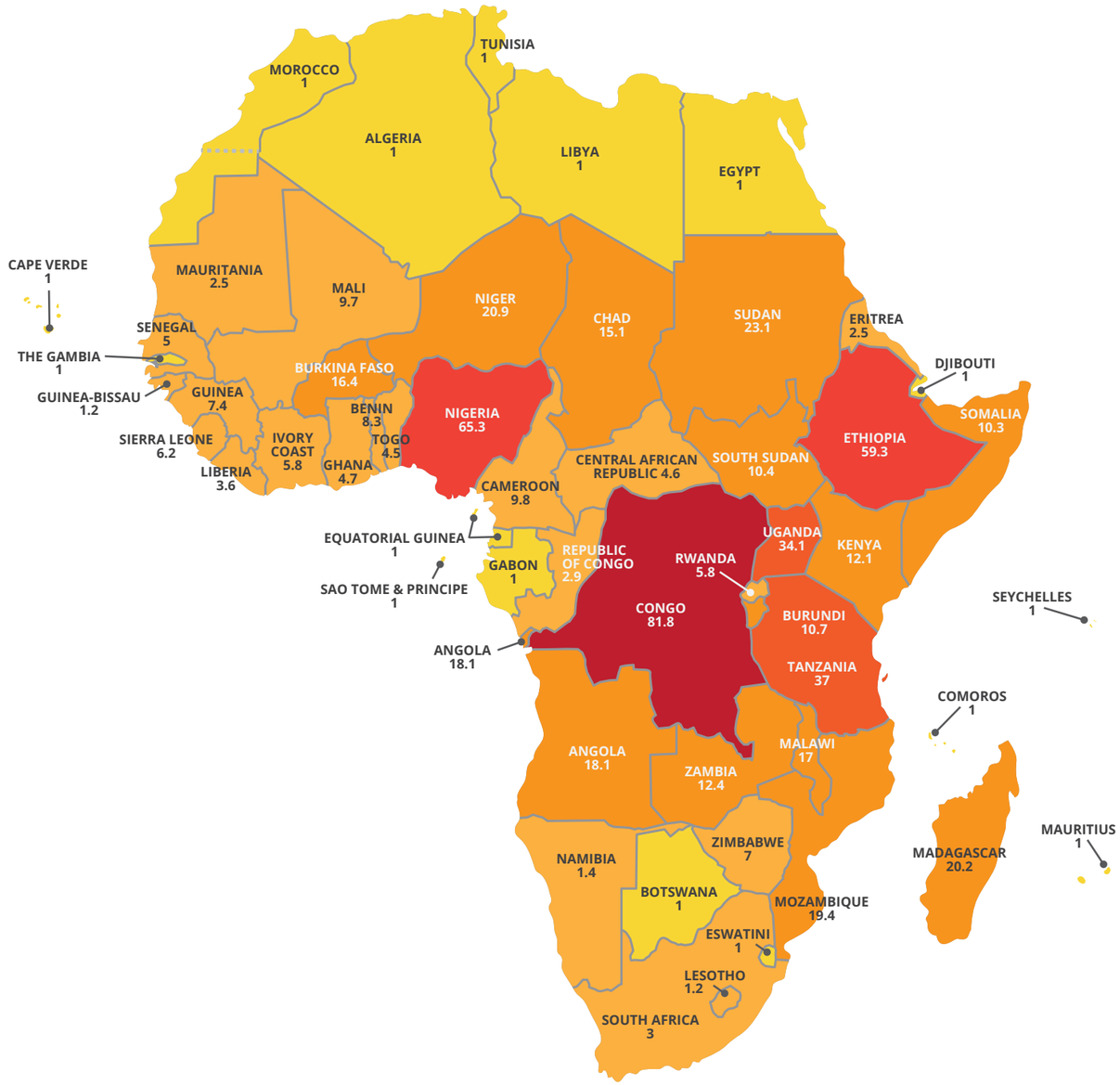
Figure 10: World's primary energy consumption per region, gigajoules per capita (2021)



Source: bp Statistical Review of World Energy 2022

[9] *IEA SDG 7 database - https://www.iea.org/data-and-statistics/data-products/sdg7-database*
[10] *bp Statistical Review of World Energy, 2022*

Figure 11: Energy access in Africa
Population without access to electricity (millions)



Source: IEA SDG 7 database

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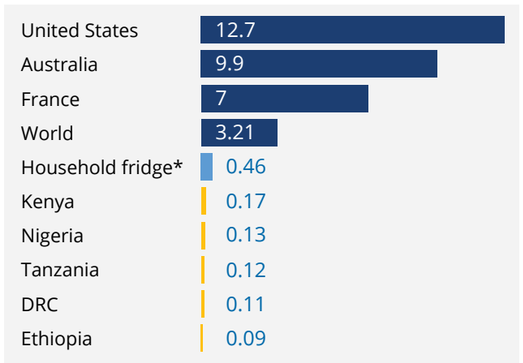
exported, as Africa remains at the bottom of the global value chain with its share of global manufacturing at less than 2%, according to the African Development Bank (AfDB)[11]. While industrialisation is a key priority for most African governments, building diversified and integrated economies without widespread access to reliable and affordable energy is impossible.

Meanwhile, the disparity in living standards is increasing, with poverty levels on the rise since the COVID-19 pandemic. Africa's poverty headcount rate (below a poverty line of $1.9 per day) is estimated to have increased by 3 percentage points because of the pandemic[12]. In total, COVID-19 is expected to have sent 37 million more Africans into extreme poverty while diverting a significant share of public spending into economic relief packages.

As a result, most infrastructure development programmes have been affected and the pace of bringing power to industries, homes, businesses, schools, and hospitals has slowed down. Continued population growth coupled with inflation is pushing more and more Africans into energy poverty, making access to modern energy, which is in short supply, unaffordable. Because of limited infrastructure and low access, African countries are also the least able to cope with climate change and build resilience. Over the past few years, the continent has witnessed heat waves, extensive floods, prolonged droughts, and rising sea levels that result too often in human and economic losses[13].

While the impact of climate change on the continent is severe, Africa has contributed almost nothing to the world's global emissions causing the problem. Combined, the continent accounts for less than 3% of the world's energy-related carbon dioxide (CO2) emissions to date[14]. Without North Africa and South Africa, the remaining 48 Sub-Saharan African countries' share of global emissions could be as low as 0.55% of global emissions since the industrial

Figure 12: Low energy
Electricity consumption, MWh/capita (2020)

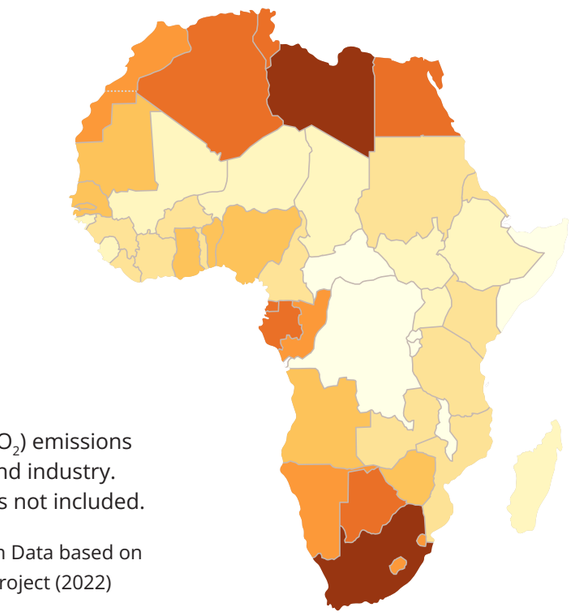


** US average*

Source: IEA, Todd Moss/Energy for Growth Hub

[11] *https://www.afdb.org/en/the-high-5/industrialize-africa*
[12] *Economic Development in Africa Report 2021, United Nations Conference on Trade and Development (UNCTAD)*
[13] *State of Climate in Africa 2021, World Meteorological Organization (WMO)*
[14] *Africa Energy Outlook 2022, IEA*

Figure 13: CO2 emissions in Africa in tonnes



Carbon dioxide (CO_2) emissions from fossil fuels and industry. Land use change is not included.

Source: Our World in Data based on the Global Carbon Project (2022)

revolution[15]. Current CO2 emissions per capita naturally remain low, standing at 1.04 tons per capita in Africa in 2021, or four times less than the global average of 4.69 tons per capita[16].

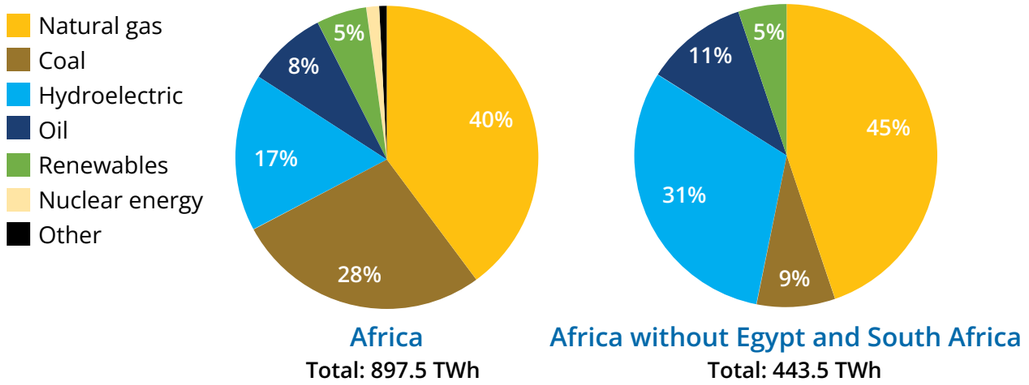
Africa's limited electricity systems continue to rely on inefficient grids, with a generation mix dominated by expensive and polluting fuels.

To generate its electricity, the continent heavily relies on polluting sources of energy. However, wide inequality in electricity production and consumption calls for a careful review of statistics. Egypt and South Africa alone produce almost as much electricity as the rest of the continent combined. Because their electricity mix is heavily dominated by gas and coal respectively, they heavily weigh into the continent's overall mix, which may hide the actual diversity of electricity sources across the remaining countries.

Overall, natural gas dominates Africa's electricity mix, led by strong generation centers in North Africa (particularly

[15] *"Moving Beyond 'All or Nothing': Finding the Pragmatic Middle Ground on Gas in Africa", 15 November 2022, Energy for Growth Hub*
[16] *Global Carbon Project, 2021*

Figure 14: Africa's electricity mix (2021)

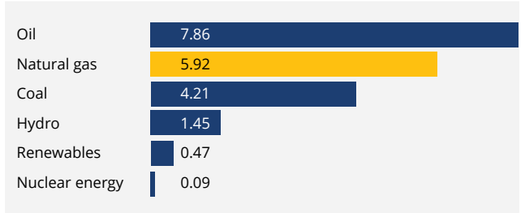


Source: bp Statistical Review of World Energy 2022

Egypt and Algeria). Coal-based power generation is mostly centered in South Africa, the biggest electricity producer on the continent, ahead of Egypt. Oil is mostly consumed for power across Sub-Saharan Africa where it supports a thriving decentralised power generation industry that uses diesel (fed into large generators) and gasoline (for smaller generators). Recent estimates of Africa's decentralised diesel generation capacity vary from 45 GW[17] to 100 GW[18]. But because it is off grid, this is often not reflected in global data repositories.

Thanks to its lower emissions profile, despite natural gas being the dominant source of power generation in existing grids, it's share of Africa's CO2 emissions is three times less than that of coal and oil. According to data gathered by the Global Carbon Project[19], coal and oil are responsible for 68% of Africa's emissions, while gas accounts for only 22%. Gas generates 50% less GHG emissions than coal when used to generate electricity and a third less to provide heat[20].

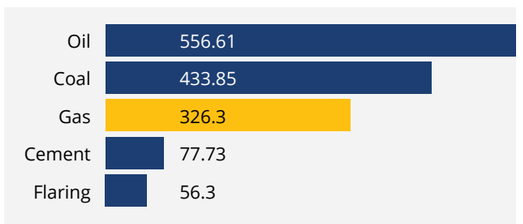
Figure 15: Primary energy consumption in Africa by fuel, exajoules (2021)



Note: Primary energy here comprises commercially traded fuels used to generate electricity

Source: bp Statistical Review of World Energy 2022

Figure 16: CO2 emissions by fuel in Africa (2021) in million tonnes



Source: Global Carbon Project

[17] *Africa Energy Outlook 2022, IEA*
[18] *"Utility evolution in Africa to reshape global electricity demand", 17 March 2022, Wood Mackenzie*
[19] *Our World in Data based on the Global Carbon Project (2022)*

For the same reason, the share of gas could increase further as countries seek to cut the burning of coal and oil (including diesel and heavy fuel oil, or HFO) and switch to gas to lower GHG and air pollutant emissions. Key countries such as South Africa and Senegal are already advancing coal-to-gas switching projects that will rely both on imports of liquefied natural gas (LNG) and domestic gas monetisation to decarbonise their electricity mixes and improve their local environment (see Section 2. 3.). Meanwhile, power transmission and distribution infrastructure remains inadequate and forces millions of individuals and enterprises to rely on off-grid solutions to access electricity. The continent's two biggest economies, Nigeria, and South Africa, are struggling the most with inadequate power systems. Between January and September 2022, Nigeria's grid collapsed four times[21].

Meanwhile, South Africa experienced one of its worst load-shedding years on record in 2022, a practice that forces the country to switch off power in parts of the distribution system to avoid total grid collapse. Between January and September 2022, South Africa experienced 1949 hours of load shedding[22].

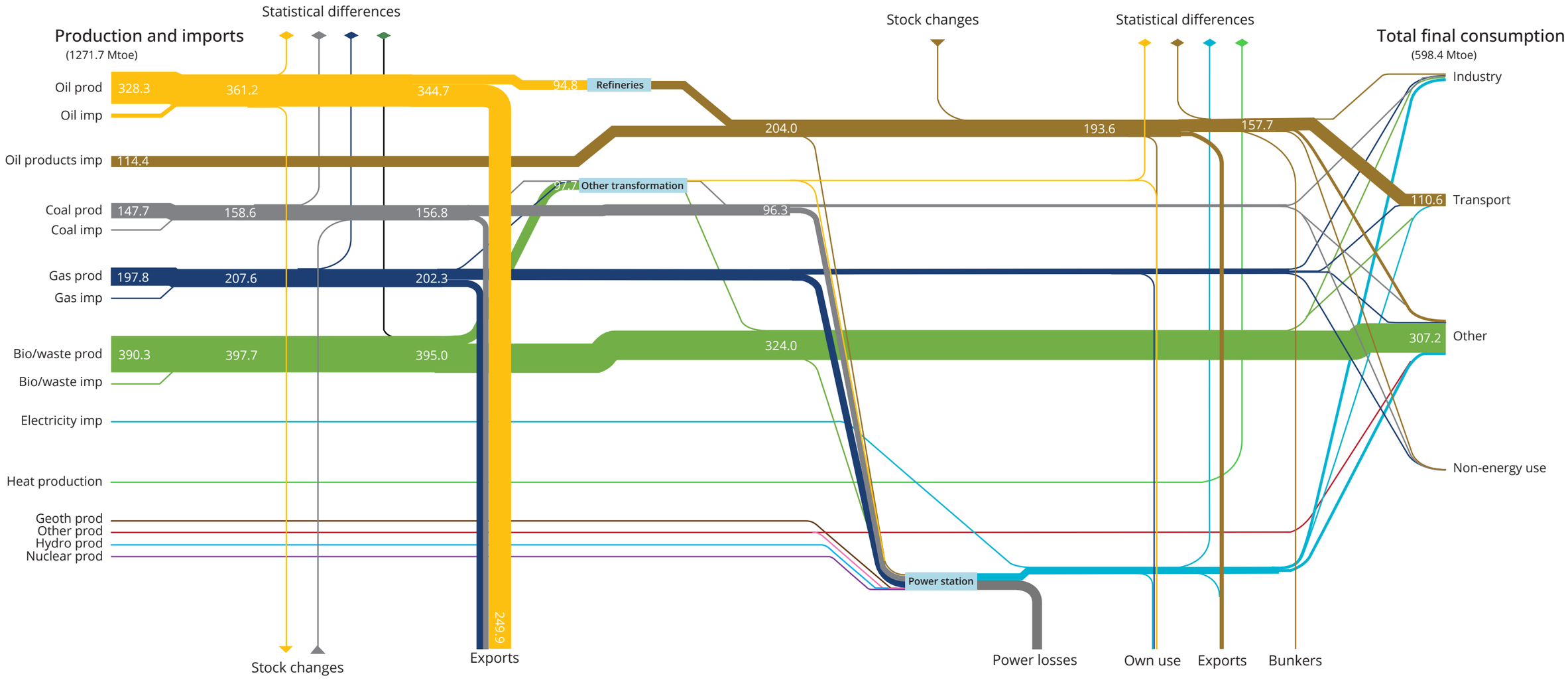

Picture: Globeleq

[20] *"The Role of Gas in Today's Energy Transition", July 2019, World Energy Outlook special report, IEA CC BY 4.0*
[21] *"Nigeria suffers widespread blackouts after electricity grid fails", 26 September 2022, Reuters*
[22] *Statistics of utility-scale power generation in South Africa, October 2022, CSIR*

1 / Africa's Energy Context

Figure 17: Africa's energy balance 2020 in millions of tonnes of oil equivalent

The International Energy Agency's Sankey diagram on Africa's energy balance reveals that most of Africa's final consumption in energy is biomass and imports, while two-thirds of its oil and much of its gas are exported. The scale of fuel in power losses is another striking detail revealed by the diagram.



Source: IEA

Beyond electricity, the broader energy mix is dominated by emissions-heavy traditional sources.

Within the residential segment, conventional biomass, charcoal, and firewood remain the main fuels for cooking and heating needs. The International Energy Agency (IEA) estimates that 970 million Africans currently lack access to clean means of cooking, and recent spikes in the price of cooking gas have forced millions back into more polluting but cheaper alternatives. If nothing is done to provide cleaner cooking alternatives, 1.67 billion Africans will be using wood and charcoal for cooking by 2050 according to the United Nations Framework Convention on Climate Change (UNFCCC)[23]. This has a serious impact on climate, on the conservation of African forests, and especially on health. According to 2022 data from the World Health Organization (WHO), 3.2 million people already die prematurely every year from illnesses attributable to household air pollution caused by the incomplete combustion of solid fuels and kerosene used for cooking[24].

While forest degradation in Latin America and Asia is largely driven by logging for commercial products, Africa is particular in that its forests are mainly cut and burned to make fuelwood and charcoal. It is estimated that over half of the continent's deforestation and degradation is made to secure primary energy source[25].

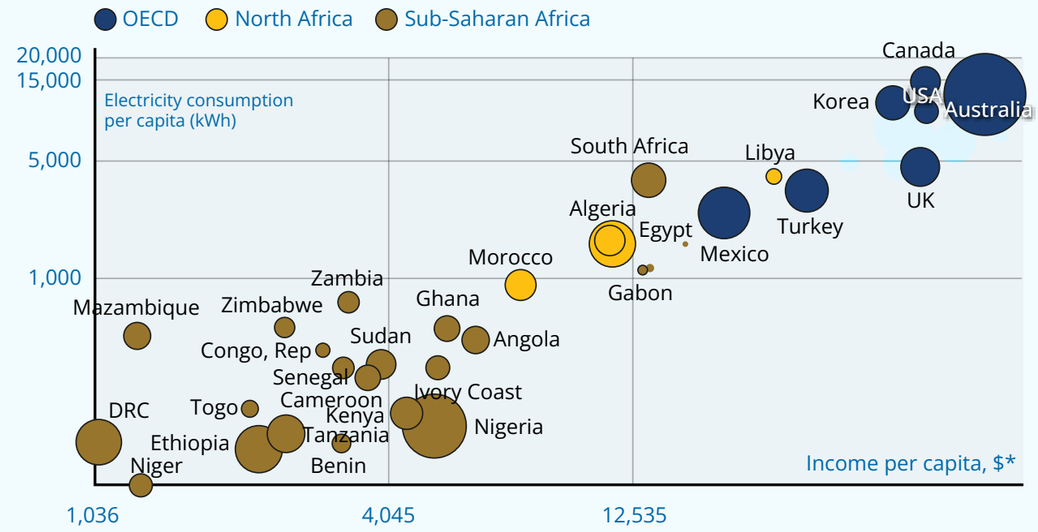
The use of charcoal and firewood is something the world should work with Africa to discourage. Without access to modern energy, Africa is depleting its forests and natural carbon sinks, with the Central African forest alone absorbing 1.5 billion tonnes of CO2 annually, or 4% of the world's emissions every year[26]. Providing alternatives to fuelwood and charcoal, further calls for the adoption of gas even in residential settings and for domestic use.

To fight poverty and climate change, Africa needs energy.

Africa's ability to progress its economic development, improve the lives of its people, and address climate change is tied directly to its ability to provide reliable, modern, and affordable energy access. Its population is expected to at least double by 2050, by which time a quarter of the world's people will be African.

[23] *"Too many cooks", 14 June 2021, UNFCC*
[24] *https://www.who.int/news-room/fact-sheets/detail/household-air-pollution-and-health*
[25] *Hosonuma, N., Herold, M., De Sy, V., De Fries, R. S., Brockhaus, M., Verchot, L., ... & Romijn, E. (2012). An assessment of deforestation and forest degradation drivers in developing countries. Environmental Research Letters, 7(4), 044009.*
[26] *"Gabon becomes the first African country to receive payment for reducing CO2 emissions", July 2021, Africa Renewal Magazine, United Nations*

Figure 18: Understanding energy poverty



There is a direct correlation between income and energy consumption. High-income countries are all high-energy, while low-income countries are all low-energy. The threshold of 1,000 kWh of electricity consumption/capita marks the Modern Energy Minimum set by the Energy for Growth Hub.

* Lower middle-income economies are those with a GNI per capita between $1,036 and $4,045; followed by upper middle-income economies with a GNI per capita between $4,046 and $12,535; and high-income economies with a GNI per capita above $12,535.

Source: IMF, World Bank

To address ongoing demographic growth and tackle rampant unemployment, Africa needs resilient power systems that provide reliable and affordable energy to its industries and households. Without energy, Africa will not reach higher income levels and will not build resilience to address climate-related risks. Excluding South Africa and North Africa, the continent's per capita electricity usage is around 200 kWh[27]. At that level, Africa's per-capita consumption of electricity continues to be largely below that of the world's average of 3,210 kWh per year per capita, and far below that of developed economies like the United States (over 12,000 kWh)[28]. Given that reality, Africa's energy use must go up to allow its development, reduce poverty,

[27] *SDG 7 TAG Policy Briefs: Addressing Energy's Interlinkages with other SDGs 2022, United Nations Department of Economic and Social Affairs.*
[28] *IEA*

improve lives, build climate change resilience, and contribute to the global energy transition. This echoes growing calls from African leaders to better capture the kind of energy consumption that will drive the continent's economic growth. "Access to electricity means more than charging a phone through a solar panel," Malawi's President Lazarus Chakwera wrote in 2021.

The Energy for Growth Hub recently proposed a new metric for energy access, the Modern Energy Minimum of 1,000 kWh/capita (300 kWh at home and 700 kWh within the broader economy). The hub suggests that this will improve the accuracy of tracking realistic energy poverty and raise the ambition on energy access. For Africa to meet this access level, it would need to generate and consume 45% more energy today. If the continent reaches 2.5 billion people by 2050 in line with the UN projections, it would need to grow its electricity supply by 175% between 2020 and 2050 to achieve this basic access level of 1,000 kWh/capita.

The exponential growth of Africa's energy supply will need to be anchored into robust infrastructure and power systems that pave the way for a low-carbon future.

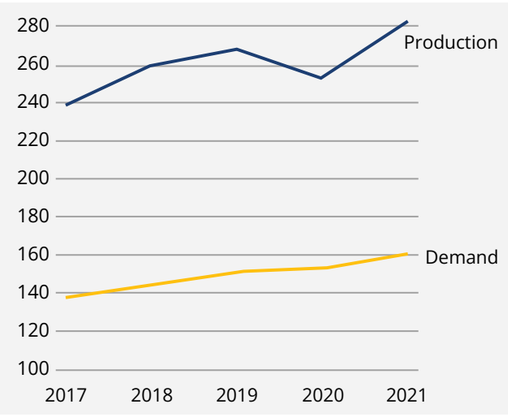
Picture: Savannah Energy

1.2. Africa's Domestic Gas Penetration Remains Minimal

8.8% of the world's proven reserves of natural gas are in Africa.

By the end of 2021, some 18 trillion cubic metres (tcm) of proven gas reserves had been discovered across Africa. A large majority of this gas is in Nigeria (over 32%), followed by Algeria (25%), Egypt (12%), and Libya (8.3%)[29]. While Nigeria and North Africa hold most of these reserves, gas has been found in commercial quantities across the continent.

Figure 19: Africa's gas production and demand (MMscm)

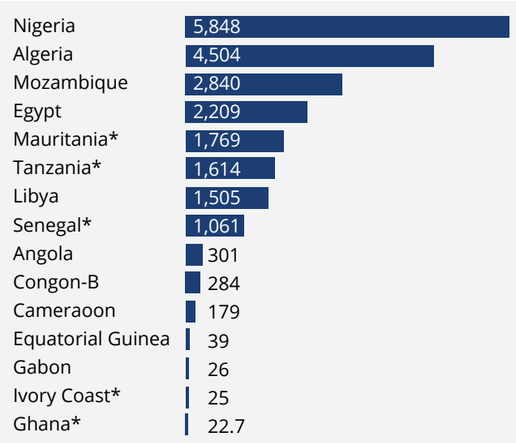


Source: OPEC, Hawilti Research

Considering smaller or yet-to-be-classified reserves, Hawilti's research shows that more than 20 African markets have discovered gas, including Morocco, Algeria, Tunisia, Libya, Egypt, Mauritania, Senegal, Côte d'Ivoire, Ghana, Nigeria, Equatorial Guinea, Gabon, the Republic of Congo, the Democratic Republic of Congo (DRC), Cameroon, Chad, Angola, Namibia, South Africa, Mozambique, Tanzania, Rwanda, and Ethiopia. Except for Mauritania, Namibia, and Ethiopia, all these countries already produce gas in various quantities for exports or for small consumption in power, transport, industry, and cooking.

African gas reserves have also grown over the past decade following significant

Figure 20: Africa's gas reserves, Bcm (2021)



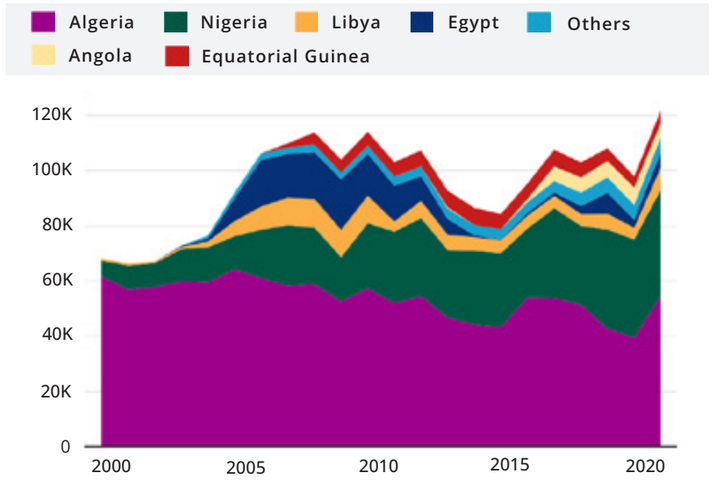
* Not officially classified as proven reserves.

Source: OPEC, PIAC, Bank of Tanzania, World Bank, Government of Cote d'Ivoire, Hawilti Research

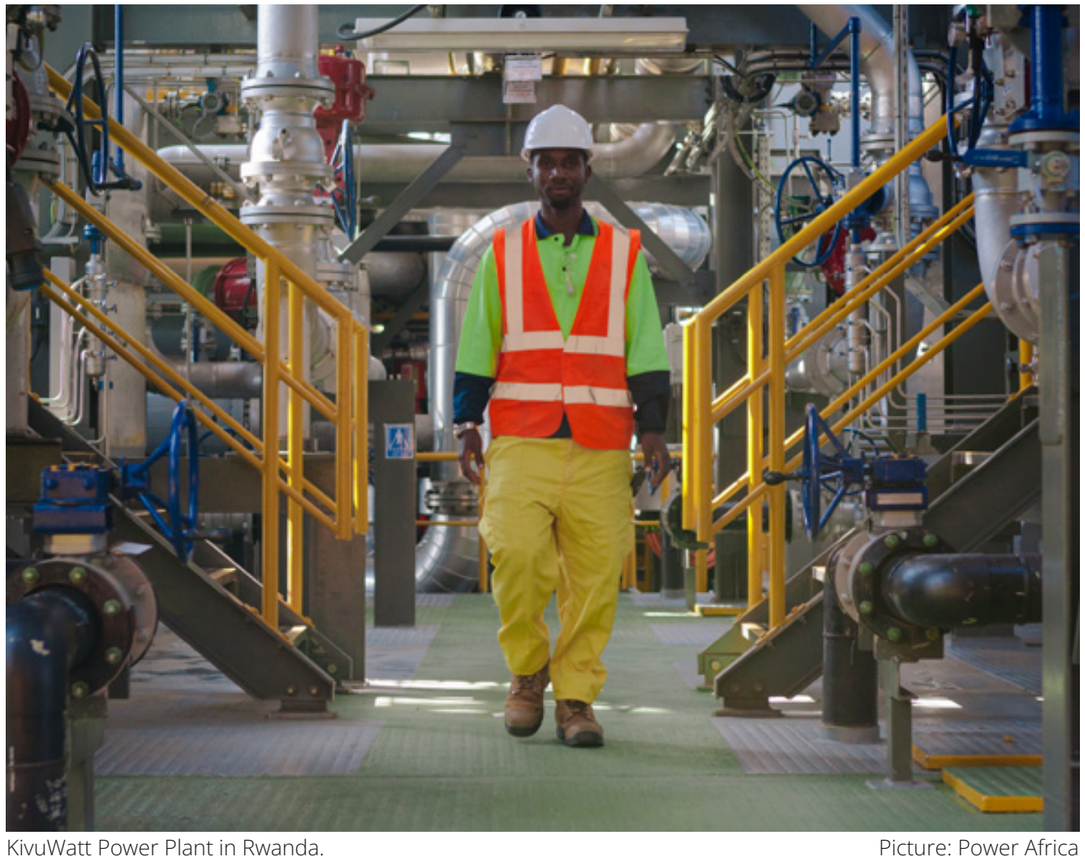
[29] *Annual Statistical Bulletin 2022, Organisation of Petroleum Exporting Countries (OPEC)*

discoveries in Mozambique (2010-2014), Tanzania (2010-2014), Egypt (2015), Senegal (2015-2017), and Mauritania (2015 and 2019). Between 2010 and 2020, 40% of all the gas discovered worldwide was in Africa. Recent exploration has continued yielding tremendous results with large discoveries made in Côte d'Ivoire in 2021 and 2022, and in Algeria in 2022.

Figure 21: African natural gas exports, MMscm (2000-2021)



Source: Annual Statistical Bulletin 2022, OPEC



KivuWatt Power Plant in Rwanda. Picture: Power Africa

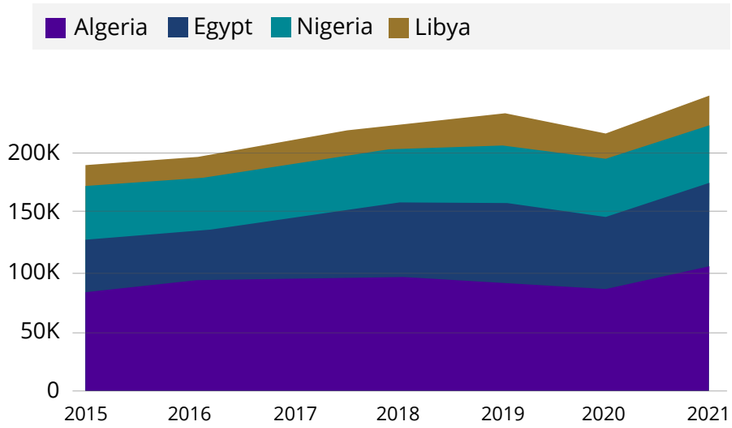
Gas production remains driven by lucrative exports.

Meanwhile, gas production has continued to increase, albeit affected by external shocks such as commodity price fluctuations and the COVID-19 pandemic. Despite these negative impacts, natural gas production in Africa grew at a yearly average of 2.5% a between 2011 and 2021, above the world average of 2.2%[29].

Production reached some 282 bcm in 2021, but remains concentrated within a few markets only. Algeria produces 37% of gas on the continent, followed by Egypt (25%), Nigeria (17%), and Libya (8.5%). While other producers like Angola or Cameroon have seen their production rise over the past decade on the back of LNG exports, their volumes are still small relative to their northern neighbours. Gas production remains driven by exports in most markets, except for Egypt and Libya.

Figure 22: African marketed gas production, MMscm (2015-2021)

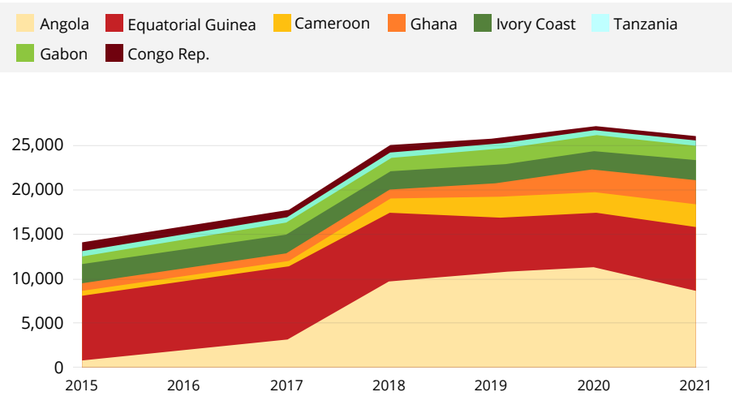
Large African gas producers (10,000 MMscm/year or more)



Source: Annual Statistical Bulletin 2022, OPEC

Figure 23: African marketed gas production, MMscm (2015-2021)

Medium-sized African gas producers (less than 10,000 MMscm/year)



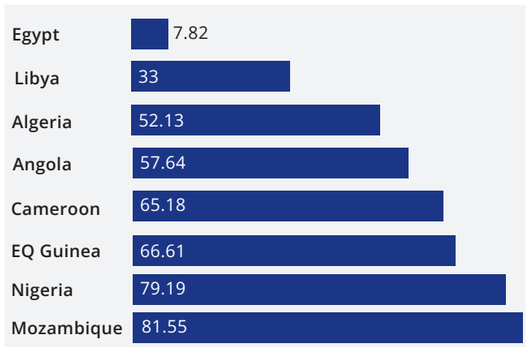
Source: Hawilti research from various sources, including OPEC, PIAC (Ghana), DGH-C1 (Cote d'Ivoire), and Bank of Tanzania

[29] *bp Statistical Review of World Energy 2022*

Picture: Century Group

Picture: Powergas

Figure 24: Share of marketed gas used for exports in 2021



Shares expressed in % of marketed gas production volumes. Calculations based on OPEC data, except for Mozambique and Cameroon whose shares are calculated from 2020 volumes reported by ITIE.

Source: Annual Statistical Bulletin 2022, OPEC; Hawilti Research

The world's fastest-growing gas consumption region.

Domestic gas consumption remains on the rise having witnessed the world's strongest growth rates between 2011 and 2021. In that period, Africa's consumption of natural gas grew at an average of 4.5%, above that of the Asia Pacific region[30].

This was mostly driven by East, West, and Central Africa, which all had very low starting points explaining some of the rapid acceleration. In absolute terms, consumption volumes remain small with estimations ranging from 160 bcm (OPEC) to 165 bcm (bp) in 2021, compared

[30] *bp Statistical Review of World Energy 2022*

with over 570 bcm for Europe or the Middle East.

Consumption also remains concentrated in Egypt and Algeria, two markets that have developed strong export industries but have also successfully deepened gas penetration domestically in the form of gas-fired power generation, industry feedstock, direct gasification of communities and regions, and compressed natural gas (CNG) to fuel transport.

Combined, Egypt and Algeria represent 70% of the gas consumed in Africa[31]. Other mid-sized consumption centers can also be found in countries with export facilities or where some gas is consumed for power and industry, including Nigeria, Libya, Tunisia, South Africa, and Equatorial Guinea.

Assessing Africa's gas future in light of persistent energy poverty and climate change.

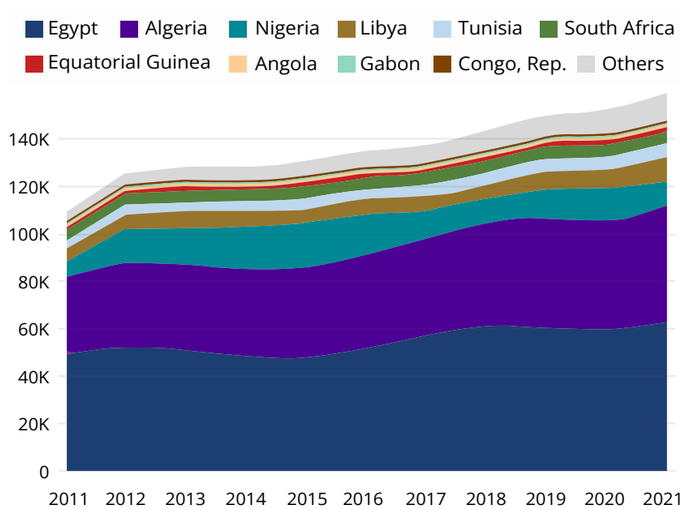
Increasing the consumption of natural gas in Africa offers a pragmatic solution for underpinning the continent's sustainable development.

The IEA estimates in its latest outlook that Africa's undeveloped gas resources could provide an additional 90 bcm of gas per year by 2030 for the fertilizer, steel, cement, and water desalination industries, with cumulative CO2 emissions of 10 gigatonnes (Gt). This level of consumption would take Africa's share of global emissions from 3% today to 3.5% by 2050.

The analysis of the potential future gas demand in Africa, using socio-economic outlooks, to date has been very sparse. The IEA forecasted its growth between 2020 and 2050 at 94% in its stated policies scenario[32], the fastest in the world. It then revised it down to 16% between 2020 and 2030 in its latest outlook, with gas maintaining a 17% share of total primary energy demand over the period[33].

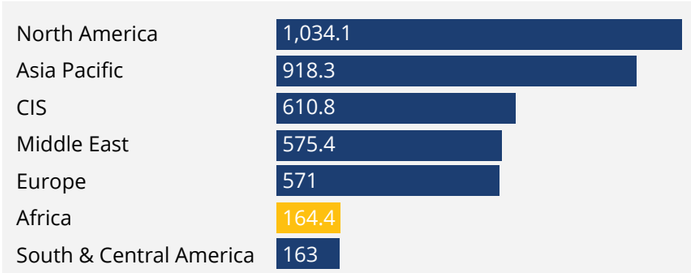
The potential demand for gas in Africa can be challenging to estimate because existing research tends to overlook suppressed demand. Several regions and industrial clusters on the continent remain energy starved for lack of infrastructure and gas availability. Poverty and lack of access to modern energy infrastructure prevent most African stakeholders from meeting their human development needs, which is often not reflected within global data repositories and their associated scenarios.

Figure 25: Natural gas demand in Africa, MMscm (2011-2021)



Source: Annual Statistical Bulletin 2022, OPEC

Figure 26: Natural gas consumption by region, Bcm (2021)



Source: bp Statistical Review of World Energy, 2022


Picture: Sasol

[31] *Annual Statistical Bulletin 2022, OPEC*
[32] *World Energy Outlook 2021, IEA*
[33] *World Energy Outlook 2022, IEA*

1 / Africa's Energy Context

Regional dynamics - 1 / North Africa is building upon strong foundations

Morocco, Algeria, Tunisia, Libya, Egypt

Status

North Africa has the most established gas markets on the continent and is its top gas-producing region thanks to production centers in Egypt and Algeria. Proximity to Europe has enabled the development of robust gas export industries, both via LNG terminals and pipelines. Domestic markets are also growing, and gas has been supporting the industrial base expansion in the region while providing a reliable power supply. Infrastructure is developed, paving the way for better gas penetration across economies. However, the region remains prone to geopolitical tensions (such as those in Algeria and Morocco) and security threats (Libya).

Outlook

North Africa is expected to remain Africa's biggest producing region, led by Egypt and Algeria. Both countries have increased cooperation with international energy companies in 2022 and are committed to exploring additional gas and hydrogen projects.

On the back of recent onshore and offshore discoveries and while seeking to cut coal consumption, Morocco is expected to become a much bigger gas player by 2030. Gas will notably help to supply thermal power stations, switch from coal, and provide a decarbonisation opportunity for transport and industry. While SDX Energy already produces gas there, bigger projects are currently being developed by Sound Energy and Chariot. The former is currently developing a micro-LNG project from its onshore Greater Tendrara Concession, while the latter is progressing with the shallow-water Anchois Gas Project. Both undertakings will focus on domestic supplies but will also tie into the Maghreb-Europe Gas Export Pipeline to balance domestic exposure and improve the bankability of their development plans.

Both Morocco and Algeria are also involved in multi-billion-dollar transnational gas pipeline projects proposed to distribute gas across West Africa before reaching Europe: the offshore Nigeria-Morocco Gas Pipeline (NMGP) and the onshore Trans-Saharan Gas Pipeline (TSGP).

Disclaimer: The boundaries, colors, denominations, and other information shown on any map in this work do not imply any judgment on the part of Hawilti Ltd nor the International Gas Union concerning the legal status of any territory or the endorsement or acceptance of such boundaries.

1 / Africa's Energy Context

Regional dynamics - 2 / West Africa seeks better gas penetration

Mauritania, Senegal, The Gambia, Guinea-Bissau, Cabo Verde, Guinea, Sierra Leone, Liberia, Côte d'Ivoire, Ghana, Mali, Burkina Faso, Togo, Benin, Niger, Nigeria

Status

West Africa's gas reserves are concentrated in Nigeria and offshore Mauritania and Senegal. Gas production is mostly reserved for exports via Nigeria LNG's terminal in the Niger Delta. While Nigeria, Côte d'Ivoire, Ghana, Benin, and Togo have all monetised gas domestically, consumption is limited.

The power sector remains the main gas off-taker but is plagued by liquidity constraints in Ghana and Nigeria.

Lack of infrastructure continues to hamper gas penetration despite the emergence of "virtual pipelines" (networks over which gas is trucked) over the past few years. As a response, increasing political will is placed on the development of gas-based industrialisation, expansion of CNG networks, and construction of small-scale gas projects.

Outlook

West Africa is expected to emerge as a much bigger gas-producing region, as both Mauritania and Senegal join Nigeria and Ghana in the club of gas exporters (see Section 3.3.). Both countries hope that domestic allocation from export projects could support gas-fired generation and replace existing coal and diesel consumption.

Meanwhile, Nigeria is trying to position itself as a regional export hub more actively. NNPC is promoting two export pipeline projects, the Trans-Saharan Gas Pipeline (TSGP) and the Nigeria-Morocco Gas Pipeline (NMGP), while the private sector has proposed new onshore terminals and floating LNG projects. The success of these ventures will now rely on the provision of an enabling business environment and the improvement of the security situation in the Niger Delta.

Finally, Côte d'Ivoire and Ghana will both have consolidated their domestic gas value chains with clear intent by the operators Eni and Tullow Oil to monetise associated gas and avoid flaring. Significant gas-to-power capacity is soon expected to be commissioned in the region, mostly in Senegal and Côte d'Ivoire.

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1 / Africa's Energy Context

Regional dynamics - 3 / In Central Africa, small-scale is a winning game

Chad, Cameroon, CAR, Equatorial Guinea, Gabon, Sao Tome e Principe, Republic of Congo, DRC

Status

Despite much smaller gas reserves, Central African markets have successfully developed export facilities in Equatorial Guinea and Cameroon, with additional ones currently in development in the Republic of Congo and Gabon (see Section 3. 3.). Domestic consumption has mostly remained limited to power, except for Equatorial Guinea, which has developed a robust and diversified downstream gas infrastructure hub at Punta Europa. However, Central Africa remains the most intensive flaring region on the continent and could benefit from new strategies to monetise flared gas. This has caused several technological and technical challenges given the relatively small size of the domestic markets and the need to aggregate flare volumes between several operators (see Section 3. 2.).

Outlook

Moving forward, cooperation will be key to unlocking the region's gas potential, especially in the Gulf of Guinea, where Equatorial Guinea is trying to position itself as a regional gas hub. The country is also trying to revive the Fortuna FLNG project, while positioning its domestic gas processing facilities at Punta Europa on Bioko Island as a regional center for the processing of stranded gas in the Gulf of Guinea. The country already benefits from strong regional leadership but its ability to create a true hub for gas will rely on the improvement of its business climate.

Congo plans to start exporting LNG by 2023, once Eni commissions its first of the two planned floating LNG units on its Marine XII block. The country also relies on gas for most of its power production and a few additional units are in the pipeline there. Gabon also hopes to start exporting LNG by 2026 via a project proposed at Cap Lopez by independent operator Perenco. Meanwhile, authorities have sought to encourage the processing of associated gas to reduce flaring and produce key products such as cooking gas.

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1 / Africa's Energy Context

Regional dynamics - 4 / Southern Africa is on the verge of transformation

Angola, Namibia, South Africa, Botswana, Zambia, Zimbabwe, Lesotho, Eswatini, Mozambique, Malawi, Madagascar

Status

Southern Africa has remained a very limited gas frontier, until now. Angola used to be the primary gas market there with the development of an LNG export industry purely reliant on associated gas. But exploration activity has unlocked new reserves in Mozambique and South Africa, redrawing the cards of the region's energy security scenario. Regional cooperation is already thriving and could grow further with gas, especially if new discoveries are confirmed in Namibia and Zimbabwe.

Outlook

Southern Africa is on the verge of profound transformations that will shape its energy future. Long dominated by Angola as a key gas-producing and exporting country, the region is seeing the entry of several new local and regional gas players.

Mozambique, which has been a key supplier of gas to South Africa for two decades, has become an LNG exporter in 2022 and hopes to significantly ramp up its LNG export capacity by 2030. While export facilities are being developed in the north, the country's capital in the south could also house an LNG import hub serving the sub-region. But Mozambique is also focusing on its domestic economy, with several gas-to-power projects currently in development along with the growth of its domestic LPG supply.

For South Africa, gas has become the natural alternative to move away from coal and the country is currently planning LNG import terminals on its coast to switch several gigawatts of coal-based power generation capacity. Recent discoveries onshore and offshore are also providing the foundation to grow the gas value chain and serve already well-established manufacturing and transport industries. The country became a small LNG producer in 2022 and will seek to further develop its domestic reserves to supply industrial facilities and decarbonise its transport sector.

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1 / Africa's Energy Context

Regional dynamics - 5 / East Africa has strategic decisions to make

Tanzania, Kenya, Burundi, Rwanda, Uganda, South Sudan, Sudan, Ethiopia, Eritrea, Djibouti, Somalia

Status

Gas is almost absent from East African economies, whose baseload power has traditionally been met by hydropower. Geothermal energy has also become popular in the region, especially in Kenya but increasingly in Ethiopia and Djibouti as well. For the same reason, gas will play a different role from elsewhere on the continent. Tanzania and Rwanda are two notable exceptions. Tanzania adopted gas as early as 2004 to generate electricity and support Dar es Salaam's growing industrial base, while Rwanda started extracting methane from Lake Kivu in 2016 to produce power. The latter has since then embarked on additional gas extraction to produce CNG and cooking gas for its domestic market.

KivuWatt Picture: Power Africa

Outlook

After growing a functioning domestic gas value chain, Tanzania plans to start exporting LNG by developing its vast offshore reserves in the south. The country could also become a strategic hub for the region and is notably considering a gas pipeline to Kenya, where 10% of electricity generation relies on HFO and diesel and could be replaced by gas imports. Additional domestic projects in Tanzania, such as Ntorya, could unlock more supply to deepen gas penetration across the economy while supporting regional supply ambitions.

Ethiopia could finally emerge as a gas market this decade provided it can secure a new investor to develop its 113 bcm of recoverable gas in the Ogaden Basin, with reserves concentrated within the Calub and Hilala fields. Development plans initially involved a pipeline to Djibouti before exporting gas as LNG, but the contract with a Chinese operator was terminated in 2022.

Disclaimer: The boundaries, colors, denominations, and other information shown on any map in this work do not imply any judgment on the part of Hawilti Ltd nor the International Gas Union concerning the legal status of any territory or the endorsement or acceptance of such boundaries.

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Assessing the potential for gas in Africa

Picture: Century Group

On the back of the global energy crisis, there has been a surge in optimism about investments in African gas as a potential source of additional supply in an energy-constrained world. This is a positive development for the local industry and stakeholders. Yet, it is important that this newfound optimism also contributes to real changes for Africans.

While African gas has been contributing to the global energy security and decarbonisation agenda through exports, it has done much less of that domestically. In this current opportunity for gas development on the continent, it is critical to build Africa's energy security. Scaling up the development and monetisation of African gas reserves could lift hundreds of millions out of poverty while significantly contributing to the decarbonisation of the energy mix and paving the way for a low-carbon future. In its Roadmap to Africa's COP27, for instance, the Africa Finance Corporation (AFC) called for a "natural gas imperative" that could advance the development of African economies while helping many to transition to clean energy.

Picture: ND Western Ltd

2.1 The Local Development Opportunity

African Gas for Domestic Energy Security

By increasing energy access and displacing coal and oil, gas can bring cleaner energy to African industries, unlock billions of dollars of investments, generate long-term and sustainable economic growth, and create the jobs needed to put millions of young Africans to work. From Abidjan, Côte d'Ivoire to Dar es Salaam, Tanzania, Sub-Saharan Africa has slowly but steadily built a track record of monetising gas domestically. Such experiences now need to serve as bases to scale up gas commercialisation, support industrialisation, create jobs, and build a sustained and sustainable economic recovery.

The multiplier effects of natural gas investments make gas an ideal source of energy to spur Africa's development and industrialisation, while creating skilled jobs.

Limited adoption is preventing entire African economies from fully benefiting from the utilisation of natural gas across their value chains. In the United States for instance, one of the world's largest consumers of gas, the employment multipliers for oil and gas extraction and natural gas distribution stood at 5.37 and 6.38 respectively in 2019, according to the latest estimates available from the Economic Policy Institute[34]. This means that for every 100 jobs in the American natural gas distribution industry in 2019, another 638 indirect jobs emerged elsewhere in the economy. The gas industry jobs multiplier in the US is above those in the power generation, transmission, and distribution (564.3) and all mining industry segments (235 to 537.3).

With unemployment rates at an all-time high in Africa, the benefits of natural gas for job creation cannot be understated. In Mozambique, for instance, studies by Standard Bank found that the development of natural gas deposits with the Coral South FLNG, Mozambique LNG, and Rovuma LNG projects could create as many as 1 million direct, indirect, and induced jobs across the economy[35].

In addition to supporting job creation, gas also has a strong multiplier effect across local economies because of the span of its value chain and its possible usage across sectors (electricity, cooking, heating and cooling, transport, and manufacturing of fertilizers, petrochemicals, cement, steel, etc.). Gas-based industrialisation can

[34] *Updated employment multipliers for the U.S. economy, January 2019, Economic Policy Institute*
[35] *This includes 323,050 jobs from Rovuma LNG (low capex scenario) and 700,000 jobs from Mozambique LNG (6 trains, no construction delays).*

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notably support the expansion of several supply chains in agriculture and mining, two of the continent's largest industries. In the African context, using gas to produce fertilizers or power-efficient freight transportation is key to supporting the continent's growing industrial base as it rolls out the African Continental Free Trade Area (AfCFTA).

Gas-based industrialisation is already strong in North Africa, but it has also made strides in Nigeria and South Africa, where gas is used as feedstock to produce petrochemicals, fertilizers, and cement. In these countries, successful African ventures were able to grow. Nigeria and South Africa both have reputable fertilizers, petrochemicals, and gas-to-liquids facilities for instance.

PetroSA Natural Gas processing and refining plant at Mossel Bay in South Africa

In South Africa, PetroSA's Mossel Bay Gas-to-Liquids Refinery was designed with a capacity of 36,000 bpd, making it one of the biggest in the world, and can sustain at least 5,000 indirect jobs in the Southern Cape Province[36]. It has successfully transformed gas into diesel, gasoline, kerosene, and specialty products since 1992. In Nigeria, the Indorama Corporation is doubling the urea production capacity of its petrochemicals and fertilizer complex in Port Harcourt from 1.5 to 3 million tons per annum (MTPA), further contributing to the country's food security and economic diversification. It has now been joined by additional large-scale urea producers such as Dangote Industries, which commissioned the Dangote Fertilizer plant in 2022, the world's second-largest granulated urea plant. Beyond large African economies, other markets with smaller gas reserves have been equally successful in the monetisation of their natural gas resources to extract domestic value. Côte d'Ivoire, Cameroon, Tanzania, and more recently Ghana have all been running very successful gas-based ventures in transport, industry, and power generation. The multiplication and scaling up of these ventures could now have tremendous benefits for local economies and local supply chains.

[36] *Production from Mossel Bay was suspended in 2020 due to challenges in securing natural gas feedstock. PetroSA is currently seeking a partner to reinstate full production from the facility using either domestic or imported gas.*

CASE STUDY 1

Two Decades of Domestic Gas Monetisation in Tanzania

The development of the Songo Songo gas field and its associated infrastructure is the backbone of Tanzania's thermal power generation and has resulted in one of the most successful domestic gas monetisation ventures in Africa, with a significant development impact for the Tanzanian economy.

The adoption of gas has also resulted in significant carbon emissions reduction since 2004. In one of its monitoring reports on the project, the World Bank notably demonstrated that between 2004 and December 2010 alone, CO2 emissions from power generation and local industrial fuel consumption fell by 1.8 million tons and 730,000 tons respectively[37].

The Songo Songo gas development remains purely oriented toward the domestic market and has grown on the back of a cooperation between private investors and Tanzania's state-owned energy companies. It was commissioned in 2004, making it one of Africa's longest and most successful domestic gas ventures.

Laying the ground

The Songo Songo gas development includes upstream, midstream, and downstream components, from the production of gas to its monetisation across Dar es Salaam. Orca Energy Group's subsidiary PanAfrican Energy operates the wells and the 3.1 million standard-cubic-metres-per-day (MMscmd) gas processing plant on Songo Songo Island, but the development is owned by Songas, itself majority owned by Globeleq[38].

The first 1.3 MMscmd of gas from Songo Songo is classified as "protected gas" and has served as the anchor for the project. It is owned by state-owned TPDC and sold under a 20-year gas agreement. This gas is used by Songas to fuel its 190-MW Ubungo gas-to-power plant but is also used for distribution to the Tanzania Portland Cement Company and Tanzania's village electrification programme.

Beyond 1.3 MMscmd, the gas is classified as "additional gas" and can be freely commercialised by PanAfrican Energy. As a result, the company has grown a strong base of industrial customers over the years, including steel, glass, textiles, beverages, tobacco, cooking oils, flour, cement, and paper, as well as supplying gas to the hotel industry. It also ventured into the CNG business in 2009 with an investment of $2.5 million for the supply of natural gas to industries and hotels, as a fuel for trucks and buses, and more recently even ride-hailing firm Uber.

Picture: Globeleq

Assessing the development impact

The steady supply of gas to Tanzania's economic capital Dar es Salaam, first from protected gas and then from additional gas, has provided cleaner and cheaper feedstock than diesel or HFO to several local power stations and industries. Songo Songo is now responsible for approximately 45% of the Tanzanian electricity supply,

[37] Implementation Completion and Results Report, 30 September 2011, World Bank
[38] Gas volumes have been converted from cubic feet for consistency.

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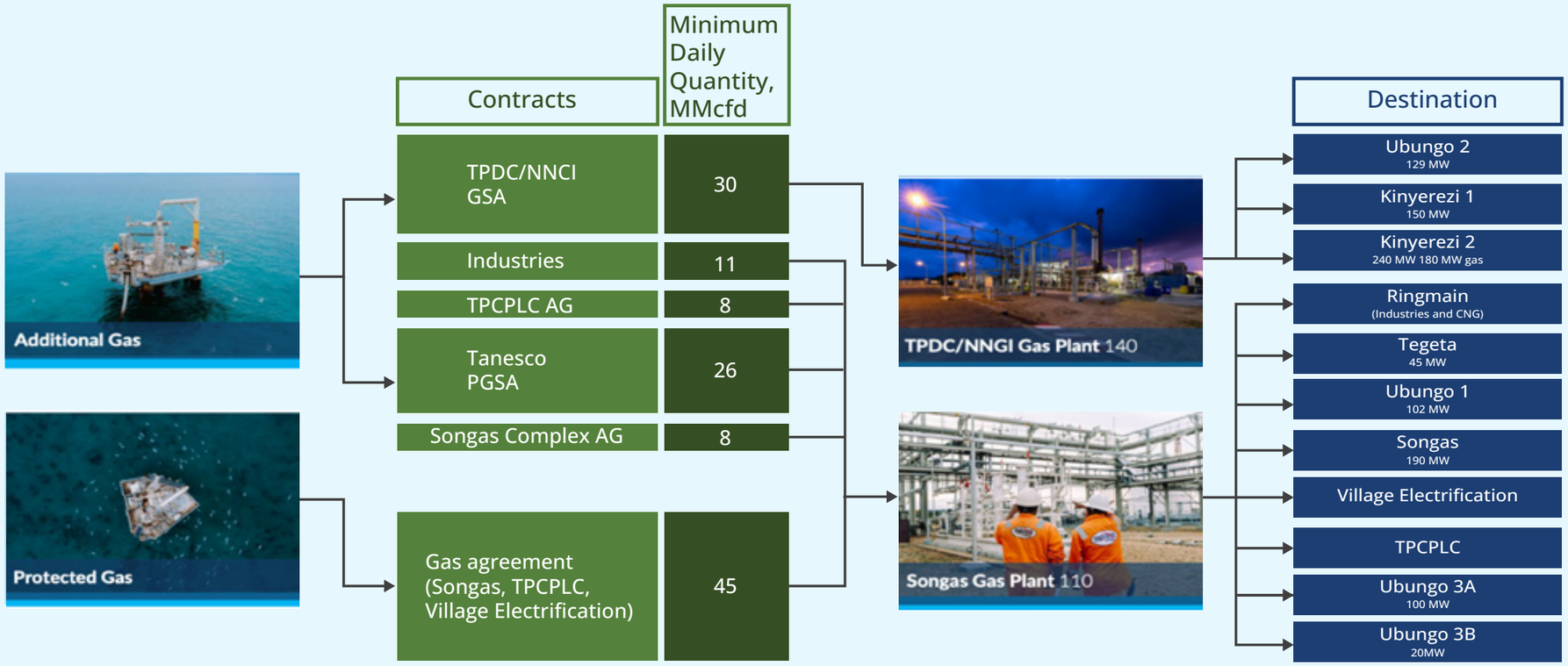
according to ORCA Energy Group's inaugural Sustainability Report released in 2022[39].

Because droughts have affected the country's hydroelectric dams, gas-fired generation has also provided a reliable baseload when dam reservoirs are low. Natural gas has also displaced diesel and HFO at several power plants in Dar es Salaam and limited the imports and consumption of oil. Globeleq's latest Sustainability Report[40] estimates that its Ubongo power plant has generated savings of over TZS 14 trillion (around $6 billion) since 2004 for the Tanzanian economy by reducing the need for imported fuel. In 2021, its electricity also reached some 5 million Tanzanians, or over 8% of the country's population.

Figure 27: Approximately 130 MMCFD of gas contracted



Source: Orca Energy Group

Equally important, the development of domestic gas for power has resulted in a significant drop in electricity costs in the country. By 2010, the weighted average of energy cost for the power plants supplied by Songo Songo had fallen from around $0.13/kWh to around $0.64/kWh, according to the same World Bank monitoring report. Until today, protected gas enables Songas to be the lowest-cost supplier of thermal power generation in Tanzania.

Both Orca Energy and Songas have also created jobs. They currently have a workforce of 190 employees consisting mostly of Tanzanians, including 116 employees at Orca Energy and 74 at Songas. Globeleq's study into the impact of its Songas operations estimated that another 113,809 indirect jobs were enabled by businesses using the electricity generated[41].

Finally, the Songo Songo operations are largely responsible for helping to grow Dar es Salaam's industrial base by providing more affordable and locally available feedstock for manufacturing and power. The Tanzania Portland Cement Company (TPCC) for example has transitioned from HFO to gas to run its cement kilns. Following its transition, TPCC increased its clinker production from 600,000 tons to 1,050,000 tons while significantly reducing its costs. The analysis provided by Orca Energy revealed that TPCC has cut costs by a factor of almost six by transitioning to gas. It also estimates that it has decreased its carbon emission intensity by almost 80,000 tons of CO2 per year by consuming gas instead of HFO.

[39] *Orca Energy Sustainability Report 2021.*
[40] *Globeleq Tanzania Sustainability Report 2021.*
[41] *Estimations based on Joint Impact Model (used by British International Investment, majority-owner of Globeleq).*

Picture: Presidency of Benin

The switch to gas in the industrial and commercial transport sectors provides an opportunity to reduce emissions.

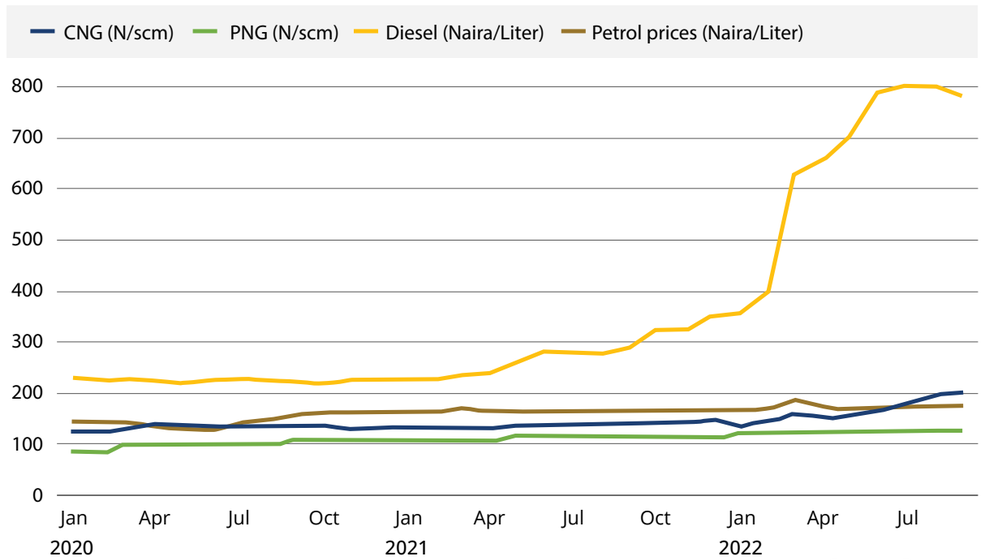
Cutting reliance on expensively imported HFO and diesel, decreasing GHG emissions, and improving air quality are important components of the business case to continue the adoption of gas by African industries.

Based on interviews conducted for this project with gas distributors, the demand for gas from African industries has increased in recent years. This is particularly the case from sectors such as fast-moving consumer goods (FMCG) and mining, where economic actors have sought to cut diesel consumption. Switching to gas offers both a cleaner alternative, but also a cheaper one as gas is often available locally, while diesel remains imported across most of Sub-Saharan Africa.

More recently, the historic rise in the prices of oil and petroleum products has put further pressure on industries that continue to rely on diesel and HFO instead of accessing locally available gas. Wood Mackenzie conservatively estimates that over 100 GW of distributed diesel capacity is operational on the continent, representing some $20 billion a year spent by African consumers on fuel for their backup generators[42].

For the same reason, demand from industry is expected to keep increasing and is

Figure 28: Price comparison petrol, diesel, PNG and CNG in Nigeria, in niara



Source: Powergas Africa

[42] *"Utility evolution in Africa to reshape global electricity demand", 17 March 2022, Wood Mackenzie*

no longer driven just by emission reduction targets but also by the affordability of gas compared with diesel and petrol on the continent.

In Nigeria for instance, gas distributors have seen much more traction by industries seeking to buy CNG and LNG for their factories, according to Powergas Africa CEO Sumeet Singh. Most of them have concluded that diesel prices would not come down soon, nor was the power grid going to increase substantially in the short to medium-term. In that context, the ideal solution is to procure gas to meet their power needs.

While gas was initially only procured by factories as a backup to an unreliable power grid, it has now become popular in the transport sector as well (cars, buses, trucks). When it comes to the logistics industry, North Africa has so far been the only region to have made significant strides in gas-fuelled transport, especially in Egypt and Algeria.

Across the rest of the continent, most cars and commercial vehicles remain fueled with imported petrol. However, Sub-Saharan Africa is steadily embracing the trend as well with gas increasingly used by the long-haul trucking industry (particularly in Nigeria and South Africa) or in public transport (Côte d'Ivoire and Tanzania). While conversions of engines to gas were driven by multinationals seeking to decarbonise their environmental footprints, the need to secure affordable fuels has unlocked further growth in recent years.

Since the start of 2022, escalating diesel prices have also generated a huge appetite for CNG and LNG among truck fleet owners, according to Femi Babajide, CEO of road haulage company Ecologique. He adds that because most vehicles in Africa are second-hand and rely on Euro-2 or Euro-3 type fuels, replacing them with gas can generate carbon savings of 60% or more.

The role of gas in the future African energy mix: building Africa's transitional infrastructure.

If all of Sub-Saharan Africa tripled its electricity consumption overnight using only natural gas, the additional CO2 would be equivalent to just 1% of global emissions[43]. However, the potential of gas to provide reliable and lower-carbon electricity to Africa remains unexploited. According to a 2018 study by Power Africa, Sub-Saharan Africa has used only 5% of its gas-to-power potential estimated at 400 GW[44].

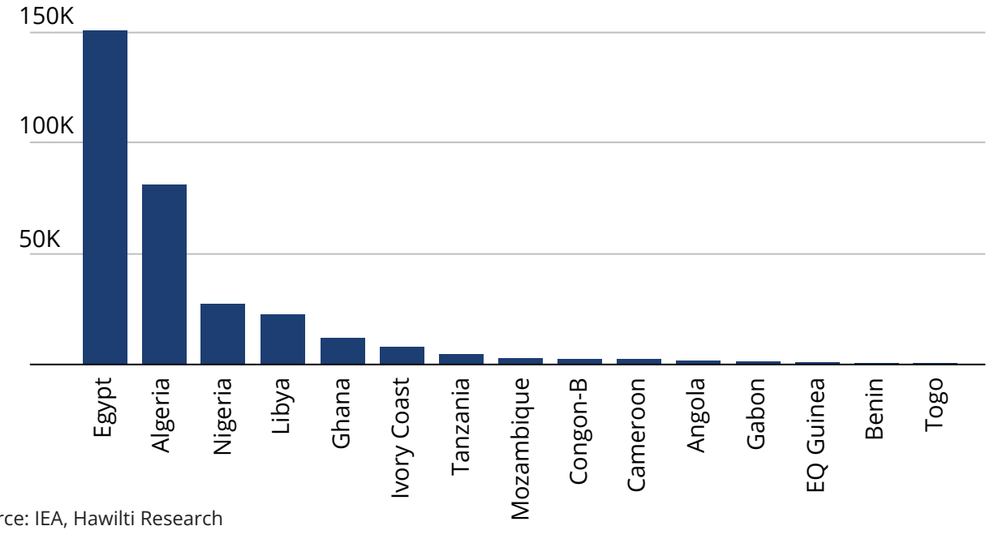
This is expected to change, as the quest for developing resilient electricity grids, which

[43] *"12 reasons why gas should be part of Africa's clean energy future," 23 July 2020, World Economic Forum*
[44] *Power Africa Gas Roadmap to 2030, June 2018*

can be flexible enough to integrate large amounts of variable renewable generation, including possible distributed sources, will support more gas-fired generation capacity by 2030. That is a conservative estimate, given the scale of new electricity generation that will be required to energise and develop Africa's growing economies. Gas-powered plants provide the backup generation capacity that is needed to balance the grid during periods of intermittency in renewable generation.

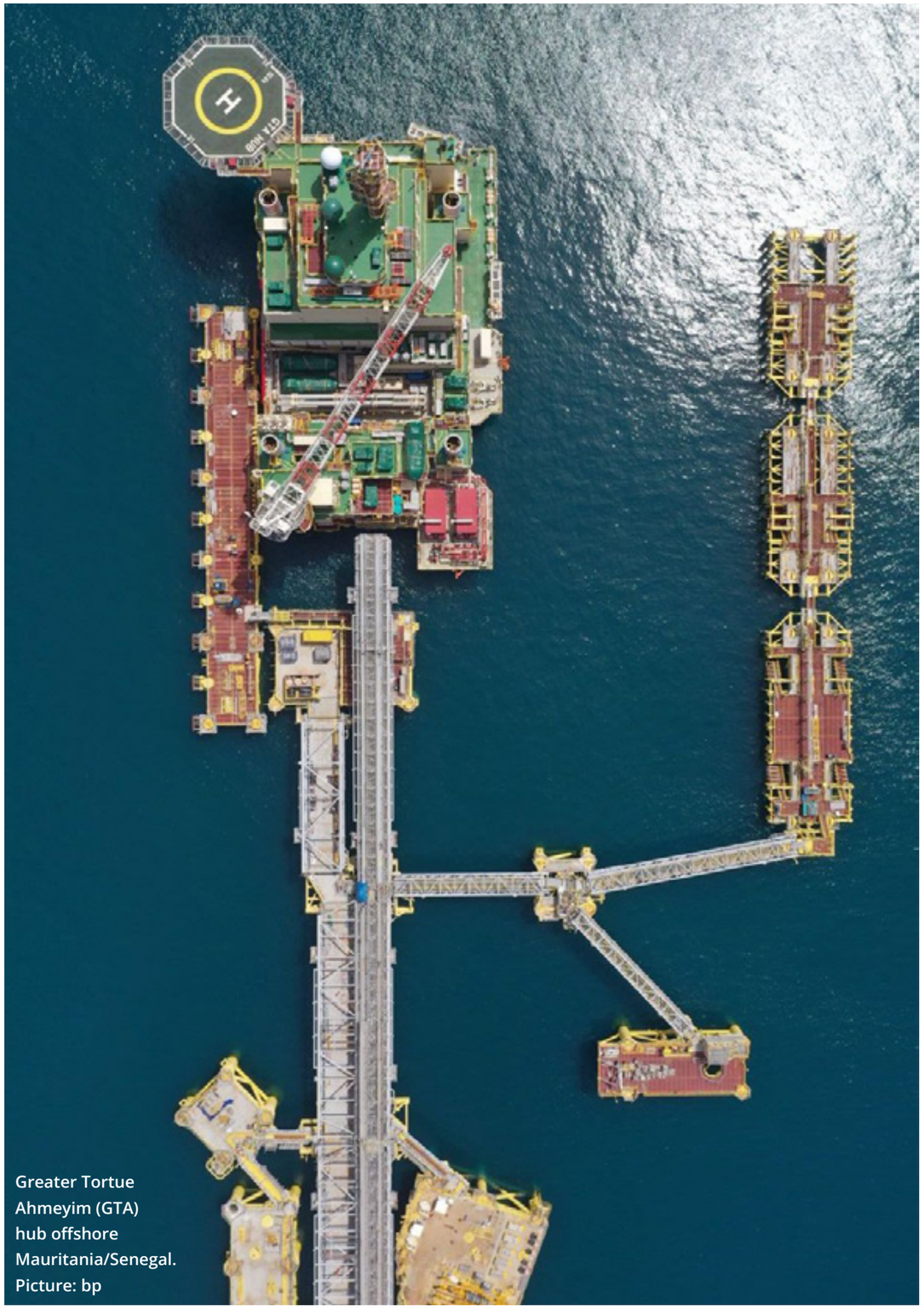
The IEA estimates that an additional 30 GW of gas-fired capacity will be brought online by 2030. In its Sustainable Africa Scenario (SAS), gas is expected to maintain the same share of modern energy as today (about 16%) by 2030. In that scenario, additional gas-fired generation is mostly developed to help meet rising energy demand, build grid flexibility to integrate renewable energies, and secure backup power in countries where hydropower dams experience droughts (see Section 2.3)[45].

Figure 29: Gas-to-power production (grid-connected) in selected African countries in GWh (2020)



Source: IEA, Hawilti Research

[45] *Africa Energy Outlook 2022, IEA*



Greater Tortue Ahmeyim (GTA) hub offshore Mauritania/Senegal. Picture: bp

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2.2 Africa's Export Market Opportunity

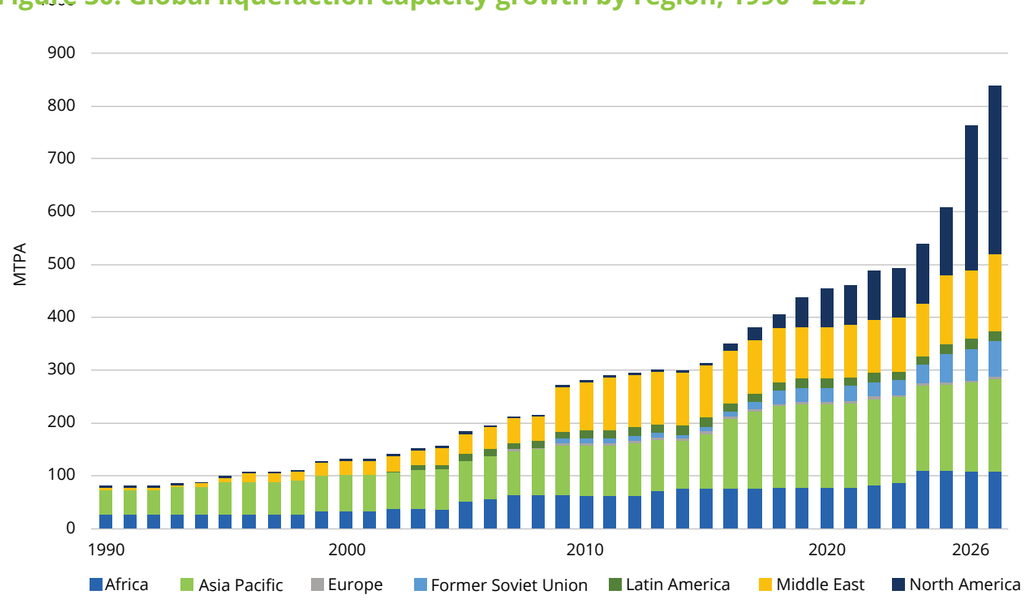
Leveraging Export Revenues to Energise Local Economies

The growth of global gas demand over the past two decades has supported the development of LNG trading across the world. Asia and Europe have emerged as robust demand centers importing vast quantities of LNG to fuel their economies, switch away from coal, and integrate more renewables. In 2022, the impact of the Russia-Ukraine conflict and the drastic reduction of Russian gas flow to Europe sent it on an urgent quest to secure alternative sources of gas supply, most of it via LNG.

The overall growth trend of global LNG demand has enabled African countries to monetise their gas for the lucrative export market and gave birth to several LNG export terminals on the continent. But Africa's export capacity has remained relatively small compared to its potential. With new market fundamentals calling for investments in LNG supply, the continent is now getting a new window of opportunity to position itself as a strategic and reliable global gas supply hub.

That window is not exclusive to Africa, however, nor will it stay open forever. A pragmatic approach, sense of urgency, and focus on competitiveness will be required for Africa to attract the billions of dollars that will be injected into LNG projects this decade (see Section 3. 3.).

Figure 30: Global liquefaction capacity growth by region, 1990 - 2027



Source: World LNG Report 2022, IGU/Rystad Energy

The limited rise of Africa's gas export industry

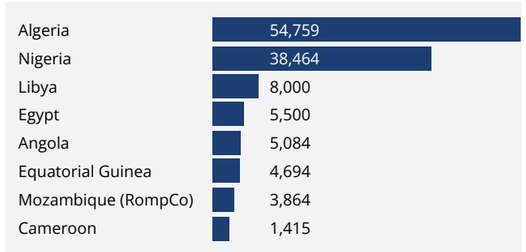
By 2021, Nigeria, Algeria, Egypt, Angola, Equatorial Guinea, and Cameroon were all LNG exporters with a combined global market share of 11.4%[45]. In the same year, Africa exported a total of 60.2 mt of LNG, most of which went to Europe (27.8 mt) followed by Asia (23.9 mt) and the broader Asia Pacific region (5.9 mt).

Additional exports are also ensured through pipelines, especially from Algeria via the Transmed Pipeline (Algeria-Italy via Tunisia), the Medgaz Pipeline (Algeria-Spain), and the Maghreb-Europe Pipeline (Algeria-Spain via Morocco[46]), but also from Mozambique to South Africa (ROMPCo) and Nigeria to Ghana (WAGP). Overall, African exports of gas have increased by over 75% since 2000, driven by the expansion of Nigeria's LNG (particularly in the years 2003, 2005, 2006, 2007), and by the commissioning of new LNG terminals in Equatorial Guinea (2007), Angola (2014-2016), and Cameroon (2018).

However, several additional capacity expansion projects have remained stalled and have prevented Sub-Saharan Africa from playing a larger role in the global LNG export market, subsequently missing out on supplying the current high-price environment created by an exceptionally tight market.

The Coral Sul FLNG offshore Mozambique exported its first cargo in 2022.
Picture: Eni

Figure 31: African natural gas exporters (2021), MMscm



Source: OPEC, Hawilti Research

Nigeria LNG for instance has remained a six-train facility with its last train commissioned back in 2007, while Nigerian gas reserves could easily support 10 trains at Bonny Island alone. Similarly, lack of investment in Equatorial Guinea has prevented the expansion of EG LNG, even though a FEED study for a second train there had been done in the mid-2000s. The country has also been unsuccessful so far in developing the 2.2 MTPA Fortuna FLNG project as the previous operator could not raise financing for the project in the mid-2010s.

Following a period of relative stagnation, the volume of gas exports from Africa will grow again in the short and medium term on the back of new projects in West and Southeastern Africa. In 2022, Eni commissioned its 3.4-MTPA **Coral Sul FLNG** unit in offshore Mozambique.

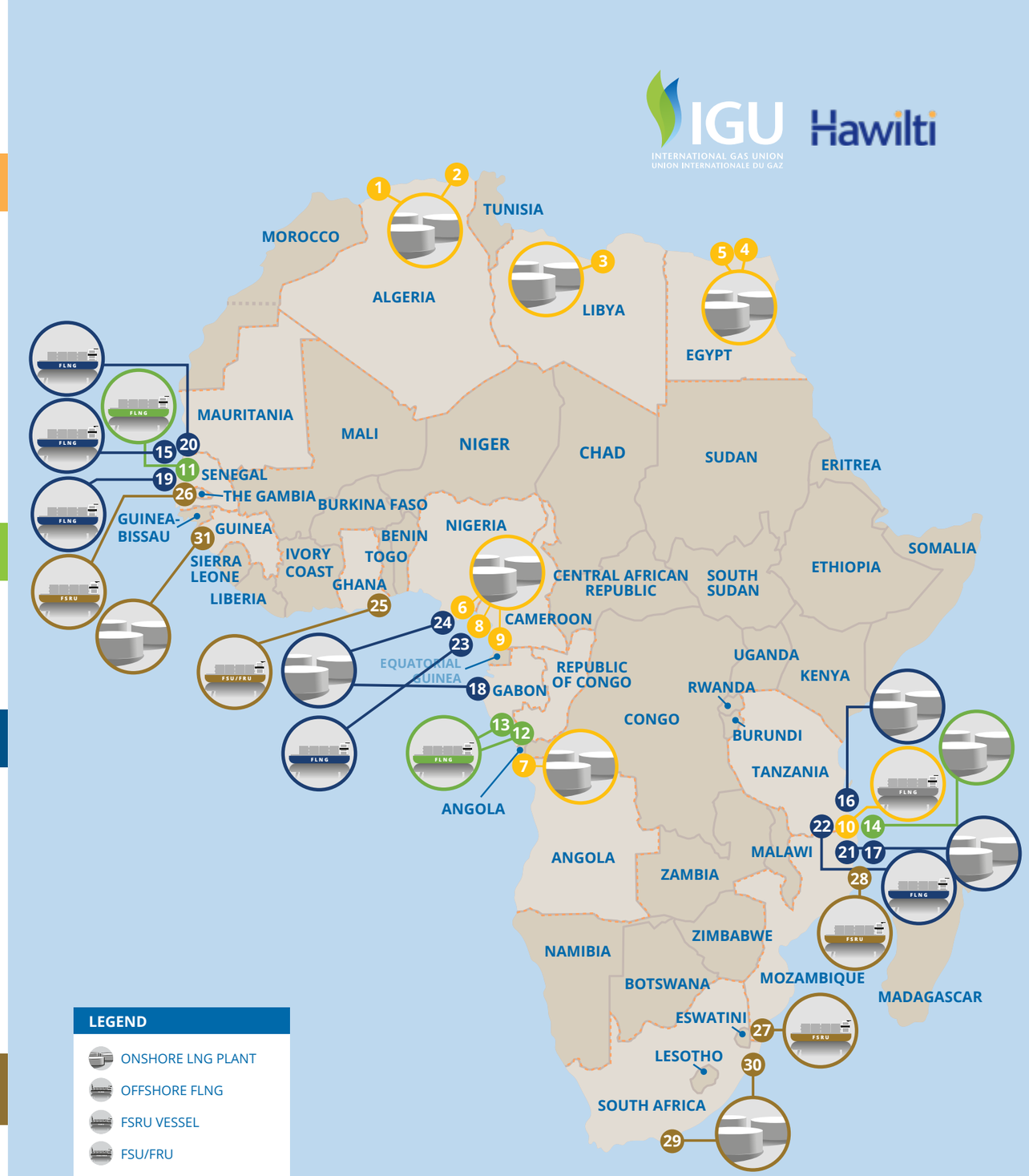
In 2023, bp will commission the **GTA LNG** hub at the maritime border between Mauritania and Senegal, adding another 2.45 MTPA of floating LNG export capacity. In the Republic of Congo, Eni is also moving forward with the installation of the **Tango FLNG** unit with a capacity of 0.6 MTPA expected to be commissioned before the end of 2023. These three floating LNG projects are the ones expected to grow Africa's LNG export capacity by 2025.

The second half of the decade could see more significant capacity addition coming from both established and new markets. By 2030, Nigeria LNG should have completed its **NLNGSevenPlus** (or Train 7) project, targeting an additional 7.6 MTPA. Similarly, TotalEnergies could have commissioned its 12.88 MTPA **Mozambique LNG** terminal, where construction could restart in 2023.

[45] *World LNG Report 2022, IGU*
[46] *Algeria stopped supplying gas to Morocco at the end of 2021. Morocco is currently getting its gas supplies from Spain, using the same pipeline in reverse flow.*

Figure 32: Africa LNG Infrastructure

	Existing LNG Export Infrastructure	Type	Capacity	Owner/ Operator	Commissioning
1	Arzew/Bethioua LNG (GLI-2-3Z)	Onshore	20.8 mtpa	Sonatrach	1977-2014
2	Skikda LNG (GLIK)	Onshore	4.5 mtpa	Sonatrach	2013
3	Marsa El Brega LNG	Onshore	3.2 mtpa	LNOC	1970
4	Damietta	Onshore	5 mtpa	Segas LNG	2005
5	Idku LNG	Onshore	7.2 mtpa	Egyptian LNG	2005
6	Bonny LNG	Onshore	22.5 mtpa	Nigeria LNG	1999-2007 under expansion
7	Soyo LNG	Onshore	5.2 mtpa	Angola LNG	2013
8	EG LNG	Onshore	3.7 mtpa	EG LNG	2007
9	Hilli Episeyo	FLNG	2.4 mtpa	Golar LNG	2018
10	Coral South	FLNG	3.4 mtpa	Eni	2022
	Under-Construction LNG Export Infrastructure	**Type**	**Capacity**	**Owner/ Operator**	**Commissioning**
11	GTA	FLNG	2.5 mtpa	bp	2023
12	Marine XII (Tango)	FLNG	0.6 mtpa	Eni	2023
13	Marine XII	FLNG	2.4 mtpa	Eni	2025
14	Mozambique LNG	Onshore	12.88 mtpa	TotalEnergies	2026
	Planned LNG Export Infrastructure	**Type**	**Capacity**	**Owner/ Operator**	**Commissioning**
15	GTA Ph.2	FLNG	2.5 mtpa	bp	2025/2026
16	Tanzania LNG	Onshore	15 mtpa	Equinor, Shell	2030
17	Rovuma LNG	Onshore	15.2 mtpa	ExxonMobil, Eni	TBA
18	Cap Lopez	Onshore	0.6 mtpa	Perenco	2026
19	Yakaar-Teranga	Possible FLNG	4.5 mtpa	bp	2026
20	BirAllah-Orca	Possible FLNG	TBA	bp	FID 2025
21	Mozambique LNG	Onshore	30 mtpa	TotalEnergies	2026
22	Coral 2	FLNG	TBA	Eni	TBA
23	Fortuna	FLNG	TBA	TBA	TBA
24	Padah	Onshore	3.4 mtpa	Sterling Group	2025
	Planned LNG Import & Regasification Infrastructure	**Type**	**Capacity**	**Owner/ Operator**	**Commissioning**
25	Tema LNG	FSU/FRU	1.7 mtpa	Helios Inv. Partners	2022
26	KARMOL LNGT Powership Africa FSRU	FSRU	84 MMscf/d	KARMOL	2022
27	Matola LNG	FSRU	TBA	TotalEnergies, Gigajoule	2025
28	KARMOL (ex. LNG Vesta)	FSRU	TBA	KARMOL	TBA
29	Coega LNG	Onshore	TBA	TBD	TBA
30	Richards Bay LNG	Onshore	TBA	Transnet SOC	TBA
31	Kamsar LNG	Onshore	TBA	West Africa LNG Group, Inc. (WALNG)	TBA



Source: World LNG Report 2022, IGU; Hawilti Research

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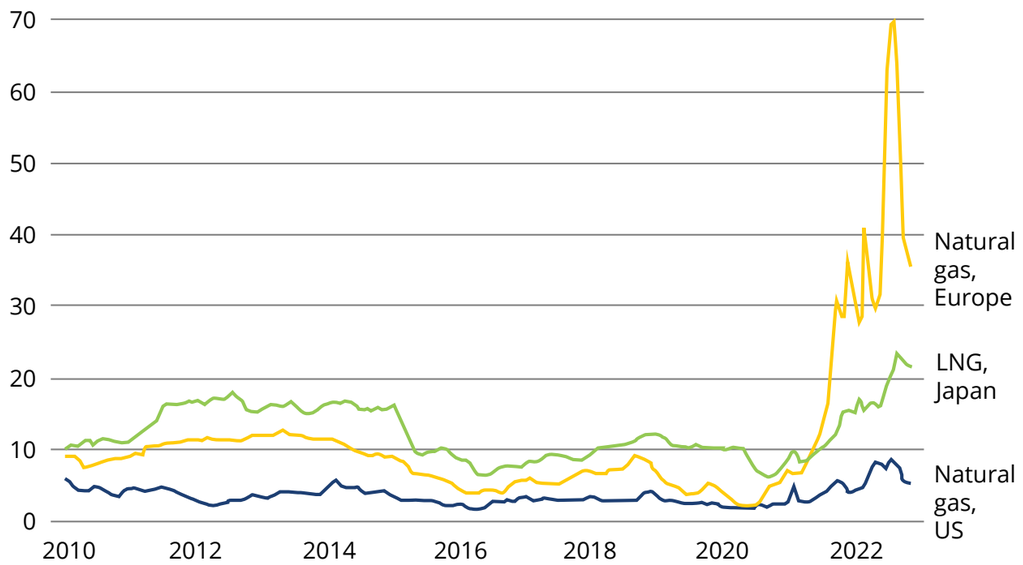
Market fundamentals call for more investments in LNG supply

Meanwhile, market fundamentals for LNG investment in Africa have witnessed a U-turn since 2021 and have become very favorable. Between 2015 and 2017, the decrease in global gas prices led to a slowdown in new LNG project investments contributing to the supply constraints in the market. The few projects that did get sanctioned after 2017 are now suffering delays. This is the case with African projects such as bp's GTA LNG Phase 1, delayed to 2023.

Meanwhile, the insurgency in Mozambique has also delayed TotalEnergies' 12.88 MTPA Mozambique LNG project, expected to be commissioned only in 2026 at the earliest. These delays have exacerbated the scale of the supply gap.

The Russia-Ukraine war added even more uncertainty, taking volatility in the gas markets to historically unprecedented levels, delaying key Russian LNG export projects and generating massive European demand for alternative sources of gas. But while short-term demand will be driven by Europe's transition away from Russian supplies, global markets in Asia will continue needing increasing volumes of gas in the long term. Shell's latest LNG Outlook (2022) expects global LNG demand to cross the 700-MTPA per year threshold by 2040, a 90% increase on 2021 demand.

Figure 33: Global gas prices, $/Mmbtu (2010-2022)



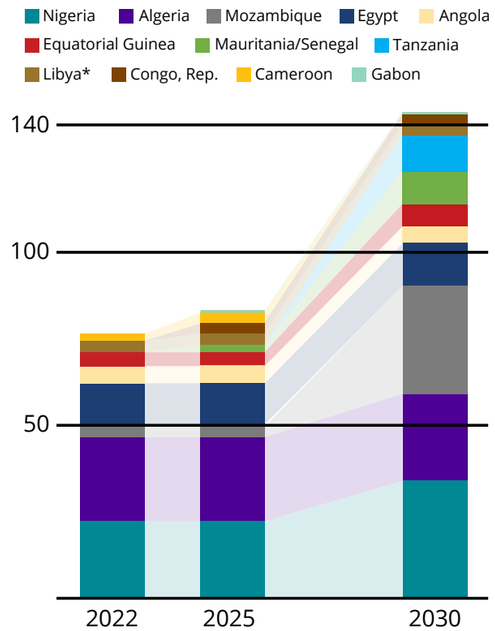
Source: World Bank

There is a plethora of pre-FID options in Africa that can boost the continent's export revenues and bridge the global supply gap.

These industry fundamentals are auspicious for African gas markets. The continent's list of pre-final investment decision (FID) LNG projects has grown over the past few years, and the current appetite for gas could provide a boost to several of them as they seek to reach financial close. Floating LNG projects are currently seen in a very positive light for their ability to start delivering cargo in under 2 years.

As Sub-Saharan Africa seeks to ramp up its LNG export capacity, it must ensure that new projects work in tandem with the development of its domestic markets to create a stronger business and societal case. In that regard, the development history of Nigeria's LNG offers a great example.

Figure 34: African LNG export capacity, mtpa (2022-2030)



Best-case scenario projections based on approved and pre-FID projects.
* Libyan capacity is unoperational

Source: IGU, Hawiliti Research

Figure 35: Selected pre-FID LNG projects in Africa

PROJECT	OPERATOR	CAPACITY	COUNTRY	STATUS
GTA Phase 2 FLNG	bp	2.5 mtpa	Senegal/Mauritania	FID expected in 2023/2024
Yakaar-Teranga	bp	4.5 mtpa	Senegal	FID expected in 2023
BirAllah-Orca	bp	TBA	Mauritania	FID expected in 2025
Tanzania LNG	Equinor/Shell	15 mtpa	Tanzania	FID expected in 2025
UTM FLNG	UTM Offshore	1.2 mtpa	Nigeria	FEED
Cap Lopez	Perenco	0.6 mtpa	Gabon	Project under study
Area 4 FLNG	Eni	TBA	Mozambique	Second FLNG under study
Fortuna FLNG	TBA	TBA	Equatorial Guinea	Under negotiations. Initial concept targeted 2.2 mtpa
Padah LNG	SEEPCo	3.4 mtpa	Nigeria	Tender documents issued in 2022
Rovuma LNG	ExxonMobil	15.2 mtpa	Mozambique	New concept under study
Nigeria LNG T8	Nigeria	TBA	Nigeria	Concept under study

Source: Hawiliti research, media reports

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CASE STUDY 2

Nigeria LNG's Contribution to the Development of the Nigerian Economy

Data from Nigeria LNG (NLNG), the continent's biggest LNG exporter, shows the extent to which gas projects can lift economies when they successfully combine export revenues with domestic supply and capacity building.

Sub-Saharan Africa's Flagship LNG Facility

NLNG's terminal on Bonny Island was Sub-Saharan Africa's first LNG export facility, with its initial train commissioned in 1999. The company is made up of four shareholders, including NNPC (49%), Shell Gas (25.6%), Total Gaz Electricite Holdings France (15%), and Eni International (10.4%). Over the past two decades, NLNG has become a six-train, world-class LNG facility and has delivered over 5,000 LNG cargoes around the world, where Nigerian gas is used to provide reliable power supply and decarbonise European and Asian grids.

NLNG has now embarked on the NLNG-SevenPlus (or Train 7) project, targeting a seventh train with a capacity of 4.2 MTPA and an additional 3.4 MTPA of capacity from the debottlenecking of existing trains.

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The company is by far the biggest venture for the monetisation of Nigerian gas, commercialising on average 38% of the gas produced every year in the country. Between 1999 and 2021, it had already generated over $124 billion in revenues, paid over $7 billion in corporate income tax, and generated over $19.5 billion in dividends to the Federal Government of Nigeria[47]. Over the same period, it generated considerable foreign direct investment (FDI) with current assets worth well over $19 billion.

Export and Domestic Supplies

NLNG is not purely an export business and has been increasing its domestic supplies of gas in recent years. Globally, the company manages several long-term LNG sales purchase agreements (SPAs), but it has also committed to supplying LNG to the domestic market. In June 2021, it signed 10-year SPAs with three local companies (Bridport Energy, Asiko Energy, and Gas Plus Synergy) to supply an initial 1.1 MTPA of LNG on a delivered ex-ship (DES) basis to the domestic market. The move facilitates the local availability of LNG to support gas distribution for Nigerian industries across the country. Beyond just LNG, NLNG also produces high-quality natural gas liquids (NGLs) including liquefied petroleum gas (LPG) and butane as by-products. Between 2007 and 2021, NLNG supplied over 2.4m tons of LPG to the Nigerian market via its Domestic LPG Scheme, which supports the domestic availability of cooking gas for Nigerian households. In early 2022, the company's board decided to allocate all its LPG supply to the Nigerian market, representing some 450,000 tons a year.

Local Content Development

As it embarked on expansion phases in the 2000s, NLNG put a focus on domestic capacity building and local content development. The company's Nigerianisation scheme resulted in 100% of its management team being Nigerian and 95% of its workforce being local. In addition, NLNG has provided over 12,000 direct jobs at the peak of each expansion project over the years, and the same number of jobs will once again be supported by its ongoing Train 7 expansion.

With the support of Nigerian banks, it set up a $1.2-billion local vendors' finance scheme to help its vendors access finance and boost local content. For Train 7, 55% of both engineering activities and procurement will be carried out in Nigeria by Nigerian vendors. The growth of NLNG is a demonstration of the impact gas can have on a developing economy. The company now represents 10% of Nigeria's total export revenue, employs thousands of Nigerians, and estimates its contribution to GDP at 4% between 2008 and 2014. Equally important, it is now the country's biggest supplier of domestic cooking gas and will start delivering LNG as well from 2023.

Picture: Nigeria LNG

[47] *Facts and Figures 2022, Nigeria LNG*

2.3. Africa's Just Energy Transition

The Decarbonisation Opportunity

For natural gas to continue playing its critical role in helping meet future energy demand in Africa while tackling climate change and improving air quality, encouraging the switch away from coal and diesel while managing methane emissions must become a priority for producers and consumers.

The urgency for effective management and elimination of methane emissions globally, as well as for ending routine flaring is growing. While the reduction of flaring offers attractive opportunities to cut carbon emissions and make more gas available for the local economies, the elimination of methane emissions calls for a new approach to projects' development, operations, and maintenance. It is a prerequisite for the gas industry's license to operate and to ensure a supply and delivery of gas to fuel a sustainable energy future, aligned with the Paris Agreement.

Gas is a pathway to the decarbonisation and strengthening of the African grid.

The current African energy supply mix relies significantly on highly emitting and polluting fuels, including coal, oil, and traditional biomass (see Section 1).

Switching coal-fired and diesel-fired power plants, which make up some 60% of the continent's electricity mix, to gas will help to decarbonise a significant share of Africa's power generation industry. According to the IEA, switching to gas-fired generation today would produce 45-55% less GHG emissions than coal. Replacing kerosene and diesel with gas in industries and homes can also reduce emissions by a third, according to IEA estimates. In addition, gas has a clean burning profile and low or zero emissions of the main air pollutants: PM2.5, sulfur oxides (mainly SO2), and nitrogen oxides (NOX)[48]. According to the Global Carbon Project,

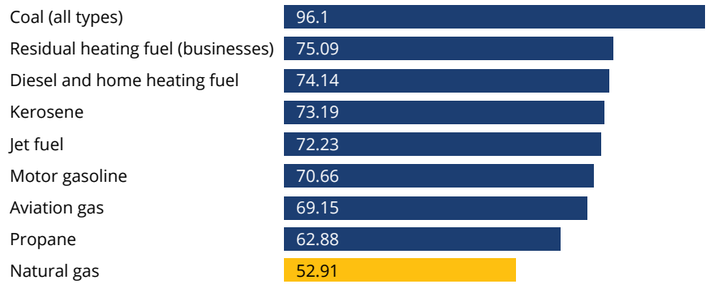
[48] *"The Role of Gas in Today's Energy Transitions", 2019, IEA*

Pollution from a coal-fired facility

Africa has been emitting over 400 million tons of CO2 every year from burning coal for the past two decades[49]. Current coal-related emissions are heavily driven by South Africa (85%), with the rest made up of much smaller polluters such as Morocco, Zimbabwe, Egypt, Botswana, and Zambia among others.

Some of these key coal consumers, including South Africa and Morocco, are moving ahead with domestic gas developments or gas import projects to secure supply, with the aim of retiring or switching several of their coal power plants. In November 2021, South Africa negotiated a Just Energy Transition Partnership with France, Germany, the United Kingdom, the United States, and the European Union to mobilise an initial $8.5 billion towards decarbonisation. The investment plan is targeted at scaling up renewable energy generation,

Figure 36: Carbon dioxide (CO2) emissions coefficients for homes and businesses



Source: U.S. EIA

[49] *Our World in Data based on the Global Carbon Project (2022)*

but also includes several policy reforms to increase gas usage within the country's power mix, retire coal stations, and stabilise the grid as wind and solar generation grows. As a result, South Africa is likely to remain the continent's biggest gas importer as it seeks to secure additional supplies via the construction of LNG import terminals on its coast.

Elsewhere, the focus is also on cutting diesel and HFO consumption within power plants by using gas instead. Ghana's LNG import terminal at Tema was notably set up to satisfy the excess demand requirements in Eastern Ghana where power plants are in shortage of gas and must often burn light cycle oil (LCO). The project is owned by Access LNG (Helios Investment Partners) and consists of a floating storage unit (FSU) and floating regasification unit (FRU). Once demand from the power sector is met, its expansion phase aims at replacing LCO, residual fuel oil (RFO), coal, and diesel for industrials as well.

In Senegal, where some 83% of generated electricity comes from diesel and HFO, several independent power producers (IPPs) are also planning to switch to gas once the commodity becomes available domestically. The CES, which owns the country's only coal power plant at Sendou, has also started working on plans to switch the station to gas and expand it to 360 MW. It is also in Senegal where KARPOWERSHIP is in the process of switching its 236-MW Ayşegül Sultan powership in the Port of Dakar from diesel to gas.

The Turkish contractor's joint venture with Mitsui O.S.K. Lines, KARMOL, is working on delivering several floating storage regasification units (FSRUs) to Africa to decarbonise KARPOWERSHIP's floating stations thereby consuming LNG instead of diesel and HFO. Its next one is being converted by Keppel Shipyard and is due for delivery in 2023 in Mozambique.

For many of these countries, replacing liquid fuels or coal within existing power plants is also a perfect way to address traditional barriers that come with developing domestic gas value chains (see Section 3. 2.). Most of them are small gas demand centers that would otherwise struggle to provide the kind of economies of scale that justify investing in gas infrastructure. As such, the existence of operating infrastructure assets that can absorb gas makes it an ideal scenario to anchor future lower-carbon energy infrastructure.

The quest for stable grids with lower carbon footprints is driving the appetite for gas amongst most of these countries that have traditionally relied on coal or diesel to generate electricity. For the same reason, gas imports are likely to rise in Africa over the coming decade and future gas imports by African countries will mostly be driven by their decarbonisation and energy transition agenda.

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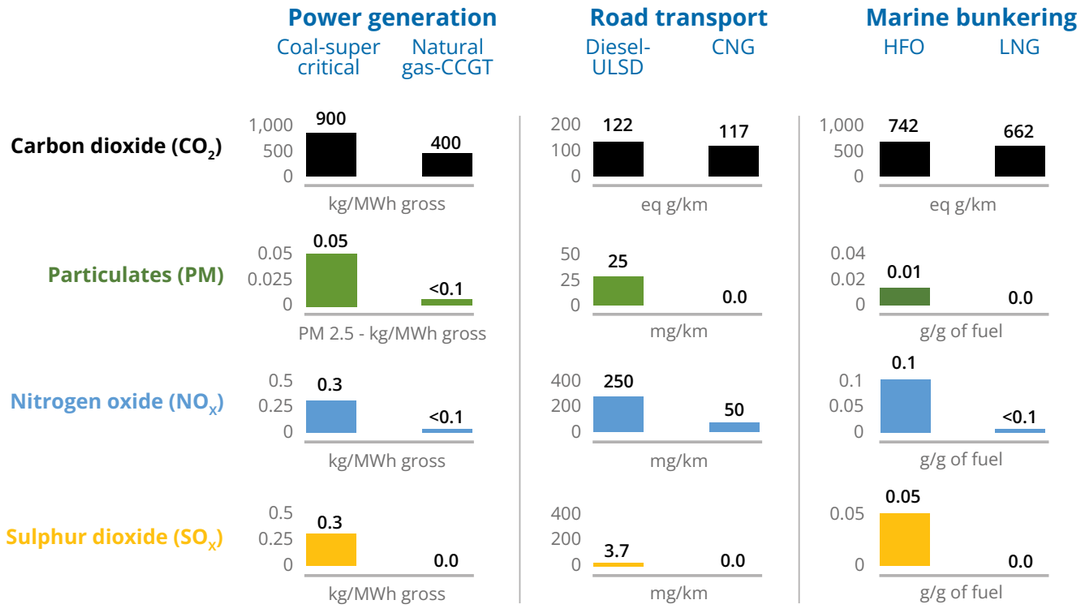
The switching opportunity for African industries

Beyond decarbonising the grid, developing domestic gas markets in Africa will also undoubtedly allow industries to switch to lower carbon sources of energy and be more competitive regionally. This is particularly relevant to tackling emissions from the continent's burgeoning diesel generators. In 2019, a study by the International Finance Corporation (IFC) estimated that these generators account for the majority of power sector emissions of nitrogen oxides (NOx) and fine particulate matter (PM2.5)[50]. Switching diesel with gas in these engines would significantly reduce operating costs and the environmental impact.

In West and Central Africa, gas provides an ideal source of energy to switch captive diesel power plants in the mining and manufacturing industries. Nigeria has pre-developed a few gas demand clusters served by trucked gas for over a decade, via what it calls "virtual pipelines". Several private operators can run on CNG and LNG via these networks that supply gas to captive power plants and a few truck fleet owners. Industry experiences have demonstrated that trucking CNG is

Figure 37: Emissions factors for natural gas vs. coal and oil



Source: NETL, EEA, OIES, BCG analysis

[50] *The Dirty Footprint of the Broken Grid – The Impacts of Fossil Fuel Back-up Generators in Developing Countries, September 2019*

very beneficial to meeting power demand of up to 8-10 MW, after which LNG becomes more economical because it is denser.

The Nigerian experience shows how CNG players were able to capture and develop demand from the industry before LNG was able to get into the market. As demonstrated in our previous case study, Increased demand for gas even pushed Nigeria LNG to sign agreements in 2021 with domestic companies to supply 1.1 MTPA of LNG on a DES basis to the domestic market.

Gas consumption has become essential to the survival of Nigerian industries and manufacturers, according to Ken Etete, Group CEO at the Century Group. Its subsidiary GasPlus Synergy has recently achieved infrastructure readiness to receive LNG in Nigeria and distribute it across the country. According to him, the capacity to negotiate friendly, stable, long-term gas sales contracts and access locally available gas as cleaner and more efficient fuel is gaining traction in the region.

Just next door in Ghana, gas is becoming popular amongst mining companies who want to run cleaner operations. In 2022, American energy solutions provider Genser Energy closed a $425-million funding package to support the expansion of its midstream gas business in the country and meet the growing demand for gas from the mining sector. Miners in Ghana are seeking to secure gas both for power and for transport, with Goldfields Ghana aiming to convert up to 60 Caterpillar Mine Haul trucks from diesel fuel to LNG or diesel dynamic gas blending (DGB) systems by 2031.

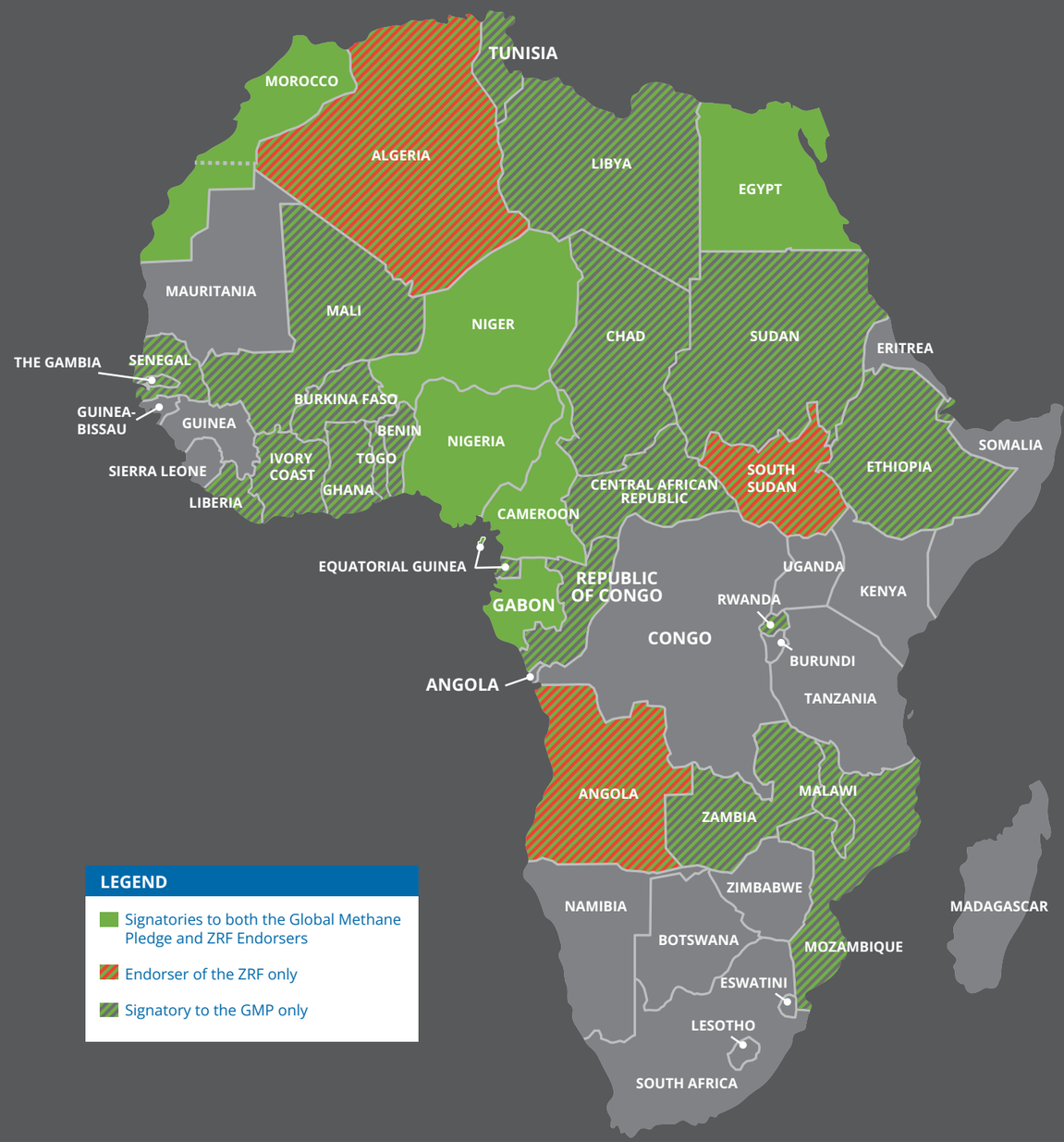
Soaring oil prices since 2021 have exacerbated this switching trend because of the disastrous economic impact they have had on manufacturing industries and their operational expenditures. Switching to gas is not only a carbon issue but has also become a matter of survival for many African industries. With up to 100 GW of back-up diesel power generators operating across the continent, the potential to switch to cleaner, locally available, and more affordable fuels is significant.

Managing and eliminating methane emissions is a prerequisite for Africa's gas sector to remain competitive and sustainable.

In 2021, the USA and the European Union led the launch of the Global Methane Pledge at COP 26 in Glasgow. The Pledge has now gathered 150 signatories who have all agreed to take action to reduce global methane emissions by at least 30% below 2020 levels by 2030[51]. The initiative has been joined by some of the continent's biggest oil and gas producers,

[51] *https://www.globalmethanepledge.org*

Figure 38: African signatories to the global methane pledge (GMP) and endorsers of zero routine flaring (ZRF) by 2030



SOURCE: World Bank, Global Methane Pledge

including Nigeria, Egypt, Congo, and Gabon.

Achieving the Global Methane Pledge target requires widespread implementation efforts in key sectors including energy, agriculture, and waste. Oil and gas represent up to a fifth of methane emissions from human activity)[52], and the share between the two is roughly equal. Hence, actions in the natural gas value chain present a significant opportunity to reduce human-made methane emissions. For the same reason, the reduction of flaring, venting, and fugitive emissions provides valuable near-term opportunities to limit climate change and one where Africa can make a noticeable difference.

Methane emissions in the natural gas supply chain can arise from venting, fugitive emissions, or incomplete combustion (otherwise known as "methane slip"). Their successful management and reduction require the implementation of several industry practices that have so far been only sparsely adopted on the continent. Chief amongst them are the 10 best practices identified by the Methane Guiding Principles to which the International Gas Union is an associate signatory[53].

The primary focus is on the identification, detection, valuation, and quantification of methane emissions across infrastructure assets to develop necessary response measures and repair programmes when and where needed. Unfortunately, beyond flaring detection, very little data is currently available on methane emissions in Africa, especially when it comes to fugitive and venting emissions data. This area should be prioritised, as data collection and standardisation is a lengthy process that requires assessments over a sufficiently representative set of assets for at least a year to understand where, when, and what methane emissions may be occurring[54].

The second one is the execution of periodic leak detection and repair surveys (LDAR) and the rollout of robust asset integrity and maintenance programmes on existing and future gas infrastructure. This is especially the case for key assets such as storage tanks, compressors, and glycol dehydrators that are traditionally prone to venting, but also for key upstream and downstream assets such as wellheads, pipelines, and LNG transmission and distribution infrastructure.

Additional principles worth noting include the implementation of effective engineering design and construction strategies to tackle methane loss possibilities right from the project's conceptual phase; the recovery, processing, or storage of associated gas to eliminate flaring (see below); the improvement of combustion engines' efficiency when gas is used as a fuel; and the inspection and repair of emitting pneumatic devices, or their replacement with electrical pumps and controllers or mechanical controllers.

The topic of methane emissions reductions and the rapidly developing new technologies and practices to continuously improve the efficiency and effectiveness of mitigation is vast and critically important. It is outside of the scope of this report to delve much deeper into their examination; however, it is highly recommended for African gas leaders to consider and implement the Methane Guiding Principles. Methane Guiding Principles can be accessed at https://methaneguidingprinciples.org.

Flaring reduction projects can significantly contribute to emissions reduction while making more energy available to growing African economies.

So far, the best-known measures to mitigate and manage flaring in Africa involve the capture and monetisation of associated gas, thereby improving energy security in most affected countries. Most African oil and gas producing markets have indeed recognised the need to reduce flaring, or the process of burning associated gas that indirectly comes with oil production activities. To do so, they have joined the World Bank's Zero Routine Flaring by 2030 Initiative (ZRF)[55], which commits governments and companies to stop routine flaring on greenfield oil projects and end routine flaring on existing oilfields by no later than 2030.

Besides adherence to global flare reduction initiatives, most African producing countries are committed to minimising or eliminating methane emissions within their oil and gas sectors and have all adopted different approaches to tackle flaring, with varying degrees of success.

The World Bank's Global Gas Flaring Reduction Partnership (GGFR) estimates that Africa's oil producers still burn on average 30 bcm of associated gas every year[56]. While Africa represents less than 10% of global oil production, it accounts for 20% of global flaring volumes. Such volumes represent CO2 emissions of over 80 million tons every year and a value loss of $3.46 billion in gas sales last year according to World Bank data[57].

The continent's biggest oil producers naturally flare the most, with Algeria,

[52] *Global Methane Tracker, 2022 (IEA)*
[53] *https://methaneguidingprinciples.org/resources-and-guides/best-practice-guides*
[54] *IEA*
[55] *https://www.worldbank.org/en/programs/zero-routine-flaring-by-2030/endorsers*
[56] *Global Gas Flaring Tracker, World Bank*
[57] *Idem*

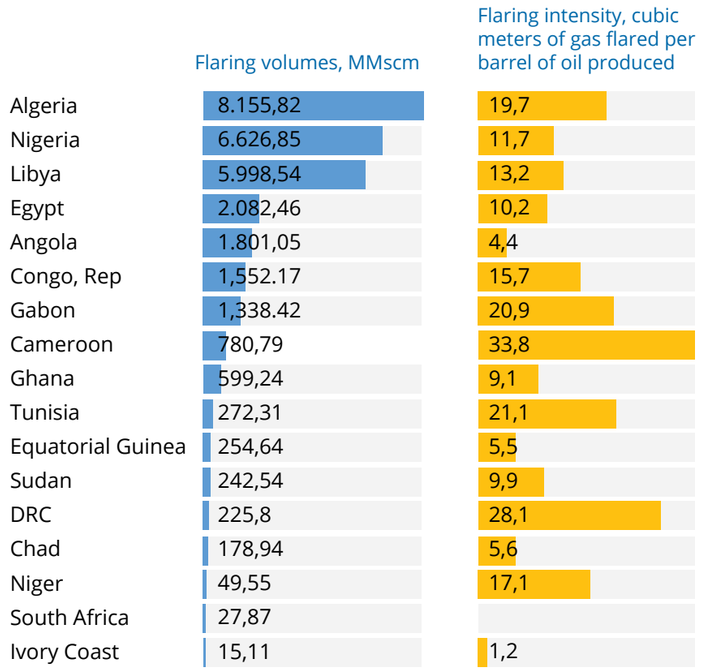
Nigeria, and Libya representing 70% of flaring emissions in Africa in 2021. However, smaller producers flare more gas relative to their production. Data from the World Bank shows that flaring intensities in Africa are the highest in Cameroon, the DRC, Tunisia, and Gabon. In that regard, the Gulf of Guinea should be subject to increased stakeholders' attention as significant improvements could be made from an intensity perspective there (especially in the DRC, Gabon, and Cameroon). The region is particularly representative of the challenges faced by African operators of producing oil and gas resources more sustainably.

Emissions there are scattered across hundreds of small fields where gas is produced in low volumes and at low pressure (see case study below). This in turn makes the development of processing and distribution infrastructure a capital-intensive and technologically challenging venture.

According to the latest IEA estimates, reducing flaring and venting in Africa could make some 10 bcm of gas available in the short term for export, without the development of any new supply and transport infrastructure[58].

However, success has been limited so far, and in cases where flaring has been reduced, its intensity has increased. For Africa to capitalise on its resources and ensure its long-term viability, financeability, and sustainability, it will need to institute serious change. Angola provides one example of taking the right steps toward that change.

Figure 39: Flaring in Africa (2021)



Source: Global Flaring Reduction Partnership (GFRP), World Bank

[58] *Africa Energy Outlook 2022, IEA*

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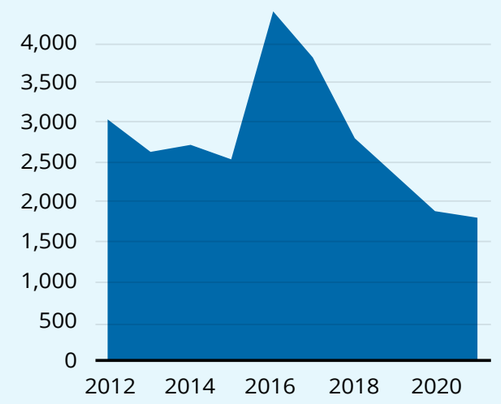
CASE STUDIES 3, 4 & 5

Actions on Flaring Reductions

3) ANGOLA adopted material sanctions against flaring as early as 2009. In doing so, it incentivised operators to process associated gas while creating an integrated value chain for its monetisation. Fiscal measures encouraged investments in midstream gas infrastructure, including the Angola LNG export terminal at Soyo, while various regulations enabled operators to re-inject gas, commercialise the surplus, or transfer it as feedstock to Angola LNG.

Figure 40: Flaring volumes in Angola, MMcm (2012-2021)



Source: Global Flaring Reduction Partnership (GFRP), World Bank

These initiatives were accompanied by strict enforcement of regulations equally applicable to all industry participants, public and private. By 2021, Angola's flared gas volumes had come down to 1.8 bcm compared with 3 bcm in 2012.

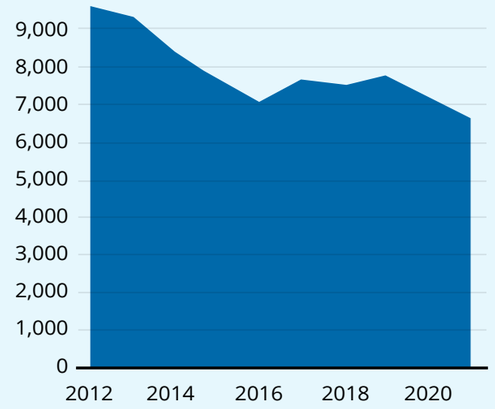
The drop is particularly significant after 2016, the year when Angola LNG's terminal became fully operational and was able to offtake most of the associated gas from offshore fields.

4) **NIGERIA** has adopted a similar approach, although material anti-flaring sanctions were adopted only recently. The country's efforts to cut flaring date back to the development of the Nigeria LNG Bonny LNG export terminal in the 1990s. Most feedstock for LNG production comes from associated gas that was previously flared, to such an extent that the commissioning and expansion of Nigeria LNG led to the monetisation of about 218 bcm of associated gas and decreased flaring in the country from 65% in 2001 to less than 20% today. It is expected that this trend will continue toward elimination.

Flaring reduction became national policy in 2015 when Nigeria included specific commitments to reduce flaring into its nationally determined contributions (NDCs) zat the foundational COP21 Paris meeting, which produced the Paris Agreement.

Regulations on flare gas came into force in 2018[59] as a result. Under these regulations, flare penalties were set at $2 per 1,000 standard cubic feet per day (scfd) of gas for companies producing 10,000 barrels of oil per day (bopd) or more and $0.50 per 1,000 scfd for companies producing less than 10,000 bopd. Efforts to cut flaring were further strengthened with the adoption of the Petroleum Industry Act (PIA) in 2021, which lightened fiscal provisions around the monetary sanctions.

Figure 41: Flaring volumes in Nigeria, MMcm (2012-2021)



Source: Global Flaring Reduction Partnership (GFRP), World Bank

Flaring has continued to steadily decrease in Nigeria, reaching approximately 6.6 bcm in 2021 against 9.6 bcm in 2012 (see Figure 41). However, a significant part of the reduction in the flaring volumes is also tied to a drop in the country's overall oil output while, concerningly, flaring intensity has increased by 10% over the past decade. Nigeria's 2018 regulations on flaring were a step in the right direction, but more needs to be done if the country wants to meet its NDC commitment of ending flaring by 2030.

Moving forward, Nigeria plans to focus on addressing flaring across hundreds of small and disparate fields. In that respect, the regulator has relaunched in September 2022 an auction of these flare sites under the Nigerian Gas Flare Commercialisation Programme (NGFCP), a competitive process initially announced in 2016, under which flare sites are auctioned to investors seeking gas. Hopes are that the relaunch and restructuring of this bid process will attract technically and commercially competent third-party investors to these flare sites. The process is now ongoing and proposals are to be submitted at the end of February 2023.

Picture: Seplat Energy

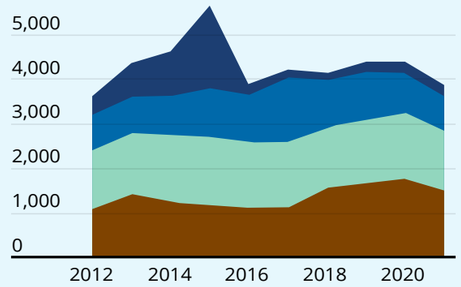
[59] *Flare Gas (Prevention of Waste and Pollution) Regulations, 2018*

5) The **GULF OF GUINEA** in Central Africa is home to the continent's small and medium-sized oil producers with production ranging from 100,000 to 300,000 bopd on average. It illustrates a shared challenge in Africa's efforts to reduce emissions and flaring, because the bulk of its flared volumes often comes from small and disparate fields spread across very large onshore and offshore areas, making flare elimination projects economically challenging.

An equally important challenge is that most flared gas is in small volumes and at low pressure, so operators need to make significant investments into the development of high-pressure gas networks to aggregate and distribute their associated gas, providing they find off-takers for it. This partly explains why oil-producing countries like Cameroon, Gabon, the Republic of Congo, and the DRC have some of the highest flaring intensity indexes in the world.

Thankfully, governments there have committed to eliminating routine flaring and are increasingly promoting the use of gas domestically to create a value chain that can absorb associated gas. Meanwhile, operators have developed innovative business models and projects that can address the technological and economical challenges of tackling methane emissions from marginal and mature fields.

Figure 42: Flaring volumes in Nigeria, MMcm (2012-2021)



Source: Global Flaring Reduction Partnership (GFRP), World Bank

Independent operator Perenco, the largest oil and gas producer in Central Africa, is leading such efforts in cooperation with regulators and industry stakeholders. Perenco's approach has been to first anchor the development of its small gas reserves with the domestic power sector, and then diversify the products made from gas (LPG, CNG, LNG) in a second phase to ensure additional revenue streams and make its projects economically feasible. Interestingly, this business model puts the export market as the third component and final stage of development.

Cameroon was the first country to benefit from such a strategy. Perenco's fields there initially supplied gas to the 216-MW Kribi Power Station, before the additional investment was made to develop remaining gas reserves to supply 26,000 tons of domestic LPG per year and export 1.2m tons of LNG annually via the FLNG Hilli Episeyo from 2018 onwards.

This new business model has proven so successful that Perenco is now replicating it to monetise flared gas in Gabon and the DRC. In northern Gabon, the company has already developed a 400-km offshore gas network back in 2006 and a compression station at Batanga to supply previously flared gas to the power stations of Libreville and Port Gentil.

It has since then installed additional compressors to further reduce flaring and supply up to 1.13 MMscmd of gas to both power plants. The existence of such a network has enabled the company to make an additional investment and it is currently building a $50 million LPG production unit at Batanga to produce some 15,000 tons of LPG a year for the domestic market.

But moving forward, its plans in Gabon also include the development of a scalable power station at Mayumba in the south of the country, a region with very little access to electricity. A memorandum of understanding (MoU) will be signed with the Government of Gabon in 2023 for the project, which involves the power station in the first phase before ramping up gas utilisation to set up a 0.6 MTPA LNG terminal at Cap Lopez and developing the domestic gas-to-industry segment to supply Gabon's growing mining industry and possibly the future Mayumba deep-water port.

In the DRC, the same scheme is being planned, starting with a power station in Muanda on the coast before increasing gas utilisation via CNG and for the future Banana Deep-water Port developed by DP World.

Picture: Perenco

2 / Africa's Natural Gas Imperative

In conclusion, while Africa has had some degree of success in cutting flaring, results have stagnated. The cases of Nigeria and Angola have demonstrated the important role of policy to drive emissions reductions, including the set-up of penalties and the development of infrastructure projects able to off-take associated gas.

However, while policy frameworks have significantly improved in recent years, there remains a significant opportunity for improvement.

Where they exist, the current policies are largely inconsistent across the continent. Most still do not cover fugitive methane emissions or do not cover both flaring and venting within the same framework. This would notably help capture the whole value chain and include emissions from midstream and downstream infrastructure as well.

Gas flaring in Nigeria

Figure 43: Global flaring and venting regulations: A comparative view of African Policies

	Targets/ limits are set	Authorities are empowered by legislation and regulation	Emergency flaring/venting allowed without prior approval	Routine flaring or venting is prohibited	Development plans must include provisions for use of associated gas	Associated gas projects require an economic evaluation	Measuring and reporting standards are prescribed	Monetary fines, penalties and sanctions imposed for violations	Non-monetary sanctions are imposed for violations	Engineering performance requirements are set	Fiscal incentives provided for reductions	Market-based incentives provided for reductions	Mid- and downstream regulations encourage reductions
Algeria	Y	Y	Y	Y	Y	Y	N	-	-	N	Y	N	Y
Angola	N	Y	N	Y	Y	Y	Y	Y	N	N	Y	N	N
Egypt	N	Y	N	N	N	N	N	N	N	N	N	N	Y
Gabon	Y	Y	N	Y	Y	N	N	Y	-	N	N	N	N
Libya	N	Y	N	N	Y	Y	-	N	-	N	N	N	N
Nigeria	Y	Y	-	Y	Y	Y	Y	Y	Y	-	Y	Y	Y

Source: World Bank (May 2022)

Natural gas and its infrastructure today form a progressive highway to a low-carbon future.

Africa needs gas to support the development of resilient grid infrastructure. These are needed to integrate significant shares of variable renewable and distributed energy, without compromising energy security or economic development.

African power grids, where they exist, remain largely weak and unstable, which is a bad combination for any significant renewable capacity integration. To allow for this, the grid needs sufficient flexibility, and that means African power networks need to be expanded and reinforced with a reliable supply of dispatchable power-generation resources that are available in sufficient quantities and on demand[60]. While hydropower and geothermzal energy are ideal options to generate frequency control and dispatchable power in East Africa, gas is an essential tool for most of the rest of the continent to build robust and flexible electricity grids. In that regard, developing gas-to-power must be part of the process of building and expanding reliable power systems that can integrate intermittent energies and pave the way for a low-carbon energy mix.

Once resilient African grids are in place, anchoring intermittent energy and adding large-scale renewables will become much more feasible without further compromising reliability. For the same reason, the IEA sees gas maintaining its role as the leading source of grid flexibility in Africa[61]. Globally, it actually forecasts a significant increase in flexibility needs as the shares of solar PV and wind grow in the electricity mix. In its Announced Pledges Scenario (APS), the IEA predicts that power system flexibility[62] needs will double by 2030 and then double again by 2050[63].

Equally important, gas infrastructure developed today will provide a long-term backbone for integrating decarbonised, low-carbon, and zero-carbon gases that African countries will need to achieve low-carbon or carbon-neutral economies in the future.

Globally, biofuels are increasingly embracing biomethane and renewable gas produced from biological materials like organic waste instead of fossil fuel deposits. Biomethane is the same substance as natural gas and can integrate seamlessly into existing gas infrastructure, making it very attractive and cost

[60] *Because renewable generation sources like wind and solar fluctuate based on the weather, dispatchable backup resources are required to maintain the electricity network stability.*
[61] *Africa Energy Outlook 2022, IEA*
[62] *Measured as the amount the rest of the system needs to adjust on an hourly basis to accommodate demand patterns and the variability of wind and solar output. The IEA mentions four main sources of flexibility in power systems: generation plants, grids, demand-side response and energy storage.*
[63] *World Energy Outlook 2022, IEA*

efficient to develop in countries where a gas network is already in place. Of the proven low-carbon gas technologies (renewable gas, hydrogen, and and carbon capture, utilisation, and storage or CCUS), renewable gas holds the highest potential to reduce emissions in existing natural gas networks because it comes with no constraints on blending or combustion. When renewable gas feedstock is produced using sustainable agricultural practices, it can achieve emissions reductions of at least 80% for instance[64].

Gas infrastructure also provides a backbone for the gradual blending and integration of hydrogen within the energy mix. In Mozambique, the 420-MW Temane gas-fired power plant currently in construction will notably be equipped with SGT-800 turbines that can blend up to 70% hydrogen in the future.

Gas pipelines can also be converted to carry up to 100% hydrogen, though this requires significant investment equivalent to around ¼ of the cost of building new hydrogen pipelines[65]. Medgaz, for instance, is carrying out studies in 2023 to examine the compatibility of its 10-bcm-per-year pipeline infrastructure with a view to linking Algeria to Europe for the transportation of hydrogen and natural gas.

When it comes to hydrogen production, projects have been minimal in Africa so far and remain carbon intensive. Production is mostly oriented towards ammonia-based fertilizer and relies on natural gas feedstock or coal. But developed African economies with efficient power infrastructure or large electricity off-takers are now looking to the future and serving as pathfinders in the production of green hydrogen. Egypt and South Africa are natural leaders in that aspect, but projects are also planned in Morocco, Mauritania, and Namibia. However, green hydrogen production requires significant electricity generation and water capacity, which makes its scalability unlikely across the continent in the short-term. Blue hydrogen, on the other hand, has more potential because it relies on natural gas. Hydrogen solutions are being put on the table as part of large upcoming LNG facilities in countries like Nigeria and Tanzania.

Elsewhere in Africa, innovation could mostly come from major energy companies seeking to decarbonise their assets and develop low-carbon projects. In the short-term, additional low-electrification and CCUS solutions can be expected from the power generation and LNG industries.

Using CCUS, blending low-carbon and zero-carbon gases like hydrogen, or scaling up renewable energy generation capacity are all steps towards the goal of a carbon-neutral supply. But building a low-carbon future relies on strong foundations that most African nations are yet to cement.

[64] *"A greener gas grid: what are the options?", 2017, Imperial College London*
[65] *Global Renewable and Low-Carbon Gas Report 2021, IGU*

3 / Bridging the gap

Assessing barriers and solutions to the development of African gas markets and how to overcome them

View of the Maria-Gléta power plant in Benin
Picture: Presidency of Benin

Natural gas is a critical component of Africa's fight against energy poverty and has been chosen by many African governments as the energy required to provide baseload electricity, anchor future low-carbon power infrastructure, integrate more renewables, and deliver modern energy to households and industries. However, making the most of African natural gas resources requires Africa's policymakers and industry stakeholders to address several local and global barriers to development.

3.1. Challenge 1: Overcoming Financing Barriers

The financing of capital-intensive energy projects in Africa faces two major barriers.

The first one is the growing debt burden of many African governments, which in turn raises debt service expenditures and debt-to-GDP ratios and increases default risk, leaving little room for budget allocation to infrastructure projects.

The second is the movement of many global asset managers away from all hydro-carbon related investments to support their net-zero pathway aspirations. In that process, gas is often treated on par with coal and oil, despite their significant differences in emissions impacts and decarbonisation potentials.

This blunt policy mechanism can be arguable for its emissions implications in poorer areas like Africa, where the available alternative to gas is not renewable electricity, but rather coal, diesel, and most of all, polluting biomass. Concretely, both challenges translate into insufficient public spending on gas infrastructure projects, compounded by the drying up of global development capital from anything gas related.

Shareholder pressure to divest out of hydrocarbons drove significant cuts to the capital available for financing gas projects in emerging markets by several global financial powerhouses and development finance institutions (DFIs). As of 2021, 587 investors representing over $46 trillion in assets under management had signed the Global Investor Statement to Governments on the Climate Crisis[66]. Ahead of COP26, the Glasgow Financial Alliance for Net Zero (GFANZ)[67] had also gathered over 450 financial firms across 45 countries responsible for over $130 trillion in assets, all committed to accelerating global decarbonisation. Both initiatives sent a strong message about the accelerating phaseout of fossil fuels and increased scrutiny for any hydrocarbon-related investment. Because most financial institutions do not make distinctions between coal, oil, and natural gas, the pressure to stop funding all hydrocarbons has negatively impacted gas projects despite their demonstrated emissions reduction and improvements to air quality, in addition to positive socio-economic development impact.

This growing withdrawal of investments has had a concrete impact on Africa. Some of the continent's biggest financiers, including the African Development Bank (AfDB), are finding it increasingly difficult to support gas project developments that require loan syndication and foreign partners. Because local banks are limited by their capital base, they cannot finance major gas projects on their own. For TotalEnergies' Mozambique LNG project for instance, $14.9 billion had to be raised in project finance from multiple financial institutions, led by Export Credit Agencies (ECAs) along with commercial banks. The withdrawal from funding gas projects is particularly affecting development and concessional finance[68], which used to support several gas projects for their poverty-reducing and economic development value. Development and concessional finance have indeed traditionally played an important role in mitigating the risks associated with gas projects in Africa.

The removal of this source of de-risking capital will significantly reduce Africa's options for financing its projects. For example, without DFIs' guarantees or patient risk capital, most of Africa's recent gas-to-power plants would have never been built in the first place. In that regard, the withdrawal of development finance from downstream gas and gas-to-power projects is a serious cause for concern for Africa's electrification and moving the needle on energy access.

Picture: Sasol

[66] *Institutional Investors Group on Climate Change (IIGCC)*
[67] *https://www.gfanzero.com/*
[68] *Below market rate finance provided by major financial institutions, such as development banks and multilateral funds, to developing countries to accelerate development objectives (World Bank definition).*

Figure 44: DFI natural gas finance policy status

DFI (Country/Region)	Indicatied or implied support for gas	Restrictions on most fossil fuels, with exceptions of gas	Ban on all fossil fuels (including gas)	No mention of gas restriction
ADB (Asia)	x			
AfBD (Africa)	x			
CDB (CHN)	x			
DFC (USA)		x		
EDFIs (Europe)		x		
BIO (BEL)		x		
BMI-SBI (BEL)				x
CDC (UK)		x		
COFIDES (ESP)				x
DEG (DEU)		x		
Finnfund (FIN)		x		
FMO (NLD)				x
IFU (DEN)			x	
Norfund (NOR)	x			
OeEB (AUT)		x		
Proparco (FRA)		x		
SIFEM (CHE)				x
SIMEST & CDP (ITA)				x
SOFID (PRT)				x
Swedfund (SWE)			x	
EIB (Europe)			x	
ERBD (Europe)				x
FinDev (CAN)				x
IDB (Latin Am.)	x			
IsBD (Islamic states)		x		
JICA (JPN)	x			
KDB (KOR)	x			
World Bank		x		
IFC (WB)				x

Note: while several DFIs still make exceptions for gas, most of these exceptions will end in 2030 and/or come with stringent ESG-related scrutiny and alignment with the Paris Agreement.
Source: Energy for Growth Hub (2021)

Solution 1: Futureproofing gas projects can help ensure global capital remains available for gas projects in Africa.

Considering ongoing shifts in global policy-making and capital markets, future-proofing needs to become a priority for African gas projects[69]. This will enable African developers to anticipate the future and develop adequate measures to mitigate the impact of their projects by building resilient and bankable business models. As part of the process, assessing each project's compatibility within the Paris Agreement's stipulations is a necessity, especially when seeking to attract foreign capital.

While gas can serve as the ideal fuel to displace coal and immediately reduce emissions, it is also the only fossil fuel that is itself 'decarbonisable' at scale. Natural gas infrastructure also provides a resilient, long-term network for delivering low-carbon and zero-carbon gases (see Section 2.3.).

New gas infrastructure can and should be designed in a way to enable the further scaling up of these low-carbon and zero-carbon gases and ultimately help meet the objectives of the Paris Agreement. In doing so, future gas development plans would be aligned with the vision of a just energy transition and find the right balance between economic development and emissions reductions[70]. In the African context, countries must demonstrate the role of gas projects today in meeting their net zero targets, which for many African countries are beyond 2050.

Futureproofing will especially be required from big ventures seeking to access large pools of capital. For the upstream (exploration and production) segment of the industry, that could mean focusing on minimising operational emissions and the development of gas feedstocks with low carbon content, or the monetisation of associated gas that would otherwise be flared.

The focus of upstream operators on net-zero projects is already gaining traction in Africa, with Eni making the development of its recently discovered Baleine offshore field in Côte d'Ivoire the first net-zero development in Africa for scope 1 and scope 2 emissions[71]. Eni's strategy includes the implementation of highly efficiency plant solutions, process energy recovery, and the reduction and control of fugitive emissions. For other already producing assets, brownfield strategies are required to decarbonise operations around initiatives such as flue gas metering, improved air compression

[69] *Futureproofing in this context means finding solutions to guarantee environmental sustainability and compatibility with the goals of the Paris Agreement. Today, it requires upholding the best available standards for minimising and eliminating emissions, maximising efficiency, and being ready for further decarbonisation.*
[70] *See for instance AfDB Africa Economic Outlook 2022*
[71] *https://www.eni.com/en-IT/eni-worldwide/africa/costa-d-avorio.html*

Picture: Dorman Long Engineering

technology, the development of co-generation solutions, or the use of renewable power for operations.

In midstream (transmission) and downstream (distribution), special attention needs to be given to the decarbonisation of the LNG supply chain and the development of futureproof LNG infrastructure. Applying CCUS will become the norm, and it is the reason why Nigeria LNG is already studying such an option for its Train 8. Similarly, the use of solar energy to power liquefaction (or regasification) infrastructure will also increase. The world's largest LNG liquefaction project, Qatar's North Field East LNG development, will integrate both CCUS and solar[72]. In the future, the ability of LNG infrastructure to accommodate hydrogen blends is likely to also be factored in. In that regard, the first pilot projects for hydrogen blends into liquefaction are already in development[73].

The other critical component of making these gas investments futureproof is the extent of their ability to eliminate methane emissions. Having the benefit of greenfield construction, combined with a new wealth of science and technology, the opportunity

[72] *Shell LNG Outlook, 2022*
[73] *Idem*

to achieve zero-methane emissions by design is real.

Fortunately, there are indications that these trends are already being considered and adopted in Africa. Tanzania LNG could be a pathfinder in that regard, with former Equinor Vice President Al Cook meeting with Tanzanian President Samia Hassan in August 2022 to discuss the climate mitigation aspects of the project. "We are fortunate that the gas we have discovered in Tanzania has a remarkably low carbon dioxide content. And the country's reliable sunshine means we can use solar power to cool the gas, ready for transportation as LNG. That all helps a lot. But if we are to make the project genuinely low carbon, we will need to convert the gas into hydrogen before it is used," Mr Cook said after his meeting.

The gas sector development in Africa is in many ways aligned with the goals of the Paris Agreement and has a role to play in supporting net-zero transitions.

- Natural gas generates dispatchable and efficient power that supports a reliable and necessary backup generation to stabilise power grids, especially in areas without hydropower, nuclear, or geothermal facilities. It provides mid-merit and peaking power supply and the balancing and ancillary services required to build a resilient electricity value chain capable of integrating large volumes of intermittent renewables.

- Natural gas has lower CO2 emissions than any other fossil fuel and is the ideal, immediately available, rapidly deployable, and large-scale substitution fuel for coal, diesel, or HFO.

- Domestic natural gas in Africa often offers the most affordable power and is part of the Least Cost Power Development Plans (LCPDP).

- Gas-to-power plants require much less land than other sources of energy, such as solar and wind, and can easily be located close to demand centers, thereby decreasing the need for investments in transmission infrastructure.

- While gas is a fossil fuel, its infrastructure can be reconfigured to accommodate the production and distribution of new energies in the future, including renewable gas and hydrogen.

- Gas offers the most efficient, flexible, and low-emission solution for hard-to-electrify areas of the economy, like heavy manufacturing, that require extremely high temperatures and high energy density.

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CASE STUDY 6

Central Térmica de Temane (CTT) as a Futureproof Project

In Mozambique, the Central Térmica de Temane (CTT or Temane gas-to-power plant), is a project led by the Temane Energy Consortium (TEC), majority-owned by Globeleq. Additional shareholders include state-utility company EDM and South African chemicals group Sasol.

The $650-million project reached its financial close in December 2021 and is currently under construction. Not only did it manage to attract funding from several Western DFIs, but it also got unanimous approval from the board of the World Bank without any abstentions. The reason is simple: the CTT is a gas project strongly aligned with the Paris Agreement.

1) The power plant aims at supplying low-cost and reliable electricity to Mozambique by relying on domestic natural gas and is part of Mozambique's least-cost generation and transmission expansion plan.

2) It will be equipped with Siemens SGT-800 turbines that can blend up to 70% hydrogen in the future.

3) It is structured with a flexible technical and commercial configuration that allows for a variable supply of baseload and dispatchable power, hence delivering complementary power so that Mozambique can easily integrate renewables into the grid.

4) Its power purchase agreement (PPA) ends before 2050.

By demonstrating its alignment with the Paris Agreement, the CTT secured a large debt financing package provided by the International Finance Corporation (IFC), FMO, and the Emerging Africa Infrastructure Fund ($253.5 million combined), the US International Development Finance Corporation ($191.5 million), and the OPEC Fund for International Development ($50 million).

In December 2021, the Multilateral Investment Guarantee Agency (MIGA) also signed contracts issuing guarantees totaling $251.3 million in political risk insurance to private sector equity investors, including Globeleq Africa Ltd,

Mozambique's President Filipe Nyusi lays the foundation stone for the Temane power plant in March 2022.

Sasol Africa Pty Ltd, and Moz Power Invest, S.A. Meanwhile, the termination payment obligations from the offtaker (EDM) will be backstopped by the Government of Mozambique, represented by the Ministry of Mineral Resources and Energy (MIREME). Finally, the project also benefits from a World Bank Partial Risk Guarantee (PRG) that backstops EDM's payment obligations to the IPP and to the gas supplier.

Solution 2: the development of alternative and domestic sources of funding can help expand domestic value-chains.

In response to the drying up of foreign funding for gas projects, African stakeholders have increasingly sought to tap their domestic markets to unlock long-term capital at home. However, accessing domestic institutional money or channeling private capital into African gas projects will require innovation and the development of new finance mechanisms. Succeeding in unlocking that capital would make a significant difference: the African Development Bank (AfDB) estimated in 2020 that assets under the management of African domestic institutional investors were worth $1.8 trillion[74].

Some markets have started tapping into such pools of capital, including Nigeria and more recently Kenya. In 2017 the Nigerian Sovereign Investment Authority (NSIA) and GuarantCo established the Infrastructure Credit Guarantee Company Ltd (InfraCredit), a Nigerian private entity focused on providing local currency guarantees to enhance the credit quality of debt instruments issued domestically.

Since then, InfraCredit has been successful in unlocking long-term and domestic institutional capital for infrastructure projects. In 2018, it guaranteed the issuance of a $30 million, 16% Senior Guaranteed Fixed Rate Bond for the Viathan Group, one of Nigeria's fastest-growing gas utility companies. The transaction demonstrated the efficiency of a new mechanism to access domestic capital and has opened the way for several more bond issuances by infrastructure developers since then.

Across the continent, African DFIs are also increasingly stepping up to support domestic gas ventures, with key institutions such as the African Export-Import Bank (Afreximbank), the Africa Finance Corporation (AFC), or the Development Bank of Southern Africa (DBSA) taking the lead on advocating for gas funding. The AFC is supporting several gas-fired power plants on the continent by focusing on projects with a strong development impact. In Ghana, it was the lead developer, lead sponsor and mandated lead arranger (MLA) for the 350-MW Cenpower Kpone IPP that started commercial operations in June 2019. The transaction was largely an African deal with 67% of the equity held by African entities and 83% of the senior debt issued by banks and African financial institutions.

In 2021, the AFC was also the MLA and provided project development capital to another important project in Senegal, a 300-MW gas-to-power facility developed by West African Energy, a 100%-Senegalese venture. The company was able to mobilise

[74] *Unleashing the Potential of institutional investors in Africa, November 2019, AfDB Working Paper Series No. 325*

FCFA 220 billion ($363 million) for the project, in a debt package that also gathered Coris Bank International and Afreximbank.

Moving forward, additional actions can be expected from such African institutions to provide the capital required for the continent to maximise the potential of its natural resources. In May 2022, for instance, the African Petroleum Producers Organization (APPO) and Afreximbank agreed to work together on the establishment of an African Energy Transition Bank. The bank aims at facilitating investment in energy projects, including gas, to finance the development of robust energy infrastructure and ultimately support a just African energy transition.

Solution 3: The contribution of carbon financing

Since the signing of the Kyoto Protocol in 1997, African countries have implemented several Clean Development Mechanisms (CMD)[75] generating carbon credits that are now sold and traded globally. CDM offers real potential as a source of capital to develop gas projects, which has been overlooked by large gas producers on the continent.

Several CDM projects implemented in Africa so far have directly targeted the processing of associated gas to reduce routine flaring.

The launch of the African Carbon Markets Initiative (ACM) at COP 27 in November 2022. Picture: Kenya Ministry of Environment, Climate Change & Forestry

However, despite their ability to earn sellable certified emission reduction (CER) credits and generate returns by reducing emissions, their extent has been limited. In Nigeria, government sources estimate that $385 to $500 million are lost in emission credit value by not monetising flared gas and certifying the corresponding reduction in carbon emissions[76].

With the historic rise of carbon prices since

[75] *The Clean Development Mechanism (CDM), defined in Article 12 of the Protocol, allows a country with an emission-reduction or emission-limitation commitment under the Kyoto Protocol (Annex B Party) to implement an emission-reduction project in developing countries. Such projects can earn sellable certified emission reduction (CER) credits, each equivalent to one ton of CO2, which can be counted towards meeting Kyoto targets. https://unfccc.int*
[76] *National Gas Expansion Programme (NGEP)*

2021[77], market fundamentals now provide strong incentives to invest in emission reduction projects to issue CER credits. COP26 also agreed to the rule for Article 6 of the Paris Agreement, under which countries can continue paying for greenhouse gas emissions reductions or removals projects in other markets to meet their domestic emission reduction commitments.

New market dynamics have incentivised African stakeholders to make the best of carbon financing, and the Africa Carbon Markets Initiative (ACMI) was launched at COP27 to dramatically expand Africa's participation in the voluntary carbon market. The venture focuses on increasing the production of African carbon credits by focusing on clean energy and sustainable development projects, with the aim of producing 300 million carbon credits a year by 2030, and 1.5 billion a year by 2050[78]. In the process, ACMI wants to unlock $6 billion in revenue and support 30 million jobs by 2030. While flare reduction projects are not identified under ACMI's scope, direct air capture (DAC) and carbon capture and storage ventures are. This could provide the right incentives to unlock financing for the decarbonisation of natural gas and potentially support methane emissions management projects (see Section 2. 3.).

Putting a price on emissions is a highly effective policy mechanism to incentivise switching to cleaner fuels, and a robust carbon pricing scheme could strengthen the business case for Africa's gasification in many applications.

3.2. Challenge 2: Developing Gasification Infrastructure

Investing in African gas infrastructure is still seen as a risky and uneconomical game.

The chicken and the egg dilemma of missing demand to build infrustructure versus missing infrastructure to allow the demand to grow has characterised Africa's gassification discussions from their start.

The success of domestic gas ventures requires the synchronisation of several components across the value chain, from upstream production to downstream distribution. That makes any domestic gas project a complex puzzle where every piece must be in sync for it to be bankable and successful. Domestic gas projects also come with a higher level of risk than export-oriented ones, including currency, convertibility, construction, institutional, political, and demand uncertainty. In a context where global gas prices are high, incentives are also stronger to export gas and earn steady foreign exchange from overseas buyers instead of selling in local currency to the domestic market. As a result, developing Africa's gas reserves for the sole purpose of monetising them locally is likely to remain a tough pitch to investors, at least until demand can be better assured. This means that for Africa's successful gasification, the business case would need to be creatively constructed, leveraging new export opportunities created by the current global market appetite for new gas supply.

Most gas consumption on the continent remains in the north (see Section 1), where the power sector has anchored a lot of domestic gas monetisation projects that have eventually broadened gas penetration across industries and households. There, electricity production, industrial growth, and gas exports have unlocked enough gas demand to support domestic gas access infrastructure investments. But that model of anchoring gas infrastructure expansion on the back of a gas-fired power generation plant has been tricky to replicate in Sub-Saharan Africa. While a few successful examples do exist, like in Tanzania (Songo Songo) or Nigeria (Uquo), they remain rare exceptions.

The reason is simple: outside of North Africa, the rest of the continent is a patchwork of small domestic gas markets within under-industrialised economies where effective demand is scattered across small centers. For several of them, the option of producing gas locally relies on the development of a single field (as in Mauritania and Namibia). This explains why gas has remained a niche fuel in Sub-Saharan Africa, contributing only 5% of the total energy mix versus a global average of 20-25%, according to the IEA[79].

A lack of economies of scale in upstream and midstream gas projects has created serious barriers to investment in gas-fired power plants, which traditionally serve as the foundation of future gas infrastructure expansion.

In 2014, a study by the World Bank found that developing a 30 bcm gas field the size of Kudu in Namibia requires a price of $6-10 per MMBTU to be economically viable, whereas larger fields in the big resource centers can be produced for $2-3 per MMBTU[80]. Examples include both the offshore Banda gas field in Mauritania and the Kudu gas field in Namibia, which have remained undeveloped since their discovery decades ago because of unattractive returns linked to their domestic gas-to-power concept. For the same reason, only a third of the gas produced in Africa is used for electricity generation, compared to nearly 40% globally and 45% in Asia[81].

Lack of economies of scale continues to be the major obstacle to gas-to-power development in Sub-Saharan Africa, which in turn has negative implications for the rest of the midstream and downstream gas value chain. Even in countries with a large resource base and

[77] *Emission permits in Europe witnessed a historic rise to close at almost €100 per ton in mid-2022. Since the creation of carbon markets, emission permits had never gone above €40 per ton.*
[78] *Africa Carbon Markets Initiative (ACMI): Roadmap Report Harnessing carbon markets for Africa, November 2022*
[79] *Africa Energy Outlook, 2019*
[80] *"Harnessing African Natural Gas : A New Opportunity for Africa's Energy Agenda?", 2014. Santley, David; Schlotterer, Robert; Eberhard, Anton. World Bank, Washington, DC. © World Bank*
[81] *"Natural Gas in the African Energy Landscape: A special Policy Report on Energy", July 2021, AFREC Policy Brief 2*

attractive economies of scale, serious additional risks exist around the creditworthiness of gas or power off-takers.

The creditworthiness of African off-takers has remained another major risk, especially in the power sector.

The absence of cost-reflective electricity tariffs[82] , the persistence of several subsidy schemes and the challenges of revenue collection are all weighing heavily on the balance sheet of African state utilities and overall sector liquidity. Because of these factors, developing African electricity markets are largely dysfunctional, lacking appropriate mechanisms to balance supply and demand.

The struggling utilities are also the ultimate buyer and off-taker of power, and their unstable financials weaken the entire power sector value chain. As a result, most gas-to-power projects that would usually anchor the development of gas infrastructure are not bankable. DFIs have traditionally addressed the risk associated with selling power to state utilities with the issuance of guarantees. But, as we have seen, the same institutions are increasingly shying away from supporting gas projects.

Unfortunately, nowhere are these forms of guarantees more necessary than in the power sector, which remains by far the largest off-taker of domestic gas in Africa. The bankability of the African gas-to-power industry has largely relied on such securities issued by the World Bank, giving assurance that bills would be paid to gas producers and power generation companies. These same structures that have made projects bankable are not only becoming harder to secure from DFIs, but they are also increasingly being challenged by African governments as they are deemed too expensive for state utilities and bulk power purchasers whose balance sheets are weak. Ghana and Kenya have already been involved in transitions from take-or-pay to take-and-pay clauses within their power purchase agreements (PPAs) for a few years. Nigeria has also seen several parties voicing criticism about similar agreements.

The combined challenges of supplying small demand centers and gradually losing critical guarantee mechanisms to address key off-take risks make investments in African gas infrastructure a very challenging venture at a time when more incentives are required to unlock capital.

[82] *Electricity prices that reflect the true cost of supply and are not subsidised.*

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Picture: Seplat Energy

Solution 1: Innovations and reforms in the power sector.

To address the off-take risks associated with selling power to African utilities, the guarantee mechanisms that the continent is already familiar with are a good option to carry forward, with some possible new caveats. Such critical guarantees notably include partial risk guarantees (PRGs) and take-or-pay clauses in project agreements. PRGs are typically issued by the World Bank's International Development Association (IDA) to private lenders or investors against the risk of a government or state-owned entity failing to perform its contractual obligations with respect to a private project.

On the other hand, take-or-pay clauses are another form of guarantee under which a purchaser commits to both buy a minimum agreed volume of gas or electricity from a producer and to pay a contract price on that minimum agreed volume.

From a policy perspective, the growing unwillingness of some African states to enter into such commercial guarantee mechanisms or the shift to take-and-pay clauses is likely to make domestic gas projects unattractive to prospective lenders and investors. While it is only natural that governments would seek to sign better deals that do not put pressure on their state budget, this should not come at the cost of must-have guarantees required by investors to inject hundreds of millions of dollars into projects.

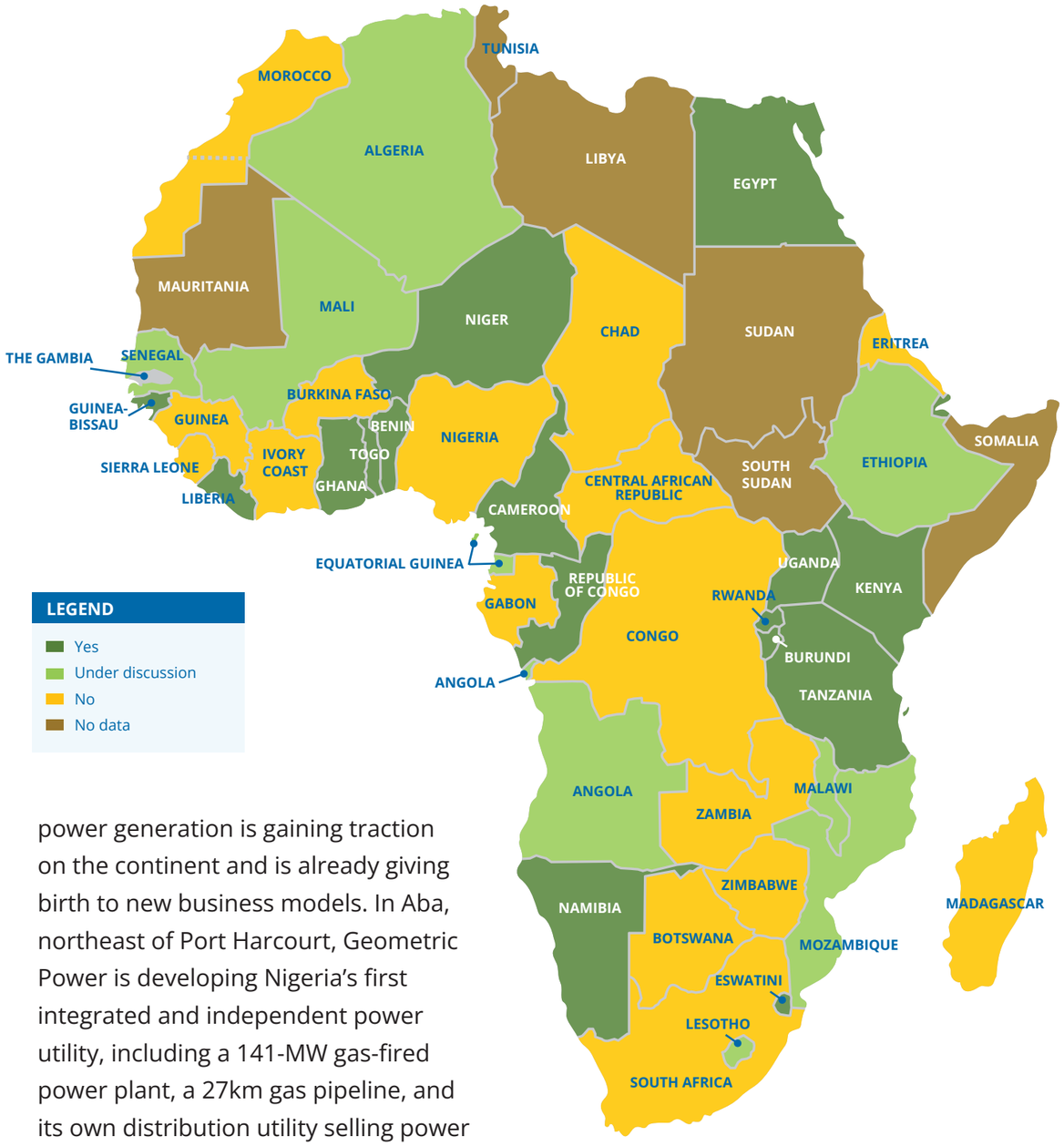
On the other side, international development bodies could play a bigger role in supporting the lending process by offering lower investment guarantees, especially in cases where gas projects are aligned with net-zero ambitions (see Section 3.1.).

Meanwhile, the focus needs to remain on strengthening the balance sheet of state utilities and implementing reforms that boost liquidity within the power sector value chain. Pricing reforms are especially important to implement cost-reflective electricity tariffs and bring subsidies down. Additional measures that would benefit the sector include a sustained focus on metering to reduce energy losses and improve revenue collection.

Finally, policy can encourage private investors to take risks with ambitious embedded generation regulations. If the state is unwilling or unable to commit to costly guarantee mechanisms, or if its state utility cannot abide by take-or-pay terms, decentralisation can prove beneficial. Embedded generation, under which power producers are linked to a distribution network as opposed to the national grid, is one such solution.

Evolving regulation around distributed power generation is gaining traction on the continent and is already giving birth to new business models. In Aba, northeast of Port Harcourt, Geometric Power is developing Nigeria's first integrated and independent power utility, including a 141-MW gas-fired power plant, a 27km gas pipeline, and its own distribution utility selling power within a ring-fenced distribution network. In doing so, it secures its own direct power sales arrangements without relying on the Nigerian state utility.

Figure 45: Status of cost-reflective tariff reforms in selected African countries, 2021



Previously published in Africa Energy Outlook 2022 by the IEA

Source: AfDB Electricity Regulatory Index for Africa (2021)

Solution 2: The power sector must not be the only option for anchoring lower-carbon energy projects.

Developing and scaling up Africa's domestic gas value chain will necessarily rely on credible off-takers serving as anchor buyers for the development of gas clusters. Even though the power sector has traditionally always played this role in the past, other options exist.

The export industry has been a strong anchor for the growth of domestic gas markets and this role could be further encouraged. Both Nigeria LNG and Angola LNG, for instance, have grown their domestic supply of gas liquids such as cooking gas to their respective markets over recent years, with ambitions to do more moving forward. Upcoming LNG terminals in Sub-Saharan Africa now make it compulsory to allocate a certain amount of gas to the domestic market, as is the case with Mozambique LNG (2.8 MMscm/d) or GTA Phase 1 (1 MMscm/d)[83].

The availability of domestic gas from export facilities can then encourage gas-based industrialisation (Senegal) or additional gas-to-power capacity (Mozambique, Mauritania, and Senegal). In August 2022, for instance, Senegal's Petrosen Trading & Services signed an MoU with Turkey's Çalık Enerji and Japan's Mitsubishi for the pre-feasibility study of a gas-based ammonia and urea manufacturing unit. Domestic gas allocations from LNG export projects are also an effective way to ensure that even if developers decide to prioritise lucrative exports over local sales, they must still reserve part of their production for the domestic market.

Figure 46: Domestic gas allocations from LNG export terminals

Project	Capacity (mtpa)	DomGas Allocation (MMscfd)	Receiving Country
Greater Tortue Ahmeyim (GTA)	2.45	35	Senegal
Greater Tortue Ahmeyim (GTA)	2.45	35	Mauritania
Mozambique LNG	12.88	100	Mozambique
Coral Sul FLNG	3.40	0	Mozambique

Source: Hawilti Research

[83] *Allocations are officially stated in MMscfd, ie 100 MMscfd for Mozambique LNG and 35 MMscfd for GTA Phase 1.*

Gas export pipelines have followed a similar pattern. In Mozambique, the development of the Temane and Pande gas fields has supported the successful operations of ROMPCo's Mozambique-Secunda pipeline since 2004. Royalty gas from the project also served as a basis for the development of Mozambique's first gas-to-power plants in the 2010s. There are already indications that gas export pipelines can continue to anchor domestic gas ventures, including in Morocco, where future domestic gas projects like Anchois and Tendrara are seeking to secure connections with the Maghreb-Europe Gas Pipeline (GME) to build investors' confidence around their business case.

Picture: Eni

In addition to domestic gasification requirements on export projects by decree, governments can reinvest the revenue received from export projects to expand domestic access. This would be particularly prudent now, as increased export revenues generated in an elevated global price environment begin trickling into African gas-exporting countries. The price premium is most likely temporary until the markets rebalance, and this lucrative period will not last forever.

Gas-consuming industries are another major off-taker that can spur the development of domestic gas infrastructure, especially process industries such as fertilizers and petrochemicals. A few successful examples exist in Sub-Saharan Africa, but they have remained limited to Nigeria (Indorama Eleme Petrochemicals, Dangote Fertilizer, Escravos GTL) or South Africa (Mossel Bay GTL refinery).

As the continent seeks to industrialise and process more of its raw materials at home, opportunities exist to use energy-intensive industries as a basis for the development of gas access infrastructure. Anchoring larger gas-to-power projects on power demand from the mining sector for example could be an option, especially given the growth of the mining sector in West and Central Africa. This is the case for the Kamsar LNG terminal in Guinea, which proposes to import LNG to power the country's mines and future alumina refineries.

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Figure 47: Current Southern Africa scenario

Source: Standard Bank

point for virtual gas pipelines across the rest of the region. An integral part of the project is the development of a cryogenic and train filling facility to support the expansion of Southern African gas markets by ensuring the "virtual" supply of LNG via trucks as far as 1,000km from the loading point.

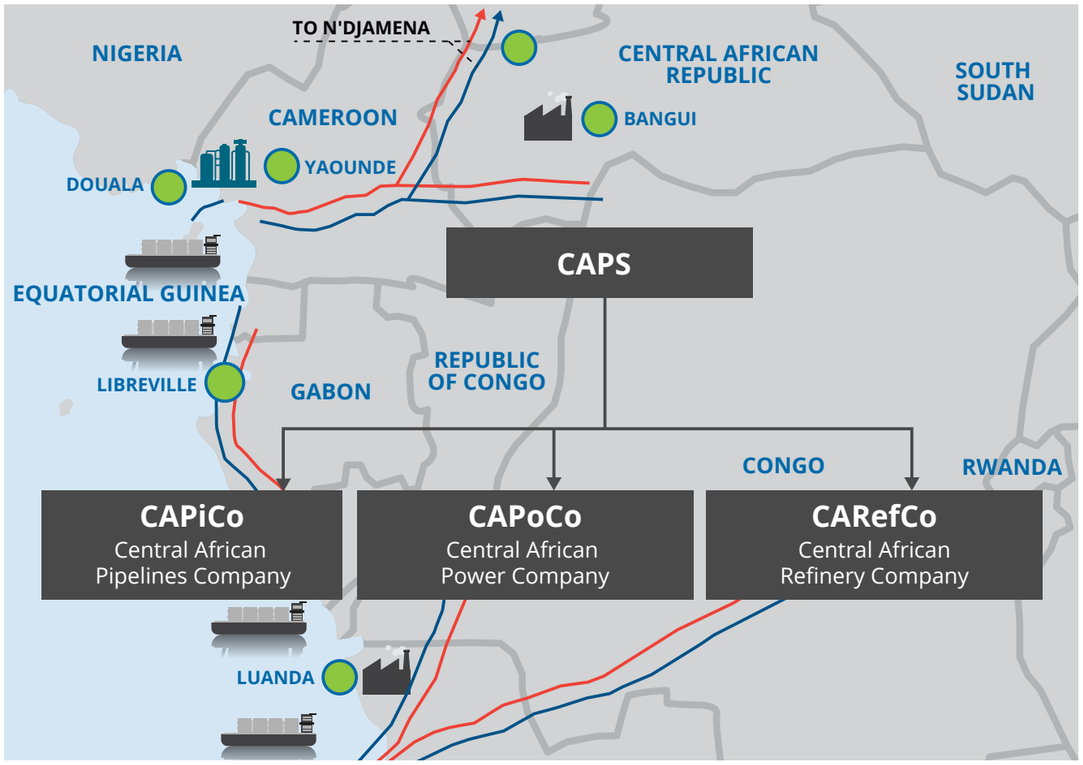
Solution 3: Stronger regional cooperation can help accelerate the development of gas infrastructure and consumption.

Africa has embraced regionalisation and cross-border cooperation and is seeking ways to further its integration. Along with the roll-out of the African Continental Free Trade Area (AfCFTA), the development of sub-regional and regional gas and energy networks can help support better economies of scale and justify investments into infrastructure that work for the whole continent.

In Southern Africa, there are opportunities to deepen gas penetration and build on the success of the Republic of Mozambique Pipeline Company (ROMPCo). Additional gas from Mozambique can notably supply the broader Southern African Development Community (SADC). Gigajoule and TotalEnergies are planning an LNG import terminal in the port of Maputo that would support a gas-to-power plant in Mozambique but also be the starting

As a result, South Africa, Botswana, and Zimbabwe could be supplied with competitively priced LNG imported at Matola. Providing gas discoveries are confirmed in Namibia and Zimbabwe, additional supply could also be secured from other new frontiers that are well connected to serve the rest of the region, including Zambia and Botswana where appetite is strong to secure gas and switch away from coal.

Figure 48: The Central African Pipeline System (CAPS)



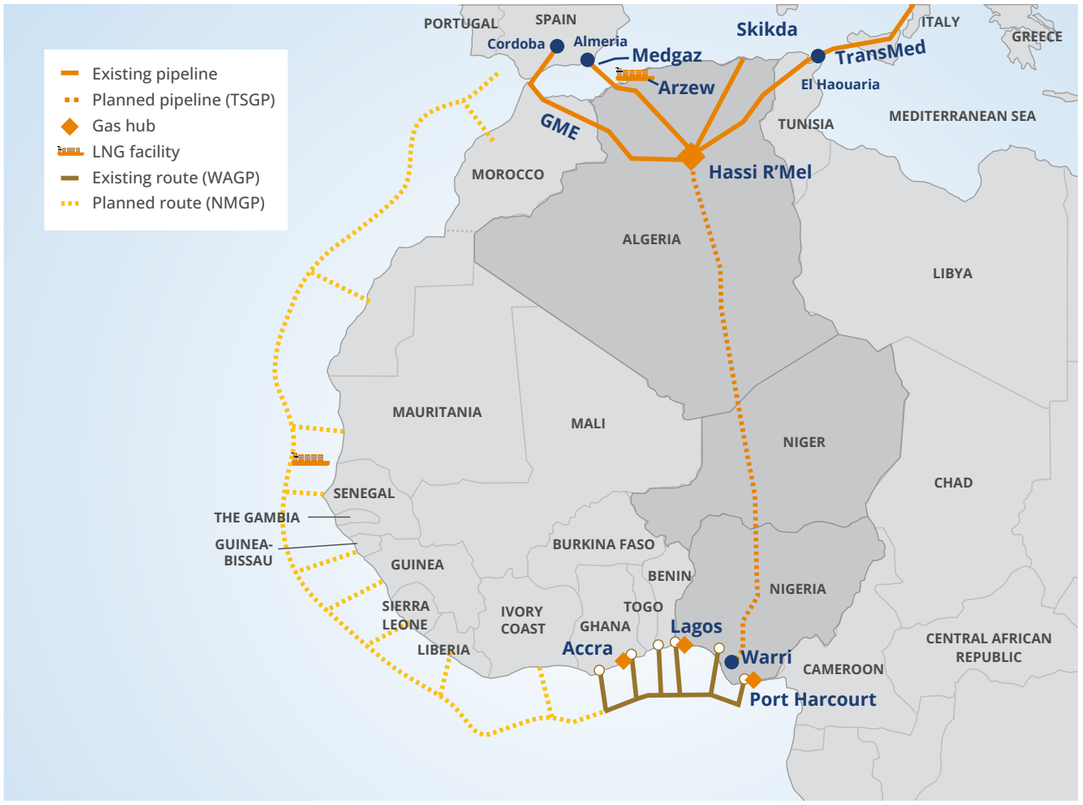
Source: Potential future pipeline routes in Central Africa

In **Central Africa**, oil and gas producers are seeking to boost their integration with the building of a regional pipeline network for which an MoU was signed in September 2022. This Central African Pipeline System could include Angola, Cameroon, Chad, the Republic of Congo, the DRC, Equatorial Guinea, and Gabon, and would serve as the backbone for the development of storage, LNG, power, and refining infrastructure. Most countries in the region share the same currency and legal regime, which would further facilitate the exchange of commodities between them. However, addressing scattered demand centers and anchoring the network around key credible off-takers will be key to success.

In **West Africa**, regionalisation around gas has so far not shown much progress but has tremendous potential for growth, especially for land-locked countries in the sub-region.

The West Africa Gas Pipeline (WAGP) continues to operate below capacity but could play a larger role in the development of the Nigeria-Morocco Gas Pipeline (NMGP) that has entered the FEED stage.

Figure 49: Current West Africa scenario



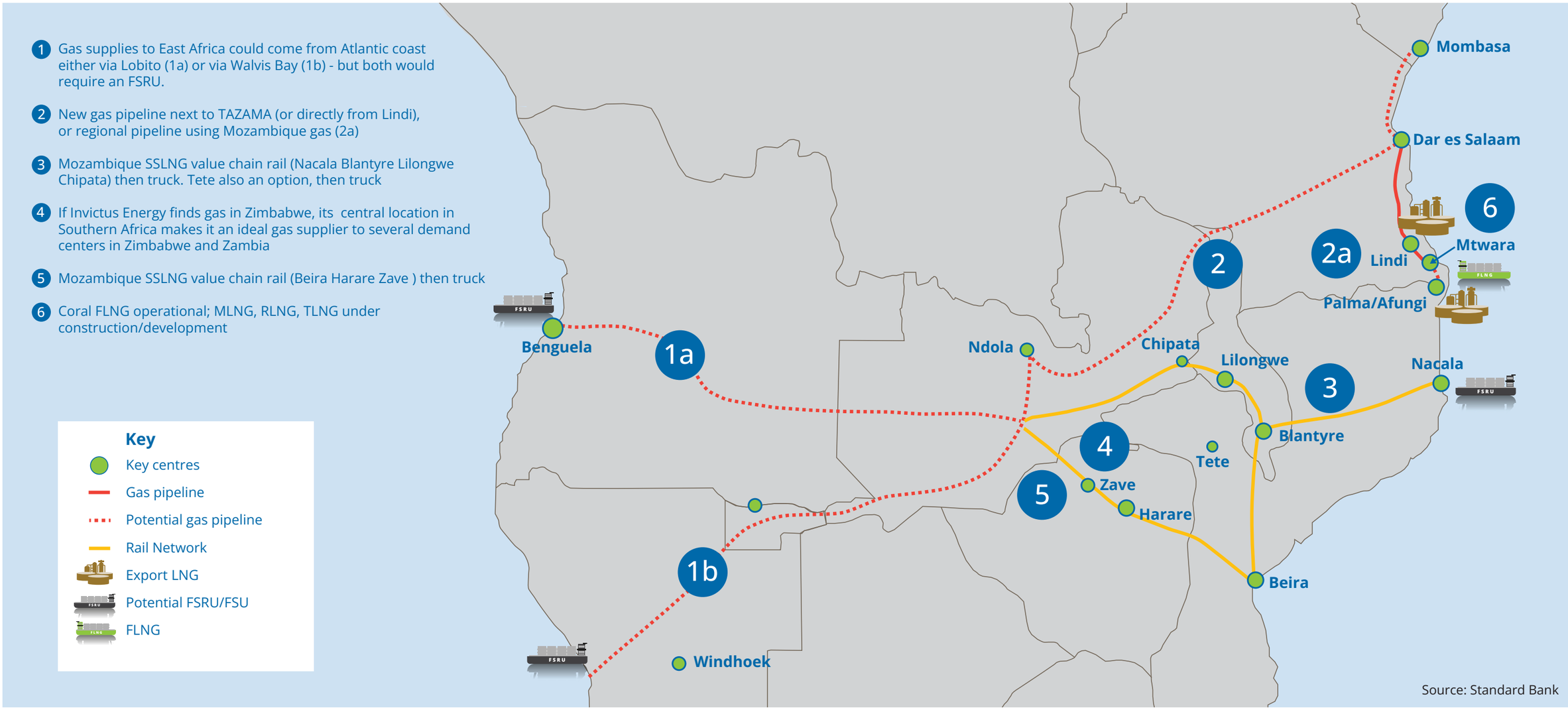
The mega project would have tie-in points in Nigeria, Benin, Togo, Ghana, Côte d'Ivoire, Liberia, Sierra Leone, Guinea-Bissau, Guinea-Conakry, The Gambia, Senegal, Mauritania, and Morocco before reaching Europe. Each country located on its route could access gas to meet its respective local demand or further supply the sub-region where Burkina Faso, Mali, and Niger continue to consume diesel for power generation.

Before the NMGP materialises, several gas companies in West Africa are already seeking to regionalise their footprint to provide gas across the region. Ghana is especially well positioned in that regard given the appetite of local private players to make gas a regional commodity. In 2022, a subsidiary of Afreximbank backed an LNG distribution infrastructure platform called Ecow-Gas, which aims to provide gas as a cheaper and cleaner fuel to under-served industrial customers in West Africa. Ecow-Gas could use Tema LNG, Ghana's gas import facility, as its key supply center to provide LNG handling, truck loading, and storage services to Togo, Burkina Faso, Benin, Sierra Leone, and Liberia.

3 / Bridging the gap

Figure 50: Current Southern and Eastern African scenario

1. Gas supplies to East Africa could come from Atlantic coast either via Lobito (1a) or via Walvis Bay (1b) - but both would require an FSRU.
2. New gas pipeline next to TAZAMA (or directly from Lindi), or regional pipeline using Mozambique gas (2a)
3. Mozambique SSLNG value chain rail (Nacala Blantyre Lilongwe Chipata) then truck. Tete also an option, then truck
4. If Invictus Energy finds gas in Zimbabwe, its central location in Southern Africa makes it an ideal gas supplier to several demand centers in Zimbabwe and Zambia
5. Mozambique SSLNG value chain rail (Beira Harare Zave) then truck
6. Coral FLNG operational; MLNG, RLNG, TLNG under construction/development



Source: Standard Bank

In **East Africa,** only Tanzania is well positioned to build a regional gas hub because of the size of discovered gas reserves and the existence of a gas pipeline network from Mtwara in the south to Dar es Salaam in the north. This could provide the pillar to expand gas distribution regionally and extend the network to key regional partners such as Kenya or Uganda. The first of these projects is likely to be a 600km gas pipeline linking Dar es Salaam in Tanzania to Mombasa in Kenya, where power plants and industries are trying to reduce imports of expensive and polluting diesel and HFO, and switch to gas instead.

Picture: Globeleq

Solution 4: Promoting small-scale developments can provide the foundations to expand transmission and distribution infrastructure.

The lack of large, credit-worthy off-takers in Sub-Saharan Africa has naturally pushed the development of the small-scale gas industry. While small-scale projects won't drastically transform Africa's gas sector in the short term, they can be built with much fewer risks, provide a sandbox to demonstrate new business models, and eventually scale up as demand grows. This has made them very credible options to pre-develop domestic gas markets on the continent.

The case of Nigeria notably illustrates how small, flexible, modular solutions can go a long way in pre-developing markets before proper infrastructure can be built. One of the country's main challenges is bringing energy to its manufacturing hubs in the north when all its gas is produced hundreds of kilometers further south. In the absence of pipeline infrastructure, private investors started investing in small CNG stations over a decade ago, allowing gas to be trucked across the country to factories and industries. The growth of these "virtual pipelines" has successfully pre-developed markets and unlocked enough gas demand to justify the development of the 614km Ajaokuta-Kaduna-Kano (AKK) pipeline that is now under construction[84].

Nigeria has also been successful in attracting private capital into piped natural gas (PNG) projects within local industrial areas. The market has been developed by the private sector by forming joint ventures with state governments or through franchise agreements with the state-owned Nigerian Gas Marketing Co. (NGMC)[85]. The model has generated several small PNG networks in main cities in the south of the country, with networks averaging 100km each with peak utilisation rates of as little as 0.1 MMscm/d and as high as 2 MMscm/d. Several of these ventures were developed by Axxela. The company has grown gas distribution ventures around small demand centers in Lagos and Port Harcourt and is now able to scale up operations. In 2022, the Sojitz Corporation of Japan acquired a 25% interest in Axxela, demonstrating the success and scalability of its business model.

The growth of small-scale ventures and adoption of relevant technologies could be further encouraged by recognising their strategic contribution to gas infrastructure development. Governments could seek to grant them fiscal incentives or special status enabling them to go through the permitting process more efficiently. For instance, the second phase of the Virginia Gas Project in South Africa, the country's first domestic LNG and helium project, benefits from a status of "Strategic Integrated Project (SIP)" that reduces its approval times for all its licences and regulatory approvals.

[84] *A similar practice has been successfully applied in China, where trucked LNG has delivered gas to mainland consumers while delivery infrastructure was developed (see IGU LNG report 2019).*
[85] *Recently renamed NNPC Gas Marketing Ltd (NGML).*

Solution 5: Domestic gas projects must make the most of every molecule and diversify output.

As the Perenco strategy demonstrated in the Gulf of Guinea (see Section 2.3), diversifying gas products can go a long way in multiplying revenue streams and making gas infrastructure investments profitable. To make domestic gas ventures more attractive, African developers and sponsors are increasingly working on diversifying revenue streams from their projects or finding alternative arrangements to counterbalance above-the-ground risks. Successful strategies typically include injecting dry or lean gas into a pipeline for power generation and processing wet gas into additional commodities that can be sold locally.

Most recent midstream gas projects on the continent include both dry gas and liquid gas components to maximise extraction. This is supporting the growth of domestic and small-scale CNG, LPG, and LNG industries across the continent. In Ghana, Genser Energy raised $435 million in 2022 to expand its gas pipeline network to captive power off-takers, but also launch an integrated NGLs business, including a 5.6-MMscmd gas conditioning plant. In Mozambique, the second phase of developing the Temane and Pande gas fields was approved in 2021 and now includes 30,000 tpa of domestic LPG as well.

3.3. Challenge 3: Providing a Positive Business Climate

Last but not least, stakeholders and financiers must address several risks associated with doing business on the continent.

Africa's investment climate and business environment continue to deter investment, although wide disparities exist from country to country. Countries with large natural resources continue to score poorly within most recognised global benchmarks on issues of investments and governance, such as Transparency International's Corruption Perception Index (CPI) or the Fraser Institute's Economic Freedom of the World report. These are often representations of weak governance frameworks, outdated investment laws, or overall instability in the political and business climate.

Security issues have been a major barrier to investment in African infrastructure projects and have stalled existing ventures. This is directly preventing gas from making it to market, as two of the biggest gas countries on the continent continue to be plagued


Picture: Sahara Group

with security threats that affect their development prospects. In Nigeria, crude theft and vandalism in the Niger Delta are directly affecting the production of gas feedstock required to run power stations and the LNG terminal on Bonny Island. In Mozambique, the insurgency in Cabo Delgado Province has led to the suspension of construction work at TotalEnergies' Mozambique LNG project. These are no doubt very complex challenges, but it is imperative that they are resolved because high physical security risk factors will quickly eliminate prospects for the continent to take advantage of its resources and develop its economies.

Beyond physical risks, some credit risk assessments by global credit rating agencies could sometimes overstate the level of macroeconomic risk, significantly raising Africa's cost of borrowing from global debt capital markets[86]. To this end, African leaders have become increasingly vocal about differentiating actual and perceived risks, with Senegalese President Macky Sall calling in 2022 for the creation of a pan-African credit ratings agency that could address the very arbitrary nature of global credit ratings and resulting insurance premiums. Addressing the high cost of perception premiums with better balance in financing rules could help the continent further diversify its funding sources.

[86] *"The ruinous price for Africa of pernicious 'perception premiums'", 7 October 2021, Hippolyte Fofack, Brookings*

Lack of policy certainty coupled with above-the-ground risks is severely restricting the ability of Africa's gas sector to become globally competitive. As obtaining finance to develop gas projects is becoming increasingly challenging, Africa's reputation for both cost overruns and delays in project execution puts it at a disadvantage. Africa has great potential to become an alternative gas supplier to Europe in the short-term while meeting long-term gas demand growth in Asia and the rest of the world, thanks to its proximity to Europe and access to the Indian Ocean. However, these helpful factors will not be enough to justify investing billions of dollars into new LNG projects on the continent. In a world where the speed of execution of new projects has become a determinant factor for final investment decisions, Africa needs to do much more to realise its great potential.

Investments into gas supply between 2022 and 2030 will likely be focused on cost-competitive, flexible projects with a minimal carbon footprint that can be brought to the market quickly. Securing the capital needed to get these ventures off the ground calls for, among other things, the provision of a secure environment, policy certainty, and environmental responsibility, but also a stable and attractive regulatory framework.

Solution 1: Stakeholders can work together to create better enabling environments and decrease risks associated with investing in Africa.

As Africa seeks to grow its share of the global gas export market, it is in competition with several well-established producing areas, and it will not be an investment destination by default. Its success in attracting investments will depend on the development of a secure and enabling environment, the execution of a long-term vision for its low-carbon energy future, and the achievement of energy access and socio-economic development aspirations at home.

Providing a safe and stable business environment is necessary to ensure that multi-billion-dollar investments benefit societies and communities to avoid violence, conflict, and unrest. Developers and sponsors of large infrastructure projects can support community development programmes and local job creation to reduce poverty in the short-term while supporting long-term economic development. There is often a direct correlation between societal indicators like poverty, youth unemployment, and violence. A particular focus could be given to increasing the participation of local businesses within projects' supply chains. Governments would be well placed to work with key stakeholders, investors, and communities to build cohesiveness and inclusivity. Following this commitment, stakeholders can work to

build an enabling environment that reduces operating risks and makes investments more attractive. This involves addressing regional insecurity, especially in the Gulf of Guinea and in northern Mozambique, but also improving the ease of doing business. Regional cooperation on gas development could serve as a cornerstone for broader diplomacy in regional disputes, as the experience of the East-Mediterranean gas developments has demonstrated, where Israel and the Arab nations are coming together to enjoy the benefits of regional gas markets. In June 2022 for instance, a new MoU was signed between Israel, Egypt, and the European Union to pave the way for significant exports of Israeli gas to Europe using Egypt's liquefaction terminals. Finally, streamlining the permitting processes and guaranteeing contract enforcement by governments and/or multilateral bodies would go a long way in making the overall business climate more attractive in several key jurisdictions. Large infrastructure projects require stable legal environments.

The rising presence of one-stop-shop investment centers and the adoption of more transparent contracting and tendering procedures are additional moves in the right direction.

Egyptian LNG

Solution 2: Policymakers should adopt a clearer gas policy framework that addresses the particularities of gas investments.

Local regulations must also align with the ambitions that each country has with regard to its energy transition journey and the role of gas within it. This is especially the case for oil-producing countries where regulatory frameworks tend to cover crude oil and natural gas with the same piece of legislation without directly addressing the particularities of the gas sector. Several supporting and enabling policy orientations have proven to be useful in facilitating gas developments and should be prioritised across the continent.

These include:

• Updating gas master plans to provide investors clarity on each country's vision towards a low-carbon energy future and integrating new regional supply dynamics. New gas master plans should consider regionalisation as an opportunity while promoting infrastructure developments anchored on long-lived gas assets such as non-associated gas fields.

• Adopting and updating Gas Codes to offer a specific legal framework that regulates midstream and downstream gas ventures.

• Optimising fiscal regimes to improve the cost competitiveness of African resources. Specific attention should be given to flexible approaches to midstream taxation to make projects economical. Nigeria's recent Petroleum Industry Act (PIA), for instance, introduced a new fiscal framework to incentivise upstream developments and provided several incentives for investments in midstream gas infrastructure.

• Increasing compliance with flaring reduction and elimination regulations and incentivising the processing and monetisation of associated gas.

Picture: Sahara Group

Solution 3: Find the right balance between local content development and cost-effectiveness.

Last but not least, more efforts must be allocated to capacity development among administrations and the workforce so that fundamental risks around skills availability are also addressed. By striking the right balance between building domestic capacity and reducing cost, African gas-producing countries can significantly improve their cost environment and become more competitive.

In that regard, particular attention can be given to:

• Developing regional educational centers that favour the sharing of experience among African gas markets and with emerging gas frontiers on best industry practices.

• Regionalising local content approaches to make the best use of competencies, capacities, and skills available on the continent to develop, operate, and maintain gas assets. Better regional cooperation in the private sector would support cost reductions while making sure that developing African gas serves the growth of local industries.

• Operators' skills development programmes should start addressing gas more specifically, especially when it comes to upskilling their workforces on HSE practices and issues around methane management.

• Developing in-house capacity within domestic financial institutions, especially institutional investors, to understand and assess the credit risk of gas infrastructure transactions. This will increase risk appetite among domestic investors to invest in gas and encourage them to share credit risk on related infrastructure transactions.

By taking bolder steps to create enabling environments, African leaders can contribute to improving access to new capital pools, attracting and retaining the right skills and capabilities, and unlocking true domestic value from their gas resources.

Picture: Dorman Long Engineering

3 / Bridging the gap


Picture: Seplat Energy

4 / Summary conclusions

Key Principles to Supercharge the Development of Africa's Gas Markets

As we have demonstrated, natural gas has two major roles to play in the sustainable development of Africa. The first is to address energy poverty, energising industrialisation and development, and the second is to pave the way for a just African energy transition towards a low-carbon future. In conclusion, this report proposes eight key principles that would help to develop and maximise the benefits of gas resources for Africans. Because of their deep interconnectedness, an ideal approach would focus on addressing each of these principles within a common strategy.

1. FUTUREPROOFING BY DESIGN

Futureproofing gas projects should be considered as a built-in risk management tool for project sponsors. By finding solutions to guarantee environmental sustainability and compatibility with the goals of the Paris Agreement, developers and promoters can both build long-term business models and enhance value propositions to meet the stringent requirements of global investors. The increasing scrutiny around funding gas projects by global financial institutions calls for a rigorous approach to structuring projects, from decarbonising gas production to operating sustainable gas infrastructure that can anchor low-carbon or zero-carbon gases. To tap into foreign sources of capital, African developers must offer stronger sustainability and climate change risk assessment frameworks and propose projects that are aligned with the Paris Agreement.

2. FINANCIAL INNOVATION

The drying up of global capital for gas projects should encourage the development of alternative and innovative financing mechanisms, especially domestically. To finance its energy needs, Africa must look inward and promote domestic financing mechanisms that can tap into its vast pools of institutional money. Actions can be focused on building domestic capacity around credit risk assessment and incentivising institutional investors to increase their exposure to private markets. Similarly, initiatives such as the African Energy Transition Bank could be supported by public and private stakeholders, so that capital is available to build today the kind of energy infrastructure Africa needs to reach its net-zero ambitions, while lifting millions out of poverty.

3. ENABLING GOOD BUSINESS CLIMATE

A safe and stable investment climate will be pivotal to growth and to ensuring that the continent is globally competitive. Sound sector governance and friendly investment jurisdictions can be promoted for Africa to sustainably develop its gas resources when the opportunity is ripe. Sustainably developing Africa's vast resources of gas and making it a leading investment destination will require it to address above-the-ground risks. On the governance side, regulatory frameworks should seek to address the challenges of the gas value chain (currency, convertibility, construction, institutional, political, and demand risks) and optimise fiscal regimes accordingly to make projects more bankable.

4. REGIONALISATION

Along with the roll-out of the African Continental Free Trade Area (AfCFTA), the development of sub-regional and regional gas and energy networks can help support better economies of scale and justify investments in infrastructure that work for the whole continent. In doing so, regionalisation can help address energy imbalances on the continent while creating bigger demand centers to anchor lower-carbon energy infrastructure projects.

5. CLUSTER AND ECOSYSTEM INVESTING

Industrialisation plans can favour the creation of manufacturing clusters that bring supply-chains closer to energy sources and raw materials. Industrial clusters developed close to gas fields can easily rely on a power plant serving an enclave of industries while offering an opportunity to process additional gas into LPG or LNG to convert, store and thereafter transport gas for domestic and commercial usage.

Picture: Sasol

6. GRADUAL SCALING

The lack of receiving, processing, and distribution infrastructure is hampering the commercialisation and adoption of gas across Africa. Small-scale projects rely on modular and flexible supply options and have proven as a winning strategy to pre-develop gas markets, unlock suppressed demand, and eventually justify larger infrastructure investments. Small-scale natural gas generation technologies can be further promoted as they come with more operational flexibility and can address a wide range of needs, capabilities, and demand sizes. Africa's burgeoning small-scale gas industry can mitigate several risks associated with gas infrastructure investments while providing a sandbox to demonstrate new, scalable business models. Small-scale projects in CNG and LNG can notably be used for power generation but also serve other end uses such as transportation, heating, and cooking.

7. REFORM ELECTRICITY MARKETS

To increase electricity production and address energy poverty, reforms are needed to restructure electricity markets and increase sector liquidity, while improving operational efficiencies. Only well-functioning electricity markets can pave the way for the kind of investments Africa needs to bridge its energy deficit and develop resilient power systems.

While each market's size and dynamics are different, key reforms include the removal of subsidies to ensure cost-reflective electricity tariffs, the unbundling of state utilities to make the value chain more efficient, and encouraging privatisation models such as embedded generation to attract private capital.

8. PRICE ON EMISSIONS

The recent launch of the African Carbon Markets Initiative at COP27 is an encouraging sign of the potential future of African emissions trading systems. Further awareness around the functioning and benefits of carbon markets could unlock additional capital for emission-reduction projects and support the decarbonisation of the African gas sector. It would importantly incentivise switching from coal and oil to lower-emitting natural gas and would greatly benefit emissions-reduction projects such as direct air removal (DAR), carbon capture, utilisation, and storage (CCUS), and the monetisation of associated gas to eliminate routine flaring.

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