pwc

Africa Energy Review 2023

Africa's opportunities and challenges in the energy transition

November 2023

www.pwc.co.za

Contents

1 Executive summary

1 Global Energy Dynamics

As Russia has reduced gas supplies to Europe, and Europe seeks to limit its dependence on Russian gas, Africa has an opportunity to fill the gap, but needs to act now. What is evident from the recent energy market volatility is that reliable energy availability and pricing are key considerations for many governments in the selection of their respective energy strategies. The solution for the power sector is not an either/or, renewables or natural gas, proposition. It requires a multi-pronged approach to decarbonisation with renewables and natural gas power at its core.

2 North Africa

North Africa remains the most developed region in respect to energy security and highest levels of access to electricity. The area is endowed with significant oil and gas reserves, particularly Algeria, Egypt and Libya. The region and its piped gas has become more important as an energy supplier to Europe.

3 West Africa

West Africa is a net exporter of fossil fuels primarily from Nigeria. Export growth will be driven by liquified natural gas (LNG) exports with the Senegal and Mauritania Greater Tortue Ahmeyim (GTA) LNG project coming online. The region has huge potential for investment and growth, with 70% of the population below 30 years. Renewables, excluding hydro are unfortunately still small and insignificant despite the potential.

4 Central and East Africa

The Central Africa energy sector is dominated by Angola's oil exports. The LNG export market may grow modestly, however the lack of new discoveries could hamper growth as gas fields in Equatorial Guinea and Cameroon deplete. Hydro power is still the main stay of Central Africa's clean energy focus and provides potential for significant growth.

In East Africa Kenya's geothermal power investment is paying off. Tanzania and Mozambique's gas potential are starting to come to fruition.

5 Southern Africa

Southern Africa, as with the rest of the continent, is blessed with an abundance of natural resources and finds itself, on the back of the Namibian Oil discoveries, on the cusp of transformative changes in its energy landscape. Although energy prospects look favourable, Southern African nations have been grappling with power shortages due to outdated infrastructure. Southern Africa, particularly South Africa, is on a cleaner energy transition path with gas playing a part in the transition from coal generated power to renewables and gas.

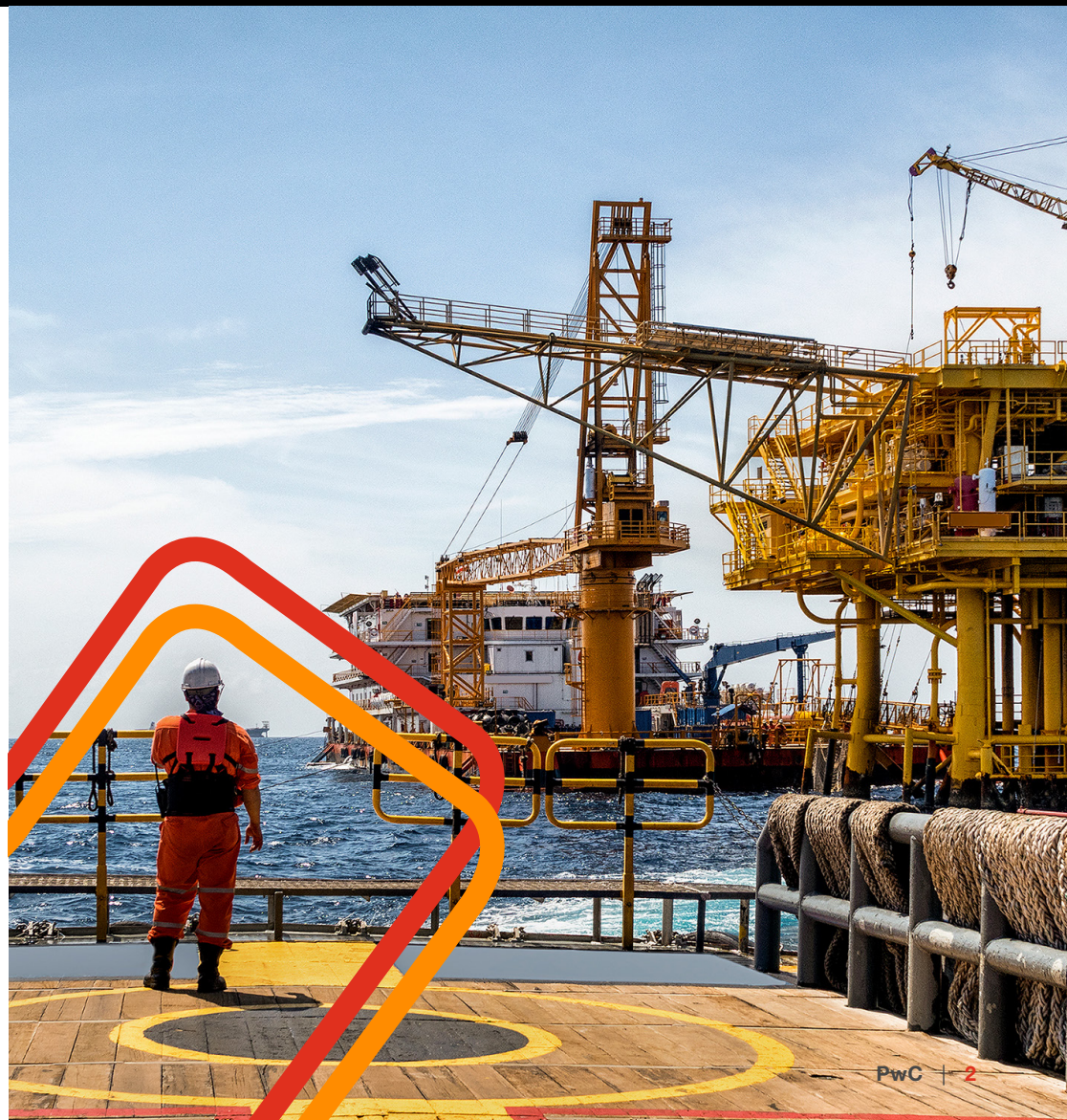
6 The essential need for collaboration at national and regional levels

The continent's energy success will depend on the strength and appetite for collaboration. Public-private collaboration, where governments, businesses, and communities unite in purpose and shared prosperity, are necessary to unlock the continent potential. Collaborative, transformational and agile leadership will be required for consistent economic development that addresses economic, social, and environmental factors that provides uninterruptible energy for everyone.

2 Energy snapshots

Africa overview

Oil data			2021	2022	
Proven reserves	Oil	bbo	125,3	125,4	Billion barrels
% change	Oil	%	0,30%	0,08%	
Global proven reserves	Oil	%	7,20%	7,20%	
Production	Oil	mbpd	7298	7043	Thousand barrels per day
Production	Oil	bbo/pa	2,66	2,57	billion barrels/pa
% change	Oil	%	6,10%	-3,50%	
Global production	Oil	%	8,10%	7,50%	
Consumption	Oil	mbbl/d	3958	4163	Thousand barrels per day
Consumption	Oil	bbo/pa	1,44	1,52	billion barrels/pa
% change	Oil	%	10,00%	5,18%	
Global consumption	Oil	%	4,19%	4,28%	
Refinery Throughput	Oil	mbbl/d	1892	1912	Thousand barrels per day
Refinery Throughput	Oil	bbo/pa	0,69	0,70	billion barrels/pa
% change	Oil	%	-1,30%	1,06%	
Refinery Throughput	Oil	%	2,38%	2,33%	
Trade movements	Oil	mbbl/d	6256	5629	Thousand barrels per day
Trade movements	Oil	bbo/pa	2,28	2,05	billion barrels/pa
% change	Oil	%	14%	-10,02%	



Gas in Africa data			2021	2022
Proven reserves	Gas	tcf	625,6	621,8
% change	Gas	%	37%	-0,60%
Global proven gas reserves	Gas	%	6,90%	6,90%
Production	Gas	bcm	257	249
% change	Gas	%	11,20%	-3,11%
Global gas production	Gas	%	6,39%	6,16%
Consumption	Gas	bcm	168,5	162,5
% change	Gas	%	7,10%	-3,54%
Global gas consumption	Gas	%	4,14%	4,12%
Exports pipeline	Gas	bcm	47,2	43,5
% change	Gas	%	45%	-7,84%
Global gas pipeline exports	Gas	%	6,69%	6,05%
LNG Exports	LNG	bcm	58,5	53,9
LNG % Change	LNG	%	7%	-7,80%
Global LNG Exports	LNG	%	11,25%	9,94%

Coal in Africa			2021	2022
Proven reserves	Coal	bn T	14,80	14,84
% change	Coal	%	0	0,25%
% Global reserves	Coal	%	1,4%	1,4%
Production	Coal	mT	248,70	251,07
% change (MT)	Coal	%	6,60%	1,19%
% Global production (MT)	Coal	%	3,05%	2,85%
Consumption	Coal	EJ	4,21	3,97
% change	Coal	%	2,40%	-5,63%
% Global consumption	Coal	%	2,60%	2,46%
Net African Exports	Coal	EJ	1,30	1,42
% change	Coal	%	-13,73%	9,18%
% Global exports	Coal	%	5,97%	6,61%

Figure 1: Clean energy capacity in Africa

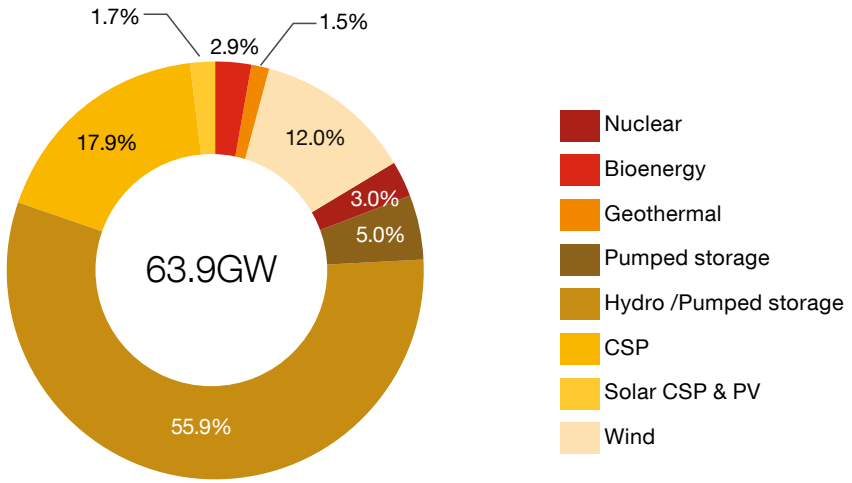
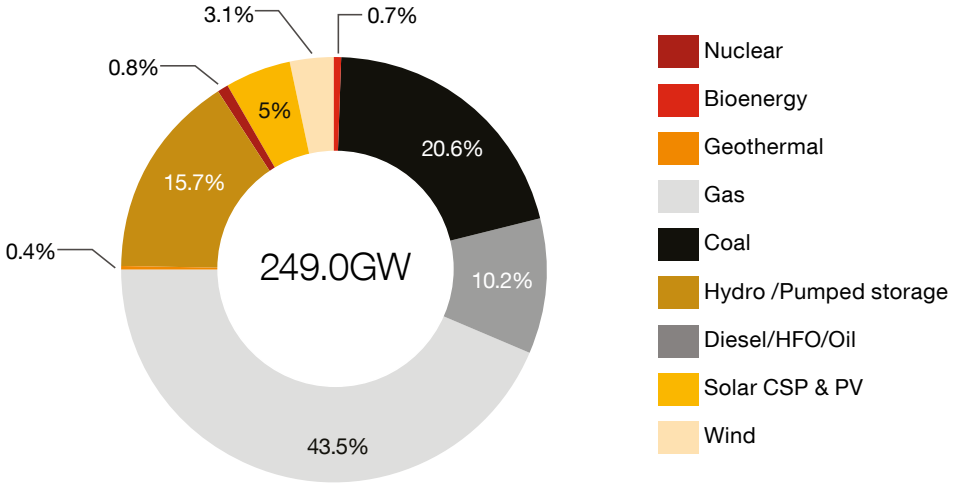


Figure 2: Overall generating capacity in Africa



Generated power in TWh

Coal and nuclear dropped due to planned and unplanned maintenance to the power generation fleet in South Africa. The increased use of diesel was primarily due to Eskom burning diesel to limit load shedding and load reduction at significant cost at its open-cycle gas turbines (OCGT) peaking power plants (currently using diesel).

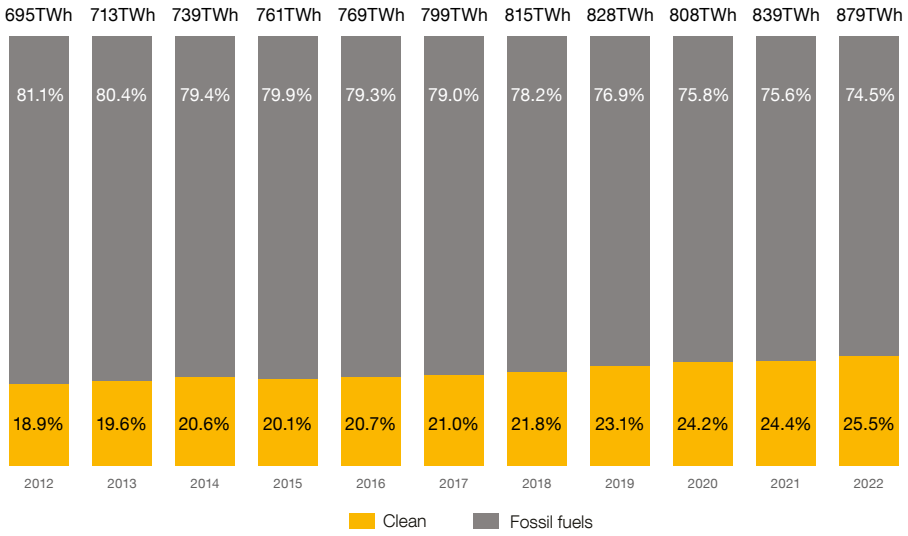
Gas power produced decreased in 2022 due to Egypt diverting a portion of its domestic gas to the international market.

All other technologies, except biomass, went up due to increased MW capacity being installed.

Generation Technologies		2021	2022	YoY absolute change	YoY % change	
Biomass	TWh	4,39	4,23	-0,16	-3,64	↓
Coal and peat	TWh	224,61	210,86	-13,75	-6,12	↓
Diesel/HFO/Oil	TWh	72,65	135,25	62,6	86,17	↑
Gas	TWh	337,2	308,86	-28,34	-8,40	↓
Other renewables	TWh	5,12	5,65	0,53	10,35	↑
Hydro/ Pumped Storage	TWh	145,22	163,62	18,4	12,67	↑
Nuclear	TWh	12,15	10,07	-2,08	-17,12	↓
Solar CSP & PV	TWh	17,12	17,26	0,14	0,82	↑
Wind	TWh	20,89	23,64	2,75	13,16	↑
Total	TWh	839,35	879,44	40,09	4,78	↑

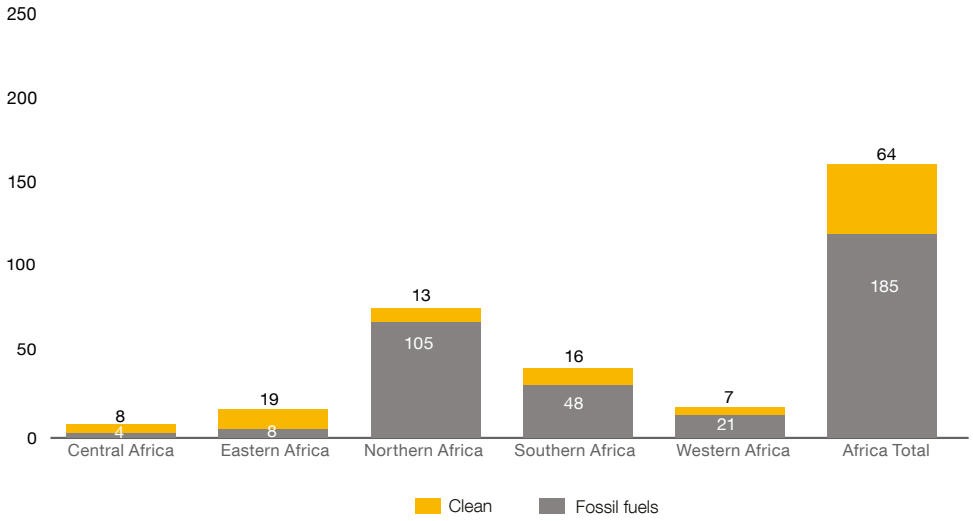
Clean generated energy for both fossil fuels and clean technology have doubled over the last 20 years. Additional clean energy generation from 2010 through wind and solar increased the clean energy proportion from 19.6% to 25.7% in 2022. This is the first year that a quarter of the energy was generated with clean technology, however Africa needs to quadruple the amount of solar and wind in order to meet its energy transition targets and address energy poverty.

Figure 3: Clean and Fossil fuel TWh generation change 2012 to 2022



Both in terms of energy technology mix and capacity, Africa is quite diverse with North(ern) and West(ern) Africa dominated by gas, Southern Africa by coal and Central and East(ern) Africa by hydro.

Figure 4: African Regional Clean and Fossil Fuel Electricity Energy Mix



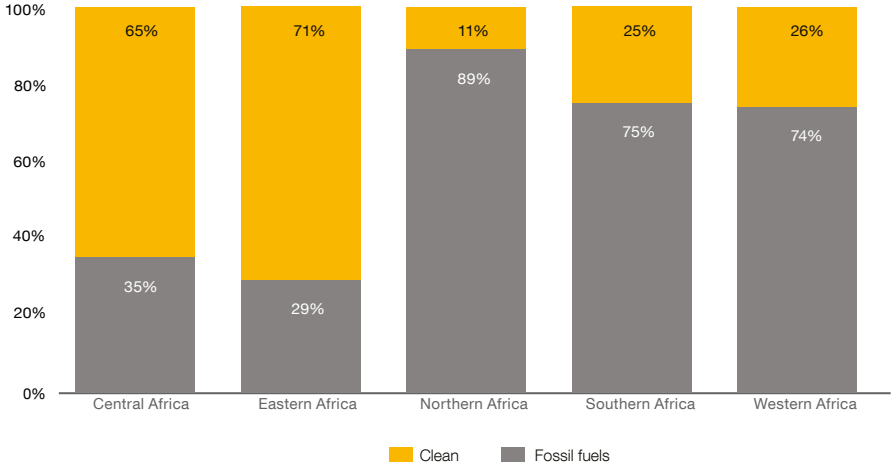
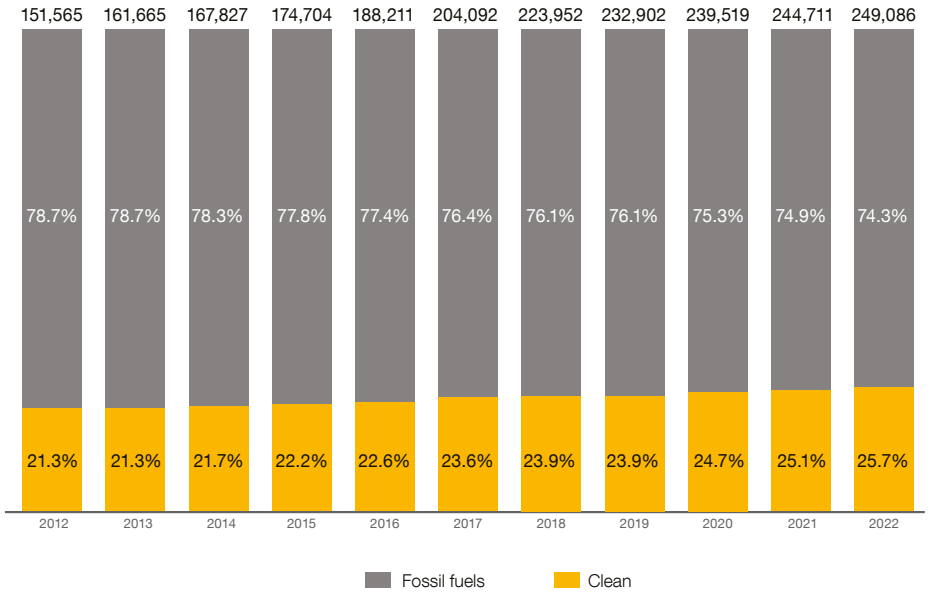


Figure 5: Total GW capacity installed in Africa



Discoveries

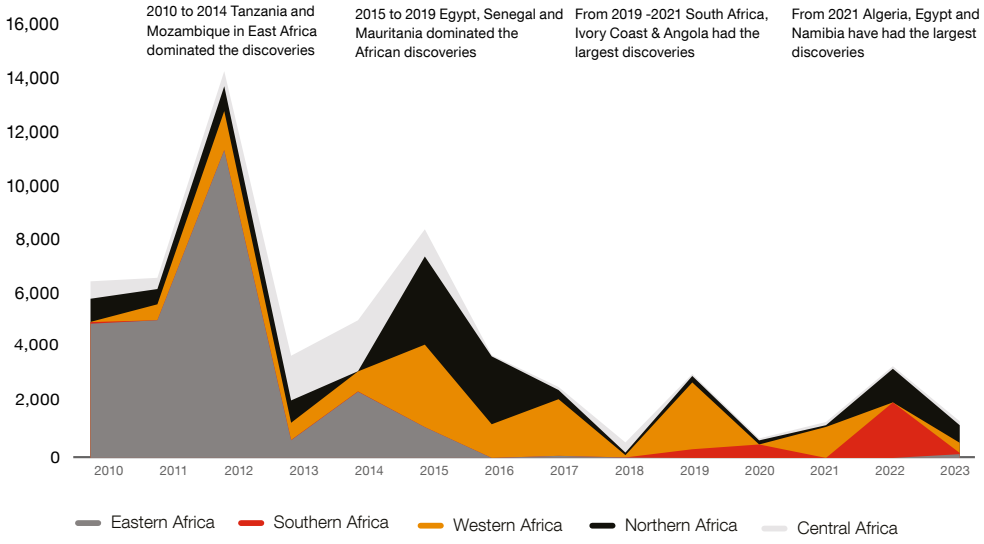
Gas discoveries since 2010 have driven economic growth in Africa. The major gas discoveries of Mozambique and Tanzania between 2010 and 2014 in East Africa are starting to be realised with first LNG being exported in 2022 from Mozambique.

Between 2015 and 2018 Egypt, Senegal and Mauritania dominated the African gas discoveries with the Zohr field producing 40% of Egypt's gas. While the Senegal/ Mauritania Greater Tortue Ahmeyim (GTA) LNG project has experienced some delays, it should start production in Q3 2024.

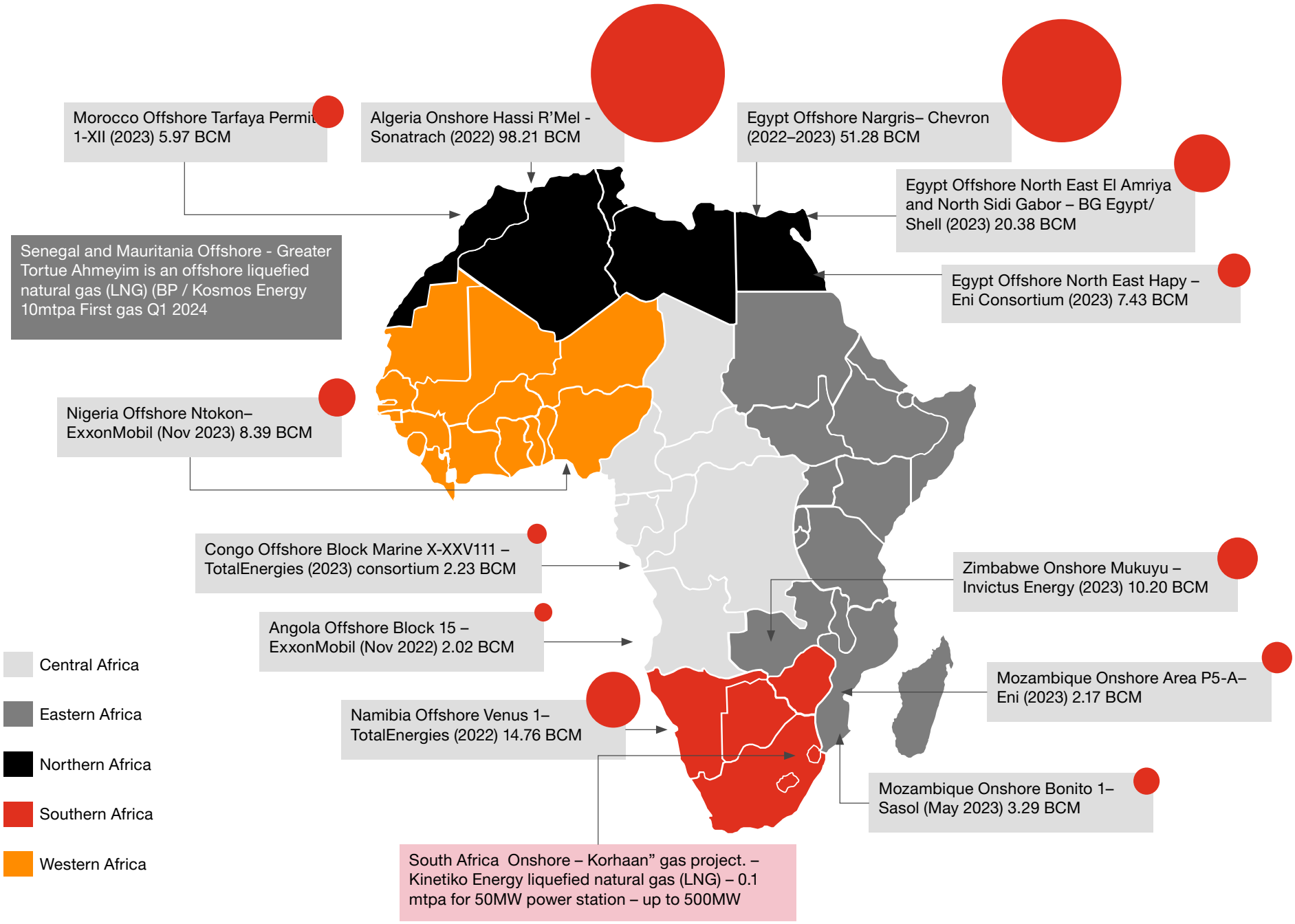
Between 2019 and 2021 South Africa, Ivory Coast and Angola had the largest discoveries. However only Angola has managed to monetise these discoveries so far.

Between 2021 and 2022 Algeria, Egypt and Namibia had the largest gas discoveries. The largest of which is Namibia, with oil and gas discovered in ultra deepwater that have the possibility of making the country a top 20 producer by 2035.

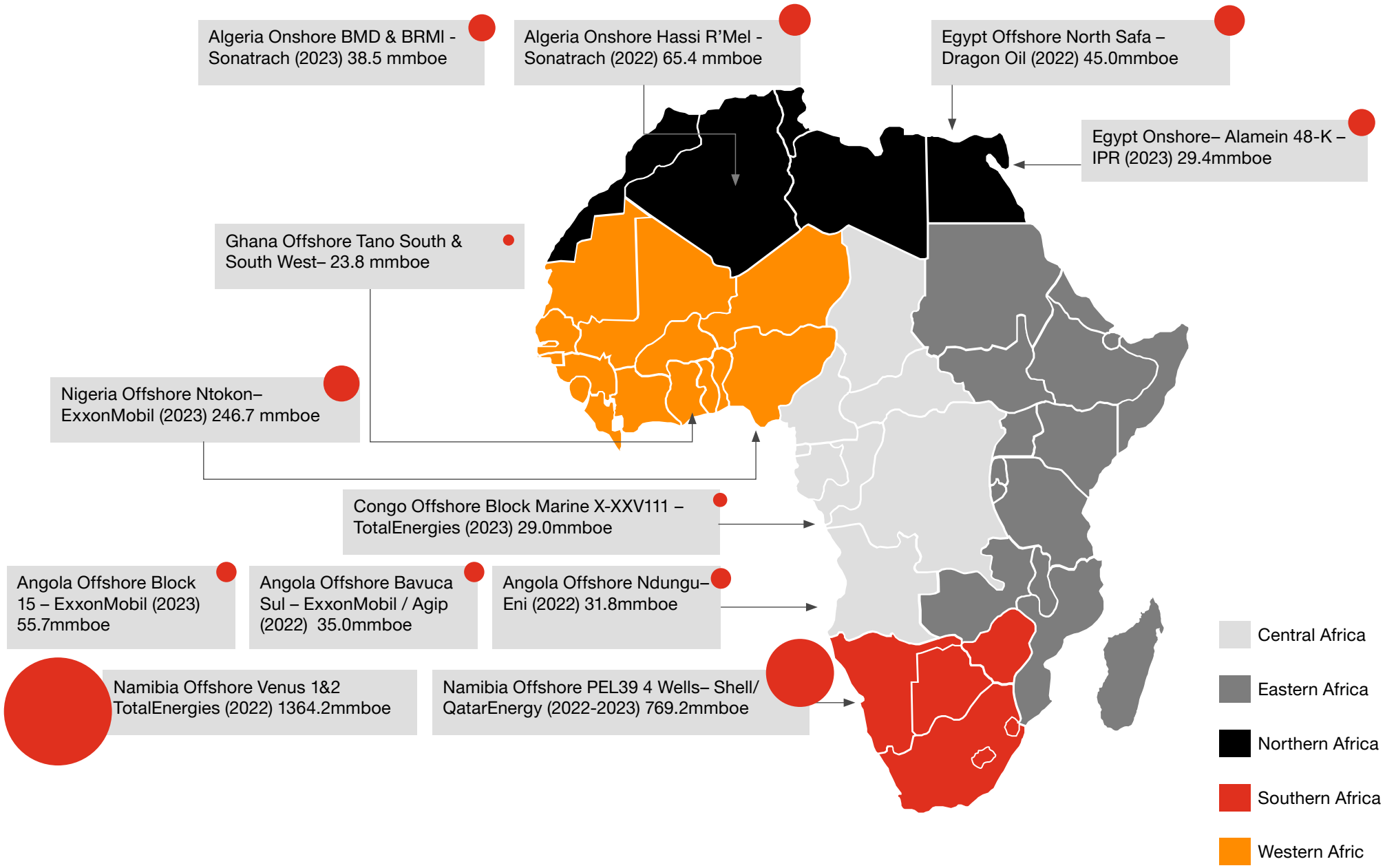
Figure 6: Liquid and gas discoveries from 2010 to Q2 2023



2022/2023 gas discoveries were in Egypt and Algeria with smaller gas discoveries in Zimbabwe and Namibia.



2022/2023 African oil discoveries were dominated by Namibia with 2.2 bn Barrels, with reserves estimated to be between 11 and 15 bn Barrels.



3 Global energy dynamics

The energy sector has an essential role to play in achieving the decarbonisation of the global economy. This shift to decarbonise the energy system has created a general push towards electrification, which includes a drive towards electric mobility. Both decarbonisation and electrification face significant challenges and constraints that offer risks and opportunities to Africa.

The global fossil fuel economy is a mature system that reflects more than a century of investment in complex value chains defined by a network of infrastructure that spans the globe, even though such infrastructure is concentrated in OECD countries with limited penetration on the African continent. A key positive attribute of the fossil fuel industry is the high energy density of crude oil and derived liquids such as diesel, gasoline, paraffin and others. The aggressive displacement of the fossil fuel sector with renewable energy systems will require a significant and accelerated build out of new infrastructure across renewable energy value chains and, in many instances, the technologies depended upon are still in a relatively nascent stage of development. The global fossil fuel industry currently supplies 102mmbbl/d of crude (a peak in June 2023) and is expected to peak at about 106 mmbbl/d in 2026).[1] Part of this growth will be in Africa where peak demand is expected in 2030.

In the global fossil fuel industry energy consumption of oil is 190.7 EJ (102 mmbbl/d), gas is 141.9EJ (381.3 bcf/d), coal is 161.5EJ (24.1 mmt/d) and nuclear is 24.1. By comparison the established RE industry currently only amounts to 85.9EJ (Renewable Excl Hydro 45.2 EJ) in total, which illustrates the challenge that it has to overcome as RE energy consumed accounts for 16.6% with hydro and only 8.7% without hydro. All forms of energy consumption in terms of EJ were at their highest in 2022, except coal with its second highest year and nuclear which has been declining since 2016.

The fossil fuels industry is an extractive industry subject to the need for continued investment in new capacity to displace lost reserves and to cater for a world increasingly demanding more energy as developing economies are set to continue growing. Like all extractive industries, fossil fuels too have sensibly targeted the more attractive resources first, however easy resources have largely been consumed and more complex, deeper conventional resources or new frontiers or unconventional resources are now necessary to sustain the global fossil fuel economy.

The economic crisis of 2008 followed by a decade-long depressed oil price consequent to a rush into unconventional resources, principally in North American shale, materially impacted the structural supply-demand outlook in fossil fuels as the O&G sector materially under invested in exploration during this period. The shale industry benefited materially from a period of access to cheap finance and a hubris associated with a drive

1 https://www.iea.org/reports/oil-market-report-july-2023

for ever more volume defined by the slogan “drill-baby-drill”. An abrupt correction in the shale industry towards rationality, coupled with high inflation rates and an O&G sector weary of a troubled past decade is placing significant pressure on the supply side of oil and gas and related sectors such as LNG. The increasing demand for LNG into traditional and new markets in Asia to fuel those rapidly growing economies and as a bridging fuel away from carbon heavy fossil fuels is a trend that is expected to continue. Much speculation exists as to whether the shale-based LNG supply from the USA will lead to a restructuring of the LNG business model, however LNG is globalising the gas industry.

The nature of the fossil fuel industry and its recent period of under investment portends an extended period of increased energy prices and a tightening of supplies, even if geopolitical dynamics are not considered and short term volatility is ignored. Such supply tightness and price pressure poses a challenge to energy affordability and energy security, especially in developing economies. Nonetheless, the fossil fuel industry is obliged to seek new resources, with both established hydrocarbon settings and new frontier exploration to be pursued to support an orderly energy transition. Significant investment is required for the industry to “run-fast-just-to-stand-still” even as decarbonisation becomes an ever greater urgency. An added challenge is that financiers and investors are increasingly challenging fossil fuel investments, which could find expression in higher costs and delayed development and further upwards pressure on energy prices.

Besides the natural tensions in the fossil fuels sector, it is well understood that electricity generation needs to shift to low-carbon technologies, relying on a diverse range of technological solutions (both centralised and decentralised). Notwithstanding its inherent virtues, such a shift to lower carbon energy systems has to deal with significant challenges too. The nature of renewable energy systems is that they are inherently of low energy density requiring greater area use and a higher requirement for specific capital per unit of energy to enable harnessing of an essentially free, when available, fuel. In addition, renewable energy systems are inherently

difficult to store and multiple chemical and/or mechanical processes are required to overcome increasingly longer transportation distances. The details of this ‘low-carbon electrification’ will differ from region to region depending on a number of factors including geography, consumption density, resources, level of revenues and existing infrastructure. Additionally, renewable energy systems depend on extractive industry inputs and have complex life cycle dynamics to consider. Decarbonisation of the power system is occurring with renewable energy generation TWh increasing faster than the increase in fossil fuel powered generation as most regions shift towards a greater renewables-based power system. Only West Africa has seen a higher percentage of its power being generated by fossil fuels. This was driven by Ghana and Côte d’Ivoire utilising their oil and gas, particularly gas as a domestic source of power. Northern Africa and Eastern Africa have largely remained unchanged, however North Africa in particular is pushing ahead with more aggressive renewable policies and construction of large renewable plants.

The recent geopolitical political impacts of the war between Russia and Ukraine has again shone a light on the need to ensure the resilience of energy systems as a key priority. Russia’s response to sanctions that limit gas supply to Europe led to regions around the world experiencing soaring energy prices that have hit consumers hard.[2] The supply cuts came just as EU energy demand was rebounding from the drop caused by COVID-19. What’s more, the world’s dependence on fossil fuel consumption, including the price and resource volatility that it entails, has come into sharp focus. The unfolding circumstances re-emphasised the need for a shift to alternative energy sources with energy security at its heart.

In order to promote energy security, whilst ensuring the decarbonisation of the energy sector, a realistic mix of energy supply technologies must be adopted based on the resources and energy potential within each region. Whilst the transition to renewables is undoubtedly necessary in order to achieve the Paris Agreement target of limiting global warming to 1.5°C above pre-industrial levels, there are still certain realities that cannot be ignored.

The diffusion of renewable energy in the power system implies high supply variability. Lacking economically viable storage options, renewable energy integration has so far been possible thanks to the presence of fast-reacting mid-merit fossil-based technologies, which act as back-up capacity. In the context of the global transition to less emission intensive energy technologies, this is the most critical barrier, as it would challenge the deployment of renewables even if these were cost competitive and old fossil-fuel based technologies are close to the end of life.

2 International Monetary Fund “How a Russian Natural Gas Cutoff Could Weigh on Europe’s Economies” https://www.imf.org/en/Blogs/Articles/2022/07/19/blog-how-a-russias-natural-gas-cutoff-could-weigh-on-european-economies

Technological opportunities and challenges of the energy transition

A careful consideration of the relationship between renewable capacity and other generation technologies, and especially fast-reacting fossil-based electricity generation, unveils two significant shortcomings. First, it highlights that the trade-off between renewable deployment and security of supply is exacerbated as renewable penetration increases. Second, it suggests that unless cheap storage options become widely available in the immediate future, the penetration of renewable energy will increase system costs, as a significant amount of capital-intensive and under-utilised back-up capacity will have to be maintained. Overlooking these two issues leads to an underestimation of the costs of the energy transition.

Renewable energy curtailment will be important for the energy transition as it provides for management of the grid infrastructure and reduction of RE generation as required to maintain the balance between supply and demand as well as the integrity of the infrastructure. This is particularly critical in Africa which has underdeveloped transmission infrastructure and requires significant capital upgrades to increase capacity and for its location to be more optimal. Curtailment on windy and sunny days occurs when these technologies exceed the maximum design capacity of the grid and the transmission operator needs to restrict generation capacity to stop transmission structure overloading. Curtailment approach to grid connectivity is able to unlock scarce grid capacity and, with co-locating wind and solar, greater system optimisation and grid capacity can be achieved with renewables technology providing more consistent generation to the grid and act more like baseload.

Battery Energy Storage Systems (BESS) have emerged as a technology to help hedge the variability risk associated with renewables. However, the deployment of BESS technologies is in its nascent phase. These early stages of deployment typically rely on a 'technology push' in the form of public or private investments in idea creation and R&D. Whilst there has been an increase in utility scale BESS deployment, the costs associated with the wide scale adoption of BESS systems remain a barrier, especially in Africa. Based on the current research available, projections show a wide range of storage costs, both in terms of current costs as well as future costs. In the near term, some projections show increasing costs while others show substantial declines, with cost projections by 2025 of -3% to 36% based on a 2022 starting point of $482/kWh.[3] This illustrates the uncertainties and nascency of the BESS sector. For BESS deployment to become more economically feasible, the involvement of integrated skills composed of individuals with technical, economic, regulatory, and public expertise will be critical in order to help anticipate and respond to challenges that likely will not be recognised if only technical experts are involved. Without clear energy storage strategies or roadmaps, the only real growth in battery storage remains with residential, industrial and business premises.

Hydro pumped storage systems can be thought of as a natural battery and can significantly help support grid structures and reduce rolling blackouts that have been experienced in countries across Africa, such as Nigeria, South Africa, Zimbabwe, Malawi and Zambia. Pumped hydro therefore not only has the ability to support renewables, but also keep the power on. The importance of pumped storage can be best demonstrated in South Africa where electricity demand has outweighed supply, however the City of Cape Town (CoCT) has managed to reduce peak shaving costs from Eskom and more importantly reduce the level of rolling blackouts (levels of load shedding) compared to the rest of the country which allows greater economic activity and growth with fewer energy constraints. Unfortunately this solution currently does not constitute clean energy as the water is pumped back into the upper dams using power generated primarily from coal. The increase in the capacity of the dams and the use of PV and wind has the potential of having a mixed pumped hydro storage micro system that ensures greater stability of supply.

3 "Cost Projections for Utility-Scale Battery Storage: 2023 Update" National Renewable Energy Laboratory (NREL) at www.nrel.gov/publications.

Outside Morocco and South Africa, almost no pumped storage exists in Africa. However it is important that other countries start to invest in this 'natural battery' storage solution for greater energy security and transition to cleaner power solutions.

A number of Gravity Energy Storage Solutions (GESS) that store excess electricity particularly from renewables have technologically advanced in the last few years, and through economies of scale they have started to be economically viable. Like all energy storage systems, GESS power can be deployed when required and from any location where it is built. Old decommissioned power stations, mine shafts and newly designed GESS buildings can be used for this purpose. GESS provides another alternative to batteries and in principle provides a lower cost of energy storage and longer life cycle with no output degradation as noted with BESS.

Unlike the rest of the world where utility supplied BESS makes up over 70% of the storage energy capacity, in Africa it is in the nascent phase with the majority of energy storage being used for commercial (offices), industrial and residential purposes. Not using solar to power BESS creates additional strain on the grid when generating capacity on the grid is restored with the batteries pulling additional power to recharge.

Battery technology research and investment is leading to improvements in battery technologies, while prices have dropped. Lithium-ion batteries are the most common, but other technologies that can assist energy transition are also gaining traction. All new technologies have their pros and cons from a size, price, energy density, safety and recyclable perspective. Other storage options besides lithium-ion technologies are in use or in the nascent stage of development and include sodium-ion (salt), solid state, hydrogen fuel cells, aqueous magnesium, graphene and vanadium.

Vanadium Redox Flow Batteries (VRFB) for example are currently twice the cost of lithium-ion batteries factor, primarily due to current economies of scale, R&D, technology maturity and use in electric vehicles. However VRFB provides energy for longer than four hours. The cost of VRFB is $400/ kWh, but it is expected to half by 2030 due to greater economies of scale, greater improvements in charge density and integrated value chains. A VRFB battery system is typically effective over long duration (four to ten hours), has minimal degradation and easy scalability features, though upfront capital expenditure requirement is a lot higher as compared to other battery chemistries. Hence, levelized cost of electricity (LCOE) and better recyclability lower the cost of ownership, with greater battery duration allowing for greater renewable energy integration, power back-up and uninterrupted power supply.

Globally, green hydrogen is emerging as an extremely promising source of energy, with the potential to power industries. However, the economics of green hydrogen are challenging, primarily because the underlying costs of electrolysis and availability of renewable energy sources vary widely. Recently, PwC analysed the green hydrogen market worldwide and identified potential demand growth, cost trajectories per country and the most promising export and import markets. Demand growth will grow at a moderate, steady pace through niche applications until 2030. Currently, hydrogen projects under construction and in operation are, despite growing capacities, almost exclusively at pre-commercial phase and have limited electrolyser capacities, typically well below 50MW. Proposed plants have larger electrolyser capacity of 100MW or more, but those are still small compared to current grey hydrogen production plants. It is also worth noting that building the infrastructure for large scale hydrogen use, such as pipelines or export/ import terminals, will take many years. As electrolyser costs decrease and infrastructure deployment accelerates, green hydrogen demand growth will accelerate, particularly from 2035 onward. Hydrogen demand by 2050 could vary from 150 to 500 million metric tonnes per year, depending on global climate ambitions and the development of sector-specific activities, energy-efficiency measures, direct electrification and the use of carbon-capture technologies.[4]

As other energy technologies mature, an immediate opportunity emerges in the form of gas that has the potential to offer the balance needed between decarbonisation and energy security. Historically, electricity networks were based on the concept of baseload and this remains one of the prime justifications for utilisation of natural gas in the near- to medium-term. Fast-reacting fossil technologies, which include most gas-generation technologies, are characterised by mid-merit order, quick ramp up times, lower capital costs and modularity (meaning that efficiency does not fall significantly with size). They are thus particularly suitable to meet peak demand and mitigate the variability of renewables. Additionally, natural gas-fired combined cycle power plants are the lowest emitting fossil fuel power plants.[5] Going forward, however, there will be a need to reduce CO2 emissions further and there is a concern that deploying new gas generation capacity will 'lock in' CO2 emissions for the lifetime of the power plant. However, the complementary nature of renewables and gas offers tremendous potential to address climate change with the speed and scale the world requires. Gas turbines currently in operation or yet to be deployed have a pathway to enabling decarbonisation and avoiding lock-in of CO2 through utilisation of green hydrogen as a fuel. As such, there is an opportunity to reduce coal emissions by retiring existing coal-fired capacity and replacing it with new, high efficiency combined cycle capacity. Doing so would almost immediately bring down global power sector emissions by 10% and total energy-related CO2 emissions by 4%.[6]

Within the global context, Africa is emerging as a key enabler to the global energy transition. There is a will to transition to cleaner energy and there is momentum with numerous planned renewable energy projects, although it is tempered by a lack of finance, associated transmission and other infrastructure and the need to significantly increase uninterrupted power for all. The continent has significant renewable energy potential particularly in the

4 https://www.pwc.com/hydrogen

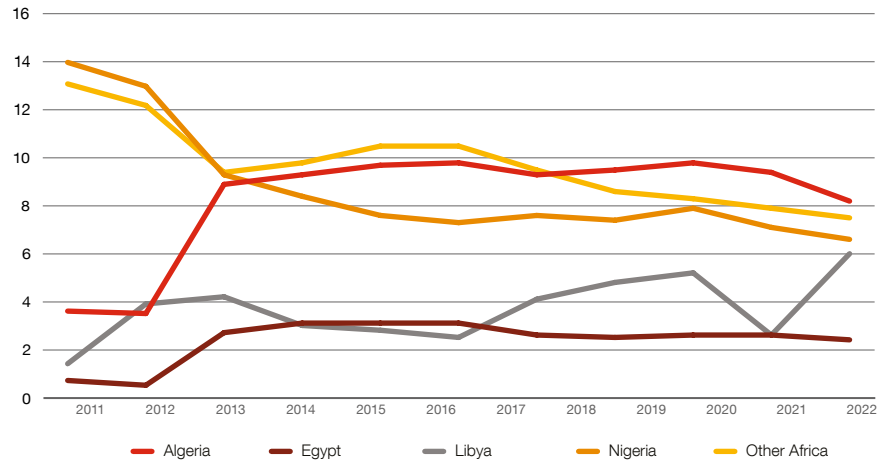
5 https://www.iea.org/energy-system/fossil-fuels/natural-gas

6 IEA special report, The Role of Gas in Today's Energy Transitions, July 2019, https://www.iea.org/reports/the-role-of-gas-in-todays-energy-transitions

North and South from which to develop renewable energy and become more energy secure in a sustainable net zero manner. Africa's renewable, oil and gas resources offer a unique opportunity to embark on an inclusive energy transition and chart a course towards a sustainable future with inclusive growth in a measured way.

The development of gas will be necessary in Africa and be part of the ecological transition. The current and future gas developments need to reduce and tackle methane emissions to meet GHG emission targets. Even with new projects in Africa coming online, the current level of emissions and flaring need to be reduced significantly. Africa's gas production global share is at 6.2% while it flares 29.2bcm annually or 20.0% of the global total. Key areas for reduction are the elimination of all non-emergency flaring and processes with carbon capture, utilisation and storage (CCUS). It is estimated that this can add 5% to the cost of production. The most impactful and cost effective way to reduce methane emission is the elimination of non-emergency flaring and development of a gas economy, particularly gas to power.

Figure 7: Africa Flaring BCM



The recent discoveries and both current and future developments could see global companies such as Eni, TotalEnergies, Shell and BP bring gas online in a more responsible and sustainable manner as they have pledged net zero targets and need to be accountable to their shareholders and align operations to their net zero strategies.[7]

7 See https://iea.blob.core.windows.net/assets/2f65984e-73ee-40ba-a4d5-bb2e2c94cecb/EmissionsfromOilandGasOperationinNetZeroTransitions.pdf

4 The role of Africa within the global energy system

Energy poverty in Africa

Africa as a net exporter of energy resources

Africa is a continent of expansive potential, not only in terms of its rich natural resources but also in its capacity to contribute significantly to the global energy system. Africa's role in the global energy system has been a multifaceted and pivotal one, marked by its historical significance as a net exporter of energy resources. This historical context has forged a complex relationship between the continent and the global energy landscape, as it has been a source of various forms of energy, from fossil fuels to minerals, in addition to its increasing relevance in the renewable energy sector.

Africa's historical role as a net exporter of energy resources finds its roots in the extraordinary diversity of the continent's energy portfolio and has made it a substantial player on the global stage. Nations such as Nigeria, Angola, Algeria and Libya have consistently ranked among the foremost oil and gas exporters globally. Their contributions have left their mark in meeting the global demand for hydrocarbon resources, particularly in regions such as Europe and Asia. These exports have not only moulded global energy markets, but have also been instrumental in their role of maintaining the stability of energy supply chains worldwide.

In addition to its hydrocarbon resources, Africa boasts an abundance of mineral wealth that plays an integral role in the energy sector. Rare earth elements (REEs), copper, cobalt, and lithium, have been indispensable in the production of batteries and renewable energy technologies that are pivotal to the clean energy transition, further cementing the continent's place in the global energy transition. African nations, notably those within the Southern African Development Community (SADC), have risen to prominence as suppliers of these minerals.

Beyond this, South Africa has been a notable producer of coal on the continent. The global movement to reduce coal usage, driven by environmental concerns, has prompted African nations to explore the path towards cleaner energy alternatives. Simultaneously, responsible maximisation of coal reserve value remains a priority.

Africa with its excellent solar and wind resources is positioning itself as a place for green hydrogen investment and global exportation in the next few years, with Morocco and Namibia leading the way.

The importance of Africa's energy resources exports extends beyond mere economic transactions. It has been a driving force behind geopolitical dynamics, with global powers vying for influence and access to the continent's wealth of energy resources. These diplomatic and economic relationships have not only shaped regional politics but have also influenced African nations' foreign policy decisions. These also aided in attracting foreign investment and international partnerships, with investments from numerous multinational energy

corporations and state entities into African energy projects that have fostered collaboration and technology transfers.

Furthermore, the export of energy resources has been crucial in fueling economic development within many African countries. The need to transport energy resources to international markets has driven the development of critical infrastructure, including pipelines, ports and terminals. These infrastructure projects have not only facilitated exports but have also provided opportunities for regional cooperation and integration, promoting economic growth and stability. The revenues generated from these exports have also enhanced infrastructure development, education, healthcare and industrialisation, ushering in periods of economic growth and poverty reduction.

Although Africa's historical role as a net exporter of energy resources has been marked by its contributions to global energy security, economic development and international partnerships, it has also faced challenges that include, resource dependence, corruption, environmental sustainability and the need to adapt to changing global energy dynamics.

The continent has experienced the volatility of global commodity prices, which has led to economic uncertainty in the countries that export energy resources. This reality has underscored the importance of diversifying economies and reducing dependence on energy exports.

There have also been growing environmental and social concerns relating to the extraction and export of energy resources in Africa, as a result of an increase in issues around environmental degradation, displacement of local communities, as well as conflicts over resource ownership and revenue distribution. Moreover, as global efforts to reduce carbon emissions continue to gain momentum, African nations that export energy resources find themselves at a crossroads. The transition to cleaner energy sources, coupled with addressing environmental concerns and resource governance issues, presents a complex set of challenges and opportunities for the continent.

Understanding energy poverty in Africa

Electricity access in Africa is facing a critical challenge, particularly in sub-Saharan Africa, where approximately half the population lacks access to electricity.

This electricity access problem is self-perpetuating because weak energy infrastructure discourages investment, making individual projects less viable and riskier, especially for private sector investors who historically contribute only about 10% of infrastructure funding in Africa. Infrastructure encompasses not only electricity grids but also essential public services like trained utility workers, water resources, and public safety.

Africa's energy infrastructure has suffered from chronic underinvestment. In the past decade, the continent received only a small fraction of global energy investment, with a mere 0.5% directed towards transmission and distribution networks. To address these issues, substantial annual investments in electricity grids are required, as outlined in the Sustainable Africa Scenario (SAS), but existing financing mechanisms are inadequate to attract investors. Therefore, development banks and governments must step in to mitigate investment risks and incentivise large-scale infrastructure projects.

Africa, despite being home to 17.2% of the global population, consumes only a minimal 3.1% of the world's electricity, making it the lowest electricity consumer among all regions on the planet as of 2019.[8] This lack of access is compounded by low electricity consumption rates, often falling below the global average, due to frequent power outages. Even in countries like Nigeria and South Africa, which are considered industrial powerhouses on the continent, the electricity grids are insufficient to meet the growing demand. For example, Nigeria, with a population of 206 million, has a power generation capacity of only 12 gigawatts, far below its needs. The continent faces significant disparities in access to electricity, with a stark contrast between North Africa and sub-Saharan Africa. By 2019, North Africa had achieved nearly universal access to electricity, while the electrification rate in sub-Saharan Africa stood at a mere 48%.[9] Consequently, more than three-quarters of the global population without access to electricity resides in sub-Saharan Africa, highlighting the region's considerable electricity access challenges. These challenges encompass issues related to access, affordability, and the reliability of electricity supply, all of which remain significantly lower in performance compared to other regions worldwide.[10]

Energy poverty in Africa stands as a formidable challenge, one that extends far beyond the mere absence of electricity. It is a pervasive issue, affecting over 600 million people in sub-Saharan Africa alone, with ramifications experienced by communities, individuals and nations alike. At its core, energy poverty represents the stark disparity between Africa's vast energy resources and the persistent lack of access to modern and reliable energy services. It is not only the access to electricity that is an issue, but also its interruptibility with rolling blackouts across the continent.

Energy poverty in Africa is a complex matter that is present in rural-urban disparities, where rural areas bear a more pronounced burden due to limited access to modern energy services. Rural communities often rely on traditional biomass for cooking and heating, perpetuating a cycle of energy inequity. The consequences of this disparity are not confined to energy alone; they extend to health as well. The use of traditional biomass fuel, such as wood and charcoal, without adequate ventilation leads to indoor air pollution, particularly affecting women and children who spend significant time indoors. This has increased the prevalence of respiratory diseases,

8 United Nations, 2019. Livre de poche des statistiques mondiales 2019.

9 IEA, 2021a. Access to electricity – SDG7: Data and Projections – Analysis - IEA [WWW Document]. URL. https://www.iea.org/reports/sdg7-data-and-projections/access-to-electricity, 9.20.21.

10 Blimpo, M., McRae, S., Steinbuks, J., 2018. Why are connection charges so high? An analysis of the electricity sector in Sub-Saharan Africa. Why Are Connection Charges So High? An Analysis of the Electricity Sector in Sub-Saharan Africa. https://doi.org/10.1596/1813-9450-8407.

Blimpo, M.P., Postepska, A., Xu, Y., 2020. Why is household electricity uptake low in Sub-Saharan Africa? World Dev. 133, 1–41. https://doi.org/10.1016/j.worlddev.2020.105002.

Streatfeild, J.E.J., 2018. Low electricity supply in Sub-Saharan Africa: causes, implications, and remedies. J. Int. Commer. Econ. 1.

underpinning the urgent need for a transition to cleaner energy sources and greater access for these communities to enhance public health outcomes.

The ripple effect of energy poverty is evident in its impact on education. The lack of electricity in homes creates challenges for students, hindering their ability to study after dark and limiting their educational attainment. Meanwhile, schools without access to reliable energy face similar difficulties, impeding the use of modern educational tools and technologies. This, in turn, affects economic development and productivity, particularly among small and medium-sized enterprises (SMEs), as unreliable power supply increases production costs and reduces competitiveness, highlighting the critical role of energy access in fostering entrepreneurship and job creation.

Leveraging Africa's abundant renewable energy potential holds promise in the battle against energy poverty. Solar home systems, microgrids, and decentralised renewable energy solutions offer reliable and alternative electricity access, even in remote areas where extending the central grid may be impractical. Realising this potential however, requires effective policy frameworks and investment in energy infrastructure. Insufficient investment in energy generation, transmission and distribution networks results in frequent power outages and unreliable energy services. As a result, governments, international organisations and the private sector are encouraged to collaborate to facilitate funding for energy access projects, promote clean energy technologies and develop supportive regulatory environments. It can also be stated that international collaboration is paramount in addressing energy poverty, as underscored by global initiatives such as Sustainable Energy for All (SE4All) and the United Nations Sustainable Development Goals (UN SDG7).

The global transition to clean energy offers new opportunities for Africa's economic and social development. Many countries, representing more than 70% of global CO2 emissions, have committed to achieving net-zero emissions by around mid-century, including 12 African nations that account for over 40% of the continent's total CO2 emissions. These ambitious commitments are reshaping the global energy sector, driven by declining costs of clean technologies and changing patterns of global investment. African countries, nearly all of which are signatories to the Paris Agreement on Climate Change, are well-positioned to benefit from technology advancements and attract increasing flows of climate finance as they navigate this transition.

Africa's opportunity to expand its contribution by leveraging its broader endowments linked to energy solutions.

With a diverse range of energy resources that encompass oil, natural gas, coal, minerals, uranium and an array of renewable energy sources, Africa has emerged as a pivotal player in the intricate web of global energy supply chains.

Recent years have witnessed a growing recognition of Africa's potential as a renewable energy powerhouse. The continent's abundant sunlight, considerable wind resources, and numerous hydroelectric potential sites have captured global attention. African nations have been proactive in investing in large-scale renewable energy projects, such as the Grand Ethiopian Renaissance Dam and expansive solar farms across North and sub-Saharan Africa, aligning their efforts with global climate change mitigation goals.

African leaders from resource-rich nations have expressed the importance of utilising their energy resources for development. Recent developments, such as the easing of restrictions on fossil fuel projects abroad by the European Union and the US, align with African nations' desire to achieve development goals.

Paving the way for Africa's energy transformation

The global energy sector is undergoing a profound transformation, driven by a series of crises and changes, including the aftermath of COVID-19, the Russian invasion of Ukraine, soaring energy prices, and the pressing challenges of climate change. This global energy transition is marked by a growing focus on clean energy investment, targets set out by the Paris Agreement and ambitious net-zero targets by 2030. Energy security and sustainability have risen to be top priorities for governments worldwide, and Africa should seek to strategise accordingly. The continent faces rapid population growth that has had a domino effect in that it has led to increasing energy demand, significant gaps in energy access, and a critical need for development. Accelerating the deployment of clean energy is seen as a crucial step for Africa's sustainable and resilient socio-economic development.

Investments in renewable energy have surged to unprecedented levels, reaching a staggering $358bn during the first half of 2023, representing a remarkable 22% increase when compared to the same period last year, marking a historic milestone for any six-month duration in the renewable energy sector's history. Despite Africa's substantial population, comprising nearly 20% of the world's total, Africa has received only a small fraction of this investment, amounting to just 2% of the world's investment in clean energy, despite its abundant resources. To harness the potential of abundant natural resources such as wind, solar and hydropower, it is imperative that investment blockages are identified and addressed. Failure to do so would mean missing a substantial opportunity to modernise infrastructure and achieve sustainable economic growth and development in line with the UN Agenda 2030 and Agenda 2063 goals. Recent initiatives like the Partnership for Global Infrastructure Investment aim to mobilise significant capital for sustainable infrastructure projects in emerging markets, including Africa. These initiatives prioritise climate-resilient infrastructure and clean energy supply chains.

The cost of electricity generation from renewable sources has been falling for more than ten years, making wind and solar generation on average more affordable than new fossil fuel power plants, despite the fact that the global energy market has become an increasingly competitive market for renewable energy. In Africa, the levelised costs of electricity from solar and wind power are now competitive with coal and less expensive than natural

gas.[11] Additionally, renewables are the best solution for addressing energy access in rural places since they are modular, adjustable, and quick to deploy. Renewable energy also promotes socio-economic growth and strengthens the ability of the climatic system.

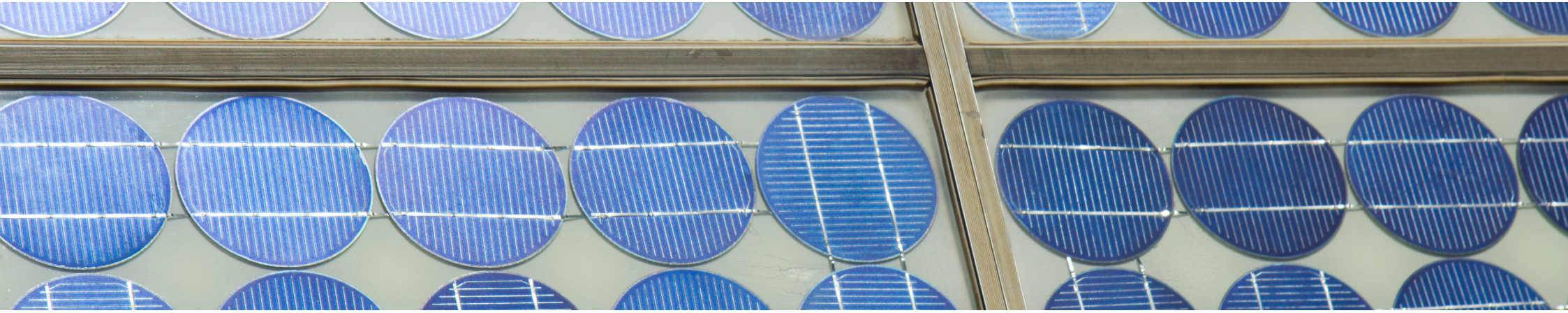
The green industrialisation of Africa and the growth of clean energy technology supply chains and manufacturing both have potential with renewables. The continent is well-positioned to profit from developments in clean energy technology and should not overlook the chance to take advantage of the benefits that clean energy, power markets, grid infrastructure, and green hydrogen have to offer. Africa needs to invest in transmission and distribution networks as well as storage facilities if it is to implement renewable energy on a major scale. Grids and storage are the backbone of power systems and essential for reaching Sustainable Development Goal 7 and green industrialisation, even though renewable generation is crucial. To provide dependable access to power, particularly in rural places, grid extension, interconnection, digitalisation, and storage facilities are required. Systems for storing energy in batteries are essential for stabilising the grid and managing intermittent renewable energy. However, as discussed above, BESS costs remain uncompetitive and the role of gas must be considered as a key industrialisation option given Africa's rich gas resources.

With models predicting that renewables, especially solar PV, will lead capacity increases by the end of the decade, there are high expectations for renewables in Africa. The most optimistic predictions from the International Energy Agency predict an eight-fold increase in solar and wind energy in Africa by 2030. Turning these hopes into reality will require breaking down investment barriers and partnering with both the public and private sectors. These sectors must work together and coordinate their efforts if energy projects are to be scaled up throughout Africa. Innovative public-private partnerships are required to close investment gaps, build confidence, and guarantee infrastructure that is future-proof. The moment to act is now, with an emphasis on renewables and gas at the core of Africa's energy future, as the continent faces an energy landscape that is fast changing.

11 Africa's Energy Future is Renewable https://res4africa.org/wp-content/uploads/2023/06/Africas-Energy-Future-is-Renewables-Flagship2023.pdf

Alongside renewables growth will be the expansion of gas across the continent. Gas will be crucial to support the renewables and energy transition and will primarily be developed in Africa using floating liquefied natural gas (FLNG) infrastructure as it reduces risk and provides a more efficient use of capital in an economical way that can monetise new and marginal fields for LNG exports more quickly. The early monetisation of assets and cash flows in turn also provides an intermediate solution for development of larger onshore liquefaction trains such as Afungi LNG Park in Mozambique. Onshore facilities such as Afundi have higher security risks from insurgents and local communities protests. FLNG capex costs compared to onshore are estimated to be 40-50% cheaper as noted by Cameroon's Golar FLNG coming in at $550/T. (*AFC Fola Fagbule O&G Week CTICC). The development of domestic gas markets will be driven by piped gas to GTP and subsequent development of the industrial and residential gas market economy.

		LNG Exports and capacity							Piped gas exports		
Country	Region	2022 MT	MT change	% change	Liquefaction capacity	Regassification capacity	Spot/ Short Term MT	% Spot / Short Term	2022 BCM	BCM change	% change
Algeria	North Africa	10,04	-1,70	-14.5%	25,3		4,25	42%	35,50	-3,40	-8,7%
Angola	Central Africa	3,19	0,44	12.1%	5,2		3,13	98%			
Cameroon	Central Africa	1,19	-0,01	-1.1%	2,4		0,8	67%			
Egypt	North Africa	6,78	0,20	3.4%	12,2	5,7	4,97	73%			
Equatorial Guinea	Central Africa	3,54	0,02	30.2%	3,7		1,71	48%			
Mozambique	East Africa	0,04	0,04	100,0%	3,4		0,04	100%	3,60	0,05	1,5%
Nigeria	West Africa	14,22	-2,20	-13.4%	22,2		5,77	41%			
Others	Others	0,00	0,00	0,0%	0,0	0,0	0	0%	4,40	-0,31	-6,6%
Total		39,00	-3,27	-7,7%	74,4	5,7	20,67	53%	39,10	-3,35	-7,9%



5 Exploring Africa's regional perspectives

North Africa (The right place at the right time)

North Africa will be a net exporter of clean energy and fossil fuels and be the leading exporter of piped gas and renewable energy into Europe. The region is blessed with abundant wind and energy potential, with Egypt and Morocco significantly investing into renewable infrastructure and thus reducing the level of reliance on fossil fuels. The Ukraine-Russia conflict has provided North Africa the opportunity to exploit the energy crisis in Europe. There is likely to be a shrinkage in gas production in 2022, and even 2023, due to ageing fields and lack of investments. However, with recent discoveries and collaboration and commitment by governments and international companies, additional gas, hydrogen and renewable energy growth for the domestic and export market will start to come to fruition from 2024.

The region is ideally placed to secure long term contracts to supply hydrocarbons to Europe. However this should not be to the detriment of local demand, as both are attainable.

The Energy sector

- With major gas and renewable export-oriented projects under consideration and under construction, North Africa has emerged as a global gas and renewable hotspot that has the potential to be a viable source of global energy security and as an alternative option to Russia to be the primary provider of gas into the EU.
- The area is endowed with significant oil and gas reserves (for gas Algeria is ranked 2nd, Egypt 4th and Libya 5th in Africa, and for oil Libya is ranked 1st and Algeria 3rd in Africa).
- Become the largest viable energy provider into the EU.
- Managing the huge O&G reserves and integrating them with the mammoth renewables potential in the region.
- The power sector needs growth of renewables to help manage blackouts and allow the region to increase gas and RE exports to the EU.
- A vision for North Africa is driving and accelerating RE deployment and managing gas resources so that the region becomes a viable source of global energy security.
- Only Egypt has a progressive plan to accelerate renewables deployment.
- Industrialisation will accelerate with the diversification and beneficiation of the energy resources within the region.
- There is an essential need for collaboration at national and regional levels to ensure the area continues to be a major exporting energy hub.

Energy Security

North Africa generally has good energy security with an average of 0.3% without access to electricity for Egypt, Morocco, Algeria and Tunisia. Sudan has 44% and Libya has 30% without access to electricity which is a decline over previous years, due to the level of instability within these countries. In respect to calculating the MWh per Capita, only Libya is above the global average and the rest of the countries bar Sudan occupy the third to sixth highest places in Africa in respect to MW/h per capita, but well below the global average.

North Africa Energy Summary	Algeria	Egypt	Libya/Rest of North Africa
LNG pipeline exports	35.5	0	2.5
2021–2022 NG pipeline exports change %	-8.7%	0%	-18.8%
LNG trade MT	14.4	6.8	0
2021–2022 LNG trade change %	-14.5%	-3.4%	0%
Local gas consumption	44.3	60.7	18.2
2021–2022 Consumption change %	-7.2%	-2.3%	0.6%
Flaring	8.5	5.4	2.2
2021–2022 Flaring change %	4.9%	-4.3%	-8.5%
Natural gas production BCM	98.2	98.2	14.5
2021–2022 Natural gas production change %	-2.9%	-4.9%	2.4%

Fossil fuels

North Africa fossil fuel reserves hold immense potential for both domestic consumption and export, presenting a lucrative opportunity for government and global players seeking to capitalise on the growing demand for natural gas.

The region is blessed with large oil and gas reserves, with offshore and onshore fields. However the countries are not without issues as the large fields start to deplete and numerous small discoveries are less feasible. There has been a reduction in large discoveries over the last seven to eight years with only a couple of big discoveries.

In Algeria the main producing field of Hassi R'Mel had additional gas discoveries of 98.2 bcm in 2022/23, otherwise the other 25 onshore gas discoveries were much smaller. Hassi R'Mel produced 3,105 MMCFD in 2022 and economic production from the field can continue into and past 2043. Algeria in particular is a hive of activity. In 2022 it became the largest supplier of gas into Europe with 31.5BCM of piped and 13.4 BCM[12] of LNG.

Algeria also has untapped shale gas reserves of 707 trillion cubic feet (tcf) of technically recoverable resources which hold huge potential and lucrative opportunities as the government attempts to attract interest from international companies through more strategic favourable regulatory policies aimed at attracting investment.

Egypt, like Algeria, has significant oil and gas reserves both on and offshore. Over the last decade the country continued to have discoveries, with nine offshore and 15 onshore discoveries made in 2022/23. The Nargis discoveries are between 51-70 bcm and are the most significant since the massive ZOHR discoveries of 2015-2016. The ZOHR field produces around 40% of Egypt's gas (2610 mmcfd in 2022), but saw a slight decline in production last year. However the field should remain economically viable until after 2043. The gas production decline noted in 2022 and again in 2023 is of concern, but significant investment into drilling programmes and projects will likely see a reversal of this trend in the reserves that are depleting (onshore and offshore).

Libya has potential for growth and can increase its supply of gas into Europe with companies such as Eni willing to spend USD8bn into the country. It is unlikely that Europe will wish to have a significant portion of gas from a single supplier from a risk perspective, so this may limit the Algerian Piped gas supply into the EU, as the reliance on a single market and the loss of that supply significantly affects the EU.

Both Egypt and Algeria have local and international markets which provide both opportunities to be potentially the main regional energy hub in North Africa. Both countries must address their gas production declines. Fossil fuel reserves are on the decline globally, thus it is likely that there will be an increase in reliance on exported gas from North Africa.

12 Stats BP

North Africa has a strong domestic gas market with consumption of 123bcm in 2022 which is about 76% of the gas consumption in Africa, and Egypt has potential for strong local growth in gas power production. The region has the lowest annual growth rate in Africa at 1.4% (excluding Sudan with a decrease of 0.35 in the last five years). Having a local gas market offers the opportunities for greater industrial development, economic growth and a sustained growth path of rising income and energy security. Both Egypt and Algeria have local and international markets which provide the opportunities for one of them to be the main regional energy hub in North Africa. Both countries must however address their gas production declines and have a clear energy strategy and regulations in which to execute and deliver on their plans

Egypt is the only country with a significant population in a few large cities, with 26 million people living in the four largest cities (Giza and Cairo alone have a combined population of around 20 million) which provides a huge opportunity for growth in the local gas market. Gas supply was rationed in 2022 and into 2023 as the government wanted to export more gas due to the high international prices. However this led to a shortage of power and rolling blackouts during the year. Egypt's population is double that of the rest of Northern Africa and its population of 111 million has a growing demand for gas. The country has doubled its domestic production of petrochemicals in the last five years to 3.4 Mtpa after investing heavily in its energy sector and having discovered almost 300 new fields.

Morocco's (the second largest consumer of coal in Africa) recent gas discoveries and its intent to move away from coal into a mix of renewables and gas signals its intention to move into a lower decarbonised energy future and the development of a domestic gas economy.

Renewable / Clean Energy

North Africa's renewable energy has increased to 11%. Solar PV was initially driven out of Morocco, however since 2020 Egypt has tripled its solar PV capacity.

Egypt is pushing to increase its electricity generation power from the current 56GW with 14% renewables. The Scatec solar plants and the Infinity Power 10 GW wind project is part of Egypt's Green Corridor initiative. The government has set targets of tripling renewable energy to 42% of its energy mix by 2035 (wind -14%, pv solar -22%, CSP -4% and hydropower at 2%.

North Africa is a massive land mass with some of the best solar photovoltaic conditions ranging primarily between 1700 and 1900 kWh/m, with the only main drawback the water scarcity across most of the region.

The wind resources of Northern Africa are significant, with steady wind speeds across much of the region ranging from 7m/s (25 kmhr) to 11 m/s (40 kmhr).

Wind and solar resources have greater potential energy than even their fossil fuels reserves. The good wind and solar resources will ensure that the average price of both wind and solar will be globally competitive. The IFC noted that Algeria has the highest wind resources with a total potential of 7,700 GW, and Morocco and Egypt have technical wind potential over 1000 GW.

Low carbon / green hydrogen could potentially be supplied through pipeline under the Mediterranean Sea to the EU. This has been muted as a parallel pipeline to the Nigeria-Morocco Gas Pipeline to carry green hydrogen. Transporting hydrogen via existing pipelines can become a low-cost option if delivering huge volumes, due to avoiding the high initial capital costs of construction. Research and development and improving technology is making this more economically viable, but still poses significant challenges.

Summary

North Africa will remain a net exporter of energy, however it also needs to improve regional cooperation and planning to develop an energy market that uplifts the region now and into the future. The integration and growth of clean energy into the market will need both the government and public sector to work together. The issue of the rolling blackouts in Egypt due to the government wishing to export gas at the expense of the public and private sector needs to be addressed in a way that ensures the public good and inclusive sustainable economic growth for the whole population.

East Africa: Time to Act

East Africa energy expansion will primarily be driven by gas development and the export of LNG. Currently the primary source of electricity is from hydro power, however by 2035 half of it could come from GTP as the economies benefit from domestic gas and exports. Uganda, with MoUs in place, now has a chance to become an exporter of crude.

The Eastern African Energy sector

- Mozambique's first LNG exports were in Dec 2022 from FLNG Coral. After insurgent delays, TotalEnergies is renegotiating terms to recommence. Mozambique LNG includes the development of offshore gas fields in the country's Area 1 and a 12.8 mtpa liquefaction plant at the Afungi complex.
- Uganda's economic growth is intertwined with the development of the Tilenga and first export via Tanzania in 2025.
- Tanzania has been late in coming to the party. The Songo Songo Globeleq consortium domestic gas development is an excellent example of government and business cooperation that has developed a gas value chain that benefits the general public and the economy as a whole while significantly dropping CO2 emission. GTP generates 57% of the power in Tanzania.
- Shell, ExxonMobil and the Tanzania government in May agreed on the framework for development of a 10 mtpa LNG which is anticipated to reach FID in 2025 and commence operations in 2031. Block 2, operated by Equinor and block 1 and 4 operated by Shell have estimated recoverable reserves of 20 Tcf and 16 Tcf respectively.
- Kenya has increased its geothermal capacity and now produces 47% of its power from geothermal energy.
- Currently 95% of the renewable energy capacity in Central Africa is generated by hydro. The possibility of additional power from pumped storage would create additional power that could be used as a 'natural battery' to act as a dispatchable storage to complement renewable energy development.
- Significant investment into the GTP, the transmission and distribution sectors are required and this is only possible with international funding and expertise from international companies with the most likely beneficiaries expected to be Tanzania and Mozambique.
- The development of LNG exports could be linked to domestic gas provisions to facilitate the gas market and associated economies and to reduce energy poverty.
- Besides Angola the region has the worst flaring intensity in Africa, although much of this can be attributed to the flaring off from small fields.
- East Africa with its 'reasonably newly' discovered reserves population growth of 2.5% per annum and 70% of the population below 30 provides a significant opportunity for international investment in a region with high potential human capital and hydrocarbon resources that can provide significant growth.

Energy Security

East Africa has very poor energy security with an average of 55% (more than 250 million) of the population without access to electricity.

The region's low level of electrification calls for a need to monetise the gas and even oil reserves to generate greater growth and industrialisation and not rely on hydro power as the primary source of power generation.

Fossil fuels

Eastern Africa nascent signs of developing greater energy security, primarily through gas.

The region has strategic investment decisions and security concerns that need to be addressed in order for the region's economies to prosper. There are nascent signs that East Africa will become a global player with first production coming from FLNG Coral in Q4 2022 and Mozambique's LNG project to restart at the end of 2023.

Ninety-percent of Mozambique's gas production is on long term contracts, compared to an average of 47% in the rest of Africa. This provides Mozambique and financial investors a secured lower risk investment.

Tanzania at last appears to be moving forward in respect to gas production with a MOU signed between business and the government and FID expected in 2025 and first production possibly in 2031. Uganda's oil from Tilenga will go through Tanzania's Port of Tanga, which provides the country besides its gas, to become an energy hub for East Africa.

Mozambique has the third largest gas proven reserves after Nigeria and Algeria with 100 Tcf.

The Uganda Tilenga final investment decision (FID) of $4bn was approved in 2022 and the East African Crude Oil Pipeline (EACOP) costing $3.5bn will possibly carry 246,000bpd of oil to Tanga for export.

Discoveries

East Africa drilling exploration activity has been relatively limited since 2015. However the huge discoveries from 2010 to 2015 have just started producing, in pre construction and under FID consideration.

The huge gas discoveries in Mozambique (3219 bcm) and Tanzania (765 bcm – Rystad) created significant excitement and interest as the new frontier in 2015 to be developed. Mozambique was first out of the blocks, but has stuttered along, due to security and force majeure being implemented in 2019.

Oil discoveries were also associated with the Mozambique and Tanzania discoveries. However, beside these oil discoveries there were others found onshore in the African rift valley of Uganda and Kenya with 352 mmboe (2010-2013) and 572 mmboe (2012-2017) discovered respectively.

East Africa has yet to truly benefit from its abundant oil and gas resources, in particular gas. However it appears that the time is now right and investment decisions are, or have been, made to develop these resources.

Domestic market

The local gas market is limited and has only existed in Tanzania from 2004 and ramped up in 2016 to 4509 GWh, while Rwanda's small generation ramped up in 2016 to 213 GWh and Mozambique GTP started in 2017 and generated 2690 GWh. In Africa and global terms gas usage is extremely low at 7.5%. Oil generates 8.3%, geothermal 5.2% and the bulk with 68.4% comes from hydro.

Renewable / clean energy

The region's energy has primarily been supplied by hydropower 68%, 5% geothermal (geothermal in Kenya and to a minor extent in Ethiopia and Djibouti). Only Kenya has made positive steps to move to clean energy with an increase in solar and geothermal energy in 2022.

Summary

East Africa started LNG exportation from Mozambique in 2022 and this will continue to grow with the country's LNG construction set to continue. It has the opportunity to be the hub for gas in the region as the first mover, with neighbouring South Africa being the third largest economy in Africa in need of gas to support its clean energy transition.

Uganda is the first landlocked country in Africa (excluding South Sudan) that will become a net exporter of oil in 2025/2026.

West Africa – Untapped potential

West Africa will continue to be a net exporter of energy, with LNG commencing to monetise assets in Senegal and Mauritania. Energy security will be enhanced with the commencement of production from the Dangote refinery. Domestic gas and renewables (excluding hydro) are underdeveloped and there is a need for increased renewable penetration across the entire region, with modular gas and mini-micro grid solutions likely required to solve the electrification crisis.

The West African energy sector

- Continue to be a significant oil and gas net exporter.
- Nigeria will continue to be the major oil exporter in the region.
- West Africa to potentially become a larger gas producing region reaching 6% of the global production by 2035.
- Greater monetisation of domestic gas.
- Even with a major pipeline proposed, it is likely that LNG/FLNG will be the route to market.
- Senegal and Mauritania will become global players in the LNG export market.
- Currently 92% of the renewable energy capacity in Western Africa is generated by hydro.
- Only Senegal, Mali, Togo and Burkina Faso's renewable energy has increased since 2019, with merely 55MW, 88MW, 50MW and 65MW of solar installed primarily through IDF funding.
- Significant investment into the GTP, the transmission and distribution sectors are required and this is only possible with international funding and expertise from international companies.
- A vision for West Africa is driving and accelerating LNG exports to drive industrialisation and energy security.
- Industrialisation will only occur with the diversification and beneficiation of the energy resources within the region. Gas could have a multiplier effect on job growth, both skilled and unskilled, and help Western Africa become more industrialised and with population growth of 2.5%.

Energy security

West Africa has very poor energy security with an average of 47% (193 million) of the population without access to electricity. Ghana with only 14% of its population without access to electricity is performing the best. The lack of gas infrastructure and monetisation of the gas available and the frequent power cuts hampers the region, and it has only been through the participation of the private sector with oil companies such as Eni and Tullow that there are parts of the domestic gas value chain working. Collaboration and partnerships between business and government are necessary for the region to increase its energy security and prosper.

GTP power will come online in Senegal and Mauritania, with greater expansion of GTP in Ghana and Nigeria. However the entire gas infrastructure needs investment, management and cooperation between government and the private sector to ensure this happens, which includes cost reflective tariffs, greater governance, transparency, maintenance, investment and expertise. The region has significant potential with around 70% of the population below 30 and continued year on year growth rates of 2.5%.

Fossil fuels

West Africa fossil fuel reserves hold immense potential for both domestic consumption and exports with Nigeria being the power house in the region in respect to population and oil and gas reserves. Second largest gas reserves with 36.1 mmboe (31.2 mmboe oil and 5.9 mmboe condensate and the largest gas reserves with 203 tcf). The other large gas reserves are offshore, with Mauritania estimated at 57 tcf and Senegal at 37 tcf.

Discoveries

West Africa gas discoveries have been limited since 2019, although the large gas discoveries in Mauritania in 2015-2019 and Senegal in 2015-2016 are in the process of being monetised, with these two countries coming on line in 2024. The domestic allocation of gas will be able to reduce the use of diesel generators and coal power generation. The Ahmeyia discovery that is part of the (GTAF) had significant gas and oil discoveries of 358 bcm of gas and 152 mmboe of oil. The Senegalese discoveries of Sangomar, Yakaar, Fan and Terranga had significant gas and oil discoveries of 362 bcm of gas and 672 mmboe of oil (Rystad).

Nigeria's gas discoveries have been disappointing over the last decade and only the Nkonan and Omo discoveries in 2023 and 2013 with an estimated 247 mmboe and 225 mmboe of substance.

The 2.3 MPTA FPSO vessel for the Greater Tortue Ahmeyim (GTA) LNG project, operated by BP should process around 500 mscf of gas per day. The first production of gas was meant to be in 2023, but has been plagued by a number of delays. Kosmos indicated production will now start around Q3 2024. This project highlights a significant level of cooperation between Senegal and– Mauritania and the private companies BP and Kosmos consortium to develop their fields together as the Greater Tortue Ahmeyim Field (GTAF). The new West African frontier is in the deepwater of 2km and for monetisation and GTP the development and execution of the delivery is essential to create value for all stakeholders.

The 4,128KM Trans-Saharan Gas Pipeline (TSGP) first muted in the 1970's has MOUs signed between the Algerian and Nigerian governments in 2022, but still in the proposed stage and with political instability in the region, the safety concerns about the operations and funding the investment causing further delay. The plan is for the pipeline to start in the Warri region of Nigeria and go through Niger to Hassi R'Mel in Algeria. In Hassi R'Mel it will connect to the existing Trans-Mediterranean, Maghreb–Europe, Medgaz and Galsi pipelines.

The proposed Nigeria-Morocco Gas Pipeline (NMGP), which will go through Nigeria, Benin, Togo, Ghana, (The West African Gas Pipeline) will be extended to include Ivory Coast, Liberia, Sierra Leone, Guinea, Guinea- Bissau, The Gambia, Senegal, Mauritania and Morocco. This would require a significant amount of cooperation, coordination, and management to get off the ground. The time it is likely to take may mean that the EU will make other gas deals, especially LNG/FLNG deals which can increase on a modular level at a lower cost and quicker pace.

Domestic market

There are limited local gas markets in Ghana, Ivory Coast, Benin and Togo. Nigeria consumes the bulk of the gas with domestic consumption of around 26 bcm and the other countries in the region less than 1 bcm annually. The lack of infrastructure remains the most significant barrier to growth, although this has become slightly less of an issue with greater use of networks with the expansion of CNG networks.

Rolling black outs remain a constant issue in the region with Nigeria having experienced 'system' collapse (4 times in 2022 and again in 2023).

Diesel and petrol generators and inverters are a common source of electricity as the electrical system has failed. Most businesses and affluent families can afford to resort to using their own generators due to the instability and lack of capacity on the national grid even though the cost of running diesel generators is 4 times that of the electrical tariff per KWh. The Nigerian national grid capacity is 13,128MW (4 and 5 times less than South Africa and Egypt). The Transmission Company of Nigeria has noted that the daily average of power generated is 4100MW or 31% EAF due to a lack of maintenance, corruption and mis-management of the infrastructure.

The electricity tariffs set by the country's regulatory bodies are below the cost of generation and distribution for socio-political reasons, with a negative impact on the sustainability of the network. This also results in a lack of private investment. The level of revenue recovery also increases additional risk and reduces the willingness of private investment.

Both Senegal and Mauritania will require expertise to develop their domestic gas market with it mostly being around Nouakchott with a population of 1.4 million and Dakar in Senegal with 3.3 million .

Nigeria provides the greatest opportunity being the most populous country in Africa with a population of 219 million. Although many challenges exist, it has a ready made domestic market with 17 cities with a population over 1 million. The biggest challenges remain with legislation, corruption, governance and transparency and the need for both government and business to collaborate for the public good.

Renewable / clean energy

A lack of a clear strategy has hampered any growth in renewable energy in Western Africa.

Summary

Western Africa will continue to be a net exporter of energy with an increase in LNG from FLNG as Senegal and Mauritania become global exporters in 2024. Like Nigeria (79%) 80% of the gas produced will be exported, however the 20% domestic gas will need to be carefully managed to ensure it is utilised for the public good, primarily for GTP, but also to develop a gas market in these countries, which will require distribution and transmission networks that could be run and operated by private companies to monetise the countries' gas assets.

Dangote Refinery progress

The Dangote refinery, which cost around $19bn and is Africa's largest oil refinery and the world's largest single-train refinery, is expected to start operations in Q4 2023 and ramp up to 650,000 barrels a day by the end of the year. Although five years behind schedule, it demonstrates how private business can drive energy security and contribute to the Nigerian energy sector. This mega refinery will do that and reduce the amount of imported refined product from 80% to below 20% and produce fertilisers that can supply the entire region. The refinery can potentially reduce petroleum imports across the continent by 36% and benefit the Nigeria economy by between $20 and$30 bn.

The refinery will be self-sufficient in that it has 435MW of IPP produced electricity and a deep seaport. The power supplied by the independent power plants (IPPs) will add an additional 15% to the total power generated on the national grid).

Central Africa (global energy influence is crumbling)

Central Africa will continue to be a net exporter of oil and gas, but requires additional discoveries to maintain its status. Renewables outside hydro are negligible and only Angola has been making strides towards a greener economy with fossil fuel revenues being invested into renewable and hydro power expansion.

Summary

The Central African energy sector

- Will grow its LNG exports, however the lack of new discoveries could hamper growth as gas fields in Equatorial Guinea and Cameroon deplete.
- Angola to continue to be the major oil exporter in the region.
- Currently 95% of the renewable energy capacity in Central Africa is generated by hydro.
- Significant investment into the GTP, the transmission and distribution sectors are required and this is only possible with international funding and expertise from international companies.
- The development of LNG exports must be linked to provide gas into the domestic markets so that the economies can grow and energy poverty reduced.
- The area has a number of hydro power projects and additional power from pumped storage would create additional power that could be used as a ‘natural battery’ to act as a dispatchable storage to complement renewable energy development.
- Besides Angola the region has the worst flaring intensity in Africa, although much of this can be attributed to the flaring off for small fields. Angola has the most proactive flaring and venting regulations in Africa and is reducing its methane emissions in order to meet its own, and the countries it exports to, energy transition targets.
- There is a need for the other Central African countries to also reduce their emissions for exports to remain sustainable as tighter international legislation is enforced.

Energy security

Central Africa has very poor energy security with an average of 67% (125 million) of the population without access to electricity. GTP and other strategies with the government and the private sector needs to be developed at a system level in order to develop these relatively small economies.

Fossil fuels

Central Africa, apart from Angola, is not as blessed with resources as West Africa. However the region has been able to develop LNG with Equatorial Guinea and Cameroon exporting 4.7 bcm and 1.4 bcm respectively in 2022. Angola has both the most proven oil and gas reserves in the region with 7.79 bn bbls (fourth largest) and 12Tcf (sixth largest) respectively. The Republic of Congo with 2.88 bn bbls and Gabon with 2.00 bn bbls of oil have been utilising their oil reserves for decades without significant beneficiation and industrialisation for the general public. There is hope that Gabon will use the gas revenues from Perenco’s 0.7 mtpa LNG facility that has planned production from 2026 to help beneficiate and alleviate energy security issues.

The regional gas plays are small even in African terms with reserves in Angola at 12 Tcf, The Republic of Congo at 10 Tcf, and Equatorial Guinea and Cameroon both with 5 Tcf, which combined is less than that of Libya the country with the fifth largest proven reserves in Africa.

LNG has been exported out of Equatorial Guinea since 2007, before being joined by Angola in 2014 and Cameroon in 2018. The Republic of Congo's Tango FLNG has a storage capacity of 16,100 m3 and liquefaction capacity of up to 0.6 mtpa and is expected to start activities in Q4 2023. This project is being developed alongside Eni Congo FLNG II Terminal which will increase capacity up to 3 mtpa by 2025 (4.5 bcm pa). The additional 2.4 MPTA vessel will be able to store both LNG and LPG 180,000m^3 of LNG and 45,000 m^3 respectively. The example of the Tango FLNG provides insights into how relatively small reserves can be developed and fast tracked in a modular way or as part of an overall gas strategy that allows rapid monetisation of the reserves while greater capacity is developed.

Discoveries

Central Africa gas discoveries have been very limited since 2016. The largest oil discovery was in 2019 with Angola's Ndunga and Agogo with 499 bcm. Since 2019 the region's discoveries for both oil and gas have been disappointing and account for less than 10% of the discoveries on the African continent each year.

In many ways Central Africa has punched above its own weight globally and has used its potential relative to its reserves. The opportunities that this provided and continue to provide have not been exploited, with very low GTP with the largest GTP generation coming from The Republic of Congo with 1587 GWh. The development of LNG / natural has not benefited the domestic market with almost no change in generation from gas since 2015.

Domestic market

The local gas markets are extremely limited and undeveloped across Central Africa even though the economies lack power. With a population of 196 million and growth rates of 3.1% annually, the energy crisis will get worse unless significant investment comes in.

Renewable / clean energy

Only Angola with an increase of 284MW in 2022 and an increase of 296MW through a mini grid system over the next three years has committed to increasing its renewable capacity. The new mini grid system will also be a first as the 296MW of solar combined with 719MWh of lithium-ion storage.

Angola has also had the most proactive flaring and venting regulations in Africa which indicates that the country is moving forward with cleaning up its oil and gas sector and developing a more sustainable and cleaner economy.

Southern Africa – The new frontier

Southern Africa is the new energy transition frontier, with the decommissioning of coal. The large oil and gas discoveries and favourable renewable energy potential provides an opportunity for the region, in particular Namibia, to be a new frontier for investment as hubs for oil and gas, as well as green hydrogen.

Summary

The Southern African energy sector can provide sustainable development and energy security that ensures economic growth, social inclusion, and environmental management. The development of gas in tandem with renewables will decrease the region's carbon footprint and reduce pollution while taking into account the environment. Namibia in particular provides another possibility of FLNG/LNG development as the country has lower security risks and less issue with insurgents than either Nigeria or Mozambique which makes it an attractive area for investment. The actual generation of electricity in TWh has dropped by 8% in a decade primarily due to coal power generation plant EAFs dropping into the low 50s, with renewable growth not yet filling this gap.

- Southern Africa is endowed and blessed with abundant natural resources from excellent wind and solar potential, coal, minerals and now gas and oil reserves, which provides an opportunity to become energy self-sufficient while transitioning to a cleaner future.
- Namibia's large oil and associated gas discoveries should be a game changer for the region.
- 3.7GW of solar panels[13] was imported in the first half of 2023, primarily for roof top solar and lighting – a quadrupling of the amount in 2022, which in itself was a record year.
- Coal-fired power generation delivered 80.1% to system demand in 2022 down by 5.4% compared to 2021 due to lower EAFs.
- Overall coal produced power is likely to continue to decrease from 80% to 75% in 2025. In 2046 only the Kusile and Medupi coal powered plants will still be operating based on their designed plant lives.
- Load shedding in 2022 was estimated to have reduced South Africa's GDP by 1.3%.
- In the first six months of 2023 the minister in the South African presidency responsible for electricity (MPRE) noted that Eskom had spent R22bn (USD 1.2bn) on diesel that is burnt to immediately keep the lights on, while only R10 bn (USD 0.55 bn) was spent on maintenance that carries long term benefits.
- The MRPE indicated in September 2022 that R250 Bn (USD 13.1 bn) investment is required in the transmission grid in the next ten years.
- South Africa has used its pumped storage successfully generating more power than from hydro generation projects. Currently the power to pump the water up to the upper reservoir uses Eskom power primarily generated from coal.
- The 513MW Tubatse pumped storage project that was meant to start operating in 2022 has only managed to get to a published tender stage in March 2023.
- Other gravity energy storage systems that have significant potential in South Africa are the use of old abandoned mine shafts.
- The lack of spare transmission capacity in the right places for renewables remains a significant stumbling block for Southern Africa as the grid profile is not set up to manage for renewables energy production fluctuation, depending on the external weather conditions.
- Gas-to-power, if located in the right place, would allow South Africa to utilise some of the spare grid capacity as it can act as a baseload and, unlike renewables, can be managed and does not pose a risk of variable heat loads and potential damage to the transmission network.
- South Africa's fuel to remain dirtier for longer as Cleaner fuels 2 and the introduction of a 10 ppm sulphur content cap and 1% benzene limit on petrol has been delayed by four years to July 2027 (Gazetted September 2023), as the government aims to persuade Natref to extend its refinery operations and not close as per SAPREP (Shell/BP) and ENREF (Engen) which have closed in the last few years.
- To ensure economic growth the troubled power sector has to transition and be able to provide universal uninterruptible access to all. The power nexus links to all aspects of the economy including water, food, industrial growth, social welfare and social stability.

13 StatsSA Easy Data

Fossil fuels

The Southern Africa energy sector is on the fringe of becoming an oil and gas hub, but must successfully navigate the transition. Energy regulations, especially those supporting the energy transition, require policies and legislations that have been informed by collaboration with business, government, technical and legal experts to ensure agreement and socialisation of the regulations to ensure quick promulgation and execution on the countries development plans.

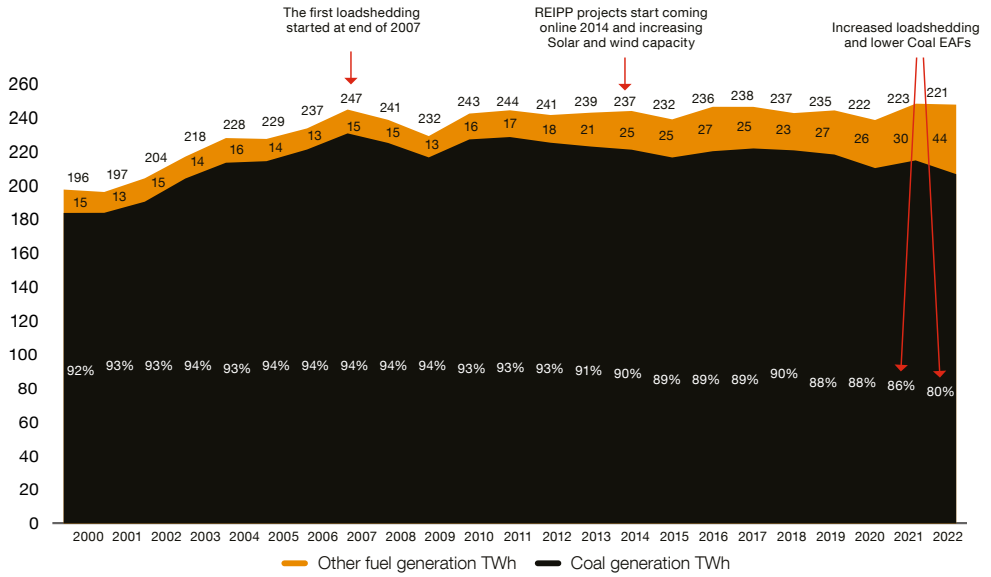
Southern Africa has not exported any of its oil or gas that it has discovered and produced, however successful exploration in South Africa and Namibia may change the energy landscape in the region.

Southern Africa, particularly South Africa, is on a cleaner energy transition path with gas playing a part in the transition from coal generated power to renewables and gas. The driving force is the need to replace the ageing and underperforming coal fleet which faces scheduled decommissioning. Although coal fired power plant lives will be extended as far as practically possible given the generation shortfall, the engineering challenges and cost of maintaining these plants will likely result in decommissioning or repurposing which will support the energy transition and net zero targets.

The objective of the Kinetiko Energy / Kibo Energy estimated reserves of 10tcf in Mpumalanga is to feed a 50MW LNG project in the next few years, which can possibly be expanded to 500MW. The project has been registered under the Strategic Infrastructure Projects (SIP) management mechanism that operates from the office of the president which indicates that the South African government is starting to recognise the importance of energy and energy security as SIPs can be fast tracked with less red tape and even small discoveries can make a difference.

The new discoveries onshore Mozambique, especially in Bonito which lies next to Pande and Temane, could become a new alternative source of gas to provide additional gas down the Rompco pipeline and the gas value chain of Gauteng, KZN and Mpumalanga.

Figure 8: Coal fired power South Africa



Discoveries

Southern Africa discoveries had been limited until 2019-2020 when TotalEnergies successfully drilled the Luiperd and Brulpadda wells which discovered 187mbboe oil/condensate and 87bcm of gas. This was considered a game changer for the region with the gas reserves being able to sustain the current energy sector and potentially supply gas to the 4 Open Cycle Gas Turbine (OCGTs) peaking power plants currently running on diesel with a peaking capacity of 3,068MW.

TotalEnergies' main goal is to export the gas into international markets. The discussion with PetroSA and other government institutions have yet to achieve any success, with issues over gas pricing and its escalation method still being discussed. A gas sales agreement still remains a distant dream with the cogs of government moving slowly.

Namibia – Unlocking and monetising the Ultra deepwater discoveries

In 2022/2023 Namibia discovered a reported mammoth 2225mmboe (2.2 bn) of oil/condensate reserves and 48bcm of gas from the Orange Basin. The potential of other areas has yet to be determined, thus the Orange basin represents the only de-risked acreage. The Shell/Qatar Energy and TotalEnergies consortium's discoveries have also encouraged other multinationals to take the plunge, with Galp starting exploration in Q4 2023 and Chevron paying a reported USD 100m for a stake in the field next to the

Graff and Venus discoveries. The reserves have been estimated to be in the range of 11-15 Bn boe with potentially recoverable reserves of 1-2 Bn boe, and the government has indicated that the gas reserves are c. 7.6 Tcf. Market experts have indicated that by 2035 Namibia could be one of the top 15 producers globally. TotalEnergies has called it “a potential new golden bloc”.

Ultra deepwater plays are considered anything deeper than 1500m of water, and Namibia discoveries are in 2400m to 3000m which has only become possible in the last decade and allowed these discoveries to be economically viable. The Lower Cretaceous reservoirs still require additional appraisal and exploration drilling. The majority of the finds in Namibia have been associated with ‘oil plays’. With the discovery of more gas, Namibia would be one of frontier locations that would be able to attract international investment.

Namibia’s relatively attractive fiscal and regulatory environment and local content policies are likely to both be attractive to global investors/operators as well as provide socio economic benefits to the country. The prioritisation of gas-to-shore facilities, allocation of domestic gas and the need for a gas economy is being driven by the government and the current operators. FID on any such development of the Namibian resources is still a few years away. Namibia can learn from Ghana’s TEN project which was developed in seven years (discoveries in 2009, government development plan approval in 2013 and first production in 2016).

Coral South in Mozambique took eight years to reach first production after the final exploration wells were drilled in 2014. However other FLNG projects have taken less time if the correct business legislation is in place and the government and operators collaborate.

Namibia’s first production could be from 2030 with Shell and TotalEnergies possibly sharing infrastructure. The crude would be exported and the smaller volumes of gas would be viable as GTP that served the local and South African Market. Potential LNG into Saldanha, and later piped gas into Cape Town, remains a possibility.

Namibia has the chance of not getting the ’oil curse’ that has been a problem across much of the continent, and help the region to be energy self-sufficient.

No large-scale gas infrastructure currently exists in either Namibia or along the West coast of South Africa.

Domestic gas market

Gas has been a part of South Africa’s energy environment, with roughly 4.6 BCM or 0.16EJ being supplied via the Rompco pipeline from Mozambique since 2000, and feeds into the industrial sector which is limited to Gauteng and parts of KZN and Mpumlanga.

PetroSA GTL and its technology was a world first and world leader, however the depleted reserves from PetroSA’s current reserves led to a mothballing of the facility in 2020, although it is anticipating reinstating production with the support of a new partner.

Coal is the dominant fuel source of electrical power with 80% of the generated power in 2022 even with a significant amount of the coal fleet down for unplanned maintenance throughout the year leading to loadshedding of 3,773 hours (8.3TWh).

Gas powered plants replacing coal powered plants provides an opportunity for South Africa to reduce its power plant emissions by around 50-60% or about 20% of the country’s total emissions (That would drop South Africa from the 13th Biggest GHG emitter to 21st).

No gas markets exist outside South Africa in the Southern region.

Power sector

Legislation / market operator

Eskom’s Turnaround Plan aims to reform the electricity supply industry as it is unbundling into three entities (generation, distribution, and transmission). The National Transmission Company South Africa (NTCSA) has successfully received licences to operate the country’s transmission system, trading and import/export. (System Operator (SO), Transmission Network Service Provider (TNSP), Interconnected Power System (IPS), Transmission System Planner (TSP) and Grid code Secretariat (GCS).
The liberation of the South African generation market has taken a long time to start and a type of collaborative privatisation of the utility sectors in power is required.

The 2019 Integrated Resource Plan (IRP 2019) was driven by Eskom and, with the energy transition and South Africa’s pledge to reduce emissions from 420 to 350 MtCO2e by 2030, (17% decrease), changing technologies and LCOE of new technologies decreasing the plan needs to be updated to meet the current environment.

The most effective way of getting power into the grid is by opening up grid access and procuring power through a flexible competitive market. Uninterrupted universal access to electricity, cost reflective fair tariffs and legislation are key elements to economic growth and future sustainability.

Renewable / clean energy

Namibia with a population of only 2.6 million is a country with large potential for renewable energy in the form of wind and solar, which can support the country's electricity needs. The country is looking at becoming a hub for green hydrogen with Hyphen Hydrogen Energy preparing to construct a $10bn green hydrogen project. Similar to the potential hydrocarbon plays through legislation, the country is estimated to get 15 000 construction jobs, 3 000 permanent jobs and 30% local procurement. The Namibian government has agreed to invest and take a 24% equity stake in the project that is anticipated to generate 1mtpa of green ammonia in 2027 and 2mtpa by 2029, most of which will be exported.

South Africa also has potential to be a hub for green hydrogen with Sasol having produced the first green hydrogen from Sasolburg in June 2023 and anticipates exporting 0.1mtpa. Green corridors potential identified include Mpumalanga (mining areas) and in the Northern Cape with optimal solar PV levels.

The Risk Mitigation Independent Power Producer Procurement Programme (RMIPPPP) has been plagued with controversy and delays. Scatec's investment of ZAR 16.4bn (USD 0.96 bn) is the first dispatchable project and started commissioning by September 2023. This is a mega hybrid project with 540MW of solar and 225MW / 1,140MWh of battery storage that can dispatch 150MW.

Only G7 Renewable Energies and Engies Oya Energy Hybris Dispatchable Facility took 30 months to go from preferred bidders status to signing a 20 year PPA with Eskom for the Hybrid project with 155MW of solar, 86.4MW of wind and 94MW / 242MWh of battery storage.

The 6 REIPPPP bidding rounds and RMIPPPP have procured over 10GW of capacity from IPPS, with Bid window 7 and 8 to be launched.

The success of the REIPPPP process is the billions of private sector dollars and expertise invested into the sector and quick timelines from start to build to commissioning.

Grid capacity and allocation of capacity to IPPS is the biggest risk for renewable expansion and the murky waters of grid queueing rules in South Africa as the current interim rules suggest a 'first-ready-first-served principle' versus the previous rules that stated a 'first-come-first-served approach'.

Eskom's upcoming Generation Connection Capacity Assessment (GCCA) will indicate where grid capacity remains available for the REIPPPP and private projects.

South Africa, even with its grid capacity constraints, remains the most successful country on the continent for procuring renewable energy. However the success of executing and delivering renewable power from the REIPPP and IPPs has not been without some prolonged agony with legislation that is old and outdated and did not support private access to the grid, a lack of investment into the transmission grid and Eskom's unwillingness to sign power purchase.

Sectors that will help drive the energy transition are those that utilise a significant amount of energy, such as the 27 companies that form the Energy Intensive Users Group (EIUG) whose goal is to work towards a sustainable energy future. These companies come from mining, iron and steel, smelting and manufacturing.

A significant risk and interdependency for these companies to meet their strategies and procure a significant amount of renewable energy into their ecosystems is the affordability of energy. Without energy tariffs being cost effective, it is near impossible to get the required funding as projects will fail lenders' due diligence processes. While taking into account renewable energy tariffs, the remaining portion of the energy that can be supplied from Eskom can put the energy transition ecosystem at risk, if reduced rates cannot be firmed up as Eskom sticks to mega-flex rates for the remaining power.

To be sustainable these companies with energy transition strategies of carbon neural operation from 2040 to 2050 have needed to go out and develop partnerships with companies that can provide clean renewable power to their businesses. To be successful these companies need to ensure that the proportion of the RE produced at cost effective rates is available for the general good of society to ensure that the entire value chain of suppliers and consumers can benefit.

Examples include Anglo American's partnership with EDF Renewables to develop an ecosystem of 3-5 GW.

Sasol has generated its own gas and renewable power generation, however it has also started sourcing renewable power from renewable IPPs.

The largest energy users in South Africa (Such as South32, Anglo America, Glencore, AccelorMittal, Rand Water, Sibanye Stillwater) due to the nature of their businesses are all looking at the future and will partner, procure and ramp up power from Renewable IPPs in order to reduce their carbon footprint and meet their environmental targets. The new Wheeling legislation has made it possible for companies and municipalities to become sustainable and a portion of the IPP energy provided is available for residential and commercial use. With good wind and solar resources across South Africa, a blended mix of the two technologies will provide some levels of energy security if a curtailment approach is utilised that could unlock scarce grid capacity.

The South African Renewable Energy Masterplan (SAREM) that has been released for public comment articulates the vision, objectives and an action plan for South Africa to tap into these opportunities. It aims to leverage the rising demand for renewable energy and storage technologies, and unlock the industrial and inclusive development of associated value chains in the country. The four main pillars are supporting demand, driving industrial development, fostering inclusive development and building capabilities.

Energy security

South Africa had reasonable good energy security and spare generating capacity until 2007. The country's current MW capacity should be sufficient, however due to a lack of maintenance and investment, poor planning, corruption and mismanagement it is not. The country's total capacity of 54.6 GW (excluding imports) or 45.7 GW (excluding the diesel OCGT and pumped storage) should be able to cope with a peak of around 35 GW, however due to decreasing EAFs at the coal powered stations this has not been the case with significant amounts of load shedding being experienced in 2022 and 2023. Loadshedding would be appreciably worse if the private and residential sectors had not ramped up their own storage and generating capacity.

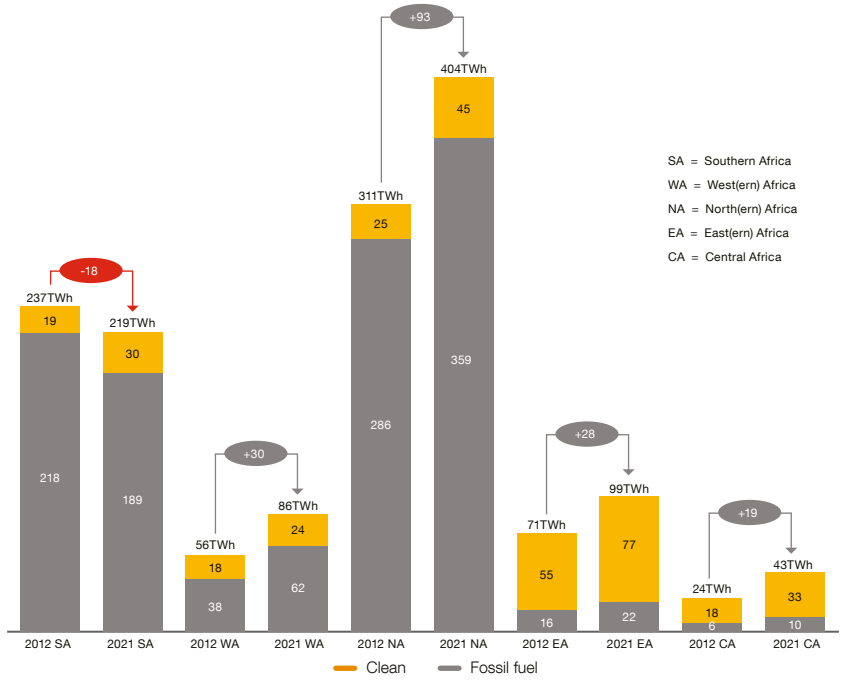
Around 15% of the South African population has no access to electricity.

Outside the REIPPPP process, the development of renewables and increased roof top solar is based on a project by project basis with little consideration for energy security for everyone.

The collaboration model requires a vision and system based strategy that is defined by regional and national requirements and includes a clear focus on execution. This can only be done through creating execution vehicles with capability, capacity, credibility and inclusivity.

Collaboration is required across Africa to continue to increase power generated while Southern Africa and in particular needs to reverse the trend of reducing output.

Figure 9: African regional clean energy and fossil fuels TWh generated power change between 2012 and 2021



6 Requirements for Energy success

Energy is the key to development in Africa and the foundation for industrialisation. Like in Europe and other parts of the world, the deployment of more sustainable sources of energy goes beyond the provision of reliable energy and climate protection. Economic development as a whole will benefit and new jobs and opportunities for entire industries will emerge. Reliable, sustainable energy is at the same time indispensable for ensuring that people are provided with important basic services such as health care and safe drinking water.

Considering its unparalleled potential to be a key player in the global energy transition, Africa's starting point for the transformation of the energy sector is strong. This said, electricity supply in Africa is lagging considerably. Clear guidance and initiatives from national governments across the continent will be critical to realise the continent's potential. With this in mind, African leaders have made clear their commitment to attaining inclusive and sustainable economic growth and development in Agenda 2063: the Africa We Want.[14] – which is the continent's blueprint and master plan for transforming itself into the global powerhouse of the future. Achieving universal energy access is a critical underpinning of resilient and prosperous economies and societies and remains a top priority for African nations. In the past, attempts to conduct ambitious electricity sector reforms have sometimes failed because they challenged the sector's political economy. It is crucial that governments demonstrate the political will to overcome such challenges and follow through with comprehensive reform in order to foster private sector confidence. To support these goals, the international community should bolster support efforts and encourage accelerated action.

However, international financing alone will not be sufficient to fund Africa's energy transition. The investments needed to meet Africa's growing energy demand are far greater than the funds available from public sources such as governments and development partners. This gap can only be bridged by private investments and lending, as well as private-public collaboration. The real and perceived risks of accessing sufficient financing differ from country to country, but they are generally related to political instability, macroeconomic uncertainty, weak policy and regulatory frameworks, financially weak utilities, and lack of transparency and institutional capacity. If African countries are to fully and affordably harness their energy potential, these investment risks need to be mitigated. An appropriately enabling environment must include improved regulatory frameworks, innovative financing instruments, modern procurement practices and execution models to bridge the capacity gap currently faced by governments across the continent.

There are emerging examples in Africa that are being implemented in order to address the aforementioned gaps. When considering the South African example, various strategies and plans for infrastructure development have been introduced over the past year. However, execution of those strategies has almost always fallen well short of expectations. The need to have an effective execution approach is key. What is apparent is a need for political, institutional, business and societal alignment around a common energy end-state vision and transitory plan at both national and regional levels in order to improve energy security and modernise the power system. In order to do so, a collaborative funding and execution model can be implemented with commercial support from credible large scale off takers to facilitate funding, de-risk projects and remove pressure on national governments. A similar approach is already in use in South Africa in the water sector. The model provides strong governance around the procurement and execution processes to ultimately benefit both the public and the private sector. It uses a collaborative special purpose vehicle in which the government and the private sector have a shared interest. Duplicating these collaborative approaches across the continent will enable it to position itself as a global energy player whilst improving energy security and avoiding a situation where energy interventions are aimed at solving individual needs.

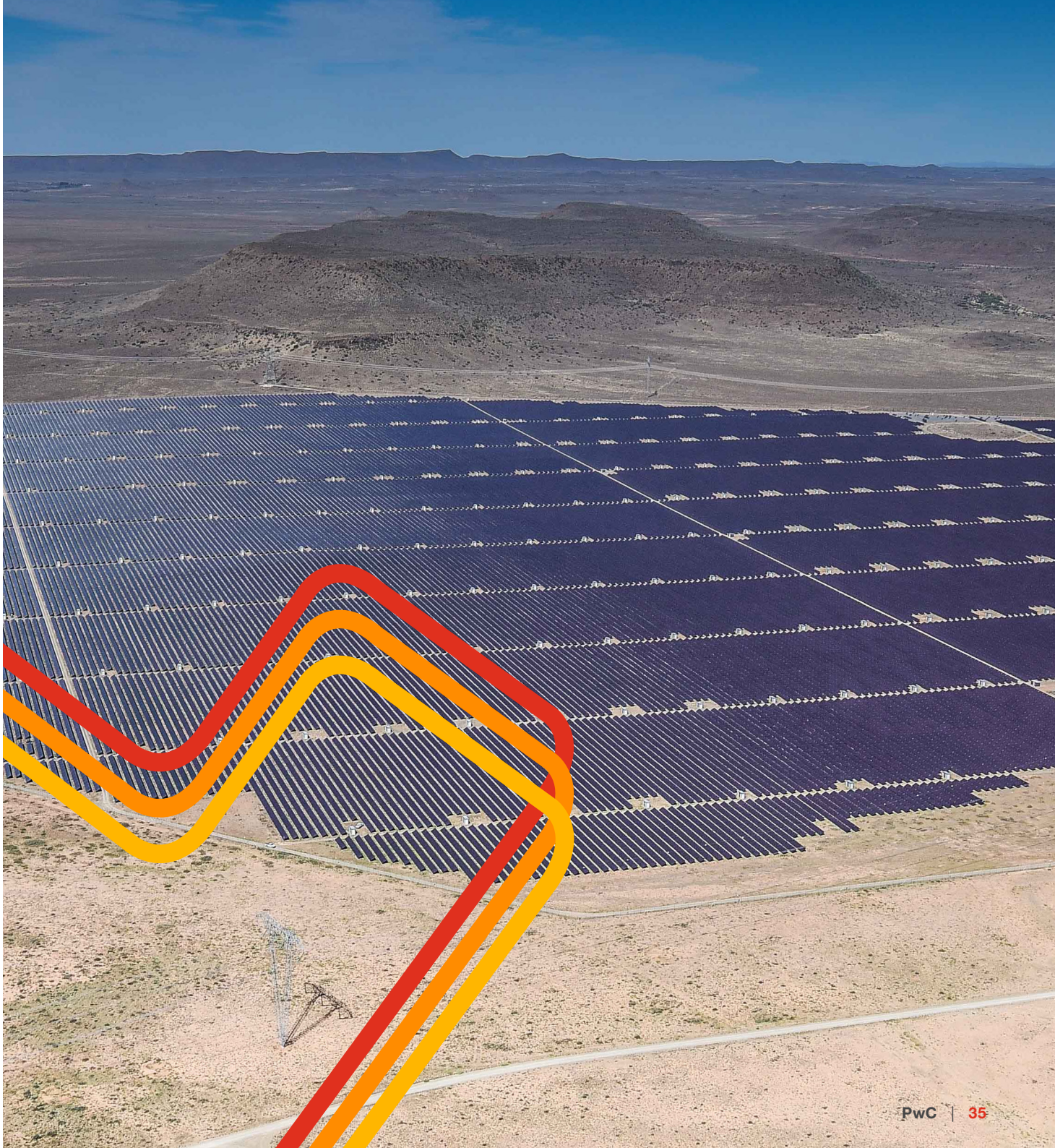
It is important to stress that the absence of serious, comprehensive, and stable national energy and climate policies will amplify the uncertainties that bear on all elements of energy security. Weak policy and regulatory frameworks, insufficient short- and long-term power system planning, a lack of transparency in terms of decision-making, insufficient regional integration and

14 https://au.int/agenda2063/goals

policy consistency across countries and shortfalls in institutional capacity are key structural barriers to energy security in many African countries. Addressing these issues by providing targeted technical support and capacity building focussed on execution of national strategies will help to enable the energy transition. Additionally, liberalising electricity sectors by unbundling utilities coupled with private sector participation in electricity markets – particularly generation – can significantly improve efficiency and reduce costs.

In some respects, liberalisation puts even greater pressure on regulatory authorities' capacity to ensure that laws and regulations are followed and efficiency gains are achieved. As such, intermediary mechanisms can be implemented in order to provide policymakers with the necessary time to develop enabling regulatory frameworks. A proven mechanism to assist with liberalisation has been the adoption of energy aggregators.[15] The EU 2019/944 Electricity Directive defines aggregation as a "function performed by a natural or legal person who combines multiple customer loads or generated electricity for sale, purchase or auction in any electricity market." The multitude of aggregator examples in Europe demonstrate that economic value creation from aggregation is possible. An aggregator can combine the capacity of many distributed energy resources, creating a sizable capacity similar to that of a conventional generator. This aggregation can also be called a 'virtual power plant'. Aggregators can then sell electricity or ancillary services in the wholesale market, or through procurement by the system operator, as has been the approach in developed countries.

By adopting efficient execution models to drive energy sector development at a national and regional level, coupled with proven transitional mechanisms such as aggregators, African countries will be able to present a credible case to access international support.



15 "The key role of aggregators in the energy transition under the latest European regulatory framework" International Journal of Electrical Power & Energy Systems, Volume 134.

7 The South African collaboration model

South Africa has developed a case study proving that collaborative infrastructure can be adopted and implemented for the greater good. Although the South African example is not an energy based solution, the concept behind the execution model can be replicated within the energy sector. The Lebalelo Water User Association (LWUA) was established in 2002, to supply bulk raw water to both the mining sector and communities in the Eastern Limb of the Bushveld Igneous Complex in the Limpopo province.

Lebalelo subsequently developed a collaboration-aggregation model to implement the Olifants River P2 programme. This collaboration between Government and the private sector will bring bulk raw and potable water to the Limpopo region to address both economic and social needs. The programme will impact approximately 400 000 people.

The Lebalelo water model aggregated water demand and established an execution approach that has found broad acceptance within government, communities, business, and financiers.

This proven aggregation execution model leverages commercial support from credible large scale off takers to facilitate funding, de-risk projects and remove pressure on the fiscus.

Given the proven concept the opportunity also exists for energy collaboration-aggregation. The essence of this system based energy model is that it would aggregate demand (using a series of sub-aggregation pilots) and design a best mix of technologies to provide stable power at best cost, including transmission/distribution considerations. The respective roles of the public and private sectors would be critical for success. This model can provide energy sector security at best cost.

Aggregation mechanisms offer the following benefits:

1. **Economies of scale:** Aggregation enables businesses to aggregate their energy demand. This creates economies of scale, as the collective demand is significantly larger than individual procurement requirements. With a larger purchasing power, aggregated-buying can attract competitive pricing from energy suppliers, leading to potential cost savings and more favourable contract terms.
2. **Strong negotiating and purchasing power:** Through aggregated-buying, businesses can negotiate with energy suppliers from a stronger position. The collective buying power creates the opportunity to negotiate favourable PPA terms. The combined energy demand of multiple buyers increases their bargaining power and allows for more favourable negotiations on pricing and contract conditions. This empowers businesses to secure better deals and optimise their energy procurement outcomes.
3. **Risk mitigation:** Aggregation models mitigate risks associated with energy procurement. By combining the energy demand of multiple buyers, the risk is spread across a larger portfolio, reducing the impact on individual entities. This diversification of risk can help buffer against potential market volatility, fluctuations in energy prices, and changes in regulatory policies.
4. **Accelerated energy deployment:** Aggregation can support the accelerated deployment of alternative energy projects. By pooling the energy demand of multiple buyers, the aggregated demand becomes more attractive to renewable energy developers and investors. This can stimulate investment in renewable energy as well as other energy infrastructure, promote sustainable development, and contribute to accelerated improvement of energy security.
5. **Flexibility and customisation:** Aggregation allows buyers to customise their energy procurement options based on their specific needs and preferences. The collective demand can accommodate a variety of energy sources, including renewable energy, promoting a diversified and sustainable energy mix. This flexibility enables buyers to align their procurement strategies with their sustainability goals and adapt to changing market dynamics.

8 List of abbreviations

BESS	Battery Energy Storage Systems
BCM	Billion cubic metres of natural gas
CCUS	Carbon capture, utilisation and storage
CMP	African Continental Power Systems Masterplan
CNG	Compressed natural gas
CoCT	City of Cape Town
COVID-19	Coronavirus 2019
CO2	Carbon Dioxide
CSIR	Council for Scientific and Industrial Research
CSP	Concentrated Solar Power
EACOP	East African Crude Oil Pipeline
EAF	Energy Availability Factor
EIUG	Energy Intensive Users Group
EJ	Exajoule
EU	European Union
EV	Electric Vehicle
FID	Final investment decision
FLNG	Floating liquefied natural gas
GCCA	Generation Connection Capacity Assessment
GCS	Grid code Secretariat
GESS	Gravity Energy Storage Solutions
GHG	Greenhouse gases
GTA	Greater Tortue Ahmeyim
GTAF	Greater Tortue Ahmeyin Field
GTP	Gas to Power
GW	Gigawatt
G7	Group of Seven
IPP	Independent Power Producers
IPS	Interconnected Power System
IRP	Integrated Resource Plan
kWh	Kilowatt hour
kmhr	Kilometre per hour

KZN	KwaZulu Natal
LCOE	Levelized cost of electricity
LNG	Liquified Natural Gas
LWUA	Lebalelo Water Users Association
mmbbl/d	Million barrels per day
mmboe	Millions of barrels of oil
MMCFD	Million cubic feet per day
MOU	Memorandum of understanding
MtCO2e	Metric tons of carbon dioxide equivalent
mtpa	Metric Tonnes Per Annum
MW	MegaWatt
MWh	MegaWatt-hour
NG	Natural gas
NMGP	Nigeria-Morocco Gas Pipeline
NTCSA	National Transmission Company South Africa
O&G	Oil and Gas
OCGT	Open-cycle gas turbines
OECD	Organisation for Economic Co-operation and Development
PPA	Power Purchase Agreement
PV	Photovoltaics
PwC	PricewaterhouseCoopers
R&D	Research and Development
RE	Renewable Energy
REEs	Rare earth elements
REIPPP	Renewable Independent Power Producer Programme
RMIPPPP	Risk Mitigation Independent Power Producer Procurement Programme
SADC	Southern African Development Community
SAREM	South African Renewable Energy Masterplan
SAS	Sustainable Africa Scenario
SDG's	Sustainable Development Goals
SE4All	Sustainable Energy for All
SIP	Strategic Infrastructure Projects
SMEs	Small and medium-sized enterprises
SO	System operator
SPV	Special Purpose Vehicle
TNSP	Transmission Network Service Provider
TSGP	Trans-Saharan Gas Pipeline
TSP	Transmission System Planner
TWh	Terawatt-hour
USA	United States of America
USD	United States Dollars
UN SDG7	United Nations Sustainable Development Goal 7
VRFB	Vanadium Redox Flow Batteries

9 Contacts

Andries Rossouw

Africa Energy, Utilities and Resources Leader
Johannesburg, South Africa

andries.rossouw@pwc.com

Laetitia Le Roux

Energy, Utilities & Resources South Market Tax Leader

laetitia.le.roux@pwc.com

Pedro Omontuemhen

Africa oil and Gas lead

pedro.omontuemhen@pwc.com

George Arhin

West Market Mining Industry Leader – Ghana

george.arhin@pwc.com

Emmanuel le Bras

Francophone Africa Energy & Mining Industry Leader – Republic of the Congo

emmanuel.lebras@pwc.com

David Tarimo

Energy, Utilities & Resources Leader – Tanzania

david.tarimo@pwc.com

Contributors

Jeremy Dore

Katharina Scheller

Martin Solomon

Dr. Roelof van Huyssteen

Rowyn Naidoo

Siviwe Memela

Wayne Jansen

Wessel van Wyk