Africa Energy Review 2022

Fuelling Africa's Transition

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Acronyms

bbl	Barrels
Bbo	Billion barrels of oil
bbl/d	Barrels per day
bcm	Billion cubic metres
bn	Billion
CAGR	Compound annual growth rate
CO_2	Carbon dioxide
COP21	21st Conference of the Parties
COP26	2021 United Nations Climate Change Conference
CoUE	Cost of unserved energy
CSP	Concentrating solar power
EJ	Exajoule
EU	European Union
FID	Final Investment Decision
GDP	Gross domestic product
GHG	Greenhouse gas
GW	Gigawatt
IRENA	International Renewable Energy Agency
kW	Kilowatt
kWh	Kilowatt-hour
LNG	Liquefied natural gas
m	Million
mbbl	Thousand barrels
mbbl/d	Thousand barrels per day
mmbbl	Million barrels
mmbbl/d	Million barrels per day
Mt	Million tonnes / Megatonne
mtpa	Million tonnes per annum
MW	Megawatt
NDC	Nationally Determined Contribution
PAREF	Pan-African Renewable Energy Fund
PV	Photovoltaic
RE	Renewable Energy
SDGs	Sustainable Development Goals
tcf	Trillion cubic feet
tn	Trillion
TWh	Terawatt hours
UNFCCC	United Nations Framework Convention on Climate Change

1. Overview of Africa's energy landscape

The world's energy sector is and will continue to go through profound changes as it transitions to stay in line with sustainable planetary boundaries. Recent global events such as the COVID-19 pandemic and the Russia - Ukraine conflict have amplified this change, bringing to the forefront issues of behavioural change, social justice and energy security.

Political and market responses at times are seemingly chaotic, but the long-term global commitment to addressing climate change and the ambition to achieve Net Zero by mid-century remains firm, and a sustainable Energy Transition is fundamental to that success.

It is well documented that the wealthy, global north, have historically and still do generate the vast majority of global emissions. Despite this, Africa as with much of the global south have committed to a decarbonised future and ultimately achieving Net Zero in line with global climate ambitions. The ability however, for Africa to finance and afford such a transition remains in doubt.

Energy is also key to the growth and prosperity of any modern economy and Africa has the added challenge of having to address both the Energy Transition and vast energy poverty. Africa's existing domestic energy supply remains dominated by fossil fuels but the vast and high-quality renewable resources across the continent present an opportunity to transition towards viable green growth. Such scaling of clean technologies would also create much needed economic growth, job creation and vibrant green economic sectors.

Africa still holds large fossil fuel reserves, which can attract significant investment and be extracted for much-needed export revenues. However, investing in fossil fuel extraction is becoming increasingly challenging under global climate change policies on financed emissions and few African countries have the fiscal capability to make such investments themselves.

Developed economies who have benefited from decades of fossil fuel driven economic growth can afford a more rapid transition in their energy demand towards clean technologies. This declining demand for fossil fuels is already creating a closing market window and opportunity for Africa to invest in, extract and sell fossil fuels.

In this report we have outlined latest updates and outlooks for both fossil fuels and renewable energy development across Africa. Our assessment shows that Africa is progressing a green agenda and making good progress in green policy and regulations. Our analysis, however, also shows that the current pace is too slow and the future scale of investment required is unaffordable. This implies that under a 'business as usual' outlook, Africa will not achieve its ambitions of decarbonisation, or of energy security for all its people.

Africa's Energy Transition must be economically viable, technically feasible, environmentally coherent and socially just. The global north has committed to climate reparations for the global south, and specifically Africa, but the speed and scale of execution remains insufficient. This will be a major focus at the first Africa United Nations Framework Convention on Climate Change (UNFCCC) COP summit to be held in Egypt in November 2022 and hopefully will set a new benchmark in climate related finance for Africa.

A significant increase in investment into Africa's energy sector is required, which if based on the good natural resources, access to international technology and coherent local policies. Africa can sustainably transition into a globally competitive continent that meets both the planet's needs as well as the needs of its people.

2. Drivers of change across Africa's energy landscape

2.1 Economic growth and energy poverty

The role of energy in sustainable economies and economic growth

It is estimated that nearly 600 million Africans have no access to electricity[1] and a further 180 million Africans still rely on traditional solid biomass for cooking[2]. To bring Africa in line with average world electricity access standards as a measure of alleviating energy poverty (many African countries have access as low as 1% of global average in East and Central Africa but South Africa and much of North Africa ranks above the world average) and do this on a carbon neutral pathway i.e. dominated by renewable generation, PwC estimates that an additional 2,354 GWs of capacity will be required at a cost of 2,6 trillion dollars. This would require more than 20% year on year growth in renewables to 2050 and is also not in line with the current reality that there is still strong growth in fossil fuel generation, especially in natural gas.

Compounding the challenge of energy poverty is the associated lower levels of energy safety standards as demonstrated by the Oxford Economics estimate that 800,000 people across Africa died from air pollution in 2020, and 500,000 from household air pollution (HAP)[3] largely due to exposure to unclean energy use or activities. Reliable access to clean and affordable energy, as per the United Nations Sustainable Development Goals (SDG) also serves as a critical economic multiplier, enabling inclusion to the digital world, increasing productivity and industrialisation, which in turn create financial inclusion and social upliftment.

The economic cost of unserved energy

The cost of unserved energy (CoUE), referenced colloquially as load-shedding, is a descriptor of the economic opportunity cost of unplanned electricity interruption or energy not supplied to the economy. In South Africa, for example, the state power utility shed 2,276 GWh of power in rolling blackouts in the first half of 2022, in order to maintain a stable power grid. PwC estimates the value of this CoUE at between $2.54/kWh and $2.88/kWh. When this range is applied to the actual load-shedding during 2021, the loss of real gross domestic product (GDP) growth was between 2.4 and 2.9 percentage points, which would have equated to an additional 290,000 to 350,000 potential jobs being created. This highlights that reliable and affordable access to electricity is the single biggest economic growth and job creation lever for Africa's most industrialised economy, which will largely hold true for all other economies in the continent.

Governments and regulators have a key roll to play to provide an enabling environment though appropriate legislation and regulation to facilitate additional energy investment.

1 International Energy Agency, SDG7: Data and Projections, Access to electricity https://www.iea.org/reports/sdg7-data-and-projections/access-to-electricity
2 International Energy Agency, SDG7: Data and Projections, Access to clean cooking https://www.iea.org/reports/sdg7-data-and-projections/access-to-clean-cooking
3 Oxford Economics, 2022. A holistic view of Africa's role in combating climate change. https://www.oxfordeconomics.com/resource/a-holistic-view-of-africas-role-in-combating-climate-change/

2.2 Sustainability: Planet, people and purpose

It is widely documented that Africa is a minor contributor (less than 4%) to global cumulative carbon emissions and yet is home to some of the highest risk communities when considering climate change impact.

Off the back of fossil fuel-enabled economic wealth, developed economies are accelerating their Net Zero ambitions, as evidenced by recent studies showing 21% of major global companies and 61%[4] of national governments have set ambitious decarbonisation or Net Zero targets (concentrated in developed economies).

Building sustainable societies and communities

ESG is recognised as a global purpose that promotes sustainable livelihoods, improves living conditions, and advances environmental health. Greater emphasis is needed on the 'S' factor, particularly across emerging economies where vulnerable communities will be further impacted by climate change and the global Energy Transition.

In addition to sustainable emissions practices, access to 'clean energy' will further socio-economic development and resilience at the household level for personal advancement, education and diversification of livelihood strategies. Similarly, at the community, and regional level, access to 'clean energy' can enable quality healthcare and education as new skills and services are necessitated, and the needs of communities expand. A focus on reducing inequality through energy access with the associated job creation and skills development would enable financial inclusion, independence and essentially a broader sense of community participation and social well-being.

Shaping a Just Energy Transition for Africa

Africa is highly dependent on rapidly changing global markets and developed economies in order to sustain international trade and foreign direct investment. With lower fiscal strength and economic affordability, Africa will however continue to fall behind the pace of the global Energy Transition if it remains unassisted. This has the risk of creating an emissions fault line that will penalise Africa investment and trade competitiveness in the longer term.

Balancing the developmental impact and the growth of Africa with the pace of the Energy Transition being undertaken by developed economies is seen as a major challenge and increasingly referred to as part of a Just Energy Transition (JET).

Although the Energy Transition will contain a share of fossil fuels for many decades to come, it will increasingly be anchored on expanding green energy access through renewables and clean technologies. An important part of this journey is increasing the awareness of broader sustainability principles under environment, social and governance (ESG) as a pathway to unlock new opportunities for Africa through technology adoption, green manufacturing and balancing both traditional and new global markets.

2.3 Global disruptors: COVID-19 and the Russia-Ukraine conflict

The global COVID-19 pandemic and the Russia-Ukraine conflict have caused unprecedented global disruption but with common outcomes of an increased focus on societal purpose and sustainability. In the energy context, energy security has prompted varied short-term responses to the potential of unserved energy but in the medium to long term has led to an overwhelming acceleration in Energy Transition and global investment into clean technology innovation and scaling.

COVID-19 has fundamentally changed behavioural frameworks

The global response of locking down economies gave the world a glimpse of a cleaner and more sustainable environment. The necessity for remote working also caused a significant increase in digital connectivity and changes to commuter patterns. On the energy front, the world saw a collapse in oil demand which sent futures into negative prices. Due to over-generation in the UK, intraday prices for electricity also went negative.

And in 2022 Oil, gas and coal reached record prices underlying the importance of Africa's fossil fuel supply to support the energy transition.

4 https://www.pwc.com/gx/en/energy-utilities-mining/assets/road-ahead/eur-tomorrows-energy-system.pdf
5 https://irena.org/-/media/Files/IRENA/Agency/Publication/2022/Apr/IRENA_-RE_Capacity_Highlights_2022.

These are profound glimpses of what disruptions the Energy Transition may still hold. Despite major disruptions to global supply chains, the world still realised double-digit growth in renewable energy deployment in 2021 – 19% growth in solar and 13% in wind[5]. The increased focus on societal purpose and sustainability also fuelled support for the global ambition of Net Zero by mid-century. This led to stronger calls at the 2021 United Nations Climate Change Conference (COP26) for developed countries, largely the global north, to accelerate climate reparations to the global south and specifically to honour the 2015 commitment at the 21st Conference of the Parties (COP21) in Paris of providing $100bn per year in climate finance for developing countries.

The Russia-Ukraine conflict has disrupted energy security and geopolitics

The North Atlantic Treaty Organisation (NATO) block of countries quickly rallied to condemn the Russian invasion of Ukraine and committed to rapidly reduce their reliance on imported Russian oil and gas, triggering a major global price shock and energy security crisis.

Europe's urgent need to diversify away from Russia has spurred interest in the African gas export market. European focus has been to boost natural gas and LNG imports from Nigeria, Angola, the Republic of the Congo, Egypt and Algeria with the Algerian government proposed to revive the Trans-Saharan gas pipeline which could send up to 30 billion m^3 a year from Nigeria to Algeria, and then on to Europe. Countries with sizeable offshore gas reserves, including Mozambique, Tanzania, and Senegal, could also see renewed investor interest.

Despite the short-term increased demand, natural gas still has a limited window of opportunity when considering the emissions impact of natural gas against a global Net Zero target. As such the timing of new Africa projects is critical.

Clean technologies remain the long term focus for future power markets

In their pursuit of energy independence, Europe and the UK have also significantly accelerated their development of RE capacities, particularly wind, solar and green hydrogen. For example, Germany has brought forward its goal of 100% renewable energy by more than a decade to 2035[6], despite its short-term increase in coal-fired power generation. Solar installations have seen a 22% increase in the first six months of 2022 compared to the same period the previous year[7]. By 2030, the German government aims to have installed capacities of 215 GW of solar, 115 GW onshore wind, and 30 GW of offshore wind[8]; as well as a three-times increase in solar power by 2027.

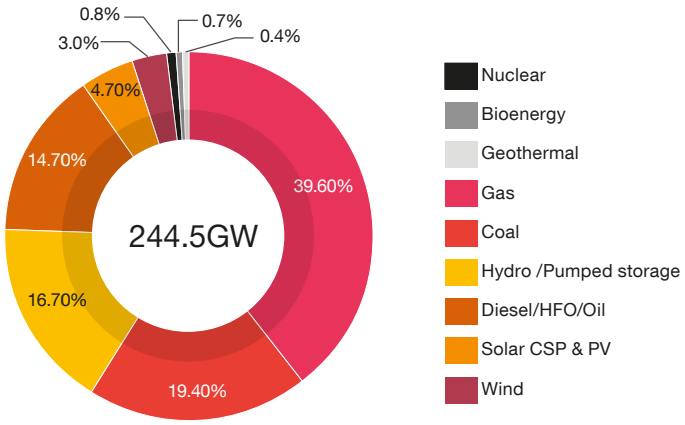
The rapid reshaping of energy policies due to the energy security crisis, including reverting to fossil fuel generation, should not be interpreted as a move away from the Net Zero commitments but rather intervention to avoid the economic cost of unserved energy. Although the Russia-Ukraine conflict may have provided a short-term setback to the Energy Transition, it has ultimately accelerated the focus on energy security through the scaling of domestic renewable energy capacity and diversified energy supply chains.

6 https://www.washingtonpost.com/business/energy/the-war-in-ukraine-is-speeding-europes-pivot-to-renewables/2022/05/18/7057e59e-d6c6-11ec-be17-286164974c54_story.html
7 https://edition.cnn.com/2022/08/24/business/germany-solar-power-russia-gas-crisis-intl-hnk/index.html
8 https://cleanenergynews.ihsmarkit.com/research-analysis/germany-launches-fullscale-renewable-power-transition-in-easte.html

3. Africa energy overview and status update

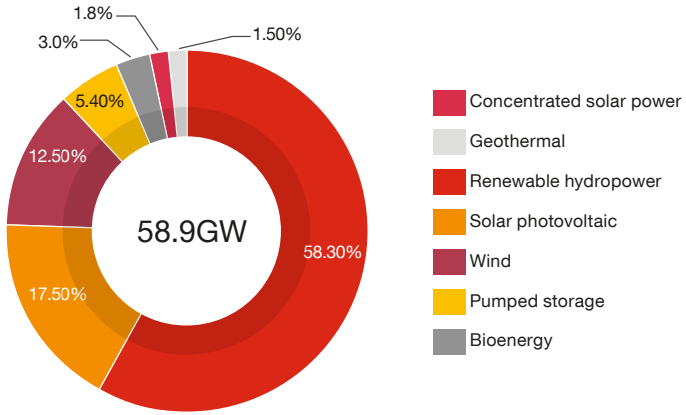
Although inter-dependent, a distinction is required between Africa's energy development for exports vs domestic consumption. Although Africa's domestic energy supply is still dominated by fossil fuels (71%), wind and solar generation (8%) are achieving the highest growth rates.

Figure 1: Africa's power generation mix 2021



Source: Irena 2020, IEA 2019 and usaid.gov/powerafrica

Figure 2: Africa's renewable installed capacity power generation mix 2021



Source: Irena 2020, IEA 2019 and usaid.gov/powerafrica

Table 1: Africa's current energy mix based on exajoule (EJ)

Source	Percentage EJ including biomass	Percentage EJ excluding biomass	EJ per energy source excl biomass	Percent terawatt hours (TWh) (power sector)	Percent Megawatt (MW) capacity (power sector)	Africa as % of Global energy mix consumption
Oil	21.8%	39.3%	7.86	8.8%	14.7%	4.2%
Natural gas	16.4%	29.6%	5.92	40.1%	39.6%	4.0%
Coal	11.7%	21.0%	4.21	27.9%	19.4%	2.8%
Nuclear	0.3%	0.5%	0.09	1.2%	0.8%	0.5%
Hydro	4.0%	7.2%	1.45	17.1%	16.7%	3.4%
Bioenergy	0.2%	0.4%	0.08	0.7%	0.7%	1.2%
Solar	0.4%	0.8%	0.16	1.5%	4.7%	1.4%
Wind	0.6%	1.2%	0.23	1.9%	3.0%	0.9%
Geothermal		0.1%	0.01	0.6%	0.4%	5.6%
Biomass **	44.5%					
Total	100%	100%	20.00	100%	100%	24%

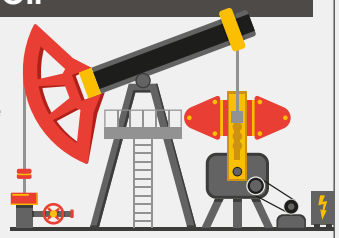
Source: BP Stats, IRENA, IEA, PwC analysis

** Footnote: Biomass is predominantly used in heating and cooking

3.1 Fossil fuels overview: Coal, oil and gas

Fossil fuels snapshot: Proven reserves, production, consumption and exports

Oil



Proven reserves

Oil proven reserves saw a slight drop of **0.3%** from the end of 2021 to 2022, amounting to **125.3 Billion** barrels of oil (Bbo).

Production

Production increased by **6.1%** to **7.2 Million** barrels per day (mmbbl/d) from the prior year. Africa's current production accounts for **8.1%** of global production.

Consumption

Consumption saw an increase of **10%** to **3.9 mmbbl/d** from the prior year. Refinery throughput saw a decline of **1.3%** from the previous year, amounting to **1,801 bbl/d**.

Exports

Exports increased by **14%** to **6.6 mmbbl/d**, reflecting the commencement of the global energy security crisis and global economic recovery.

Gas

Proven reserves

Proven gas reserves saw a significant increase of **37%** to **625.6 tcf** compared to previous year.

Production

Gas production experienced an increase of **11.2%** compared to prior year, which amounted to **257 billion cubic metres (bcm).**

Consumption

Gas consumption saw an increase of **7.1%** relative to the previous year, amounting to **164 bcm**.

Exports

Gas pipeline exports saw a significant increase of **45%** to **38 bcm** compared to the previous year while LNG exports saw an increase of **7.1%** to **58.5 bcm**.

Coal

Proven reserves

Africa's proven coal reserves remained at **14.8 bn** Tonnes [9] (over 95% located in South Africa, Mozambique, Botswana and Zimbabwe).

Production

Coal production saw a decline of **6.6%** to **6.04 EJ** compared to the previous year [10].

Consumption

Coal consumption saw an increase of **2.4%** to **4.21 EJ** relative to the previous year.

Exports

Coal exports saw an increase of **24.5%** to **2.23 EJ** compared to the previous year.

Recent oil and gas discoveries in Africa

Africa's proven oil reserves declined marginally from 125.8 Bbo in 2021 to 125.3 Bbo in 2022. This can largely be ascribed to under-investment in exploration activities and related infrastructure in recent years.

Natural proven gas reserves however saw a significant increase of 37% to 625.6 trillion cubic feet (tcf) in 2022. It is estimated that over 175 tcf of proven gas reserves across Africa have not been able to proceed to production.

Notable oil and gas discoveries made across Africa in 2021/22.

The Namibia Graff discovery is one of the biggest oil and gas discoveries on the continent made in early 2022 by Shell. This links to earlier known deposits that together could potentially hold up to three billion barrels of oil with associated gas. When considered with the current large-scale Green Hydrogen projects, Namibia has the potential to become a major energy hub for the region and a global energy player.

In September 2021, Eni and its partner Petroci Holding announced a major discovery of oil and gas in CI-101 block of Côte d'Ivoire. The deposits were estimated at between 1.5 and 2 billion barrels of oil and around 1.8-2.4 tcf of gas. Sonatrach announced three oil and gas discoveries in the Algerian desert Sahara in July 2022. The first exploration located in the Illizi Basin, with two reservoirs, recorded flow rates of 300,000 m^3/day of gas and 26 m^3/day of condensate from the first reservoir and 213,000 m^3/day of gas and 17 m^3/day of condensate from the second reservoir. The second discovery was made by Sonatrach and Eni in the northern region of the Berkine Basin. They indicated that during the production test the well yielded 1,300 barrels/day of oil and 51,000 m^3/day of associated gas.

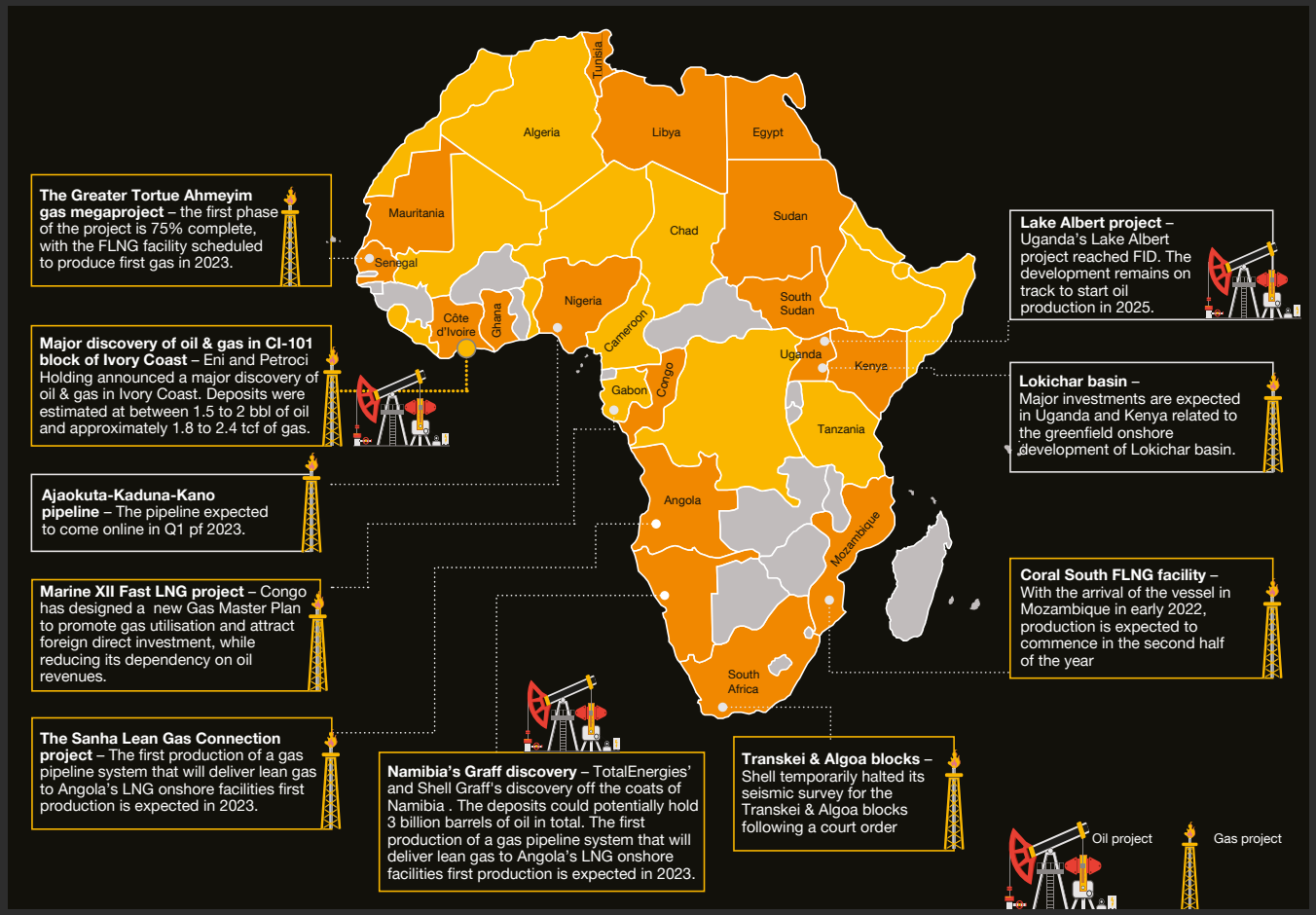
9 BP Statistical review of world energy,2022,https://www.bp.com/content/dam/bp/business-sites/en/global/corporate/pdfs/energy-economics/statistical-review/bp-stats-review-2022-full-report.pdf, PwC analysis

10 BP Statistical review of world energy, 2022, https://www.bp.com/content/dam/bp/business-sites/en/global/corporate/pdfs/energy-economics/statistical-review/bp-stats-review-2022-full-report.pdf

Major discoveries and ongoing progress have seen solid progress, this includes South Africa's Luiperd-Brulpadda gas condensate discovery that could potentially produce its first gas by 2027. TotalEnergies and its partners have applied for production rights and have indicated discussion with PetroSA regarding a potential supply of 45,000 barrels/day to the GTL refinery in Mossel Bay. This could unlock gas-to-power through conversion of the 740 MW Eskom Gourikwa diesel peaker plant as well as potential expansions.

An important announcement in the DRC was the launching of a major new licensing round for 27 oil blocks and three gas blocks. The blocks contain 22 billion barrels of oil and 66 billion normal cubic metres of gas, covering an area of more than 240,000 square kilometres. This licensing round aims to turn the DRC into a major oil and gas producer and to diversify the economy away from mining. The government estimates that oil and gas will eventually make up 40% of government revenue.

The map below includes additional oil & gas discoveries as well as project developments.



Source: Energy Capital & Power[11]

11 Energy Capital & Power, https://energycapitalpower.com/top-5-gas-projects-in-africa-for-2022-23/ , Rystad energy, BP Statistical review of world energy 2022, PwC analysis

A positive outlook for Africa's fossil fuel exports

Europe's energy security crisis has created renewed interest and opportunity for Africa fossil fuel exports, especially gas and LNG as a long-term alternative supply for Europe. Coal exports to Europe have also benefited, particularly from South Africa (coal exports from South Africa to European nations year to date have already increased 40% compared to the previous year)[12].

Positive progress in dealing with the unrest in northern Mozambique has resulted in Total Energies resuming the construction of the 12.8 million tonnes per annum (mtpa) Mozambique LNG mega-project after previously suspending work due to security concerns. The 3.4mtpa Eni Coral floating LNG project was also successfully commissioned with first shipments in 2022.

Mauritania will commence global LNG shipments in 2023 when BP's 2.5 mtpa floating LNG Greater Tortue Ahmeyim (GTA) project comes online. BP anticipates this could increase to 10 mtpa of LNG for a period of 30 to 50 years as FID for phase 2 and 3 has been finalised[13].

In liquid fuels, South Africa has shut much of its refinery capacity over the past two years, including ENREF 120,000 barrels per day (bbl/d); SAPREF 180,000 bbl/d, and PetroSA 45,000 bbl/d), which has increased dependence on finished product imports. In contrast, the Nigeria Dangote Refinery under construction is on schedule for full operation in 2023. The 650,000 bbl/d facility will be the largest single-train refinery in the world costing more than $25bn[14].

Total estimated coal exports from Africa in 2021 was 76.3mt with estimated coal imports to Africa in 2021 of 23,2mt. Coal exports to Europe for a similar period have almost doubled in the first half of 2022.

Table 2: Africa's fossil fuel exports 2021

	Export: Trade outside Africa	% of global seaborne trade	Trade within Africa	Imported into Africa	Consumption within Africa
Crude	98%	9.8%	2%		2%
Coal	90%		10%	23%	10%
LNG	100%		0%	0%	0%
NG Pipeline	81%		19%	0%	19%
Refined product	14%		2%	64%	36%

Source: BP Stats 2022a and IEA[15]

Recent M&A activity

Despite the setbacks experienced in the last two years due to COVID-19, M&A flow in African oil & gas has grown from $2.9bn in 2021, with over $12bn worth of M&A deals signed in the first half of 2022[16]. This includes the $827m merger between Tullow Oil and Capricorn Energy, where the integrated firm will own one billion barrels worth of resources and is expected to produce 100,000 barrels per day by 2025 across Ghana, Kenya, Gabon, Côte d'Ivoire, Mauritania, Egypt and Senegal.

Another major farmout that took place in April 2022 is Sonangol, which entered into a $336m deal with Sirius Petroleum and Somoil. The two firms plan to participate in producing Blocks 18 and 31 which are operated by BP.

M&A activity in Africa's oil & gas sector is set to increase further in 2023 with numerous planned field acquisition deals in progress, including Shell's plans to sell it's Nigerian assets and Eni's plans to exit Tunisia.

12 PwC analysis, Energy Capital & Power
13 BP, 2022, https://www.bp.com/content/dam/bp/business-sites/en/global/corporate/pdfs/energy-economics/statistical-review/bp-stats-review-2022-full-report.pdf
14 Fitch, 2022, South Africa Oil & Gas Report
15 With total energy consumed excluding biomass of 19,995 PJ or 36,016 PJ https://www.bp.com/en/global/corporate/energy-economics/statistical-review-of-world-energy/downloads.html with IEA2019 Biomass figure
16 Energy Capital, https://energycapitalpower.com/top-oil-gas-deals-in-africa-in-2022/, 2022

3.2 Renewable energy overview: Wind, photovoltaic (PV), hydro, geothermal

Africa's renewable energy installed capacity is just below 60 GW (based on 2021 baseline) with Southern Africa having the largest share at 17GW, followed by North Africa at 12.6 GW. The majority of Africa's renewable energy comes from hydropower with installed capacity of 34.3 GW and predominantly located in East Africa and Central Africa.

Renewable energy growth (excluding hydropower) in Africa has slowed over the past five years with the lower growth being attributed to COVID-19 disruptions in construction and delays to South Africa's large-scale renewable energy independent power producer procurement programme.

Table 3: Energy growth in Africa

	Annual RE growth over the last 10 years	Annual growth over the last 5 years	Annual RE growth over the last 10 years (Excl Hydro)	Annual growth over the last 5 years (Excl Hydro)
Central Africa	6.4%	7.0%	16.6%	4.9%
East Africa	4.9%	5.8%	14.4%	11.4%
North Africa	7.2%	9.4%	20.0%	20.5%
Southern Africa	22.0%	15.7%	37.8%	19.1%
West Africa	4.5%	4.9%	24.7%	23.5%
Total Africa	7.3%	8.2%	23.3%	17.9%

Overview of renewable energy development by region

North Africa

- Installed renewable capacity for 2021 was approximately 398 MW, accounting for 19% of Africa's installed renewable capacity.
- Hydropower accounts for approximately 6% of the regional generation capacity with wind at 1% and solar at 2%.
- Notable renewable energy projects in recent years include the 510 MW Ouarzazate solar power station (2016-2018) in Morocco.
- Unexploited renewable potential for solar capacity is estimated at 2,792 GW and 223 GW for wind.

West Africa

- Installed renewable capacity for 2021 was approximately 252 MW, accounting for 12% of Africa's installed renewable capacity.
- Hydropower accounts for approximately 31% of the regional generation capacity with wind at 1% and solar is less than 1%.
- Notable renewable energy additions in recent years include the 275 MW Soubré hydropower plant in Côte d'Ivoire, 65 MW solar plant installed in Senegal in 2017 and the 10 MW wind power plant in Katsina State.
- Unexploited capacity potential of 1956 GW for solar, 106 GW for wind and hydropower potential of 162 GW.

Central Africa

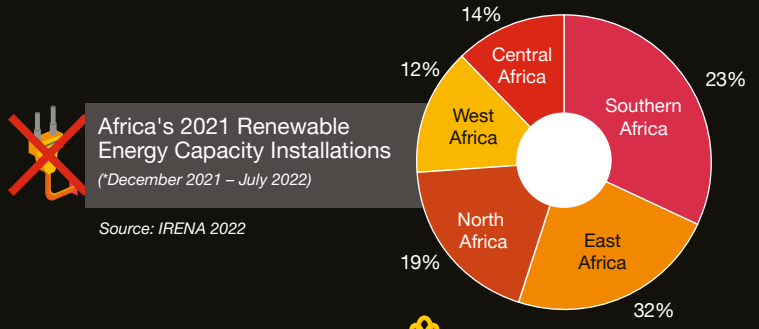
- Installed renewable capacity for 2021 was 293 MW, accounting for 14% of Africa's installed renewable capacity.
- Hydropower accounts for ~98% of regional generation capacity with negligible wind and solar generation.
- Notable renewable energy additions in recent years include the 668 MW and 334 MW and Zongo II hydropower plant, Democratic Republic of the Congo.
- Unexploited renewable potential estimated at 31 GW for wind, 1055 GW for solar and 767 GW for hydropower.

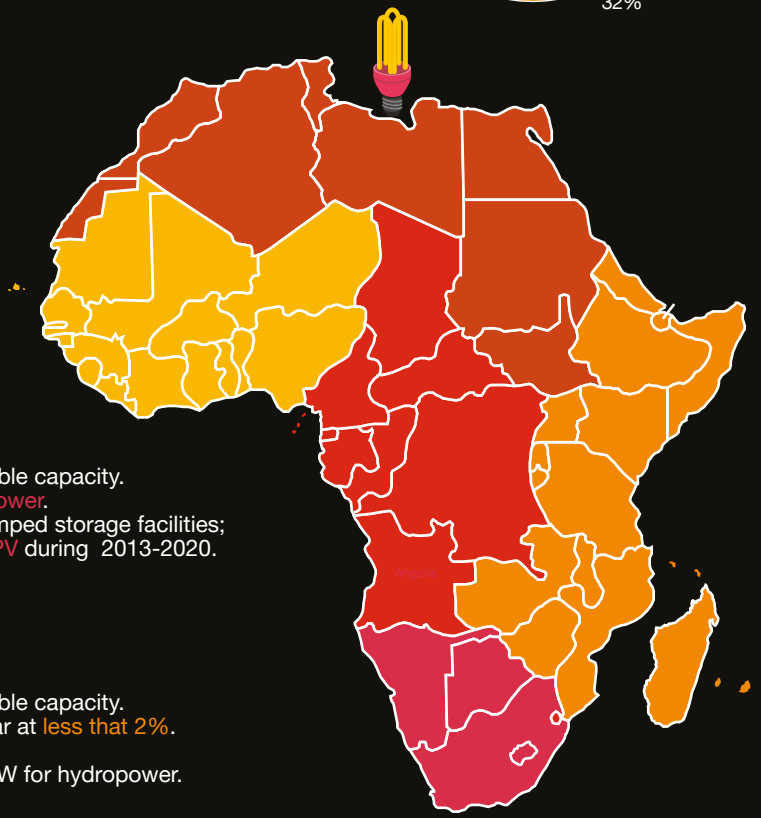
Southern Africa

- Installed renewable capacity for 2021 was approximately 482 MW, accounting for 23% of Africa's installed renewable capacity.
- Only 1.8% of the region's generation capacity is derived from hydropower, 2.6% from solar and 0.1% from wind power.
- Notable renewable capacity additions in recent years include (all in South Africa): the 333 MW Ingula 3 in 2017 pumped storage facilities; a combined total of 500 MW of concentrated solar power during 2014-2019, and combined total of 5.5 GW solar PV during 2013-2020.
- Unexploited capacity potential of 908 GW for solar, 53 GW for wind and hydropower potential of 447 GW.

East Africa

- Installed renewable capacity for 2021 was approximately 671 MW, accounting for 32% of Africa's installed renewable capacity.
- Hydropower accounts for approximately 54% of the regional generation capacity with geothermal at 12% and solar at less that 2%.
- The most notable renewable addition was the 310 MW Lake Turkana wind plant in Kenya (2018).
- Unexploited renewable potential for wind is estimated at 1067 GW for wind, 47.2 GW for solar and a further 263 GW for hydropower.





4. Roadmap to growing a green energy sector

4.1 Climate change policy and regulation.

International climate change policy as a driver of the African Energy Transition

As signatories to the Paris Agreement, nearly all African countries have committed to enhancing climate action through the reduction of greenhouse gas emissions and improving climate resilience. These commitments will largely be achieved by an accelerated uptake of renewable energy and clean technologies on both the domestic as well as on a regional scale. In the year under review, African jurisdictions have adopted and implemented numerous laws and policies enabling such increases in the deployment of renewable energy technologies.

Climate change, energy law and policy lack coherence

International climate change policy and the commitments set out in African Nationally Determined Contributions (NDCs) have resulted in the rapid adoption of domestic climate change laws and policies. Appendix A sets out the latest climate and energy related laws and policies adopted in Africa as of the beginning of 2021[17].

On review of these laws and policies, it is clear that Africa is setting ambitious energy goals as set out in domestic climate related laws and policies.

However, much support is still required in the enabling regulatory frameworks and incentivising mechanisms to support the decarbonisation of the energy sector and scaling of new renewable technologies.

By comparison, Germany's renewable energy targets set out in climate change regulation have been supported by policies that address every stage of the renewable energy development value chain, including research and development, testing, deployment, commercialisation, market preparation, market penetration, maintenance and monitoring, as well as integration into existing energy systems. Although 2021 saw a number of renewable energy-related regulatory improvements, implementation frameworks and policy support as seen in developed economies is still lacking across Africa and considered an area of development.

The Energy Transition in African courts

Africa is considered one of the more vulnerable regions to the impacts of climate change[18]. Ten climate change court cases have been raised in African jurisdictions to date and it is likely that litigation linked to the pace of decarbonisation will continue to grow.

A significant trend in climate change litigation has been the emergence of rights-based claims, where claimants are increasingly invoking their human rights as a means to hold governments and corporations accountable to the continued reliance on fossil fuels. Given Africa's vulnerability to the impacts of climate change, it can be expected that there will be an increase in the amount of climate change based court cases forcing further emissions abatement to take place in the energy sector.

17 Source: Grantham Research Institute on Climate Change and the Environment Climate Change Laws of the World, available at https://climate-laws.org/
18 UNFCCC, "Climate Change is an increasing threat to Africa" (27 October 2020) https://unfccc.int/news/climate-change-is-an-increasing-threat-to-africa.

In order to harness Africa's renewable energy potential and to enable the continent to meet its climate change targets, urgent regulatory reform measures must be introduced on a domestic level. The current state of laws and policies reflects a disproportionate focus on top-down climate change commitments, with a lack of renewable energy laws and regulations that enable and incentivise new investment.

4.2 Development trends in renewable technologies

The rapid innovation and declining costs in clean energy technologies has become a major factor in driving the transition to renewable resources, especially wind and solar. This combined with increasing efficiency through ongoing innovation is making the transition to clean technologies economically self-sustaining. Examples of clean technology frontiers that are receiving a great deal of attention include varying battery storage chemistries, scaling of green hydrogen; clean fuels, specifically for aviation and shipping; low entropy geothermal and carbon capture.

As energy markets become increasingly decentralised and digitally integrated, new energy management technologies will also drive the use of big data and artificial intelligence (AI) to manage the complexities presented by variable power and digital measurement of grid stability.

Trends in solar PV energy will continue to improve efficiency and lower cost

Solar PV innovation continues to improve panel power ratings and increase the application flexibility of solar generation.

A future can be envisaged where solar generation technology will go beyond discreet installations and be embedded in buildings and materials resting an abundance of available day-time energy.

Current average solar power ratings are in the range of 500W per panel with conversion efficiencies just above 18%. Technology trends are already achieving 600W+ power rating at efficiencies of up to 23% with projections that 1 Kilowatt (kW), with efficiencies of up to 40%, could be achievable by 2030. According to the International Renewable Energy Agency (IRENA), the global weighted capacity factor for solar PV has increased from 13.8% in 2010 to just above 17% in 2021.

Bifacial solar technology and the incorporation of automated irradiation tracker increases the amount of energy yield that a module can produce. This technology can absorb light from both sides of the panel and automated radiation trackers move the solar panels as the sun moves to boost the amount of light striking the solar panel to absorb the radiation.

The development of floating solar is another frontier that unlocks more opportunities for the rapid adoption of solar PV technology, while optimising land use and reducing water loss through evaporation. The lower water temperature also has an advantage of automatic cooling which in turn improves performance and reduces degradation caused by overheating.

Solar PV is growing rapidly on a global scale with an estimated 843 086 GW of capacity installed in 2021[19]. As of 2021, Africa has just over 11 GW of installed solar capacity with South Africa being the largest contributor, estimated at 6.2GW.

Trends in wind energy will continue to improve power ratings and efficiency

Wind energy technology advancements as a catalyst to transition

Wind technology innovation has realised increases in average capacity from 0.2MW in 1990 to 7.2MW in 2021. This current average turbine power rating is likely to increase further through a combination of efficiency, increasing height and rotational diameter of the blades.

Between 2000 and 2010, the hub height increased by over 80%, correlating with the increase in turbine capacity from 2MW to almost 4MW. Thereafter, hub heights have seen minimal change but increases in diameter of the blades and internal turbine technology (electrical generators) continued to increase power output.

It is estimated that turbine capacity will continue to increase with average capacity approaching 10MW and the larger units being in the range of 15 MW by 2030.

Offshore wind is a major new frontier where, according to the US Wind Energy Technology Office, 2021 saw the largest increase of global offshore wind installed to date at 17GW (14GW being installed by China). In 2021 global offshore wind project pipeline increased by 20% from 2020 to a total of 370 GW. The EU is the global leader in offshore wind, targeting over 300 GW by 2030. The rapid ramping up of offshore wind portfolios by the US and China bodes well for opportunities to start introducing such technology into Africa.

19 https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2022/Apr/IRENA_RE_Capacity_Statistics_2022.pdf

Energy storage scaling and learning curves will continue to reduce cost

Energy storage has a critical role to play in future power sectors dominated by variable energy from renewables and where storage is critical to deal with intra-day load management as well as longer duration variability. Multiple forms of energy storage solutions exist in the market, including electro-chemical, mechanical, and thermal energy storage.

Electrochemical Stationary Battery Energy storage is currently leading in the market as a means to shift the curtailment to keep for peak demand. Lithium-ion batteries have become the most favoured in the market currently due to their flexibility, scalability and declining cost. The electric vehicle market is driving innovation in battery energy storage technology with large investments being made into the chemistry, design and manufacturing efficiencies. Other technology developments include improved performance with longer battery life, light weight and improved safety, thus leading to increased value for consumers/customers.

According to the International Energy Agency, storage capacity additions in 2020 alone grew to a record high of 5GW which was up 50% from 2019[20]. These gigawatt-scale additions were mostly recorded in China and the US.

Green hydrogen is one of the best long-term strategic low carbon energy vectors in both power applications as well as green industrial feedstock. Technology advancements in green hydrogen production include the Membrane Electrode Assemblies (MEAs) chemistry, which is at the heart of both the electrolyzer and the fuel cell technology and will help to reduce cost and improve efficiency.

Other power technology trends on the watch list

Other technology innovation that may contribute to future energy stability and supply include:

Low enthalpy Geothermal: unlike traditional geothermal that relies on very high heat gradients and surface temperatures of above 400 degrees, low enthalpy geothermal operates off significantly lower temperature gradients by using a geothermal fluid that is circulated through a porous fractured reservoir in a targeted high heat area.

Piped hydro presents an opportunity to generate power from contained water flow. Typically, pressure reducing valves are used to control and manage flow and pressure. This same operational function is being achieved with in-flow generators.

Small scale or modular nuclear. Although largely still piloting; small scale modular reactors are in development, mostly in China, and commercialisation will make Nuclear safer and more affordable. South Africa has a long history in research and development through the Pebble Bed Modular Reactor programme, which was discontinued in 2010. Despite the challenges faced with nuclear technology, Africa should still consider it in the energy mix while taking into account the environmental as well as economical and legislative measures in order to address the energy gap while at the same time complying with the global trends of transitioning to cleaner energy.

4.3 Outlook for renewable energy growth across Africa

As outlined Africa requires significant growth in domestic energy supply, which will largely come from decentralised and variable renewable energy generation. Renewable energy scaling will also require major changes to current centralised utility structures and energy management. Policy direction must move towards dynamic energy markets, decentralised generation planning, strengthening of grids and use of micro-grids to service rural communities. Sustainable utilities are a critical enabler of such future markets, which must remain a large financial support and planning focus area.

Decentralisation is an inevitable outcome of the Energy Transition due to the dispersed geographical nature of wind and solar and invariably the private sector ownership model.

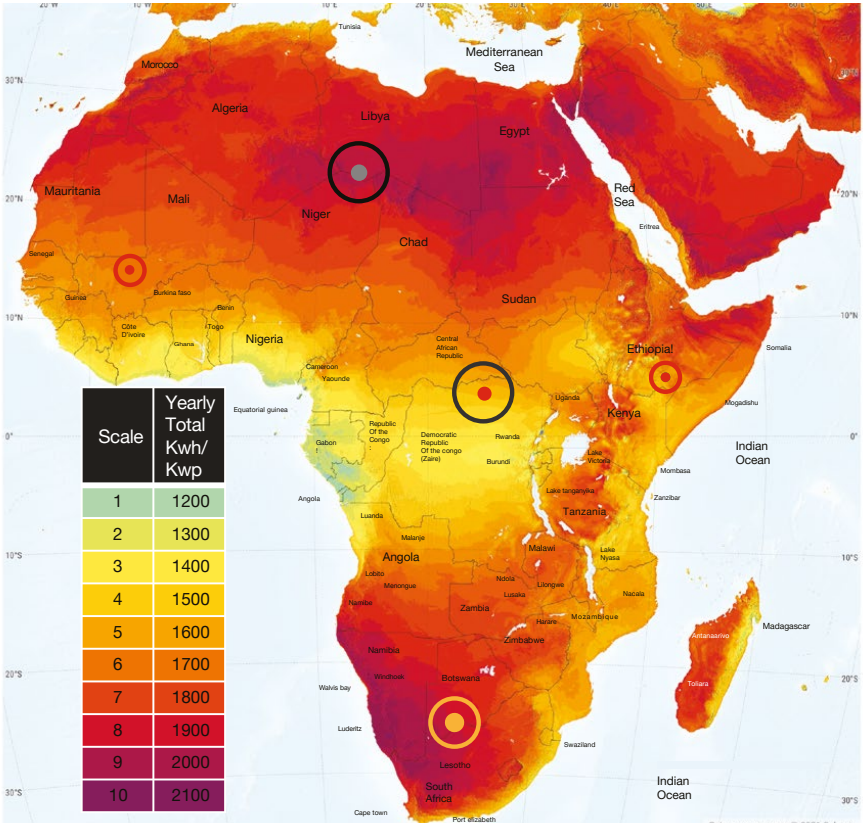
Although energy exports are currently exclusively driven by fossil fuels, there are opportunities for foreign earnings through green fuels exports. Examples of these opportunities are already evident through Morocco and Namibia, who have active green hydrogen (through green ammonia) export strategies as well as South Africa that has numerous projects in the pipeline to export green ammonia, green methanol and green Sustainable Aviation Fuel (SAF).

20 https://www.iea.org/reports/energy-storage

Solar PV outlook

With roughly 11GW of installed solar PV, Africa has approximately 1% of global installed solar PV and an insignificant capacity against its estimated solar potential of 7500 GW[21]. The annual solar irradiance across the continent ranges anywhere between 1200 kWh/m^2 to 2100 kWh/m^2 [22], compared to average levels of 730 – 1095 kWh/m^2 a year in the UK[23].

Installed vs potential solar capacity of Africa



Installed Capacity (GW)	Potential Capacity (TW)
0-1	0-0.5
1-2	0.5-1
2-3	1-2
3-4	2-3

Source: Solargis Photovoltaic Electricity Potential

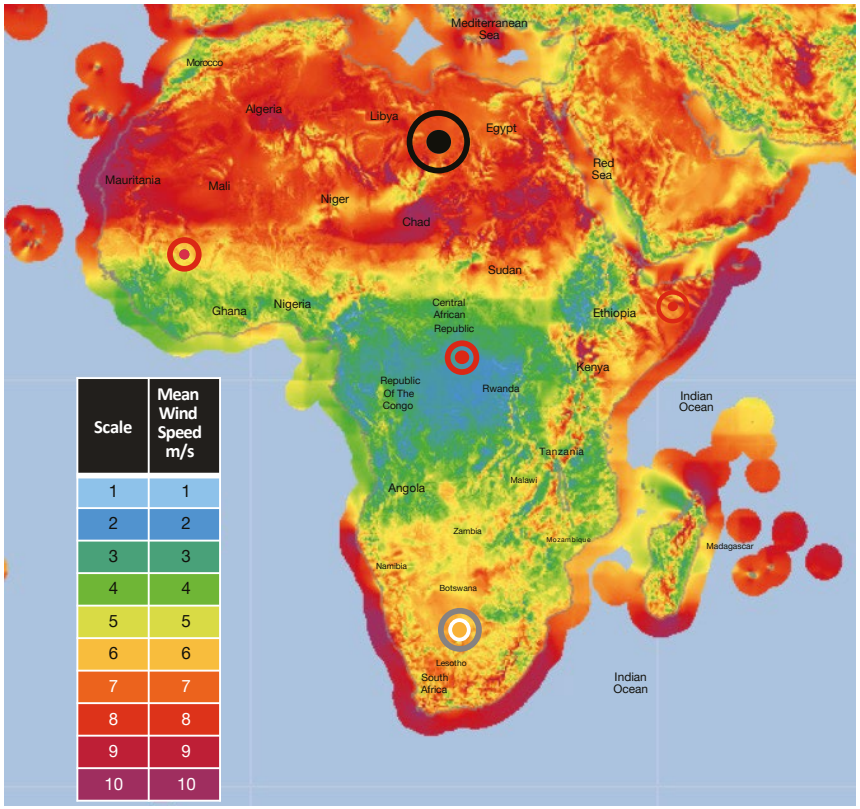
21 https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2015/IRENA_Africa_2030_REmap_2015_low-res.pdf
22 Solargis, https://solargis.com/maps-and-gis-data/download/africa
23 Climatebiz, https://climatebiz.com/average-peak-sun-hours-united-kingdom/

Wind outlook

At 7.3 GW installed capacity, Africa compares better at 6.7% of global wind capacity with an estimated potential of 1,800GW.

A continental-scale offshore wind resource assessment of Africa estimated this potential capacity to be a very significant 26,968 GW[24], largely concentrated around the three African power pools, namely the Comité Maghrébin de l'Electricité (COMELEC), Southern African Power Pool (SAPP) and Eastern African Power Pool (EAPP).

Installed vs potential wind capacity of Africa



Installed Capacity (GW)	Potential Capacity (GW)
0-1	0-200
1-2	200-300
2-3	300-600
3-4	600-800

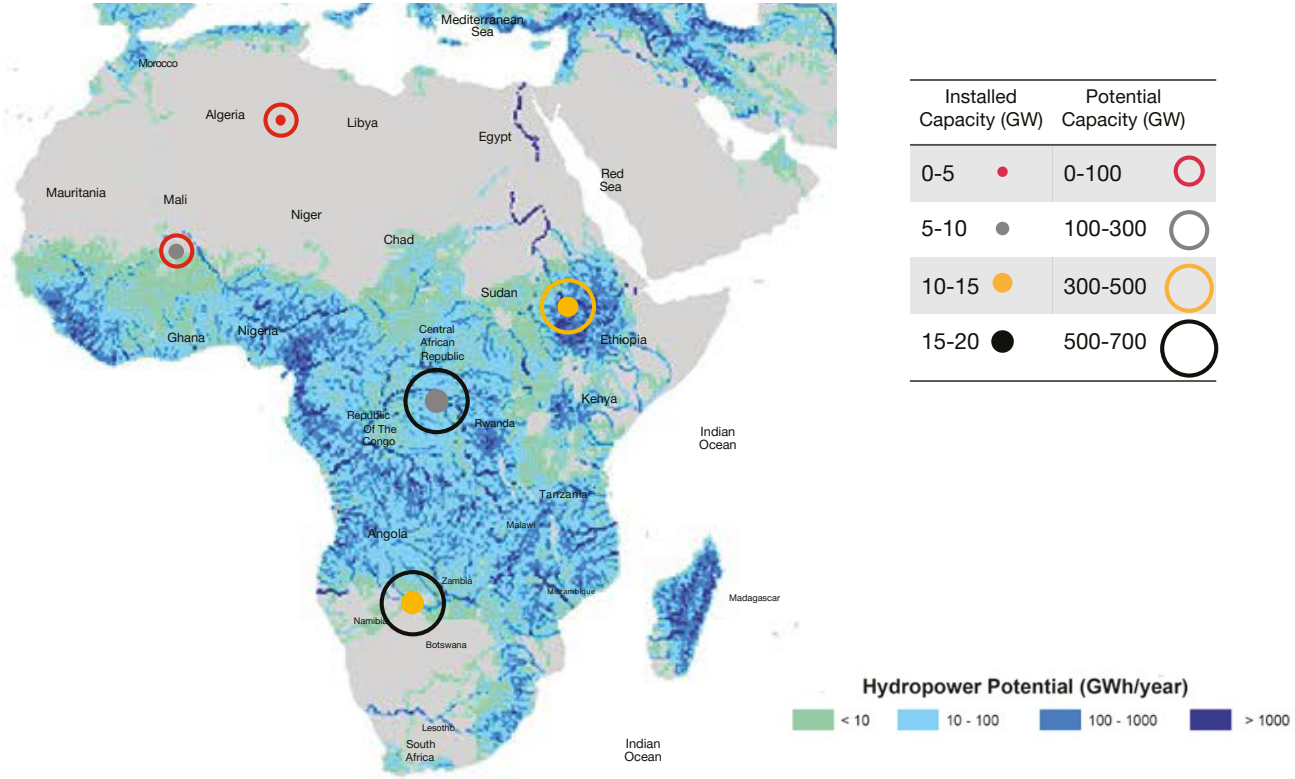
Source: Global Wind Atlas
[Data/information/map obtained from the] "Global Wind Atlas 3.0, a free, web-based application developed, owned and operated by the Technical University of Denmark (DTU). The Global Wind Atlas 3.0 is released in partnership with the World Bank Group, utilizing data provided by Vortex, using funding provided by the Energy Sector Management Assistance Program (ESMAP). For additional information: https://globalwindatlas.info"

24 Elsner (2019), https://www.sciencedirect.com/science/article/abs/pii/S1364032119300449

Hydropower outlook

Hydropower is currently Africa's largest source of renewable energy accounting for approximately 60% of the total RE installed capacity. The continent's hydropower potential is estimated at 1,800 GW, where the largest potential lies in the central, eastern and southern regions, particularly in countries such as Ethiopia, Angola, the Democratic Republic of Congo, Madagascar and Mozambique.

Installed vs potential hydro capacity of Africa



Installed Capacity (GW)	Potential Capacity (GW)
0-5	0-100
5-10	100-300
10-15	300-500
15-20	500-700

Source: Systematic high-resolution assessment of global hydropower potential[25]

25 https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0171844

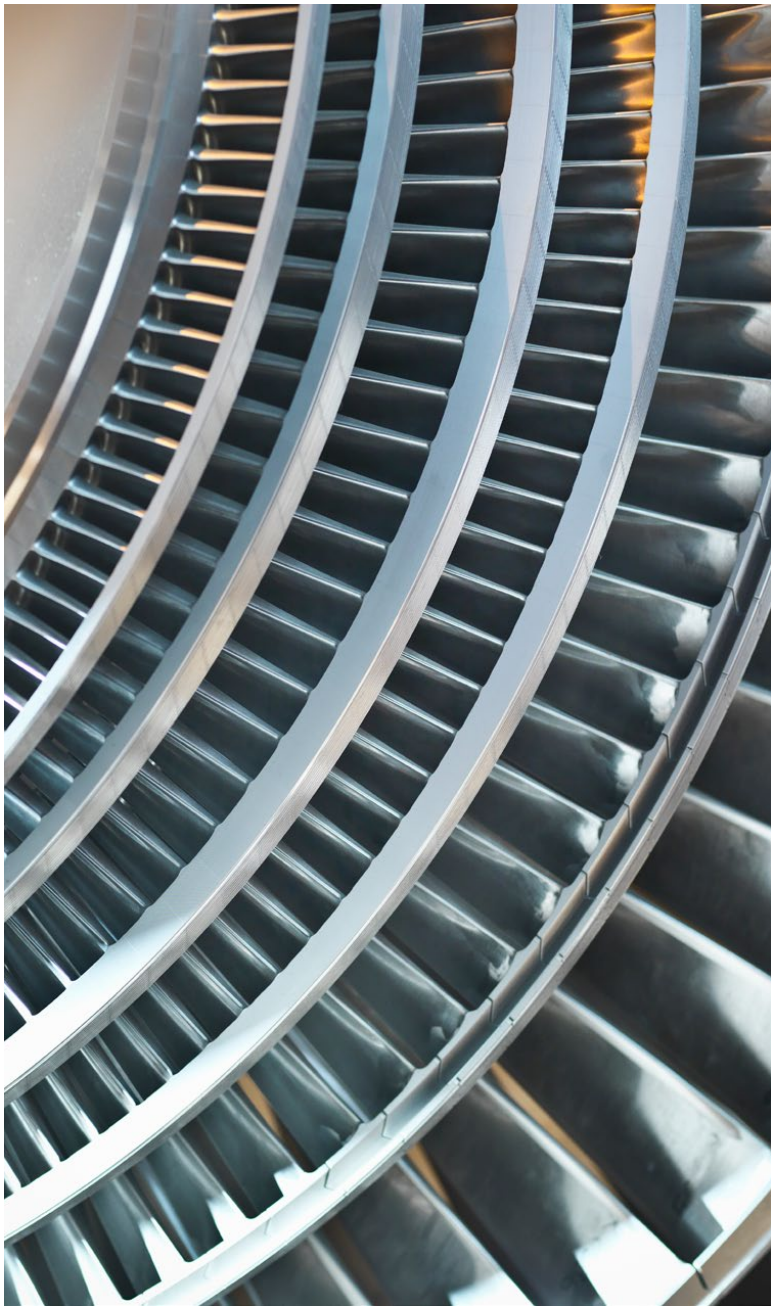
Expanding hydropower is a significant opportunity for Africa due to the lower variability and flexibility to augment wind and solar. It has the challenge of large upfront costs as well as major geo-political influences but is also one of the most efficient means of producing electricity with long lifetimes of up to 100 years[26]. With Africa's considerable vulnerability to climate change, the additional benefits of hydropower such as flood control, water supply and irrigation give it a very relevant place in Africa's future.

Storage outlook

Considering the variable nature, specifically of wind and solar generation, storage is an essential part of a stable energy system. Storage must be deployed as part of the planning for wind and solar, giving due regard to the design for short-duration or intra-day load management as well as long-duration or seasonal load management. Typically, a stable renewable energy system can require storage deployment in the range of 20% to 30% of the installed wind and solar capacity, adding significant cost to the overall system design.

Geothermal outlook

Africa's geothermal energy sources are primarily located in the eastern region of the continent, owing to the East African Rift System (EARS) which experiences ground temperatures of 400°C at relatively shallow depths of 2,300 metres. The continent's estimated generation potential sits at 15 GW, of which only 5.6% has been exploited. While this generation potential is minor in comparison to wind and solar, the dispatchable nature of geothermal energy makes it significant in demand-supply matching as a clean energy base-load source[27].



26 https://www.nrel.gov/docs/fy04osti/34916.pdf

27 International Renewable Energy Agency (IRENA), 2020. Geothermal development in Easernt Africa: Recommendations for power and direct use. https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2020/Nov/IRENA_Geothermal_Eastern_Africa_2020.pdf

Green hydrogen outlook

Africa has huge potential to produce hydrogen using its rich renewable resources. A number of low-carbon hydrogen projects are underway or under discussion in Egypt, Mauritania, Morocco, Namibia and South Africa. These are focused primarily on using renewables-based power to produce ammonia for fertiliser, which would strengthen Africa's food security.

Global declines in the cost of hydrogen production could allow Africa to deliver renewable hydrogen to Northern Europe at internationally competitive price points by 2030. With further cost declines, Africa has the potential to produce 5000 megatonnes of hydrogen per year at less than $2/kg[28].

4.4 Accelerating Africa's decarbonisation pathways

Outlining the scale of Africa's energy needs

We have outlined the need for Africa to address energy poverty as a critical enabler of economic growth and prosperity as well as decarbonising the existing power systems in line with global Net Zero target by 2050. To help shape the scale of these challenges, we have outlined potential energy transition pathways, driven by increasing levels of ambition for renewable energy.

The "as-is" projection will see continued energy poverty and increasing emissions.

Using historical energy data and statistical analysis, PwC estimates Africa's baseline electricity demand will more than double to reach 1,735 TWh by 2050. Assessment of baseline indicates an approximate doubling of GHG emissions due to the continued coupling of GDP and emissions growth through the reliance on fossil fuels and inadequate growth rates for renewables.

Under an Energy Transition and energy access ambition that would see Africa achieving carbon neutrality in the power sector and meeting the current world average for energy access, demand by 2050 could be as high as 8,455 TWh. This would equate to a total installed renewable capacity base of 2,413 GW, an increase of 2,354 GW over the current installed base of 59 GW. This would require an extraordinary increase in the level of Africa wide focus, coordination and investment to accelerate renewable energy development to growth rates above 20% per annum.

28 https://www.weforum.org/agenda/2022/07/africa-hydrogen-iea/#:~:text=Africa%20could%20produce%205%2C000%20megatonnes%20of%20hydrogen%20a%20year%20at,today%2C%E2%80%9D%20the%20IEA%20says.

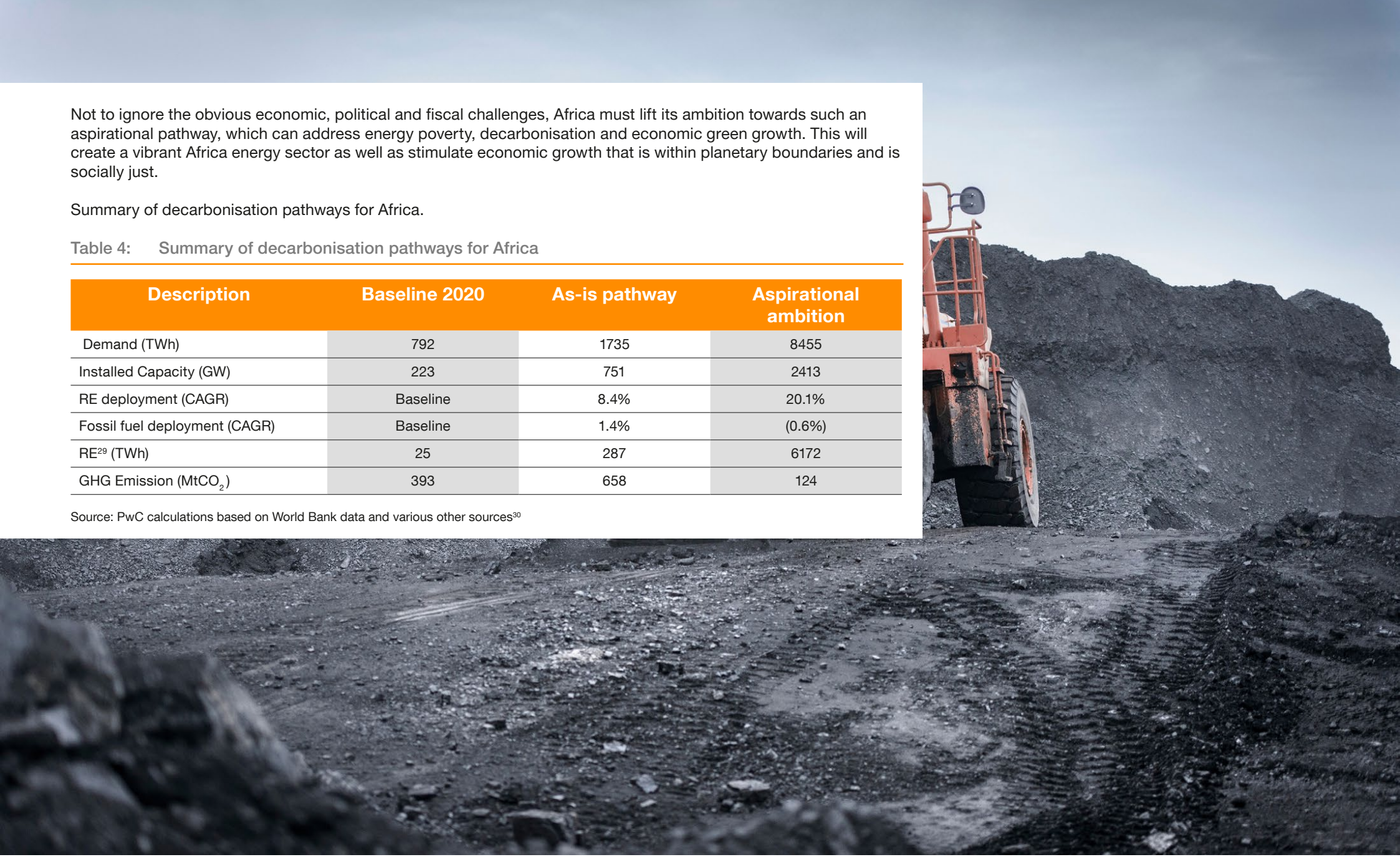
Not to ignore the obvious economic, political and fiscal challenges, Africa must lift its ambition towards such an aspirational pathway, which can address energy poverty, decarbonisation and economic green growth. This will create a vibrant Africa energy sector as well as stimulate economic growth that is within planetary boundaries and is socially just.

Summary of decarbonisation pathways for Africa.

Table 4: Summary of decarbonisation pathways for Africa

Description	Baseline 2020	As-is pathway	Aspirational ambition
Demand (TWh)	792	1735	8455
Installed Capacity (GW)	223	751	2413
RE deployment (CAGR)	Baseline	8.4%	20.1%
Fossil fuel deployment (CAGR)	Baseline	1.4%	(0.6%)
RE[29] (TWh)	25	287	6172
GHG Emission ($MtCO_2$)	393	658	124

Source: PwC calculations based on World Bank data and various other sources[30]



29 This is only considering Wind and Solar - Modelling approach is based on a Net Zero scenario that allows total decarbonization using historical data of electricity consumption, GHG emissions, and demand projections.
30 https://ember-climate.org/insights/research/global-electricity-review-2022/

5. Funding Africa's Energy Transition

Definition of regions used for financial analysis is based on IRENA regional definition.

5.1 Outlining the investment need for Africa's energy sector

This review has outlined the importance of energy in building a sustainable and vibrant African future, and that significant international technology and financial support will be required. PwC analysis estimated the cost of transitioning Africa's power sector to carbon neutral and providing reasonable access to electricity is approximately $2.6tn, which is roughly the current size of Africa's GDP.

Figure 3: Africa's renewable energy requirements

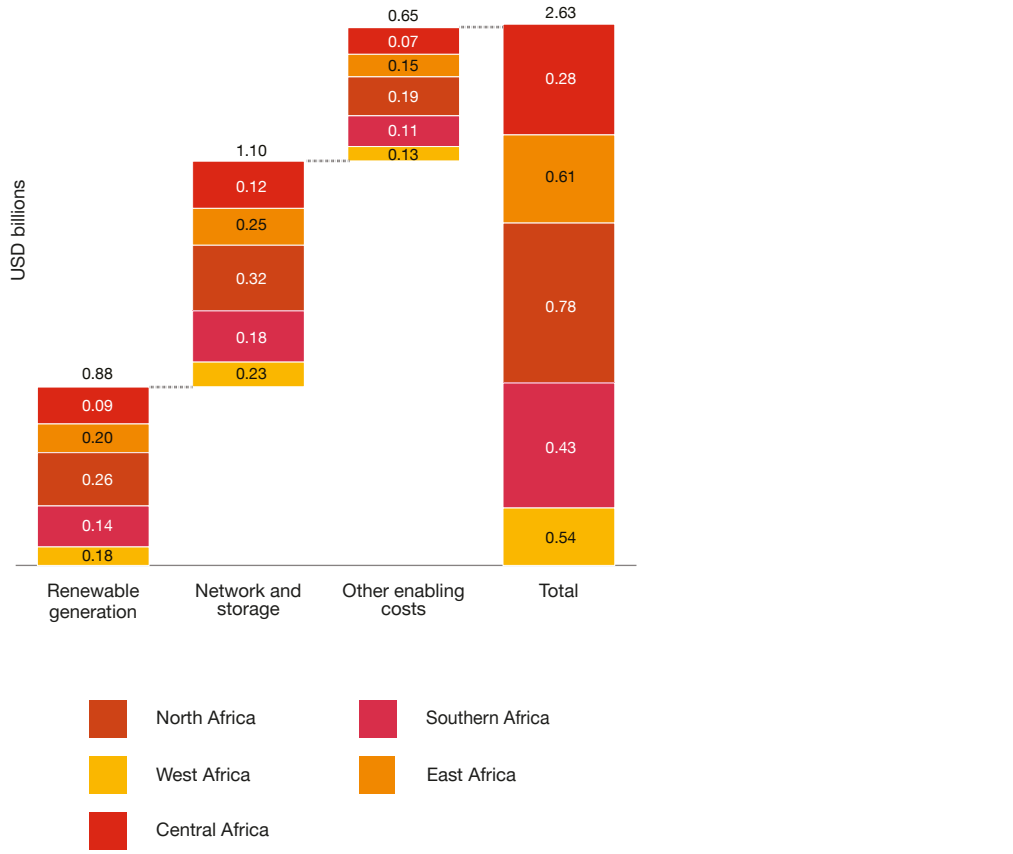


Figure 4: Africa's funding requirements

Source: IEA, IRENA, PwC analysis

5.2 Sources of investment in Africa's renewable energy

Total Africa investment in renewable energy (funded by the public and private sectors, local as well as foreign investors) increased significantly from $4.8bn between 2000-2009 to $55.0bn between 2010-2020[31]. This is however significantly below the estimated required investment of close to $100bn per annum to meet energy demand growth and emissions targets.

Africa public sector investment in energy is predominantly focused on renewable energy with a peak of 94% in 2019[32]. This demonstrates that governments are already focusing the bulk of energy investment into renewables and that a significant increase in private sector investment is required to realise a greater scale of renewable deployment.

According to IRENA, African countries need to increase the available pipeline of bankable energy projects and make improvements to the political and regulatory landscape in order to attract more private investment [33].

International donors and development financing institutions play a key role in supporting Africa's funding of renewables. According to IRENA, 54 donors were active in Africa renewable development during 2010-2019, with the top ten of these providing 85% of the public funding for renewables in Africa. These included bi-lateral loans from China, France, Germany and the UK, multilateral development banks (MDBs) such as the African Development Bank (AfDB) and World Bank, and development finance institutions (DFIs) such as the Netherlands' FMO, Germany's KfW and France's Proparco [34].

Approximately 75% of the finance was in the form of direct project non-recourse term loans. Approximately 20% of the finance was in the form of bi-lateral loans with the remaining share being made up of other bonds, grants and development loans [35].

Some examples of climate finance initiatives in Africa include:

- **South Africa Climate Partnership Deal:** South Africa secured a ground-breaking climate finance partnership deal at COP 26 in 2021, with an international partnership (France, Germany, the UK and the US, as well as the European Union) establishing a Political Declaration to support the accelerated decarbonisation of South Africa's economy through a $8,5bn financial package that would include the decommissioning of coal-fired power, accelerating the green hydrogen economy and support the mobility transition to new energy vehicles (NEVs). Through the Presidential Climate Commission, a financial task team has been established to lead this initiative and to present a Just Energy Transition Investment Plan that will incorporate the climate partnership deal (recognising that the $8.5bn is a small percentage of what is estimated for a full Energy Transition in South Africa).

31 World Bank, 2021. The road to recovery in Sub-Saharan Africa: Capitalizing on transformative opportunities from shifting FDI patterns. https://blogs.worldbank.org/africacan/road-recovery-sub-saharan-africa-capitalizing-transformative-opportunities-shifting-fdi

32 International Renewable Energy Agency (IRENA) and the African Development Bank (AfDB), 2022. Renewable Energy Market Analysis: Africa and Its Regions. https://irena.org/-/media/Files/IRENA/Agency/Publication/2022/Jan/IRENA_Market_Africa_2022.pdf

33 International Renewable Energy Agency (IRENA) and the African Development Bank (AfDB), 2022. Renewable Energy Market Analysis: Africa and Its Regions. https://irena.org/-/media/Files/IRENA/Agency/Publication/2022/Jan/IRENA_Market_Africa_2022.pdf

34 International Renewable Energy Agency (IRENA) and the African Development Bank (AfDB), 2022. Renewable Energy Market Analysis: Africa and Its Regions. https://irena.org/-/media/Files/IRENA/Agency/Publication/2022/Jan/IRENA_Market_Africa_2022.pdf

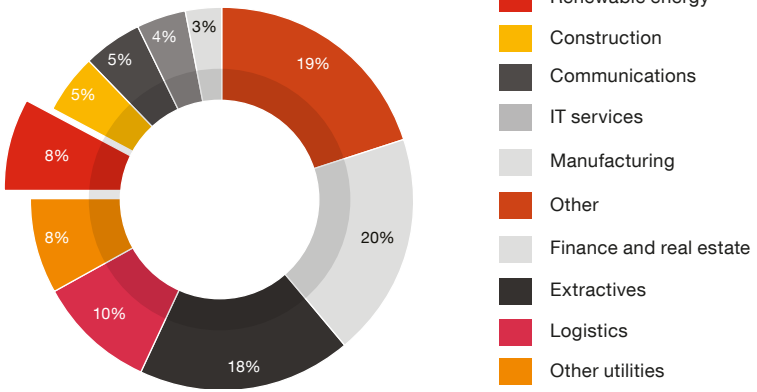
35 Note that this data excludes large-scale hydropower projects.

- **Pan-African Renewable Energy Fund (PAREF):** A new fund has been established to help accelerate the adoption of renewable energy in Africa. The fund is worth $300m. PAREF is backed by the infrastructure investment firm Harith General Partners, and power company Anergi Group.
- **World Bank:** The World Bank recently approved a $30m grant from the Green Climate Fund which aims to increase the development of clean electricity for Central Africa. This fund could benefit the region to further exploit the green energy potential of hydropower, solar and wind.
- **African Development Bank (AfDB):** A good example of interventions planned by the African Development Bank is the flagship Desert to Power (DtP) initiative that aims to deploy a 10GW solar capacity to approximately 250 million people in 11 countries of the Sahel region. Approving the Desert to Power G5 Sahel Financing Facility, the bank envisages a $379.6m[36] financing commitment over the next seven years, recently approving a $5.5m technical assistance grant[37] to kick-start the East Africa Regional Energy Project, following last year's $6m grant to the West Africa Regional Energy Project.

Foreign direct investment (FDI) into the continent has historically had a strong focus on the energy sector. For example, resource extraction accounted for more than half of the FDI inflows into sub-Saharan Africa during 2006-2010. The region has, however, subsequently seen a steady decline of FDI in extractive industries to less than a quarter of total FDI inflows during 2016-2020[38].

In contrast, FDI in renewables for the same periods increased from approximately 20% during 2006-2010 to over half of total inflows during 2016-2020, amounting to $16bn or 8% of announced greenfield FDI projects during 2016-2020[39].

Figure 5: Announced SSA greenfield FDI projects 2016-2020 (share by value)



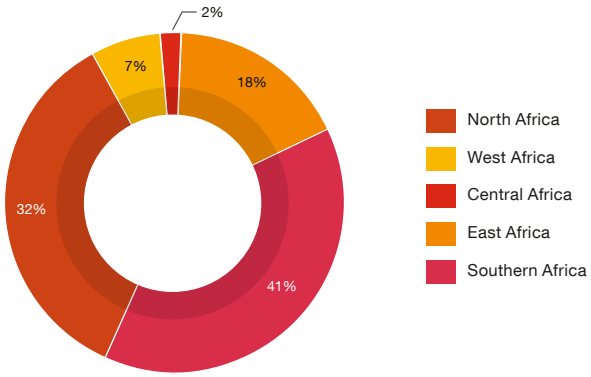
36 https://www.afdb.org/en/news-and-events/press-releases/african-development-bank-group-approves-3796-million-desert-power-financing-facility-g5-sahel-countries-49325
37 https://www.afdb.org/en/news-and-events/press-releases/african-development-fund-approves-55-million-grant-fund-phase-two-flagship-desert-power-energy-project-djibouti-eritrea-ethiopia-and-sudan-50900
38 World Bank, 2021. The road to recovery in Sub-Saharan Africa: Capitalizing on transformative opportunities from shifting FDI patterns. https://blogs.worldbank.org/africacan/road-recovery-sub-saharan-africa-capitalizing-transformative-opportunities-shifting-fdi
39 World Bank, 2021. The road to recovery in Sub-Saharan Africa: Capitalizing on transformative opportunities from shifting FDI patterns. https://blogs.worldbank.org/africacan/road-recovery-sub-saharan-africa-capitalizing-transformative-opportunities-shifting-fdi

5.3 Regional Investment

Renewable energy investment has been most prevalent in North and Southern Africa where a combined $39.9bn was recorded in 2010-2020, accounting for nearly three-quarters of the renewable energy investment on the continent. From a technology perspective, solar (PV and thermal) accounted for 55% of investment across Africa with wind accounting for a further 32%[40].

Southern Africa was the biggest recipient of renewable energy investment. South Africa – through its solar – and wind-focussed Renewable Energy Independent Power Producer Procurement Programme (REI4P) – accounted for 85% of the region's investment in 2010-2020. In North Africa, investment was focussed in Morocco and Egypt and split about two-thirds to solar (PV and thermal) and a third towards wind[41]. These are some of the largest economies on the continent.

Figure 6: Regional composition of renewable energy investment in Africa (% of value, 2010-2020)



Source: PwC calculations based on IRENA data

Outside of the major focus on solar and wind, geothermal projects in East Africa, bioenergy in West and East Africa, and small hydropower across all regions except Southern Africa made up the remaining 13% of investment by technology category[42].

The eastern region has dominated investment in geothermal with approximately a third ($2,9bn) of total renewable energy investment, equivalent to wind generation. There is, however, significant room for additional growth and investment in geothermal energy across Africa, especially with the technology improvements with low-entropy geothermal. According to the International Renewable Energy Agency (IRENA), the high cost of geothermal exploration funding and a shortage of skilled workers are some of the key challenges, which will also be alleviated by increases in low-entropy geothermal technologies[43].

40 International Renewable Energy Agency (IRENA) and the African Development Bank (AfDB), 2022. Renewable Energy Market Analysis: Africa and Its Regions. https://irena.org/-/media/Files/IRENA/Agency/Publication/2022/Jan/IRENA_Market_Africa_2022.pdf

41 International Renewable Energy Agency (IRENA) and the African Development Bank (AfDB), 2022. Renewable Energy Market Analysis: Africa and Its Regions. https://irena.org/-/media/Files/IRENA/Agency/Publication/2022/Jan/IRENA_Market_Africa_2022.pdf

42 International Renewable Energy Agency (IRENA) and the African Development Bank (AfDB), 2022. Renewable Energy Market Analysis: Africa and Its Regions. https://irena.org/-/media/Files/IRENA/Agency/Publication/2022/Jan/IRENA_Market_Africa_2022.pdf

43 World Bank, 2021. The road to recovery in Sub-Saharan Africa: Capitalizing on transformative opportunities from shifting FDI patterns. https://blogs.worldbank.org/africacan/road-recovery-sub-saharan-africa-capitalizing-transformative-opportunities-shifting-fdi

Regional composition of renewable energy investment in Africa ($ bn)

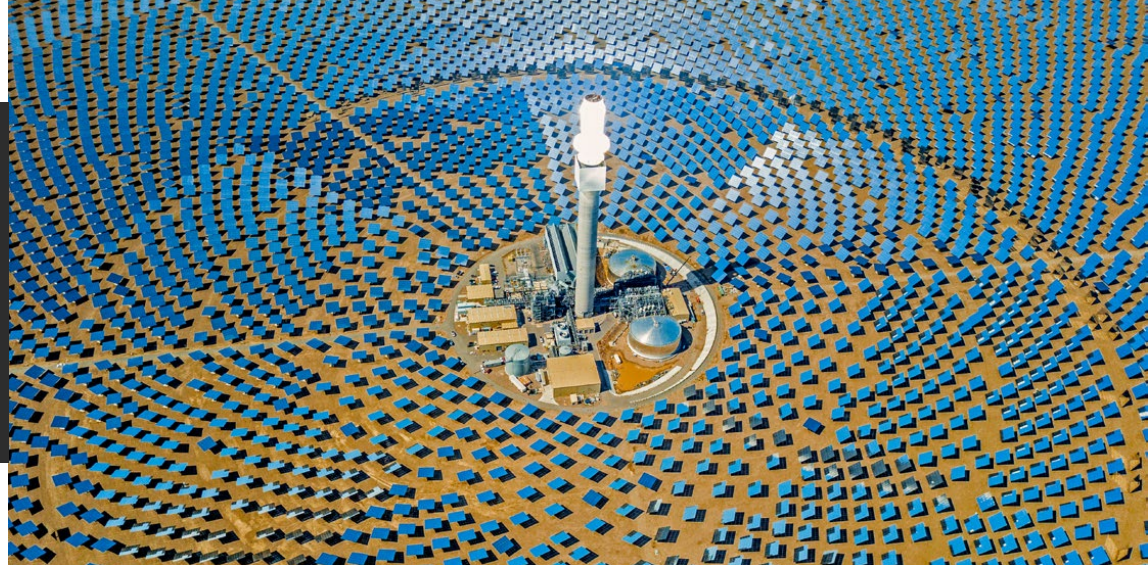
Solar (PV and Thermal)	Wind	Geothermal	Bioenergy	Small hydropower
11.8	5.6	0.0	0.0	0.1
2.4	0.6	0.0	0.5	0.4
0.7	0.0	0.0	0.0	0.7
1.2	2.9	2.9	1.7	1.0
13.4	7.8	0.0	0.0	0.0

Definition of regions used for financial analysis is based on IRENA regional definition.

- North Africa
- West Africa
- Central Africa
- East Africa
- Southern Africa

Source: PwC analysis, IRENA

Conclusion



There is little debate that we must rapidly decarbonise our planet and a key part of that journey will be the exponential deployment of clean technologies and renewable energy systems. Africa is embracing a green pathway but at a pace that will likely fall short of decarbonisation ambitions and unlikely to address broad access to clean energy i.e. the challenge of energy poverty. A key theme raised in this review has been the growing risk of emissions driven economic separation as developed economies transition quicker than developing economies, impacting Africa's global competitiveness as well as investment and foreign earnings potential.

With lower levels of affordability, Africa will not be able to finance the scale of investment required for a Net Zero pathway and the development of a large-scale green economic sector. Extended activity in the fossil fuel sector therefore remains a fiscal necessity and the most likely pathway for Africa. This will compound the fact that Africa is particularly vulnerable to climate change impact and already home to poor communities with little capability to effect climate mitigation or adaptation actions.

Given higher levels of finance, a green energy future for Africa has the potential to support education, inclusive and healthy societies with an equally healthy, diverse and resilient environment. Access to clean energy will also serve as an economic multiplier, powering secondary and tertiary economic growth.

This review has identified the need for greater planning and clarity in order to realise a real acceleration in the Africa Energy Transition. Key issues are: (i) What transition pace is affordable for Africa? (ii) Can the transition pathway be leveraged to address energy poverty? (iii) How can Africa better leverage international partnerships and technology innovation? and (iv) Is a global Just Energy Transition framework possible, that would allow Africa global market space to self-fund some of the transition through extended use and global sales of fossil fuels from the continent?

Appendix A

Climate change laws and policies

Country	Climate change law/ policy	Description
Egypt	Egypt National Climate Change Strategy (NCCS) 2050	The strategy aims to increase the share of all renewable energy sources in the country's energy mix and reduce the country's reliance on fossil fuels. Sources such as wind farms, concentrated solar power (CSP), solar photovoltaic plants, as well as bioenergy plants will be key.
Sierra Leone	National Climate Change Policy	The updated climate change policy specifically includes the ambition to increase the deployment of renewables.
Ghana	National Medium-term Development Policy Framework 2022-2025	Focus area 11 in the strategy specifically aims to ensure availability of clean, affordable and accessible energy. This includes increasing the country's renewable energy mix by 7% by 2025.
Morocco	National Roadmap for Green Hydrogen	The strategy sets out the country's roadmap to produce and export green hydrogen from renewable energy sources (solar and wind).
Nigeria	National Climate Change Act	The Act sets out the legal framework for the country to achieve its climate goals. It requires the government to publish an Action Plan and establish a fund to incentivise private and public entities to increase energy decarbonisation efforts.
Nigeria	Medium Term National Development Plan (MTNDP) - 2021-2025	The strategy aims to eliminate dominant constraints across the existing electricity value chain including gas-to-power, generation, transmission, and distribution. It also aims to put in place the policy and regulatory support to build the necessary infrastructure to drive renewable energy generation.
Uganda	National Climate Change Act	The Act mandates the creation of a Framework Strategy on Climate Change, as well as a National Climate Action Plan and District Climate Action Plans. It permits the development of mechanisms such as emissions trading mechanisms as well as mechanisms to increase renewable energy deployment while penalising the use of emission intensive fossil fuels.
South Africa	Climate Change Bill	Once passed, the Bill will govern the country's response to climate change and require emission intensive industries to comply with mandatory carbon budgets, or face punitive measures for non-compliance. This will implicitly support the increased uptake of less emission intensive energy technologies.

Key energy law and policy developments

Country	Energy law/ policy	Description
South Africa	Electricity Regulation Amendment Bill	The proposed amendments will drastically reform the country's energy sector. The key amendments of the Bill includes the following: Moving away from a mostly single-buyer power market to a competitive multi-market where willing buyers and willing sellers are able to trade with each other on an hourly and daily basis. The establishment of a separate Transmission System Operator. Establishment of a day ahead and balancing market, coupled with direct agreements between willing buyers and sellers, and physical contracts
South Africa	Schedule II of Electricity Regulation Act	The latest amendment exempts any generation facility with a capacity of no more than 100 MW from obtaining a generation licence with the National Energy Regulator of South Africa (NERSA). Importantly, on 25 July 2022, President Cyril Ramaphosa announced that the government decided to remove the licensing threshold for embedded generation completely. This will enable private investment in electricity generation to rise to higher levels.
Ghana	Bui Power Authority (Amendment) Bill	The Bill empowers the Bui Power Authority to develop renewable energy and other clean energy alternatives in the country.
Ghana	Renewable Energy (Amendment) Bill	The Bill enables consumers of electricity in Ghana to benefit from the reduced cost of electricity generation from renewable energy sources through the introduction of a competitive procurement mechanism instead of the feed-in-tariff scheme introduced by the Act in 2011.

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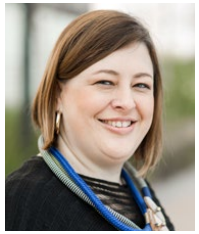

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