Net Zero

Zero Carbon Analytics

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Africa's energy transition: solar and wind fuel energy security

Key points:

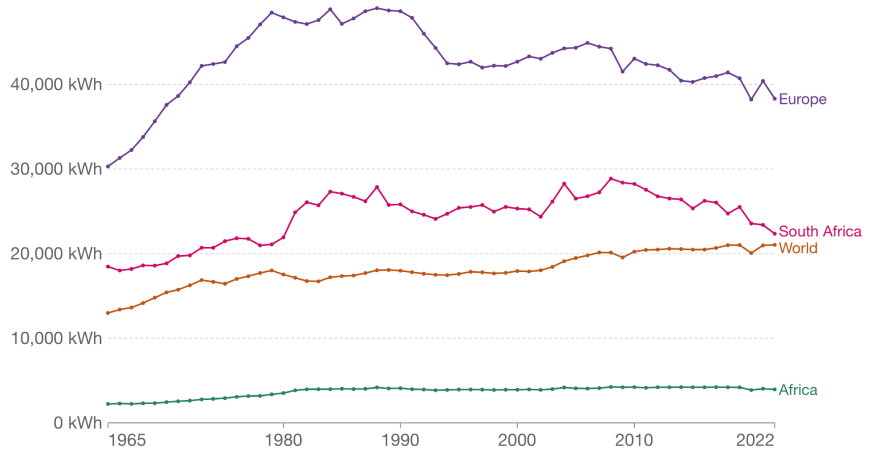
- Though Africa only accounts for less than 3% of global renewables capacity, renewables deployment has grown substantially over the last decade, doubling between 2012 and 2022 to almost 59 GW.
- Wind energy capacity in Africa has been steadily increasing over the last decade and is expected to rise by over 900% based on announced projects to date. Egypt is set to dominate the wind sector.
- Solar energy is the fastest-growing renewable energy resource in Africa and accounted for 57% of renewable investments between 2010 and 2021.
- Africa is the fastest-growing region for Chinese solar panel imports.
- In response to energy insecurity and lacklustre government action on a clean energy transition, South Africans have installed more than 4,800 MW of solar capacity to power their businesses and households.
- Stand-alone off-grid solar systems – such as solar lights, home solar systems and mini-grids – have improved access to electricity on the continent, with their use having seen a compound annual growth rate of 62% between 2009 and 2019.
- Despite remarkable growth in solar and wind capacity, gas accounted for more than half of all capacity additions (renewable and fossil) between 2011 and 2021.
- Namibia has experienced the fourth-fastest growth in renewable energy capacity in the world over a five year period.
- Burkina Faso, Cameroon and Tanzania are in the top 10 countries globally expected to experience the most rapid clean power transitions over the next five years.
- Kenya is the world's eighth-largest producer of geothermal energy and has more geothermal capacity under construction than any other country in the world.
- Renewable investments in Africa grew at an average rate of more than 96% per year over 2010-2020 – higher than the global rate of 7%.
- During 2010-2020, 86% of private energy investments in Africa were directed at renewables in southern Africa, 82% in East Africa and 67% in North Africa.

We are at a pivotal moment in our response to climate change. We are off track, but meaningful action is happening, often faster than we think, and momentum is building towards an exponential shift in our energy systems. Some countries are getting ahead of the curve by taking significant steps towards decarbonisation, while at the same time building new industries, creating jobs, reducing dependence on energy imports and insulating consumers from volatile fossil fuel prices. This briefing presents evidence of where and how this is happening.

Africa's tiny contribution to global warming

From 1751 to 2017, Africa contributed only 2.73% of global carbon dioxide (CO2) emissions. When North African countries and South Africa are excluded from this calculation, **48 African countries – home to more than one billion people – have contributed only 0.55% of global CO2 emissions**. The average energy use on the continent per person remains substantially below the global average (Figure 1). Compared to the rest of the continent, South Africa is an outlier and has the highest per-capita energy use in Africa, more closely matching the global average.

Fig. 1: Energy use per person for Africa, the world, Europe and South Africa



Source: Our World in Data, 2023.[1]

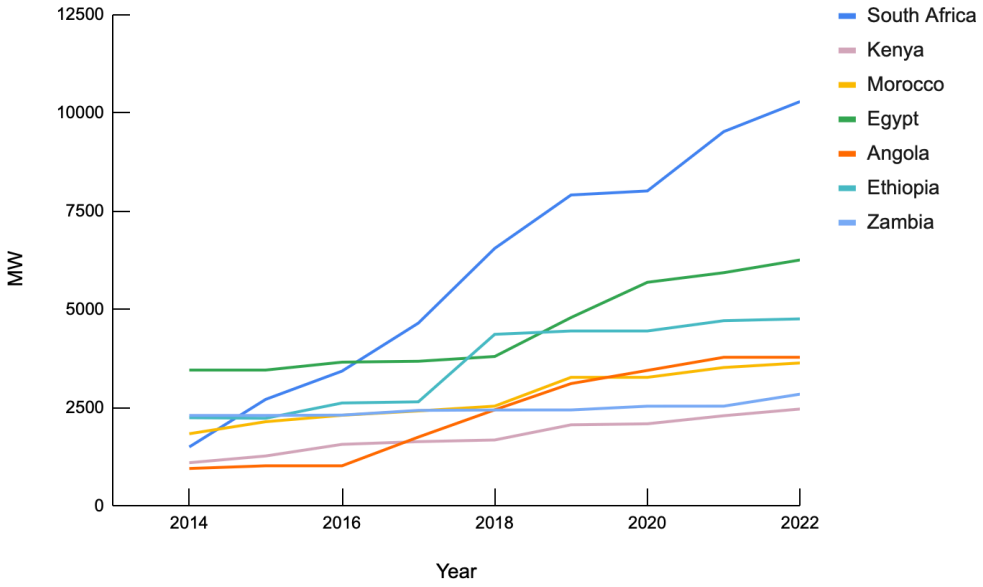
Renewables growth in Africa

Though Africa only accounts a tiny percentage of global CO2 emissions, renewables deployment has grown substantially over the last decade, **doubling between 2012 and 2022**, from 28.45 GW to 58.78 GW, with an average year-on-year growth rate of 7.6%. South Africa has seen the highest growth in generation capacity, followed by Egypt (Figure 2). As of 2021, around 25% of installed capacity on the continent was renewables-based.

Despite this growth, Africa still only accounts for less than 3% of total global renewables capacity. Renewable energy development on the continent remains underfunded, leaving significant untapped potential for increasing renewable power generation and improving energy access and security.

[1] Energy use refers to electricity, transport, heating and cooking. Africa includes South Africa. Europe is shown for comparison.

Fig. 2: Growth in renewable energy capacity for selected African countries (2014-2022)



Data source: IRENA, 2023.

Renewable electricity generation

Three of the top 10 countries globally with the highest share of their grid powered by renewable energy in 2022 were in Africa. **Ethiopia** generated 98.1% of its electricity from hydropower, biomass and onshore wind; **Lesotho's** grid was 99.3% powered by hydropower and a small amount of solar; while 95.5% of the **Democratic Republic of Congo's** electricity came from hydropower.

At the regional level, renewables accounted for 72% of electricity generated in Central Africa in 2019, and 71% in East Africa. This is followed by southern Africa with 27%, West Africa with 25% and North Africa with 9%. In terms of absolute renewable energy generated, southern Africa accounts for 19 GW – around a third of the continent's total – followed by North Africa and East Africa. The majority of renewable power generation on the continent comes from hydroelectric, followed by wind, solar, geothermal, and biomass and waste (Figure 3).

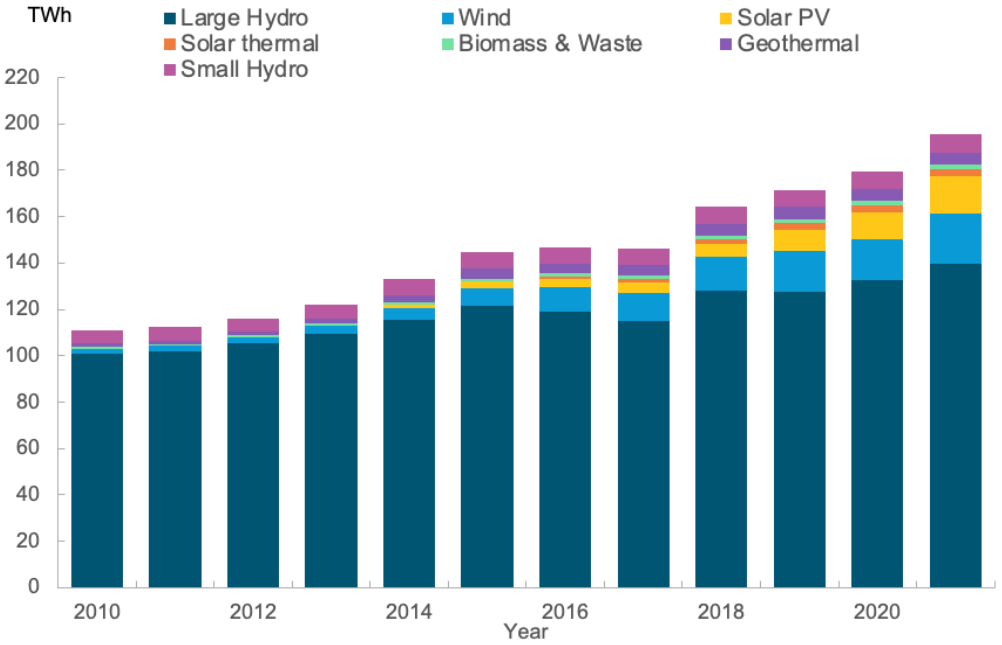
Off-grid potential in Africa

While access to electricity in Africa has improved substantially over the last decade, many people still lack access, particularly in rural areas and peri-urban areas (mixed rural-urban landscapes on the outskirts of cities).[2] In 2020, electricity access was below 50% in 24 African countries, due to inadequate generation capacity and insufficient and poorly maintained transmission and distribution networks.[3] Off-grid renewable systems, which have short lead times and can therefore be deployed rapidly, offer a solution to limited electricity access in Sub-Saharan Africa, particularly in rural areas where grid expansion is not possible. Stand-alone off-grid solar systems – such as solar lights, home solar systems and mini-grids – have improved access to electricity on the continent, with their use having seen a compound annual growth rate of 62% between 2009 and 2019. Around 8% of

[2] Around 645 million people lack access to electricity, while 700 million have no access to clean cooking energy.
[3] Only South Africa and northern African countries have reached near-universal electricity access.

households in Sub-Saharan Africa with electricity access rely on off-grid solar systems. Globally, 70% of investments in the off-grid sector went to Africa between 2010 and 2020, totalling USD 1.7 billion. These investments grew at a compound annual growth rate of 83% during this time.

Fig. 3: Annual power generation by renewable technology in Africa (2010-2021)



Source: Bloomberg NEF: Scaling up renewable energy in Africa report, 2022.

Wind capacity growth

Wind capacity in Africa has steadily increased since 2000, with annual installations topping 800 MW in 2014, 2018, 2021 and 2022. South Africa has the highest installed wind capacity on the continent, accounting for 41%, while Morocco has 22% of total capacity and Egypt accounts for 21%.

Based on both installed wind farms and those that are under construction and set to be commissioned in 2023, **total wind generation capacity on the continent will be 9 GW** – which includes new installations in **Senegal, Réunion, Nigeria, Tanzania and Djibouti**. The **Taiba N'diaye wind farm in Senegal**, which accounts for 15% of installed capacity in the country, provides power for more than two million Senegalese people. Based on planned and announced wind farm projects across Africa, **a further 86 GW is expected to be added – an increase of over 900%**. Major planned wind farm developments in **Egypt** – including a 10 GW farm in the Gulf of Suez, which will be one of the world's largest – align with **the country's goal for renewables to account for 42% of its energy mix by 2030**. The technical potential for wind power in Africa is estimated to be 461 GW, with **Algeria, Ethiopia, Namibia and Mauritania** possessing the best potential.[4]

Solar capacity growth

Solar energy is the fastest-growing renewable energy resource in Africa, with an average year-on-year growth rate of **89% between 2011 and 2021** (Figure 3). Africa holds 60% of the world's best solar resources, though it accounts for only around 1% of installed solar PV

[4] The technical potential is an estimate of the generation capacity that is technically feasible.

capacity. The technical potential for solar power on the continent is estimated to be 7,900 GW. South Africa had the highest amount of solar capacity in 2021 with 5.3 GW, while Morocco followed with 2 GW and Egypt had 1.3 GW. These three countries accounted for 65% of all installed solar capacity in Africa in 2021.

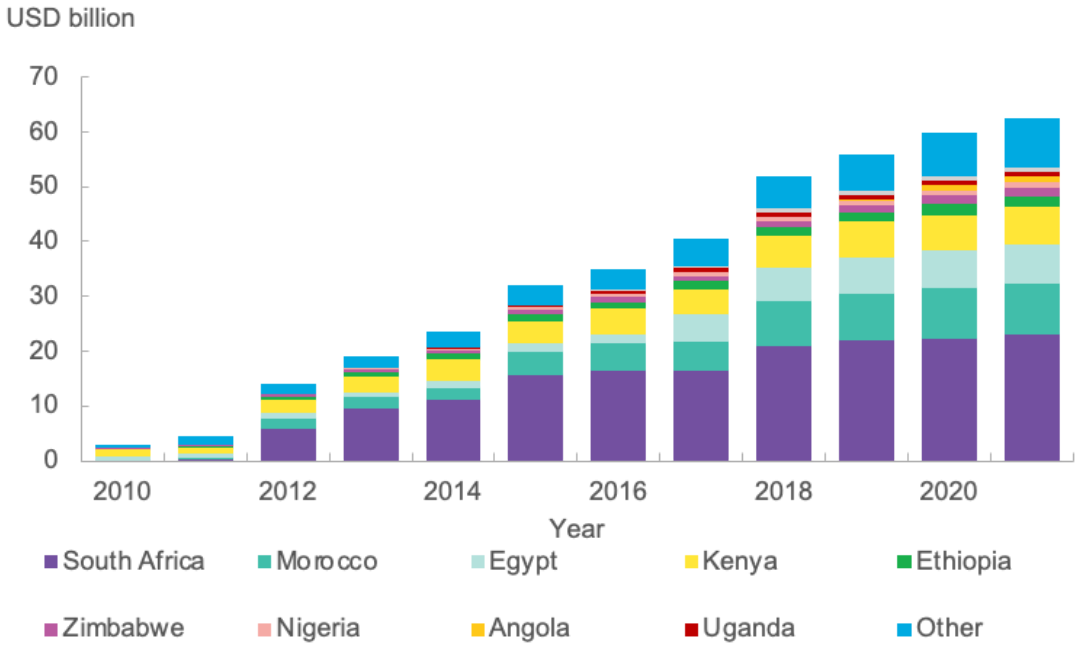
Remarkable scaling up of renewable investments

Compared to the 2000-2009 period, **annual average investments in renewables on the continent grew tenfold in 2010-2020,** rising to USD 5 billion from less than USD 500 million. Investments totalled almost USD 60 billion over those two decades, and grew on average by more than 96% per year, much higher than the global rate of 7%.[5] However, despite this high growth rate, the cumulative sum of renewable investments over the last two decades totals only 2% of global funding. New renewable capacity additions have also lagged in recent years, reaching an 11-year low in 2021.[6]

Solar and wind have together accounted for around 87% of investments in renewable technology in Africa since 2010 - 57% for solar and 30% for wind. The share of total renewable investments in Africa directed at solar technologies increased from just 2% in 2011, to 62% in 2012, and has remained between 40% and 80% since then.

Clean energy created more jobs in Africa than fossil energy over the 2019-2022 period, and growth in the off-grid sector in Sub-Saharan Africa is estimated to have increased solar PV jobs to 115,000 in 2022. The wind power work force in Africa expanded by more than 75% in 2022.

Fig. 4: Cumulative renewable energy asset finance for selected African countries (2010-2021)



Source: Bloomberg NEF: Scaling up renewable energy in Africa report, 2022.

[5] This excludes large hydropower greater than 50 MW.
[6] In 2021, Africa received only 0.6% of total global renewable energy investments.

South Africa received the highest cumulative renewable energy asset finance over 2010-2021 at USD 23 billion, followed by Morocco which attracted USD 9.36 billion, Egypt which received USD 7.14 billion and Kenya which gained USD 6.69 billion (Figure 4). **Trends in private energy investments on the continent are encouraging**: during 2010-2020, 86% were directed at renewables in southern Africa, 82% in East Africa and 67% in North Africa. Independent power producers are now one of the top sources of investment in Africa. **Renewable projects in Africa offer an attractive investment**: general project default rates – the percentage of outstanding loans that are unpaid after a prolonged period – are lower in Africa compared to the rest of the world.

Case studies: energy crisis in South Africa, rapid solar expansion in Burkina Faso and Kenya's geothermal boom

South Africans take energy security into their own hands

South Africans favour renewable energy: a survey conducted by climate change think-tank E3G in 2019 found that 80% of South Africans believe that investing in renewables is better than investing in fossil fuels in the long term.

The electricity crisis in South Africa, where peoples' livelihoods are impacted by power outages caused by an ageing coal fleet without sufficient generating capacity, has driven citizens to invest in rooftop solar. **Scheduled power outages – known as 'load shedding' – have been sporadically implemented since 2015 but have seen a drastic uptick in frequency and severity over the last year**. Since September 2022, South Africans have experienced load shedding on a near-daily basis.

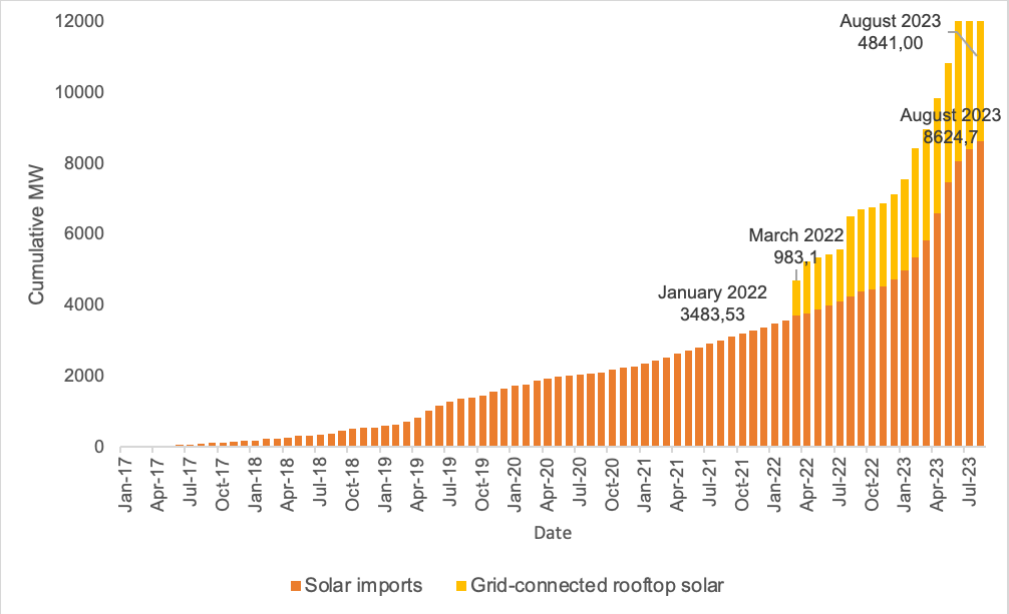
The state-owned power utility Eskom, which generates most of its power from coal, is one of the biggest polluters in the world. South Africa ranks eighth in the world in terms of the amount of coal used for energy generation and has the highest carbon intensity – the amount of CO_2 emitted per unit energy – of all G20 states. The present energy crisis that South Africa is facing is the result of Eskom failing to add sufficient electricity generation to the grid. Renewables procurement has lagged due to Eskom's persistence in investing in coal projects, which have been marred by poor planning and ineffective contracting, delaying of renewables projects, and pursuit of expensive and controversial nuclear projects.[7] South Africa might miss its legally-binding 2030 emissions target under the Paris Agreement as it extends the life of coal-fired power plants for longer than planned.

[7] Despite South Africa having ideal climatic conditions and a favourable investment environment for wind and solar power, in 2007 the government commissioned another two coal-fired power stations – two of the biggest in the world. The construction of these power stations has been delayed – one remains incomplete – and has cost more than double what was initially budgeted for. These power stations are fraught with defects and are critically underperforming. The government's renewable power purchase program, which was launched in 2011, was halted between 2015 and 2019 because the then-CEO of Eskom strongly opposed renewables projects. While the solar PV industry grew steadily in the early 2010's in South Africa – with the country being ranked 9th globally in installed capacity in 2014 – new solar and wind projects that were in the planning phases were placed on hold, with the government opting to invest in a highly controversial and expensive nuclear deal with Russia, which was ultimately blocked due to pressure from civil society. Some members of the ruling party still advocate for at least some new power generation to come from gas and nuclear power, and new renewables projects awarded under South Africa's renewable power purchase programme since 2021 have failed or face continued delays. The government recently signed the Just Energy Transition Investment Plan (JET IP), which aims to replace coal with solar and wind and explores potential for the exportation of green hydrogen. If implemented, it would be a major step towards transforming South Africa's power sector.

In response to this energy insecurity and lacklustre government action on the energy transition, South Africans imported more than 5 GW of solar panels worth USD 1.1 billion from China since the beginning of 2022 (Figure 5). That is **enough to meet around 3% of South Africa's annual energy demand.** About 3.4 GW of these imports occurred in the first six months of 2023, which is an increase of 438% compared to the same time last year. This **makes Africa the fastest-growing importer of Chinese solar panel imports (187% year-on-year growth).**

The power generated at peak production from solar panel imports in 2023 matches the generation capacity of some of South Africa's coal-fired plants.[8] Once installed, the energy generated from residential rooftop solar will exceed the solar energy the government has procured over the last decade.[9] Eskom estimates that the installed capacity of all rooftop solar power in August this year was 4841 MW – an increase of 392% in just over a year (yellow columns in Figure 5) – which matches the maximum generation capacity of South Africa's biggest coal-fired power station.[10]

Fig. 5: Solar panel imports (MW) from China for January 2017–August 2023 and installed non-utility rooftop solar capacity for March 2022-August 2023 in South Africa



Data source: Ember and Eskom, 2023.

Incentives for solar

As the cost of solar installations continues to decrease, in the first half of 2023, **South Africans imported USD 2.5 billion worth of solar panels, lithium batteries and inverters – further emphasising the exponential rollout of renewable energy by citizens**. In Johannesburg and Cape Town – the two largest cities in South Africa – feed-in tariff incentives are being offered by the government to encourage citizens to sell their excess

[8] For example, Eskom's Duvha or Matla power stations.
[9] Renewable energy in South Africa is procured by the government through independent power producers in the private sector.
[10] To put this number into perspective, 4,841 MW is more than double the peak electricity demand of Kenya. Medupi, the largest coal-fired power station in South Africa, has a total installed capacity of 4,800 MW.

solar energy to the grid. The government is also providing short-term tax incentives to households for investing in solar. It is estimated that by 2025, **renewable energy produced by the private sector (including home rooftop solar) and independent power producers will be higher than the electricity produced by Eskom's fleet.** The estimates suggest that by the end of 2025, the private sector will generate 26,600 MW of electricity, up from 13,300 MW in March 2023, while Eskom will generate 25,200 MW.[11]

Namibia switches to solar in response to South African energy crisis

Namibia imports the majority of its electricity from neighbouring South Africa, but has turned to solar as imports became expensive and unreliable due to the power crisis. State-owned utility Nampower has attracted private investment through the auctioning of independent power projects. The share of solar in Namibia's energy mix increased to 27% in 2019 from just 2% in 2015, making it the **fourth-fastest country in the world in terms of renewable energy growth.**[12] The Namibian government – together with the European Union and other investors – plans to develop the largest fully-integrated green hydrogen project in Sub-Saharan Africa, which is expected to produce two million tonnes of green fertiliser per year before the end of the decade.

Burkina Faso, Cameroon and Tanzania set for rapid transitions to clean power

Based on a comparison of current renewable capacity and renewable expansion plans, Burkina Faso, Cameroon and Tanzania are within the top 10 countries globally expected to experience the most dramatic energy transitions in the next five years. In **Burkina Faso**, solar parks currently seeking permits or being built are set to double the share of solar in its grid to 34% in 2027 from 16% in 2022. In **Cameroon**, the construction of large hydropower projects is expected to increase renewables generation capacity by 28 percentage points by 2027. In **Tanzania**, hydropower, wind and solar projects are set to more than double the country's renewable energy share to 54.1% in 2027 from 25.7% in 2022.

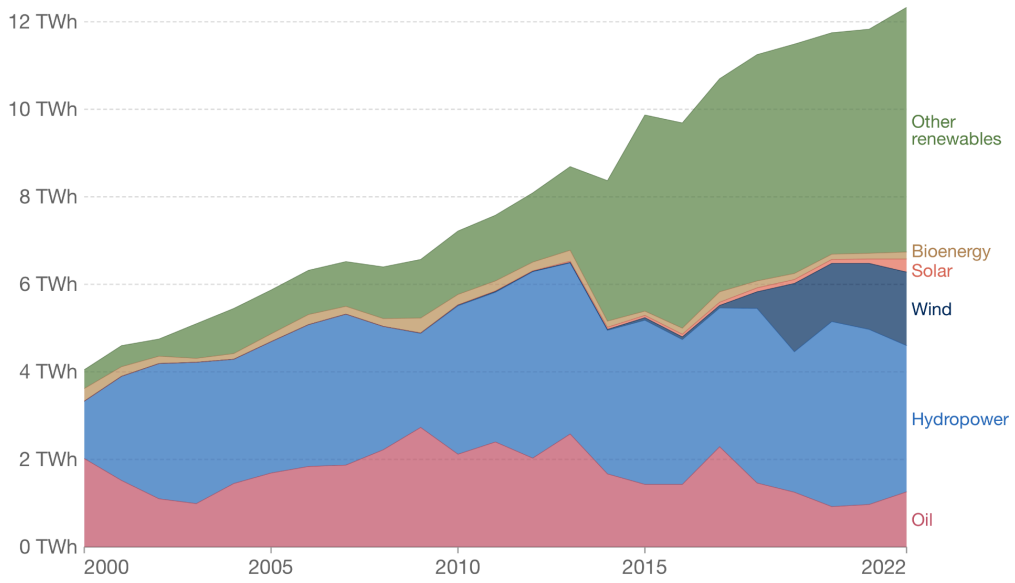
Kenya: a geothermal powerhouse

About 73% of Kenyans living in rural and urban areas strongly approve of renewables development, with 91% believing that it will reduce the cost of electricity. At the same time, only 31% of Kenyans have a positive view of fossil fuels and nuclear power.

Renewables have powered more than 80% of electricity generation in Kenya since 2018, and this share reached 90% in 2020 (Figure 6). The renewable electricity sector in Kenya has grown substantially over the last few years, with a compound annual growth rate of 13.1% from 2015 to 2020. **Kenya is the world's eighth largest producer of geothermal energy** and currently has more geothermal capacity under construction than any other country in the world. It will soon become the fourth largest producer of geothermal energy. Geothermal energy currently accounts for 45% of Kenya's electricity generation.

[11] The private sector here includes private industrial supply, independent power producers – including those on land leased from Eskom, and small scale producers (such as home rooftop solar). While these figures are encouraging, it is important to note that this does not constitute a just energy transition.
[12] Renewable energy growth measured over a five-year period.

Fig. 6: Electricity production in Kenya by source (2000-2022)



Source: Our World in Data, 2023.[13]

There is a high level of investor interest in Kenya's renewables sector, as showcased by several recent major developments, including an Australian-backed 300 MW geothermal and green fertiliser plant and a UK-backed 35 MW geothermal plant.

E-mobility gains traction in East Africa

The Kenyan government is committed to e-mobility and the phase-out of fossil-powered motorbikes. The country has set a target for 5% of all newly registered vehicles to be electrified by 2025. It has partnered with Benin-based electric motorbike startup Spiro to roll out more than one million electric motorbikes in the country. Since 2019, Spiro's electric bikes in Benin, Togo, Rwanda and Uganda have avoided over 5,000 tonnes of CO_2 emissions through 90 million kilometers of green travel. The startup also offers a trade-in scheme to reduce the number of conventional motorbikes and scooters on the road, where buyers can get around a third off the cost of a new electric motorbike for trading in, with the old parts being repurposed. It has also introduced a subscription service allowing drivers to quickly switch out their depleted batteries for charged ones at swapping stations.

Rwanda has abolished import taxes on electric and hybrid vehicles and electric motorbikes to make these vehicles more affordable and accessible, while **Uganda** added more than 200 electric motorbikes to the roads of Kampala in 2020 - charged from a renewables-dominated grid.

[13] Other renewables include geothermal energy.

Despite progress in renewables generation, investment in Africa's clean energy transition is lagging

In comparison to the rest of the world, and despite recent growth trends, renewables have been critically underfunded in Africa. Between 2015 and 2022, the average renewables investment per year in Africa was USD 11 billion – which is just below 3% of global average yearly investments for the same period. By contrast, average yearly investments in fossil fuels in Africa over the same period made up a larger proportion of the global average at around 7% – just over double that of renewables. Gas has accounted for the majority of net capacity additions, with just over 62,000 MW of gas added between 2011 and 2021 compared to 13,305 MW of solar and 6,999 MW of wind.

The International Energy Agency (IEA) and the African Development Bank Group (AfDB) estimate that, in order for Africa to achieve its energy and climate goals and universal energy access, around USD 200 billion of investment is needed every year until 2030 – more than double current annual investments. Promisingly, this is only about 4% of global yearly investments needed in the energy transition to keep warming to 1.5°C – a small percentage given that Africa represents around one-fifth of the world's population.[14] Another estimate suggests that, in order for Africa to reach net-zero goals by 2050, only 8% of global annual investments would need to be directed to Africa every year until 2030.

Access to finance remains a key barrier for the renewable energy transition in most African countries – capital costs for utility-scale projects can be up to three times higher than for developed economies. Renewables investments in Africa have been concentrated in a handful of countries. Between 2010 and 2020, 90% of investments went to 14 out of a total of 55 countries, with 75% of this received by only four countries: South Africa, Morocco, Egypt and Kenya. Enabling policies and financing mechanisms are believed to have attracted these investments. Scaling up of financing and reducing perceived investment risks will be necessary in order to attract private investment in clean energy. Concessional loans – loans that have favourable terms such as below-market interest rates – are key to encouraging investment. The IEA estimates that USD 28 billion of concessional financing will be needed per year in order to attract USD 90 billion of private sector investment to support a clean energy transition by 2030. African governments, development finance institutions, private investors and donors will be pivotal in ensuring access to capital and identifying investable assets.

According to Bloomberg, there are three common barriers hindering investment flows in renewables in Africa: A lack of consistency in clean power procurement processes, poor planning around grid expansion and electricity access, and domestic investors' lack of knowledge of clean energy opportunities. Transmission and distribution infrastructure in Africa suffers from underinvestment, receiving only 0.5% of energy investment between 2011 and 2021 Generation capacity received 95.5% of investments over the same period. Unreliable power grids are hampering economic growth on the continent, costing countries up to 2% of their annual GDP.

[14] It is estimated that around USD 5 trillion investment in the global energy transition is needed yearly to stay on the 1.5°C pathway.