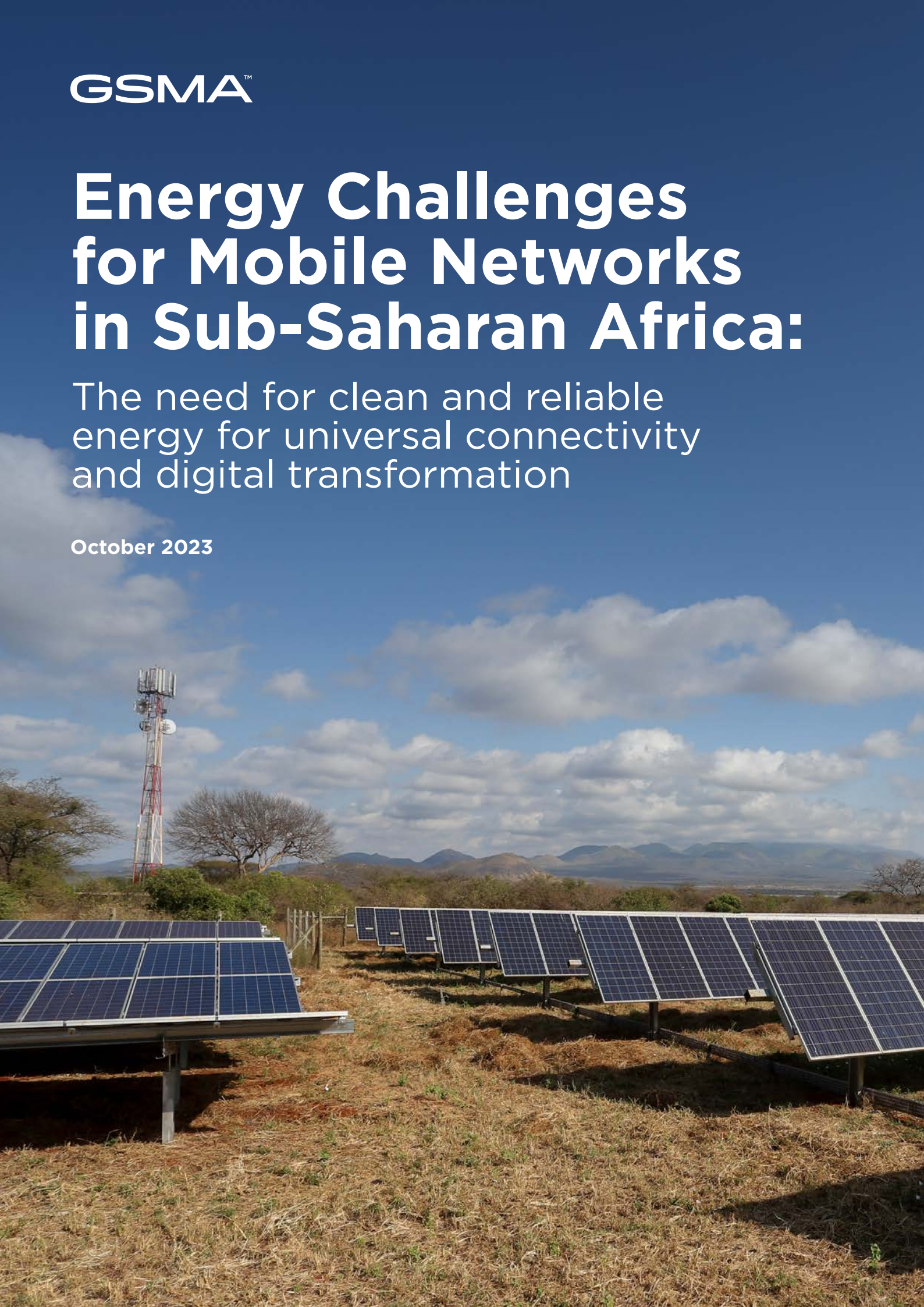
GSMA

Energy Challenges for Mobile Networks in Sub-Saharan Africa:

The need for clean and reliable energy for universal connectivity and digital transformation

October 2023



GSMA

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Contents

Executive Summary

Mobile networks need dependable and affordable energy to connect people and businesses across Sub-Saharan Africa. Reliable mobile connectivity is increasingly fundamental to many sectors and services, including other critical infrastructure and services. Mobile connectivity is especially critical given Africa's very low fixed broadband penetration of less than 1%. Disruptions in energy and connectivity have widespread impacts on people and the economy.

The region faces major challenges – as well as opportunities – in its clean energy transition. Half of the population still lacks access to electricity. Fossil fuels generate two-thirds of the region's grid electricity, with additional reliance on diesel generators due to limited and unreliable grids. The region is experiencing severe impacts from climate change, despite emitting less than 2% of all historical carbon emissions. Clean energy investment needs to quadruple by 2030 to meetdevelopment goals, but is hindered by limited public funds, policy and regulatory barriers, and the high cost of capital.

Energy challenges are negatively impacting mobile network operators. Operators in Sub-Saharan Africa are facing frequent power outages, lack of grid access, high energy costs and difficulties accessing renewable energy, according to a new GSMA survey of operators and governments. Frequent and extended power outages are impacting mobile operators and customers. The vast majority of operators reported facing at least a few outages per week, with outages typically lasting several hours or more.

In response, operators are acting to maintain connectivity for their customers, but at significant cost. Most operators have responded to outages by increasing diesel generator use, installing batteries and on-site solar, and implementing efficiency measures. Theft and vandalism of batteries and generators are also increasing, impacting service availability and costs. High costs, a lack of physical space (especially in most urban settings) and risk of theft limit the scale of these solutions.

Unless addressed, these energy-related challenges jeopardise the delivery of key development goals in the region. High energy and unforeseen capital costs are causing delays to capital investments for operators, raising risks to achieving the region's digital and sustainable development goals. The vast majority of governments responding to the survey expected energy-related challenges to hinder digital transformation in the region and the achievement of universal internet access and energy access.

Addressing these energy challenges will require action from a range of key stakeholders. Mobile network operators, for example, can implement near-term solutions with on-site solar and batteries, while equipment providers can work to design more energy-efficient and resilient solutions for the future. Operators can become reliable partners in new mini-grid and large power projects, for example, by acting as dependable 'anchor' loads that provide stable, long-term demand to increase the bankability of new projects.

Energy ministries and utilities should implement policies and deploy investments to expand utility-scale renewables and extend electricity networks. Development banks, foreign direct investment and private investors can play important roles in financing. Energy market regulators can help by aligning electricity market design to facilitate private sector investments in renewable energy projects.

Deeper public-private engagement can accelerate clean energy access across Sub-Saharan Africa, replicating recent progress and successful examples. Mobile network operators stand ready to engage with governments, municipalities and state energy companies to procure clean energy. Policy and technology solutions must be tailored to each country context, considering the social, economic, energy and political diversity across the region.

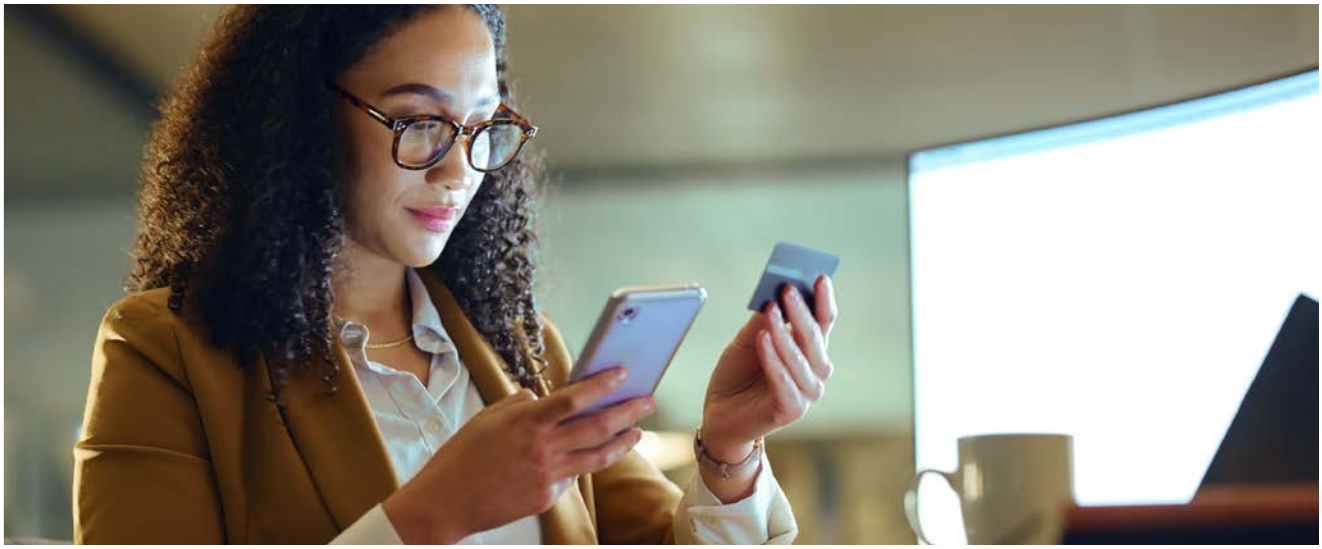
1. Introduction

Mobile connectivity is critical for Sub-Saharan Africa

Mobile connectivity is vital for the people and businesses of Sub-Saharan Africa, providing access to critical information, services, and income-generating opportunities. The region has made major strides in connecting its population in recent years with major investments in mobile networks, nearly doubling the population covered by mobile broadband from 510 million in 2015 to 970 million in 2022 – reducing the 'coverage gap' by 31 percentage points (GSMA, 2023b, 2023d; GSMA Intelligence, 2023a). Over the same period, the number of mobile internet subscribers in the region more than doubled from 120 million to 290 million.

Despite this progress, Sub-Saharan Africa remains the least connected region in the world, with just 24% of the population having a mobile internet subscription as of the end of 2022, compared with 62% in the rest of the world. Access across the region is mixed, ranging from less than 10% in some countries to nearly 60% in South Africa. The mobile 'usage gap' – populations that live within the footprint of a mobile broadband network but are not using mobile internet – stands at 680 million (59%). Further progress is needed to close this gap which impedes progress on the region's development objectives, including the UN Sustainable Development Goals (SDGs) (GSMA, 2023a).

Mobile technologies and services are a key enabler of economic and social development in Sub-Saharan Africa, contributing $170 billion in economic value in 2022 – equivalent to 8% of the region's GDP (GSMA, 2023b). The mobile ecosystem also supported more than 3.2 million jobs (directly and indirectly). By 2030, mobile's contribution is projected to grow to $210 billion as the countries in the region increasingly benefit from the improvements in productivity and efficiency brought about by the increased take-up of mobile services.



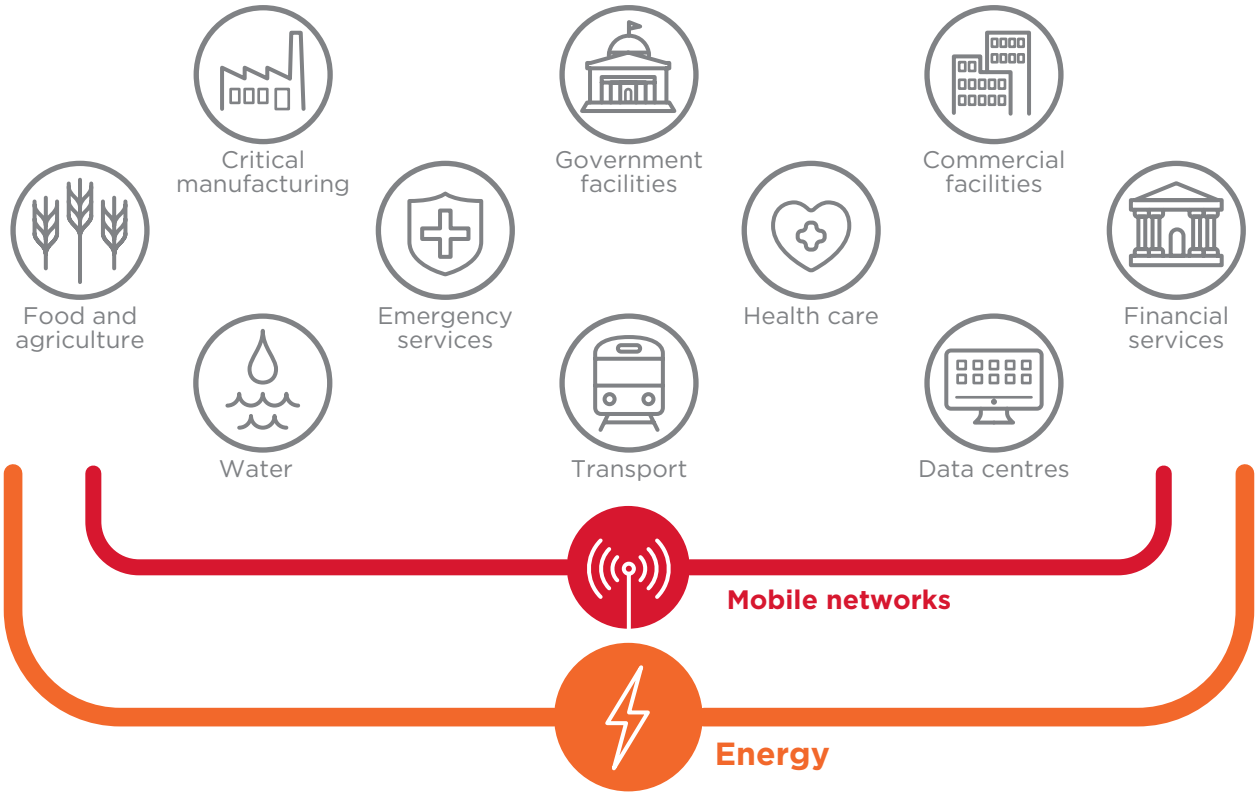
All sectors require reliable digital and energy services

Reliable data networks and services are increasingly fundamental to the proper functioning of many sectors and services, including other critical infrastructure and services such as energy, transport, banking, health and emergency services (Figure 1).

Disruptions in connectivity have widespread impacts on people and the economy. Reliable mobile connectivity is especially critical given Africa's very low fixed broadband penetration of just 0.7 subscriptions per 100 inhabitants, compared with the global average of 17.6 (ITU, 2023). Mobile technologies are also important enablers of increasing energy access and more efficient and equitable clean energy transitions (IEA, 2017).

Mobile networks need reliable and affordable energy to provide reliable, high-quality connectivity services to people and businesses across all sectors. Mobile networks are a unique commercial end-user of energy; they are highly distributed, with thousands of base stations per country, and an important energy user. The lack of reliable, widespread grid electricity and clean, affordable and scalable alternatives in the region also means that mobile network operators and tower operators are collectively using hundreds of millions of litres of diesel per year to power mobile base stations.

Figure 1 | The central role of energy and mobile connectivity in Sub-Saharan Africa



Research objectives and approach

Households and businesses, including mobile network operators, are facing several major energy-related challenges across Sub-Saharan Africa. This paper highlights the energy-related challenges and impacts faced by mobile network operators, and explores potential technical and policy solutions that could increase the reliability and sustainability of energy across the region.

This paper addresses the following questions:

- What are the biggest challenges and impacts related to energy security, affordability and sustainability for mobile networks in Sub-Saharan Africa?
- How are energy issues impacting consumers and businesses that depend on mobile connectivity? What actions have operators taken to mitigate these impacts?
- What near-term actions can help mitigate these energy-related challenges?
- How can policymakers and other stakeholders enable longer-term structural solutions?

This paper is informed by survey responses from mobile network operators and telecommunications ministries and regulators in the region (see the Appendix for additional details).

Responses were received from 22 mobile network operators covering 18 countries and more than 60% of mobile subscriptions in Sub-Saharan Africa. Twelve survey responses were received from telecommunications regulators and policymakers in Burkina Faso, Cameroon, the Democratic Republic of the Congo (DRC), Ethiopia, Ghana, Kenya, Niger, Nigeria, Senegal and South Africa, representing nearly 60% of the regional population.

2. Energy and climate context in Sub-Saharan Africa

Sub-Saharan Africa faces major challenges and opportunities in its clean energy transition

Sub-Saharan Africa faces major challenges – and opportunities – in its clean energy transition. Despite some progress over the past decade, the lack of access to electricity and clean cooking remains the biggest energy-related challenge in the region.

In 2021, around 590 million people in Sub-Saharan Africa – approximately half of the population – lacked access to electricity (IEA, 2022a). This means that 85% of the people in the world without access to electricity live in Sub-Saharan Africa, despite the region representing only 15% of the overall global population.

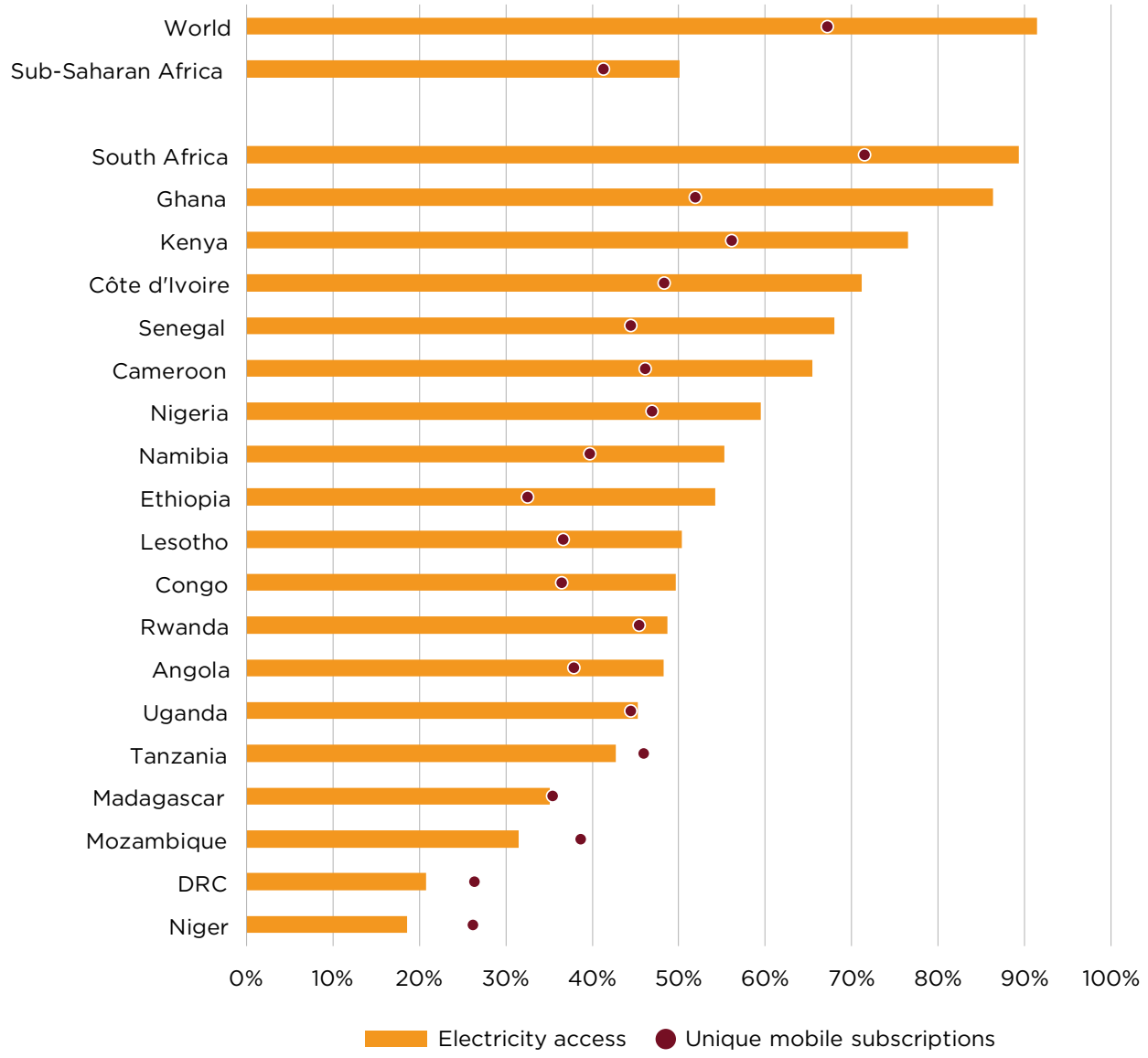
Electricity access rates vary considerably between and within countries (Figure 2). Access exceeds 85% in several countries including South Africa and Ghana, but remains below 25% in eight countries[1] which have a combined population of more than 200 million. Across Africa, approximately 80% of those without access live in rural areas (IEA, 2022a).

Multiple factors are contributing to low access rates and the slow pace of progress. More than half the population live in rural and remote areas, making grid extensions costly, while rapid population growth is outpacing electrification efforts. Poor regulatory frameworks and financial difficulties of utilities are hindering investment in the sector. Low tariffs as a result of high poverty levels and low electricity demand mean that most state-owned utilities in the region do not recover their costs (World Bank ESMAP, 2023). If no additional efforts and measures are put in place, some 560 million people will continue to remain unserved in the region by 2030 (IEA et al, 2023b).

Progress on electricity access deteriorated considerably as a result of the Covid 19 pandemic due to project delays and financial difficulties of household and utilities. The number of people without access increased by 4% between 2019 and 2021, effectively reversing the gains of the previous five years (IEA et al, 2023b). In contrast, progress on mobile connectivity has continued, with more than 45 million unique mobile subscriptions (+10%) added in the same period (GSMA Intelligence, 2023a).

1 South Sudan (8%), Burundi (10%), Chad (11%), Malawi (14%), Central African Republic (16%), Niger (19%), Burkina Faso (19%) and the Democratic Republic of the Congo (21%). For country-by-country data, see: trackingsdg7.esmap.org/results

Figure 2 | Electricity access and unique mobile subscription rates in select regions and countries, 2021



Notes: The selected countries cover each of the four subregions and 80% of the population in Sub-Saharan Africa. Mobile subscription rates based on market penetration of unique mobile subscribers. DRC = Democratic Republic of the Congo.

Sources: GSMA Intelligence (2023a) and IEA et al. (2023a).

The global energy crisis, triggered by the Covid-19 pandemic and compounded by Russia's invasion of Ukraine, sent energy and commodity prices soaring. The impacts on energy affordability in Sub-Saharan Africa have been among the highest in the world because energy accounts for a relatively higher share of household expenditures (Guan et al, 2023).

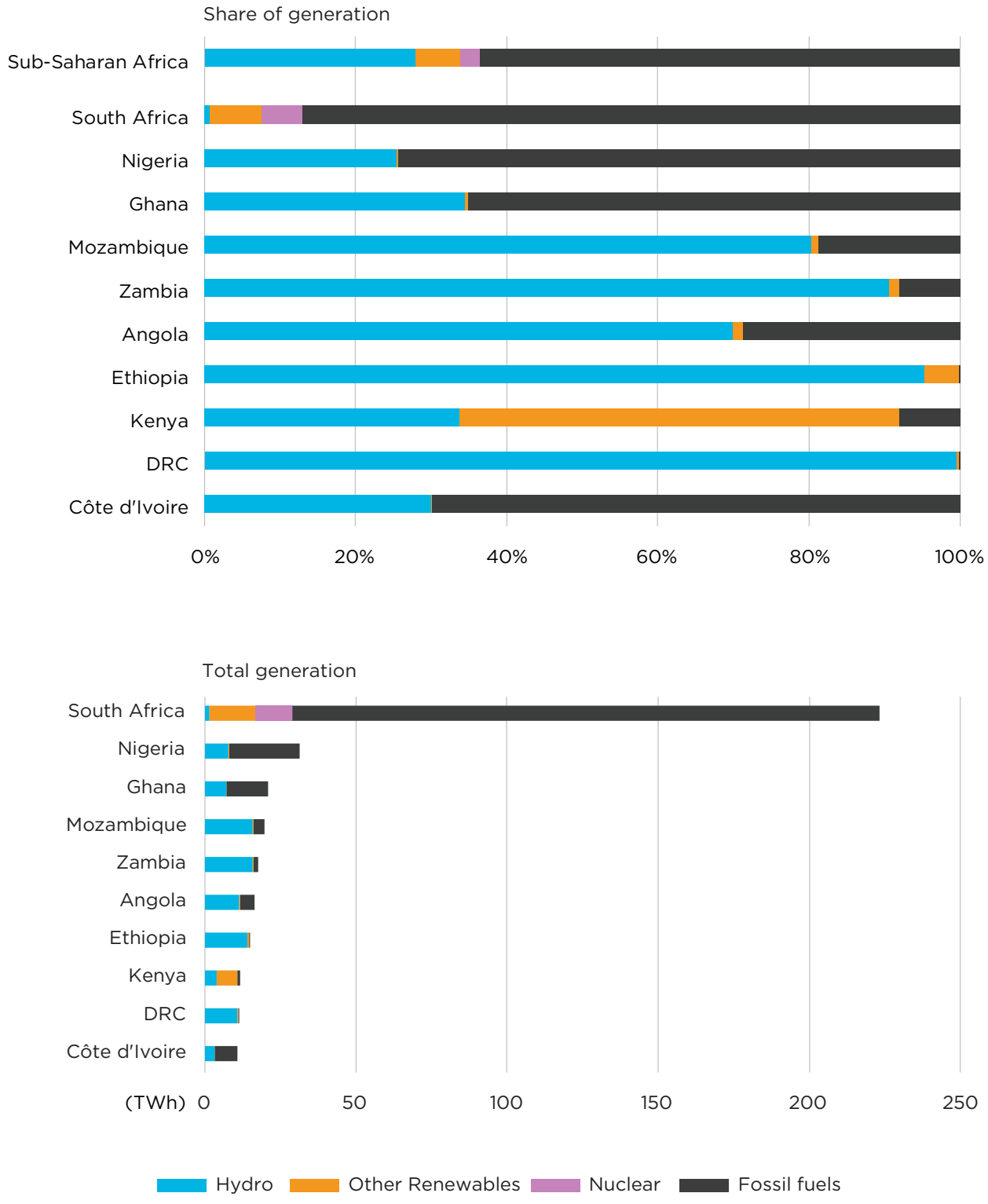
Many governments in the region have cancelled or deferred utility bill payments, exacerbating the already difficult financial health of utilities and increasing risks of blackouts and rationing (IEA, 2022a). Even with subsidies, many Sub-Saharan African households pay higher rates for electricity (adjusted for purchasing power parity) than households in many OECD countries (IEA, 2022a).

Two-thirds of electricity is generated from fossil fuels, with considerable diversity in the generation mix between countries

Around two-thirds of electricity in Sub-Saharan Africa is generated from fossil fuels. Coal accounted for nearly half of the electricity mix in 2020 (mostly from South Africa) while natural gas accounted for just over 10% (IEA, 2022a).

South Africa accounts for around half of the region's electricity generation and use, where more than 85% of electricity is generated from coal. While many Sub-Saharan African countries such as South Africa and Nigeria rely on domestic fossil fuels to generate electricity, some countries depend on imported fuels and this exposes them to global price fluctuations. Overall, there is significant diversity in generation mix across the region (Figure 3).

Figure 3 | Electricity grid mix in Sub-Saharan Africa and top 10 generating countries, 2021



Note: Other renewables includes solar, wind, geothermal and biomass.
Total generation in Sub-Saharan Africa was approximately 460 TWh.

Source: US EIA (2023).

Renewable sources generated around one-third of the region's electricity in 2020, mostly from hydropower (IEA, 2022a). Hydro accounted for more than 80% of total generation in several countries, including Zambia, Mozambique, Ethiopia, the DRC and Uganda (US EIA, 2023). These five countries collectively account for nearly half of all hydropower generation in the region.

Generation from wind and solar have more than tripled since 2015, but still only account for less than 5% of total generation (US EIA, 2023). Despite being home to 60% of the world's best solar resources, Africa holds just 1% of the world's installed solar PV capacity (IEA, 2022a).

"Namibia has emerged as a leader on solar, increasing its share of solar from less than 3% of generation in 2015 to 24% in 2021"

There are some bright spots, however. Namibia has emerged as a leader on solar, increasing its share of solar from less than 3% of generation in 2015 to 24% in 2021 (Jaeger, 2023). In Kenya, the share of renewables has increased from around 60% in 2010 to more than 90% in 2020, driven by strong growth in geothermal and wind. Geothermal generation has more than quadrupled since 2010, while wind generation increased by 20 times since 2017 (IEA, 2023b). In Uganda, generation from hydro has nearly tripled since 2010, while electricity access rates more than tripled to 45% (IEA, 2023c).

Analysis from the International Energy Agency (IEA) show that strong climate and energy policies could double the share of renewables in Sub-Saharan Africa to 65% by 2030 (IEA, 2022a).

Multiple barriers are hindering clean energy investments in the region countries

Despite having rich renewable energy resources and approximately 20% of the global population, Africa attracts less than 2% of global spending on clean energy (IEA, 2023a).

The continent's debt crisis has severely limited the amount of public capital available, including for state-owned utilities. The financial health of electric utilities has worsened over the past decade, with most utilities unable to cover their operating and debt service costs (Attia et al, 2022; World Bank ESMAP, 2023).

"The cost of capital in Sub-Saharan Africa can be at least two to three times higher than in advanced economies"

Given the lack of public funds, there is a critical role for private capital to finance clean energy. However, many investors are reluctant to invest in the region given the higher risks. For example, in markets with underdeveloped regulations, there are risks of contract instability and delays. In fragile states, the political and reputational risks can be high. Due in part to these higher perceived and actual risks, financing costs in Sub-Saharan Africa can be at least two to three times higher than in Europe, North America and China (IEA, 2022b, 2023a).

With limited grid coverage and frequent power outages, diesel generators are an important source of off-grid electricity

The African Development Bank estimates that approximately 80% of businesses in Sub-Saharan Africa (excluding South Africa) experience power outages compared with 66% in South Asia and 38% in Europe (African Development Bank, 2022).

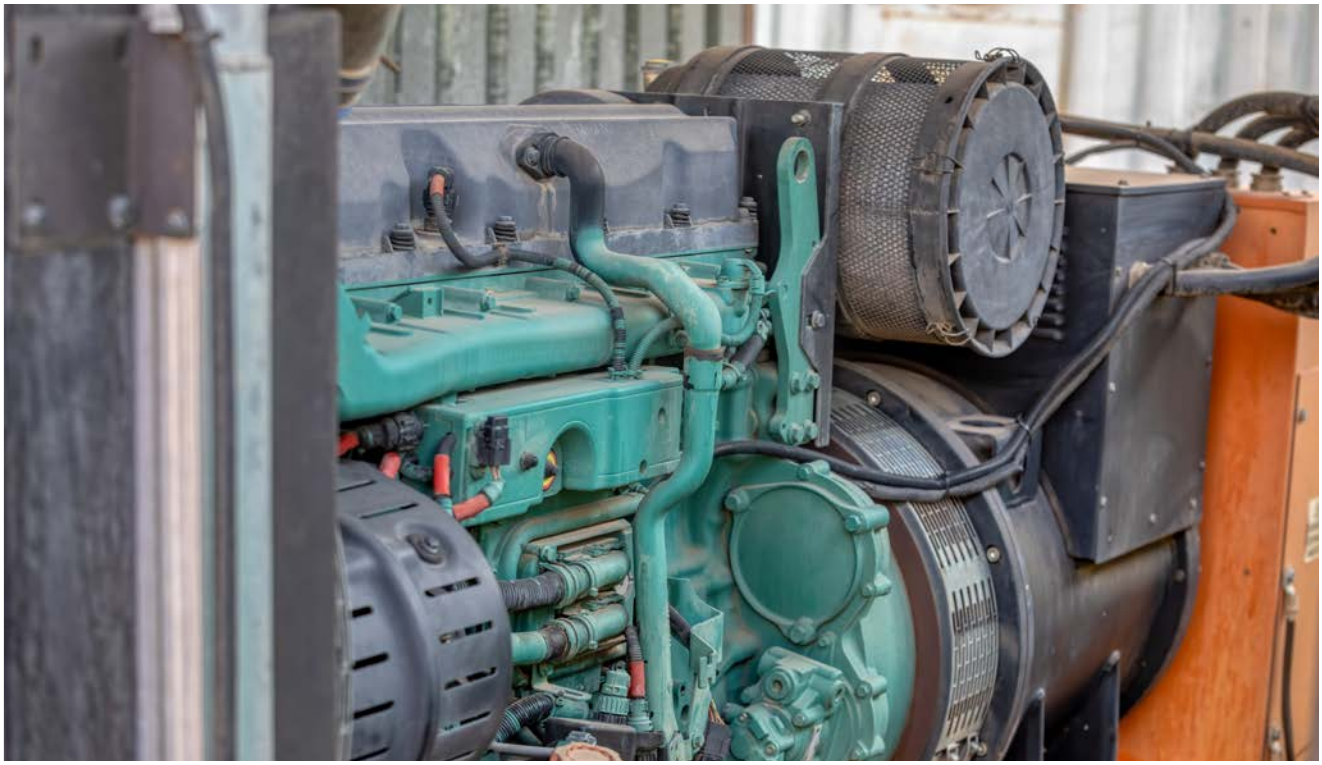
Outages inflict an average loss of 30% on businesses in the region, with some individual firms reporting losses of more than 70% (World Bank ESMAP, 2022). In some countries – including Burundi, Ghana, Guinea, Liberia, Nigeria and Zimbabwe – more than half of households connected to the grid reported receiving electricity less than half the time (Blimpo and Cosgrove-Davies, 2019).

There are an estimated seven million diesel backup generators in Sub-Saharan Africa and these consume more than $20 billion in diesel per year (Shell Foundation and Rockefeller Foundation, 2021; Wood Mackenzie, 2022). The International Finance Corporation (IFC) estimates that the amount spent by users on generator fuel is equivalent to 20% of government spending on education and 15% of healthcare (IFC, 2019b). South Africa has the most backup generators per capita in the world (2.1 generators per 100 people), followed by Angola (second, 1.9) and Nigeria (fourth, 1.6) (IFC, 2019a).

Diesel backup capacity in Sub-Saharan Africa today likely exceeds 100 gigawatts (GW), equivalent to 200 typical coal-fired power plants (Wood Mackenzie, 2022; IFC, 2019a). This is more than the region's entire grid-connected fossil fuel generating capacity (86GW) and more than double the installed renewables capacity (43GW) (US EIA, 2023).

In about half of Sub-Saharan African countries, the installed capacity of backup generators is greater than grid-connected power plants (IFC, 2019b; Wood Mackenzie, 2022). For example, Nigeria has around 60% more backup diesel capacity than grid capacity and spends three times as much on fuels for backup generators as compared to the grid (IFC, 2019b, 2019a; Wood Mackenzie, 2022).

"In about half of Sub-Saharan African countries, the installed capacity of backup generators is greater than grid-connected power plants"



Rapid and just clean energy transitions are vital to limit future climate impacts

The region is already facing some of the most severe effects of climate change in the world, despite bearing the least responsibility. Sub-Saharan Africa has accounted for less than 2% of the world's energy related CO_2 emissions to date (Our World in Data, 2023b) and has the lowest CO_2 emissions per capita of any region (0.66) – less than one-tenth of the OECD average (World Bank, 2023b).

The region is experiencing worsening water stress, reduced food production, increased frequency of extreme weather events and lower economic growth – all of which are fuelling mass migration and regional instability. Climate change is also likely to decrease hydropower output, raising electricity supply risks in countries that rely heavily on hydro (IEA, 2020b). The region also suffers from poor air quality, with more than 220,000 premature deaths attributed to outdoor air pollution in 2019 (IHME, 2023).

Rapid and just clean energy transitions in the region and globally are vital to minimising future impacts while also enhancing the region's resilience to climate impacts. There is a huge opportunity for Sub-Saharan Africa to leapfrog many industrialised nations by pursuing a development pathway with clean energy technologies. Achieving the region's energy access and climate goals requires clean energy investment – in renewables, grids, access and efficiency – to more than quadruple by 2030 (IEA, 2023a).

The region also holds a significant share of minerals that are critical to clean energy technologies, including cobalt, manganese, graphite, platinum and bauxite. Revenues from the production of these minerals in Africa totalled more than $20 billion in 2020 – approximately 13% of the global market (IEA, 2022a). Growing global demand from clean energy transitions could see revenue more than double by 2050, which is equivalent to the projected (declining) revenues from fossil fuels in 2050.

As of August 2023, 48 countries in Sub-Saharan Africa had submitted a Nationally Determined Contribution (NDC) – a climate action plan to mitigate greenhouse gas emissions and adapt to climate change – to the United Nations Framework Convention on Climate Change (UNFCCC, 2023). Of these, 43 submissions are updated first or second submissions. Ghana (2070), Nigeria (2050-2070) and South Africa (2050) have pledged to reach net zero emissions and more than 25 countries have targets in discussion (Net Zero Tracker, 2023).

As of October 2022, 51 of the top 250 publicly listed companies in Africa (by market capitalisation) had set net zero targets (Omukuti, 2022). Eight mobile network operators with operations in the region are part of the Science-Based Targets Initiative, with five having validated near-term targets (Airtel Africa, MTN, Orange, Safaricom and Vodacom) and three having made commitments (Axian, Telkom SA and Zain) (Science Based Targets, 2023). MTN, Orange and Vodacom have publicly announced 2040 net zero targets while Airtel Africa, Safaricom, Telkom and Zain have announced 2050 net zero targets (GSMA, 2023c).

Energy efficiency and renewable energy – especially solar – are the key pillars of delivering on country and company pledges.

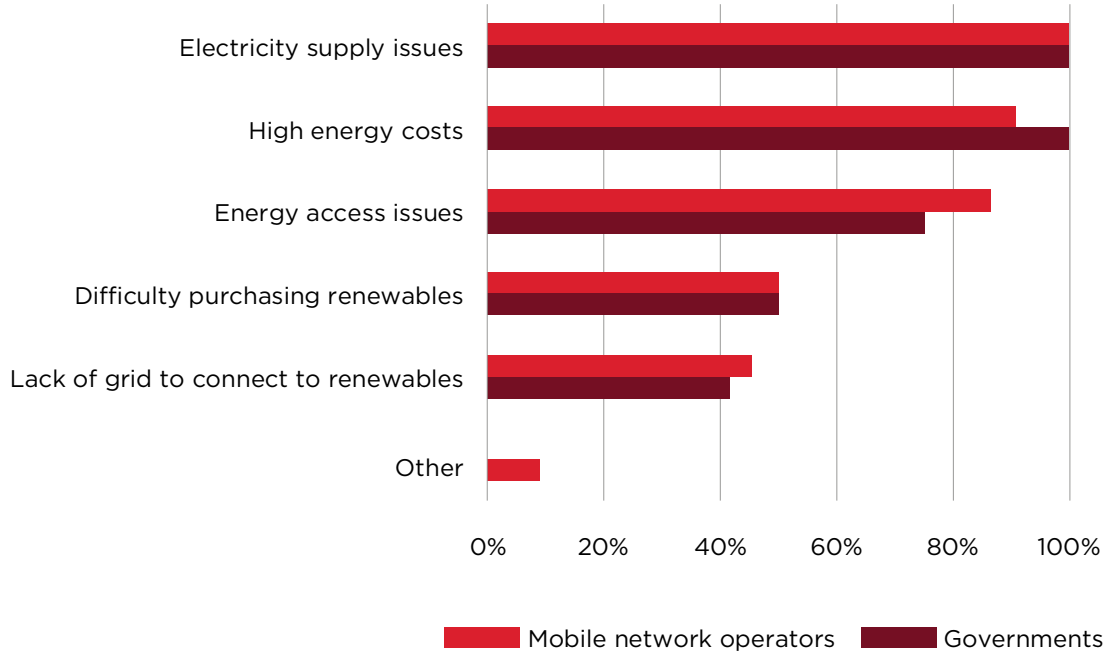
3. Energy challenges and impacts for mobile networks

Mobile network operators in Sub-Saharan Africa are facing multiple energy-related challenges

Mobile network operators in Sub-Saharan Africa are facing multiple energy-related challenges, including power outages, lack of grid access, high energy costs, and difficulties purchasing and connecting to renewable energy.

Nearly all of the operators who responded to the survey said that their three biggest energy challenges over the past 12 months were power outages, high and rising energy costs, and a lack of grid access (Figure 4). Approximately half of responding operators – mostly those operating in South Africa and the DRC – reported difficulties purchasing renewable energy and a lack of transmission and distribution infrastructure to connect to renewables. Survey responses from governments broadly indicate that governments are aware of the energy-related challenges faced by operators.

Figure 4 | Share of mobile network operators facing energy-related challenges and governments' awareness of operators' challenges



Question for mobile network operators: Has your network in Sub-Saharan Africa experienced any of the following energy-related challenges over the past 12 months?

Question for governments: Are you aware of mobile network operators in your country experiencing any of the following energy-related challenges over the past 12 months?

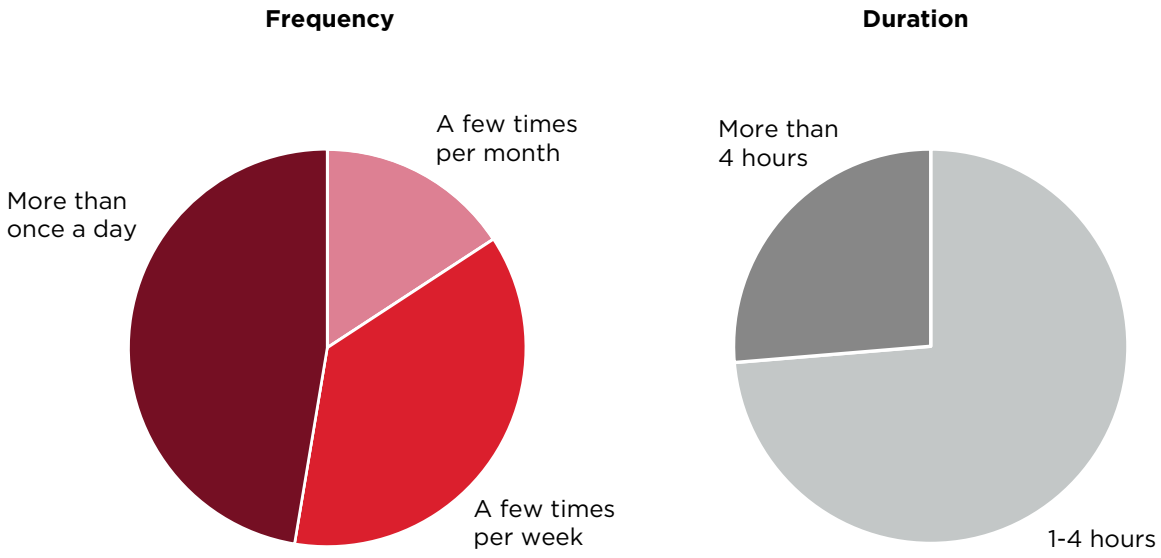
All responding operators said that these challenges had led to increased operating costs, while around 80% reported difficulty providing reliable service to customers with their existing network. More than half of operators reported that energy-related impacts and costs had delayed capital expenditures (64%) and the deployment of new technologies (55%) and 41% of operators were not able to expand coverage as a result of energy-related challenges and impacts.

Energy costs are a significant and growing share of operating expenditures for many operators. Of the operators that provided estimates on energy costs, 70% reported that energy accounted for more than 20% of their network operating expenditures. For 30% of operators, energy accounted for more than half of their network operating expenditures. Several operators reported that energy and fuel costs had increased by more than 30% over the past year.

Frequent and extended power outages are impacting mobile operators and customers

All mobile network operators responding to the survey had experienced power outages over the past year. Most operators (86%) faced at least a few outages per week, with nearly half facing multiple outages per day (Figure 5).

Figure 5 | Frequency and duration of power outages reported by operators over the past year



Questions: Over the past year, how often has your network experienced electricity supply issues?
How long have outages typically lasted for?

Power outages typically lasted one to four hours for the majority (64%) of operators. However, more than a quarter of operators – mostly from Central Africa (Cameroon and DRC) – regularly experienced outages longer than four hours. Operators in South Africa are also facing major challenges because the country is in the midst of its worst energy crisis in history, with more than 200 days of load-shedding over the first eight months of 2023 (Box 1).

As a result of frequent and prolonged outages, all responding mobile operators reported experiencing difficulty providing reliable services to customers. Operators reported having system stability issues and lower quality of service as a result of power outages, resulting in increased customer complaints, higher churn and revenue losses. Survey responses from governments, telecommunications policymakers and regulators indicate awareness of how these challenges are impacting both operators and their customers.

"Around half of operators responding to a recent GSMA survey reported facing multiple outages per day"

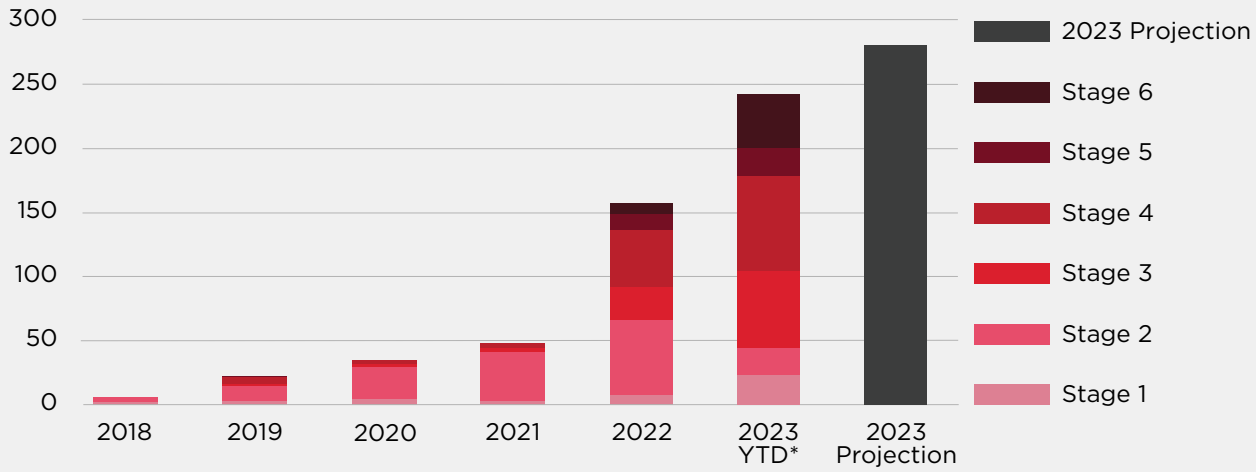
Box 1 – South Africa: unprecedented load-shedding and record-breaking deployment of solar and batteries

South Africa is in the midst of its worst energy crisis in history. Years of underinvestment and poor maintenance practices at Eskom, the state-owned utility, have resulted in an aging and unreliable coal fleet. Inadequate generation capacity has necessitated planned rolling blackouts, referred to as 'load-shedding', to avoid a total country-wide blackout (Eskom, 2021). In the event of a country-wide blackout, though unlikely, the complete restoration of power could take up to 14 days (Fick, 2023).

In 2022, the country saw more than 150 days of load-shedding (The Outlier, 2023). Through the first nine months of 2023, there have already been 240 days of load-shedding, including 42 days of Stage 6, compared with the previous high of eight in 2022 (Figure 6). Under Stage 6, the highest stage recorded to date, up to 6GW of load needs to be shed, with most South Africans without power for around six hours per day (Reuters, 2022).

These increasingly frequent and prolonged power outages have affected mobile networks as well as virtually all other sectors of the economy, from retail and other services to manufacturing and mining (African Development Bank, 2023a). The South African Reserve Bank estimated that load-shedding deducted 0.7 to 3.2 percentage points from the country's GDP in 2022 (South African Reserve Bank, 2023a), and would deduct two percentage points in 2023 (South African Reserve Bank, 2023d). The bank has estimated that load-shedding at Stages 3–6 costs the country up to R900 million per day ($50 million) (Naidoo, 2023; South African Reserve Bank, 2023c, 2023b).

Figure 6 | Days of load-shedding by stage, 2018-2023



Notes: *as of 30 September. 2023 Projection from the South African Reserve Bank (2023c).

Source: LoadShed and EskomSePush (The Outlier, 2023)

Rising energy costs are compounding these challenges. Electricity prices have more than quadrupled in real terms since 2007 (Moolman, 2021) and a further 19% price hike for 2023/2024 was approved in January 2023 (Acharya and Gumbi, 2023). The price of diesel has increased by more than 50% since early 2021 (SAPIA, 2023b, 2023a), making on-site diesel generation more than twice as expensive as grid-based electricity, even with rising grid prices (IFC, 2019a; Walwyn, 2023).

Renewable energy and batteries can help address the generation deficit in a relatively short amount of time and at lower cost compared to costly, long-duration builds of coal and nuclear (Fortuin, 2022). Over the past two years, solar PV deployments have grown exponentially, with installed rooftop solar PV capacity more than quadrupling since March 2022, reaching 4.8GW in September 2023 – more than twice the size of Eskom's own installed solar PV capacity and approximately 16% of total available generation (Eskom, 2023c, 2023b). A record R12 billion worth of solar panels and R20 billion worth of batteries were imported into the country in just the first half of 2023 – more than all of 2022 (Kuhudzai, 2023b). In February 2023, the South African Minister of Finance announced new tax incentives for household solar and renewable investments for businesses (Kuhudzai, 2023a).

The removal of the generation licensing threshold in January 2023 (previously raised from 1MW to 100MW in 2021) could further accelerate the entry of independent power producers (IPPs) and renewable energy generation in the country (Richards and Stolp, 2023). In May 2023, MTN announced its first power purchase agreement (PPA) (ITWeb, 2023). Vodacom has an active PPA covering 36 base stations in the Eastern Cape province of South Africa since 2020 (Vodacom Group, 2023a).

In August 2023, Vodacom signed a virtual wheeling agreement with Eskom. The solution, if scaled, could significantly mitigate or even eliminate load-shedding in the short to medium term. Through this initiative, Vodacom will add renewable energy to the national grid and expects to move approximately 30% of Vodacom South Africa's power demand onto renewable sources (Vodacom Group, 2023b).

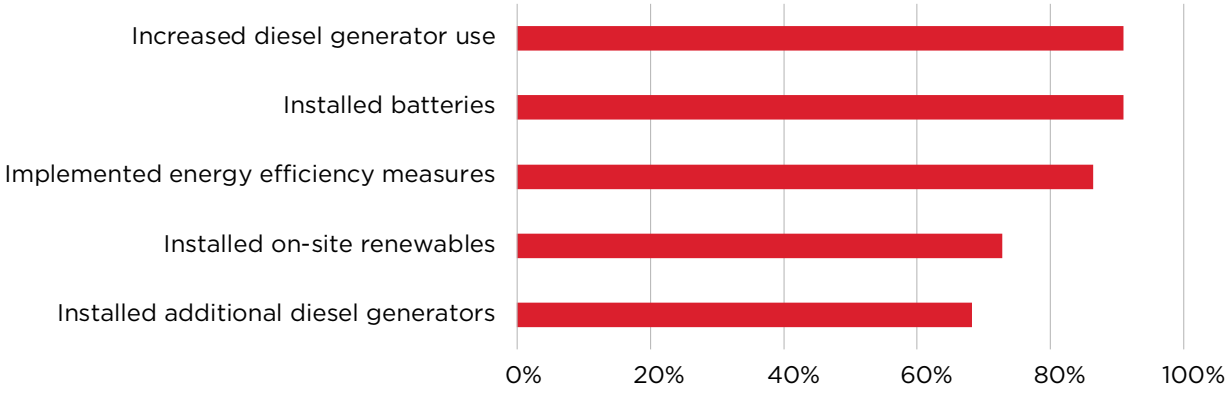
"Rooftop solar in South Africa has more than quadrupled over the past 18 months"

Mobile operators have taken action to maintain connectivity, but at significant cost

Operators have taken action to ensure continued service for customers. In South Africa, for example, public reports indicate that MTN deployed more than 2,000 generators in 2022 (Gavaza, 2023) and installed new batteries at more than 3,000 sites in 2023 (Dludla, 2023a). Vodacom reported spending more than R4 billion ($200 million) on backup power between 1 April 2019 and 31 March 2023, and a further R300 million in the past financial year on additional running costs in the form of diesel, security and maintenance (Reuters, 2023; Vodacom Group, 2023a). This investment represents approximately 11% of Vodacom's total capital expenditure over the same period.

Most operators responding to the survey had increased diesel generator use (91%), installed batteries (91%) or implemented energy efficiency measures (86%) (Figure 7). Approximately 70% had installed on-site renewables or additional diesel generators.

Figure 7 | Actions taken by mobile operators to ensure the reliable operation of networks



Questions: What actions have you taken to ensure the reliable operation of your network?

While these measures have been necessary to ensure reliable connectivity, most are also coming at significant capital and operational costs and, in the case of increased diesel generator use, higher emissions. Generating electricity with diesel generators typically costs three to four times more than grid-based electricity in the region, with even higher ratios in countries like the DRC, Ethiopia and Zambia (Farquharson, 2019). Diesel generators contribute to poor local air quality and generate 60% more CO_2 than the average grid-based electricity in Africa (IFC, 2019a; Our World in Data, 2023a).

"Generating electricity with diesel generators typically costs three to four times more than grid-based electricity in the region"

From an operational perspective, running diesel generators for prolonged periods also accelerates wear, shortens their lifespans and raises risks of mechanical failure and downtime. The need for more frequent maintenance and refuelling poses a major operational challenge for operators, given the highly distributed nature of mobile networks. Some operators report using hundreds of thousands of litres of diesel per month for their generators. The rising price of diesel could be an important driver to increase the competitiveness of on-site solar and battery solutions.

Theft and vandalism are also increasing, especially theft of back-up batteries, generators and solar panels, impacting service availability and costs. MTN reported more than 1,000 vandalism incidents over the past year in the Eastern Cape alone (Dludla, 2023a), while Vodacom has reported losing around 5,500 batteries annually to theft (Dludla, 2023b). Operators are increasing security measures, but face practical limitations and especially so in rural and distributed sites. South African operators, including Cell C, MTN, Telkom SA and Vodacom, established the Communication Risk Information Centre (COMRiC) in 2022 to discuss the sector's collective identification, mitigation and prevention of shared risks, including theft, vandalism and power outages (Tredger, 2022).

Most operators (80%) expect their fuel, security and capital costs to continue to increase over the next year.

Increased costs are delaying capital investments, jeopardising development goals

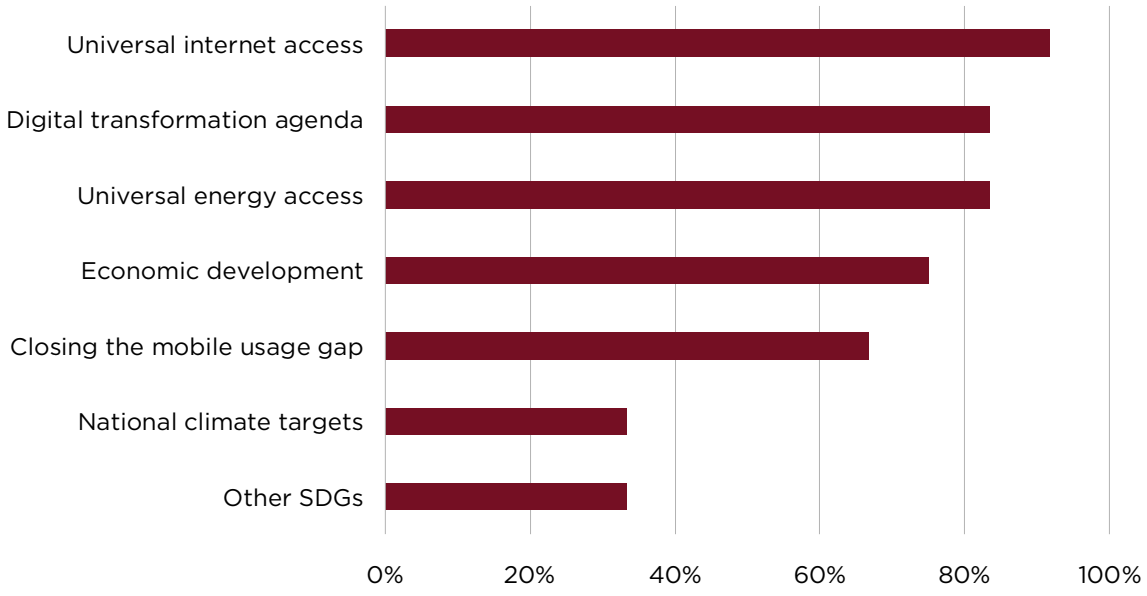
These high, unforeseen costs are causing delays to capital investments, raising risks to achieving digital development goals. More than half of responding operators had experienced delays in deploying new technologies, while nearly 40% reported delays in expanding coverage.

At their 2023 annual results conference call, Vodacom CEO Shameel Joosub stated that the company has "...spent R4 billion on energy resilience capex over the last four years. [...] Unfortunately, this [R]4 billion investment was a clear trade-off with new capacity that could have accelerated network expansion in 5G in South Africa." (Reuters, 2023; Vodacom, 2023).

Rising operational costs can also affect the affordability of mobile services. Mobile operators may also be subject to additional sector-specific taxes, exacerbating affordability and coverage barriers for the underserved (GSMA, 2017b).

Unless these energy-related challenges are addressed in a timely manner, they are likely to jeopardise the delivery of key development goals in the region. More than 80% of governments responding to the survey expected energy-related challenges to affect the achievement of universal internet access and energy access, as well as the delivery of digital transformation across the region (Figure 8).

Figure 8 | Telecommunication ministries and regulators expecting energy-related challenges to affect the delivery of key development goals



Question: Do you expect energy-related challenges to affect the delivery of any of the following high-level government agenda and goals?

Operators and governments are engaging key stakeholders on energy issues

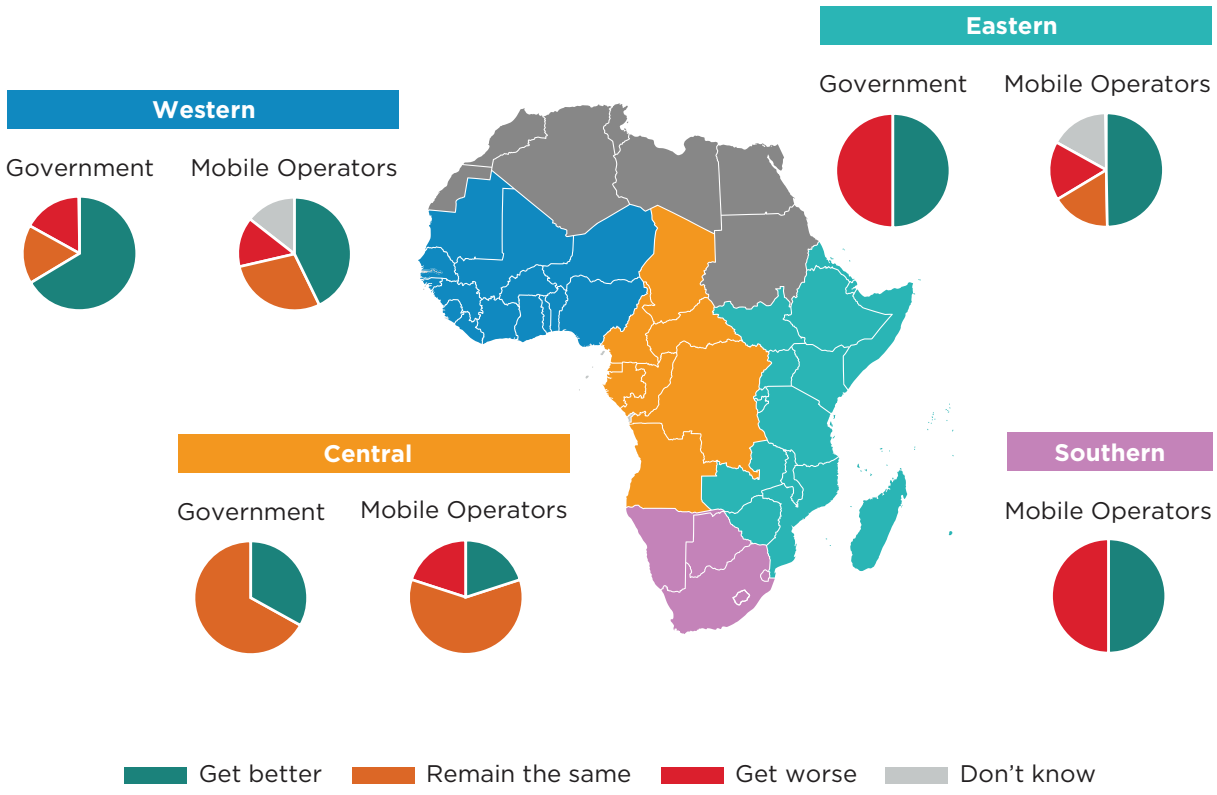
Nearly all operators responding to the survey had engaged with key stakeholders on energy issues over the past year, mostly through meetings, written correspondence (including responses to consultations) and workshops. More than 60% had engaged with the national telecom regulator, 43% had directly engaged with government ministries (primarily energy ministries) and 62% had engaged with the electricity grid operator or generator. Only 14% had engaged with the electricity market regulator. Approximately 40% had engaged with network equipment providers, other mobile network operators or tower companies. More than 80% of responding governments had engaged with mobile network operators in their countries.

Some of these engagements have already resulted in positive progress in addressing energy challenges. In South Africa, for example, the government recently announced exemptions to competition laws to allow operators to work together to jointly procure and share backup power and security (Illidge, 2023; Vermeulen, 2023).

When asked about their expectations for how energy challenges will evolve over the next three to five years, there was a notable lack of consensus among operators and among governments: 41% of responding operators expected things to improve, 23% expected things to get worse and 36% expected things to stay the same or didn't know. Among responding governments, half expected energy challenges to improve over the next three to five years, while 8% expected things to worsen and 17% didn't know.

Operators in Southern Africa were generally more pessimistic, while operators in Eastern Africa were generally more optimistic (Figure 9). Many operators noted that their expectations were dependent on governments' energy policies and investments, including increasing renewable energy generation, expanding grid infrastructure (particularly in rural areas) and other policies to support renewables.

Figure 9 | Expectations for how energy-related challenges will evolve over the next three to five years



Question: How do you expect these energy-related challenges to evolve over the next 3-5 years?

The government response from Southern Africa is not shown to ensure anonymity, because only one response was received from the subregion.

4. Potential solutions

Near-term solutions for mobile networks: energy efficiency, on-site renewables and batteries

Mobile network operators can implement a number of near-term solutions to mitigate their energy-related challenges. In fact, the vast majority of operators surveyed had already implemented energy efficiency measures (86%) and installed on-site renewables (73%) and/or batteries (91%).

Improving the energy-efficiency of networks can help mitigate some of the energy-related challenges, with radio access networks accounting for more than 80% of energy use for most telecom network operators (GSMA Intelligence, 2023b). Improving energy-efficiency not only reduces operating costs, but can also reduce energy requirements at each site – saving fuel, maintenance costs and emissions. While many operators have already taken important steps to optimise energy-efficiency, further opportunities including shutting down less energy-efficient equipment, deploying advanced battery and cooling solutions and site simplification (GSMA Intelligence, 2022) may be available.

Suppliers can also play an important role in improving the energy-efficiency of network equipment and designing equipment for the specific operational needs and constraints of mobile networks in Sub-Saharan Africa. While there are limits on the scale of energy-efficiency improvements, it is a first and fundamental step in mitigating energy-related challenges.

On-site renewables and battery storage can have an even bigger impact on improving energy reliability and reducing emissions, particularly in rural, off-grid and bad-grid areas. Nearly half of mobile towers in Sub-Saharan Africa are considered to be in off-grid or bad-grid areas, relying primarily on diesel generators for power (GSMA, 2020b).

With sufficient space, on-site solar and batteries may be sufficient to power a radio base station, even with prolonged outages. However, many operators cited high costs (91%) as the main barrier to increasing on-site renewable energy generation and battery storage. Lack of physical space was cited as the second-most important barrier (68%), followed by the risk of theft (59%).

Government policies and incentives can play a major role in reducing the cost to purchase on-site renewables and storage. Although the average costs of solar PV and batteries have fallen by more than 85% since 2010 (BloombergNEF, 2022; IRENA, 2023), these costs may still be prohibitive for some operators in Sub-Saharan Africa. Governments can support the deployment of on-site solar through financial incentives such as rebates and reduced taxes and tariffs to lower up-front costs. In February 2023, the South African government announced a renewable energy tax incentive for businesses (125%) and a solar panel tax deduction for individuals (up to 25%) (Kuhudzai, 2023a). Governments and development organisations could also play a role in helping operators and other companies access preferential financing to purchase on-site solar and batteries.

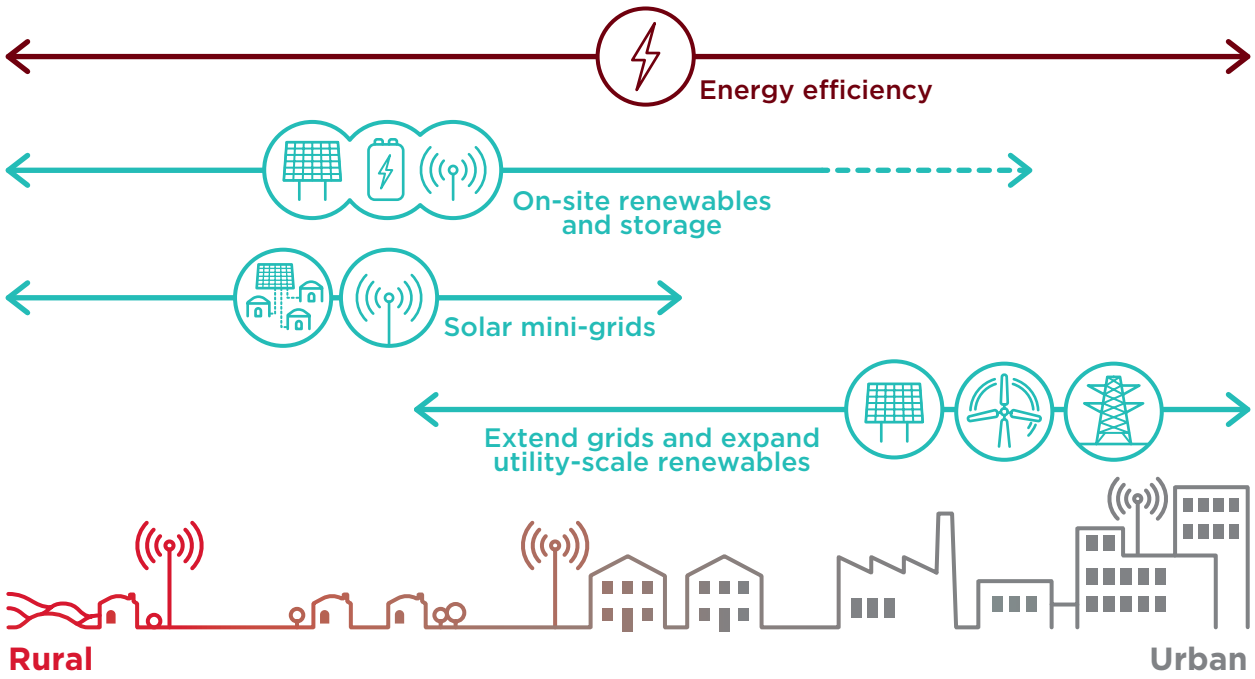
"Governments can support on-site solar through rebates, reduced taxes and tariffs, and other financial incentives to lower up-front costs"

Despite significant progress on improving solar cell efficiency and battery density over the past decade, physical space constraints are a deal-breaker for radio base stations in most urban settings. The lack of physical space is also a challenge across most sites in South Africa, where mobile networks were designed with the presumption of a reliable grid. Utilities and governments must work together to improve grid reliability in urban settings where on-site solar and batteries are not feasible.

Many operators have already taken steps to reduce theft of generators, solar panels and batteries, such as increasing physical and digital security and encasing batteries in concrete (Labuschagne, 2023). However, equipment may still be subject to vandalism and the large number of distributed sites makes security a major logistical challenge.

In many cases, on-site solar and batteries are superior to diesel back-up generators in terms of performance, operations and maintenance costs, and environmental impacts. However, shifting away from diesel, particularly in remote communities, may have hidden social costs that must be managed. In some communities, diesel is sometimes siphoned off by local residents when generators are refilled, providing much-needed energy for households and communities. Structural solutions are needed to provide reliable access to electricity and clean cooking in these communities.

Figure 10 | Potential solutions to energy-related challenges for mobile networks



Mini-grids: a win-win for resilience and access

In many contexts in Sub-Saharan Africa, solar mini-grids could also both address energy-related challenges for mobile network operators and offer co-benefits for energy access in rural communities.

Mini-grids are relatively small, decentralised electricity systems that can function independently from the national grid. In the context of advancing electricity access, mini-grids occupy a 'sweet spot' where national grid extensions are not economically viable for a community's density, location and expected consumption levels, but the energy needs of the community as a whole may eventually exceed the generation capacity of solar home systems (Bauer, 2019).

Mobile networks can act as dependable 'anchor' loads that provide stable, long-term demand to increase the bankability of new projects. Mobile-enabled digital innovations such as IoT-enabled smart metering and mobile money enabled pay-as-you-go business models are also key to supporting mini-grids towards commercial sustainability and scale (GSMA, 2019).

The World Bank estimates that nearly 300,000 load centres in Sub-Saharan Africa have favourable profiles for mini-grids – populations of between 100 and 100,000, located more than 1km from the grid and containing more than 1,000 people/km^2 (World Bank ESMAP, 2022). Deploying mini-grids in these locations could connect nearly a quarter of the region's population, or approximately 55 million households. Mobile coverage data can help identify optimal sites for mini-grid deployments, as demonstrated in the DRC (Bauer, 2022).

The latest (third-generation) mini-grids are reliable and cost-effective, with uptimes that exceed 99% (i.e. operating 99% of the time) compared with just 40–50% of many African utilities (World Bank, 2023a). Since 2010, capital costs for mini-grids in Africa and Asia have fallen by more than half to $3,660 per kilowatt in 2021, corresponding to a levelised cost of energy (LCOE) of $0.38/kWh (World Bank ESMAP, 2022). Further anticipated cost reductions could see mini-grids provide power at a lower cost than many national utilities in Sub-Saharan Africa by 2030 (World Bank ESMAP, 2022).

"Deploying mini-grids in favourable locations in Sub-Saharan Africa could connect more than 50 million households to electricity"

Mini-grids are often the least-cost, best solution to connect mobile networks and communities where the cost of extending the main grid is too expensive today. Solar mini-grids can also support electric utilities and the main grid by enhancing the economic viability of expanding the main grid. Mini-grids can stimulate economic development so that significant load already exists by the time the main grid arrives and customers have a greater ability to pay (World Bank ESMAP, 2022). Several different delivery models are discussed in-depth in World Bank ESMAP (2022), including the role of anchor loads such as mobile towers. Successful projects in Nepal, Madagascar and India provide useful case studies (GSMA, 2017a, 2020a; ISA and NEDO, 2022).

With enormous emissions reduction potential of solar mini-grids, there are also clear opportunities for climate finance to support their deployment across the region (Shell Foundation and Rockefeller Foundation, 2021).

Large-scale, structural solutions: expanding utility-scale renewable energy and electricity networks

Energy-efficiency, on-site renewables and storage, and mini-grids are key solutions to addressing energy-related challenges, but operators face physical and practical limitations in implementation and especially in urban settings. Therefore, government policies and investments to expand utility-scale renewables and enhance electricity networks are necessary to increase energy security for mobile networks, other businesses and households.

Approximately half of responding operators said that the governments in their countries had taken some action over the past year to address energy-related challenges, mostly around expanding renewable energy production. Governments had a much more favourable view, with more than 80% indicating that government initiatives had been implemented to improve the situation in their countries, including national energy strategies to address energy security and expand renewables, changes to electricity market design to allow production from independent power producers and rural electrification programmes.

"Half of operators cited high costs and the lack of options to enter PPAs as the main barriers to purchasing renewable electricity"

Nonetheless, many operators continue to face barriers to accessing and purchasing renewable energy. Around half of operators cited the high cost of renewable energy and the lack of options to enter power purchase agreements (PPAs) as the main barriers to purchasing renewable electricity. Less than 20% of operators reported facing internal barriers, including the lack of corporate buy-in and lack of internal resources and expertise. The lack of affordable options to purchase and use renewable energy is hindering the ability of mobile network operators to reduce their emissions and achieve near-term and long-term climate targets.

In South Africa, a concept known as virtual wheeling has been developed to increase the accessibility of PPAs. Virtual wheeling allows companies using electricity across many locations (and at lower voltages) to gain access to renewable energy from independent power producers through a digital platform that collects, aggregates, processes and reports time-of-use data for both generation and consumption at different locations (Eskom, 2023a). A virtual wheeling platform is being developed by Vodacom subsidiary Mezzanine, which is participating in the pilot programme to advance towards its goal of 100% renewable energy by 2025 (Creamer, 2023).

When asked about potential policy solutions to address barriers to purchasing and using renewable energy, both mobile operators and governments recommended expanding and modernising power plants and transmission and distribution infrastructure. Responding mobile operators and governments recommended further policies and incentives to support renewable energy deployment, including zero taxes on renewable energy equipment and installation, low-interest loans for renewables, net-metering and feed-in-tariffs. To maximise the environmental benefits of these policies, they must be accompanied by strengthening of institutional capacity, especially in low-income countries (Galeazzi et al, 2023). Several countries have been recognised for strong regulatory frameworks and capacity in the African Development Bank's Electricity Regulatory Index, including Uganda, Senegal, Ghana and Kenya (African Development Bank, 2023b).

In addition to expanding and diversifying electricity generation, governments and utilities must also make major investments in modernising and expanding the grid. Transmission and distribution networks in many Sub-Saharan African countries are underdeveloped and use old and outdated equipment as a result of years of underinvestment, resulting in very high network losses of approximately 15% in 2020 – double the global average (IEA, 2022a).

This means that significant investments are needed both for new lines as well as maintenance and modernisation of existing lines, including using digital technologies to optimise operations and maintenance. In Ghana, the use of GIS, outage management systems and automation and control on medium-voltage lines has reduced average outages times by more than 90% (IEA, 2022a). Greater collaboration and the use of geospatial data, including data on mobile operator sites, are needed when developing grid extension plans. Investment is also needed to enhance interconnections between national and regional systems to increase regional integration and system balancing.

The majority of countries in Sub-Saharan Africa have vertically integrated utilities with little or no private participation, limiting the availability of renewable energy PPAs (Ford, 2022; IEA, 2020a). Zambia is currently the only country where the private sector is represented across generation, transmission and distribution. Several survey respondents recommended changes to electricity market design, including market liberalisation to increase competition. Analysis from RES4Africa and PwC shows that private operators, if allowed into a market, outperform their public counterparts across a range of technical and commercial indicators (RES4Africa, 2021).

In Namibia, the state-owned utility opened up power generation to independent power projects in 2015 as part of its feed-in tariff programme (Jaeger, 2023). In the following years, they introduced competitive auctions and implemented further policy reforms which attracted significant investment in solar, including more than 20 independent power projects (Kruger, 2022). Solar now accounts for approximately a quarter of the country's grid mix, up from 2% in 2014.

Electric utilities in Sub-Saharan Africa face major hurdles in financing power plants and electricity networks due to the high cost of capital and their poor financial health. The cost of capital in Sub-Saharan Africa is at least two to three times higher than in advanced economies (IEA, 2022b, 2023a).

Development banks and private sector investors can play a key enabling role in increasing investment in clean energy. As important energy users with good credit, mobile network operators may be able to support the creditworthiness of new power projects developed by utilities or independent power producers.

An excellent example of innovative financing is the Kinguélé Aval hydro project, Gabon's first independent power producer. This 35MW project was sponsored by a private investor from France (Meridiam) alongside the Gabonese sovereign wealth fund. In order to mitigate risk of the offtaker (the state utility), an escrow account was established and payments to the project will be channelled through Airtel Africa, the mobile operator, based on prepaid electricity payments (IEA, 2023a).

"Airtel Africa played a key role in an innovative financing solution for Gabon's 35MW Kinguélé Aval hydro project, the country's first independent power project"

Strong energy and climate policies are the broadest, most important enabler of action to increase energy-efficiency, renewable energy and investments in electricity networks. Governments around the world are also increasingly integrating ambitious climate policy with industrial policy and broader development strategies. As a major producer of critical minerals in clean energy technologies, Sub-Saharan Africa has a major opportunity to reap the benefits by developing domestic industries to process key minerals and develop value chains for batteries and other clean energy technologies.

5. Summary and recommendations

Summary of challenges and implications

As this paper has explored, mobile network operators in Sub-Saharan Africa are facing several major energy-related challenges which cause negative direct and indirect impacts on operators and customers.

Frequent and prolonged power outages are affecting the availability and quality of mobile network services for customers, requiring operators to increase their use of back-up power options to keep their networks running.

High and volatile energy prices – especially for diesel – are also increasing operating costs. Higher costs for operators are in turn affecting their ability to invest in expanding coverage and deploying new technologies, jeopardising the delivery of key digital and sustainable development goals. These challenges, impacts and implications are summarised in Table 1.

Table 1 | Energy-related challenges, impacts to operators and broader implications

Challenges	Impacts to operators and customers	Broader implications and risks
› **Electricity supply issues:** operators are facing increasingly frequent and prolonged power outages › **High energy costs:** operators are facing high and volatile energy prices › **Energy access issues:** operators lack access to the grid, especially in rural areas › **Difficulty accessing and purchasing renewables:** operators do not have options to purchase renewable energy	› **Degraded quality of service and experience for mobile customers** with negative impacts on households and businesses › **Increased capital expenditures for mobile operators** to install back-up power (diesel generators, on-site solar, batteries) › **Increased fuel and maintenance costs for operators due** to increased reliance on diesel back-up generators › **Increased costs and impacts of theft and vandalism** › **Increased emissions from diesel back-up generators,** increasing Scope 1 emissions › **Delays and challenges in reducing emissions and achieving climate targets** due to a lack of options to purchase renewable energy	› **Increased capital and operating expenditures** related to energy delay investments in new technology deployment and expansion of coverage › **Delays in achieving digital and sustainable development goals** due to delays in mobile technology deployment in the region › **Increased difficulties in meeting national climate targets,** raising climate risks, as a result of poor grid coverage and continued reliance on fossil fuels › **Key industries may choose to do business elsewhere** (e.g. data centres, manufacturing) due to the lack of clean and reliable electricity

Recommended actions

Mobile network operators, governments and electric utilities across the region are already taking action to address energy-related challenges. Mobile operators have responded quickly to outages by scaling up back-up power to ensure reliable network operations.

Some governments and utilities are developing new solar, wind and hydro plants and expanding and modernising grids. But much more action is needed, especially on policies and structural solutions that can help accelerate energy efficiency, renewable energy and grid expansion. Addressing these energy challenges will require action from a range of key stakeholders (Table 2).

Mobile network operators, for example, can implement near-term solutions with on-site solar and batteries, while equipment providers can work to design more energy-efficient and resilient solutions for the future. Operators can use their financial stability to become reliable partners in new mini-grid and other power projects.

Other sectors that rely on energy and mobile connectivity can raise awareness of the criticality of mobile networks and support efforts by the mobile industry to increase energy resilience and sustainability.

Energy ministries and electric utilities must play a central role in addressing energy-related challenges through policies and investments, supported by financing and capacity building delivered by development banks and organisations.

Energy market regulators can play a key role by aligning electricity market design that facilitates private sector investments in renewable energy projects to supply the growing demand for clean electricity. Regulators and policymakers can develop mechanisms and incentives to encourage distributed energy generation (e.g. rooftop solar), for example, through feed-in-tariffs.

Telecommunication ministries and regulators can play an important role in facilitating cross-government dialogue and action to address key energy-related challenges faced by mobile network operators.

Development banks must play a key role in financing clean energy projects in the region. The African Development Bank is spearheading efforts to unlock the region's renewable energy potential. Since 2016, 87% of the bank's investments in power generation are in renewables, including the 310MW Lake Turkana wind project in Kenya – Sub-Saharan Africa's largest wind farm (IEA, 2023a). High poverty rates and low electricity demand mean that new access projects are unlikely to be commercially viable, suggesting a strong case for concessional financing given their social impact. Securing concessional funding can help mobilise private investment.

Table 2 | Recommended actions to address energy-related challenges

Solutions	Potential barriers	Recommended actions
Increase energy-efficiency of radio access networks	› Shutting down less efficient 2G and 3G networks may be restricted due to legacy licences › High cost of newer, energy-efficient equipment › Energy requirements of base stations may increase with newer technologies › High capital cost of existing solutions › Physical space constraints limits deployment in urban settings › Theft and vandalism of solar panels and batteries	› **Mobile operators:** implement energy-efficiency measures › **Equipment manufacturers:** work with operators to understand operational requirements to develop more efficient and resilient solutions for the region › **Telecommunication regulators:** work with mobile operators and legacy licensees to manage the decommissioning of legacy networks and refarming spectrum to reduce energy use › **Finance ministries:** lower excise duties for more energy-efficient equipment
Increase on-site renewables and battery storage	› High capital cost of existing solutions › Physical space constraints limit deployment in urban settings › Theft and vandalism of solar panels and batteries	› **Mobile operators:** implement near-term solutions with on-site solar and batteries where feasible › **Energy, climate and relevant ministries:** offer financial incentives to encourage adoption of solar and batteries; revise competition regulations to permit sharing of infrastructure and security › **Development banks:** work with mobile network operators to offer better financing terms for solar and batteries
Expand utility-scale renewables and electricity networks and deploy solar mini-grids in rural areas	› High capital costs › Long lead-times and other risks › Lack of options for corporates to purchase renewable energy › Regulations in some markets do not allow for mini-grids to be integrated into the grid	› **Mobile operators:** use financial stability to become reliable offtakers and partners in power projects › **Energy and other relevant ministries:** classify telecom networks as critical infrastructure; implement energy and climate policies that support public and private sector investments in new renewable capacity and electricity grids; streamline processes to get new projects approved and online › **Energy regulators:** facilitate entry of independent power producers and renewable energy purchase options › **Telecommunication ministries and regulators:** facilitate cross-government dialogue and action to address key energy-related challenges faced by mobile network operators › **Utilities:** work with telecoms as reliable off-takers of clean electricity › **Development banks and organisations:** provide preferential financing terms and implement capacity-building programmes

International investment into Sub-Saharan Africa has fallen in recent years, from around 60% of total energy investment in 2011 to just 20% in 2021 (IEA, 2023a). Just Energy Transition Partnerships (JETPs) offer a promising financing cooperation mechanism to help fossil fuel-dependent economies make a just energy transition. The JETP for South Africa was announced at COP26 in 2021, which includes an initial offer of $8.5 billion in support between 2023 and 2027 (South Africa Presidential Climate Commission, 2023). In June 2023, Senegal signed a €2.5 billion JETP deal with France, Germany, Canada and the EU, establishing a goal to reach 40% renewable electricity by 2030 (Sarr et al, 2023).

Conclusion

Solutions to current and emerging energy-related challenges must carefully consider the enormous diversity across Sub-Saharan Africa in terms of the existing electricity mix and grid infrastructure, resource endowment and renewable energy potential, electricity market design and regulations, and taxation.

Collaboration between stakeholders will be key to addressing current and emerging energy-related challenges for mobile operators as well as the households and businesses across Sub-Saharan Africa that rely on mobile connectivity every day.

Appendix

Survey methodology

Surveys were developed for mobile operators and governments to gather information on the extent and impact of energy-related challenges for mobile operators and to understand the barriers and potential solutions to address these challenges.

The survey for mobile network operators included questions to understand their existing energy-related challenges, the extent and impacts of power outages, actions taken by mobile operators and governments (including engagement with key stakeholders), and proposed solutions to address barriers to use and purchase of renewable energy.

The survey for governments, available in English and French, included questions to understand their awareness of energy-related challenges experienced by mobile operators, actions taken by governments to address energy challenges and potential solutions to address remaining challenges.

The survey was sent to mobile network operators in June-August 2023. Twenty-two responses were received from the following operators, covering more than 60% of mobile connections in the region:

- Group-level: Vodacom, MTN.
- Western: Expresso Senegal, Free Senegal, Moov Côte d'Ivoire, Moov Niger, MTN Côte d'Ivoire, Orange Burkina Faso, Orange Côte d'Ivoire.
- Central: Africell DRC, Airtel DRC, MTN Cameroun, Orange Cameroun, Vodacom DRC.
- Eastern: ethio telecom, Jamii Telecommunications Limited (JTL), Safaricom Ethiopia, Safaricom Kenya, Vodacom Mozambique, Vodacom Tanzania.
- Southern: Vodacom South Africa, Vodacom Lesotho.

The survey was sent to telecommunication ministries and/or regulatory authorities in June-August 2023 to representative countries across each of the four subregions. Twelve responses were received from the following governments, representing nearly 60% of the regional population:

- Western: Burkina Faso, Ghana, Niger, Nigeria and Senegal
- Central: Cameroon and DRC
- Eastern: Ethiopia and Kenya
- Southern: South Africa

The survey responses represent operators and governments from each of the four subregions of Sub-Saharan Africa, covering more than half of the region's population and mobile connections. However, given the diversity in social, economic, political and energy contexts in the region, the survey results are not intended to be statistically representative. Challenges in data collection have meant that not all subregions are proportionally represented in the results.

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