Vodacom Report:
Decarbonising Africa's ICT sector

Chapter 1
Challenges to decarbonisation

April 2026

Further together

Introduction

The impacts of climate change have never been felt as acutely as they are today. Without rapid decarbonisation, we risk irreversible damage to our ecosystems, economies and communities, undermining the future well-being of generations to come.

Africa is particularly vulnerable to climate change. Altered rainfall patterns, prolonged heatwaves and droughts, and inland and coastal flooding have already destroyed livelihoods across Africa and resulted in enormous costs to governments and the private sector. The African Development Bank (AfDB) estimates that climate-related disasters cost African countries between US$7 billion and US$15 billion annually[1].

Achieving net zero greenhouse gas emissions by mid-century is essential to overcoming the climate crisis. This means decarbonising electricity, transport, agriculture, industry and all other aspects of our economies and daily lives. Mobile network operators (MNOs) have an important role to play in this regard.

MNOs require high amounts of electricity to operate in urban and rural areas (through data centres and base station networks) and provide digital infrastructure. Many MNOs, including Vodacom, understand their key role in realising Africa's low-carbon growth opportunity and understand the urgent need to transition to net zero and decarbonise their operations.

MNOs provide access to data and communication services that are fundamental to daily life, influencing everything from healthcare and education to social interactions. They must provide reliable services to drive growth and development.

MNOs are important to:

Students: with access to online information, learning tools, and educational resources

Businesses: by facilitating communication, efficient operations, and access to global markets

Healthcare: with access to telemedicine, mobile clinics, and remote patient health monitoring in medicine

Democracies: by enabling information access and communication, they enhance civic participation and support transparent elections

These vital services rely on a stable electricity supply, without which MNOs cannot function effectively.

To successfully decarbonise, MNOs need stable electricity supplies, primarily provided by grid infrastructure. Africa struggles with weak and absent grid infrastructure, insufficient generation capacity, and telecommunications infrastructure is dispersed (which makes it difficult to maintain and upgrade). These factors pose significant challenges to ensuring a reliable power supply. MNOs rely on diesel generators to compensate for unstable electricity supply. Although generators are reliable, portable and widely available, they are expensive to run and negatively impact the environment. Diesel generators continue to drive rural economic productivity in sectors such as agriculture and mining and keep businesses running during blackouts. Using diesel causes considerable health, environmental and financial costs. Strengthening grid infrastructure is key to reducing these impacts and enabling MNOs to achieve net zero targets.

Onsite renewable energy is a zero-carbon alternative to diesel generators as a primary and backup power source. Solar PV is modular (solar panels can be removed or added), portable and easy to install, making it the most practical renewable solution for MNOs. Solar PV will need to be paired with batteries to provide a fully renewable energy solution. This increases cost. For this reason, diesel generators usually provide an affordable backup power solution.

For MNOs to reach their net zero targets, whether sourced on-site or from a utility-controlled or local mini-grid, they require a near 100% transition to renewable energy systems. This transition presents many challenges unique to underdeveloped markets. These challenges and potential solutions are investigated in this series.

1 AfDB. (2023). Focus on Africa.

Each chapter in this series covers a specific topic.

Chapters

1 Challenges to decarbonisation
2 Possible solutions to the challenges
3 Solutions available to MNOs
4 Finance
5 Conclusion

Chapter 1

Challenges to decarbonisation

The ICT and other electricity-intensive sectors in Africa face decarbonisation challenges that mostly stem from weak or absent grid infrastructure. This causes heavy reliance on diesel generators, carbon-intensive electricity, and fewer ways to procure renewable energy through the grid. MNOs in other developed and developing regions widely adopt these practices. The challenges are discussed on the following pages:

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09 Cost and technical challenges of powering base stations with green mini-grids
10 Conclusion

1.1 Absent or unreliable electricity supply

Weak and absent electricity grid infrastructure severely limits socioeconomic development and businesses' ability to operate.

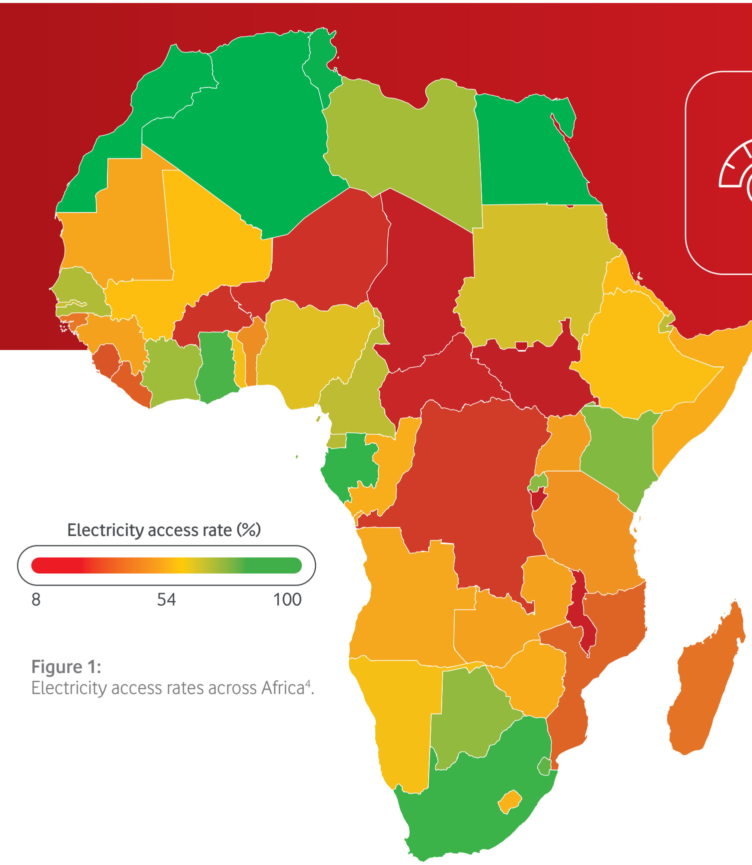

Figure 1:
Electricity access rates across Africa[4].

In many instances, grid connectivity does not bring the reliable and consistent power needed to support businesses, households and essential services.

Electricity access is necessary for social and economic development, and one of sub-Saharan Africa's most significant challenges. There is a severe lack of grid infrastructure in many African regions, especially in rural areas (Figure 1).

Approximately
600 million
people, or roughly 50% of the sub-Saharan African population, does not have access to electricity[2]

To achieve universal access to affordable electricity by 2030, the electrification rate must triple to 90 million people per year from recent years. Despite this enormous challenge, some countries have made notable progress. Ghana, Kenya, and Rwanda are on track to achieve full energy access by 2030, setting examples for other countries[3].

The quality of the grid is often unreliable – 80% of firms and close to 60% of households in sub-Saharan Africa face regular unplanned and lengthy outages[3]. Even countries with high electricity access rates and well-developed grid infrastructure, such as Egypt and South Africa, have had to implement scheduled power outages (load shedding) lasting several hours per day. Inadequate and unreliable grid infrastructure and unreliable electricity supply have far-reaching negative impacts. Power interruptions affect businesses, households and essential services by disrupting daily activities, reducing productivity and preventing economic growth. Continuous power supply is a significant challenge for the MNO sector, given its critical importance.

2 IEA. (2023, September 15). Access to electricity improves slightly in 2023, but still far from the pace needed to meet SDG7.
3 IEA. (2022). Africa Energy Outlook 2022.
4 World Bank. (2023). Access to electricity (% of population) – Sub-Saharan Africa.

1.2 Financial constraints and limited capacity of utilities

Utilities struggle with financial constraints and limited human and institutional capacity, causing sub-Saharan Africa's weak and absent grid infrastructure, which can only be remedied with significant investments into upgrading and expanding access.

Sub-Saharan Africa's weak and absent grid infrastructure is primarily due to two interconnected issues: financial constraints and limited human and institutional capacity of utilities (including skills, experience and knowledge)[3]. Most utilities in sub-Saharan Africa are in dire financial positions and operate at significant financial deficits. Operational losses among all African utilities are estimated to have exceeded US$15 billion in 2020[3]. This is attributed to under-priced tariffs, poor payment collection rates, theft, vandalism, operational problems, supply chain constraints and high network losses. Poorly maintained and ageing infrastructure resulted in network losses averaging 15% across Africa in 2020 – almost twice the global average of 8%[3].

Due to financial and resource capacity constraints, utilities cannot replace ageing transmission and distribution assets or accurately assess the location, duration and cause of blackouts, resulting in inadequate maintenance. Utilities cannot afford to extend the grid to underserved areas, and customers cannot afford to pay high tariffs, so expanding the grid takes time. Power generation shortfalls are the root cause of these power cuts in South Africa and Egypt. As many African countries are large and their terrain makes access challenging, extending the grid requires significant investment. As a result, millions of people continue to live without electricity, which prolongs poverty cycles and prevents socioeconomic development.

Substantial investment into Africa's electricity grids and generation capacity is necessary to improve system reliability, expand access and reduce reliance on diesel generators. Significant funds are also needed to upgrade the grid with newer technology to accommodate high amounts of renewable energy, such as solar and wind energy.

Grid shortcomings and an unreliable power supply result in MNOs and other African businesses relying heavily on diesel generators, which imposes financial and environmental costs.

When grid power is unavailable, MNOs and other businesses use diesel generators to power their operations and infrastructure, as they provide services to communities in areas not connected to the grid. MNOs also require an uninterrupted power supply to power data centres to avoid damaging equipment, and communities and businesses require mobile connectivity to operate and function effectively. Access to reliable power is essential for the proper functioning of MNOs' operations and critical to socioeconomic development. Diesel generators can become costly, with regular refuelling and maintenance requirements. Diesel-generated electricity is approximately four times more expensive than grid electricity per kWh. Therefore, ICT services in areas where the grid is underdeveloped is more expensive. Fuel is imported, which harms a country's trade balance and makes it vulnerable to fluctuations and volatility of fuel prices due to exchange rates. Diesel generators also negatively impact the environment, causing air and noise pollution and greenhouse emissions.

Footnote 3 referenced above can be found on page 3.

1.3 The carbon intensity of the grid

The grid's carbon intensity varies significantly across African countries and is critical in decarbonising MNOs' operations. Utilities generally aim to rely on different types of renewable energy, but several challenges prevent them from achieving this goal.

MNOs consume large amounts of electricity, mainly through their data centres and base station networks. Therefore, the carbon intensity of the grid affects their ability to decarbonise their operations. The carbon intensity of electricity generation varies widely across Africa. Some countries, including Kenya and DRC, rely heavily on geothermal and hydroelectric power, and their grid emission factors are below 0.1tCO_2e/MWh. In contrast, nations rich in fossil fuels, such as South Africa, have emission factors exceeding 1tCO_2e/MWh, reflecting their dependence on coal and other carbon-intensive energy sources. Figure 2 on the far right shows the percentage contribution of electricity generation sources for African countries where Vodacom operates.

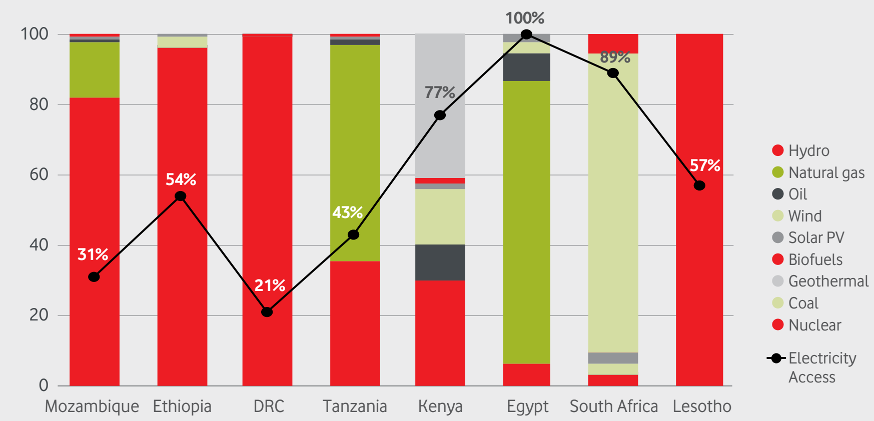

Figure 2: Percentage contribution of electricity generation sources compared with percentage electricity access for African countries where Vodacom operates[5].

Although many countries hope to transition to clean energy, investment in clean energy infrastructure is challenging. One of the biggest obstacles is that utilities cannot afford to invest in additional generation capacity. In some cases, the private sector could potentially provide funding, but utilities are often not creditworthy, so they cannot commit to buying electricity from suppliers. Thus, long-term infrastructure investment projects such as utility-scale generation are considered very high risk and require substantial sovereign guarantees (where a government promises to pay back a loan if a state-owned company cannot) to lessen the risk of investing. Additional financial support must often come from an already financially constrained national treasury. Political risk, instability, regulatory uncertainty and underdeveloped local financial markets hinder investment in clean energy projects in Africa. As new renewable energy sources become available, electricity grids need to be upgraded and modernised to accommodate electricity generation.

5 IEA. (2021). Countries and regions.

1.4 New market mechanisms to procure renewable energy in Africa

Internationally, there are various market mechanisms to purchase renewable energy, but their absence in Africa prevents MNOs from achieving decarbonisation. Developing a robust renewable energy market in Africa would accelerate decarbonisation and offer several socioeconomic benefits.

In developed countries various options for purchasing renewable energy are available, and are a key decarbonisation strategy for many businesses. Purchasing systems for renewable energy encourage renewable energy project development by providing revenue certainty to power generators and attracting investment. They enable countries to diversify their electricity mix, meet renewable energy targets, and limit price volatility. The most common market mechanisms to purchase renewable energy are PPAs, RECs, and green tariffs.

European MNOs rely heavily on their ability to purchase clean energy via these purchasing mechanism. For example, British Telecoms does not operate its own networks in Africa and buys 100% clean electricity worldwide. PPAs met around 31% of their electricity demand in the 2025 financial year, with plans to grow this in future. The rest of their electricity supply came from local green tariffs and, in some cases, RECs[6]. Another example is Vodafone, where European operations are 100% powered by electricity from renewable energy sources derived from PPAs, green tariffs and RECs[7]. Orange now uses 100% renewable energy in Spain, purchased through PPAs[8].

Renewable energy market mechanisms in many African countries are either absent or insufficient, which significantly hinders MNOs in Africa from decarbonising their operations. This places them at a distinct disadvantage compared to MNOs in more developed regions. Telecommunications companies (telcos) operating in African markets have limited options for procuring renewable energy. Developing a mature renewable energy market in Africa will help decarbonise operations and, if set up correctly, will bring multiple benefits. Renewable energy procurement mechanisms can promote the development of additional in-country clean energy projects and attract investments from the private sector. Clean energy generation projects can create jobs, enhance energy security and provide other socioeconomic advantages.

Although the effectiveness of renewable energy market mechanisms in Africa varies by country due to differing grid carbon intensities, they can still bring essential benefits.

As the carbon intensity of grids across Africa varies considerably, the benefit of renewable energy market mechanisms varies between countries. In countries where the grid emission factor is low, such as the DRC, Kenya and Ethiopia, focusing on grid expansion and reliability and the co-benefits of PPA and RECs would be more critical than the emission savings. An excellent example of this is Peace RECs (P-RECs). Countries with high grid carbon intensities, such as South Africa, Egypt and Tanzania, should prioritise the development of different market mechanisms to purchase renewable energy, specifically market instruments that enable the development of additional renewable energy capacity, such as PPAs.

6 BT Group. (2025). Digital impact and sustainability.
7 Vodafone. (2021, June 21). Vodafone's European network 100% powered from renewables.
8 Orange. (2022, December 2022). Orange steps up efforts to reduce energy consumption across Europe.

Many sub-Saharan African countries face challenges such as inadequate infrastructure, complex regulatory frameworks and a lack of financially stable off-takers, which hinder the development of market mechanisms to purchase renewable electricity.

Several vital challenges impact the development of renewable electricity market mechanisms in Africa:

Old and unreliable grids

Unreliable grids pose a significant barrier to developing PPAs and undermine their viability by increasing technical and commercial risks. Without a reliable grid, electricity generated under PPAs cannot be effectively transmitted to end-users, thus risking the entire project. Grids need to be upgraded, and new strategies must be implemented to ensure variable renewable energy, such as solar and wind, reach more people. Strategies need to consider energy storage, responding to demand, better forecasting and planning to match supply to demand, and measures to ensure the grid is stable and reliable, such as ensuring electricity is supplied at a stable rate at the correct voltage.

Policy and regulatory issues

Procuring renewable energy requires the appropriate policy, financial and legal structures to be in place. Complex and unclear regulatory frameworks result in lengthy negotiations and often lead to delays in finalising PPAs. These challenges can cause delays as they can make it difficult to get licences to generate electricity, approve tariffs and authorise network servers. The lack of standardised templates or guidelines for PPAs increases transaction costs and complicates contract negotiations. Uncertainty about regulations, including inconsistent policies or shifting government agendas, makes investors hesitant. Several power markets across Africa might undergo significant restructuring in the coming years. PPAs need to address how these changes affect the parties involved in the contracts[9].

Bankability

There are not enough financially stable off-takers willing and able to enter into long-term PPAs. This poses a significant barrier to project financing and a high risk to power developers and investors who must fulfil PPA payment obligations. Limited access to funding in Africa exacerbates the issue of inactive PPAs as developers struggle to secure financing without long-term revenue certainty.

Additionality is the concept that purchasing more renewable energy will lead to more renewable energy capacity being created, resulting in environmental benefits as power is added to the grid rather than being redistributed. Additionality is essential for reducing emissions through renewable energy procurement mechanisms. To achieve genuine carbon emission reductions, additionality must apply, and not all renewable energy procurement mechanisms are equally effective in this regard. There is growing concern that some companies use low-impact instruments to reduce their market-based scope 2 emissions (those resulting from purchased electricity) without driving real-world changes in emission reductions[10].

Market mechanisms must result in the installation of additional renewable energy generation capacity.

9 Baker McKenzie. (2019). Opportunities for corporate procurement of power in sub-Saharan Africa.
10 SBTi. (2022, June 10). Addressing the challenges of scope 2 emissions reporting.

1.5 Complex regulatory frameworks and political risk

Complex regulatory frameworks and political risk in Africa present significant obstacles to the decarbonisation of the grid, particularly in terms of expanding renewable energy deployment. While many African countries have abundant renewable energy potential. Progress in scaling these technologies is often slowed by intricate and inconsistent regulations, coupled with political instability and risk.

Firstly, regulatory complexity – including unclear permitting processes, fragmented responsibilities between ministries, and constantly changing policies – creates uncertainty for investors and project developers. In many cases, developers face protracted approval timelines, duplicative compliance requirements, or unclear rules about grid access and power purchase agreements (PPAs). This not only increases project costs but also introduces delays and risks that deter private capital, which is essential for renewable energy scale-up. For instance, in some countries, independent power producers (IPPs) must navigate a maze of bureaucracy to secure licenses, with little transparency about timelines or criteria for approval.

Secondly, political risk, including policy reversals, government interference in tariff setting, and concerns about contract enforcement, undermines investor confidence. Changes in government can result in shifting energy priorities or the renegotiation of signed agreements, as has occurred in several African states. This unpredictability discourages long-term commitments from both local and international investors. Moreover, in countries with state-owned utilities suffering from weak financial health, the risk of non-payment for electricity supplied under PPAs can further undermine renewable project viability.

1.6 Limited private sector participation in transmission and distribution

Most of Africa's power sectors are vertically integrated (where all elements are owned and managed by one entity), with only about a third of these utilities incorporating private sector participation. Unbundled power utilities (where elements are owned or managed by multiple entities) are less common in Africa.

Noteworthy examples of countries with unbundled power utilities that permit private sector involvement include Angola, Kenya, Nigeria, Ghana, and Uganda . Although many countries in Southern and East African regions allow private sector participation in the power sector, most African governments do not.

Private sector involvement in power generation in Africa is rising, but their participation in transmission and distribution remains limited due to hesitation from government and regulatory challenges.

Governments usually favour privately owned generation above privatising transmission and distribution. Transmission networks are usually centrally planned and organised to a very high degree by the government or state-owned entities, and opening up the network and involving third parties can be seen as a loss of control, particularly for governments, which often see transmission infrastructure as strategically significant Invalid source specified. The private sector is also reluctant to invest in transmission infrastructure. It is complex and challenging to navigate, and the return on investment is uncertain. Delineating roles and responsibilities between the private sector and state-owned utilities in the transmission system is tricky, as it would require legislation and regulation to allow private sector participation.

1.7 Cost and technical challenges of powering base stations with green mini-grids

Mini-grids present a significant opportunity to address the need for reliable and clean power supply to mobile network base stations (see Figure 3 and 4 – noting this excludes North Africa since this region relatively has high electricity access as discussed in Chapter 1, Figure 1). They mutually benefit base station companies and mini-grid developers. Mini-grids are the most cost-effective solution for rural communities where over 200 inhabitants are near a road but more than 10km from a primary grid. Mini-grids are considered the most suitable solution for around 30% of new household connections that are 10km to 20km from the existing grid. Mini-grids will increase to 65% of new connections in communities more than 20 km from grid infrastructure[3].

Base stations are fixed points in a mobile network that connect mobile devices to the wider network by transmitting and receiving signals within its coverage area, enabling communication and data transfer. Using mini-grids, companies that operate base stations can secure clean and reliable power in off-grid locations. Base stations are key anchor customers to mini-grids and provide consistent revenue streams. Base station companies can afford higher prices compared to households, which contributes to the sustainability of mini-grids and presents a business case that is more cost-effective than sole reliance on diesel generators. This shift to cleaner energy sources will result in more stable operational expenses for base station companies.

Several challenges must be addressed to power base stations through green mini-grids effectively*, these include:

- Base stations must be within the designated concession area where the mini-grid is authorised to operate. These base stations are not always guaranteed to fall within a mini-grid's concession area. Furthermore, mini-grid developers often lack control where concessions are granted.
- Technical requirements, such as a mobile network base station's need for three-phase power and the construction of long power lines, pose additional challenges for mini-grid developers. The remote location of base stations requires long medium-voltage (MV) transmission cables, which are too expensive for the mini-grid developer to develop.
- Mini-grids may struggle to provide 100% renewable electricity, particularly during nighttime operations when diesel generators are required for the energy supply. Achieving complete reliance on renewable sources may not be commercially viable. Currently, mini-grid developers typically achieve around 75% renewable energy generation.
- Some countries do not permit TOU tariffs for mini-grids, so MNOs will not be able to recover the higher costs of running diesel generators at night.

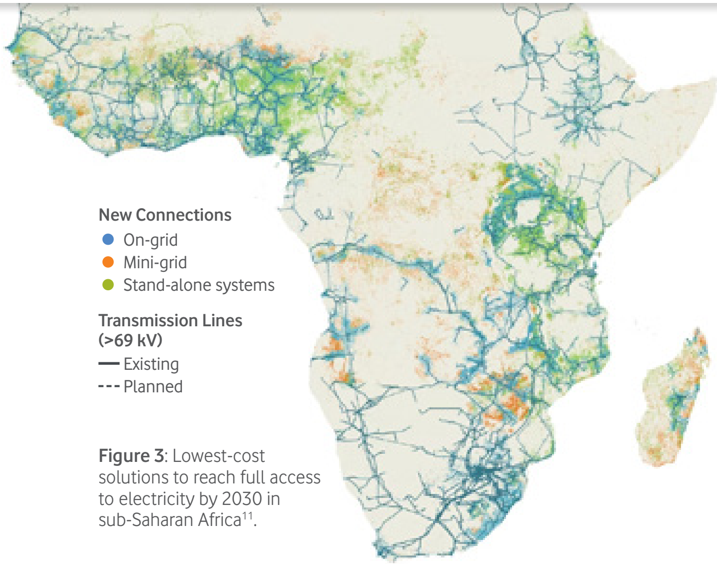

Figure 3: Lowest-cost solutions to reach full access to electricity by 2030 in sub-Saharan Africa[11].

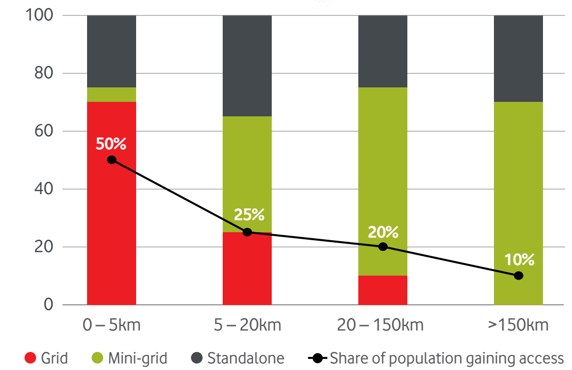

Figure 4: Share of new electricity connections by technology and distance from a grid in sub-Saharan Africa in the IEA's Sustainable Africa Scenario, 2022-2030[3].

Mini-grids provide a cost-effective, reliable power source for mobile network base stations in remote areas, benefiting mini-grid developers and base station companies.

Powering mobile network base stations through mini-grids presents several challenges, including costly technical requirements and the inability to provide 100% renewable energy.

Footnote 3 referenced above can be found on page 3.
11 IEA. (2020, November 20). The Covid-19 crisis is reversing progress on energy access in Africa.
* This section excludes wider and more commonly known market barriers that impede mini-grid development, and instead focuses on the nuanced challenges of powering a telecommunication tower with a mini-grid.

1.8 Conclusion

Primary electricity infrastructure, policy and regulatory decarbonisation related challenges for governments and utilities discussed in this chapter are summarised below. Possible solutions will be outlines in the next chapter of this series.

Absent or unreliable electricity supply

Many regions in sub-Saharan Africa, mainly rural areas, lack ade-quate grid infrastructure. About 600 million people do not have access to electricity, and others suffer frequent power outages[2]. This severely limits socioeconomic development and impacts business operations.

Financial constraints and limited capacity of utilities

African utilities often operate at financial deficits due to underpriced tariffs, poor payment collection, theft, vandalism, operational problems, and high network losses. Thus, utilities cannot extend the grid, maintain existing infrastructure and develop new generation capacity to meet demand.

Carbon intensity of the grid

The amount of carbon emitted by electricity grids varies significantly across Africa. Some countries rely heavily on fossil fuels, which leads to high carbon emissions.

New market mechanisms to procure renewable energy

The lack of methods to procure renewable energy is a challenge to decarbonisation. Most African countries lack frameworks for PPAs, RECs, and other market instruments.

Complex regulatory frameworks and political risk

Unclear and complex regulatory frameworks and political instability deter investment in renewable energy. Inconsistent policies and shifting government agendas create uncertainty for investors.

Limited private sector participation in transmission and distribution

Governments are often reluctant to allow private companies to run electricity networks (transmission and distribution methods), and the private sector is hesitant to invest due to complexity (affordability, regulations and policy) and uncertainty about return on investment.

Cost and technical challenges of powering base stations with green mini-grids

Powering mobile network base stations through mini-grids is challenging due to high connection costs, especially in remote locations requiring long, MV transmission lines. Achieving a 100% renewable energy supply is not profitable currently.

Footnote 3 referenced above can be found on page 3.