Global Grids, Money and Models
Unblocking Investment and Unlocking Africa’s Renewable Energy Future

In collaboration with

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Executive Summary

Across the world, electricity grids are under growing pressure. A rapidly changing energy landscape – swapping fossil fuels for renewables – means grids are having to quickly adapt.

New renewable energy projects are taking longer to connect to the grid, and the cost of connecting wind and solar farms to the grid is also on the rise. In many countries, archaic grid systems are frequently touted as one of the biggest barriers to the decarbonisation of electricity. Renewable energy generation has seen extensive innovation and investment – now grids must follow suit.

Globally, transforming grids to meet our future needs is going to require USD 21 trillion of investment by 2050. This is needed to fund over 80 million kilometres of electricity lines by 2040, equivalent to the total amount installed over the last 100 years.

Increasing investment into grid systems is also an investment into socio-economic development - expanding access to affordable, reliable and sustainable energy for all, as highlighted by the United Nations’ Sustainable Development Goal 7, is a major priority. Across Africa, over 600 million people continue to be without access to reliable electricity. As we work towards a global energy system that is ultimately inclusive at its core, it is vital that all people are empowered by access to electricity.

Throughout the African continent, nations are diverse culturally and economically. Their renewable energy resources also vary considerably. There’s no one-size-fits-all. The most suitable grid infrastructure solution will depend on the unique conditions of each country and local areas within it. In some rural areas, a decentralised approach to electrification is best, with 27 million people in Africa already gaining access via mini-grids – small groups of connected generators independent from the national grid.

Following extensive conversations and workshops with industry experts globally, this report has identified an overarching opportunity for the private sector to help accelerate the build-out of national grid infrastructure across Africa and unlock even more funding.

The following themes have emerged: the need for greater collaboration between the public and private sector, the necessity to place people at the heart of any grid development, the opportunity to utilise advances in digital technologies, and the importance of creating policy environments that enable innovation and change.

We believe that together this has the power to catalyse the shift to a cheaper, cleaner and fairer energy system for everyone.
## Glossary

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Acknowledgements

This report represents a summary of interviews and workshops held with electricity grid experts, financial institutions, grid developers, digital grid researchers, and several charities supporting rural electrification in Africa. Insights gathered from these discussions, as well as our own research, guide the content of this report. This report, however, is far from exhaustive. The topic of electrification in Africa is multifaceted, very complex and with no single answer, nor ‘right’ solution. It is intended that this work acts as a conversation starter, bringing together key stakeholders and enabling an ongoing dialogue which ultimately leads to accelerating access to clean reliable electricity in Africa.

To all the individuals and organisations that have lent their time and expertise to this project, thank you for your dedication and patience.

Actis  
Africa 50  
African Development Bank  
Bboxx  
Carbon Trust  
Centre for Net Zero  
Convergence  
Energy Institute  

ESMAP  
Energy Systems Catapult  
Gridworks Partners  
International Finance Corporation  
Masdar  
Mission Innovation  
Octopus Energy  

ReNew Power  
RMI  
Siemens Energy  
Southern Africa Power Pool  
Standard Chartered  
Sterlite Power  
Sustainable Energy for All
Introduction

Electricity grids worldwide are under pressure to adapt in a changing energy landscape. Current grids were built for a different paradigm around largely fossil-fuel based power generation. As the world evolves to clean energy systems, modernising and expanding the grid will be critical to better integrate renewable energy generation and enable a more just distribution of resources. The scale of transformation cannot be overstated.

While the shift to clean energy represents a challenge to grids, in Africa and many countries in the Global South, it also represents an opportunity to accelerate electrification, reduce the cost of energy, and supercharge national and local economies.

As Africa continues to work towards achieving Agenda 20631 – the continent’s flagship development blueprint to achieve inclusive and sustainable socio-economic development – clean, affordable and reliable energy will be key to bringing this vision to reality. To meet the target of universal energy access, African countries will need to overcome a number of challenges. Existing networks can be unreliable with power cuts commonplace and grid operators frequently running with commercial losses.

Despite these barriers, there is a major opportunity to transform grids across Africa to secure a clean and prosperous energy future. To unlock these opportunities, investments must be scaled rapidly, harnessing new financing structures, making best use of advances in technology and Africa’s most abundant resource – its innovative people.

In September 2023, world leaders gathered at the inaugural Africa Climate Summit in Nairobi, Kenya, and set the stage: Africa is taking control of its energy and economic future. Green growth will provide sustainable economic development and empower African nations on the global stage.

The Nairobi declaration, published after the Summit, called for reform of the global financing architecture, outlining how climate financing represents a huge opportunity for Africa and for the world.

This report examines the challenges impacting grids in Africa and sheds light on the actions needed to overcome them to achieve a more sustainable energy system on the continent. Drawing on interviews with over 50 organisations from Africa and the rest of the world and two workshops with global experts, this report synthesises our findings and extracts recommended actions that can make the most positive impact.

This report focuses on two core themes: ‘Money’ and ‘Models’. As referenced by Mark Carney at COP26, the money for funding the climate projects is available, but there must be innovation in project financing with new styles of projects into which the capital can be deployed.2

The ‘Money’ section explores the pivotal role that the public sector and Development Finance Institutions (DFIs) have played in grid development to date. It also looks at the

1 African Union, Agenda 2063: The Africa We Want, https://au.int/en/agenda2063/overview
investment gap that remains and the important role that the private sector investment must play in developing electricity transmission infrastructure.

Through closer collaboration with the private sector, greater early-stage project support, and adjustments to investment targets, DFIs can act to suitably de-risk projects and bring the scale of private sector to bear in financing Africa’s future grid. Moreover, additional innovations overcoming barriers such as market volatility and enabling private ownership within national grids are also being pioneered on the continent.

The ‘Models’ section takes stock of the opportunities arising from the skills potential of people across Africa, the innovations in data and digital technologies, and smart grids. Africa’s population is the youngest in the world and by engaging local communities, providing skills and training, local green economies can be fostered, unleashing a new wave of sustainable growth.

In addition, advances in artificial intelligence (AI), smart grids, digital technology, and demand flexibility have huge potential to unlock cheaper energy systems in countries across Africa, enabling countries to leapfrog many of the challenges associated with ageing and creaking grid networks found in the Global North.

Although this report focuses on grid expansion as a key route to reliable, clean energy, it recognises the need for multiple solutions and technologies. In sub-Saharan Africa, mini-grids and off-grid solutions will also be crucial in the electrification of more rural communities. The ideal solution will depend on the specifics of each community, determined by factors such as distance to grid, community size and wealth, local energy resources and so on.

Regardless of which is the best route forward for each community, grid expansion remains an important factor, as it can connect communities that were historically using mini-grids and offgrid solutions. Being connected to the grid can reduce the cost of electricity and improve reliability. This is recognised by the International Energy Agency (IEA), which estimates that for 42% of those gaining energy access by 2030 in Africa, grid expansion is still the most prudent option for electrification.³

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An Analysis of Grids Globally

As the transition of energy systems from fossil fuels to renewable sources gathers pace around the world, electricity grids will play an essential enabling role. Not only do grids need to accommodate new, more decentralised and more variable generators, but also meet rising electricity demand. The electrification of heating/cooling, transport, cooking, and more is poised to raise global electricity demand by 25–30% by 2030. This shift is not without challenges. Globally, electricity grids have been stretched to capacity and connecting new renewable generation to the grid is becoming increasingly difficult. Around the world, at least three terawatts (TW) of renewable power projects are currently in grid queues waiting for a connection. This is equivalent to five times all the solar and wind capacity added in 2022. Tackling these long grid connection queues and rising connection costs will be vital to meet net zero.

Grid Investments have Stagnated over the Last Decade

Over the last decade, global investment in power generation capacity has grown significantly, including an all-time high of USD 600 billion in 2022 for global renewable energy investment. However, in this same time frame, global investment in grids has mostly remained static at around USD 300 billion annually. The majority of these grid investments have occurred in advanced economies and have focused on grid upgrades to handle increased electrification and grid balancing to cater to new renewable energy sources. To meet global net zero targets, USD 21 trillion will need to be invested in the electricity grid by 2050. They will also need to emphasise digitalisation and grid modernisation, and an increased role for private sector investment.

Electricity Grids in Africa

While there have been advances in electrification across the African continent in recent decades, investment in transmission networks hasn’t moved as fast. Exacerbated by the COVID-19 pandemic damaging national economies, and high global interest rates driving up the cost of borrowing, investment into grids has stagnated.

Globally, over 80 million kilometres of grids need to be added or refurbished by 2040 to meet global clean energy goals.

Grid challenges are not unique to Africa, but Africa’s grid infrastructure has experienced underinvestment, leading to poor reliability, inefficient operation, and commercial losses in many instances. African utility operators are facing financial difficulties, making it challenging to attract the investment needed to overcome their operational problems. This often leads to power cuts for end users, which either severely impacts daily activities, or requires back-up diesel generators as an alternative power source.

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4 IEA, Africa Energy Outlook
5 IEA, Electricity Grids and Secure Energy Transitions
Today, Africa has fewer kilometres of transmission lines per person than any other region (refer to the figure below), but it is seeing rapid innovation and electrification. For example, 27 million people now have access reliable energy through mini-grids9 - more than any other continent. While the variable intermittent nature of renewables can cause grid-related challenges in Africa, the low-cost and decentralised nature of mini-grids are driving a rural energy revolution.

To date, African grids have been funded through a combination of public sector funding and DFI loans, grants, and guarantees with multilateral development banks (MDBs) - a subset of DFIs - playing a central role. According to a recent joint report by the IEA and African Development Bank (AFDB), annual investments of USD 50 billion are needed by 2030 for grids in Africa, more than quadrupling from the USD 12 billion that was invested between 2016 and 2020.10

Energy transmission is a linchpin for decarbonisation, and some of the positive innovations already emerging in this space have the potential to unlock new financing, enable flexibility through smart grids and drive efficiency through digitalisation.

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There will need to be a fourfold increase in current annual investments in the grid infrastructure in Africa to meet the continent’s growing electricity demand and reach universal energy access by 2030.

To meet this challenge, investment in grid project development must shift beyond dependence on public capital and attract private financing. With successful examples of grid build-out in South America and India, private sector investment can be used effectively to rapidly scale grid investments. Strong collaboration between the public and private sectors can lead to well-structured projects with lower risks, and therefore be more likely to attract private investment.

Public Finance Has, and Will Continue to Play a Key Role

Historically, grid projects in sub-Saharan Africa have been made by state-owned utilities, mostly funded by government through DFIs, and underwritten with sovereign guarantees. MDBs will continue to play a key role in funding grid development in Africa achieving a huge amount of positive development. However, there is an opportunity for MDBs to operate more effectively, better supporting sector development, electrification, and the entry of new external investment. MDBs can do more by leveraging their balance sheet to provide more concessional finance (financing that is preferential to that available on public markets, often containing grant elements) to developing countries (see case study below on AfDB’s ‘synthetic securitisation’).

Case Study:
The African Development Bank is freeing up capital for renewable energy investment

The African Development Bank (AfDB) has shown tremendous success in crowding in public private financing for Africa’s development with its balance sheet optimisation program.

Specifically, the AfDB executed what is referred to as the Room 2 Run Program (R2R) which now includes three transactions: two on the private sector portfolio and one on the sovereign portfolio. The ‘synthetic securitisation’ transaction, which covers 45 private sector loans from the Bank’s existing portfolio, was executed in November 2018 and was the first ever structure of its kind between a multilateral and the private investor market where the bank transferred a portion of risk from a portfolio of loans to institutional and public sector investors. The transaction created at least USD 650 million in additional lending headroom for the African Development Bank to specifically target, on a best effort basis, renewable energy transactions with the unlocked risk capital.

The AfDB concluded the Room 2 Run Sovereign in October 2022 with the transaction releasing an estimated USD 1.8 billion in additional lending capacity to support climate finance initiatives across both mitigation and adaptation. This is one of the ways the AfDB is creating new pathways that enable Africa’s development projects to benefit from new sources of private capital.
MDBs can leverage their capital to help move projects past their early stages, in turn creating a pipeline of bankable projects to invest in further. Grants and concessional debt from MDBs are critical to support early-stage project preparation activities such as feasibility and social impact studies, which, while necessary, do not typically generate returns right away so can be difficult to attract funding for. While traditional private sector investors are less likely to fund “riskier” early-stage projects, MDBs and impact investors should take steps to further support projects at this stage so they can progress and gain more funding along the way. Development banks can also provide direct equity investments to early-stage companies/projects, like Canada’s BDC Capital suite of equity financing products.\(^\text{12}\)

More comprehensive targets or mandate adjustments should be made for MDBs to encourage early-stage project support and project exiting, to avoid direct competition with the private sector, and to drive for greater use of blended finance. Blended finance is the mixing of public financing with private capital often to reduce investment risk. MDB’s concessional financing can act as a catalyst for additional private capital, amplifying the positive impact of the MDB investment. MDBs can do more to leverage their concessional finance, de-risking grid projects through credit enhancements, guarantees, and risk sharing.

A recent intervention to address the funding gaps in financing clean energy infrastructure globally is the Just Energy Transition Partnership (JETP). The JETP takes an innovative approach. It leverages international cooperation to accelerate heavily coal-dependent countries to make a just energy transition.\(^\text{13}\) It focuses on expanding access to public and private finance to support critical energy system investment needs – and in a way that addresses any social consequences involved in this shift. JETP funds, mostly in the form of concessional debt and grants, are expected to mobilise additional private investment. Piloted with South Africa, the JETP has now expanded to include Indonesia, Vietnam, and Senegal.

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At COP26 in Glasgow, the governments of South Africa, France, Germany, UK, US, and the EU (the International Partners Group – IPG) announced a new ambitious, long-term Just Energy Transition Partnership (JETP) to mobilise an initial amount of USD 8.5 billion over the next three to five years to support South Africa’s energy transition.

The JETP will provide investment in the priority sectors of electricity, new energy vehicles and green hydrogen. For the electricity sector, a key focus for South Africa is strengthening the transmission grid infrastructure to accommodate the shift to renewable energy. One of the initial JETP technical assistance grants will explore three distinct areas of technology that are critical near-term priorities for South Africa’s grid: AI tools for system stability, energy storage systems and market modelling for cross-border energy trading structures.

While the initial JETP commitment is a fraction of what is needed for South Africa’s overall energy transition, new models of international cooperation that support a just energy transition should be encouraged around the world.

As of October 2023, funds promised under the JETP for South Africa have increased to USD 12 billion with the Netherlands, Denmark, Canada, Spain and Switzerland joining the Partnership. The grant portion of the funds has also doubled after calls from South African officials to increase the grant component of the deal. 

Reuters, South Africa’s climate grant funding from rich nations doubles to $676 mln, https://www.reuters.com/sustainability/cop/south-africas-climate-grant-funding-rich-nations-doubles-676-mln-2023-10-19/

Private Investment Needs to Play a Bigger Role

Public sources of funding have to date done most of the heavy lifting in large grid projects through concessional loans and grants.

As the scale of funding required to meet electrification targets increases, the public and private sector must work together closely to fund transmission projects and help meet renewable energy goals.

This will not only increase the pool of available capital, but also release public financing to focus on less commercial, but no less crucial, infrastructure.

A major barrier to private sector investment in Africa often cited is the perceived risk in these projects – although perceived risks are often inflated relative to reality and driving up the cost of capital and increasing overall project costs. To overcome this barrier, political and financial de-risking will be crucial. A selection of tools can help mitigate project risks, including: insurance products such as those against political risk and operator illiquidity, guarantees which support credit risks and much more. This can also be mitigated through a series of successful projects which provide a helpful track record for private sector investors to look to. In addition, the economics of the development of renewables and grid infrastructure are favourable in Africa. And through new grid investment models, the private sector’s appetite for grid projects in Africa can be rapidly scaled.

While there is increasing progress with investors working closely with governments, utilities, and regulators to deliver projects in Africa, in tandem there needs to be a policy and regulatory environment that encourages and unlocks private investment.

Revamping the licensing and permitting requirements that different regulatory bodies and governmental departments need for renewables projects is one opportunity. Projects have been known to require dozens of approvals and can be delayed by months or years if one of these approvals is withheld.

South Africa’s Renewable Independent Power Producer Programme (REIPPP) is an example of an intervention to streamline this area. The REIPPP simplifies the process for Independent Power Producers to add new renewable electricity capacity. Through a series of ‘bid windows’, winning projects are awarded long-term power purchase agreements (20 years). To date, renewables (most of which built under the REIPPP) stand at about 6,200 megawatts which is around 10% of the country’s electricity capacity. Despite challenges with the programme, African policymakers can learn a thing or two from the REIPPP.

Rwanda is pioneering new renewable policies as well.

The Rwandan government is implementing policies that remove market-entry barriers to attract private sector investment in the development of renewable energy, such as mini-grid and other renewable projects.

It is streamlining regulatory procedures by developing a “one-stop shop” for mini-grids with benefits including community engagement, local capacity building, and economic development around the mini-grid sites.¹⁷

To really encourage more private sector investment, it’s important for countries in Africa to expand their local currency financing. This will address currency risks associated with borrowing in foreign currencies. Two interventions to expand local currency financing have worked well in Nigeria - the Nigeria Infrastructure Debt Fund (NIDF) and InfraCredit – as outlined overleaf.

A significant barrier to scaling up infrastructure financing on the continent is foreign exchange risk, or ‘forex risk’.

Traditionally, infrastructure in Africa has been predominantly financed by ‘hard’ (stable) currencies such as the USD, but project revenues have been in ‘soft’ (volatile) local currencies. This mismatch between debts and revenues exposes projects to substantial risk. The solution is to expand local currency financing capabilities.

**Nigeria Infrastructure Debt Fund**

Nigeria Infrastructure Debt Fund (NIDF) is Nigeria’s largest and Africa’s first-ever listed infrastructure fund, providing long-term local currency financing for infrastructure projects in Nigeria. Since it was set up in 2017, NIDF has emerged as the largest provider of long-term financing for private infrastructure projects in Nigeria, all in Nigerian naira (NGN). With its current capital base of over NGN 92 billion, NIDF has a portfolio of infrastructure loans in a broad range of sectors including power generation, energy infrastructure, transportation, marine infrastructure, student housing, as well as digital infrastructure. The NIDF helps to address the issue of unsustainable mismatches of currency and tenor between financing and revenues/cash flows, one of the key challenges that project developers face.

**InfraCredit**

InfraCredit is a local currency guarantor established in 2017 to enhance the credit quality of debt instruments issued to finance creditworthy infrastructure assets in Nigeria. Since inception, InfraCredit has issued guarantees to mobilise NGN 183 billion (USD 223 million) in 17 different infrastructure projects with over 19 local pension funds investing in the guaranteed debt instruments, demonstrating appetite from the domestic market. One of InfraCredit’s portfolio companies, North South Power issued a NGN 8.5 billion (USD 10.4 million) 15-year green guaranteed bond in 2019 which financed the operation of their hydro dams and was able to go to the market two years later for a second issuance without a guarantee.

More recently, InfraCredit announced an innovative blended guarantee to support an aggregated portfolio of off-grid renewable energy providers, a sector that pension funds generally consider too small and risky. The UK-funded Climate Finance Blending Facility provided subordinated debt which, combined with InfraCredit’s guarantee, was able to mobilise NGN 1.8 billion (USD 2.1 million) from local institutional investors to support two projects: an off-grid rural electrification project and a solar-powered rural telephony project. To date, InfraCredit has been able to leverage its own equity threefold via its guarantees, demonstrating the catalytic impact of first-loss capital.
To encourage private investment in transmission grids, African governments are embracing new grid business models. An example is independent transmission projects (ITPs). This involves the construction and maintenance of a single transmission line or a package of transmission lines under a long-term contract, generally between the state-owned utility that is responsible for transmission and the (private) project company that is established to undertake the project. Though nascent in Africa, ITPs offer an opportunity to attract private investment to grid development, as illustrated by the following case study in Tanzania.
Gridworks is developing and investing in the North East Grid transmission project in Tanzania as an Independent Transmission Project (“ITP”).

A Memorandum of Understanding was signed by Gridworks with the national utility TANESCO in July 2023. The North East Grid project is part of the Government of Tanzania’s 2025 Power System Master Plan and is being structured in three phases. Gridworks is developing the phase of the project that includes a 400kV transmission line from Segera (in the eastern part of the country) to Kisongo (in the north-east), a 400kV transmission line from Chalinze to Segera (in the north-east) and a 220kV from Segera to Tanga (in the north). Gridworks will also develop new substations at Same and Tanga and upgrade the Segera, Chalinze and Kisongo substations.

Gridworks’ investment will increase the reliability of power supply in the coastal and north-eastern region of Tanzania by reinforcing the transmission infrastructure and providing alternative routes for power transfer. The project will cater for increased demand in the key national load centres of Arusha, Kilimanjaro and Tanga regions. It will also stabilise power supply in the Tanga region, specifically to the manufacturing industries in the region. The grid extension will also support regional inter-connectivity with neighbouring Kenya.

This project will most importantly help to shape the market by demonstrating how private sector finance can be used for transmission, creating a precedent for a bankable structure and regulatory model in Tanzania and more broadly on the continent.
The model by which a grid project is developed is as important as how it is financed. Through careful holistic consideration, the positive impact on communities, cities and entire countries can be greatly enhanced.

Placing people at the heart of decision-making empowers them. It’s vital to create an enabling environment for grid development that accelerates projects and unlocks innovation.

This report highlights some key considerations when building grids of the future.

People Power

Consumers of the Future

People power means providing customers with the tools and resources they need to become a part of a sustainable future grid. This idea aligns with the principles of a just transition, where everyone should benefit from the opportunities that come from clean energy.

Due to the low-cost of renewables, communities are empowered to own their own electricity generation, democratising access to energy. The shift away from traditional, centralised power generation transforms people from passive consumers of energy to active energy market participants.

Many grid models exist from pay-as-you-go off-grid solar home systems, to mini-grids, on-grid solutions, or network expansions. All solutions should be explored in a complementary and community-led approach.

Historically, grid planning has worked by building the grid to match the highest level of demand at any given moment. Newer business models include products like smart tariffs, which reward customers who shift their consumption away from peak hours and reduce pressure on the grid.

For example, in the UK, Octopus Energy’s ‘Saving Sessions’ scheme awarded GBP £5.4 million to almost 700,000 customers who reduced consumption away from peak periods. Models like this can become more prevalent and more automated, through smart metering, scaling Internet of Things (IoT), and AI. For example, Octopus Energy’s ‘Intelligent Octopus’ tariffs leverage its tech platform Kraken to automatically shift consumption to the cheapest time, helping with constraints on the grid and making big savings for customers.

Community-Centred Development

Building new large-scale grid infrastructure can take anywhere between five to 15 years from planning to completion. Permitting issues, environmental concerns, and negative economic impact on local communities are a few of the common challenges encountered if communities aren’t properly consulted and involved – all of which can be overcome when new grid build-out is approached with a people-centric mindset.

IEA, Electricity Grids and Secure Energy Transitions
This begins with early and sustained engagement and consultations with local communities and stakeholders. Grid development should be conducted in collaboration with host communities to ensure that local needs and priorities are defined and supported, to build local capacity for accessing and using resources, and to source policy ideas from people in the community impacted.

**A worthwhile project is one the community wants, is involved with, and directly benefits from.**

Failure to engage the community can lead to unforeseen roadblocks, missed opportunities, and even project failure. Grid development planning policies focused on local economic development must provide a pathway toward wealth building and economic prosperity for these local communities, and drive economic development and new job creation. Explicit consideration of disadvantaged communities must be included when planning grid projects to ensure that renewable energy grid development is equitable and inclusive.
Skills and Training

Skills and knowledge gaps are both a challenge and an opportunity. The IEA projects that four million energy-related jobs will be created across the African continent between 2021 and 2030, with 700,000 of those jobs specifically for grid extension. This is welcome news for a continent where roughly 70% of the population is under the age of 30. Also, women and girls are actively finding solutions and innovating at the frontlines in their communities. More renewable energy jobs can result in the positive inclusion of youth and women, two groups that suffer disproportionately from energy poverty and broader economic disenfranchisement. With the right investment in skills and workforce development, there is a huge opportunity to equip youth and women to take on job opportunities across the electricity value chain.

To unlock this potential, investments must be made in education, training, skills development and knowledge transfers. African countries also need the planning, institutional and technical capacity to support these investments.

Building a workforce to support clean energy job development requires both foundational technical training and sharing of best practices.

It also requires the rapid scaling of new industry ecosystems and peer networks, governance, leadership and planning capacity, and opportunities for hands-on experience with real-time projects. Complementary global and regional platforms can provide new energy practitioners with access to curated information, tools, peer-to-peer problem-solving and coaching networks.

Social impact activities that promote equity – such as training workers or supporting local communities – struggle to attract capital as they are viewed as not generating direct investment returns (or at least not immediately). As a result, funding for these activities has been limited to government programs and grants. Investors and grid developers need to explore innovative financing mechanisms to invest in communities and talent that look beyond traditional financial “returns” and focus on the dividends that can come from investing in people.

19 United Nations, Young People’s Potential, the Key to Africa’s Sustainable Development, https://www.un.org/ohrlls/news/young-people%E2%80%99s-potential-key-africa%E2%80%99s-sustainable-development
Data and Digitalisation

Energy is entering into the digital age, creating opportunities for rapid innovation. The volume of data is growing at an exponential rate.

Global real-time data has increased tenfold in the last ten years.\(^{20}\)

Digitalisation trends will drive market transformations as has been seen in other sectors, from finance to commerce. Managing the challenge of balancing increasingly variable generation patterns (due to rising renewables penetration) and projected demand growth, is complex and requires more automation. To ensure reliability, better system visibility is required. Digitalisation presents a method for improving data collection and for intelligent action.

Digitalisation is a crucial enabler to empower consumers, allowing them to become active energy users within a dynamic energy system, unlocking cost savings and supporting grid operation. Much of this is, or will be, automated and unlocked by AI-enabled intelligent solutions and given the right policies and regulation, should lead to benefits for consumers. Policymakers, grid operators, and innovative businesses across Africa can embrace these possibilities, laying the groundwork for smart, digital grids of the future.

Digitalisation of the Consumer, a First Step to Digital Grids

A first step to digitalising electricity grids is digital metering. Modern, internet-connected metres enable not only more accurate billing, but also a more competitive, innovative retail market. Benin, for example, plans to roll out 40,000 smart metres alongside an energy management platform for consumers in Cotonou, aiming to reduce billing errors and energy losses by 5-10\%\(^{21}\). Digital metering is the foundation of dynamic, grid capable optimisation. Time-of-use tariffs provide variable electricity pricing and reward customers who consume energy outside of peak hours, reducing grid constraints and supporting a more efficient, low-cost overall system.


\(^{21}\) IEA, *Africa Energy Outlook*
Bboxx is a data-driven business transforming lives in Africa. Bboxx provides electricity to rural communities across Africa through a suite of off-grid products, using solar power and batteries.

It supports access to affordable, reliable, sustainable and modern energy for all, leveraging pay-as-you-go technology, mobile money, physical distribution and data. Reaching last-mile consumers means enabling technology access, physical access, and financial access for services. Due to their remoteness and low financial capacity, these customers are often the most impacted from financial or climatic shocks.

Through its proprietary tech platform, Pulse, Bboxx has collected vast amounts of data which it is now using to improve its service to customers. By analysing customer data, Bboxx can better understand patterns in product usage, energy consumption, and consumers’ financial behaviour - helping tailor how they serve their customers accordingly. This data informs decisions about price or product differentiation across countries. It can also help to understand how weather changes impact clients’ ability and willingness to pay for services.

Bboxx is working with multilateral organisations, investors and governments to leverage such information to accelerate sustainable energy access.
Data-driven approaches also support place-based solutions in different parts of Africa to reflect local challenges and opportunities. For example, the challenge in cities will require a very different approach than remote, rural regions.

**Globally, cities consume 78% of the world’s energy and produce more than 60% of greenhouse gas emissions.**

And Africa’s urban populations are set to rapidly increase, hosting 40% more people than today by 2030. Stable and resilient grids rely on sustainable urban planning and the power of data should be leveraged to build "smart cities" that make possible evidence-based decision-making. Cities like Nairobi – with high population growth, growing electricity demand, and high potential for renewable generation – could scale consumer demand flexibility and build renewables and batteries as community assets.

Digital technologies offer innovative data-driven solutions that can be used in energy planning to optimise grid connections and allow customers to connect to the grid simply and quickly. They also incentivise the democratisation of energy, supporting overall electrification and placing consumers at the centre of the energy transition.

Cities also have many public buildings and fleets which can work to accelerate demand flexibility. There are significant opportunities from investing into distributed energy resources, electrifying city council fleets, adopting time-of-use tariffs for public buildings and fleet charge from renewable generation and making batteries community assets. This de-risks consumer investments into local energy communities, the development of mini-grids, and the retrofitting of the existing building stock. Activities like this, underscore how to put energy planning and policy into practice and create a demand for clean electricity.

**Digital Grids of the Future**

Decentralised and people-centred energy systems are predicated on digital, as well as physical, infrastructure. Rather than firing up or down a generator, future grids will depend on managing more complex, multi-directional flows of energy from a wide variety of participants, products, and services. This requires the processing and exchange of vast amounts of real-time energy data.

Through the digitalisation of grid assets and real-time data, grid constraints can be monitored live, enabling automated flexibility in both generation and demand improving overall grid reliability at lower cost than building more large plants to manage variable load and generation patterns.

For example, seeking to address the frequent power cuts, Kinshasa in the Democratic Republic of Congo is planning to install automated substations and associated distribution systems, communicating with over 1 million clients’ digital metres in Kinshasa.

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24 IEA, *Africa Energy Outlook*
Or alternatively, a wide array of other digital solutions can support demand management and energy storage. For example, in South Africa, the public electricity utility Eskom is installing digitally managed battery storage systems to better dispatch renewables-based generation and reduce fossil fuel generation used at peak load. These will enable replacement of coal power stations with renewable energy generation paired with batteries with only 25% of the original capacity to serve the same population.

By harnessing current and future digital technologies, African grids can work to overcome many of their current challenges, accelerating access to reliable, clean energy.

### The Power of Synthetic Data

| Synthetic data is at the cutting edge of research. It is artificial data created by generative AI and can be used to fill data gaps or create entirely new datasets. Synthetic data can model any current or future consumer scenario, ensuring grids are upgraded and expanded to meet consumer needs at a minimal cost. |

High-quality demand data is a key enabler for managing future grids. It allows system planners and operators to understand grid constraints as demand increases or the network expands. Energy suppliers can also use the data to develop innovative business models, maximising the use of electricity when it’s cheapest and greenest.

However, accessing this energy data is often a challenge, either due to data privacy concerns, poor data quality, or lack of digital infrastructure. Synthetic data provides a powerful alternative. Once validated, it is scalable and removes privacy issues. It can be used to create entirely new datasets or fill holes in existing ones.

### Inconsistent and incomplete energy data in countries across Africa makes applying synthetic data in these instances even more powerful and impactful. This cutting-edge AI can help guide network expansion, upgrades, and maintenance.

The research unit, Centre for Net Zero, is currently developing Faraday, a generative AI model trained on Octopus Energy’s vast UK smart metre dataset. Producing ‘load profiles’, consumer archetypes can be created to reflect property type, seasons, or low-carbon technologies. These archetypes can then be used to model entire national populations, enabling optimisation of grid current and future grid infrastructure/investment. While much research is being undertaken privately, and some output data is available, making more of the underlying AI models publicly available rapidly compounds the opportunities for collaboration and application.

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25 Eskom, Construction of Eskom’s first battery energy storage project begins, https://www.eskom.co.za/construction-of-eskoms-first-battery-energy-storage-project-begins/

Market Catalysts

Achieving grid transformation at the pace required across Africa requires both technological innovation and an evolution of policy, regulatory and market structures.

This requires a sharing of global grid innovations and best practices from countries at different stages of energy system development. Priorities for innovation in countries with developing economies like those across the African continent typically revolve around expanding electricity access, improving utility financial performance and governance, and creating competition to incentivise greater efficiencies.

Creating an Enabling Environment through Policy and Regulation

Improving electricity access can involve expansion of a national grid. Clear and enforced market regulations ensure more efficient use of fiscal resources. This improves the financial performance of utilities and supports equitable energy access and economic development.

For example, Uganda has separated the generation segment of its energy market and has multiple Independent Power Producers, some of which are state owned, that generate power for the grid. Over the past 20 years under this structure, the country has deployed a significant amount of hydro generation capacity, which has enabled them to drastically reduce power cuts and drive-up energy access.

One of the other trends emerging in Africa is regional expansion with standardised rules and policies across countries and joint development of interconnection infrastructure. This approach can help to foster increased renewables capacity by connecting areas with high renewable potential to demand centres.

For example, the West African Power Pool - a cooperation of the national electricity companies in countries in Western Africa - plans to interconnect 14 of the 15 mainland countries of the Economic Community of West African States to improve the build-out of renewables in the region. The Southern African Power Pool of 12 member countries in southern Africa is also working to bring more renewables onto the system by addressing interconnection challenges.

A key development across emerging markets is the growth of competitive wholesale electricity markets. Many countries are introducing competition into the markets gradually through transitional arrangements. These act as a stepping stone, allowing some competition, but cautiously enough to address any design flaws as they are discovered.

To address the challenge of funding transmission infrastructure, competitive auctions have been used in some regions to aid in the expansion of transmission infrastructure. For example, in South America, market operators in Brazil, Chile and Colombia enacted reforms to centralise transmission expansion planning within government institutions but decentralise the provision of transmission services through competitive auctions.27

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Case Study: 
Sterlite Power – using technological advances to accelerate grid development

Operating across Brazil and India, Sterlite Power has used innovative techniques to overcome technical barriers and expedite grid development.

Following increased demand for electricity in the State of Rio Grande do Sul in Brazil, energy planning studies identified the need for grid reinforcement. This led to the ‘Vineyards Project’ – building new cabling to span the 368 m wide Taquari River, situated in a protected environmental area. Aerial drones were used to install guide cables between 33m towers on the river banks. This new cable launch technique using drones sped up the construction timelines and cut operation costs – and the project was completed 31 months ahead of schedule.

Not limited to pioneering new techniques in Latin America, Sterlite Power also became the first private sector power transmission developer in India to install infrastructure in the Pir Panjal mountain range in Kashmir at altitudes as high as 8,000 to 12,000 ft using helicopters. This first of its kind aviation operation helped complete the mega NRSS-29 project months ahead of schedule. Currently, Sterlite Power has deployed lightweight helicopters to expedite construction of its flagship Mumbai project that links the commercial powerhouse, Mumbai, with the Indian national grid.

Aerial innovations are also helping to bring power to the most remote corners of Brazil and India quicker and at a lower cost. And these techniques pioneered have the potential to accelerate the build-out of critical infrastructure around the world.
Potential for Grid-Enhancing Technologies

As grids globally adapt to changing generation and demand patterns, grid-enhancing technologies (GETs) can enable the existing infrastructure to be more effectively used, boosting the existing grid’s capacity while simultaneously enabling more economic renewable energy deployment and maintaining reliability.

GETs are innovative technologies that use both hardware and software-based approaches to optimise the utilisation of the existing grid. The primary technologies encompassed by GETs include dynamic line ratings, advanced power flow controls, and topology optimisation.

Put simply, they increase the capacity, efficiency and flexibility of a transmission system by enabling real-time monitoring of ambient conditions around lines or rerouting power away from congested lines and towards lines that might have spare capacity. GETs thereby unlock more capacity on the existing transmission system for new renewable generation and can reduce curtailment of existing wind and solar generation. In contrast to new transmission lines, GETs can also be installed quickly and are remarkably cost-effective.28

While these tools have yet to see widespread uptake in some markets, their impact in Africa on constrained networks could be profound.

Policy, planning, and regulatory innovations are required to create an environment that’s ripe for business and technology innovation. We recommend that governments explore more innovative solutions instead of the standard tried and tested ones. When governments create these opportunities and show they’re open to innovation, businesses will follow suit and drive forward innovative approaches.

Dynamic Line Ratings
Adjusting the carrying capacity of transmission lines based on real-time measurement of ambient conditions

Advanced Power Flow Controls
Hardware solutions that push power away from lines with capacity constraints and pull power to lines with spare capacity

Topology Optimisation
Software solutions that automatically route power flows around congested areas

Transit analogy: real-time adjusted speed limits
Transit analogy: railroad switching stations that direct trains to free tracks
Transit analogy: re-routing drivers around traffic

Source: RMI

28 RMI, Cheaper, Cleaner, Faster; https://rmi.org/cheaper-cleaner-faster/
This report has highlighted opportunities for grid development across ‘Money’ and ‘Models’, exploring four key topics: finance, people, digitalisation, and market catalysts. The following actions, to advance these opportunities, are recommended to be taken at COP28:

**Finance: Drive effective public-private partnerships to overcome barriers to private investment**

As the scale of funding required to meet electrification targets increases, the private sector should collaborate more closely with the public sector, working with governments and MDBs to deploy the capital needed. To unlock financing for grid development:

- Reform the multilateral financial system around capitalisation and deployment, governance, and debt management, and address the high cost of capital in Africa as emphasised by the Nairobi Declaration at the inaugural Africa Climate Summit.

- DFIs need to provide more concessional capital, grants, technical assistance and guarantees particularly into earlier stage projects, to encourage more private capital to flow to grid investments.

- Governments should create an enabling regulatory, legal, political, and economic environment and implement holistic approaches to remove market-entry barriers that are hindering public and private capital from flowing into critical areas across the continent.

**People: Put people at the centre of grid development**

The opportunity to unlock Africa’s grid potential is immense – it will improve lives and transform communities, achieving several of the UN’s sustainable development goals. Africa’s sustainable grid’s future will mean universal energy access, well-paying clean energy jobs, and economic prosperity for local communities among others. For people-centric grid development:

- Identify the best pathways to provide energy access to underserved communities considering different technological innovations for different scenarios while staying engaged with local communities to understand their priorities and needs.

- Empower the workforce through capacity development (skills training, peer-to-peer knowledge exchange, and hands-on learning) to build a resilient clean energy future.

- Invest in local communities ideally prioritising local entrepreneurs. Investment will need to include local infrastructure improvements as well as economic development plans that capitalise on local resources and advantages.
**Digitalisation:** Leverage digital advances to support grid infrastructure

Advances in digital technology have the potential to improve system reliability, improve customer experience, and reduce the cost of electricity. To achieve significant positive grid impact through data and digitalisation:

- Invest in digital grid infrastructure alongside physical assets to improve reliable grid operation in the short term and work towards a smart grid.
- Rollout digital metering to unlock more granular data, improve billing in the short term, and lay the groundwork for a flexible grid in the long term, which can support innovative new ways to optimise consumer demand, maximise intermittent renewable energy, and cut costs.
- Apply advancements in synthetic demand data to improvements in energy modelling and grid management, exploring the potential of synthetic data where data access is a barrier.
- Use data analytics to target solutions for consumers, particularly to improve energy access, and inform place-based local area energy planning.

**Market Catalysts:** Create an enabling environment and deploy innovative technologies

You can’t plan for tomorrow’s grids using yesterday’s plan. African utilities need to reimagine grid development through the lens of innovation, from policies and market structures to emerging technologies. To prepare markets for the grids of the future:

- Integrate generation, transmission and distribution system planning to better understand how decisions at one level of the grid might affect others.
- Update approaches to planning for grid reliability, to better understand the risks, vulnerabilities and types of solutions that can contribute to reliability, including resource adequacy and resilience.
- Incorporate new technologies, tools and processes to accelerate grid expansion.
Call to Action

This report has shown that we are at a significant inflection for grid infrastructure in Africa. It underscores the pivotal role that the private sector can play in advancing resilient and sustainable grid networks across the continent. Renewables have seen rapid innovation and investment - and grid networks must now see the same to keep up.

Globally, we stand at the precipice of transformative energy system change. Collaboration between governments, international organisations, and the private sector will provide the linchpin for long-term success. To bridge current gaps in grid infrastructure, the emphasis must be on innovative financial models, people-centric development and decision-making, and digital technology integration.

The launch of this report at COP28 represents a pivotal opportunity for advancing actionable strategies that have the potential to propel Africa towards a sustainable energy future. Now is the time for action so we can truly accelerate the shift towards a cleaner, cheaper and more resilient energy system for all.