The Renewable Energy Transition in Africa

Powering Access, Resilience and Prosperity

On behalf of the

KFW

giz Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH

IRENA International Renewable Energy Agency

Federal Ministry for Economic Cooperation and Development

Foreword

Energy is the key to development in Africa and the foundation for industrialisation. Like in Europe and other parts of the world, the expansion of renewables goes beyond the provision of reliable energy and climate protection. Economic development as a whole will benefit and new jobs and opportunities for entire industries will emerge. Reliable, sustainable energy is at the same time indispensable for ensuring that people are provided with important basic services such as health care and safe drinking water.

Considering its unparalleled potential for renewables, Africa's starting point for the transformation of the energy sector is strong. This said, electricity supply in Africa is lagging considerably. Most people in Sub-Saharan Africa face severe energy poverty. Less than half of the population had access to electricity in 2018. Further, in terms of its size and population, Africa is well behind the rest of the world with regard to the deployment of renewable energies. In 2018, only 20 per cent of the electricity generated in Africa was from renewable sources. Compared with the rest of the world, investment is low. In 2019, two-thirds of all newly added energy capacity for supplying electricity worldwide was based on renewable sources. However, only a mere two per cent of this new generating capacity was in Africa. Yet forecasts indicate that Africa could double its energy demand by 2040.

At the same time, Africa is still investing in energy from fossil fuels. A change of direction is needed in the energy sector. By harnessing the potential of renewable energy, Africa's young, dynamically growing economies can ensure energy supply is generated in line with international climate goals.

Our joint goal must, therefore, be to support African countries in transforming their energy sectors. With Agenda 2063: The Africa We Want, African Heads of State and Government have drawn up a roadmap to achieve inclusive and sustainable growth and development. One of the important topics covered is access to affordable, reliable and sustainable energy for all – SDG 7 of the 2030 Agenda. The international community, multilateral organisations and bilateral donors stand ready to partner with African countries on their path towards sustainable growth and work with them to develop and implement solutions to attain that goal.

Green energy is the answer to the challenges of climate change and a critical step for reaching climate neutrality. Without the global transformation of the energy sector, it will be impossible to achieve the 1.5 degree target of the Paris Agreement.

The prerequisites for the transformation of the African energy sector are in place. Crucial factors, in addition to know-how and technology, are the political and regulatory environment. Technology solutions are abundant, cost competitive with fossil fuels, and are ready to be deployed. The necessary elements, such as stable energy systems, reliable regulatory and financial policy frameworks, ambitious policy goals and appropriate markets, including regional ones, are increasingly available or can be realised.

This study shows how the transformation of the African energy sector can succeed and what opportunities and challenges lie ahead in the next 30 years. It identifies key tools that can be utilised to accelerate the energy transition in the African continent and achieve universal access to electricity. Most importantly, the study demonstrates that SDG 7 can be achieved in Africa by 2030. Africa can become a Green Continent.

Let us join forces to achieve this goal together.

Dr Gerd Müller, Member of the German Bundestag
Federal Minister for Economic Cooperation and Development

Francesco La Camera
Director-General,
International Renewable Energy Agency (IRENA)

Executive summary

Over the coming decades, the countries on the African continent can address fundamental challenges of energy access, energy security and climate change. Countries still suffering from energy poverty can achieve universal access to affordable, reliable, sustainable and modern energy for all by 2030, as set out in the UN's Sustainable Development Goal 7, improving the livelihoods of hundreds of millions of their citizens. At the same time, Africa can harness its abundant potential of increasingly cost-competitive renewable energy to service growing demand for electricity and avoid a potential fossil-fuel lock-in. Even with efficiency measures in place, energy demand in African economies is expected to nearly double by 2040, as populations grow and living standards improve. By choosing sustainable energy sources over fossil fuels, Africa can create new jobs, experience greater economic growth and harvest social and health benefits while helping to mitigate devastating impacts of climate change.

African leaders have made clear their commitment to attaining inclusive and sustainable economic growth and development in the Agenda 2063: the Africa We Want. Achieving universal energy access is a critical underpinning of resilient and prosperous economies and societies and remains a top priority for African nations. Successfully transitioning the energy sector will depend on political leadership and ownership of the process. To support these goals, the international community should bolster support efforts and encourage accelerated action. This study looks at the current state of play and proposes pathways for such support.

Based on an analysis of the current state of the electricity sectors on the continent, this study identifies the main enablers necessary for countries to overcome a range of barriers to a green, inclusive energy transition in Africa. Furthermore, this study outlines the need for stronger coordination in promoting the energy transition, taking into account the specific political economy of respective national electricity sectors, and highlights four focus areas where a broader set of development instruments needs to be applied in order to create a new partnership between African governments and development partners.

This study argues that African countries, bolstered by active engagement from their partners and mandated continental and regional organisations such as the African Union, could seize the opportunity to leapfrog fossil fuel technologies and pursue a climate-friendly, needs-oriented power strategy aligned with the Paris Agreement and low-carbon growth. The levelised cost of electricity from solar PV decreased by 82 percent between 2010 and 2019, while the cost of onshore wind fell by 40 percent. This means that in 2020, renewable energy is in most cases the least-cost option for new electricity generation capacity globally. Technology solutions are abundant and ready to be deployed to meet Africa's growing energy demand in an economically viable manner, while offering significant opportunities for job creation and industrial development. Importantly, energy-poor and unserved populations could get universal access to electricity. In fact, Africa's estimated potential to generate renewable energy from existing technologies is 1,000 times larger than its projected demand for electricity in 2040, which means that the continent has more than enough renewable energy potential to serve its future demand. Furthermore, renewable energy – including green hydrogen – could replace African exports of coal, oil and gas. This potential is far from fully harnessed at this point. In 2019, 72 percent of the new electricity generation capacity added globally was renewable. However, only 2,000 out of almost 180,000 MW of this new renewable power were added on the African continent. The rest of the world is increasingly transitioning towards renewable energy-based electricity systems – and Africa has the opportunity to do the same.

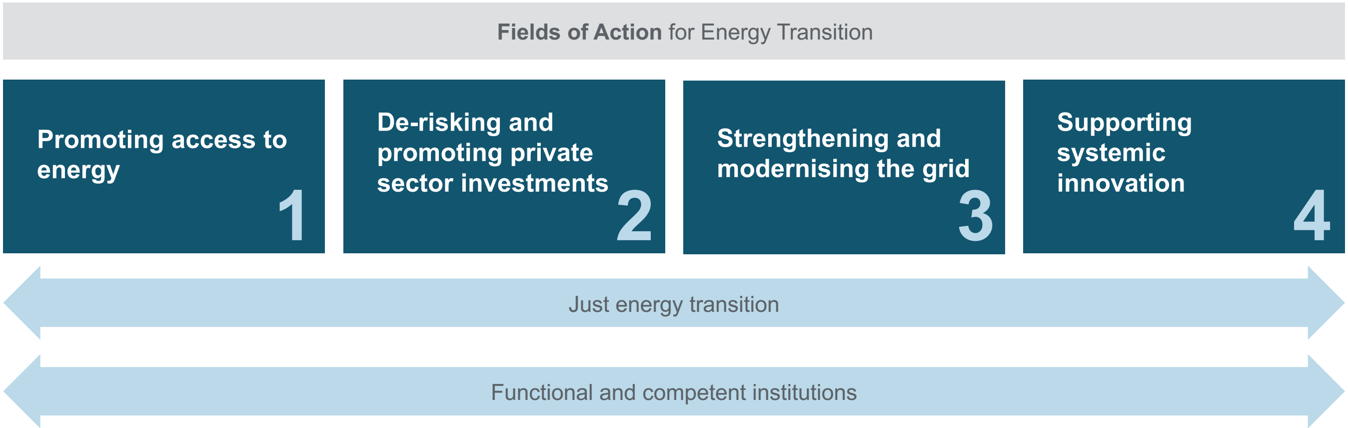
Energy transitions can be part of a strategy for a clean energy future, forward-looking industrial development, inclusive social progress and human welfare. IRENA's Global Renewables Outlook: Energy Transformation 2050 shows that decarbonising the global energy sector is more than fuel replacement. It is a means of job creation – renewables alone would account for 45 million jobs in 2050, exceeding today's 40 million energy jobs worldwide. Global GDP would be 2.4 percent higher with renewables-based energy transition, opening ample avenues for industrial development. African countries can thus leapfrog into a sustainable, secure energy future – one that fosters equitable human development and protects both livelihoods and the environment.

Accelerating energy transitions across Africa

Technology developments, falling costs for renewable energies, innovative approaches, network effects and digitalisation are opening new opportunities and making an indisputable business case for renewables. With abundant indigenous resources, Africa is well placed to leverage this potential. However, the potential and availability of cost-effective technologies alone are not sufficient. Seizing this opportunity will require strong political will, attractive investment frameworks and a holistic policy approach to fully reap the benefits of renewable energy. It also means that current average annual investments in the African energy system must double by 2030 – to approximately 40-65 billion USD.

In this context, the investments made to address the severe economic consequences of the COVID-19 crisis in Africa must spur the continent's transition towards a sustainable energy future. A relapse into unsustainable economic patterns, as happened around the world after the 2007/2008 financial crisis, should be avoided. The new partnership for the renewable energy transition in Africa, as outlined in this study, aims to support a green economic recovery.

The authors of this study envisage that this partnership will be built on four fields of action:



1. **Promoting access to energy.** Nearly half of Africans (46 percent) still have no access to electricity in their homes. Efforts to achieve universal access to affordable, reliable and sustainable electricity by 2030 must therefore be at the forefront of energy transition strategies to effectively fight poverty, enable new economic opportunities and promote equality. The speed with which modern, renewables-based solutions can be deployed will depend on a balanced combination of on-, mini- and off-grid approaches for unserved and under-served populations, and must also address the security of supply challenges, overall economic viability and affordable access.

2. **De-risking and promoting private sector investments.** The investments required to meet Africa´s growing demand for renewable energy are far greater than the funds available from public sources. By building stable, predictable enabling frameworks, identifying a pipeline of viable projects and offering targeted de-risking instruments, African governments and their development partners can facilitate the private sector investments necessary to bridge this gap.

3. **Strengthening and modernising the grid.** Many African countries have inadequate grid infrastructures designed to accommodate conventional energy sources, resulting in high electricity losses and low supply quality, among other issues. This is also a barrier to introducing and up-scaling inexpensive variable renewable energy, such as solar and wind. Improving the planning, operation and maintenance of electricity grids is of paramount importance for any form of energy transition and grid stabilisation. This needs to be combined with significant investments in the modernisation and expansion of distribution and transmission infrastructure, as well as energy storage and other technology and market solutions that improve system flexibility, reduce greenhouse gas emissions, strengthen national and regional power systems, and reduce technical and commercial losses.

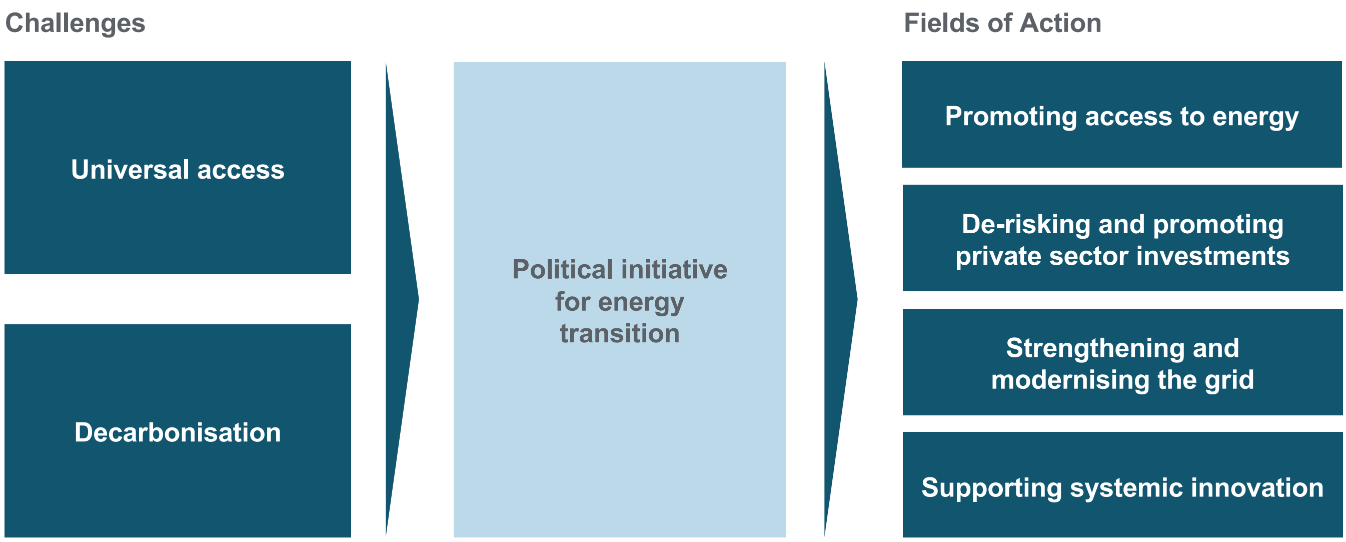
4. **Supporting systemic innovation.** For Africa to harness the potential of renewable energy a systemic approach is required. Innovative power generating technologies, such as renewable power systems combining two or more technologies (e.g., floating solar photovoltaic and pumped hydro storage) as well as off-grid renewable energy systems, combined with innovative enabling technologies (such as green hydrogen, Internet-of-Things and renewable energy mini-grids), as well as new business models, improved regulatory frameworks and system operation procedures should be adopted at scale. Innovative financing approaches – such as local currency lending, results-based financing schemes or tailor-made challenge funds – can also facilitate the energy transition, propelling economic growth and turning African countries into frontrunners in the global clean energy transition (IRENA, 2019b). Investments in innovative technologies such as green hydrogen can also create economic opportunities along the value chain.

To ensure success and sustainability, these fields of action must also systematically address two critical cross-cutting themes:

– **A just energy transition.** The energy transition can drive broad socio-economic development, guided by comprehensive policies to foster transformative decarbonisation. This holistic approach to policy making would align long-term energy transition with economic, environmental and social goals. To support a just transition – including fair sharing of the costs energy transition creates – labour and social protection policies must be tailored to the specific needs of each country and region. Social equity considerations, particularly gender aspects, must be integrated into policy and programme design in order to tap societal potential fully and to ensure no one is left behind. Dedicated and coordinated efforts in this direction are likely to contribute to overall sustainability during and subsequent to reform efforts.

– **Functional and competent institutions.** Building institutional capacity to develop and implement national policies for universal access to electricity while pursuing low-carbon development of Africa´s power sectors is a cross-cutting priority at all stages of the energy transition.

A call for political action
One of the key aspirations of the African Union’s Agenda 2063 is “to eradicate poverty in one generation and build shared prosperity through social and economic transformation of the continent”. Energy is essential to these goals. Development partners, including the European Union and its Member States, are already supporting numerous programmes and initiatives to make universal access to electricity and low-carbon power sectors a reality in Africa. Effectively contributing to the required momentum for a comprehensive renewable energy transition on the continent, however, requires a broader, more concerted initiative.



By leveraging synergies between ongoing activities at the international level, a new political initiative would amplify the impact of existing allocations and help mobilise more resources. This must include bilateral donors as well as international and regional institutions, such as the African Union, the African Development Bank and the International Renewable Energy Agency. Only a concerted approach has the potential to leverage a critical mass of support commensurate with the urgency of Africa´s twin energy challenges.

The political initiative must be rooted in countries‘ ongoing energy transitions. For it to be successful, it must be owned by countries and tailored to each specific national and local context. It must take into account each country´s readiness, capacities and needs in partnership with national and regional institutions. In the past, attempts to conduct ambitious electricity sector reforms have sometimes failed because they challenged the sector's political economy. It is crucial that governments demonstrate the political will to overcome such challenges and follow through with comprehensive reform.

This study sketches a path towards a renewable energy transition in Africa that could power socio-economic development and contribute to building a healthier planet. An essential first step will be carrying out integrated energy planning to identify the benefits of converting a given country's power sector. The outcome of this process will be a target-oriented action plan, based on which investment decisions can be made. With this analysis to hand, governments and development partners can work together to form renewable energy partnerships that drive the energy transition.

National starting points and pathways

The national-level requirements for the energy transition are well understood. Change is feasible, and solutions are at hand. Implementing the envisioned initiative is contingent upon a strong commitment from development partners and flexible, demand-driven measures and mechanisms which support a country's specific requirements (including socio-economic objectives) in its energy transition.

Building on the strong ties between Africa and Europe, this political initiative must help to realise the Paris Agreement and the AU's Agenda 2063 while also contributing to operationalising the Partnership for a Green Transition and Energy Access, as proposed in the European Commission's communication "Towards a comprehensive strategy with Africa". The recommendations of the Africa–Europe High Level Platform on Sustainable Energy Investments (EU Commission, 2019) provide further guidance in this regard.

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List of abbreviations

ACEC – Africa Clean Energy Corridor
AfDB – African Development Bank
AU – African Union
AUDA-NEPAD – African Union´s Development Agency
CAGR – Compound Annual Growth Rate
CSP – Concentrated Solar Power
CO_2 – Carbon Dioxide
CwA – Compact with Africa
EAPP – Eastern Africa Power Pool
ECOWAS – Economic Community of West African States
EU – European Union
GDP – Gross Domestic Product
GIZ – Deutsche Gesellschaft für Internationale Zusammenarbeit
GW – Gigawatt
IEA – International Energy Agency
IFC – International Finance Corporation
IPP – Independent Power Producer
IRENA – International Renewable Energy Agency
kg – Kilogram
kWh – Kilowatt-Hour
LCOE – Levelized Cost of Electricity
MW – Megawatt
MWh – Megawatt-Hour
NDC – Nationally Determined Contributions
OECD – Organisation for Economic Co-operation and Development
PPA – Power Purchase Agreement
PSP – Private Sector Participation
PV – Photovoltaic
RE – Renewable Energy
REFiT – Renewable Energy Feed-In Tariff
SAPP – Southern Africa Power Pool
SDG – Sustainable Development Goals
SEforAll – Sustainable Energy for All
T&D – Transmission and Distribution
TWh – Terawatt-Hour
UN – United Nations
USD – United Stated Dollar
WAPP – West African Power Pool

Introduction

Over the coming decades, the countries on the African continent have the opportunity to address two fundamental energy challenges. First, they can achieve universal access to affordable, reliable, sustainable and modern energy services by 2030, as set out in the United Nation´s Sustainable Development Goal 7, thereby improving the lives of hundreds of millions of their citizens. At the same time, African countries can harness the power of renewable energy, which has emerged as a technologically viable and economically attractive alternative to fossil fuels, and avoid being locked into a dependency on fossil fuel energy.

This study focuses on the electricity sector, which is responsible for the largest share of energy-related emissions in Africa. Additionally, in the long run, building robust, green electricity sectors across the continent will also enable the decarbonisation of energy end-use sectors, such as transport and industry.

The technical and commercial solutions required to provide universal access to reliable and affordable electricity from sustainable power systems across Africa are at hand. This study explores the existing structural barriers to such a renewable energy transition on the continental and regional levels, and lays out how African governments and their development partners can address these in order to enable a sustainable energy future. Country snapshots provide insights into the prospects for energy transition in 13 selected African countries, along with detailed deep dives into the transformational potential in 5 of these countries.

Seizing the opportunity for and benefits of a renewable energy transition will require political will for sector reform, including a coherent, unified approach to the promotion of renewable energy and energy access, and an effective approach to dealing with the political-economic and distributional challenges such transformations engender. This study outlines a pathway for African governments, continental and regional organisations, and their development partners to join forces in a new, concerted approach to achieving a comprehensive energy transition across Africa, powering energy access, resilience and prosperity.

The study was commissioned by the German Federal Ministry for Economic Cooperation and Development (BMZ) and is a joint product of the International Renewable Energy Agency (IRENA), the German Development Bank (KfW) and the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ).

1 Energy in Africa today

Around half of Africa's total population (548 million people) were without access to electricity in 2018 (IEA et al., 2020; World Bank, n.d.). In the same year, 900 million people on the African continent relied on traditional use of biomass – such as charcoal and firewood – as their primary source of energy for cooking. Most of these people live in Sub-Saharan Africa. Meanwhile, African businesses – from micro-enterprises to agriculture to industry – are held back by the lack of a reliable, affordable energy supply. Unless these challenges are addressed in a concerted manner, they will only intensify, as estimates indicate that the population will increase by one billion people in Sub-Saharan Africa and almost 100 million in Northern Africa by the year 2050 (World Bank, 2019a).

Only a few select electricity sectors on the continent have greenhouse gas emissions comparable to those of developed economies. In fact, the total contribution of electricity generation in Africa to climate change at this stage is actually modest compared to any other region in the world. Combined emissions from fossil fuel use in Africa made up only 3.6 per cent of the global total in 2017, even though the continent hosts nearly 17 per cent of the world´s population (IEA, 2019b). If the four countries with the highest absolute emissions (South Africa, Egypt, Algeria and Nigeria) are removed from the equation, the remaining African countries accounted for only 1 per cent of global carbon dioxide (CO_2) emissions.

Nevertheless, investments in modern, efficient power systems are crucial to ensuring that Africa can harness the potential of renewable energy and avoid a potential lock-in to fossil fuel energy. In Africa, a low-carbon pathway is not simply a matter of replacing polluting electricity sources with renewables, but rather creating new power systems based on efficiency, renewables, and flexible and decentralised (including off-grid) infrastructure, thus preventing a scenario in which growing demand is met with fossil fuel sources. Market forces may do some of the work here, as the cost of renewables has now dropped below grid parity in many instances – but more will need to be done. In this regard, it is worth noting that while Africa has contributed little to global CO_2 emissions, it will be among the continents most impacted by climate change.

> **In Africa, a low-carbon pathway is not simply about replacing polluting electricity sources with renewables, but also preventing a scenario in which growing demand is met with fossil fuel sources.**

1.1 The relevance and necessity of modern energy services for sustainable development

By 2030, the UN's Sustainable Development Goal (SDG) 7 aims to i) ensure universal access to affordable, reliable and modern energy services, ii) substantially increase the share of renewable energy in the global energy mix, and iii) double the global rate of improvement in energy efficiency. In addition to improving livelihoods directly, access to modern, sustainable energy services is also commonly seen as a prerequisite for achieving all the other SDGs. Lack of access to modern energy sources disproportionately affects women and girls, who are often the primary household energy managers.

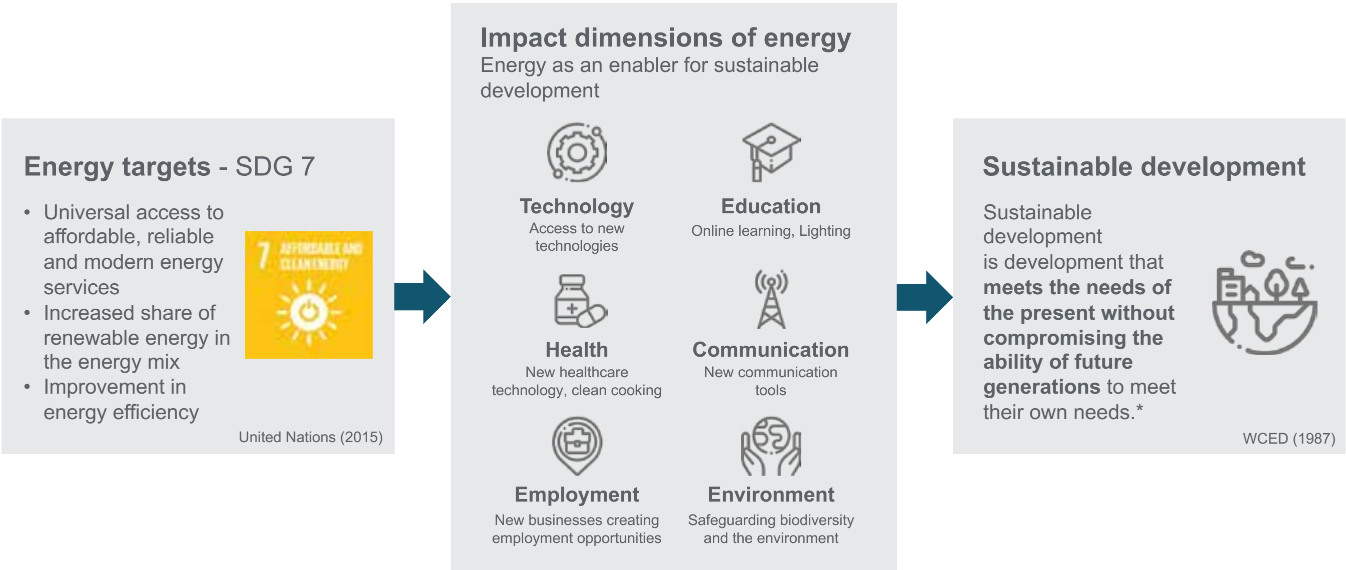


Figure 1 – Impact of access to modern energy services on sustainable development

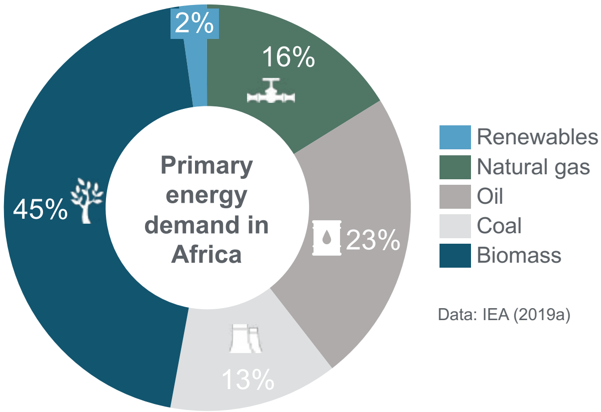
Indeed, expanding rates of electricity access and demand have so far gone hand in hand with gross domestic poduct (GDP) growth in developing countries, as documented by macro-economic studies (e.g., Stern et al., 2017). In addition to freeing up time usually spent on household labour for other economic activities, a sufficient, reliable electricity supply enables value creation and economic growth through productive use. Electricity is the gateway to a modern economy based on digital infrastructure and telecommunications, and it also allows existing and potential companies in traditional industries to improve their efficiency and participate in local and global markets.

Many African countries suffer from insufficient electricity generation capacity, often coupled with inadequate, poorly maintained transmission and distribution networks. This results in an unreliable (and often very expensive) electricity supply, which impedes critical social and economic activities. While energy-intensive productive electricity use generally requires voltage levels that only a centralised electricity grid or a robust mini-grid can provide, modern off-grid systems based on renewable energy can provide a range of energy services to improve living standards and livelihoods.

Access to modern, sustainable energy services is also a prerequisite for achieving all the other SDGs.

Finally, it is important to note that 45 per cent of the 2018 primary energy demand in Africa was met with biomass – mainly firewood and charcoal for cooking (IEA, 2019b). This has serious adverse impacts.

Indoor air pollution causes 490,000 premature deaths per year in Sub-Saharan Africa (WHO, 2018). Exposure is particularly high among women and young children, who spend the most time near the domestic hearth. Furthermore, unsustainable logging drives deforestation and environmental degradation.



Data: IEA (2019a)

Figure 2 – Primary energy demand in Africa by source

Select international agreements and initiatives

Sustainable Development Goals

The Sustainable Development Goals (SDGs), set by the United Nations General Assembly in 2015, are a collection of 17 goals designed to be a „blueprint to achieve a better and more sustainable future for all". These goals are part of the UN 2030 Agenda for Sustainable Development, and the intent is to achieve them by 2030. While the goals are broad, they are accompanied by more detailed targets as well as indicators to help monitor progress.

The following goals are particularly relevant for this study: SDG 7 – Affordable and Clean Energy, SDG 8 – Decent Work and Economic Growth, SDG 9 – Industry, Innovation and Infrastructure, and SDG 13 – Climate Action. SDG 7 is particularly well aligned with the objectives of this report, as it calls for universal access to sustainable energy by 2030.

Paris Agreement

The Paris Agreement was signed on 12 December 2015, during the 21st Conference of the Parties (COP) to the United Nations Framework Convention on Climate Change (UNFCCC) in Paris.

The central aim of this agreement is to strengthen the global response to the threat of climate change by keeping the global temperature rise this century well below 2 degrees Celsius (ideally 1.5 degrees) above pre-industrial levels. Additionally, the parties aim to strengthen countries' capacities to deal with the impacts of climate change.

Nationally Determined Contributions (NDCs) are the official commitments made by the respective signatories to the Paris Agreement. A global stocktake of NDCs will take place every five years to assess joint progress towards achieving the goals of the agreement; this includes a mechanism to update NDCs to reflect the "highest possible ambition".

Agenda 2063

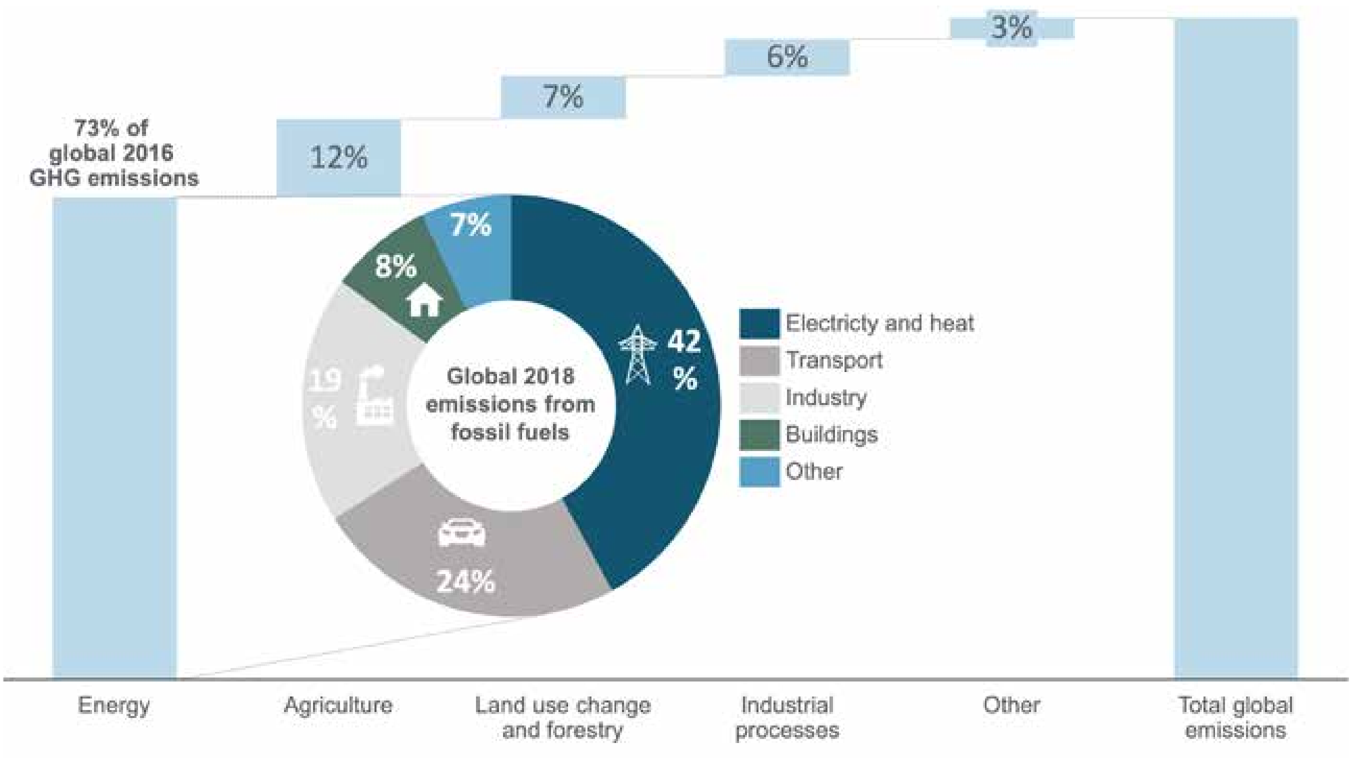
Agenda 2063 is Africa's blueprint and master plan for transforming the continent into the global powerhouse of the future. It includes a set of initiatives implemented by the African Union. The agenda was proposed in 2013 as a plan for the next 50 years and officially adopted in the African Union's Ordinary Assembly of Heads of State and Government in 2015.

Among the agenda's key goals is supporting environmental sustainability and climate-resilient economies and communities. Specific priority areas include sustainable natural resource management, consumption and production patterns as well as climate resilience and supporting renewable energy.

Sources: United Nations (2015); SEforAll (n.d.); UNFCCC (2020); African Union (n.d.)

1.2 The importance of Africa's energy transition for achieving the goals of the Paris Agreement

Energy-related activities accounted for around 73 per cent of global greenhouse gas emissions in 2016 (World Resource Institute, 2020). This includes emissions from burning fossil fuels in the electricity sector, heating and cooling, and transport and manufacturing.[1] Decoupling energy demand from emissions is therefore at the heart of efforts to decarbonise the global economy and meet the Paris Agreement targets.

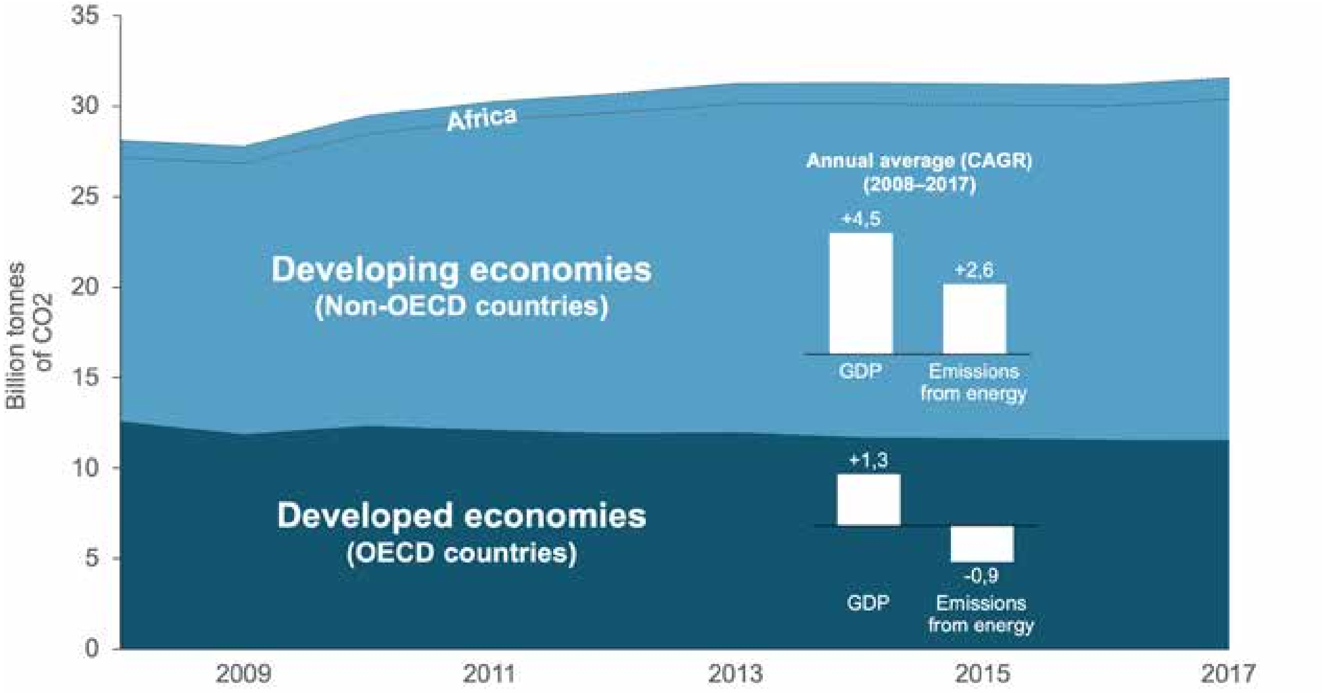


Data: IEA (2019b), World Resource Institute (2020)

Figure 3 – Global greenhouse gas emissions by source

In developed economies and some developing countries (such as China), there are clear indications that the causal relationship between economic growth and energy-related emissions can be broken – meaning that emissions decline even as these economies grow. Between 2008 and 2017, the OECD countries saw their GDP grow by an average annual rate[2] of 1.3 per cent, while energy-related emissions decreased by an average annual rate of 0.9 per cent.

[1] Emissions from land use, land-use change and forestry come in addition to the sources listed here and are partly caused by the use of biomass for energy.
[2] In this report, "average annual growth rates" is used to describe the compound annual growth rate (CAGR), a specific term for the geometric progression ratio that provides a constant rate of return over the time period.



Data: IEA (2019b), IMF (2020)

Figure 4 – Total energy-related CO_2 emissions in developed and developing economies

Energy-related emissions in non-OECD countries grew at a slower pace than GDP from 2008 to 2017, but still increased significantly over the same period. Per capita emissions from the electricity sector in 2017 were 2.3 times higher in OECD countries than in the rest of the world.

Energy-related emissions in Africa

On average, greenhouse gas emissions in African countries grew more slowly than in other developing economies from 2008 to 2017, but the total energy-related emissions still increased by nearly 20 per cent (albeit from a very low initial level). Even with efficiency measures in place, energy demand in African economies is expected to nearly double by 2040, as populations grow and living standards improve (IRENA, 2019a). Therefore, making the vision of zero-emission African power sectors a reality by 2050 is mainly about preventing the growth of emissions as demand increases. This underlines the importance of enabling developing economies to leapfrog fossil fuels and instead benefit from low-carbon energy sources, particularly renewables (as further explored in chapter 3).

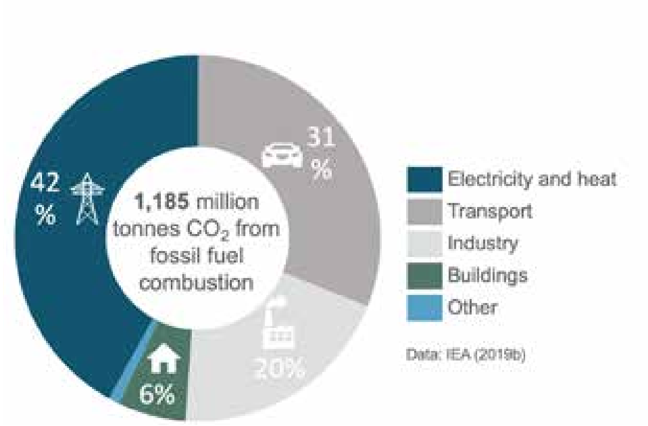


Figure 5 – Share of energy- related CO_2 emissions in Africa by sector, 2018

CO_2 and other greenhouse gases

The Kyoto Protocol and the Paris Agreement regulate six greenhouse gases: Carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), sulphur hexafluoride (SF_6), hydrofluorocarbons (HFCs) and perfluorocarbons (PFCs). The largest share of greenhouse gas emissions from human activity stems from burning fossil fuels and deforestation (CO_2), livestock fermentation, land-use and wetland changes, pipeline losses (CH_4), agricultural processes (N_2O) and the use of chlorofluorocarbon (CFCs) in manufacturing processes and refrigeration. Industrial CFC gases are regulated by the 1987 Montreal Protocol.

In reports, greenhouse gas emissions are commonly expressed in CO_2 equivalents (CO_2e). CO_2e it is the amount of CO_2 which would contribute as much to climate change as a given amount of a particular gas. Thus CO_2e provides a common scale by which to measure the climate effects of different greenhouse gases.

At approximately 73 per cent, energy use contributes the lion's share to global greenhouse gas emissions (CO_2 from burning fossil fuels). Electricity generation is responsible for approximately 30 per cent of global greenhouse gas emissions, mainly from burning coal, heavy fuel oil, diesel and gas (IEA, 2019b).

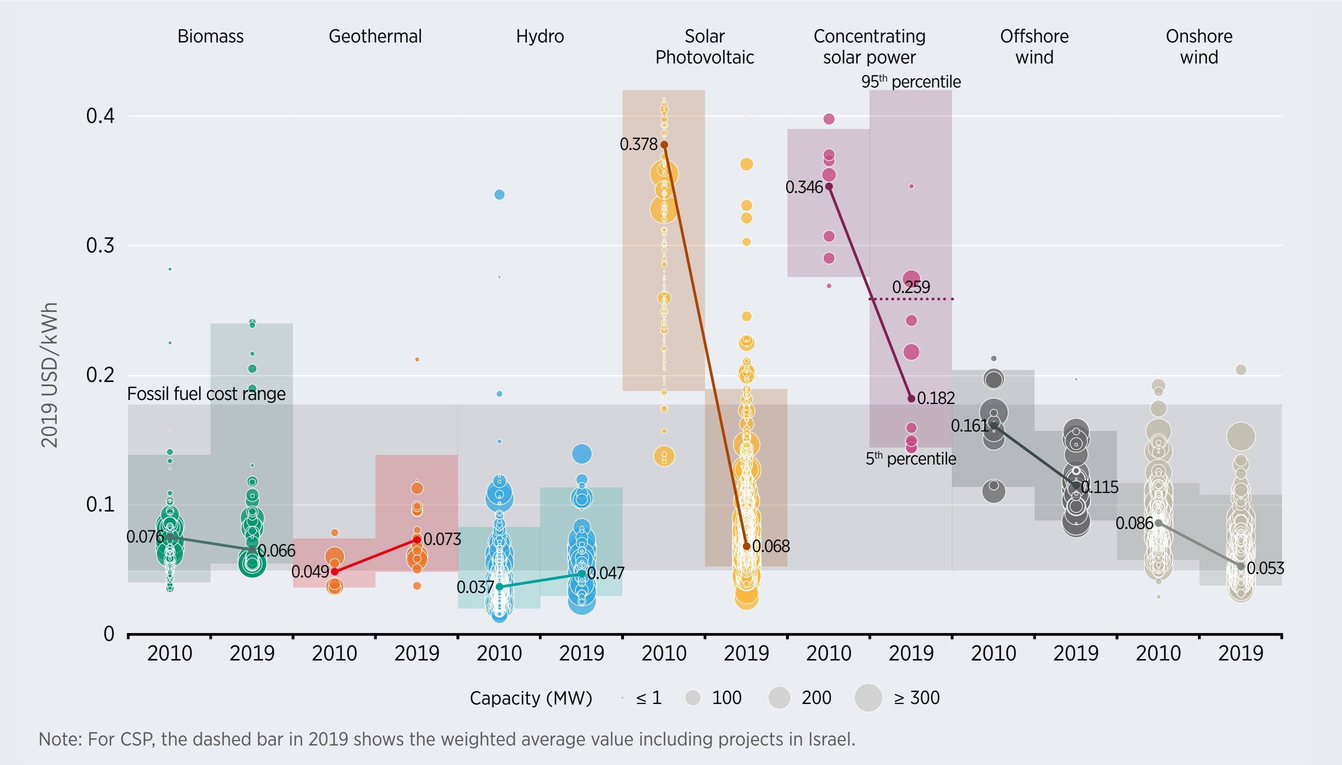
As figure 5 shows, the electricity sector is responsible for the largest share of energy-related CO_2 emissions in Africa, at around 42 per cent of the total in 2018. In the long run, building robust, green electricity sectors across the continent will also enable the decarbonisation of energy end-use sectors such as transport and industry, which account for 31 and 20 per cent of total energy-related emissions, respectively.

Leapfrogging the fossil fuel age

Between 2010 and 2019, the world saw a dramatic decrease in the average global Levelised Cost of Electricity[3] (LCOE) generated from renewable sources. The cost of utility-scale[4] solar photovoltaic (PV) came down by 82 per cent, while onshore wind fell by 40 per cent (IRENA, 2020a). This means that in 2020, renewable energy is in most cases the least-cost alternative for new electricity generation capacity globally. In 2018, almost 25 per cent of electricity was generated from renewable sources, and 71 per cent of the generation capacity added in 2019 was based on renewable technologies, mainly solar and wind (IRENA, 2020b). Most observers expect the general trend of falling prices to continue.

as natural gas peaking plants, to provide dispatchable power in many markets, even without subsidies.

Although the higher cost of capital and logistics may result in somewhat higher-than-average costs for renewables and storage in certain parts of Africa than elswhere, this is often offset to some extent by the excellent resources available across the continent. However, there is no doubt that utility-scale solar PV in 2020 is cheaper than the fossil alternatives across Africa when the right regulatory and policy frameworks are in place. This is particularly true when it is procured by means of a well-structured, well-implemented auction, as evidenced by IRENA's auction and power purchase agreement (PPA) database of global PV auctions (presented in the figure below), which tracks actual prices achieved in solar PV auctions around the world. It is interesting to note that even countries with high perceived investment risks are able to attract private investments in renewables at prices consistent with least-cost development, particularly when these are coupled with appropriate risk mitigation and supported by development partners. For example, the International Finance Corporation (IFC) Scaling



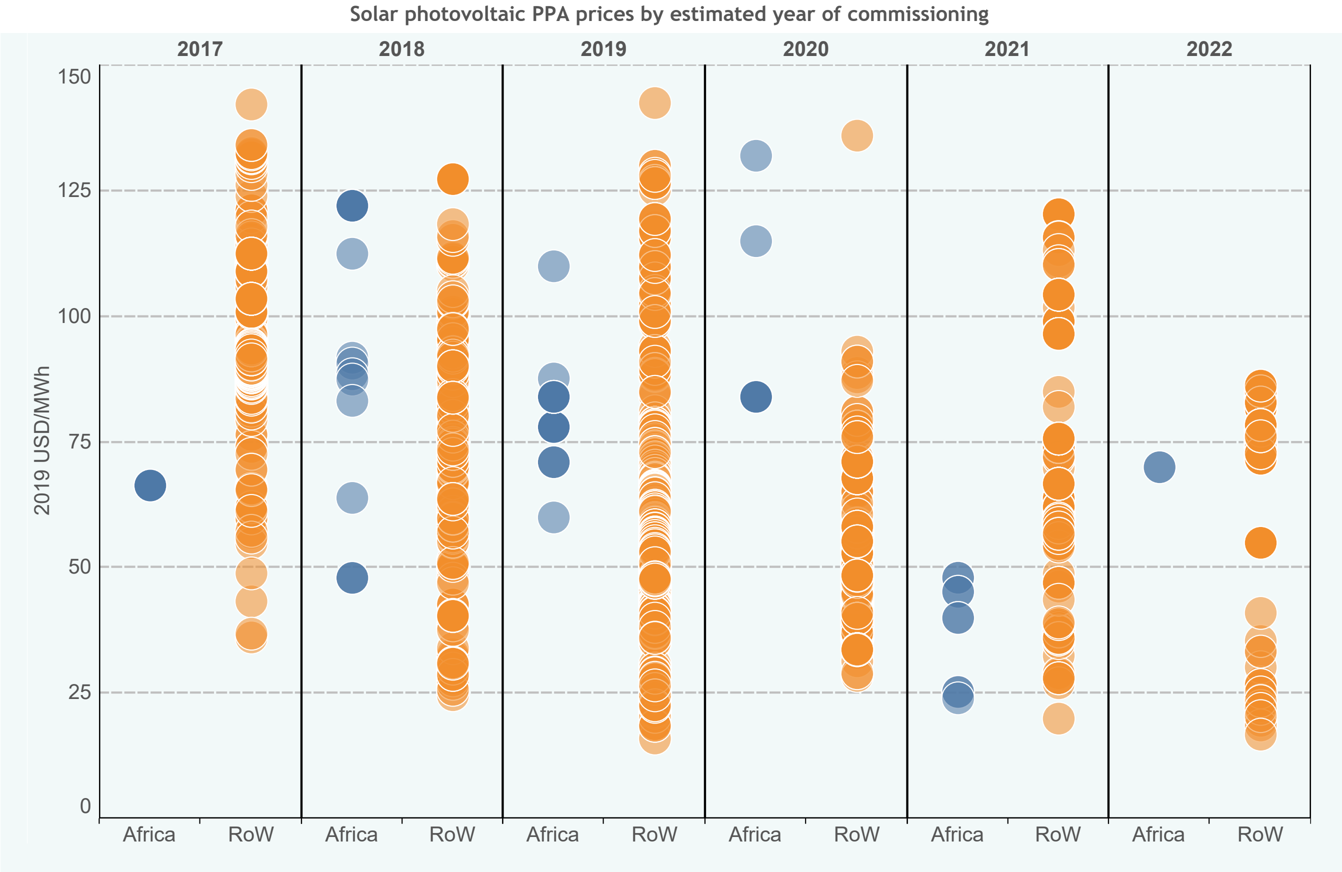
Source: IRENA Renewable Cost Database

Figure 6 – IRENA´s LCOE tracker for different renewable energy generation technologies[5]

Additionally, over the five-year period from 2015 to 2019, the cost of utility-scale battery storage has fallen by more than two-thirds (Bloomberg 2019). This is important because it allows solar and wind power – most of which is intermittent by nature, produced when the sun shines or the wind blows – to be harnessed and dispatched when there is demand, even in locations where reservoir hydropower and bioenergy are not available to provide flexible supply. In fact, Bloomberg finds that the price of multi-hour lithium-ion batteries has fallen to a point at which they are able to compete with fossil fuels, such

Solar programme (based on auction design in combination with a concessional finance offering to subsidise selected bidders' debt costs) has successfully achieved record-low prices in Zambia, Senegal and Ethiopia, with the Ethiopian auction result in 2020 coming in at a very competitive USD 25/MWh. In addition to solar energy, many African countries have other renewable energy resources (wind, hydropower, geothermal) that can be used to generate electricity at competitive prices. Finally, it is noteworthy that auctions are increasingly incorporating socio-economic goals that go beyond price (e.g., local content and CSR programmes) (IRENA, 2019e).

[3] Levelised Cost of Electricity is a measure of the average net present cost of electricity generation for a power plant over its lifetime.
[4] A power plant is "utility scale" if its operation (or lack thereof) causes a noticeable change in a utility's operation.
[5] This data is for the year of commissioning. The diameter of the circle represents the size of the project, with its centre the value for the cost of each project on the Y axis. The thick lines are the global weighted-average LCOE value for plants commissioned ineach year. Real weighted average cost of capital (WACC) is 7.5% for OECD countries and China and 10% for the rest of the world. The single band represents the fossil fuel-fired power generation cost range, while the bands for each technology andyear represent the 5th and 95th percentile bands for renewable projects.



Source: IRENA Renewable Cost Database

Figure 7 – Solar PV auction and tender prices by estimated commissioning year, 2017-2022

Falling renewable energy prices are a game-changer, with consequences beyond electricity generation. For example, cheap renewables may pave the way for the transformation of other energy-intensive sectors, such as transport and industry. Vehicles powered by electricity generated from renewable energy sources could end up enabling the climate-friendly future of transport, both in Africa and globally.

To summarise, there is mounting evidence that renewable energy technologies are viable alternatives to oil and coal as cheap, abundant fuel to power African economies. However, a low-carbon development path partly implies a transition from fossil fuel costs to upfront investments in renewables. Thus in Africa, where capital is expensive, efforts to reduce risk and enable the huge investment required will be central to development that is consistent with the goals of the Paris Agreement.

1.3 The current state of the African electricity sector: Access, climate relevance and security of supply

While Africa's electricity supply infrastructure is generally underdeveloped compared to other regions, there are large differences among African countries, not least in terms of their power systems. Therefore, the pathways to achieving universal access by 2030 and zero emissions by 2050 and across these different electricity sectors will be very different. This section explores these differences, with a focus on access to electricity, carbon footprint and security of supply. Annex 2 provides similar information for 13 African countries at the country level.

Energy and electricity

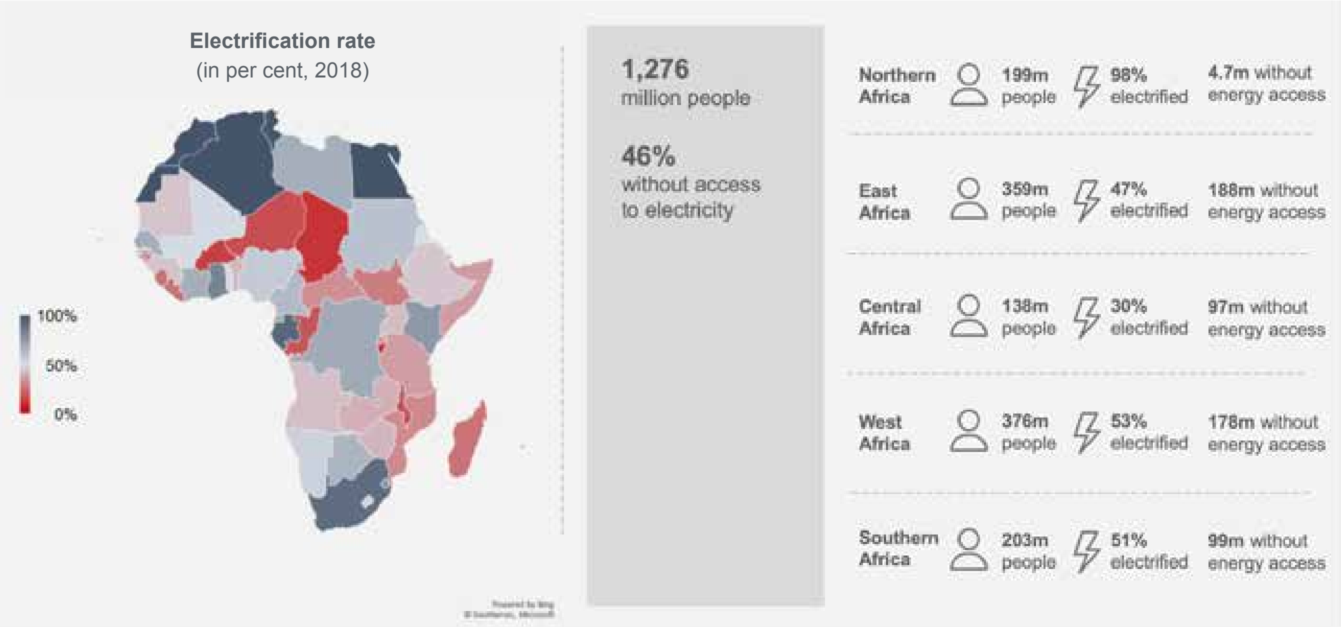
Energy is a physical property which, upon its transformation and transportation, enacts mechanical, thermal, chemical, nuclear and electric changes. The definition of energy is the „capacity of a physical system to do work". Work is defined in different ways depending on where or how it is performed. In this study, „energy consumption" indicates the work energy does and is subsequently sub-divided into energy consumption sectors: transport, industry, public services, households and others.

Electrons move between atoms based on their electrical charge and magnetic forces. **Electricity** is created when electrons move quickly. In this report, "electricity" is used to mean current electricity – that is, generated electricity that flows through lines and cables to power electric devices. The terms "electricity sector" and "power sector" are used interchangeably to refer to electricity generation, transmission, distribution and supply.

1.3.1 Access to electricity

The share of Africans with access to electricity in their homes increased from 36 per cent in the year 2000 to 54 per cent in 2018 (IEA, 2019c), which is notable progress, especially considering the significant population growth during that period and the large investments required to connect people, particularly in rural and peri-urban areas. Still, around 548 million people in Africa have no access to electricity today. Of these, 472 million live in rural areas. Yet there are significant differences between countries and regions (World Bank, n.d.; IEA et al., 2020). While lack of electricity access represents a fundamental barrier to progress, the consequences are particularly grave for women and girls.

South Africa and the countries constituting Northern Africa have reached near-universal access to electricity, while a number of countries – including Burundi and Chad – still have access rates around 10 per cent. This clearly demonstrates the need to target and tailor efforts to increase access rates in Africa.



Data: World Bank (n.d.), World Bank (2020a), CIA (2019)

Figure 8 – Electrification rates in different regions

Furthermore, access to electricity should not be viewed in isolation, as a binary indicator, because a poor, limited or unaffordable electricity supply may limit its usefulness. In cooperation with partners, ESMAP SEforALL (2015) has developed a technology-neutral, multi-tier framework to classify electricity access in households from Tier 0 (no access) to Tier 5 (full access) – the Global Tracking Framework. Tier 1 typically means 0.12 kWh of electricity per day for lighting from a solar lantern, while Tier 5 typically means 8.2 kWh/day for high-powered appliances. Clearly, the usefulness of electricity access will differ greatly depending on the tier.

What is electricity access?

This report uses the term “access” when referring to households with electricity in their homes, whether provided by the central grid, mini-grids, or stand-alone off-grid systems. The figure below gives an extract from ESMAP´s Global Tracking Framework for electricity access. The full framework also includes further criteria on reliability, quality, affordability, legality, and health and safety.

	Tier 0	Tier 1	Tier 2	Tier 3	Tier 4	Tier 5
Household Services		Task Lighting & Phone Charging	General Lighting & Phone Charging & Television & Fan	Tier 2 & any medium-power appliances	Tier 3 & any high-power appliances	Tier 4 & any very high-power appliances
Peak Capacity (in W and daily Wh)		Min **3 W** Min **12 Wh**	Min **50 W** Min **200 Wh**	Min **200 W** Min **1,000 Wh**	Min **800 W** Min **3,400 Wh**	Min **2,000 W** Min **8,200 Wh**
Availability		Day: Min **4 hours** Evening: Min **1 hour**	Day: Min **4 hours** Evening: Min **2 hours**	Day: Min **8 hours** Evening: Min **3 hours**	Day: Min **16 hours** Evening: Min **4 hours**	Day: Min **23 hours** Evening: Min **4 hours**

Source: ESMAP (2015)

Figure 9 – Multi-tiered framework for household access to electricity

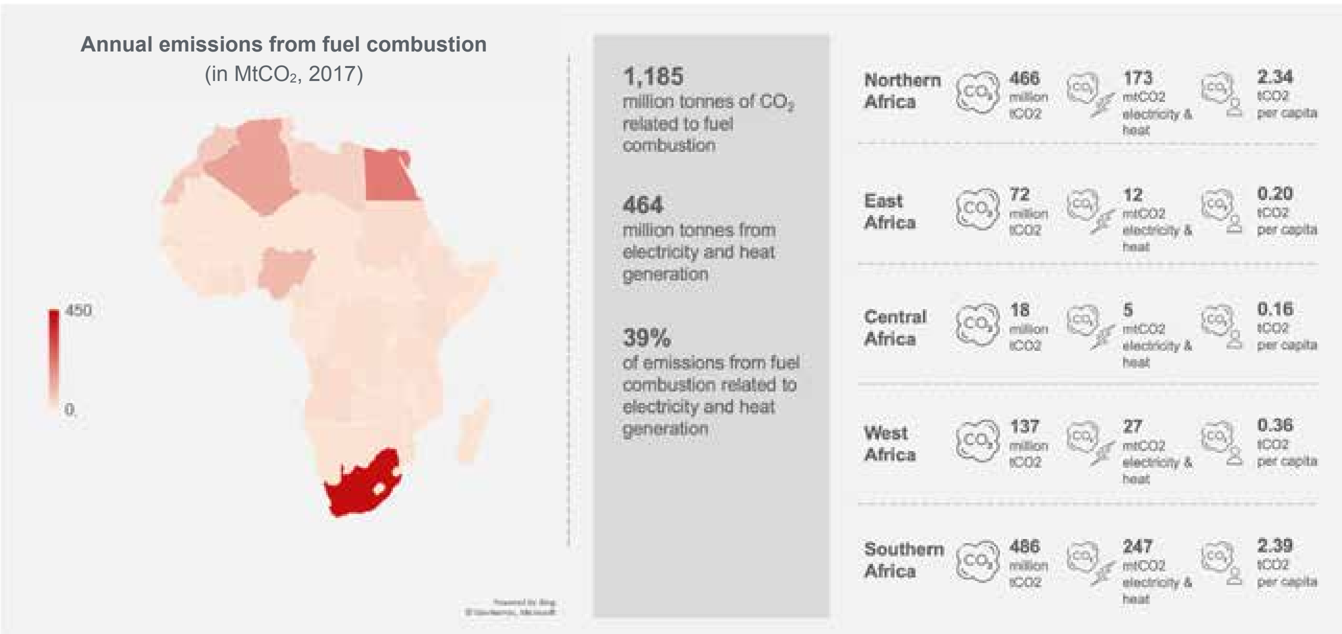
While there are no hard numbers on electricity access broken down by tiers in Africa as a whole, it is evident that many households with access are in Tier 1 or 2, meaning they are only able to use low-powered appliances at certain times of the day. However, reports indicate a general trend of households across the continent trading up to larger devices, even when they rely on solar home systems or mini-grids. For the African population to benefit fully from reliable, affordable and sustainable electricity access in their homes (Tiers 4 and 5), both technical and affordability challenges must continue to be addressed.

Finally, it is important to note that the issue of electricity access is not limited to consumptive use in households. Expanding the supply of reliable, affordable electricity is also a prerequisite for the continued growth of African economies. Productive use of electricity, be it for information technology or traditional economic activities, requires a stable, robust electricity supply. However, increased consumptive and productive use drives the need for further electricity infrastructure investment, which inevitably results in inreasing carbon emissions – unless strategies for developing a clean, sustainable energy supply are implemented at the same time.

1.3.2 The African electricity sector's CO_2 emissions

The electricity sector contributed 39 per cent of total energy-related CO_2 emissions from African countries in 2017 (IEA, 2019b). On a per capita basis, emissions from the electricity sector were almost seven times higher in the European Union than in Africa. Internal differences among countries on the continent, however, are even more striking. For example, per capita emissions from electricity generation in South Africa were around 220 times higher than those in Benin. This is a consequence of higher per capita electricity consumption, combined with the dominance of coal in South Africa's electricity mix.

Six countries – South Africa, Egypt, Algeria, Morocco, Libya and Nigeria – accounted for around 84 per cent of Africa's CO_2 emissions from electricity generation in 2017 (IEA, 2019b). As depicted in the figure below, per capita emissions from the electricity sectors in Northern and Southern Africa are nearly 15 times higher than those in Central Africa. This has clear policy implications in terms of realising the low-carbon development of African electricity sectors by 2050. A handful of African countries have well-developed electricity sectors with comparatively high greenhouse gas emissions and are therefore faced with transitioning their existing, fossil fuel-based electricity systems into a renewable energy future. The situation in South Africa, for example, is not dissimilar to that of various European countries, where an existing carbon-based sector setup and the underlying political-economic structures and systems this entails make transition a politically and economically challenging exercise. Meanwhile, most other African countries currently have negligible electricity sector emissions, and the challenge going forward will be to ensure that existing low-carbon technologies rather than fossil fuel sources are harnessed to satisfy growing electricity demand. Some countries have already established energy transition programmes. For example, under the leadership of the Economic Community of West African States (ECOWAS), all 15 countries in West Africa have developed National Renewable Energy Action Plans, with clear targets in terms of access and deploying renewable energy capacities by 2030. Some other countries have only just begun to embark on the transition towards a renewable energy future. Important work is also being done on the continental level, not least through the African Union Commission and the African Union´s Development Agency (AUDA-NEPAD's) work on "Harmonisation of Regulatory Frameworks for the Electricity Market in Africa" including development of a continental power system master plan, which will contribute to the future energy landscape in Africa.

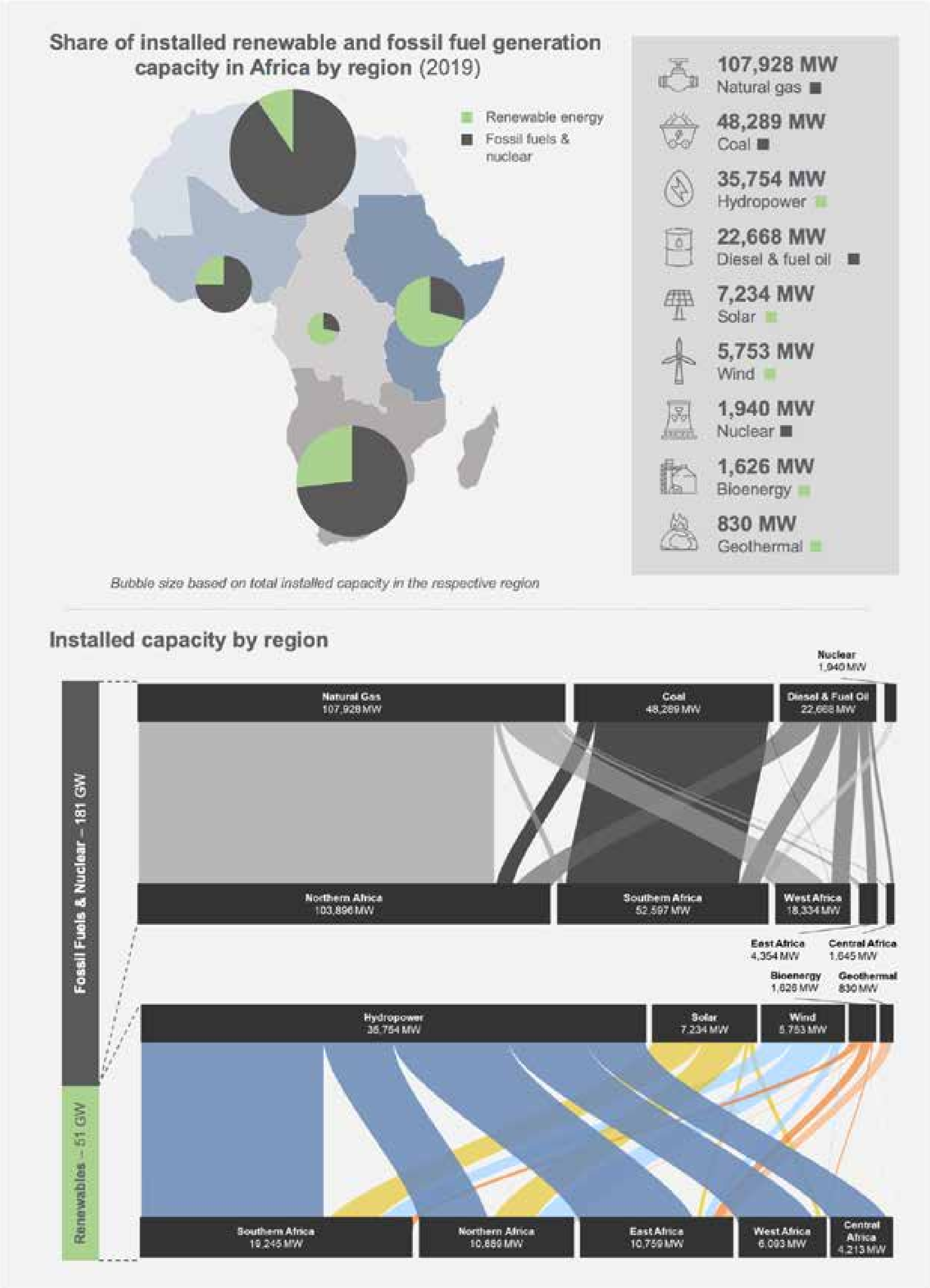


Data: IEA (2019b), World Bank (2020a), CIA (2019)

Note: Data is only available for the 30 countries with the highest emissions in Africa, whereas data for the remaining countries is only available in aggregated form. In the figure above, these emissions are distributed based on the respective population.

Figure 10 – African countries' annual energy-related emissions

The figure below illustrates the mix of renewable and fossil fuel electricity generation in Africa. Natural gas has the largest share of installed capacity, but coal-fired power plants contribute the largest share – around 54 per cent – of the electricity sector's total greenhouse gas emissions (IEA, 2019a). While renewable energy sources dominate in Central and East Africa, fossil fuels make up the largest share of installed electricity generation capacities in Northern, West and Southern Africa.[6]



Data: IRENA (2020b), Illustration: Multiconsult

Figure 11 – Installed capacities of different electricity generation sources in Africa by region.

[6] **East Africa:** Burundi, Comoros, Djibouti, Eritrea, Ethiopia, Kenya, Rwanda, Seychelles, Somalia, South Sudan, Sudan, Tanzania and Uganda. **Southern Africa:** Angola, Botswana, Lesotho, Malawi, Mauritius, Mozambique, Namibia, South Africa, Eswatini, Zambia, Zimbabwe and Madagascar. **Central Africa:** Cameroon, Central African Republic, Chad, Congo, Democratic Republic of Congo, Equatorial Guinea, Gabon, and Sao Tome and Principe. **Northern Africa:** Algeria, Egypt, Libya, Mauritania, Morocco and Tunisia. **West Africa:** Benin, Burkina Faso, Cape Verde, Côte d'Ivoire, Gambia, Ghana, Guinea, Guinea-Bissau, Liberia, Mali, Niger, Nigeria, Senegal, Sierra Leone and Togo.

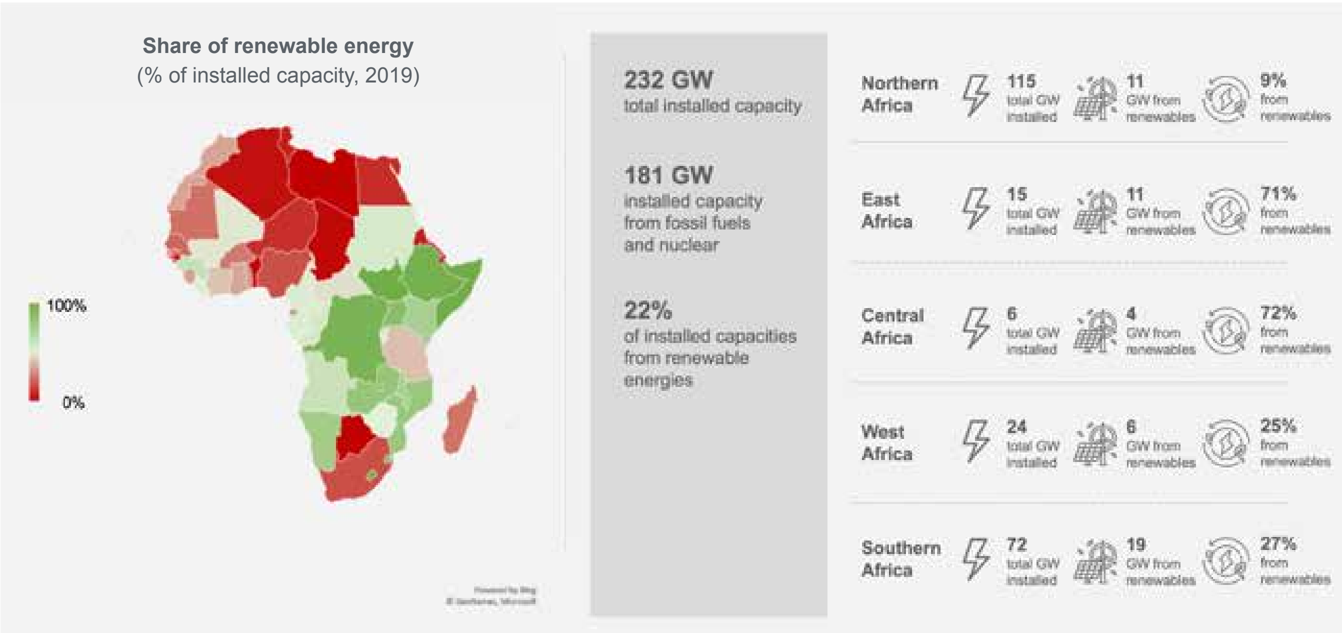
While efforts to phase out fossil fuels can be targeted at a handful of countries in Northern and Southern Africa, there are indications that certain countries on the continent may be on the verge of expanding their coal-fired power generation capacity. A recent study by the German MCC Institute (Steckel et al., 2020) finds that several countries in Africa are looking to invest in new coal-fired power plants or already have plants under construction. These include Egypt (13,240 MW[7]), South Africa (12,744 MW[8]), Zimbabwe (4,260 MW[9]) and Nigeria (2,400 MW). While about half of these plans have been shelved, partly due to international donors' and financing institutions' restrictions on funding coal power plants, the study finds that a total of 15,000 MW in new coal capacity is being actively pursued.

Meanwhile, African countries with natural gas reserves – such as Tunisia, Nigeria, Tanzania and Mozambique – are also expanding their natural gas generation capacity (Multiconsult, 2018). For countries with viable reserves, natural gas provides cost-competitive, flexible electricity that improves security of supply and also provides balancing power for integrating variable energy sources. In addition, natural gas is generally not subject to the same financing restrictions from international donors, export credit institutions and financing institutions as coal is. While investing in natural gas extends the use of fossil fuels in electricity systems, it can also play a role in supporting the expansion of variable intermittent renewable energy generation as a medium-term bridge technology. However, it will be important to ensure that such investments do not delay the eventual adjustments associated with the widespread adoption of renewable energy and complementary innovations. Appropriate regulation to ensure sufficient price signals must play a key role if such a scenario is to be avoided.

Renewable energy generation capacity in Africa

Only 20 per cent of the total installed electricity generation capacity in Africa in 2019 was based on renewable sources (IRENA, 2020b). While hydropower still accounts for the largest share of installed renewable energy capacity in Africa, its relative share has declined from 92 per cent in 2010 to 67 per cent today as other renewable technologies have become more competitive. Without significant, reasonable investments in refurbishing existing hydropower plants, this share decline will only accelerate. An additional 1,980 MW of new renewable energy capacity was added in Africa in 2019, increasing the installed capacity by 4.3 per cent over the previous year (IRENA, 2020b).

Many countries across Africa – including Morocco, Senegal, Egypt, South Africa and Kenya – are demonstrating encouraging trends in terms of adding new renewable energy capacity. Southern Africa is leading the continent in terms of installed renewable capacity, with 19,000 MW. In relative terms, however, Central Africa has the highest share of renewables installed – with 72 per cent, mainly from hydropower.



Data: IRENA (2020b)

Figure 12 – Share of renewable energy in the generation mix by country and region

[7] However, in April 2020, the Egyptian Ministry of Energy announced that the construction of the Hamrawein coal-fired power plant (6GW) – supported by a consortium of China's Shanghai Dongwei Electric Appliance Company and Egypt's Hassan Allam Holding – will be indefinitely delayed. This is apparently a consequence of oversupply in the system, driven predominantly by additional gas-fired power brought online as part of a deal with Germany´s Siemens (IEEFA 2020).

[8] For South Africa, these are primarily the Medupi and Kusile coal-fired power plants (with 4.8 GW of installed capacity each). Construction on both plants began in 2007, but full commissioning continues to be delayed due to significant challenges during construction. In addition, the South African Integrated Resource Plan provides for 1,500 MW of new coal capacity within the next ten years. However, coal's share of the electricity mix in South Africa overall is projected to decrease from roughly 80% currently to 59% by 2030, with further drops in the coal share thereafter, as existing plants are decommissioned (Department of Energy and Mineral Resources, 2019). In addition, almost all large South African commercial banks have announced they will no longer finance new greenfield coal-fired power plants (Energy Transition, 2019).

[9] However, it is highly unlikely that any greenfield coal-fired power plants will go ahead in the near- or even medium-term in Zimbabwe, due to the difficulties involved in accessing long-term hard currency financing in the context of a severe, prolonged economic crisis. At this stage, only infrastructure deals involving offshore hard currency earnings have any prospect of being realised.

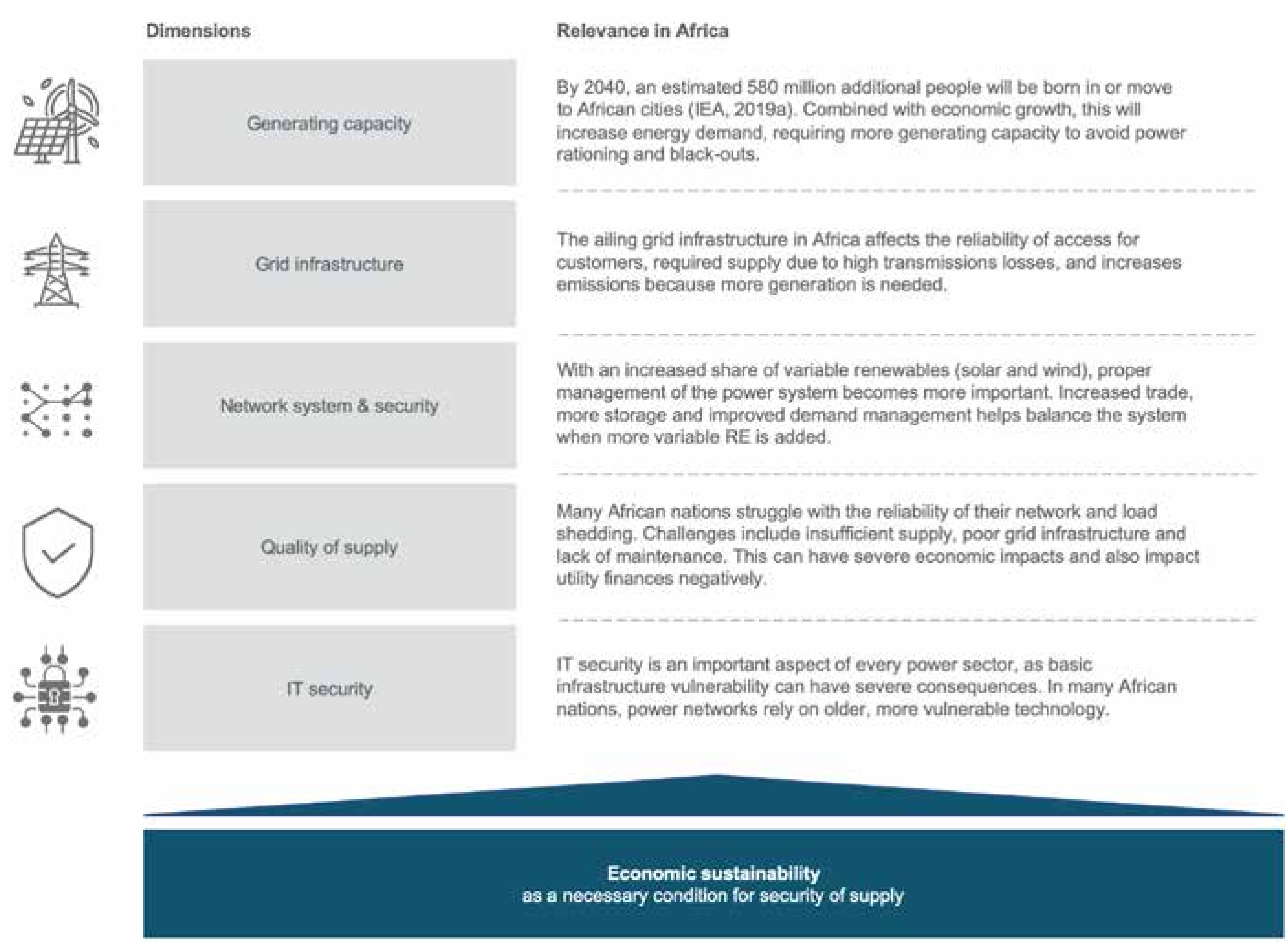
Under the Paris Agreement, 45 African countries have included targets for and activities to support renewable energy expansion in their Nationally Determined Contributions (NDCs) (AfDB, 2018). These commitments constitute a total of 97,000 MW of installed capacity, equal to 190 per cent of the installed renewable energy capacity in 2019. Around half of these commitments are unconditional – that is, they do not depend on external support.

However, 97,000 MW is only a portion of what will be required to meet Africa´s growing energy demands by 2050 (see chapter 3 for further details). Finally, it must be noted that global NDC commitments are insufficient to meet the Paris Agreement´s goal of limiting the global temperature increase to 2 or ideally 1.5 degrees Celsius above pre-industrial levels.

1.3.3 Security of supply

A secure and stable electricity supply is a vital precondition for economic growth. Many African power systems are characterised by frequent outages and grid instabilities caused by insufficient investments in both the grid and generation capacities. A recent survey found that nearly 25 per cent of households in Africa with electricity access had electricity available half of the time, occasionally, or never (Afrobarometer, 2019). Again, there are significant differences between countries. While 79 per cent of Nigerians with access reported that electricity is available only half of the time or less, the respective number in Mauritius was 1 per cent.

While outages and voltage fluctuations are disruptive for households, the impact on businesses is perhaps even more damaging to the economy, with 41 per cent of African firms identifying no or poor electricity supply as a major constraint on their operations (Energy for Growth, 2019). IRENA estimates that outages and load shedding shave around 2 per cent off of Africa's annual GDP in terms of business disruption and lost profits (IRENA, 2015a). Africa's population needs more electricity generated, but it also needs that electricity to be efficiently transmitted and distributed. Failure to provide electricity in the right quantity and quality, at the right cost, at the right time and in the right place risks stifling the growth momentum many countries are currently enjoying. Finally, weak electricity supply infrastructure is also a barrier to introducing inexpensive variable renewables, such as wind power and solar PV, on a large scale. Without concerted efforts, the challenges of supply security will only increase as demand grows. The figure below outlines the key dimensions of security of supply and their relevance in African electricity markets.



Source: Own analysis, adapted from Bundesnetzagentur (n.d.)

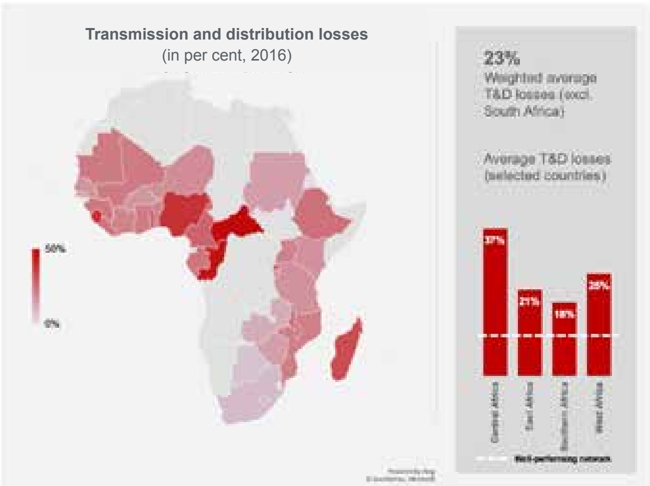
Figure 13 – Security of supply dimensions in Africa

It is important to note that security of supply is about more than strengthening and expanding electricity grids. Practical solutions need to combine a number of dimensions, including enabling technologies, market design and regulation, business models and system operation. Smart technologies that enable innovative business models are already capable of providing access to modern energy services over a continuum of on-grid, mini-grid and off-grid solutions. Coupled with strong political commitment and enabling regulatory frameworks, these innovations are a central requirement for achieving full electrification, including in rural Africa.

Funding investments in security of supply and promoting financial sustainability

In order to afford the investments and maintenance required to improve security of supply, electricity service providers such as utilities and community-owned companies need to recuperate their fair and efficient costs through the tariffs their consumers pay, or through direct subsidies. Otherwise they are forced to underinvest in infrastructure and maintenance, which results in poor security of supply and increased technical losses.

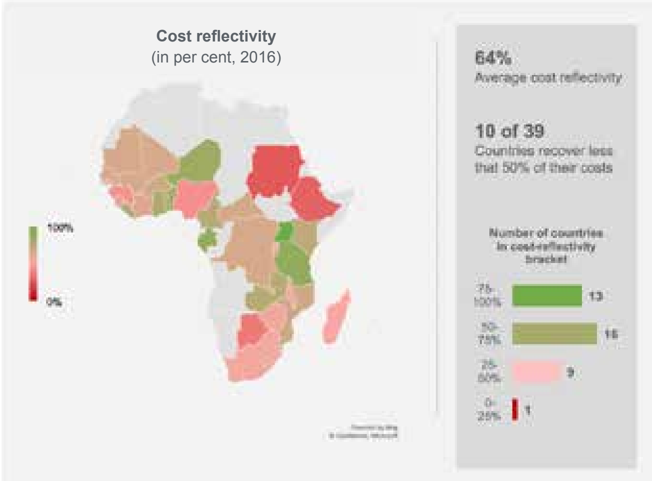
Due to old and inadequate grid infrastructure, the African continent registers the highest transmission and distribution losses globally. A study by Trimble et al. (2016) found that the weighted average transmission and distribution losses in Sub-Saharan Africa were around 23 per cent (see figure 14). Most of this is related to commercial (theft) and technical losses in the distribution network. Losses in Northern Africa are generally lower.



Note: Due to lack of data, Northern Africa is not included in this overview.
Data: Trimble et al. (2016)

Figure 14 – Transmission and distribution losses (excluding North Africa) in 2016

The same report found that only 2 of the 39 countries studied (Uganda and the Seychelles) had cost-reflective electricity tariffs, while 10 countries had tariffs that recovered less than 50 per cent of the total cost of supply (see figure 15). While the situation in specific countries may have changed since the study was conducted, the general problem persists: most African electricity service providers lose money with every additional kWh sold, and governments do not generally compensate them for this shortfall in revenue. In addition to underinvestment in new infrastructure and maintenance, this also means that utilities generally lack commercial incentives to connect more household customers.



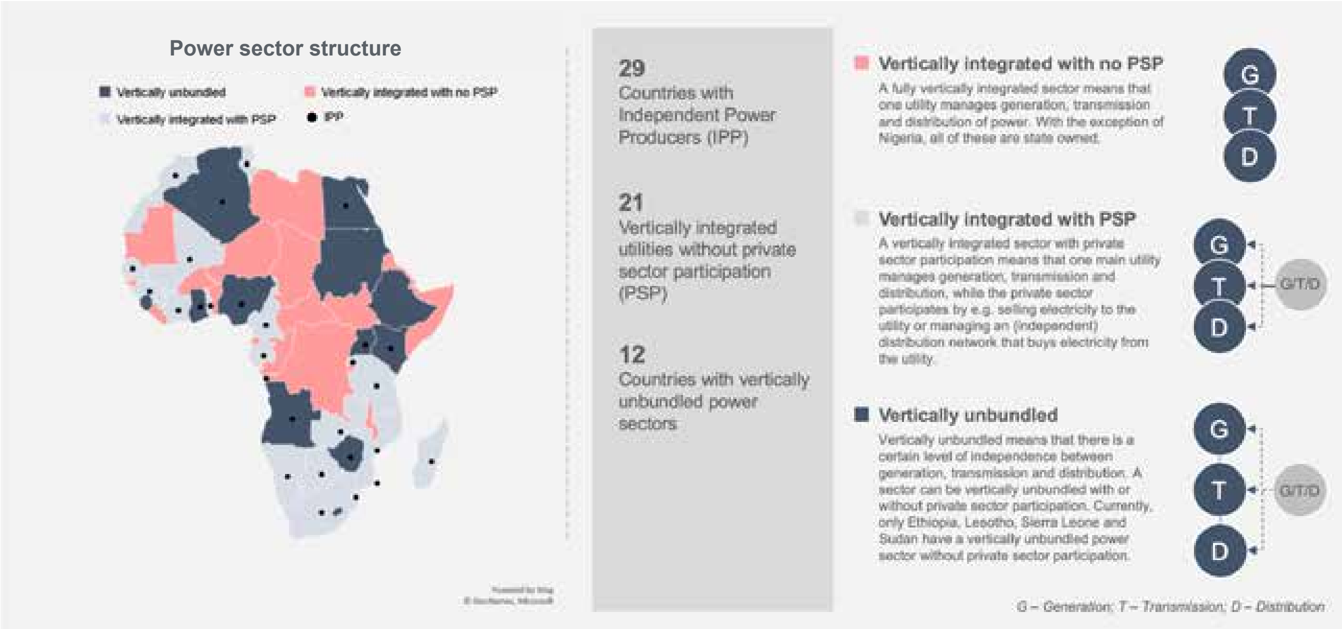
Data: Trimble et al. (2016)

Figure 15 – Cost reflectivity of 2016 electricity tariffs in selected African countries

To a varying degree and with varying results, African countries are trying to address the structural issues that threaten their security of supply via reforms aimed at improving efficiency and attracting investments. While there are currently only a few examples of unbundling and divestitures and almost no wholesale or retail competition, an increasing number of Independent Power Producers (IPPs) are entering African power markets. IPPs are privately owned companies that develop, operate and own power plants on the basis of long-term PPAs with utilities or other offtakers. In addition, new types of electricity service providers are emerging, such as community-owned companies and private mini-grid operators. In the face of rapidly increasing demand for electricity in Africa, the private sector is critical to bringing much-needed financing into the generation segment of the electricity sector. Furthermore, private investors may strengthen resilience and security of supply in the energy sector by sharing the risks, diversifying the supply and introducing cheap renewable sources of supply. In the face of widespread underperformance in the distribution sub-sectors on the continent – including significant challenges around technical and non-technical losses, particularly at low voltage levels – more widespread private sector participation in distribution through concessions, management contracts or alternative contractual models should also be explored in future. However, future efforts must also recognise the challenging history of private sector concessions in African distribution systems thus far.

Significant work is also being done on the sub-regional level to strengthen security of supply across Africa, notably through regional power pools. The West African, East African, and Southern African Power Pools all have master plans for generation and transmission, but only the Southern African Power Pool has a fully functioning regional day-ahead market. These regional master plans aim to complement national efforts to ensure security of supply.On a continental level, the African Union´s AFREC commission on Energy Transition is one of several important initiatives addressing security of supply and other critical energy issues.

While recognising that each African country has a unique power sector structure, they can largely be divided into three groups, as illustrated in the figure below: i) vertically integrated with no private sector participation, ii) vertically integrated with private sector participation, and iii) vertically unbundled. Notably, many African countries still do not allow private investments in their power sectors. This underscores the regulatory challenges that prevent direct investments which can contribute much-needed capital and expertise to strengthen security of supply in Africa.



Data: Eberhard et al. (2017), Trimble et al. (2016), own analysis

Figure 16 – Simplified overview of African power sector structures

1.4 The urgent need for energy transition in Africa

This chapter has identified a clear, urgent need for African energy transition to make universal access based on renewable energy sources a reality. It has highlighted a number of issues that need to be addressed in these transitions:

- Significant public and private investments in expanding and modernising transmission and distribution infrastructure as well as mini- and off-grid solutions are required to drive access expansion and economic growth, enable the integration of more variable renewable energy, reduce losses and ensure financial sustainability in the sector.
- De-risking investments in renewable energy and storage lowers the cost of financing. Renewable energy and storage technologies are already cost-competitive, but high upfront capital expenditures combined with adverse regulatory and legal frameworks may make fossil fuel alternatives easier and cheaper to finance in many cases, which risks unnecessarily locking systems into a higher share of fossil fuels.
- Strengthening regulatory environments and institutions and making electricity tariffs cost reflective enables power suppliers, energy service providers and grid operators to meet their financial commitments to producers while maintaining and expanding their grids as demand increases.
- Adopting a systemic approach to innovation – including lessons learned form international experience in innovative technologies, business models, regulatory frameworks and power system operation – will help to build the ecosystem required for investing in the power sector.
- Integrating African electricity markets by building on existing regional power pools in order to balance load curves and stabilise neighbouring countries' grids, especially when it comes to the future introduction of large-scale variable renewable energy capacity, would reduce the cost of electricity through trade and also reduce overall greenhouse gas emissions by maximising the share of reneweable energy generation capacity.
- Building the necessary human capacity and skills within African countries would enable them to undertake energy transitions on their own terms while also boosting economic growth and job creation on the continent.
- A series of policy interventions would enable a transition in which no one is left behind. A just and inclusive transition requires a global compact among countries, adequate resource mobilisation and measures tailored to the challenges various countries face.
- Striving to utilise COVID-19 recovery efforts in a manner which links short-term recovery to medium- and long-term strategies is paramount in achieving the SDGs and the Paris Agreement targets (IRENA, 2020h).

2 African electricity sectors: Towards 2050

Population growth and expanding economies are expected to nearly double the demand for electricity in Africa by 2040 (IRENA, 2019a). The economic, social and environmental impacts of meeting this demand will depend on the policies which African governments put in place to address the following twin challenges:

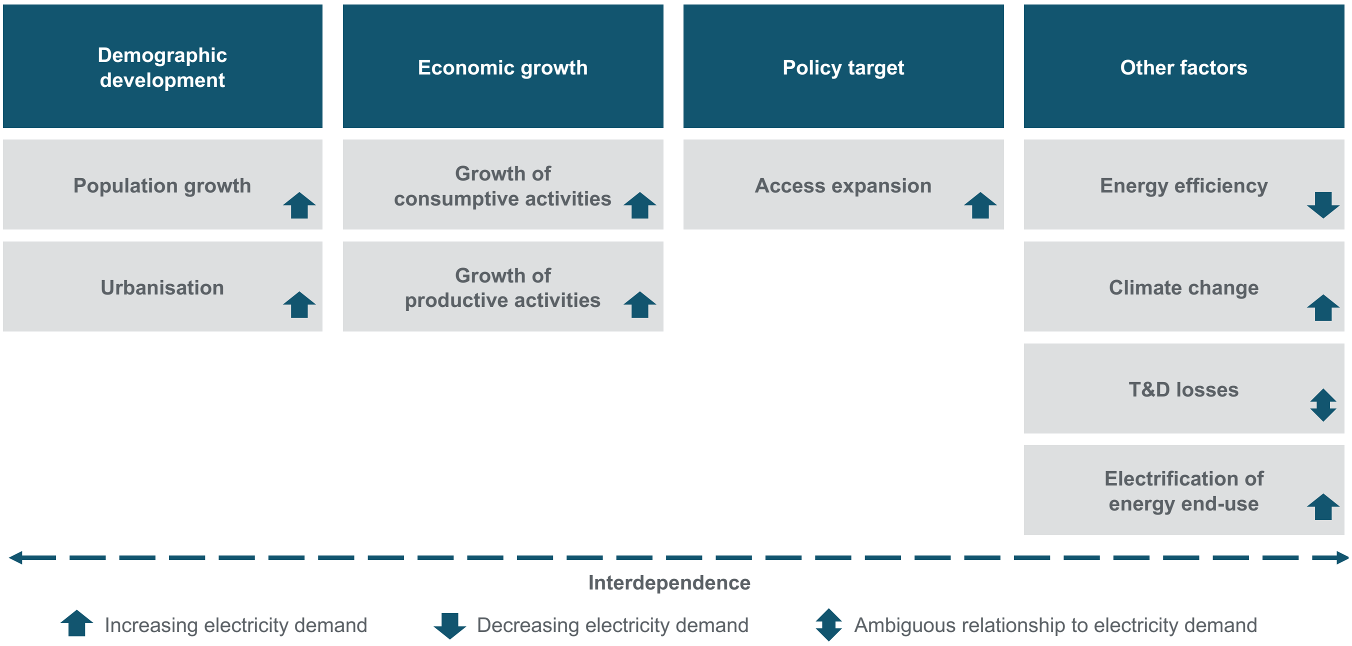
1. **Ensuring universal access to affordable, reliable, sustainable and modern energy by 2030.** Sustainable and secure access to electricity in the face of growing demand is about more than simply dividing households into those with and those without a connection to electricity. It is also about a sufficient, reliable supply that will support productive uses and create jobs. Moreover, it requires a least-cost expansion that makes end use affordable even for poor households, while maintaining financially sound utilities (on- or off-grid, as the case may be). It is about helping people enjoy the benefits of reliable electricity supply in their daily lives.

2. **Harnessing the power of renewable energy for socio-economic development while mitigating climate change.** Countries where fossil fuels currently dominate the electricity mix will need to transition towards the adoption of renewable energy technologies and phase out existing fossil fuel-based generation capacity. Where electricity systems are nascent, appropriate measures must be taken to ensure that the long-term future development path is based on carbon-free resources. Even with cost-competitive renewable energy, there are currently structural barriers that may incentivise investments in natural gas and coal power plants. These challenges must be overcome to unlock the full potential of renewables in Africa.

Making these ambitious objectives a reality will require political will, increased regional and continental integration, conducive sector policy and regulatory frameworks, as well as economically sustainable electricity sectors. This chapter outlines the potential for transforming African power systems and distills central fields of action that must be part of any political initiative to support eliminating energy poverty and achieving the low-carbon development of African electricity sectors by 2050.

2.1 The main drivers of electricity demand by region

Increased economic activity resulting from per capita GDP growth, as well as demograpic changes and the realisation of electricity access targets will increase electricity demand on the African continent. The figure below outlines the key drivers of electricity demand in Africa. The relative importance of each individual driver varies from country to country, depending on their respective starting points and economic prospects.



Source: Own illustration

Figure 17 – Key factors impacting long-term electricity demand in Africa

2.1.1 Demographic trends

Demographic developments are expected to drive electricity demand, both as the population grows and through urbanisation, because city dwellers tend to consume more electricity than the rural population.

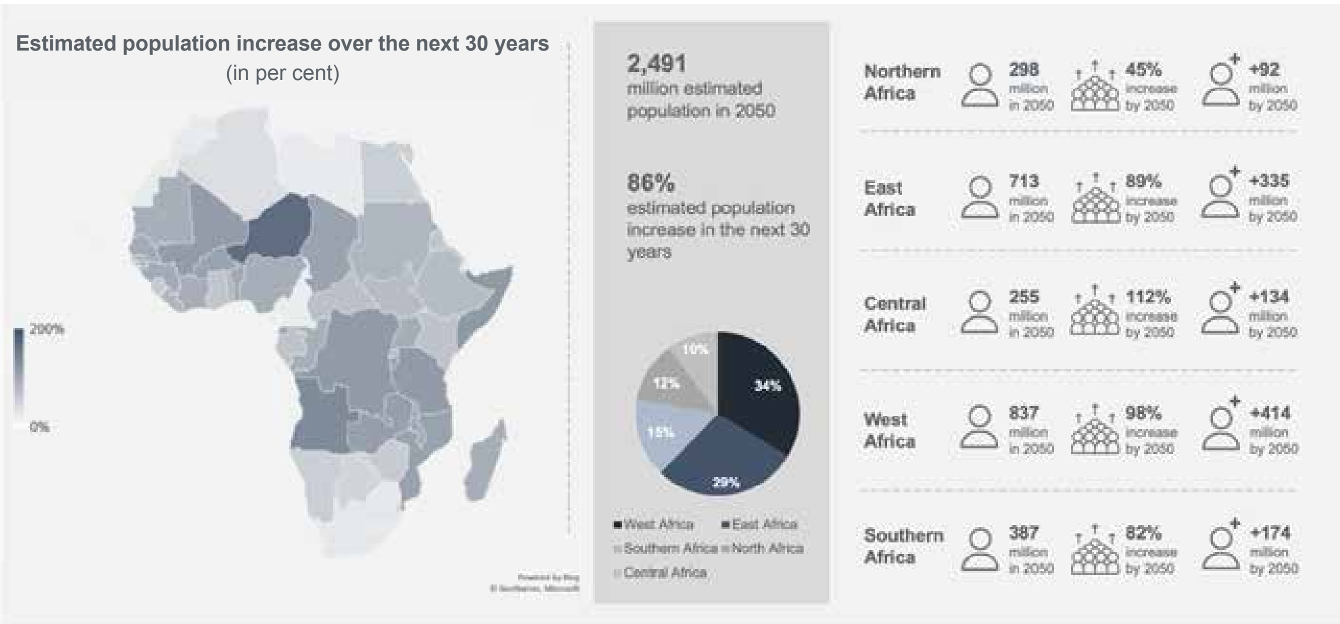
Population growth. More than half of global population growth between 2020 and 2050 is expected to take place in Africa, and the population of Sub-Saharan Africa is projected to double by 2050 (World Bank, 2019a). Africa currently has the youngest population of any continent, and the continuing population boom will also be driven by increased life expectancy (United Nations, 2019).

As the figure below demonstrates, the countries in Central Africa are expected to see the largest relative increase in their populations (112 per cent) by 2050. However, East and West Africa can expect the highest growth in absolute numbers. In fact, these two regions alone are expected to increase their populations by nearly 750 million people (roughly the current population of Europe) over the next 30 years. Coupled with the challenge of connecting the 46 per cent of existing households that do not currently have access to modern energy services, the forecasted population growth will have a significant impact on electricity demand in Africa going forward.

> **More than half of global population growth between 2020 and 2050 is expected to take place in Africa.**

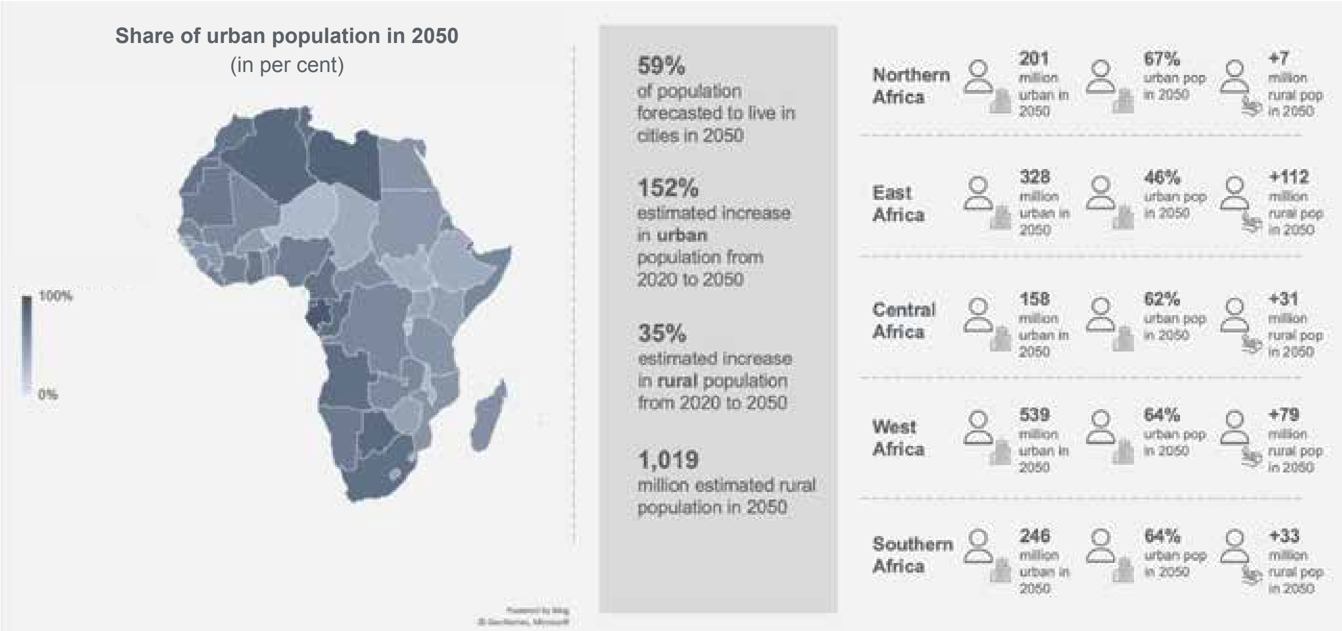
Urbanisation. By 2050, 60 per cent of Africans – more than 1,470 million people – are expected to live in cities (World Bank, 2019a). This has implications for the continent's total electricity demand, because city dwellers consume on average about three times more electricity than rural households (McKinsey, 2015).

However, it is also important to note that even with a steady influx of people to the cities, about one billion people are still expected to live in rural areas in 2050. Sustained efforts to promote rural electrification across Africa will therefore continue to be important.



Source: World Bank (2019a)

Figure 18 – Forecasted population growth in Africa from 2020 to 2050



Source: World Bank (2019a)

Figure 19 – Forecasted urbanisation in Africa from 2020 to 2050

2.1.2 Economic growth

As developing economies expand, electricity demand increases. In short, economic growth in developing countries increases consumptive electricity demand because households earn more income and choose to spend some of it on electricity and appliances. Meanwhile, productive demand increases as new businesses and industrial activities are established and existing ones expand (e.g., a mill, a digital consultancy or a factory).

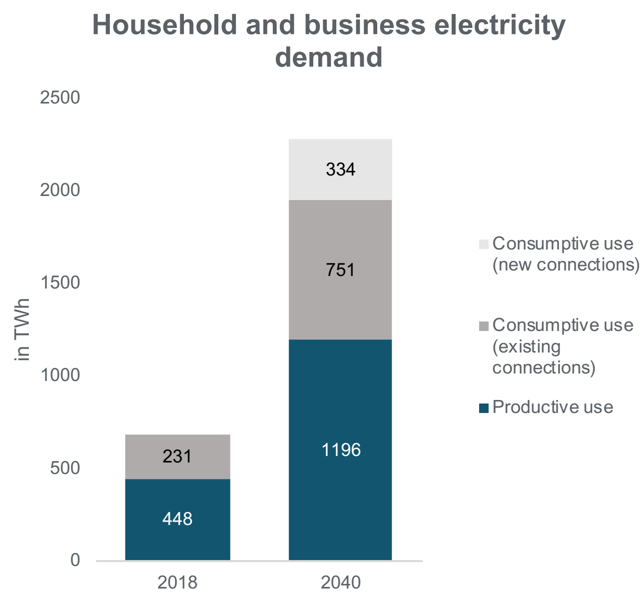


Figure 20 – Electricity demand by category in 2018 and 2040, according to the IEA Africa Case expansion scenario

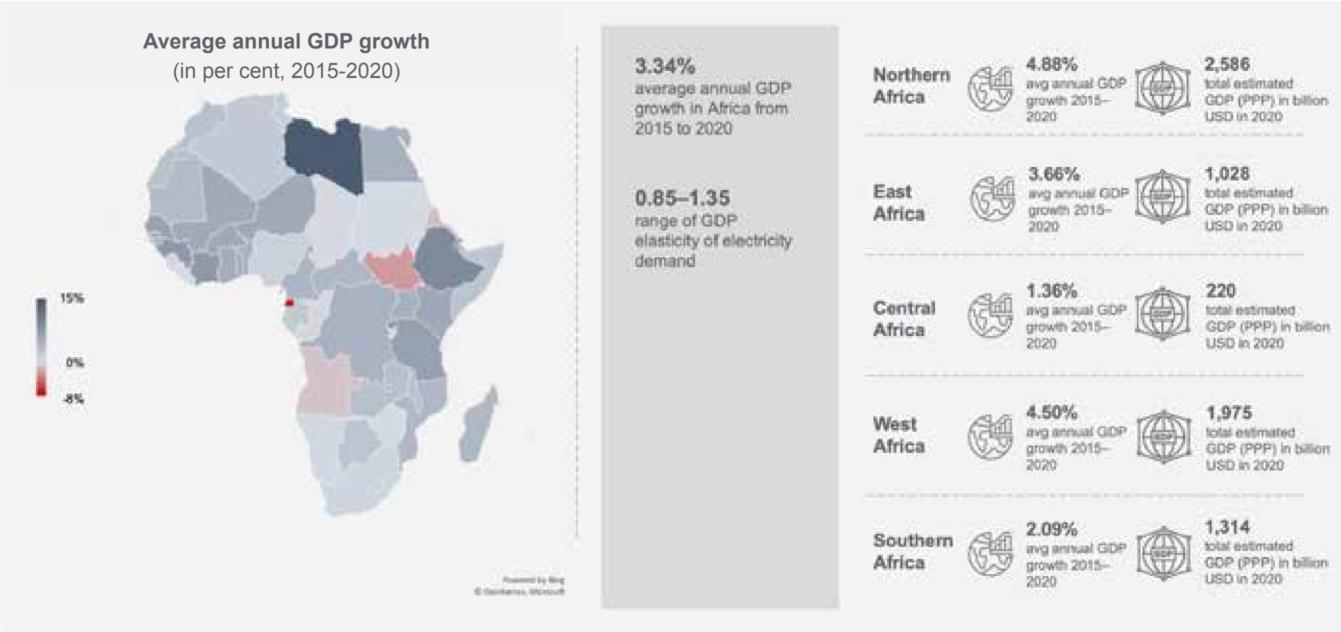
International Energy Agency (IEA, 2019a) modelled how different categories of consumers will contribute to total electricity demand in Africa in 2040 as compared to 2018. Figure 20 shows the breakdown in three categories[10]: i) productive use, ii) consumptive use from existing connections and iii) consumptive use from new connections. Significantly, consumption from current connections is expected to more than triple by 2040, due to increased purchasing power coupled with improved security of supply. For Africa as a whole, the IEA expects increased electricity consumption among existing consumers to be a larger driver of demand than access expansion.

As exemplified by the unexpected global economic contraction resulting from the 2020 outbreak of and policy response to COVID-19, it is inherently difficult to make reliable forecasts of future economic growth. Figure 21 presents historical GDP growth numbers for the five African regions.[11] Notably, the considerable differences between regions in terms of their economic performance serves as a reminder of the importance of taking a national and regional perspective when forecasting future demand.

> **The IEA expects increased electricity consumption among existing consumers to be a larger driver of demand than access expansion.**

[10] These numbers are taken from the “Africa Case” expansion scenario, which will be further explored in section 3.2.

[11] **East Africa:** Burundi, Comoros, Djibouti, Eritrea, Ethiopia, Kenya, Rwanda, Seychelles, Somalia, South Sudan, Sudan, Tanzania and Uganda. **Southern Africa:** Angola, Botswana, Lesotho, Malawi, Mauritius, Mozambique, Namibia, South Africa, Eswatini, Zambia, Zimbabwe and Madagascar. **Central Africa:** Cameroon, Central African Republic, Chad, Congo, Democratic Republic of Congo, Equatorial Guinea, Gabon, and Sao Tome and Principe. **Northern Africa:** Algeria, Egypt, Libya, Mauritania, Morocco and Tunisia. **West Africa:** Benin, Burkina Faso, Cape Verde, Côte d'Ivoire, Gambia, Ghana, Guinea, Guinea-Bissau, Liberia, Mali, Niger, Nigeria, Senegal, Sierra Leone and Togo.



Note: Annual GDP growth data from 1 January 2015 until 1 January 2020 are considered. Therefore, the COVID-19 crisis is not reflected in these figures.
Sources: IMF (2020), PIDA (2015)

Figure 21 – Recorded GDP growth from 2015 to 2020

GDP elasticity of electricity demand

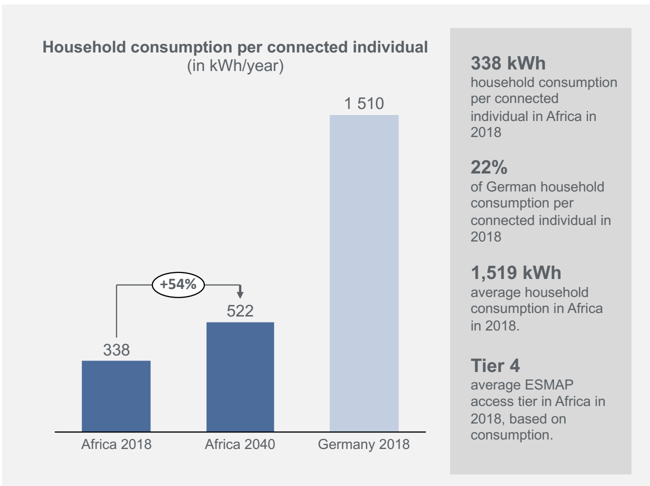
GDP elasticity of electricity demand is a measure used to describe the relationship between GDP and demand for electricity. In essence, the elasticity informs the percentage by which electricity demand will increase if GDP grows by 1 per cent. If a country has a GDP elasticity of 1.25, it means that if the GDP grows by one percent, electricity demand will grow by 1.25 percent.

Notably, the GDP elasticity of electricity demand changes over time. Earlier studies suggest that the range of elasticity for African countries is between 0.85 and 1.35. Advanced economies usually exhibit elasticities below 1 (PIDA, 2015; Jaunky, 2006).

2.1.3 Achieving access targets

In addition to macro-economic trends, country-, regional- and continent-level policies also impact demand. In particular, if ongoing efforts to expand access to sustainable energy supply – such as the UN's Sustainable Energy for All initiative and the AfDB's New Deal on Energy for Africa – are successful, this will result in extraordinary electricity demand increases.

With increased investments in access expansion, consumption from newly connected households is expected to be an important factor driving electricity demand in Africa, along with increased demand from existing connections (see figure 20). However, the size of this demand will depend on affordability and quality of access. In its Africa Case scenario, the IEA (2019a) forecasts that residential electricity consumption in Africa will increase by around 350 per cent from 2018 to 2040. This implies that even as access expands, the average person with access to electricity at home will consume about 50 per cent more electricity in 2040 than they did in 2018. The forecasted 2040 demand would approach Tier 5 (the highest level) energy supply in ESMAP´s SEforALL Global Tracking Framework (ESMAP, 2015).



Sources: IEA (2019a), Energytransition.org (n.d.), World Bank (2019a), World Bank (2020a)

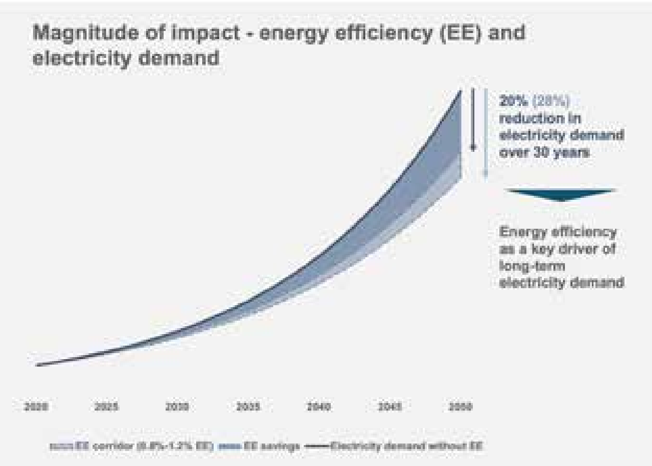
Figure 22 – Household consumption per connected individual in Africa 2018, Africa 2040 (forecasted) and Germany 2018

2.1.4 Other factors impacting electricity demand

In addition to the drivers outlined above, other factors – such as technology, climate change and infrastructure investments – will impact the rate of electricity demand growth in Africa.

Energy efficiency

Electricity demand growth can be dampened by energy conservation and increased energy efficiency – for example, new appliances and equipment – and by smart energy management. While this effect is embedded in most electricity demand forecasting models, the applied assumptions vary. The IEA Africa Energy Outlook report implies an annual efficiency savings rate of 1.2 per cent, compared to the 0.8 per cent applied by Multiconsult (2018). While the difference in these percentages appears negligible, it can have a considerable impact in the long run, due to their compounding nature. For example, a 0.8 versus a 1.2 per cent annual efficiency improvement translates into approximately 20 and 28 per cent less electricity demand in 30 years, respectively, compared to a scenario in which no energy efficiency improvements are made (see figure 23). Notably, these improvements also improve electricity affordability and reduce both emissions and investment needs.



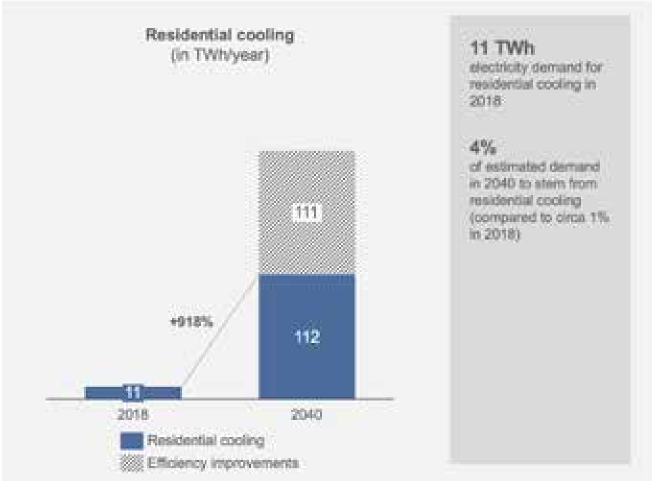
Note: Calculations assume an annual electricity demand growth in Africa of 8% (without energy efficiency improvements), in line with studies from IEA (2019a) and Multiconsult (2018).

Figure 23 – Impact of efficiency improvements on electricity demand

Among other factors, the rate of energy efficiency improvement depends on technological advancements, implementating more efficient processes and policies, and adopting minimum energy performance standards for electrical appliances. One example is cooling systems, such as air conditioners or heat pumps. As figure 24 indicates, the IEA reports that efficiency improvements can cut the forecasted 2040 electricity consumption for cooling in Africa by half, as compared to a scenario in which no efficiency gains are made.

Climate change

Climate change is expected to have a significant impact on electricity demand across the continent. Once again, cooling can serve as an example. Africa has some of the lowest cooling device ownership levels of any region, despite almost 700 million people living in areas where the average daily temperature exceeds 25 degrees Celsius (IEA, 2019a). By 2040 this number is expected to approach 1.2 billion – as the population expands, as incomes rise and more people can afford cooling, and as global climate change results in higher temperatures. Without appropriate standards for cooling equipment and energy management, the IEA estimates that electricity demand for cooling will increase from 11 TWh in 2018 to 223 TWh in 2040 (see figure 24). Even with significant efficiency gains, demand is expected to increase nearly tenfold over this 20-year period.



Source: IEA (2019a)

Figure 24 – Electricity demand from residential cooling in 2018 and 2040

Of course, cooling is also important for a number of other uses, such as refrigeration and storing vaccines and medicines or agricultural produce. On the topic of climate change, it is also worth noting that the increased frequency and intensity of extreme weather events such as droughts and floods are expected to lead to more variability in electricity generation output, particularly from hydropower.

Transmission and distribution (T&D) losses

The African continent faces among the highest rates of electricity transmission and distribution losses globally. A study by Trimble et al. (2016) found that the weighted average T&D losses in Sub-Saharan Africa were around 23 per cent, whereas an efficiently run utility can achieve losses well under 10 per cent. Most of these losses are related to commercial and technical losses in the distribution network (see the fact box below). In Northern Africa the losses are generally lower than in Sub-Saharan Africa.

Reducing transmission and distribution losses by modernising and rehabilitating grid infrastructure will significantly reduce electricity supply requirements going forward. In fact, decreasing losses by 1 per cent across Africa would reduce gross (sent-out) demand by approximately 10 TWh/year. This is approximately equivalent to the annual production of 1,500 MW of coal power capacity, or about 6,600 MW of solar capacity. For reference, the current installed solar PV capacity in all of Africa is around 6,300 MW (IRENA, 2020b). Reducing losses means that considerably less investment in generation will be required. This reduces costs as well as greenhouse gas emissions, while providing the same amount of energy to fuel economic growth and access expansion.

Gross and net electricity demand

Gross electricity demand – or sent-out demand – can be defined as all the electricity that needs to be generated in order to meet consumer demand. It is called gross demand because it includes electricity that gets lost on the way from generation to the end-consumer (T&D losses). Some of the electricity flowing through the grid will end up heating the power lines and accompanying infrastructure (technical losses), or will simply be stolen or not metered (commercial losses). Net electricity demand is gross demand minus T&D losses.

Particularly in countries with older grid infrastructure, the difference between gross and net electricity demand can be significant. This is the case in many African countries, where the total loss level can be as high as 50 per cent.

Electrification of energy end uses

New and emerging electricity end uses – such as for cooking, transport and heavy industry – could become an important source of future demand growth. For example, the transport sector is currently responsible for 31 per cent of total energy-related greenhouse gas emissions in Africa. As populations and economies grow, the number of cars is estimated to increase fourfold – to 35 million by 2040 in Sub-Saharan Africa alone (IEA, 2019a). As a thought experiment, full electrification of these 35 million vehicles would mean an additional net demand of about 84 TWh per year (equal to 6 per cent of the total projected electricity consumption in 2030).[12] The gross number (including T&D losses) is even higher.

Increased demand resulting from transport electrification, with the required corresponding investments in generation and supply infrastructure, could become a burden to power system operators. However, if electric vehicle smart-charging technologies are widely adopted, then scaling up electric vehicle deployment could actually add much-needed flexibility to electricity systems and even support the integration of high shares of renewables, because car batteries can be charged during off-peak hours and then fed back into the grid during peak hours (IRENA, 2019c).

Heavy industry is another energy end use that can be electrified. In this sector, green hydrogen can be a particularly attractive supplement to electricity as an energy carrier. The fact box below contains more information on green hydrogen.

Green hydrogen

Hydrogen is a versatile energy carrier that can help tackle some of the critical challenges of the global energy transition. It has diverse application potential, ranging from chemical and heavy industry to electricity storage and transport. The production of green hydrogen is considered a Power-to-X technology. Such technologies convert electricity into synthetic energy sources (IRENA, 2019d).

Currently, global hydrogen production facilities mainly use electricty from fossil fuels (grey hydrogen) and are responsible for approximately 830 million tons of CO_2 emissions per year (6 per cent of global natural gas and 2 per cent of global coal is used to produce hydrogen) (IEA, 2020).

For countries with high renewable energy potential, green hydrogen production represents a substantial opportunity. In addition to replacing hydrogen production from polluting electricity sources, adopting this synthetic energy source may also constitute a green alternative for certain applications in the transport sector and industry, and it can be deployed as an energy storage alternative (by making use of systems with a high share of variable renewable energy – e.g., using peak supply from solar generation during the day).

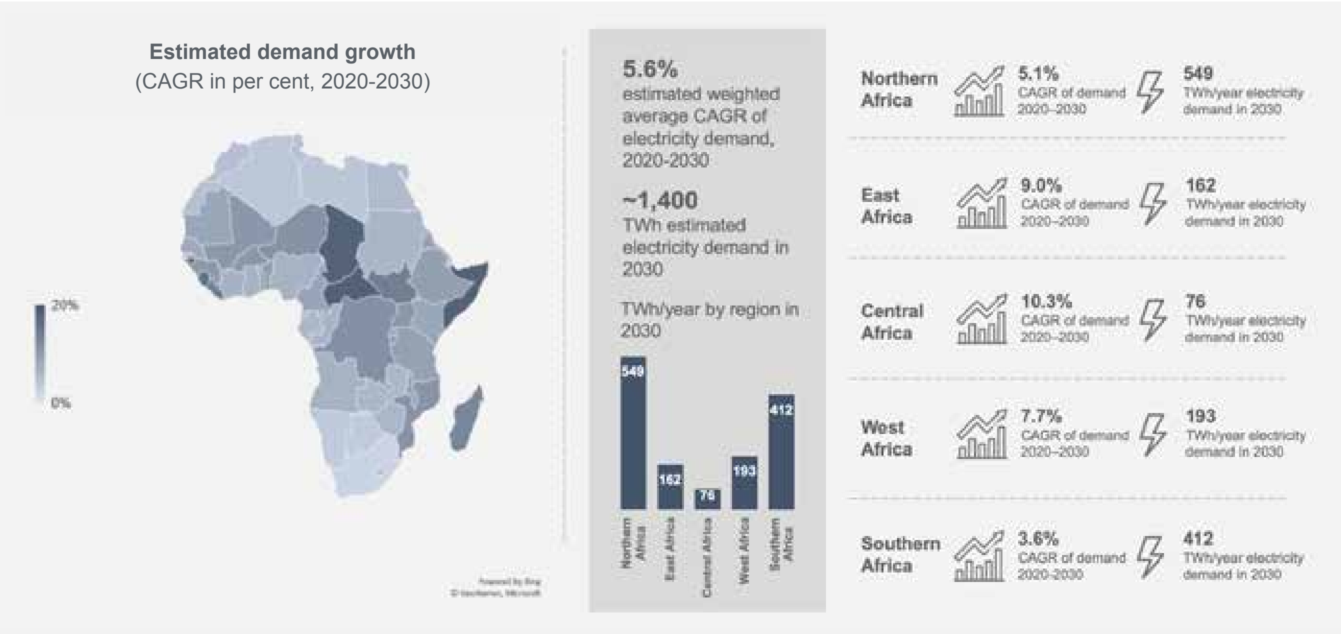
As part of its hydrogen strategy, the German government facilitates the creation of a green hydrogen sector in Morocco by supporting the construction of a preindustrial-scale pilot plant for the production of green hydrogen (Government of Germany, 2020) as well as the establishment of a research platform. The intention is to show whether and how green hydrogen can be produced in a competitive, climate-neutral manner. Green hydrogen is also a key element in both Europe’s Green New Deal and the Recovery Plan for Europe, announced in 2019 and 2020, respectively (EU, 2020).

[12] An average electric vehicle consumes 200 Wh/km (ev-database.org, 2020). Assuming an average travel distance of 12,000 km/year (similar to the European Union) results in an annual electricity consumption increase of approximately 2,400 kWh per vehicle (Odyssee-MURE, 2020).

2.1.5 Regional projections of electricity demand growth

There are considerable uncertainties around future electricity demand growth, especially over longer periods of time. Historically, there has been a tendency to be overly optimistic about future demand in Africa, particularly when forecasting has been based on national economic growth and access targets. Regional demand projections generally apply a more balanced, realistic approach. The figure below builds on regional demand projections made by Multiconsult (2018), which applied the demand drivers outlined above to estimate demand growth at a regional level up to 2030. Again, there is substantial uncertainty related to the assumptions underpinning such projections, not least regarding the long-term electrification of end uses (e.g., electrifying transport and producing green hydrogen). Space does not permit us to fully address these uncertainties in this analysis.

The combination of strong population growth, access expansion and GDP growth is expected to lead to annual electricity demand growth rates of around 9-10 per cent annually in East and Central Africa between 2020 and 2030. These relatively high growth rates would imply that demand doubles approximately every eight years. Meanwhile, the two regions with the highest current demand are expected to see around 5 per cent (Northern Africa) and 4 per cent (Southern Africa) annual growth, respectively. In total, Multiconsult forecasts that electricity demand in Africa will be around 1,400 TWh in 2030 (excluding technical losses). This is slightly lower than the total final demand of 1,600 TWh reported by IRENA, which is largely based on regional master plans. It should be noted that these projections were made prior to the COVID-19 crisis. If and when universal access is achieved and African GDP elasticities of demand reduce, demand growth rates will likely also fall.



Source: Multiconsult (2018)

Figure 25 – Estimated net electricity demand growth in Africa from 2020 to 2030

2.2 Analysis of potential renewable energy expansion scenarios in the electricity sector by region

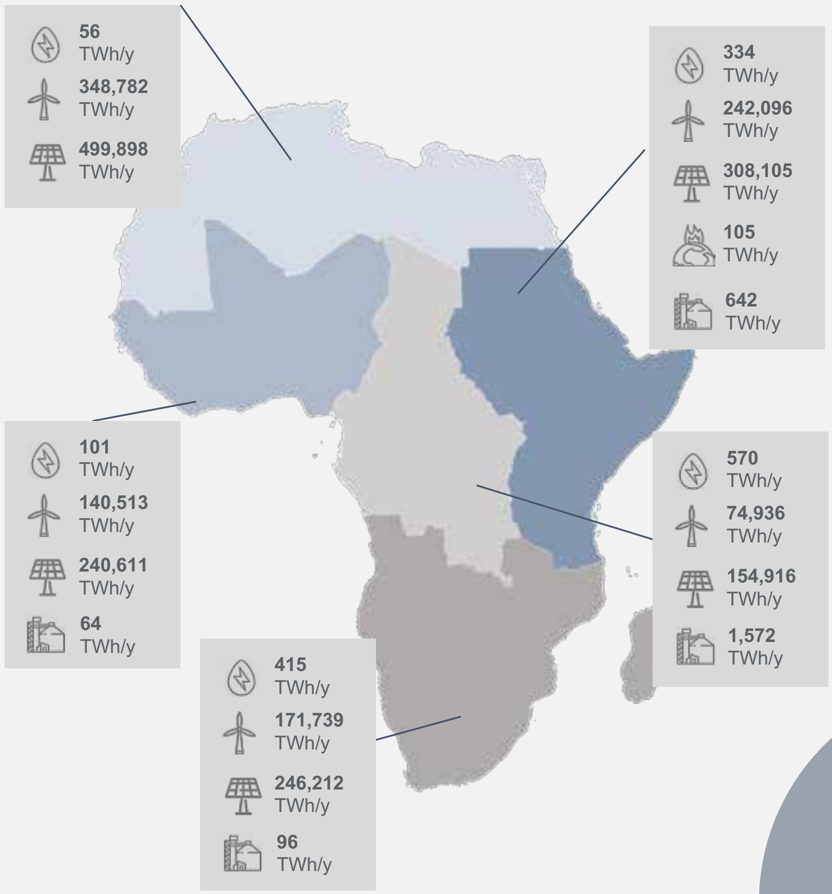
Each African country has a unique starting point in terms of electricity access, resource availability and demand. Taking a regional view, this section briefly presents the renewable energy potential across Africa and reviews three published expansion scenarios for the continent as a whole.

2.2.1 Renewable energy potential

Africa arguably has the largest renewable energy resources of any continent. Sunlight is abundantly available everywhere, while other types of resources are more plentiful in some countries and regions than in others – such as geothermal along the Rift Valley in East Africa, or wind power in the Horn of Africa and various coastal areas.

Figure 26 illustrates the theoretical generation potential of different (onshore) renewable energy technologies, for Africa as a whole and by region. It is important to note that these are theoretical assessments, and in many cases, they do not consider environmental impacts or use conflicts with other sectors, such as tourism and agriculture. Nevertheless, Africa's theoretical potential to generate onshore renewable energy from existing technologies is more than 1,000 times larger than its projected 2040 demand for electricity, which means that it has more than enough renewable energy resources to serve its own demand, even in the long run. With the right investments and enabling frameworks, it could even emerge as a net exporter of renewable energy.

Estimated theoretical onshore renewable energy potential in Africa



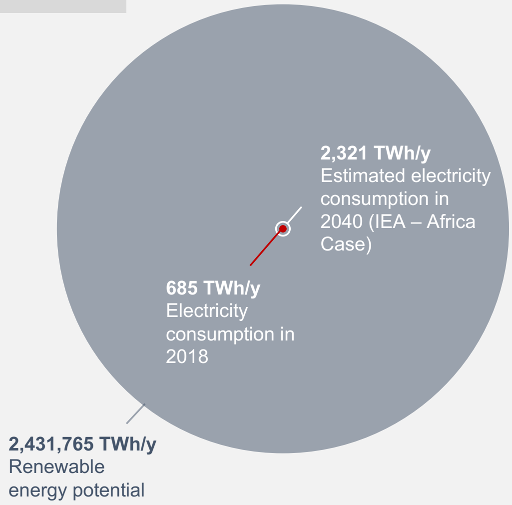
1,478 TWh/y
Hydropower

978,066 TWh/y
Wind

1,449,742 TWh/y
Solar PV*

105 TWh/y
Geothermal

2,374 TWh/y
Biomass



Solar PV

The solar energy potential in Africa is virtually limitless – with irradiation levels twice the level of Germany. In contrast to wind and hydro, solar potential is distributed fairly uniformly – with more than 80% of African land receiving more than 2 MWh/year per m^2 (Belward et al, 2011). Solar energy can bring power to rural areas without expensive grid infrastructure. CSP is another relevant but more costly technology which allows for energy storage.*

Wind power

Africa has a substantial energy potential from Wind, particularly in the coastal regions, such as Northern Africa, Eastern Africa, and Southern Africa – since these regions have generally better wind resources.

Hydropower

Africa has abundant hydropower potential, of which only a fraction has been developed. With about 40%, the largest share of hydropower potential is located in Central Africa, followed by East Africa with approximately 28% (IRENA, 2015). The total *theoretical* potential is estimated at around 1,500 TWh per year, with more than 90% currently unexploited.

Biomass power

While the current electricity generation of biomass power projects is negligible in Africa, there is substantial potential, particularly in Central Africa. Biomass can be used to generate electricity. Furthermore, it represents an opportunity by providing renewable energy for heavy manufacturing, as it can be used to produce process heat.

Geothermal power

Geothermal energy is a resource of considerable importance in the Rift Valley in Eastern Africa, stretching from Mozambique to Djibouti, with a total potential of approximately 15 GW of installed capacity. Geothermal heat can also be used for low-temperature heat, as required by the manufacturing industry, making it a suitable substitute for fossil fuels.

* The generation potential of Concentrated Solar Power (CSP) is approximately 625 PWh/y. Compared to solar PV, CSP is capable of storing energy through thermal energy storage, making it a less intermittent generation technology. Notably, the solar PV, CSP and wind estimates are GIS-based estimates, considering irradiation and wind speed as well as applying exclusion zones. Other factors may restrict the land suitable for renewable energy deployment, such as practicality, legal and socio-economic implications. Often a scaling factor as low as 1% could be applied to the potential estimate to account for these factors.
Note: For reference, wind and solar generation in Germany was 131 TWh and 48 TWh in 2019, respectively.
Data: UNEP (2017), IRENA (2014), IRENA (2017), Mandelli et al. (2014), BWE (2020), BMWi (2020), IEA (2019a), IRENA (n.d.).
Illustration: Multiconsult

Figure 26 – Overview of theoretical onshore renewable energy potential in Africa

When assessing and comparing the potential of different renewable energy generation technologies, it is important to be mindful of their technical characteristics. For example, whereas solar PV power plants can only generate during the day, wind turbine generation depends on wind speeds, and hydropower plants depend on water availability throughout the year. This issue is further explored in the fact box on the next page.

To ensure that the electricity supply meets demand throughout the day, both in national and mini-grids, new variable renewables must go hand in hand with significant investments in grid infrastructure flexibility and stability. IRENA (2019b) has shown that abundant innovations are emerging and being implemented worldwide to integrate more solar PV and wind resources into flexible power systems (see section 3.3.3).

> **Africa arguably has the largest renewable energy resource reserves of any continent.**

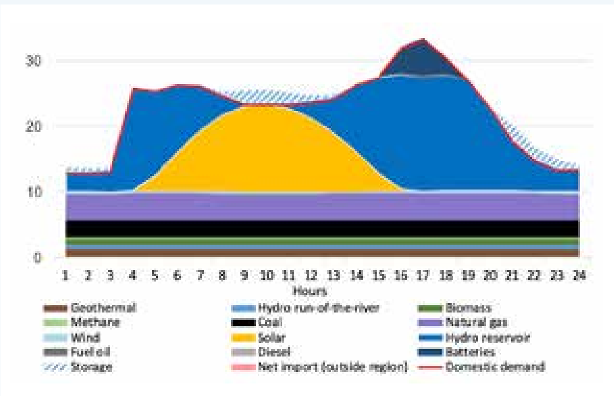
The interplay of generation technologies

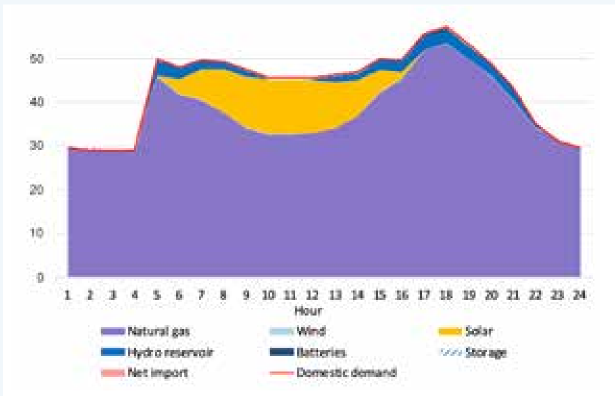
To appreciate how different renewable energy technologies fit into the energy mix, it is useful to first understand the difference between baseload and non-baseload generation.

Baseload can be defined as power-producing capacity intended to be continuously available – even under adverse conditions. Due to this constant availability, baseload is usually priced higher than other sources of electricity. Non-baseload generation sources usually lack a continuous availability guarantee.

The figure below illustrates the typical interplay between different baseload and non-baseload generation sources, showing how demand throughout the day is covered by different generation technologies. Baseload can be found in the form of natural gas, biomass, coal or geothermal – providing the first 10,000 MW. Solar generation covers a considerable share of the demand during the day and allows for charging batteries (indicated by the blue striped area) and accumulating water in hydro reservoirs. These sources, in turn, are dispatched in the evening to cover peak demand – a good example of how solar energy can be paired with hydro reservoirs to meet evening peaks.

In contrast, the second example involves limited hydropower availability. The figure below shows that electricity generated with fossil fuels (natural gas) is dispatched to meet peak demand in the evening. Because production from natural gas power plants can be flexibly increased and decreased, it is useful to fill intra-day supply gaps that are not covered by renewables. In this regard, natural gas can be used as a renewable energy integrator. Intermittent renewable capacity can be added to the mix, while natural gas is used to fill the gaps.





2.2.2 Review of existing expansion scenarios

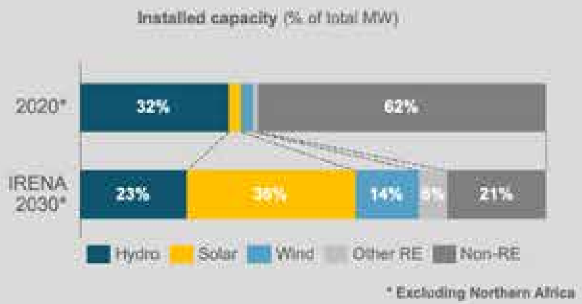
Three sector expansion studies of African power systems with a view towards 2030 and beyond were published between 2018 and 2020. The figure below summarises the key implications of the most relevant scenario from each study.

2030

REmap (IRENA, 2020d)

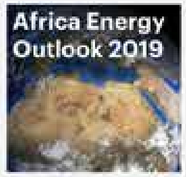
Planning horizon:	**2050** (2040, 2030)
Geographical focus:	**World** (MENA, SSA)
Model:	**IRENA**
Sector:	**Energy**

The basis for the REmap Case is the goal of a significant reduction in global CO_2 emissions by 2050. According to the authors, the analysis outlines an aggressive yet feasible course for the global energy transition. The Global Energy Transformation report was published in 2020 and covers the whole world. It not only considers the electricity sector, but energy use more broadly, the economy, the environment and its linkages. As such, the report assesses metrics, including technology, sector and system costs; externalities relating to air pollution and climate; emissions; and economic indicators, such as employment and economic growth (IRENA, 2020d).



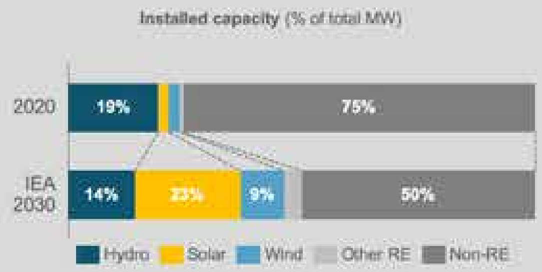
- The REmap case requires decommissioning coal power plants to achieve the goals.
- The power sector will play the largest role in the decarbonisation of the energy supply.

Africa Case (IEA, 2019a)



Planning horizon:	**2040** (2030)
Geographical focus:	**Africa** (Africa, SSA, selected countries)
Model:	**WEM**
Sector:	**Energy**
Policy document:	**AU Agenda 2063**

The Africa Case scenario builds on the African Union's Agenda 2063, which sets out an "inclusive and sustainable vision" for accelerated economic and industrial development on the continent. It includes faster economic expansion than the reference scenario (Stated Policies) and full achievement of key Sustainable Development Goals by 2030. This includes universal access to electricity by 2030, clean cooking and a significant reduction in premature deaths related to indoor air pollution. The model considers the entire energy sector, including transport, agriculture, etc. – and considers the Total Primary Energy Demand (TPED) rather than only electricity demand.

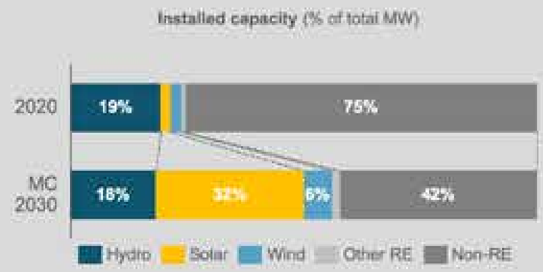


- Rising electricity needs require a major expansion of the power system.
- The development and reliability of the electricity sector will be shaped by progress in improving power infrastructure within and across borders.
- A significant scale-up in sector investments in both generation and the grid is required for a successful energy transition.
- To achieve this, policy and regulatory measures need to be put in place, improving utilities' financial and operational efficiency and facilitating the effective use of public funds.

Low-Carbon Case (Multiconsult, 2018)

Planning horizon:	**2030**
Geographical focus:	**Africa** (regional, country)
Model:	**Balmorel**
Sector:	**Electricity**
Policy document:	**AfDB A New Deal on Energy for Africa**

The Roadmap for a New Deal on Energy study models the expansion of the power sector in each of the 54 African countries by 2030. Unlike many other modelling exercises for the continent, this study takes a dynamic approach to the integration of renewables, modelling how demand can be met hour by hour through the day, including real data for irradiation and wind. A low-carbon scenario was also included, providing regional optimisation of power system expansion to meet the growing demand and access targets of the AfDB with the aggressive promotion of renewable energy. The low-carbon case is presented here, as it is most relevant to this study.



- The estimated additional annual investment cost of reducing power sector emissions by 41 per cent relative to the reference scenario is USD 10 billion.
- Each country has a unique optimal development path, but renewables will dominate generation expansion all over the continent.
- Regional integration and investments in storage are key to enabling the increased integration of variable renewables.

Note: This overview contrasts institutions' expansion scenarios of institutions, with varying optimisation models, geographical foci, planning horizons and sectoral inclusion. Therefore, comparability between the results presented above is limited. The comparison serves mainly as an illustration of ranges, outlining potential scenarios.

Figure 27 – Brief presentation of three recent expansion scenarios for the African power sector

The cross-cutting lessons from the selected expansion scenarios on a continental level help to crystalise the need for strong political will if Africa is to make universal access and a decarbonisation of its electricity sectors a reality. Specifically:

- None of the scenarios arrive at a full decarbonisation of African electricity sectors. Policy interventions would be required in order to optimise the opportunities of a renewables-based energy system while ensuring a smooth transition away from existing fossil fuel generation capacity.

- Current access expansion efforts are insufficient to achieve universal electricity access by 2030. A clear, coordinated break with business-as-usual would be required to achieve that objective.

- Economic growth coupled with efforts to realise universal access to electricity could result in African power systems' installed capacity more than doubling from 2020 to 2030. Most of this growth is expected to be served from renewable resources, showcasing the competitiveness of renewable energy and storage solutions. The current regional master plans (many of which are dated and are not continuously updated or translated into concrete power procurement plans) indicate that most of this growth will come from fossil fuel-based generation sources. However, the falling costs of renewables, storage and other flexibility options mean that economic optimisation models are increasingly pointing to renewable sources as the most economical choice, despite the need to complement their often intermittent nature. However, least-cost optimisation models do not take account of structural policy barriers and/or market distortions that hinder the deployment, integration and rapid scale-up of renewable energy in Africa. These barriers include everything from cumbersome investment requirements to end-user tariffs that do not reflect costs and significant ongoing subsidies for fossil fuels. Given that these structural barriers can be addressed, renewable energy is in a position to eliminate coal from the energy expansion mix on the African continent.

- Natural gas has inherently attractive attributes, including peaking and balancing, which increase its appeal as the level of variable renewables in the electricity supply mix also increases. While shifting from coal to gas may reduce greenhouse gas emissions in the near-term, investment in natural gas would commit individual countries to long-term fossil fuel infrastructure that would have to be paid back over an extended period, during which it is expected that renewable sources will become significantly cheaper.

- African countries are currently investing in fossil fuel generation capacity, including coal power plants and natural gas infrastructure, which will have an economic lifetime beyond 2050. To pursue a low-carbon development path, these investments will have to be reanalysed, as they may result in stranded assets and subsequent economic costs.

- Ensuring security of supply as more variable renewables are introduced into power systems requires enabling technologies, grid modernisation and expansion, appropriate business models, market design and system operation to increase flexibility. A low-emission future for the continent will depend on major breakthroughs, cost reductions and economies of scale for enabling technologies, such as energy storage.

- Overall, the significant expansion of renewables in these scenarios is projected to reduce long-term power system costs, even before taking into account the external benefits of lower pollution and improved energy security as a result of reducing reliance on fossil fuels.

2.2.3 Regional implications for access and a low-carbon development path

Against the backdrop of these three expansion scenarios, the subsequent section outlines the implications of political ambitions for universal access and low-carbon growth across the five African regions.[13] In order to accommodate a region-by-region depiction of the implications, we have chosen the Multiconsult (2018) study as the primary reference point, with additional detail taken from IRENA's power sector modelling.

[13] **East Africa:** Burundi, Comoros, Djibouti, Eritrea, Ethiopia, Kenya, Rwanda, Seychelles, Somalia, South Sudan, Sudan, Tanzania and Uganda. **Southern Africa:** Angola, Botswana, Lesotho, Malawi, Mauritius, Mozambique, Namibia, South Africa, Eswatini, Zambia, Zimbabwe and Madagascar. **Central Africa:** Cameroon, Central African Republic, Chad, Congo, Democratic Republic of Congo, Equatorial Guinea, Gabon, and Sao Tome and Principe. **Northern Africa:** Algeria, Egypt, Libya, Mauritania, Morocco and Tunisia. **West Africa:** Benin, Burkina Faso, Cape Verde, Côte d'Ivoire, Gambia, Ghana, Guinea, Guinea-Bissau, Liberia, Mali, Niger, Nigeria, Senegal, Sierra Leone and Togo.

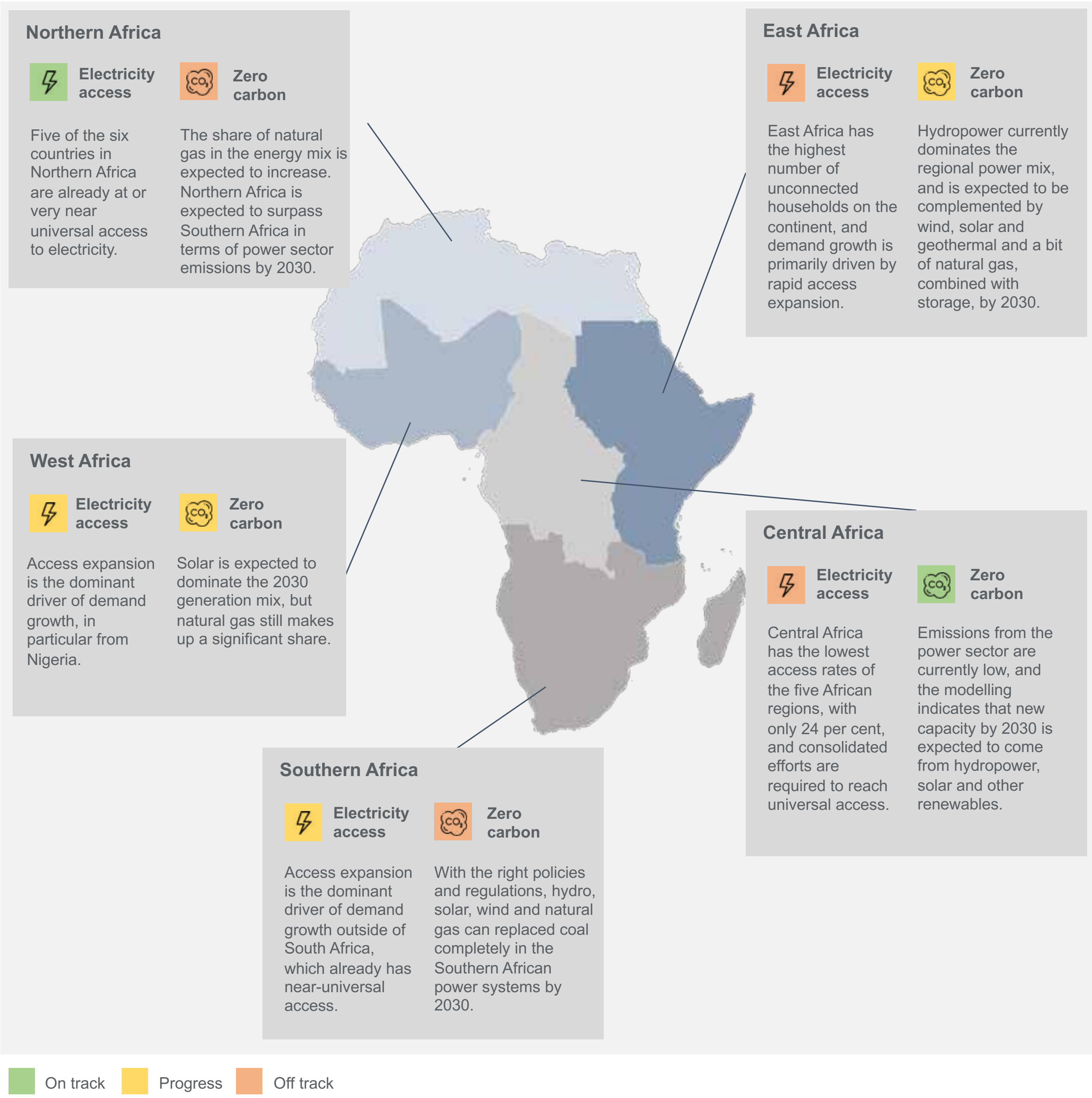


Figure 28 – Regional implications of the three electricity sector expansion scenarios

Northern Africa: Substantial investments in solar, wind and natural gas

Algeria, Egypt, Libya, Mauritania, Morocco and Tunisia

Forecasts indicate that electricity demand in Northern Africa will double over the period from 2018 to 2030. Because the region already has near-universal access, this increase will come almost exclusively from economic growth.

By 2030, installed generation capacity is also forecasted to be nearly double 2020 levels, with substantial investments in solar PV and natural gas power plants. Significant natural gas power capacity is currently under construction, and Northern Africa is expected to surpass Southern Africa in terms of electricity sector emissions by 2030. To achieve low-carbon development, available wind resources in the coastal regions should be developed, along with investments in solar power.

Given that some of the infrastructure currently under construction will have economic lifetime beyond 2050, there is a clear risk that these will be in direct conflict with current efforts to achieve a low-carbon future. With reduced generation from natural gas in the medium-term and limited potential for additional reservoir hydropower, energy storage and electricity trade will have to play a greater role.

> **Northern Africa is expected to surpass Southern Africa in terms of power sector emissions by 2030.**

The Northern African electricity markets are already quite well integrated in terms of physical interconnector capacity, although levels of regional electricity trade are limited. Therefore, major investments in interconnectors are not expected to be required before 2030. Morocco is among the countries considering green hydrogen as one of its future energy carriers (Government of Morocco, 2020).

West Africa: Strong demand increase and diverse generation expansion by 2030
Benin, Burkina Faso, Cape Verde, Côte d'Ivoire, Gambia, Ghana, Guinea, Guinea-Bissau, Liberia, Mali, Niger, Nigeria, Senegal, Sierra Leone and Togo

Electricity demand in West Africa is forecasted to grow by more than 250 per cent by 2030. Access expansion will make up an especially large share of demand growth in this region, with Nigeria alone accounting for 25 per cent of the new connections required to achieve universal access in Africa by 2030. This highlights the interdependence of access and generation expansion. If access expansion falls short of existing targets, less generation capacity will be required, particularly in West Africa.

> **Nigeria alone may account for 25 per cent of the total new connections required to achieve universal access in Africa by 2030.**

The growing electricity demand is expected to be met through significant investments in natural gas power plants, solar and reservoir hydropower, resulting in installed capacity more than tripling by 2030. With costs continuing to fall, solar PV is expected to be the technology with the largest installed capacity by 2030. Still, natural gas, batteries and hydropower – particularly the 3,050 MW Mambilla hydropower plant in Nigeria, on which construction is about to begin – may play an important role in providing flexibility. In terms of decarbonisation, however, national climate strategies in this region will also need to consider decommissioning existing gas-fired power plants in due course.

Investments in generation are expected to be complemented by a number of new interconnectors, allowing the region to better utilise its potential and develop a diverse electricity generation mix, with a substantial share of renewable energy. IRENA's dedicated modelling of national renewable energy targets in West Africa confirms Multiconsult's conclusions (2018), particularly regarding the expansion of complementary solar and hydropower generation, as well as the importance of strengthening regional interconnectivity. IRENA also provides further detail on the prospects for variable renewable energy investment in specific countries. Considering solar PV in particular, the majority of new capacity in the National Targets scenario IRENA explored is deployed in Nigeria, Ghana and Côte d'Ivoire, reflecting their large share of regional electricity demand. Relatively smaller countries with better solar resources (i.e., >20% average capacity factor) – such as Guinea, Burkina Faso, Senegal and Mali – would also have to deploy significant amounts of solar PV capacity to meet their national targets. Due to the nature of wind resources in West Africa, wind capacity deployment is less widespread, with smaller – though nationally significant – amounts concentrated in Senegal and Niger (IRENA, 2018a).

Central Africa: Strong connection growth and integration to support more renewables
Cameroon, Central African Republic, Chad, Congo, Democratic Republic of Congo, Equatorial Guinea,Gabon and Sao Tome and Principe.

At only 24 per cent, Central Africa currently has the lowest access rate of all the African regions. Given that the transmission grids in many Central African countries are small, it is expected that a relatively large share of immediate electrification could be achieved using off- or mini-grid systems with renewable energy.

Few generation projects are currently under construction, and Multiconsult (2018) expects that significant new investments will be required by as early as 2025 in order to meet the forecasted increase in demand. Few of the electricity markets in the region are meaningfully connected at present, and investments in new interconnectors are therefore crucial to the development of an integrated, well-functioning regional power system. By 2030, economic optimisation of regional generation will include a quadrupling of installed capacity, primarily through investments in large run-of-river hydropower projects in the Democratic Republic of Congo and Cameroon, as well as solar power complemented by utility-scale batteries and reservoir hydro. These forecasts are supported by IRENA´s Renewable Energy Roadmap for Central Africa (IRENA, 2020e). To enable low-carbon development paths that secure the opportunities offered by renewables-based systems, one key challenge will be providing alternatives to new fossil fuel development and avoiding any unnecessary costs associated with locked-in fossil fuel plants, not least through the cooperation of regional regulatory and operational bodies, enabling frameworks and new ways of operating power systems, and well-planned investments in storage and interconnectors, which can provide the flexibility required to support different sources of variable renewables and to take advantage of their complementarities over such a large geographical area.

> **Investments in new interconnectors are crucial for the development of an integrated, well-functioning power system in Central Africa.**

East Africa: Near-term electricity supply surplus, followed by significant investments in renewables
Burundi, Comoros, Djibouti, Eritrea, Ethiopia, Kenya, Rwanda, Seychelles, Somalia, South Sudan, Sudan, Tanzania and Uganda

By 2030, on-grid demand for electricity in East Africa is forecasted to grow by nearly 250 per cent. Since East Africa has the highest number of unconnected households on the continent, this growth will be driven primarily by rapid access expansion. The largest absolute increase in demand is expected in Ethiopia, Kenya, Tanzania and the Sudan. It is clear that robust off- and mini-grid solutions will play an important role in access expansion efforts, at least in the short- to medium-term.

The near-term electricity supply surplus is expected to evolve into a significant increase in installed capacity by 2030, with the interplay between large reservoirs and solar power playing a central role. With a number of large hydropower plants under construction, not least in Ethiopia, Multiconsult expects the region to add nearly 12,000 MW of new capacity by 2025 – entirely from plants which are reportedly already under construction. As such, the East African region has the potential to develop a diverse generation mix by realising considerable investments in solar power plants and batteries (if reservoir hydropower is not available) in several countries by 2030. Some new natural gas capacity is also included in the optimisation results, mainly in Tanzania.

East Africa is expected to add nearly 12 GW of new capacity by 2025 – entirely from plants which are already under construction.

In an economically optimised scenario, the region is expected to undergo significant system integration in the run-up to 2030, with considerable new interconnector capacity added to the large projects already under construction. As a result, over this period East Africa will emerge from relatively isolated national systems into a highly inter-connected regional power system, with significant volumes of regional electricity trade, provided the necessary enabling policy and regulatory frameworks are in place.

Southern Africa: Sluggish demand growth and phasing out coal

Angola, Botswana, Eswatini, Lesotho, Madagascar, Malawi, Mauritius, Mozambique, Namibia, South Africa, Zambia and Zimbabwe

Demand in Southern Africa is forecasted to increase by around 55 per cent by 2030. This comparatively sluggish demand growth relative to the other regions is largely explained by the expectation that South Africa’s moderate economic growth and diminishing energy intensity will continue.

Hydro, solar, wind and natural gas are expected to dominate generation expansion in Southern African power systems. IRENA forecasts that 20-25 per cent of the installed capacity in Southern Africa will be solar PV by 2030. Provided that the structural barriers currently slowing down investments in renewables are addressed, it is reasonable to expect that fossil fuels will largely be outcompeted by 2050. However, some of the coal power plants currently under construction may still be operational even then. Provided that climate change does not have significant negative impacts on the Zambezi River, existing hydropower dams in Zambia and Zimbabwe will likely provide valuable flexibility and storage for the entire region.

Hydro, solar, wind and natural gas are expected to dominate generation expansion in Southern African power systems.

The regional power system is already fairly well integrated, and the region – particularly some of the smaller countries – is reaping the benefits of trading in the Southern African power pool. Additional investments in interconnectors are currently being evaluated, given that existing physical trading capacity is tied up to a large extent in long-term bilateral trading contracts, with only marginal capacity for day-ahead trading or additional regional power exchange. With increased capacity and more routes to trading electricity, power generated from areas with high-quality, cost-effective renewable resources can be distributed more efficiently to meet demand needs in other areas. The topic of cross-boundary synergies enabled by regional power system integration is further explored in the excursus below.

Excursus

The Africa Clean Energy Corridor: Potential and prospects for variable renewable energy in Southern and East Africa

Recent work by IRENA (forthcoming, 2020) has aimed to provide more specific information on the prospects for variable renewable electricity generation projects in East and Southern Africa – jointly referred to as the Africa Clean Energy Corridor (ACEC). IRENA has supported power pool work in Africa by providing such inputs to the regional coordination and planning of power pools (e.g., updates to power pool master plans). Within the framework of the ACEC, IRENA supports the Southern African Power Pool (SAPP) and the East African Power Pool (EAPP), including the vision of fostering a North–South power transmission corridor. The ACEC comprises 21 continental countries in the SAPP and the EAPP, namely Angola, Botswana, Burundi, Democratic Republic of the Congo, Djibouti, Egypt, Ethiopia, Eswatini, Kenya, Lesotho, Malawi, Mozambique, Namibia, Rwanda, South Africa, South Sudan, Sudan, Tanzania, Uganda, Zambia and Zimbabwe.

IRENA's latest electricity sector analysis of these regions assesses the investment potentials of renewables, focussing on solar PV and wind, for the period up to 2040. It uses a generation and transmission capacity expansion model developed by IRENA, combined with a detailed zoning analysis that IRENA developed with the Lawrence Berkeley National Laboratory in 2015 (IRENA, 2015b). Using this analytical framework, IRENA has assessed the economic viability of generation project sites in the context of overall long-term power system development needs on both country and sub-regional levels. Various investment risk factors are also addressed, including the impacts of climate change (i.e., limited water availability for hydropower and storage) as well as the lack of progress on interconnector development.

These analyses are translated into targeted recommendations for potential generation and transmission projects of regional importance.

Cost-effective variable renewable energy projects are geographically distributed

Since the countries in the ACEC have excellent, geographically diverse resources, solar PV and wind deployment can be observed throughout the corridor – most prominently in Egypt and South Africa, where large numbers of project sites are being considered. The figure below presents a visualisation of the locations and capacities of solar PV and wind plants in 2040. Each bubble represents one specific geographic zone for variable renewable energy deployment identified in IRENA's analysis, while the size indicates the respective zone's estimated capacity in 2040. Each country has its fair share of opportunities. A scenario exploring higher shares of variable renewable energy generation would prompt additional buildout of solar PV capacity in South Africa and wind capacity in Egypt, Ethiopia, Tanzania, Zimbabwe, Zambia, Mozambique and Malawi.

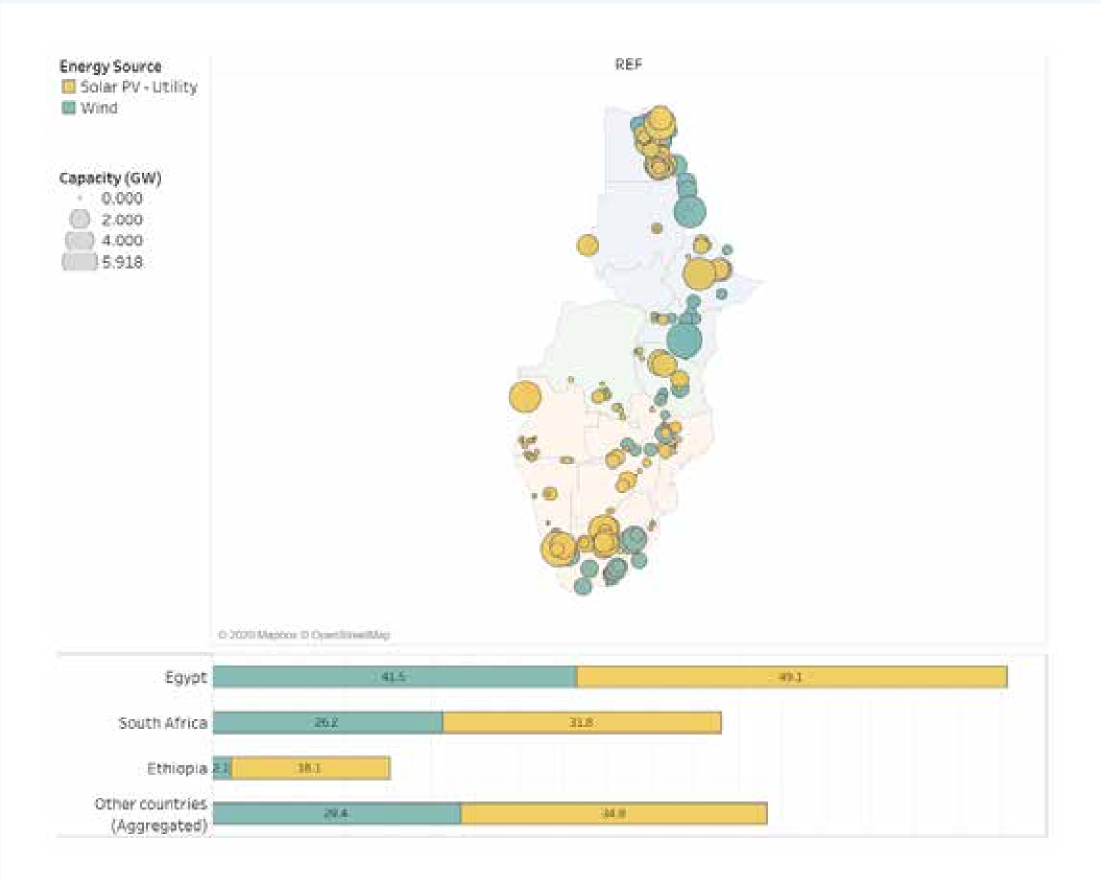


Figure 29 – Solar PV and wind generation capacities in 2040, according to IRENA's reference scenario

Regional integration where synergies exist addresses the need for flexible generation

An increase in interconnector capacities in the region over the years has not only enhanced cost-efficient production by enabling an increased flow of lower-cost electricity supplies, but has also enabled the pooling (and mutual balancing) of supplies from hourly variable resources with complementary profiles. For example, as discussed above, hydropower supplies are flexible and can thereby help balance the inherent variability of other renewable energy supplies. Complementary generation profiles between countries can be used to provide stable electricity through trade, if there is adequate interconnector capacity. With adequate transmission infrastructure and generation capacity, a country with excellent hydro resources can import solar power during the day and export its hydropower at night.

One illustrative example is the interconnection between the Democratic Republic of the Congo and Rwanda. The figure below shows IRENA's analysis of the hourly production and transmission rates for each country in 2020, 2030 and 2040. It also depicts Rwanda's hourly import. With increased transmission capacity in the coming years, high volumes of hydropower production can be exported to Rwanda at night, when there is a supply gap due to the absence of domestic solar power generation.

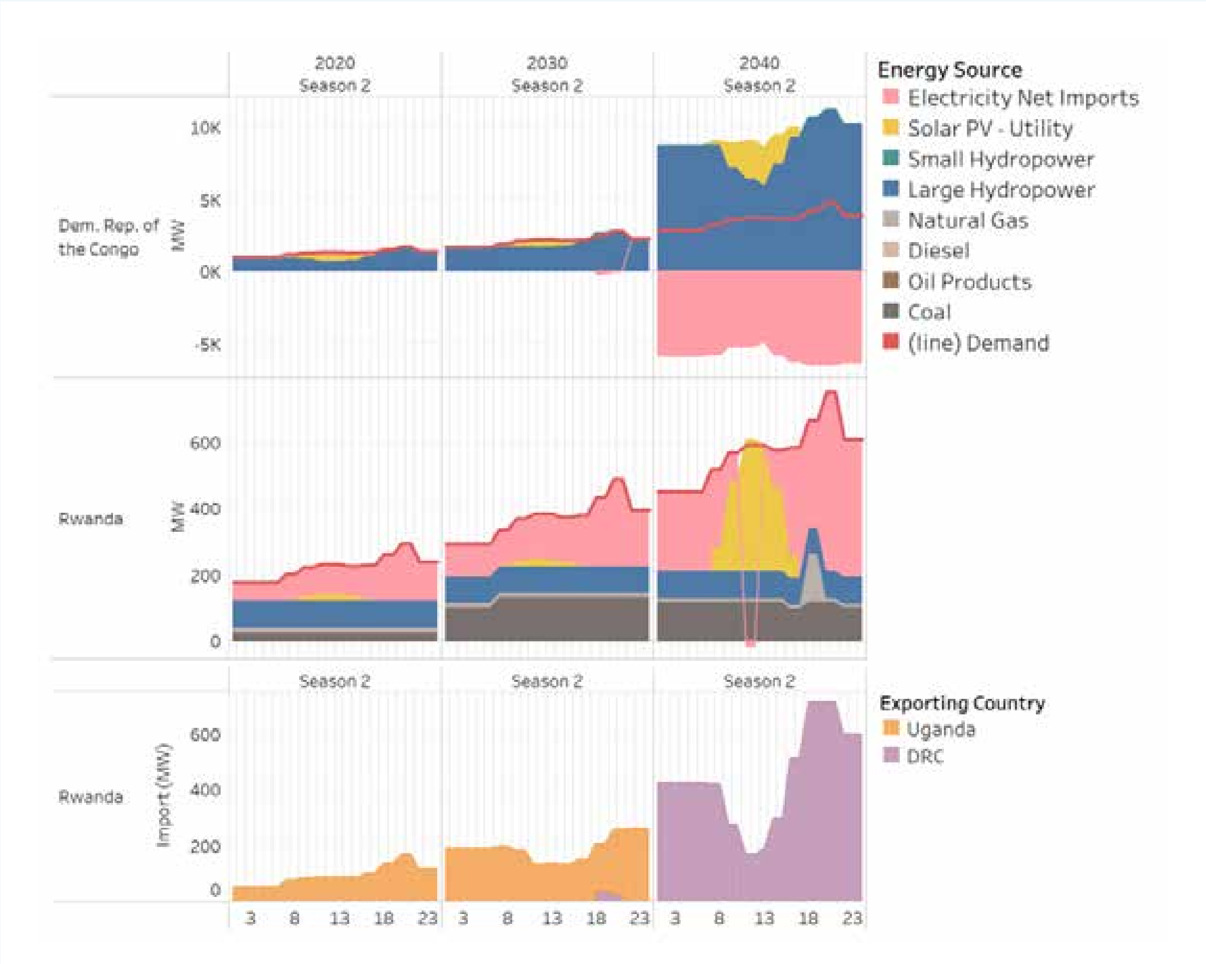


Figure 30 – Hourly production and transmission rates for the DRC and Rwanda in 2020, 2030 and 2040, season 2 (May–August), according to IRENA's analysis

More detailed data, modelling and analysis can support investment in particularly attractive variable renewable energy sites

While many studies agree on the extent to which variable renewable energy sources such as solar PV and wind could be significantly expanded in Africa, the unique nature of these resources – that is, their location-dependant resource intensity and availability – requires more detailed spatial analyses to support their development. As detailed Geographical Information Systems data on which to perform such analyses increasingly becomes available and accessible, IRENA's regional modelling uses this data to provide a list of potentially attractive solar and wind project zones at a much more detailed level than was typical in the past. The figure below provides an example of nine project zones and makes it clear that the spatial details of solar and wind resources can help to make higher-level studies of resource potential locally specific. Such zone-based analysis can provide crucial support for policy development and investment schemes (such as auctions) as African countries embark on the actual implementation of their long-term renewable power plans.

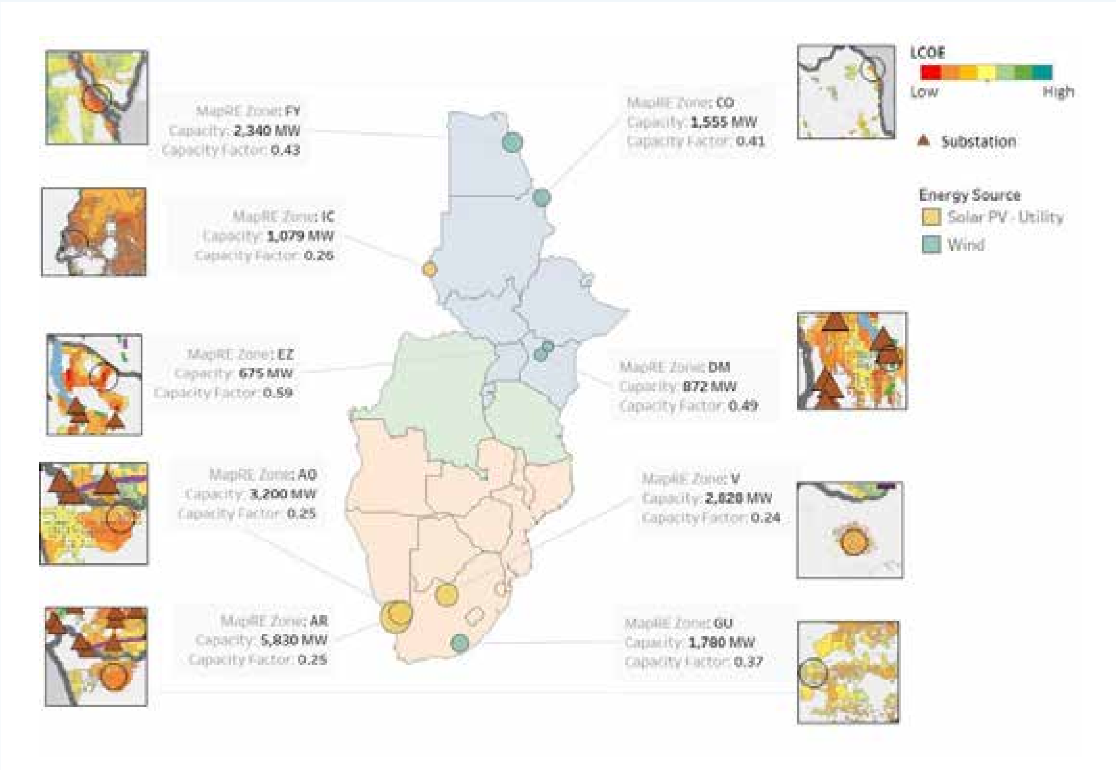


Figure 31 – Nine specific zones to consider for generation capacity expansion

2.2.4 Investment needs – What will be required?

The three continent-wide analyses by IEA, IRENA and Multiconsult all point to the need for considerable investment in the power sector over the coming years if sustainable and reliable energy for all is to become a reality. Specifically, these analyses indicate that **average annual investments in the African power system must double by 2030 – from the current level of approximately 30 billion USD (IEA, 2019; 192) per annum to 40-65 billion USD.** This implies that investments must be ramped up immediately and will need to continue to grow beyond these levels by the end of this decade, likely totalling 80-120 billion USD per year on average between 2030 and 2050, according to IEA and IRENA modelling.

It must, however, be noted that all three analyses – albeit at different levels – assume that energy generation in Africa will still be party based on fossil fuels by mid-century. For a full transition to decarbonized energy generation, investment needs are therefore likely to be higher than estimated in any of the three analyses. However, such investments cannot be considered in isolation from a broader economy and prevailing social imperatives. Investments in energy transitions are expected to result in significant socio-economic benefits, bringing a payback of three to eight USD for every USD invested. A sustainable energy pathway would create jobs, stimulate industrial development, improve health , and human welfare, and bring environmental benefits.

	Africa Case IEA	**REmap** IRENA (2019 edition)	**Low-Carbon Case** Multiconsult
Target Year	**2040**	**2050**	**2030**
Underlying strategy document	**Agenda 2063** African Union	-	**The New Deal on Energy for Africa** AfDB
Challenges	Does not focus on low-carbon development	Does not include Northern Africa	Target year is only 2030
Demand/Generation	2,740 TWh/year (1,662 TWh/year in 2030) Electricity generation	3,561 TWh/year in 2050 (1,815 TWh/year in 2040; 687 TWh/year in 2030) (only Sub-Saharan)	1,393 TWh/year in 2030 (only grid, excluding losses)
Installed Capacity	924 GW (550 GW in 2030)	1,093 GW (570 GW in 2040; 241 GW in 2030)	462 GW
Solar PV	316 GW (124 GW in 2030)	548 GW (50%) (255 GW in 2040; 79 GW in 2030)	147 GW
Hydropower	117 GW (77 GW in 2030)	108 GW (10%) (95 GW in 2040; 55 GW in 2030)	84 GW
Wind	94 GW (51 GW in 2030)	314 GW (29%) (131 GW in 2040; 33 GW in 2030)	28 GW
Other Renewables	52 GW (21 GW in 2030)	81 GW (7%) (44 GW in 2040; 24 GW in 2030)	8 GW
Fossil Fuels (including nuclear)	328 GW (272 GW in 2030)	42 GW (4%) (45 GW in 2040; 51 GW in 2030)	195 GW
Electrification	100% electrification by 2030 (by assumption)	Not specified	100% electrification by 2030 (by assumption)
Emissions	567 $MtCO_2$ (536 $MtCO_2$ in 2030)	50 $MtCO_2$ in 2050 (127 $MtCO_2$ in 2040; 180 $MtCO_2$ in 2030) (only Sub-Saharan)	343 $MtCO_2$ in 2030 from electricity generation (compared to 578 $MtCO_2$ in the reference case)
Required Investments	120 billion USD/year (including grid investments and generation) Cumulatively 2,600 billion by 2040	1,892 billion USD (including grid investments and generation) 3,681 billion USD (if transport, electrification of heat, energy efficiency, carbon capture and storage are also included)	40 billion USD/year (including off-grid, mini-grid, grid, interconnectors and generation) Cumulatively 480 billion by 2030

With the 2050 horizon in view, current investments are heavily influenced by the need to expand access, whereas meeting demand growth becomes the dominant driver of investment needs beyond 2030. This evolution has a number of implications for investors and policymakers. First, to achieve global access ambitions by 2030, one can expect considerable private and public investments in generation, transmission and distribution. The successful expansion of Africa's power systems, matched by appropriate sector reform, should help fuel both economic and electricity demand growth. This would eventually lead to further industrialization and rising incomes, and investments could increasingly be sourced by financially sound utilities. Second, to meet rapidly growing demand, the continent needs to avoid getting locked into short-sighted, unsustainable fossil fuel generation sources that risk becoming stranded assets.

The necessary public and private investment ramp-up can only be achieved if it is built on continued **sector reform and improved financial viability in the sector.** Among other things, this will require sustained, coordinated efforts to ensure cost-reflective tariffs; effective sector investment planning and organization as well as competent institutions; and efficient, credit-worthy utilities. In addition, clear, comprehensive and supportive policy frameworks are essential to attracting energy transition-related investments. Furthermore, energy targets in each country's NDC should guide investment plans and strategies . Progress on these fronts will almost undoubtedly mobilise capital.

While the required annual investments are considerable, they are achievable. With dedicated, coordinated policy action, one can expect global investors to respond, as global capital is increasingly deployed to support green technologies. Furthermore, renewable costs have a track record of rapidly falling over the past decade. This, combined with continued technology developments and breakthroughs, provides real promise that investment requirements may, in fact, be lower than otherwise expected. Efficiency gains from the household to the continental level will also be essential to reducing investment costs. Thus policymakers have the chance to actively influence rather than passively accept the level of requirements through expansion planning, market integration and efficiency incentivization. Coordinated action is required to ramp up investments and also to ensure that the continent reaps the greatest possible benefits from these investments.

A final policy consideration relates to the pace of a transition to (near-) zero emissions on the continent. The continued operation of existing fossil fuel plants as well as investment in new gas-fired generation is currently part of many countries' and regions' least-cost expansions. Still, as noted above, the decreasing cost of renewables, as well as relevant technological breakthroughs improvements, can be expected to help offset transition costs by lowering the overall required investment. Nevertheless, the complete transition from all fossil fuel investments will have to be carefully planned in order to be just and equitable. NDCs and long-term strategies provide a platform for setting and discussing targets and policies as the real costs of renewables change over time.

Policy measures and investments in the African power sector have the potential to support a wider structural shift, fostering national and regional energy transition strategies as a decisive step in building resilient economies and societies. In order to understand the full impact of the transition and to ensure it is timely and just, the energy sector must be viewed as an integral part of the broader economy. IRENA estimates that each million USD invested in renewables or energy flexibility would create at least 25 jobs, while each million invested in efficiency would create about 10 jobs (IRENA 2020h). In comparison, investing in energy transition technologies creates close to three times more jobs than fossil fuels do, for each million dollar of spending. Moreover, forward-looking industrial policies and investments can create new green industries. Such benefits hinge on leveraging and enhancing local industrial capacities, strengthening supply chains, putting adequate education and training programmes in place and adopting appropriate labour market policies.

In conclusion, achieving global universal access ambitions requires investments from both public and private sources to be immediately ramped up, likely requiring a doubling of current investment levels by 2030 and a further doubling beyond 2030. Falling prices for renewables and coordinated national, regional, and continent-wide policy action, underpinned by an effective north–south partnership, can help reduce the total investment requirements. Focused on a just transition and a sustainable development path for Africa, there is an opportunity to combine least-cost principles with the global commitment to sustainable development based on renewables.


2

3 Enabling the renewable energy transition in Africa

Africa has abundant renewable energy resources and is therefore well placed to meet the electricity demands of its growing population and economies with clean, affordable electricity. However, the previous sections have identified a number of common structural barriers to energy transition across many African electricity sectors. These include: i) a lack of capacity in key institutions, which leads to weak sector planning and management; ii) weak or absent regulatory and legal frameworks, which makes private investment in renewable energy expensive and in some cases unviable; iii) electricity grids with high loss rates and limited capacity to absorb variable renewable generation; iv) in some instances, the high costs of decentralised solutions such as mini-grids; and v) financially unsustainable grid and service providers (e.g., utilities and mini-grid operators) that are unable and/or not incentivised to expand access, undertake required maintenance or invest in guaranteeing security of supply. There is a clear need for collective action on the part of African countries and pan-African institutions, supported by their development partners, to address these structural barriers and make universal access and decarbonisation a reality.

However, each country has different socio-economic starting points and political ambitions, which will take them down different paths in the energy transition. The actual pace and eventual outcomes will be partly determined by each country's current dependence on fossil fuels, existing levels of industrial productivity, evolving technology choices, and the depth and diversity of domestic supply chains (IRENA, 2020d). Other relevant factors will include regional and national transition plans, institutional structures, capabilities and policy ambitions, as well as the political will and commitment required to overcome systemic opposition to reform efforts that challenge existing political economies. Therefore, realising universal electricity access by 2030, together with a development path towards a decarbonised electricity sector aligned with the Paris Agreement goals across Africa by 2050, will require a differentiated approach. This chapter explores different ways in which development partners can assist African countries in pursuing their differentiated strategies for universal, reliable electricity access and a low-carbon future.

3.1 Energy transition enablers

Building on the structural barriers identified above, the figure below presents seven energy transition enablers that should be available if African countries are to make universal access and resilient, modern, decarbonised power sectors a reality by 2050.

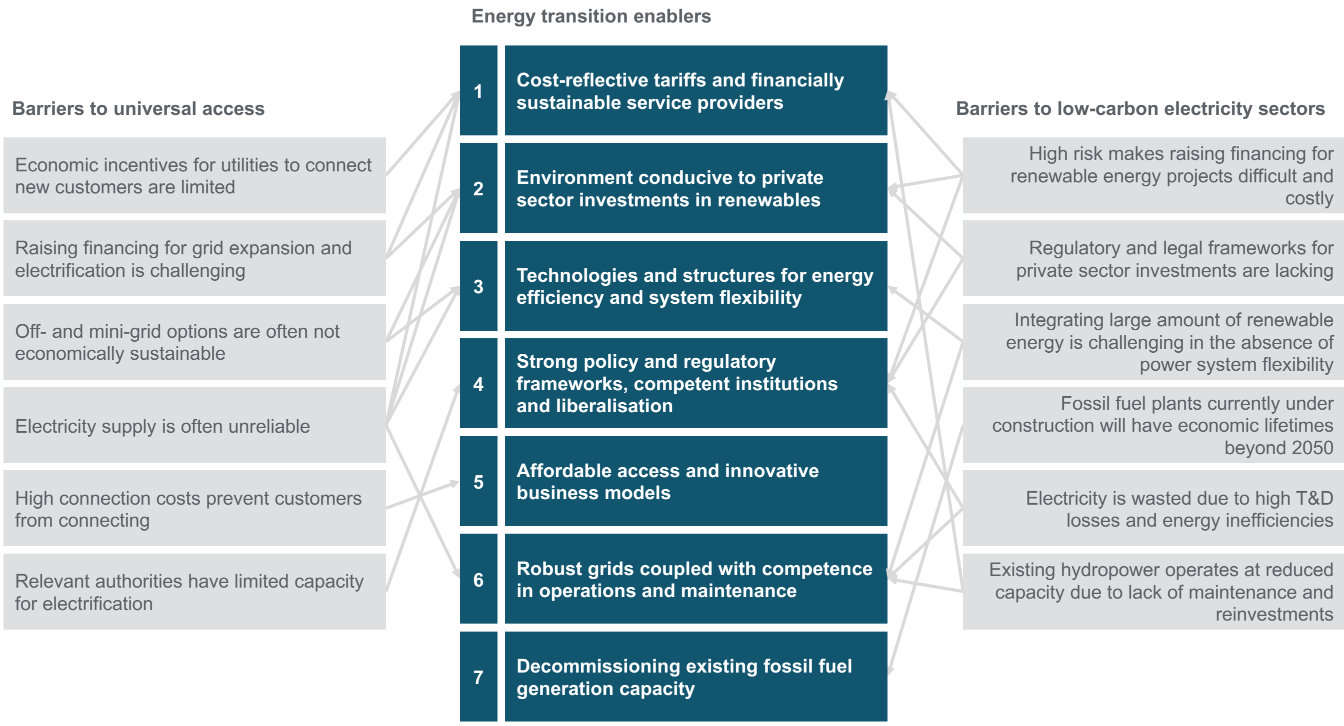


Figure 32 – Energy transition barriers and enablers in Africa

3.1.1 Cost-reflective tariffs and financially sustainable service providers

Electricity tariffs in most African countries are below cost-reflective levels – that is, they are lower than the actual cost of generating, transporting and distributing electricity to consumers. Service providers (most often utilities) are seldom fully compensated for this shortfall in revenue, which leads to several adverse effects, including:

– **Lack of incentives and financing to connect new consumers.** When utilities lose money for every kWh of electricity sold, they often have limited financial incentives to connect new consumers, particularly poorer households with typically lower demand. They also have fewer funds available for grid extension. This means that fewer consumers benefit from electricity services. While low tariffs are often motivated by a legitimate wish to keep electricity affordable, it is important to remember that those left without access to electricity – often the poorest of the poor – have to rely on expensive, often polluting alternatives, such as kerosene.

– **Underinvestment in generation and the grid.** Underfunded service providers do not have the revenue required to invest in strengthening and maintaining their network. Over time, this leads to poor, unreliable electricity supply.

– **High offtaker risk.** For private electricity generators in Africa, national electricity utilities are often their only potential customers. When IPPs fear that the utility will not be able to pay for the electricity, it becomes difficult and expensive for them to raise the necessary debt and equity. In many cases, such risk will even prevent otherwise viable investments. There are exceptions to this single-offtaker model – for example Uganda, which has unbundled and liberalised its power sector.

Service providers – whether utilities, community-based organisations or others – are the heart of every electricity sector. Improving their business operations to ensure safe, efficient service delivery combined with sound investments will directly enable the energy transition. Meanwhile, sector ministries or independent regulators are responsible for overseeing these service providers and ensuring that electricity tariffs cover the fair and efficient costs of producing and delivering electricity. Therefore, strengthening the regulatory framework and improving the competence of all the institutions involved helps to build economically sustainable electricity sectors with universal access and strong security of supply.

Regulatory objectives

It is generally accepted that effectively regulating natural monopolies, such as electricity transmission and distribution, requires balancing different regulatory objectives, including:

– Ensuring fair and equal market conditions with sustainable economic incentives and transparent market access;

– Encouraging efficient, low-cost service provision;

– Establishing cost-reflective tariffs to ensure the financial viability of the regulated entities;

– Incentivising investments in the sector to improve and expand service delivery;

– Providing affordable services to low-income groups.

3.1.2 An environment conducive to private sector investments in renewables

The investments needed to meet Africa´s growing energy demand with renewables are far greater than the funds available from public sources, such as African governments and development partners. This gap can only be bridged by private investments and lending, as well as private-public partnerships. Despite the dramatic drop in costs, renewable energy developers in Africa still face structural barriers stemming from the cash-flow profile of such projects, including significant upfront capital requirements, with payback over 20-25 years. The real and perceived risks will differ from country to country, but they are generally related to political instability, macroeconomic uncertainty, weak policy and regulatory frameworks, financially weak utilities, and lack of transparency and institutional capacity (see the fact box below). When compounded, these risks often make it difficult, costly and in some cases impossible to raise the required debt and equity to scale up investments in renewable energy across Africa.

If African countries are to fully and affordably harness their renewable energy potential, these investment risks need to be mitigated. An appropriately enabling environment must include improved regulatory frameworks, innovative financing instruments, modern procurement practices (such as auctions and feed-in tariffs), guarantee schemes, and financially sustainable power generators and system operators. These solutions are discussed in greater detail in section 3.3.

> **The investments needed to meet Africa´s growing energy demand with renewables are far greater than the funds available from public sources.**

Particularly prevalent risks associated with renewable energy investment in Africa

IRENA (2016) has identified several risks that need to be mitigated, with the following risks considered particularly relevant to the overall bankability of renewable energy projects:

Political risk – risks associated with political events that adversely impact the value of investments (e.g., war, civil disturbance, currency inconvertibility, expropriation).

Policy or regulatory risk – risks associated with changes in legal or regulatory policies that have significant adverse impacts on project development or implementation (e.g., incentive programmes, interconnection regulations, permits).

Offtaker risk – risks associated with credit and counterparty default in a financial transaction. For renewable energy investments, this is related to the risk that the power offtaker (typically the electric utility) might default.

Grid and transmission risk – limitations associated with interconnection, grid management and transmission infrastructure.

Technology risk – risks associated with the use of nascent technology or inexperienced, unskilled labour to deploy it.

Currency risk – risks associated with changing or volatile foreign exchange rates that adversely impact the value of investments. These arise when there is a currency mismatch between assets (revenues) and liabilities (debt financing).

Liquidity risk – risks associated with operational liquidity issues as a result of revenue shortfalls or mismatches between cash receipt and payment timing.

3.1.3 Technologies and structures for energy efficiency and system flexibility

Barriers to
universal access

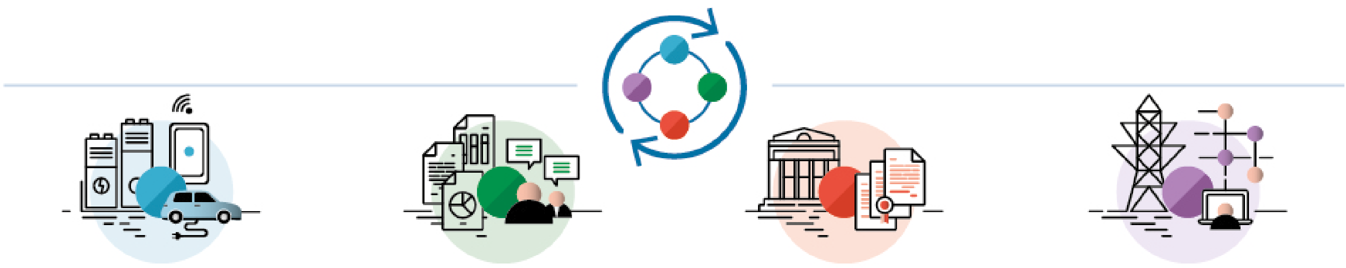
Barriers to
low-carbon electricity sectors

Electricity supply is often unreliable → **Technologies and structures for energy efficiency and system flexibility** ← Integrating large amount of variable renewable energy is challenging in the absence of power system flexibility

The variability of some renewable energy sources, such as wind and solar PV, may increase the complexity involved in operating an electricity system. It also poses technical and economic challenges for the integration of such technologies. These challenges have triggered innovative solutions in different countries and regions. Two decades ago, integrating shares of variable renewables as high as 10 per cent was thought to be extremely challenging. Today, many countries around the world have demonstrated that it is absolutely possible to operate power systems with a much higher share of variable renewable energy. Denmark manages an electricity system with a nearly 50 per cent share of variable renewables to cover its annual electricity demand; Germany achieved a similar share in early 2020. Moreover, many countries are already operating national power systems with over 20 per cent variable energy sources, including Ireland, Portugal, Spain, and Texas in the United States.

Hydropower can also play an important role, as it can be operated in a flexible way and can complement the variability of wind and solar generation. Countries such as Costa Rica and Uruguay, which have abundant hydro resources, have already achieved shares of 99 and 98 per cent of electricity generated exclusively from renewables, with 17 and 36 per cent from variable resources, respectively (IRENA 2020b). The experiences of front-runner countries show that the key to addressing integration issues is very flexible power systems that can balance the variability of supply and demand at all times.

Implementating solutions to increase system flexibility requires a systemic approach, combining innovations across four dimensions: enabling technologies, market design, system operation and business models. IRENA (2019b) has identified 30 innovations which increase system flexibility and has analysed them in detail across these four dimensions.



ENABLING TECHNOLOGIES

1 Utility-scale batteries
2 Behind-the-meter batteries

3 Electric-vehicle smart charging
4 Renewable power-to-heat
5 Renewable power-to-hydrogen

6 Internet of things
7 Artificial intelligence and big data
8 Blockchain

9 Renewable mini-grids
10 Supergrids

11 Flexibility in conventional power plants

BUSINESS MODELS

12 Aggregators
13 Peer-to-peer electricity trading
14 Energy-as-a-service

15 Community-ownership models
16 Pay-as-you-go models

MARKET DESIGN

17 Increasing time granularity in electricity markets
18 Increasing space granularity in electricity markets
19 Innovative ancillary services
20 Re-designing capacity markets
21 Regional markets

22 Time-of-use tariffs
23 Market integration of distributed energy resources
24 Net billing schemes

SYSTEM OPERATION

25 Future role of distribution system operators
26 Co-operation between transmission and distribution system operators

27 Advanced forecasting of variable renewable power generation
28 Innovative operation of pumped hydropower storage

29 Virtual power lines
30 Dynamic line rating

Figure 33 – IRENA's overview of innovations in variable renewable energy integration

These innovations offer a great opportunity for African countries to leapfrog traditional power system architectures while developing and investing in the new infrastructure and market reforms required. Countries in Africa could plan for and implement innovative solutions, considering global best practices while tailoring these to their own context and needs.

Innovations such as smart renewable mini-grids, digital technologies like blockchain and business models such as pay-as-you-go and peer-to-peer trading can help to accelerate the realisation of universal energy access in Africa (IRENA, 2019b). Countries with considerable hydro resources – such as Guinea, Ghana and Nigeria – can benefit from innovations in modernising hydropower facilities and operating pumped hydro storage to integrate variable renewables and reduce the overall cost of the power system. Regionally, interconnected regional markets and supergrids may support the plans for clean electricity corridors in Africa, as well as economies of scale for particularly advantageous renewable energy sites.

Electrifying the transport sector – by using electric vehicles as well as two- and three-wheelers – can address pollution in densely populated African cities while also making batteries on wheels a storage solution to support distribution grids. When considering future economic opportunities, the production, use and export of green hydrogen from low-cost renewable electricity in countries with abundant resources might be an option. Countries such as Morocco could use the advantage of geographical proximity to Europe to deliver green hydrogen to a larger market. South Africa has long-term experience in producing synthetic fuels from coal, which it can now turn to producing renewable electric fuels from green hydrogen.

Using innovative solutions to increase power system flexibility and energy efficiency reduces the investment requirements and the environmental footprint of the energy transition. Improved national planning, country-wide industry standardisation and certification measures, and incentives to attract long-term investments and encourage people to adopt new technologies, combined with new business models, new ways of operating the power system and enabling regulatory frameworks are some of the key measures that can improve the uptake of renewable electricity generating technologies.

3.1.4 Strong policy and regulatory frameworks, competent institutions and liberalisation

Weak policy and regulatory frameworks, insufficient short- and long-term power system planning, a lack of transparency in terms of decision-making, insufficient regional integration and policy consistency across countries and shortfalls in institutional capacity are key structural barriers to energy transition in many African countries. Addressing these issues by providing targeted technical support and capacity building will help to enable the energy transition by efficiently implementing political priorities as well as mobilising and correctly allocating resources.

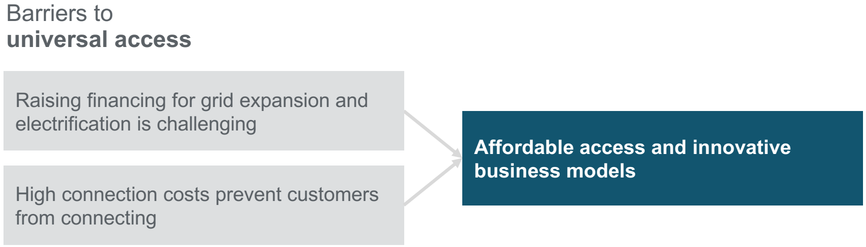
Liberalising electricity sectors by unbundling utilities (see the fact box below), coupled with private sector participation in electricity markets – particularly generation – can significantly improve efficiency and reduce costs. In some respects, liberalisation puts even greater pressure on regulatory authorities' capacity to ensure that laws and regulations are followed and efficiency gains are achieved.

Unbundling electricity utilities

Vertical unbundling is the separation of generation, transmission, distribution and power supply to an electrical utility's retail consumers. Vertical unbundling allows potentially competitive segments (generation and supply) – where competition is possible – to be separated from segments that are natural monopolies (transmission and distribution networks) and generally require a single actor to manage their infrastructure.

Horizontal unbundling is the separation of any of the functions mentioned above into multiple entities that compete with one another or provide services in different areas. The resulting companies may be private or state owned.

3.1.5 Affordable access and innovative business models



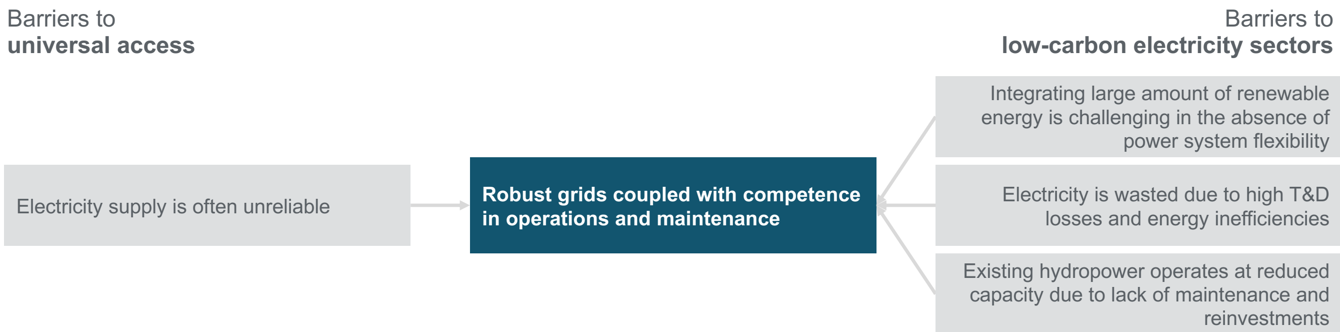
For most end uses, electricity is cheaper and (when renewable) more sustainable than other sources of energy, and therefore enables socio-economic development and dignified lives. Nevertheless, the high upfront cost of individual connections often prevents potential consumers from getting access, despite living in proximity to the grid. Therefore, targeted efforts to reduce consumers' upfront costs or provide payment plans are an important aspect of enabling the energy transition.

However, expanding the electricity grid into all rural areas in Africa will be costly, and in the end perhaps not the most economically viable option. Closing the access gap, particularly in Sub-Saharan Africa, will require concerted, ongoing efforts. Policy frameworks will require consistent updates and enforcement to support innovation, such as off-grid solutions, and newer business models, such as Private Public Partnerships (PPP). Geospatial analysis undertaken to determine how least-cost universal access can be achieved will surely reinforce the necessity of integrated policies that embrace both centralised and decentralised solutions. Given the importance of electricity to making progress on other SDGs (such as those related to gender, health and education), the potential impact of access expansion will only be realised if an inclusive approach is applied – one that leaves no one behind while maximising the socio-economic benefits of electricity. Enabling technologies and innovative business models for off- and mini-grid electrification are continuously maturing, thus ensuring that even the most remote households will have affordable options for energy access. However, off- and mini-grid options entail a different set of challenges than grid expansion. For example, while grid electrification benefits from both direct and indirect subsidisation, consumers in distributed systems are often required to cover the entire cost via a tariff which is normally higher than what grid customers pay. This is in many cases politically unsustainable. Therefore, financing to lower the cost of connection for off- and mini-grid solutions may be a political necessity. Such financing may take the form of direct subsidies for infrastructure investments, as well as subsidies from governments and development partners for individual connections or network operations, or even tariff cross-subsidisation from other consumers.

As discussed in section 4.1.3, distributed renewable electricity with innovative business models such as peer-to-peer trading and pay-as-you-go can empower consumers in Africa to generate their own affordable electricity while reducing the need for grid extension and distribution network investments (IRENA, 2019b). On an industrial scale, some African countries could consider relocating industrial facilities to areas with abundant low-cost renewable electricity. Such innovative business models would not only support the electricity sector, but also create new economic opportunities for the region.

> **Targeted efforts to reduce the upfront cost of on-grid connections are important enablers of the energy transition.**

3.1.6 Robust grids coupled with competence in operations and maintenance



The poor technical state of many African electricity grids – often coupled with design issues as well as long low-voltage lines – and the lack of preventive maintenance results in high T&D losses (mostly in distribution) and negatively impacts security of supply. In particular, many existing hydropower plants and electricity grids operate at reduced capacity due to lack of maintenance and improper operations. The aging, poorly maintained grid and generation infrastructure in many African countries is also a barrier to the integration of more renewable energy in the electricity mix (see the fact box below).

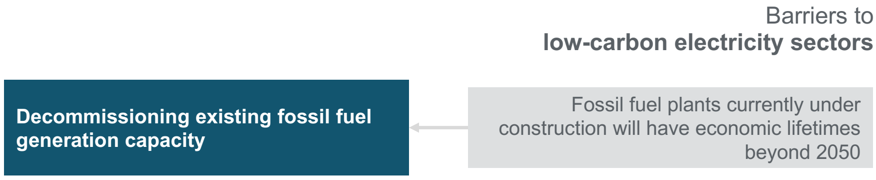
Therefore, investments in transmission and distribution, including interconnectors for regional electricity trade, are indispensable enablers in achieving universal access and realising renewable energy's potential. These investments need to be coupled with capacity building for the planning, operation and maintenance of generation and grid infrastructure.

Infrastructure reinvestments and maintenance

Expanding the generation and T&D capacity through new power lines, grid modernisation and power plants will not be sufficient to meet future demand. The existing infrastructure must also be maintained and, at the end of its economic lifetime, rehabilitated or replaced (via reinvestment) in order to pursue the least-cost option in the expansion scenarios.

In particular, much of Africa´s 43,000 MW of installed hydropower infrastructure is aging and in need of reinvestment to avoid reduced output. Such modernisation can stabilise and often increase output, even without increasing the amount of water diverted, because lack of maintenance over time has diminished generation capacity. Losing significant hydropower generation capacity due to a lack of maintenance and reinvestments will result in much larger investment requirements for additional (flexible) capacities in the future to replace these assets in the energy mix. The exact scale and scope of this reinvestment requirement is difficult to quantify, partly because many African countries have no regulatory framework to monitor the safety of hydro infrastructure, such as a lack of enforcement around dam safety guidelines (International Hydropower Association, 2017).

3.1.7 Decommissioning fossil fuel generation capacity



Across Africa, fossil fuel plants currently under construction will have economic lifetimes well beyond 2050. As the price of renewable energy keeps falling, there is a clear risk that this infrastructure will end up as stranded assets in a low-carbon future. Given the socio-economic challenges Africa is facing and the continent's current and historically limited contributions to global climate change, the cost of decommissioning these fully functional stranded assets should not fall on African governments or consumers. African countries and their development partners should discuss whether these costs can be covered as part of the efforts to achieve the goals of the Paris Agreement.

However, in order to meet these targets, African governments (like all governments) should be discouraged from investing in any additional fossil fuel-based generation assets and encouraged to phase out subsidies for fossil fuel-based electricity generation, as these weaken renewables' competitiveness and prolong the lives of existing polluting power plants. IRENA (2020f) reports that global subsidies for fossil fuels amounted to USD 447 billion in 2017.

3.2 Central fields of action for international development cooperation

Many African countries are already taking important steps to put in place the energy transition enablers described above. For example, South Africa and Morocco are promoting technological innovation with hydrogen, while many countries on the continent are making or enabling large investments in solar PV and wind generation. A number of African countries are also improving their enabling frameworks and attracting increased private sector participation. On the continental level, a number of important initiatives, including the AU's Programme for Infrastructure Development in Africa (PIDA) is in place to support and coordinate national efforts.

In addition, a large number of bilateral, regional and multilateral initiatives and programmes have been established to address energy-related challenges in Africa. Between 2010 and 2014, EU institutions and member states funded more than 3,240 energy-related Official Development Assistance (ODA) programmes and projects globally (EUEI, 2017). However, these efforts remain fragmented and insufficient.

The figure below presents a selection of organisations and initiatives working to promote decarbonisation and/or universal access (more details on these can be found in Annex 1).

While this plethora of initiatives and institutions enables the testing of a large number of approaches, many of them overlap in terms of objectives and content, which creates inefficiencies. This study concludes that:

– Current efforts should be streamlined and more resources (e.g., financial support and capacity building) should be made available to realise the energy transition in Africa;

– These efforts must focus on the core energy transition enablers;

– Programmes should be driven by countries' demands, and all the efforts should aim at enhancing in-country human and institutional capacities.

Reducing fragmentation, increasing coherence and leveraging synergies between existing initiatives to support national policies and strategies while focussing on the core enablers will maximise the impact of existing allocations and help to mobilise more resources for the energy transition. Building on the seven enablers described above, this study has identified four core fields of action in which international development cooperation can support the energy transition in Africa most effectively: i) promoting access to energy, ii) de-risking and promoting private sector investments, iii) strengthening and modernising the grid, and iv) supporting systemic innovation. Capacity building is a priority that cuts across all four of these core fields, which are briefly presented in the figure below and will be discussed in more detail in the next chapter.

> **Reducing fragmentation, increasing coherence and leveraging synergies between existing initiatives to support national policies and strategies will maximise the impact of existing allocations and help to mobilise more resources for the energy transition.**

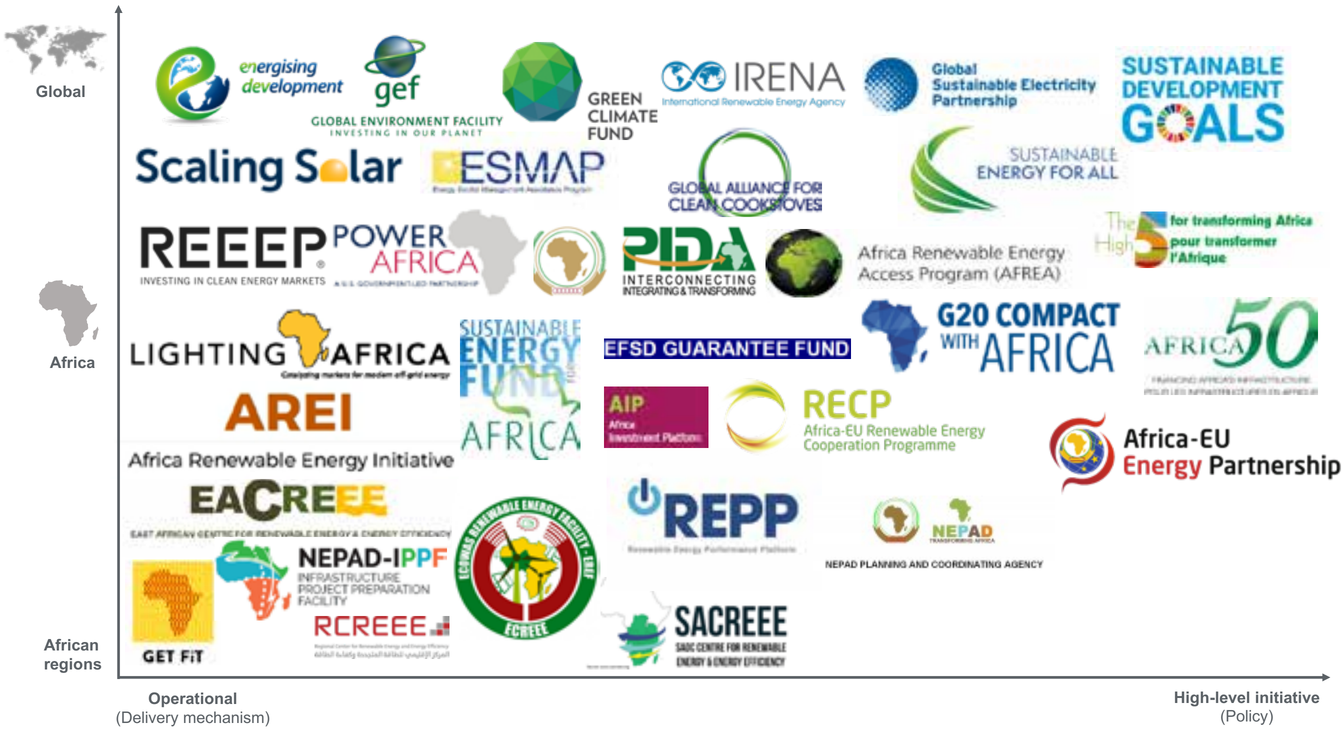


Figure 34 – Overview of selected global, Africa-wide and regional electricity-sector institutions and initiatives supported by development partners

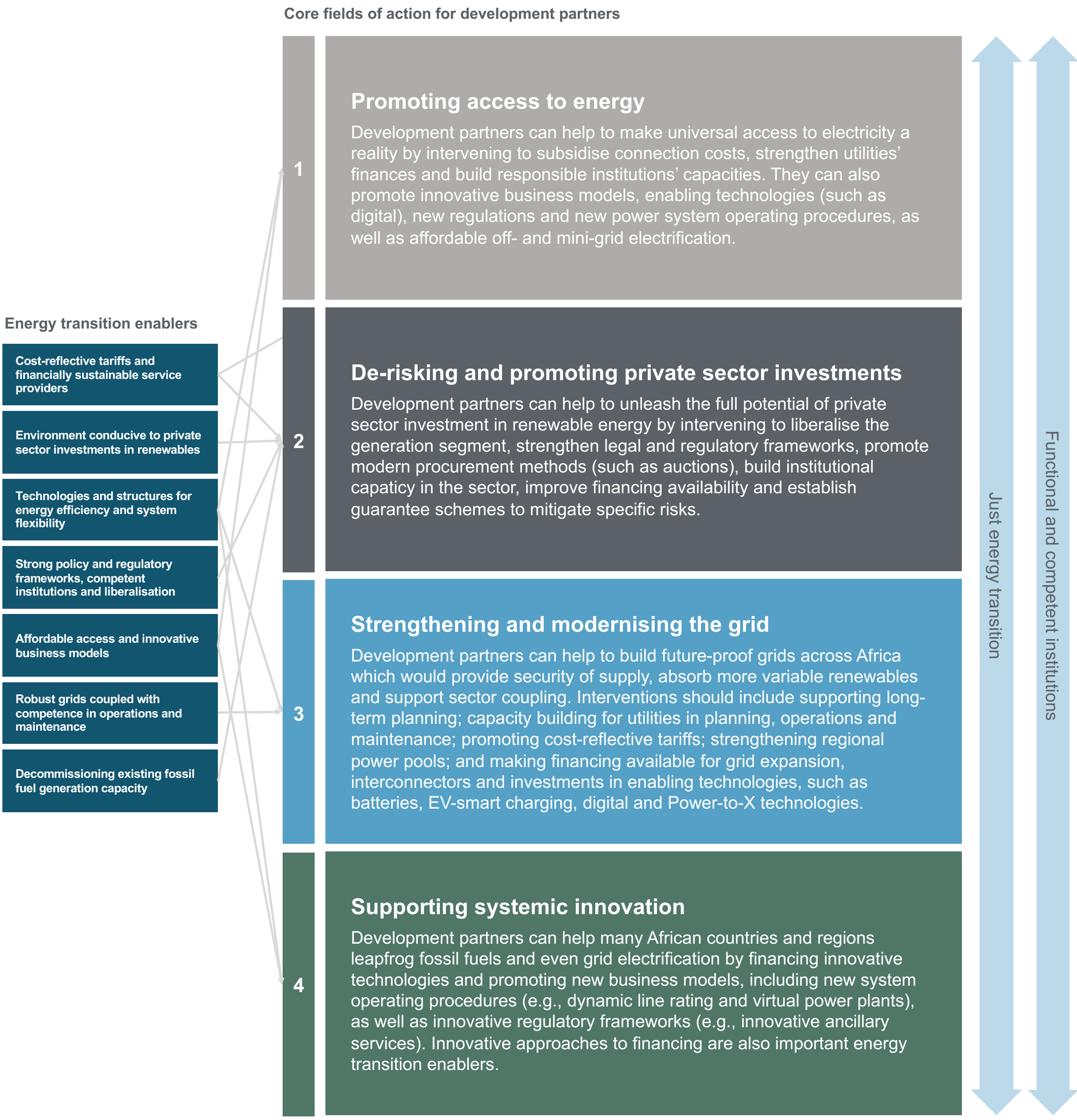


Figure 35 – Core fields of action for development partners

In addition to these fields of action, two critical cross-cutting themes will be of utmost importance if the global community is to successfully ensure a rapid, sustainable energy transition in Africa:

– **Ensuring a just energy transition.** A holistic approach to the energy transition must align energy decarbonisation with economic, environmental and social goals. The energy transition has the potential to drive broad socio-economic development, guided by comprehensive policies to foster transformative decarbonisation. A just transition will require tailoring labour and social protection policies to each region's and country's specific needs. To fully tap societal potential and ensure no one is left behind, social equity in general, and gender-related aspects in particular must be integrated into policy and programme design. Such dedicated, coordinated efforts are likely to contribute to overall sustainability both during and subsequent to the transition (IRENA, 2020d).

– **Buidling functional, competent institutions.** Developing and implementing national policies to promote universal electricity access while also pursuing low-carbon development in Africa's power sectors is a cross-cutting priority at every stage of the energy transition – one that will require competent institutional support and oversight.

In implementing the four fields of action listed in figure 35, policymakers and development partners must continuously ensure that the two themes above are appropriately addressed in both the design and the implementation of policy and investment programmes.

3.3 Development cooperation instruments and avenues for implementation

Overarching sector reform and support for sector-wide planning is critical to fully and appropriately addressing the four fields of action in a given country. While pursuing quick wins with regard to electricity access and power system decarbonisation, decision makers should recognise the importance of long-term energy planning (over the course of 20 to 40 years) as an essential activity for any electricity sector. Such planning helps to anticipate the potential challenges and benefits of energy transition, such as integrating a high share of cheap variable renewables into the grid. An appropriate energy development plan for the sector – including the process of planning itself – can equip policymakers with a better understanding of the complex socio-economic, political and environmental interrelations and uncertainties involved in power system development. For example, a transition to renewable energy sources may be threatening to existing sector stakeholders, but appropriate planning allows policymakers to preempt potential challenges to the reform efforts. Long-term energy plans usually feature energy scenarios and energy mix targets that meet a country's overall policy goals, guiding the process of when, where and how to invest in the electricity sector. Policy instruments and regulations need to be created or adapted to achieve these targets.

As a point of departure for a consolidated approach to energy transition, the resources required to build and maintain a national process for long-term energy planning and model-based scenario analyses must be made available. International partners have helped some African countries to build institutional capacities in using and developing long-term energy scenarios (see the example below). By supporting country-led energy planning exercises, development partners can help to establish good practice in managing sector reform leading to universal access and a low-carbon expansion path, as well as what this means in terms of necessary structural changes. A key outcome of this process is a comprehensive, target-oriented plan as a basis for making investment decisions.

Integrated energy planning exercises are only the first step in a comprehensive approach to energy transition and access. As a follow-up to this exercise, countries would benefit from peer-to-peer knowledge and experience-exchange platforms, capacity building supported by local and international experts, and advisory services to identify political and legal measures to support the implementation of the whole transition process. A broad set of complementary technical and financial instruments is available. Some of these are tried-and-tested approaches ready to be scaled up, while others are innovative instruments responding to new challenges the sector is facing. This section presents the key instruments that can be applied within each of the four fields of action.

Example
Supporting energy planning and modelling in Africa

IRENA
International Renewable Energy Agency

IRENA provides energy planning support with a view to enhancing institutional capacity at the country level and strengthening each country's ownership of the planning process. The ability to translate key energy data into robust energy planning enables countries to develop comprehensive national energy master plans and to continually update these as the basis for sound policies and investments.

IRENA's energy planning support is delivered through a mix of online software training and hands-on working sessions guided by IRENA experts and partners. The primary focus is on long-term power system investment planning, but this can be extended, upon official request, to cover the entire energy system. Throughout the training activities and the parallel process of developing master plans, IRENA experts guide each country team through customised technical support, on-demand advisory services and reviews of draft plans.

For example, in 2016, the government of the Kingdom of Eswatini (then known as Swaziland) and IRENA agreed to hold a joint Energy Planning Capacity-Building Programme. Over a two-year period, IRENA provided energy planning support to Estwatini, including trainings on a least-cost optimisation model, data management and scenario development. Based on these trainings, the national experts formed a national Working Team to prepare a national energy master plan. The Energy Masterplan 2034 was approved by the cabinet and formally launched on 25 October 2018.

The Ministry of Natural Resources and Energy has outlined how this national Energy Masterplan provides a roadmap to guide the national energy sector towards a future with adequate, sustainable and reliable supply that is environmentally friendly, competitively priced, and which puts Eswatini on the path to achieving its development objectives. Based on the Energy Masterplan, Eswatini has also announced that it will start implementing competitive bidding and develop a short-term (five-year) power sector generation plan, and has emphasised its commitment to regularly updating the national Energy Masterplan. These activities in support of Eswatini are now being replicated in Sierra Leone and Cameroon.

Given the wide range of actors involved in supporting energy planning in Africa, co-operation with other organisations is an important feature of IRENA's activities. Through various memoranda of understanding and by participating in the Roundtable Initiative on Strategic Energy Planning, IRENA co-ordinates with both international and regional partners to avoid needless duplication and leverages complementary resources whenever possible.

3.3.1 Promoting access to energy

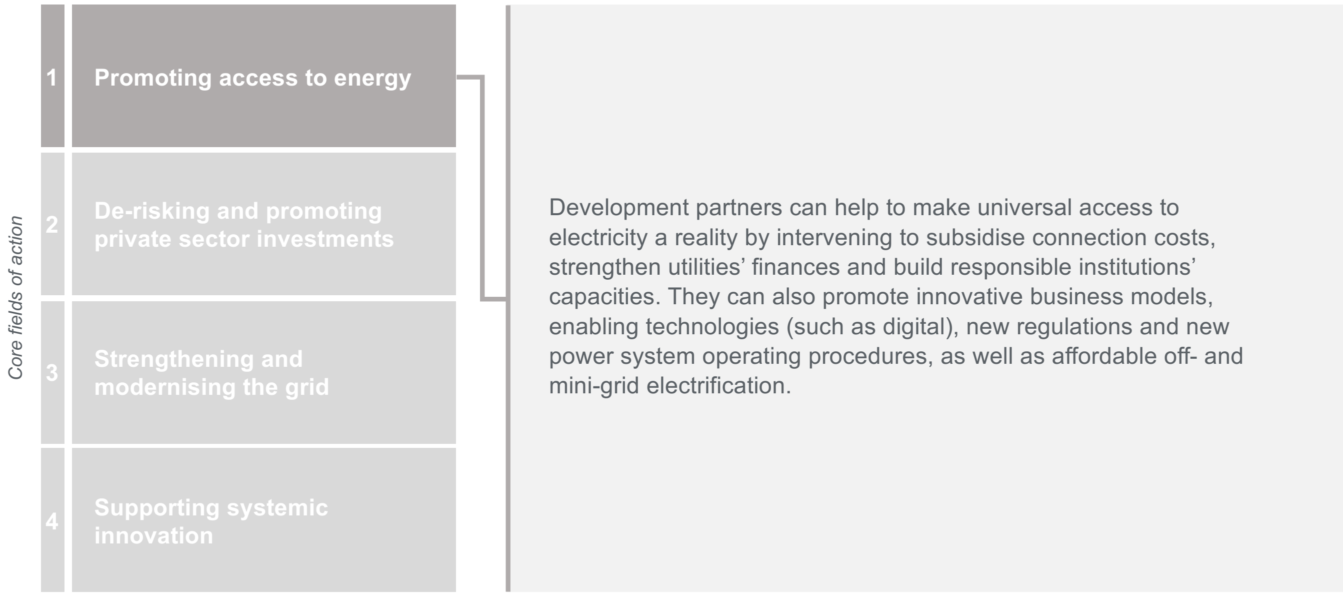


Figure 36 – Development cooperation instruments for promoting access to energy

In the long run, universal access to a sustainable, reliable electricity supply will only be possible in economically sustainable electricity sectors in which service providers are allowed to charge tariffs that reflect the efficient costs of expanding access and providing security of supply. In the short- to medium-term, however, a number of instruments are available to help governments and their partners to promote access expansion. Several of these are presented below.

Access expansion policies and strategies. Most African countries have ambitious political targets for bridging the electricity access gap. Development partners can support these countries in shaping political amibtions and turning them into reality – for example, by deploying local and international long-term experts. These experts can support sector institutions such as ministries, regulators and utilities in building and implementing robust legal and regulatory frameworks.

Interventions can also help to incentivise and enable utilities to connect more consumers. This often requires technical assistance and capacity building to improve regulations, planning and operations, combined with sub-sovereign lending[14] to support economically viable investments. Finally, development partners can support the movement towards fair, cost-reflective electricity tariffs – for example, by financing cost-of-service studies.

Example
Enabling modern energy access in rural Ethiopia

In rural Ethiopia, the main sources of supply for rural electrification are hydro, solar, wind and diesel. EnDev´s Access to Modern Energy Services project provides technical assistance to achieve sustainable access to modern energy services (mainly electricity for social infrastructure) for via appropriate low-cost grid and off-grid supply options.

As part of the project, the GIZ and its technical advisors are facilitating ongoing policy and stakeholder dialogue to strengthen the established champions of electrification: the Ministry of Mines and Energy, the utility (EEPCo), the Ethiopian Rural Energy Development and Promotion Centre (EREDPC), regional and sub-regional energy bureaus and the private sector. The aim is to provide momentum and leverage for additional funding for electrification via three key interventions: i) Energy for Lighting and Household Applications, ii) Energy for Social Infrastructure and iii) Energy for Productive Use/Income Generation (EnDev, n.d.).

[14] Sub-sovereign lending refers to lending to public entities below the level of the ultimate governing body of a nation, country or territory, such as lending to municipalities or utilities.

Example
Facilitating energy inclusion

The Facility for Energy Inclusion (FEI) is a USD 450 million debt-financing facility for off-grid, small-scale renewable energy access projects initiated by the AfDB. Through KfW, the German government has invested EUR 40 million in this facility to support AfDB member states.

AfDB identified access to debt financing as a major barrier to implementation and expansion in the off-grid, small-scale renewable energy and mini-grid segments of African energy markets. FEI was established to provide debt financing via two separate investment funds:

1. FEI OnG: This fund offers flexible project and corporate finance solutions for off-grid renewable energy projects with an installed capacity below 25MW – mainly large mini-grids and captive power.

2. FEI OGEF: This fund provides consumer and corporate financing solutions for solar, off-grid companies and related ecosystems.

FEI intends to target electricity sector segments that remain underserved by both international investors and domestic lenders – that is, small-scale projects and products that fall below traditional minimum investment thresholds and are unfamiliar to investors.

Bringing down the cost of off- and mini-grid electricity. Existing off- and mini-grid business models often result in a high electricity cost for the end user, as compared to on-grid tariffs. This is partly because on-grid tariffs are often not cost-reflective, but also because demand per connection in rural areas is low – meaning that the fixed costs of off- and mini-grid systems need to be recovered by a limited number of kWh sold.

One approach to reducing this gap is stimulating demand through results-based financing, with outcomes beyond connections. Examples of such financing criteria include productive use as well as secondary effects on health and education as a result of providing clinics and schools with electricity. In addition to lowering the cost of electricity per kWh and making off- and mini-grid solutions viable, this approach may also produce additional development benefits, such as job creation.

When it comes to bringing down capital costs and mobilising financing, providing long-term debt as well as guarantee schemes for investors and other market actors in the mini- and off-grid space is another avenue available to governments and development partners (see the fact box in section 3.3.2). The Facility for Energy Inclusion is a dedicated new debt platform initiated by the AfDB that seeks to address the dearth of affordable long-term financing for the off-grid space, whereas the GET.invest programme (get-invest.eu) is a good example of how capacity building for developers and sector institutions can be coupled with financial instruments to realise the potential of decentralised electricity solutions in Africa. Finally, the Facility for Investments in Small Renewable Transactions (FIRST) is a new, KfW-anchored debt platform that provides highly leveraged long-term debt to corporate and industrial clients seeking to invest in renewable energy and energy efficiency in the South African market, thereby closing a market gap.

Example
Increasing clean energy access in developing countries

EDFI ElectriFI is a EUR 215 million EU-funded impact investment facility to finance early-stage private companies and projects, focusing on new/improved electricity connections as well as on generation capacity from sustainable energy sources in emerging markets. This initiative aims to support investments that increase and/or improve access to modern, affordable and sustainable energy services.

EDFI ElectriFI's goal is to accelerate development for businesses providing access to clean energy for hundreds of millions of people by 2030. ElectriFI's unique business model relies on EU funding so that it can invest in local markets in poorer economies and fragile situations. By combining technical assistance and risk capital, EDFI ElectriFI can take greater risks than other investors (ElectriFi, n.d.).

To date, the initiative's EUR 53 million portfolio has supported 26 investments in 16 countries, including mini-grids, solar home systems, independent power producers and captive power plants.

Financing and subsidising on-grid access expansion. The high upfront cost of on-grid connection is an important structural barrier to electricity access for those who live within reach of national grids. With support from development partners, governments can fully or partly subsidise connection costs for these households and businesses, or establish schemes that allow them to pay in instalments. There are a number of models for such support, both with and without results-based financing (see the fact box below). Many successful programmes also incentivise and enable the productive use of electricity by mitigating market and growth barriers, coupled with technical support to help developers and governments at all levels absorb international best practices. However, it is important to note that in the absence of cost-reflective tariffs, continued expansion of on-grid access will further worsen the financial problems many African utilities face.

Results-based financing

Results-based financing is a form of funding for project implementation or service provision in which all or part of the payment is made upon verified achievement of predefined results. The objective of this approach is to ensure that the incentives of development partners and implementing parties are well aligned, and that development partners only pay for documented results. Results-based financing can be offered to both the private and the public sector.

3.3.2 De-risking and promoting private sector investments

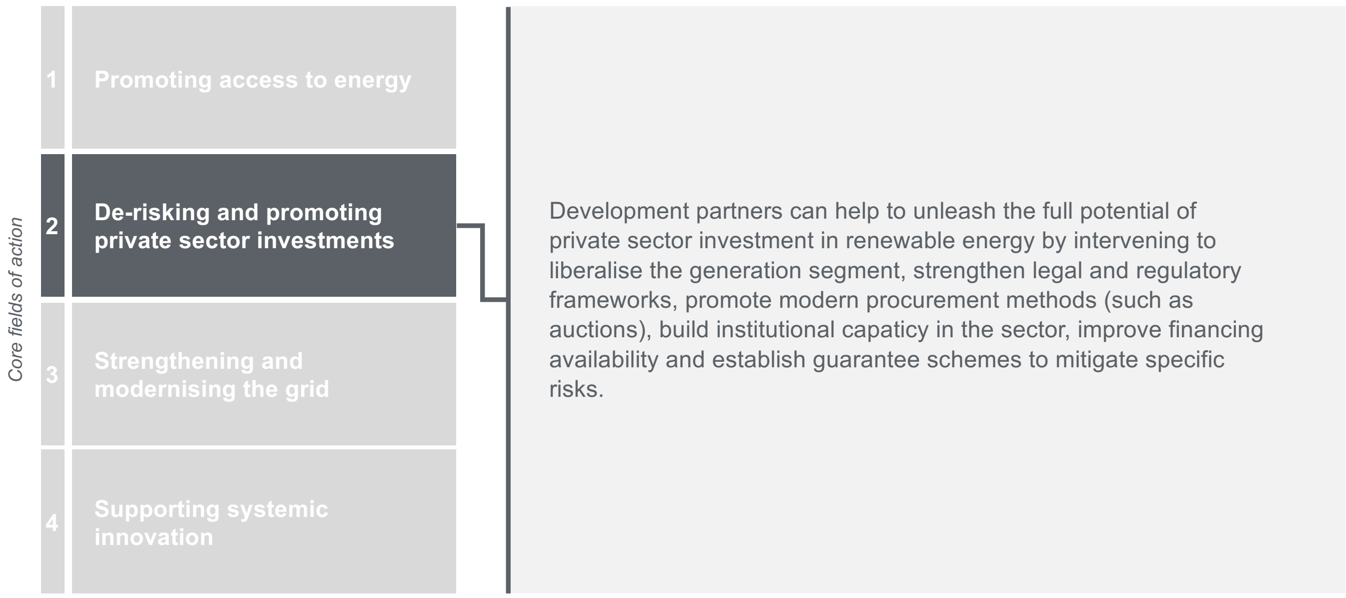


Figure 37 – Development cooperation instruments for de-risking and promoting private sector investments

Public funds alone are not sufficient to finance the energy transition in Africa. However, several instruments are available to help leverage private investments to bridge this gap.

Creating enabling regulatory frameworks for private investments. In many African countries, legal and regulatory frameworks for private investments are weak or absent (World Bank, 2019f). This increases risks and limits market participation on the part of national as well as international investors. Depending on each country's needs and wishes, development partners have a number of tools available to support legal and regulatory systems that ensure predictability and efficient risk and revenue sharing. Examples include employing national and international experts as well as facilitating platforms for the exchange of knowledge and experience between African countries. However, at the end of the day, it takes strong political commitment to make these enabling frameworks work, especially where they challenge the sector's existing political economies.

In addition, training financial institutions in investment appraisal of renewable energy as well as off- and mini-grid technologies, and guiding the private sector in navigating the regulatory framework in a given country have proven conducive to making private investments happen.

Example
Improving framework conditions for private investments

GET FiT Uganda is designed to leverage private investments into renewable energy generation projects in Uganda. Launched in 2013, the programme has received funding from the governments of Norway, the United Kingdom, Germany and the EU through the EU Africa Infrastructure Fund. The GET FiT concept is currently being rolled out in Zambia and Mozambique as well.

GET FiT's main objective is to assist governments in pursuing a climate-resilient, low-carbon development path resulting in growth, poverty reduction and climate change mitigation by facilitating private sector involvement and improving the framework conditions for private investments in renewable energy. In Uganda, GET FiT is fast-tracking a portfolio of 17 small-scale renewable energy projects, promoted by private developers, with a total installed capacity of 158 MW. This will yield approximately 765 GWh of clean energy production per year, thus transforming Uganda's energy mix.

One key programme instrument is the GET FiT Premium Payment Mechanism, which supports small-scale renewable energy projects under the Renewable Energy Feed-In Tariff (REFiT) system and makes them financially viable, thus enabling a large portfolio of projects to move into implementation. GET FiT Premium Payments are performance-based, additional payments per kWh beyond the regulated REFiT tariff levels. Payments are made as grants, following an open and transparent Request-for-Proposal process.

Example
Mobilising renewable energy investments

Launched in 2018, GET.invest is a European programme for mobilising investment in decentralised renewable energy. GET.invest links a broad range of financing instruments with investment-ready projects and businesses. As a key service, the programme facilitates the development of proposals for investment and enables access to available funding from development financing as well as commercial institutions.

Building on its predecessor, the Africa–EU Renewable Energy Cooperation Programme, GET.invest mobilises investments by providing technical assistance to developers to make project proposals bankable.

The programme's database of funding instruments currently contains 40 tools, representing at least EUR 6 billion in financing. Most of these contributions are fully or partly funded by EU institutions and member states, the private sector and banks (GET.invest, n.d.)

Example
IRENA/ADFD Project Facility

The International Renewable Energy Agency (IRENA) and the Abu Dhabi Fund for Development (ADFD) have collaborated in the provision of a joint Project Facility to support replicable, scalable and potentially transformative renewable energy projects in developing countries. The IRENA/ADFD Project Facility supports developing countries access finance to develop climate-safe energy solutions. Through the Facility, USD 350 million in concessional loans has been committed with an additional USD 567 million in co-financing mobilised.

In 2014, the project ‚Solar Park Freetown' in Sierra Leone was selected for funding by the Abu Dhabi Fund for Development (ADFD) through the Facility. The project represents one of the first large-scale PV installations in Western Africa and will see a 6 MW solar PV plant installed at Newton town. The project is implemented by the Ministry of Energy and will connect to the national grid, producing some 9.9 GWh of electricity per year. It is funded with a loan of USD 9 million from ADFD and co-financing provided by the Government of Sierra Leone.

Sierra Leone's energy developments have been modest over the last decade, with less than 200,000 households - about 15% of the population - having access to grid-connected electricity. Through the project, more than 190,000 people will benefit from the electricity generated and generate indirect benefits from improved education, healthcare and access to the internet. It will improve grid stability and reduce emissions by 8,000 tons of CO_2e annually. Increased investor confidence has also triggered discussions of a 30 MW solar PV plant to be installed next to the 6 MW facility.

Example
Hedging the short-term liquidity risks of private renewable energy projects

A successful example of a guarantee instrument is the Regional Liquidity Support Facility (RLSF). Investors who lend to energy projects in many African countries ask to mitigate the liquidity risk – that is, the risk that the debt cannot be serviced if the offtaker does not pay on time. Historically, the offtaker was asked to make cash collateral available, but utilities are increasingly reluctant to do so.

The RLSF addresses a key problem in IPP financing: IPPs conclude standard purchase agreements with the (often public) utility, usually for a period of 20 years. During this period, the contract secures the purchase of electricity at fixed rates, thus providing predictable revenues for the project. However, public electricity companies pose a high political and economic risk to many investors. In such cases, investors may require IPPs to provide short-term liquidity support to safeguard the buyer's (offtaker's) payment obligations. Many IPPs on the African continent struggle to mobilise financing because neither the utilities nor the IPPs have the cash or cash equivalents required to provide short-term collateral to address liquidity concerns. The RLSF provides this collateral with support from the German government, the European Investment Bank and others. The African Trade Insurance Agency is also a project partner (KfW, 2020; ATI, n.d.).

RLSF support has been requested in various countries, including Zambia, Malawi, Burundi and Madagascar.

Example
De-risking investments with the EFSD guarantee

The European Fund for Sustainable Development (EFSD) is a ‚one-stop-shop', receiving financing proposals from financial institutions and public or private investors, and delivering a wide range of financial support to eligible investments. The EFSD is composed of two regional investment mechanisms, one for Africa and the second for the EU Neighbourhood.

The fund includes the EFSD guarantee and the EFSD guarantee fund, which were established in 2017. The EFSD guarantee has a total volume of up to EUR 1.5 billion and is designed to leverage additional financing by allowing risk-sharing with private investors, international financial institutions and development banks. The EFSD guarantee fund will provide liquidity to compensate, if necessary, losses covered under the guarantee agreement. The EFSD combines resources from two existing EU blending facilities (the Africa Investment Facility and the Neighbourhood Investment Facility) – amounting to approximately EUR 2.6 billion.

Mitigating specific risks to increase private sector participation. This study has already highlighted guarantee schemes as a tool to reduce off- and mini-grid electricity costs, but these schemes can be equally effective in mitigating the specific risks investors and other stakeholders face in utility-scale projects. Guarantees can enable investments that would otherwise be deemed too risky. Examples of such risks include political risk, offtaker risk, liquidity risk and currency risk (see the fact box on p. 40). Guarantees can be targeted at developers or can also offer risk reduction for other stakeholders, such as banks and suppliers.

Supporting modern procurement methods for renewable energy capacity. Many African countries have traditionally relied on direct negotiations with private companies to attract investments in generation. This has frequently resulted in consumers having to pay above-market prices for electricity. Renewable energy auctions[15] – at which several companies compete to provide governments or utilities with new renewable generation capacity and storage solutions – have proven effective in lowering the cost of electricity. Most of the African countries that held renewable energy auctions in 2017-2018 did so for the first time. In that period, Africa auctioned more than 7,000 MW, primarily solar PV, with Algeria, Egypt and Morocco playing the major roles (IRENA, 2019e).

IRENA has identified three characteristics of renewable energy auctions that make them particularly appealing to African governments: i) the potential for price discovery, especially when there is uncertainty over how to price renewable-based generation; ii) the ease with which they can be tailored to a particular context or policy purpose; and iii) their ability to attract private investment, both domestic and foreign, as a result of clear and transparent processes.

Another way to encourage renewable energy investments is by setting up Renewable Energy Feed-In Tariff (REFiT) schemes. Such schemes provide transparent, fixed tariff conditions for prospective private developers, but in many countries they have been plagued by cost overruns. Development partners can set up and fund such schemes, as Germany has successfully done with the GET FiT programme in Uganda. A feed-in tariff is often preferred for smaller projects, where the transaction costs of participating in an auction may be too high.

[15] Renewable energy auctions are also known as procurement auctions, whereby a government issues a call for tenders to install a certain capacity of renewable energy-based electricity or storage.

Irrespective of how renewable energy capacity is procured, good governance in terms of processes and project approvals is crucial. Therefore, successful schemes often strongly emphasise both technical and financial instruments to build capacity and strengthen regulatory frameworks. For example, GET FiT includes a comprehensive package of support for regulators, investors and other stakeholders.

> **Renewable energy auctions have proven effective in lowering the cost of electricity.**

Example
The Climate Investment Platform

In March 2020, IRENA issued a call for interested parties to register their interest in the Climate Investment Platform. In collaboration with the Green Climate Fund, IRENA and its partners – SEforAll and UNDP – launched the platform to scale up investment in renewable energy projects in developing countries within 14 regional clusters. To date, over 140 projects and more than 260 potential partners have registered their interest. IRENA is preparing a series of regional Investment Forums to connect registered projects with financial partners, as well as to support policymakers in developing strong enabling environments for renewable energy investments. For details of future events and more information on the platform, please visit **www.irena.org/irenaforcip.**

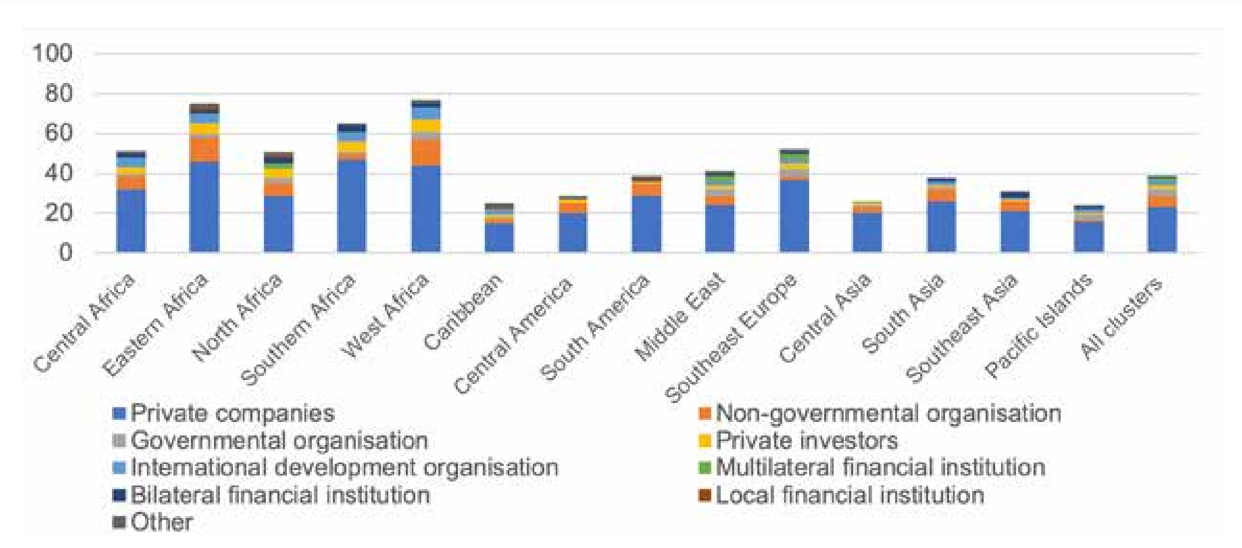


Figure 38 – Registered Climate Investment Platform partners by type and regional cluster

3.3.3 Strengthening and modernising the grid

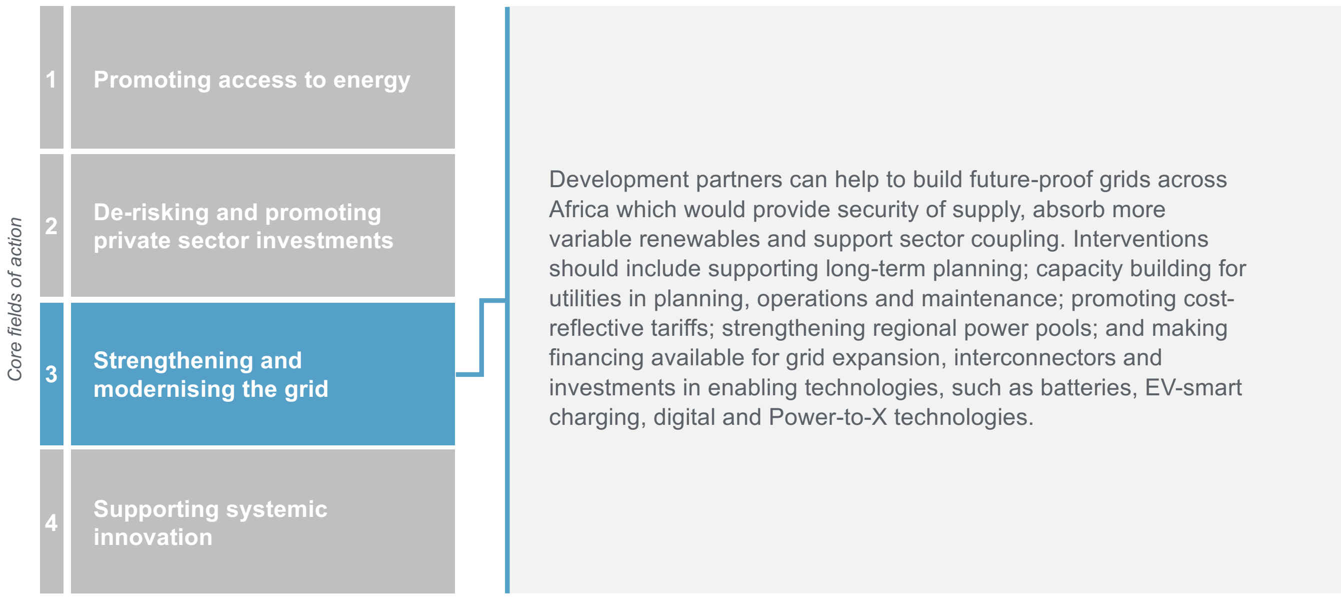


Figure 39 – Development cooperation instruments for strengthening and modernising the grid

Strong, reliable, flexible electricity grids that can absorb more variable renewable energy, reduce losses and provide robust security of supply are crucial to a successful energy transition. The instruments below can all be tailored to support modernising and strengthening electricity grids across Africa.

Building capacity and technical assistance for grid planning, maintenance and system operation. Technical assistance and capacity building are important to ensuring that integrated energy plans are implemented, as well as to improving the quality of grid planning, operations and maintenance. Examples include financing power system master plans; capacity building in the regulation of variable renewable energy sources; on-the-job training in the operation and maintenance of national grids, mini-grids and off-grid solutions; and innovative solutions which combine enabling technologies (e.g., digital technologies) and new ways of operating the power system, such as support from advanced weather forecasting.

Example

Renewable energy and energy efficiency for productive use in Ghana

As part of the German–Ghanaian reform and investment partnership, the Ghanaian government is working to improve the framework conditions for the expansion of renewable energy and increased energy efficiency.

On behalf of the German government, GIZ is supporting these efforts with a four-year project employing technical instruments at the national level. These include training, advice and other support services to strengthen key stakeholder capacity, so private companies with high electricity consumption can increasingly cover their energy needs using renewable energy, or reduce them with energy-efficient solutions. In addition, the project provides needs-based training and further education for the specialists required in the sector. On the one hand, the project's strategic focus is overcoming market entry and development barriers, which have thus far prevented Ghana's large private electricity consumers as well as traders and households from increasing their use of renewable energy and energy-efficient solutions. On the other hand, the project aims to prepare public power supply companies for the changes which the increased generation of renewable energy will entail for the electricity sector.

Financing grid expansion and modernisation. Financial support for grid modernisation projects (e.g., new transmission lines, upgrading and expanding distribution networks, digitalisation and battery storage) is another central instrument available to governments and their partners to help them realise sustainable energy transitions. While grants, standardised financing or policy- and results-based lending on the national level must continue to play a pivotal role in many cases, sub-sovereign loans to grid owners (e.g., utilities and municipalities) are increasingly important for the development of African power systems. Such loans can be an efficient way of enabling financially viable grid modernisation and expansion projects. While development partners have historically offered loans in EUR or USD, the ability to borrow in local currency could significantly reduce borrowing risks for African countries (see the fact box below). In addition to infrastructure investments, implementing digital technologies and advanced weather forecasting are examples of innovations that can help to modernise electricity grid operations in many African countries.

Sub-sovereign loans to grid owners can be an efficient way of enabling financially viable grid modernisation projects.

Example
Supporting investment in renewable small transactions

The Facility for Investments in Renewable Small Transactions (FIRST) supports the South African government in the implementation of its policy objectives. This includes supporting small and medium-sized enterprises in South Africa to help them engage in the rapidly growing market for renewable energy and energy efficiency, with the objective of anchoring the growth of these markets in the local economy.

FIRST has been operational since September 2017. It focuses on providing state-of-the-art financing services for decentralised renewable energy extraction plants for corporate and industrial clients, companies (industry and commercial) and private households, with projects up to 20 MW of installed capacity. Individual projects are too small to carry the high costs of legal, insurance, technical and environmental and social advisors inherent in traditional finance-funded projects, and development teams focussed on small projects are generally not set up to administer high volumes of small projects. FIRST has therefore developed a portfolio approach, using instalment sales as a lending instrument. As such, the facility enables corporations to access financial support for their own renewable energy and energy-efficiency projects. KfW provides a First Loss grant investment to leverage refinancing lines and contributes to a Technical Assistance Facility. Furthermore, the South African commercial bank RMB has also provided a long-term loan to support the facility.

To date, FIRST is supporting five quite different projects:

- Cross Valley (Kruisvallei), a small-scale hydropower plant;
- Various PV roofing systems, including on a shopping centre (with two different project developers);
- A biogas plant;
- Energy Drive Systems, which promotes energy efficiency measures.

Facilitating regional electricity grids and market integration. Improving the regional integration of power markets supports the addition of variable renewables at a lower cost through resource complementarity, which helps balance the power system and increase cost-efficiency. Development partners can and should support such integration by financing transmission lines and underlying infrastructure to connect countries, as well as technical assistance for the development of regional regulatory frameworks and institutional capacity building.

Local Currency Lending

While big international companies are usually able to borrow in common international currencies and hedge the currency risk, smaller local companies are not able to do so. Local currency lending – borrowing long-term internationally in a local currency – can have unique benefits for companies and governments. First, it enables borrowing in the same currency as the revenue stream of a project. While international companies are usually able to borrow in common international currencies and hedge the currency risk appropriately, many local actors are not able to do so. Second, local currency lending can have a catalysing effect, because the projects may become attractive for local investors and co-financers.

Local currency lending is still a relatively novel approach for development finance institutions. It can significantly reduce borrowing risks in low-income countries and help to reduce the risk of a debt crisis.

Example
Clean Energy Corridors in Africa

Clean Energy Corridors are regional initiatives that aim to transform the current fuel mix by promoting the development of clean, indigenous, cost-effective renewable power options and supporting regional efforts to create and develop electricity markets. Tailored to the specific needs and priorities of each region, these corridors are structured around five core pillars, namely: i) resource assessment, ii) national and regional planning, iii) frameworks to enable investment, iv) capacity building and v) public awareness. Corridor implementation relies on high-level political commitment in the respective regions and leverages synergies with the ongoing work of national, regional and international partners.

In Sub-Saharan Africa, the Africa Clean Energy Corridor (ACEC) was launched in 2014 to complement the PIDA in Eastern African Power Pool and Southern African Power Pool member countries, which cover the proposed region for PIDA’s proposed north–south corridor. A January 2014 communiqué endorsed by ministers from both power pool regions guides its implementation. The corridor concept was extended to the West African Power Pool region in 2016 as the West Africa Clean Energy Corridor (WACEC) to support efforts to create a regional power market.

In March 2017 and again in April 2019, the African Union recommended the integration of IRENA’s Clean Energy Corridor initiatives into national renewable energy and climate change agendas. In 2014, the energy ministries in the relevant regions adoped the ACEC, and the regional heads of state endorsed the WACEC in 2017, annexing it to the Economic Community of West African States Treaty.

High-level political commitment, local leadership and guidance, and a strong sense of ownership on the part of all the parties involved are essential to the success of Clean Enery Corridotrs. IRENA has begun working with global financial institutions and other key partners within the framework of the Climate Investment Platform, which aims to translate targets into concrete investments on the ground. Sub-regional Investment Forums will help African decision makers lay the groundwork for more ambitious uptake of renewables and will support developers in preparing bankable projects.

3.3.4 Supporting systemic innovation

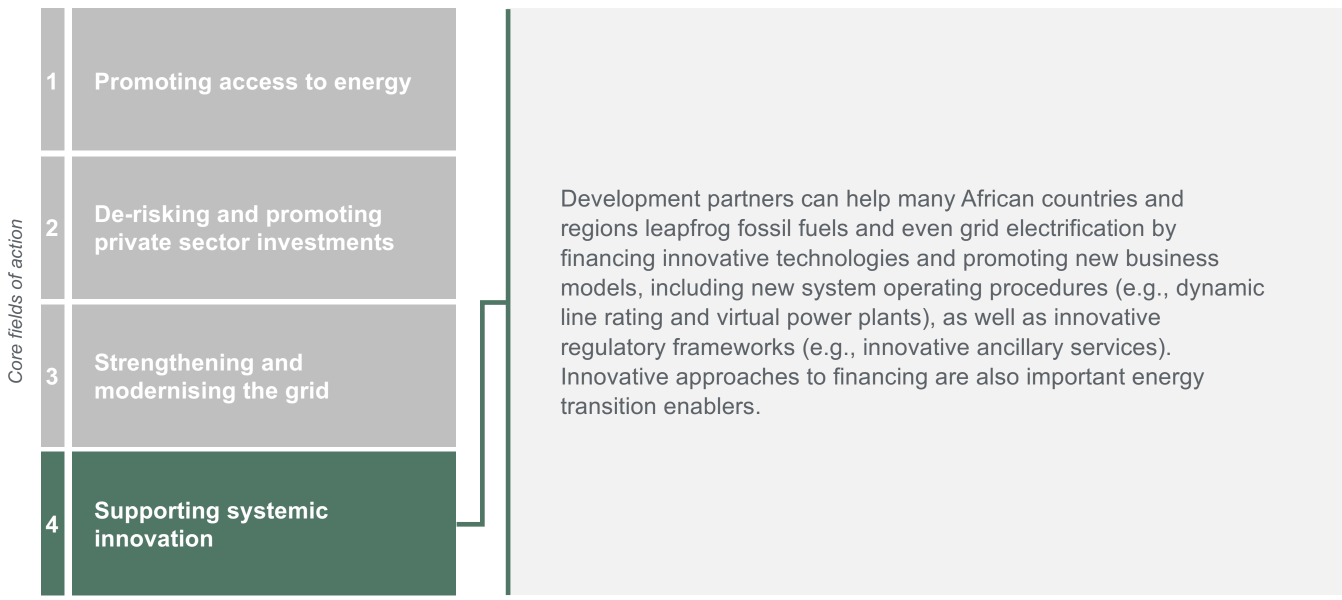


Figure 40 – Development cooperation instruments for supporting systemic innovation

Leveraging new technologies and spurring innovation is a key success factor for the energy transition in Africa. A number of instruments are available to support such innovation.

Facilitating innovative projects. Development partners can provide project financing or portfolios of innovative projects with scaling potential. Access to cheap capital can be provided via local currency lending as well as lending in international currencies. Grants and technical support for innovative pilot projects can also be provided – for example, through challenge funds (see the fact box and the example below).

Challenge funds

Challenge funds can help to develop markets and leverage private sector expertise to address high-risk market barriers. These funds can be provided in the form of grants to help de-risk private sector engagement in projects that are perceived as too risky for prospective developers. They can also help to build a project pipeline by providing capital for feasibility studies and fundamental analyses. As such, challenge funds can promote technological and product innovations that benefit the public, while absorbing commercial risk that would otherwise impede the implementation of new business models and technologies. Such funding is usually awarded in the early stages of a project. Challenge funds can be used to stimulate the market through competitive mechanisms for the allocation of funds, or they can be distributed on a first-come, first-served basis.

Example
Promoting new renewable energy technologies with grant support

The Geothermal Risk Mitigation Facility (GRMF) – a challenge fund – was launched in 2012. The GRMF awards grants to cover part of the investment costs associated with early-stage geothermal power projects in East Africa, which was a relatively new generation technology in the region at that time. As of May 2020, 6 application rounds have been launched, and 14 surface studies and 16 drilling programmes have been supported in 6 different countries.

The GRMF provides financial support to assist in mitigating the financial risks associated with geothermal exploration. This support improves access to equity or other funding sources and thus plays a catalytic role in establishing geothermal energy as a strategic option in power expansion planning. The GRMF's success is expected to encourage the development of more geothermal investments (GRMF, n.d.).

Promoting innovative solutions tailor-made for each country. Systemic innovation appreciates the specific contexts of different African countries and thus includes tailor-made innovative solutions based on local specificities. The focus is on new practical solutions. As outlined in section 4.1.3, for example, combining distributed renewable electricity generation with innovative business models – such as peer-to-peer trading, community ownership and pay-as-you-go models – empowers electricity consumers in Africa to generate their own affordable electricity. Development partners can support the innovation, adaptation and scaling-up of these approaches in a number of ways, including grants or results-based financing schemes. Adaptation can also be driven by policy and regulatory reform – for which development partners can provide technical assistance and capacity-building support. Finally, development partners can support the implementation of innovative approaches by connecting partner countries and local businesses with investors. Examples of such activities include initiatives to advise investors on host-country rules and regulations, as well as establishing dialogue platforms with relevant authorities.

Example
Tailor-made solutions for integrating variable renewables in Africa

Since there is no one-size-fits-all solution which can help all African countries to integrate a higher share of renewable (especially variable) energy sources across the board, innovative solutions need to be tailored to each specific country context.

IRENA has developed a toolkit for countries seeking to integrate high shares of renewables into their power systems over the next few decades. This toolkit encompasses 30 key innovations in enabling technologies, business models, market design and system operation, the combination of which represents innovative solutions (IRENA, 2019b). Direct and indirect electrification of end-use sectors – such as buildings, transport and industry – via renewable power-to-hydrogen can be integral elements of a holistic approach. This toolkit can be applied to specific country contexts, as for example in Sweden (IRENA, 2020g).

Considering the specific objectives, needs and challenges each African country faces, this IRENA toolkit can be applied in partnership with national stakeholders, such as ministries, energy agencies, utilities and system operators. Tailored formulations can serve as a basis for further techno-economic feasibility studies. For example, solution narratives can be used in energy scenarios to quantify their impact on and contribution to national obejectives such as flexibility, energy access and integrating variable renewable energy sources, depending on the specific case.

4 Conclusion

Over the coming decades, the countries on the African continent have the opportunity to address two fundamental energy challenges. First, they can achieve universal access to affordable, reliable, sustainable and modern energy by 2030, thereby improving the lives of hundreds of millions of their citizens. At the same time, they can harness the power of renewable energy to ensure that increased energy demand does not lock the continent into dependency on fossil fuels. Choosing a low-carbon, sustainable development pathway now will determine Africa's long-term success in mitigating climate change and its impacts. Importantly, it will steer the continent towards a resilient, modern energy system and improve energy security by harnessing indigenous potential of renewables.

By choosing sustainable energy sources, Africa has the opportunity to create new jobs, engender significant sustainable economic growth and reap social and health benefits. Working with their partners, African countries both should seize the opportunity to leapfrog fossil fuel technologies and pursue a climate-safe energy strategy aligned with low-carbon growth, with an eye towards 2050 and the Paris Agreement goals. Certain advantageous trends that currently characterise energy markets on the African continent could contribute to these goals:

- Considerable reductions in the cost of renewable energy and related technologiesl mean that renewable energy is already the least-cost alternative for new electricity generation capacity in most cases globally.

- Current estimates indicate that Africa has the potential to generate 1,000 times more renewable energy than it needs to meet its own future demand by 2040.

- Global investments are increasingly responsive to the green transition and impact investing, which makes it easier to mobilise investments in renewables-based energy transition.

A successful energy transition in Africa has the potential to contribute to long-term sustainable economic development, inclusive social progress and increased human well-being.

Seizing this opportunity will require strong political will, attractive investment frameworks and a holistic policy approach, as well as critical upgrades to infrastructure and energy efficiency. Mandated continental organizations such as the African Union and the AfDB have an important role in driving contintent-wide progress, ensuring coordination and facilitating best-practice.

The scale of the challenge
A successful energy transition will be different for every African country, but will generally involve achieving universal access to affordable, reliable, sustainable and modern energy across the continent by 2030 and fully harnessing the potential of renewable energy by 2050. These are highly ambitious yet achievable goals – ones that will require a global call to action.

One key to success will be mobilising sufficient investment within the established timeframe. Average annual investments in the African power system must increase to double the current level of approximately 30 billion USD (IEA, 2019; 192) by 2030. Realising universal access to sustainable energy calls for doubling of current investments and continuous growth well beyond these levels by the end of this decade. This study argues that such a ramp-up of public and private investment can be achieved, with concerted, coordinated action. The global community will need to play an important role in ensuring that African countries and their development partners are able to raise sufficient capital and to implement the investment required to fast-track a timely, just energy transition.

A call to action
The African Union's Agenda 2063 sets out the goals of mitigating climate change, broadening the policy space for sustainable development, eradicating poverty within a generation and building shared prosperity through social and economic transformation. Electricity is essential to achieving these goals. Africa's development partners are already supporting numerous programmes and initiatives to make universal access to electricity and low-carbon, climate-resilient electricity sectors a reality across the continent. However, a comprehensive, renewables-based energy transition in Africa will require a broader, more joint initiative in line with each country's needs.

Based on this analysis, it is concluded that such an initiative must take the form of a partnership built on four fields of action:

1. **Promoting access to energy.** Energy transition strategies to effectively fight poverty, enable new economic opportunities and promote equality must prioritise universal access to affordable, reliable and sustainable electricity in Africa by 2030. These efforts need to involve a balance of on-, mini- and off-grid approaches, and must also address the challenges of supply security, overall economic viability and affordable access.

2. **De-risking private sector investments.** African governments and their development partners can facilitate the private sector investments necessary to bridge this gap by building stable, predictable enabling frameworks, identifying a pipeline of viable projects and offering targeted de-risking instruments.

3. **Strengthening and modernising the grid.** In order to effectively introduce and up-scale inexpensive variable renewable energy (such as solar and wind), the planning, operation and maintenance of electricity grids must be improved in many African countries. As part of this transition, the expansion of interconnectors for cross-border electricity trade is also needed to support energy security and ensure the flexibility required to accommodate a high share of renewables.

4. **Supporting systemic innovation.** To harness the potential of renewable energy, Africa will require a system approach underpinned by innovative technologies, business models, hybridisation, improved regulatory frameworks, policy support and financing frameworks. Innovations sketched out in this study must go hand in hand to harness their full potential.

Moreover, this partnership and the corresponding fields of action must consistently and systematically address the cross-cutting themes of i) supporting competent, functional institutions and ii) pursuing a just transition characterised by economic and social inclusion.

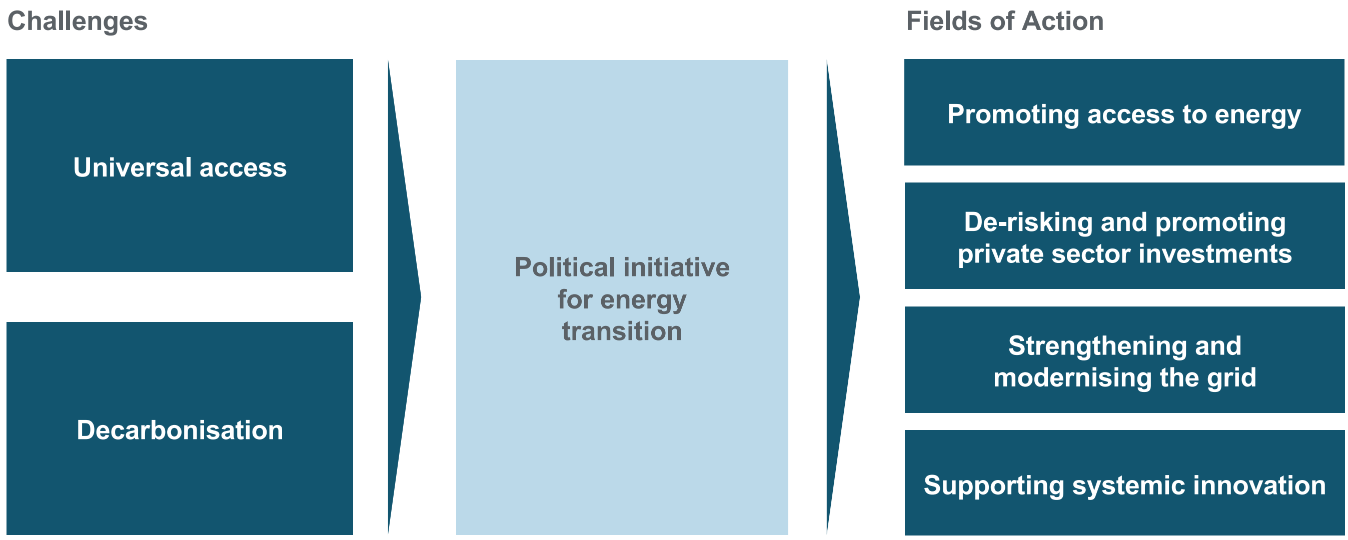


Figure 41 – Rationale for and approach to a political initiative for energy transition

Importantly, the recovery effort in response to the COVID-19 crisis offers an opportunity to align intensified, short-term efforts on the part of the global community with the long-term ambitions related to the energy transition. Investment flows in low-carbon areas could trigger a decisive shift towards resilient energy systems and avoid locking the continent into unsustainable practices of energy generation. Climate-safe energy pathways, underpinned by strong political will and a holistic policy approach, would pave the way for equitable, inclusive and resilient economies. If this political initiative can be harnessed to implement the four fields of action and the two cross-cutting themes listed above, then the energy transition in Africa will contribute to both its socio-economic development and a healthier planet. Moreover, Africa will be able to generate enough renewable energy to meet its future needs in a cost-effective, sustainable manner, while increasing well-being across the continent and contributing to long-term, resilient global economic development.

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Annex 1:
Overview of selected development partner-funded initiatives in the energy sector

	Value proposition and objective*	Description*
Africa Clean Energy Corridor By: IRENA	"The Clean Energy Corridors in Africa aim to meet the continent's fast-growing electricity needs through the accelerated development of renewable energy potential and cross-border trade of renewable power within the Eastern and Southern African Power Pools (Africa Clean Energy Corridor) as well as within the West Africa Power Pool (West Africa Clean Energy Corridor)."	Work on the initiative spans four main pillars: 1. Zoning and Resource Assessment to site renewable power plants in areas with high resource potential and suitable transmission routes. 2. National and Regional Planning to consider cost-effective renewable power options. 3. Enabling Frameworks for Investment to open markets and reduce financing costs. 4. Capacity Building to plan, operate, maintain and govern power grids and markets with higher shares of renewable electricity generation. 5. Public Information and Awareness to raise awareness on how the corridor can provide secure, sustainable and affordable energy.
Power Africa A U.S. Government-Led Partnership By: USAID	"Power Africa's goal is to add more than 30,000 megawatts (MW) of cleaner, more efficient electricity generation capacity and 60 million new home and business connections."	Power Africa brings together companies, political leaders and financial institutions to help Africa overcome its energy crisis. Key effort areas: – Transaction: Addressing the critical impediments to a particular deal's progress. The pipeline of projects Power Africa is tracking includes 60 gas projects in 17 countries, with a potential new generation capacity of more than 17,000 MW. – On-the-Ground Support: Using in-country advisors to identify technical, financial and political solutions. – Bridging the Financing Gap: Providing instruments to de-risk investments. – African-led Reform: Supporting policy reforms and improved governance.
AREI Africa Renewable Energy Initiative By: The African Union	"10 GW of new and additional renewable energy generation capacity by 2020, and mobilize the African potential to generate at least 300 GW by 2030."	AREI is an overriding, continent-wide initiative with a long-term timeframe that builds on, strengthens and bridges gaps in relation to other efforts. It primarily outlines various policy approaches and work programmes that can serve all countries on the continent. Complementing this programmatic approach, the initiative will also support renewable energy projects – in both existing and future project pipelines –that conform to AREI's guiding principles.
Africa-EU Energy Partnership By: African Union, COMESA, Egypt, the European Commission, Germany and Italy	"Improve access to secure, affordable and sustainable energy for both continents, with a special focus on increasing investment in energy infrastructure in Africa."	Structured as a long-term framework for political dialogue and cooperation between Africa and the EU, AEEP aims to increase the effectiveness of African and European efforts to secure reliable and sustainable energy services in the coming decades on both continents and to extend access to modern energy services and expand the use of renewable energy in Africa.
Lighting Africa By: World Bank	"Meet the basic electricity needs (lighting and mobile phone charging) of around 250 million Africans through quality-verified off-grid solar products by 2030."	Lighting Africa works to catalyse the market for off-grid lighting and energy products via a number of different activities across the supply chain, including: – Market Intelligence: Making market research on the African off-grid market available to market actors and policymakers. – Quality Assurance: Developing quality standards and testing methods. – Access to Finance: Offering credit facilities for manufacturers, distributors and consumers. – Consumer Education. – Business Development Support: Providing advice to players in this sector on best business practices, corporate governance and risk management.

PIDA INTERCONNECTING INTEGRATING & TRANSFORMING By: AfDB	"PIDA's Energy vision is to develop efficient, reliable, affordable and environmentally friendly energy networks and to increase access to modern energy services for all Africans."	PIDA is a strategic continental initiative – with buy-in from all African countries – to mobilise resources to transform Africa with modern infrastructure. Its 51 cross-border infrastructure projects comprise more than 400 actionable sub-projects across 4 main infrastructure sectors, namely energy, transport, transboundary water and ICT.
endev By: The Netherlands, Germany, Norway, the United Kingdom, Switzerland and Sweden	"More than 21.3 million people gained access to either electricity and lighting devices or improved cooking technology. In addition, more than 21,150 social institutions and 46,200 small and medium enterprises have benefitted from access to modern energy services. Moreover, about 40,500 technicians, stove producers and sales agents have been trained."	EnDev is a multi-donor programme working in 25 developing countries. It supports energy access by establishing economically sustainable energy solutions and distribution schemes, such as: – Energy for Household Applications: Providing modern energy for lighting and small electrical appliances. – Energy for Cooking: Providing efficient and clean cooking, baking and space-heating devices. – Energy for Social Infrastructure: Providing energy for schools, hospitals and community centres. – Energy for Small and Medium-Sized Enterprises, Cooperatives and Craftsmen.
REEEP INVESTING IN CLEAN ENERGY MARKETS	"Accelerate the market growth of low-carbon renewable and energy efficiency systems, decrease their costs and turn them into affordable energy options for all."	REEEP designs and implements tailor-made financing mechanisms, using targeted injections of public funding to build dynamic, sustainable markets, ultimately making clean energy and energy-efficiency technology accessible and affordable for all. REEEP invests primarily in disruptive approaches led by small and medium-sized enterprise (SME) players in low- and middle-income countries, facilitating market- and community-led energy transitions. It has 385 partners, 45 of which are governments.
GET FiT By: KfW	The main objective of the GET FiT programmes is to assist nations in "pursuing a climate resilient low-carbon development path resulting in growth, poverty reduction and climate change mitigation."	The GET FiT programmes are (multi-)donor funded undertakings that aim to improve the framework conditions for private sector investments in the power sector, usually coupled with the introduction of feed-in tariffs for small-scale renewable energy projects. Procuring and fast-tracking a renewable energy portfolio is the core of the programme, providing viability gap funding as well as technical assistance to key sector stakeholders, depending on the needs of the respective country. GET FiT has already been successfully implemented in Uganda, by means of a 160 MW portfolio. The second roll-out in Zambia aims to fast-track 100 MW of solar PV and 100 MW of hydropower.

* Partly built on public information offered by these initiatives

Annex 2:
Potential for energy transition in selected African countries – country snapshots

The prospects for a successful energy transition in African countries can be assessed based on a number of indicators, including: i) existing greenhouse gas emissions, ii) share of renewable energy in the electricity mix, iii) expected energy demand growth, iv) percentage of the population without access to electricity, v) security of supply, and vi) sector framework. This section provides an overview of the urgency of a sector-wide approach to energy transition in the 12 African countries that have joined the G20 Compact with Africa (CwA), as well as South Africa. It also explores the opportunities and challenges that need to be addressed in these countries in order to make universal energy access and zero emissions electricity sectors a reality by 2050.

Country	Region	Electrification rate	kg CO_2 per cap per year	Fossil generation capacity
Benin	West Africa	42%	18	301 MW
Burkina Faso	West Africa	14%	23*	289 MW
Côte d'Ivoire	West Africa	67%	151	1,298 MW
Egypt	North Africa	100%	845	58,614 MW
Ethiopia	East Africa	45%	1	104 MW
Ghana	West Africa	82%	117	3,161 MW
Guinea	West Africa	44%	23*	226 MW
Morocco	North Africa	100%	625	7,259 MW
Rwanda	East Africa	35%	23*	89 MW
Senegal	West Africa	67%	193	866 MW
South Africa	Southern Africa	91%	3,903	44,426 MW
Togo	West Africa	51%	3	158 MW
Tunisia	North Africa	100%	762	5,782 MW

Compact with Africa

The countries presented in this overview are member countries of the *Compact with Africa*.

The G20 Compact with Africa (CwA) was initiated under the German G20 Presidency to promote private investment in Africa, including in infrastructure. The CwA's primary objective is to increase attractiveness of private investment through substantial improvements of the macro, business and financing frameworks. It brings together reform-minded African countries, international organisations and bilateral partners from G20 and beyond to coordinate country-specific reform agendas, support respective policy measures and advertise investment opportunities to private investors. The initiative is demand-driven and open to all African countries. - Compact with Africa (n.d.)

Note: South Africa is not part of CwA

*No country-level data available. Estimates are based on regional emissions and population data.
Sources: Electrification rates for 2018 (World Bank, n.d.), Emissions data for electricity and heat generation in 2017 (IEA, 2019b), Installed fossil capacity for 2019 (IRENA, 2020b)

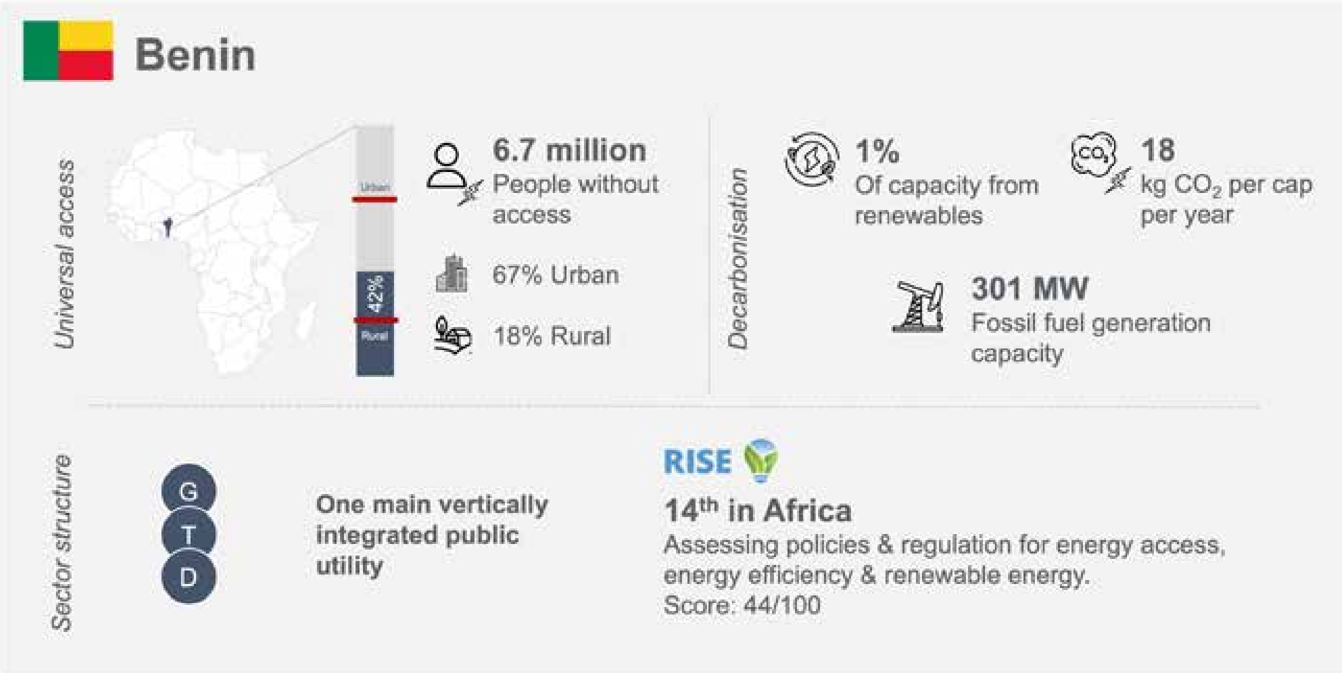
Figure 42 – Key power sector indicators for Compact with Africa member states and South Africa

When it comes to energy access and the extent to which countries rely on fossil fuels for energy production, there is great diversity among the 13 countries analysed in this section. Access rates range from 14 to 100 per cent, and installed fossil fuel generation capacities from 89 MW to nearly 59,000 MW.

The urgency of action in any given country depends on how governments plans to develop the electricity sector. For example, countries with low emissions today may plan to meet future electricity demand with new generation from coal power plants. Another factor for taking urgent action in some countries is the impact of climate change on hydropower generation. Many African nations are highly dependent on large hydropower projects (e.g. Ghana, Mozambique, Cote d'Ivoire, Benin, Togo, Ethiopia) which are already experiencing reduced water availability due to the increasing frequency of drought events and high temperatures. Developing a diverse mix of renewable energy generation is therefore an important measure for improving climate change resilience.

Regulatory Indicators for Sustainable Energy (World Bank)

RISE scores reflect a snapshot of a country's policies and regulations in the energy sector, organised according to the three pillars of the SEforALL initiative: i) energy access, ii) energy efficiency and iii) renewable energy. These indicators are assigned to each pillar to determine the scores, with a total maximum of 100. The latest scoring was published for the year 2017, with 39 African countries assessed (RISE, n.d.).



Note on sector structure: G – Generation; T – Transmission; D – Distribution. Blue (grey) circles indicate public (private) ownership.
Sources: IEA (2019b), RISE (n.d.), Trimble et al (2016), IRENA (2020b), World Bank (n.d.)

Figure 43 – Snapshot of energy transition urgency in Benin

Benin

Benin is a densely populated country with low levels of rural electrification. Per capita emissions from the electricity sector are low, but Benin has one of the most fossil fuel dominated electricity systems in Sub-Saharan Africa.

Access to electricity

Benin had a rural electrification rate of 18 per cent in 2018, raking in the lowest quarter among all African countries. As with all ECOWAS countries, Benin has adopted a concerted approach to implementing the SEforALL Country Action, developing an Action Agenda to achieve urban and rural electrification rates of 95 per cent and 65 per cent, respectively, by 2025 (SEforAll, 2020a). This is an ambitious plan, currently facilitated by the African Development Bank via a USD 97 million programme covering 309 localities and an estimated beneficiary population of one million (out of a total population of 11 million).

The low electrification rate in Benin has been ascribed to tariffs below cost-reflective levels and a lack of financial capacity at the main distribution utility, SBEE (Société Béninoise d'Energie Electrique). Some responsibility for rural electrification has been shifted to the Rural Electrification Authority.

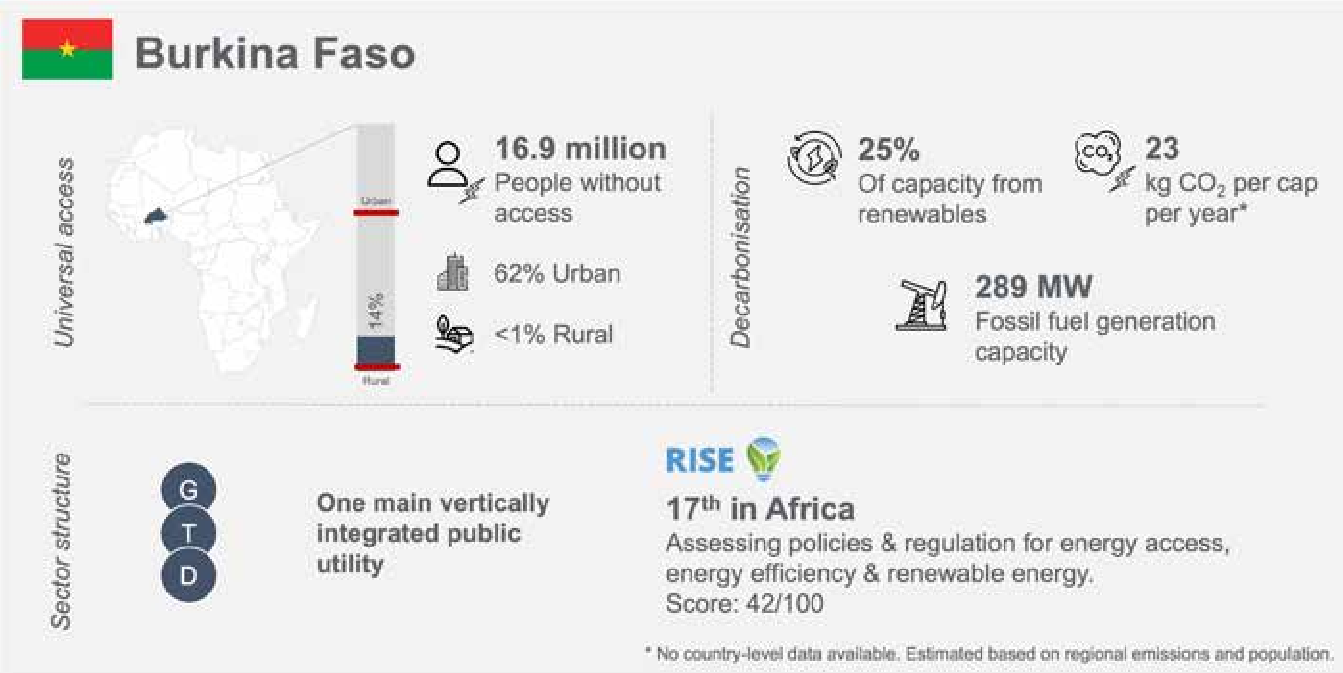
Decarbonisation path

Currently, electricity generation in Benin is dominated by diesel and heavy fuel oil (57 per cent) as well as natural gas (42 per cent). Only 1 per cent of generation comes from solar energy (IRENA, 2020c). Electricity-related per capita emissions are nevertheless the third lowest among the 13 countries studied, due to the low per capita electricity demand.

Benin is a member of the WAPP and a major electricity importer from both Ghana and Nigeria, via the CEB-NEPA Power Interconnector. An increase in interconnector capacity between Benin and its neighbouring countries, combined with increases in renewable energy generation in these countries, means that Benin may opt to reduce the carbon dependency of its electricity supply by importing more from its neighbours. Benin shares its transmission and wholesale generation utility (Communaute Electrique du Benin) with Togo.

The government has an ambitious target of 24.6 per cent renewable energy in the electricity mix by 2025, and the targets in Benin´s Nationally Determined Contributions (NDC) include the development of 335.5 MW of hydropower plants, 95 MW of solar PV and 15 MW of bioenergy.

Benin scores below 50 out of 100 in the World Bank´s annual RISE study (see the fact box below), with particular room for improvement in the categories of renewable energy, energy efficiency and support for IPPs. To help address these gaps and meet its electrification and renewable energy targets, the Millennium Challenge Corporation (MCC) and the EU are supporting the government in establishing an independent electricity regulator with the authority to regulate tariffs and developing a new law encouraging public-private partnerships, as well as a performance plan with measurable targets for SBEE (USAID, 2020a).



Note on sector structure: G – Generation; T – Transmission; D – Distribution. Blue (grey) circles indicate public (private) ownership.
Sources: IEA (2019b), RISE (n.d.), Trimble et al (2016), IRENA (2020b), World Bank (n.d.)

Figure 44 – Snapshot of energy transition urgency in Burkina Faso

Burkina Faso

Burkina Faso has one of the lowest levels of rural electrification in Africa. The installed fossil fuel generation capacity is 289 MW (IRENA, 2020b), and the country relies heavily on imported electricity from nearby WAPP countries.

Access to electricity

Rural electrification rates in Burkina Faso were around 1 per cent in 2018. Most schools and hospitals outside the capital lack electricity supply, although there are now several programmes underway to address this key challenge (SEforAll, 2020b).

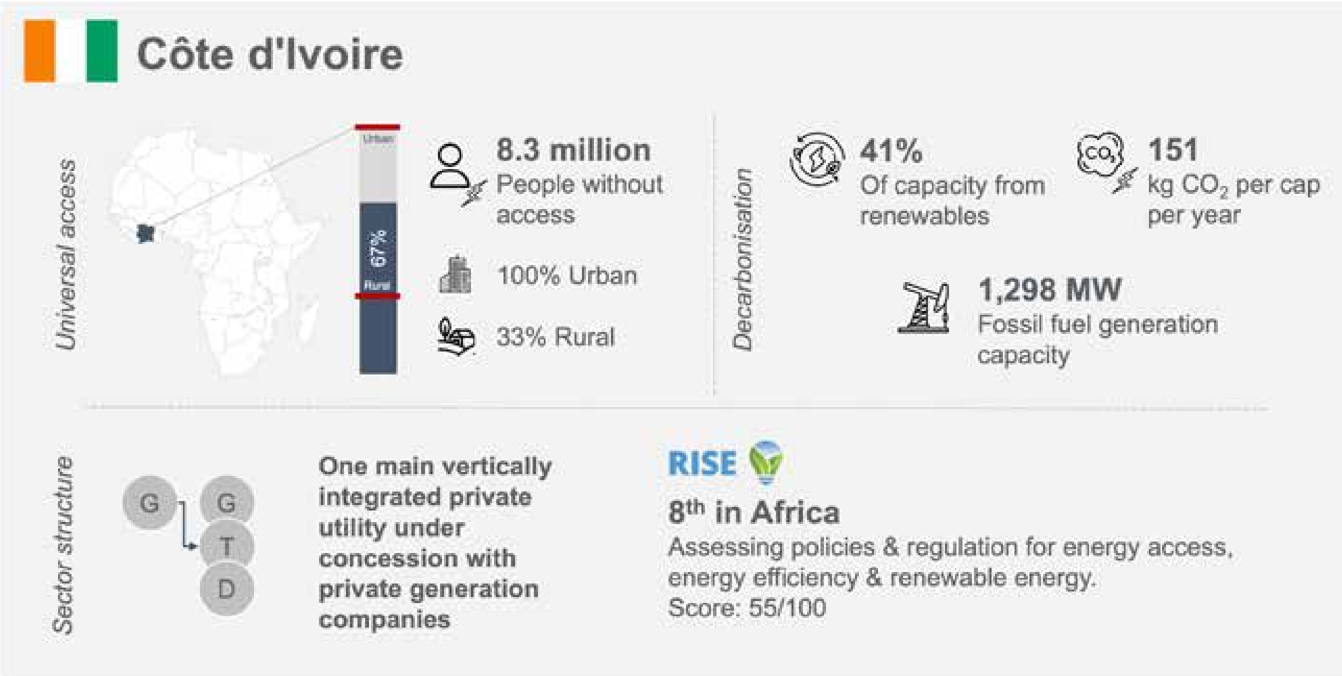
The Rural Electrification Agency is responsible for all rural electrification activities, and improving access to electricity is a key component of the government´s strategic development plan. In urban and peri-urban areas, customer numbers for the national utility company SONABEL have been increasing steadily, but the network regularly experiences load shedding during peak periods.

Decarbonisation path

Burkina Faso is a WAPP member country and is heavily reliant on energy imports from Côte d'Ivoire and Ghana (SEforALL, 2020b). The installed on-grid electricity generation capacity in Burkina Faso includes heavy fuel oil and diesel (75 per cent), solar (16 per cent) and hydropower (9 per cent) (IRENA, 2020c).

The government and SONABEL are eager to reduce expensive diesel fuel imports and substantially increase domestic electricity supply (SEforALL, 2020b). Being an arid country with some of the highest solar irradiation levels on earth, solar PV is an obvious choice for Burkina Faso, notwithstanding its intermittency. A new energy law adopted in 2017 removes market segmentation and the single-buyer model, as well as liberalising production and distribution. As a result, Burkina Faso has seen approximately 155MW of IPP and publicly owned solar projects move into the advanced planning or construction stage (USAID, 2020b). Burkina Faso ranks 17th out of 39 African countries in the World Bank RISE study.

The renewable energy targets in Burkina Faso's NDC include the implementation of several hydropower, solar, bioenergy and mini-grid projects. Between 2015 and 2019, renewable installed capacity grew at an average annual rate (CAGR) of 24 per cent – bringing the total installed capacity up to 98 MW at the end of 2019. This reflects an additional 57 MW of mostly on- and off-grid solar PV power installed in recent years. As of the end of 2019, Burkina Faso has achieved 21 per cent of the renewable electricity target established in 2015.



Note on sector structure: G – Generation; T – Transmission; D – Distribution. Blue (grey) circles indicate public (private) ownership.
Sources: IEA (2019b), RISE (n.d.), Trimble et al (2016), IRENA (2020b), World Bank (n.d.)

Figure 45 – Snapshot of energy transition urgency in Côte d'Ivoire

Côte d'Ivoire

While urban areas in Côte d'Ivoire have near-universal electricity access, around 8.3 million people (67 per cent of the population) in rural areas remain without access to electricity. Per capita emissions are still low, but significant efforts are required to ensure that future demand growth is met by renewable energy.

Access to electricity
The low access rates in rural areas (33 per cent) can be largely explained by high upfront connection costs, particularly in central and northern areas (USAID, 2020c). The government is committed to grid extension as the preferred electrification policy and has launched the Programme Électricité Pour Tous, which aims to achieve 100 per cent access, including in rural areas, by the end of 2025. Continued support and increased resources for this and other initiatives to expand rural access are urgently needed.

Decarbonisation path
Côte d'Ivoire ratified the Paris Agreement in October 2016. The renewable energy targets in Côte d'Ivoire's NDC are conditional and include 42% renewable electricity generation by 2030, of which 26% from hydropower, at an estimated cost of USD 12.9 billion. This is in line with the targets established at the national level in the Plan d'Action National des Énergies Renouvelables (PANER). The NDC also mentions the development of small hydropower, off-grid solar, biomass and biogas, albeit without quantified targets.

To reach these targets, electricity generation in Côte d'Ivoire should shift from natural gas to renewables. Between 2016 and 2018, the share of renewable electricity generation in the country doubled from 15% to 30%. The country achieved this by replacing around 17% of their electricity generation from natural gas with hydropower (IRENA, 2020b).

Since the target was established in 2016, an additional 278 MW of renewables were commissioned during 2017, reaching a total capacity of 887 MW by 2019 (CAGR of 13% – keeping up with the 11% CAGR projections in the PANER) (IRENA, 2020b). As of end of 2019, the country has achieved 14% of the renewable energy target established in 2016.

International public investments are particularly important for Côte d'Ivoire to accelerate progress toward the targets set in the NDCs. International public investments totaled USD 1 billion in the 2010-2018 period (IRENA, 2020a). While this represents a significant amount of public investment, these were highly focused on hydropower and specifically on the 2017 Gribo-Popoli Hydropower Project (USD 459 million) and the 2013 Soubre Hydropower Project (USD 485 million). Increasing public investments could be a key strategic objective for Côte d'Ivoire due to the link between public investments in these projects and the increase in renewable electricity generation from hydropower.

The electricity grid in Côte d'Ivoire is aging and overloaded (World Bank, 2017a), leading to high losses and reducing its absorption capacity for variable renewable energy. The national utility company (CIE) is making steady improvements. However, if the country is to increase its share of renewable electricity generation, there is an urgent need for continued investment in its transmission network, particularly the north–south axis, as well as interconnectors to neighboring WAPP members. The country ranks 8th in Africa in the RISE study.

Note on sector structure: G – Generation; T – Transmission; D – Distribution. Blue (grey) circles indicate public (private) ownership.
Sources: IEA (2019b), RISE (n.d.), Trimble et al (2016), IRENA (2020b), World Bank (n.d.)

Figure 46 – Snapshot of energy transition urgency in Egypt

Egypt

Egypt is a middle-income country with near-universal access to electricity, even if supply is often unreliable in rural areas and provincial cities. Egypt has the largest installed fossil fuel generation capacity in Africa and is working hard to harness a combination of new domestic natural gas, solar, wind and hydropower resources.

Access to electricity

Egypt benefits from 100 per cent (universal) access to electricity in both urban and rural areas. However, electricity supply is not always reliable due to chronic underinvestment in generation, transmission and distribution networks in recent decades. A series of laws and policies to manage demand and to support the financing and construction of new power plants and transmission lines is now redressing this problem.

Decarbonisation path

Over the past five years, Egypt has expanded its renewable energy generation capacity significantly in an effort to exploit the large solar and wind resources in its desert regions. And yet, gas-fired generation supplied by both imported and domestically produced natural gas still dominates electricity mix, totalling 58.6 GW of installed capacity. Build-out of gas-fired power plants is being driven by recently commissioned, low-cost offshore natural gas fields. Egypt has a further 1,500 MW in HFO/diesel capacity, and 5,972 MW in various renewables (hydropower, solar and wind) (IRENA, 2020c).

Due to growing energy demand, as well as the dominance of gas-powered electricity and heat generation, Egypt is the second-largest per capita emitter in Africa, after South Africa.

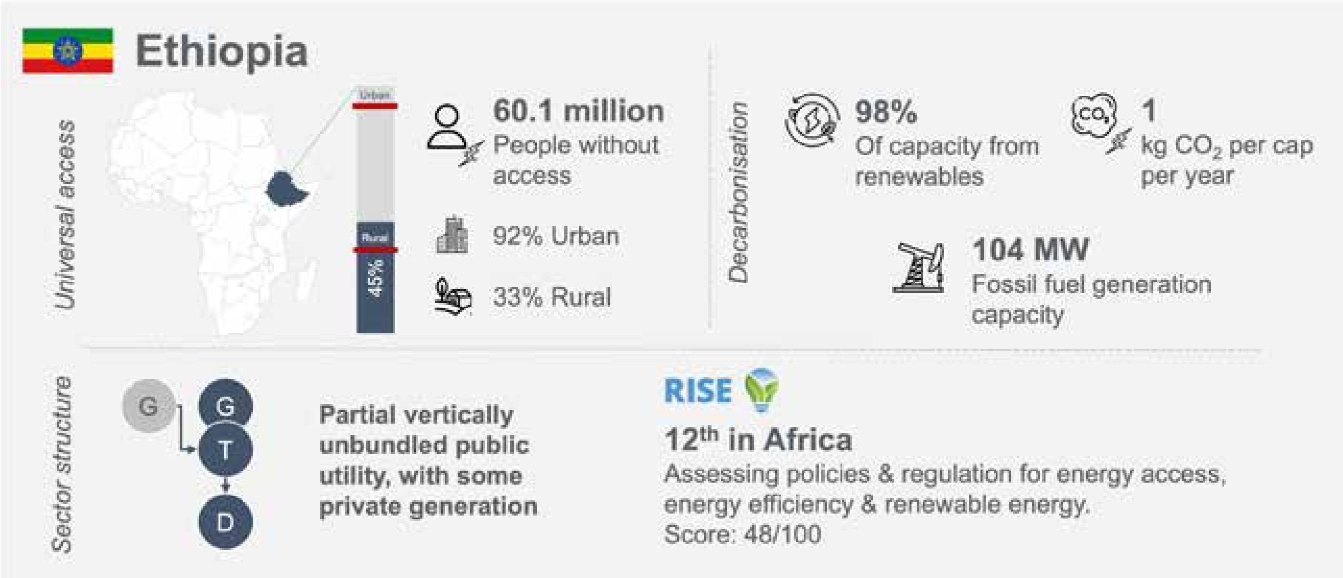
Egypt's NDC does not include any quantified renewable energy targets, but the country's 2018 Voluntary National Review of the High-level Political Forum on Sustainable Development set a national target of 20 per cent of electricity generation from renewable sources by 2022, and 37 per cent by 2035. This may be difficult to achieve, considering that the share of electricity generation from fossil fuels has increased by 4 per cent (7,776 GWh) since the submission of the NDCs, reaching an all-time high of 181,674 GWh in 2019 (IRENA 2020b). Today, Egypt faces the novel challenge of overcapacity in electricity generation, as demand plummets due to COVID-19 and new gas capacity is added. Data on the current share of renewables in power generation vary, with high estimates around 16 per cent.

Egypt scores especially high in the RISE study, ranking 2nd of all African countries. It scores particularly well with regard to electricity access (receiving a full score) and renewable energy. Following the passage of the Renewable Energy Law in Dec 2014, the Egyptian Electricity Transmission Co. has run a series of competitive tariff auctions for large IPP-financed solar and wind projects, including the 1,000 MW Zafarana wind project (the largest in Africa) and the 1,465 MW Benban solar PV project. The New and Renewable Energy Authority (NREA) is considering implementing solar and wind energy projects with a total capacity of 3,170 MW (Daily News Egypt, 2020).

In 2017, Egypt held its first auction for the development of solar parks, which took the form of a technology-exclusive bidding round designed to award 600 MW of solar capacity (IRENA, 2019e). In August 2018, an additional project-specific auction was launched to contract the 200 MW Kom Ombo solar PV project. The winning bid was awarded at USD 27.5/MWh (IRENA, 2019e).

Given the country's substantial solar resources, one potential policy avenue for Egyptian policymakers seeking to pursue a low-carbon development path is to decommission heavy fuel oil and older gas-fired (combined-cycle) power plants, which would yield significant improvements in the country's current account. The construction of wind and solar PV could replace these decommissioned facilities, leveraging existing natural gas capacity as a flexibility provider to integrate variable renewable energy into the power system.

The IRENA Renewable Energy Outlook for Egypt (2018) concludes that by adopting the right policies now, Egypt could realistically draw 53 per cent of its electricity from renewables by 2030.



Note on sector structure: G – Generation; T – Transmission; D – Distribution. Blue (grey) circles indicate public (private) ownership.
Sources: IEA (2019b), RISE (n.d.), Trimble et al (2016), IRENA (2020b), World Bank (n.d.)

Figure 47 – Snapshot of energy transition urgency in Ethiopia

Ethiopia

Approximately 60 million people in Ethiopia remain without electricity access (about 55 per cent of the population). Per capita emissions from the electricity sector are low, due to minimal household consumption and significant hydropower in the electricity mix.

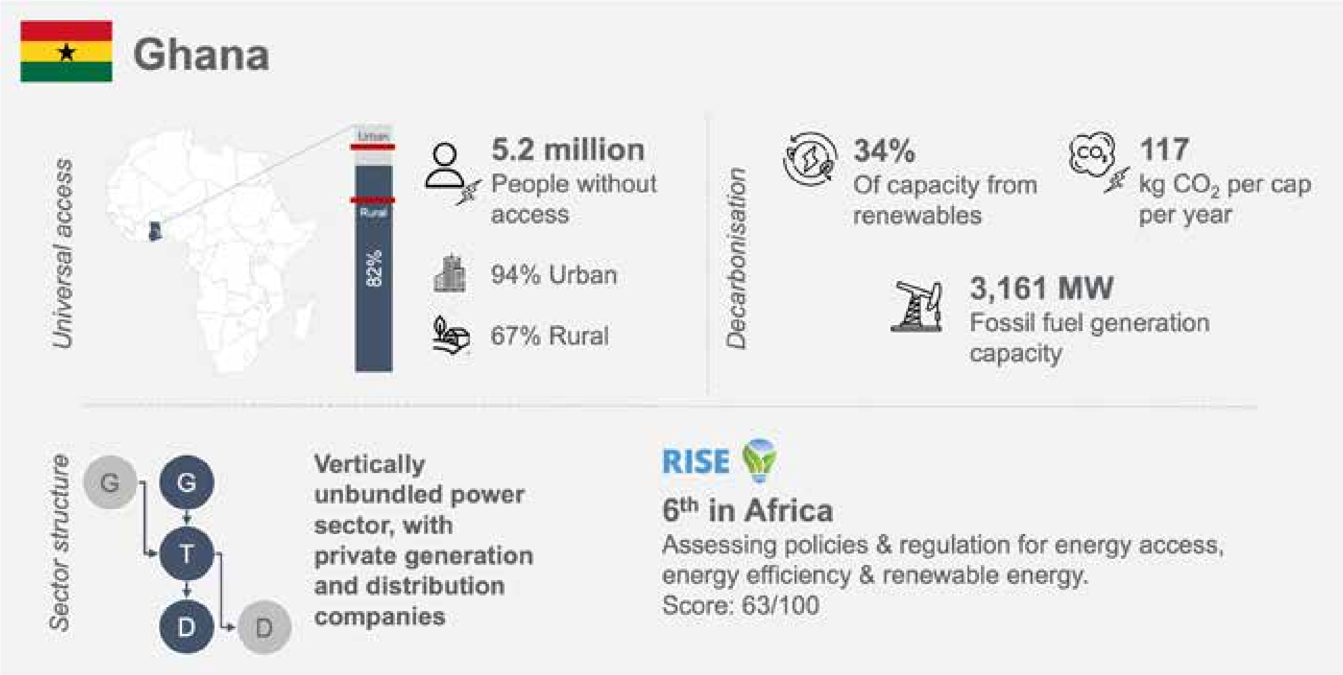
Access to electricity
Energy access in urban areas (especially in and around Addis Ababa) is high by regional standards, even if it is not always reliable. In rural areas, roughly two-thirds of the population is still without access to electricity. The grid extends into most regions of Ethiopia, with the main gap in the south and south-eastern parts of the country, in Somali and Oromia provinces (AfDB, 2017). In these and other areas far from the existing grid, mini-grids and solar home systems are common, although further expansion of commercially viable mini-grids is hindered by low household incomes. In any event, among the CwA countries, Ethiopia had the largest population benefitting from off-grid renewable energy solutions in 2018, at around 5.7 million (5 per cent of the population). Solar lights shone for 5.6 million people, while a smaller group of 77,000 people benefitted from biogas for cooking, and 10,000 benefitted from off-grid hydropower.

The electricity tariffs which the utility company (EEPCo) charges are well below cost-reflective levels. The continuation of such loss-making tariffs results in delays to much-needed investments in distribution network reinforcement and leaves IPPs and mini-grid developers discouraged (SEforAll, 2017).

Decarbonisation path
Ethiopia´s energy mix consists almost exclusively of renewable energy, with the largest share coming from hydropower (3,817 MW) (IRENA, 2020b). The country has also installed wind (324 MW), bioenergy (79 MW) and solar (11 MW), and geothermal resources are also being explored for future generation projects. Only 104 MW (2 per cent of total installed capacity) comes from fossil fuels (diesel and heavy fuel oil).

Ethiopia plans to cover almost all of its future electricity needs with renewable energy, particularly from large hydropower in the form of the 6,000 MW Grand Renaissance hydropower project on the river Nile, which is now under construction. The sheer scale of the Renaissance project overshadows the IPP sector, as it is likely to lead to an oversupply of domestic electricity for years to come. Nonetheless, a pipeline of unsolicited IPP renewable energy projects is under development. Several donor-funded financial and technical support programmes are in place to further develop renewable energy-powered mini-grids. In June 2017, Ethiopia awarded 100 MW of solar PV. In October 2017, a site-specific auction was launched to contract two 125 MW solar plants with a combined capacity of 250 MW (Power Engineering, 2019).

Ethiopia's NDC only mentions the completion of the Grand Renaissance dam, as well as the expansion of geothermal, wind and solar technologies. In its Second Growth and Transformation Plan (GTP II), published in 2016, Ethiopia sets the target of reaching 16,700 MW of renewable energy capacity by 2020, of which 13,800 GW (83 per cent) will come from hydropower, 1,200 MW (7 per cent) from wind, 800 MW (5 per cent) from bioenergy, 600 MW (3 per cent) from geothermal and 300 MW (2 percent) from solar. Implementing these targets would translate into a renewable installed capacity of 19,300 MW in 2020; as a result, renewables in the country are expected to grow at 64 per cent CAGR from 2017 to 2020, well above the 19 per cent recorded from 2017 to 2019 (IRENA, 2020b). In mid-2020, Ethiopia published its 10-year development plan, establishing additional ambitions for the energy sector. Ethiopia ranks 12th among the 39 African countries assessed in the RISE study and scores the lowest on energy efficiency and renewable energy frameworks, mainly due to the offtaker's (Ethiopian Electric Utility) lack of solvency/financial capacity.



Note on sector structure: G – Generation; T – Transmission; D – Distribution. Blue (grey) circles indicate public (private) ownership.
Sources: IEA (2019b), RISE (n.d.), Trimble et al (2016), IRENA (2020b), World Bank (n.d.)

Figure 48 – Snapshot of energy transition urgency in Ghana

Ghana

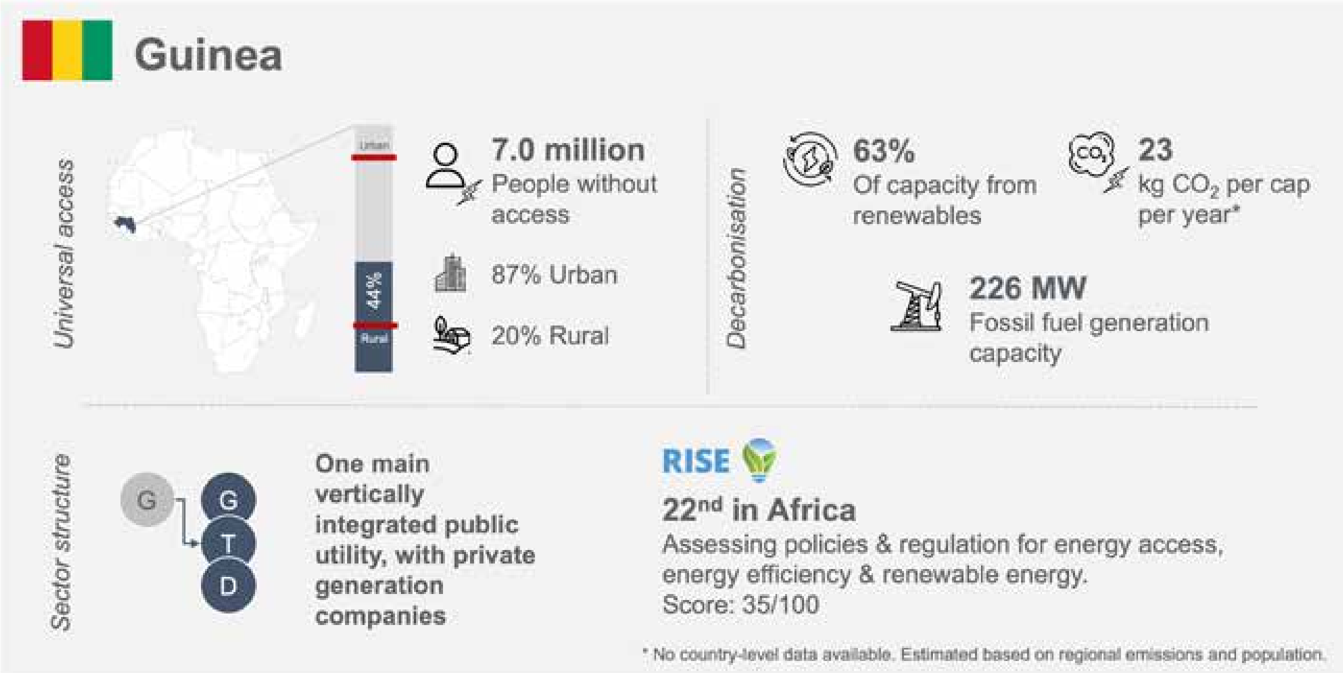
Ghana has one of the highest connection rates in Sub-Sahara Africa, yet approximately 5.2 million Ghanaians (nearly 16 per cent) still lack access to electricity. Most of them live in rural areas. Per capita emissions from electricity generation are still relatively low, but ensuring the country pursues a low-carbon expansion path as demand grows will require concerted efforts to promote investments in renewable energy as well as significantly upgrading the grid.

Access to electricity
Most Ghanaians without access to electricity live in rural areas. Whereas the number of households with access has nearly doubled – from 42 per cent around the year 2000 to 82 per cent in 2020 – continued efforts will be required for Ghana to reach all rural households by 2030. Ghana's access expansion strategy emphasises grid extension even in rural areas and mostly considers off-grid solutions for island communities (notably on Volta Lake).

Decarbonisation path
Fossil fuel generation capacity (approximately 64 per cent of the electricity mix), mainly natural gas and crude oil, dominates electricity generation in Ghana. Renewable energy capacity consists mainly of hydropower (approximately 36 per cent, predominantly from the Akosombo dam) and, to a far lesser extent, of grid-connected solar PV (approximately 0.6 per cent). Ghana would require significant growth in renewables – particularly hydropower – in the coming years to accelerate its progress towards meeting its NDC targets. In fact, the share of renewable electricity generation in Ghana has consistently decreased since 2009, when renewables generated 77 per cent of electricity, to 37 per cent in 2018 (IRENA, 2020b).

The electricity sector in Ghana is in a state of financial emergency caused by significant overcapacity (peak demand stands at around 2,781 MW, whereas dependable capacity is approximately 4,700 MW), with most of the capacity signed on a take-or-pay basis. This means that Ghana has to pay for energy it does not need. The government predicts that the total financial loss could reach USD 12.5 billion by 2023 if business as usual continues.

Gaps in domestic transmission and distribution infrastructure constitute an additional challenge for the integration of more variable renewables in the future. These problems are compounded by tariffs below cost-reflective levels, which limits the utility's ability to invest. While ongoing generation and transmission expansions will allow costly, polluting emergency power plants to be decommissioned, Ghana will still have considerable fossil fuel generation capacity – not least from natural gas. Incentives for early decommissioning, combined with targeted efforts to increase renewable energy generation coupled with innovative solutions would be required to ensure a low-carbon future for Ghana's power sector. Ghana scored 6th among all African countries in the RISE study.



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Sources: IEA (2019b), RISE (n.d.), Trimble et al (2016), IRENA (2020b), World Bank (n.d.)

Figure 49 – Snapshot of energy transition urgency in Guinea

Guinea

Access to electricity in Guinea is heavily skewed towards the urban centre of Conakry. Only 20 per cent of rural household have access. Greenhouse gas emissions per capita are the fourth lowest among the 13 countries studied.

Access to electricity

Following a concerted effort by the Electricité Nationale de Guinée (EDG) utility, with development partner support, the electrification rate in Guinea has soared in recent years – from 27 per cent in 2010 to 44 per cent in 2018 (World Bank, 2020c), albeit with a high concentration in urban areas (almost 80 per cent, versus 20 per cent among the rural population). Today, access expansion efforts mainly take place under the auspices of the National Electricity Access Scale Up Program, which was implemented via two World Bank-funded projects: (i) the USD 200 million ECOWAS Regional Off-Grid Electrification Project, part of the Lighting Africa Program, and (ii) the USD 50 million Guinea Electricity Access Scale Up Project, with another USD 58 million of financing from the French Development Agency. This latter project will involve financing, rehabilitating, densifying and expanding distribution networks in Greater Conakry and the secondary cities of Kindia and Forécariah (World Bank, 2019d; Lighting Africa, 2017). The government oversees electrification in Guinea by means of the recently created Agence Guinéenne d’Électrification Rurale and l’Agence de Régulation des Services Publics d’Eau et d’Electricité.

Decarbonisation path

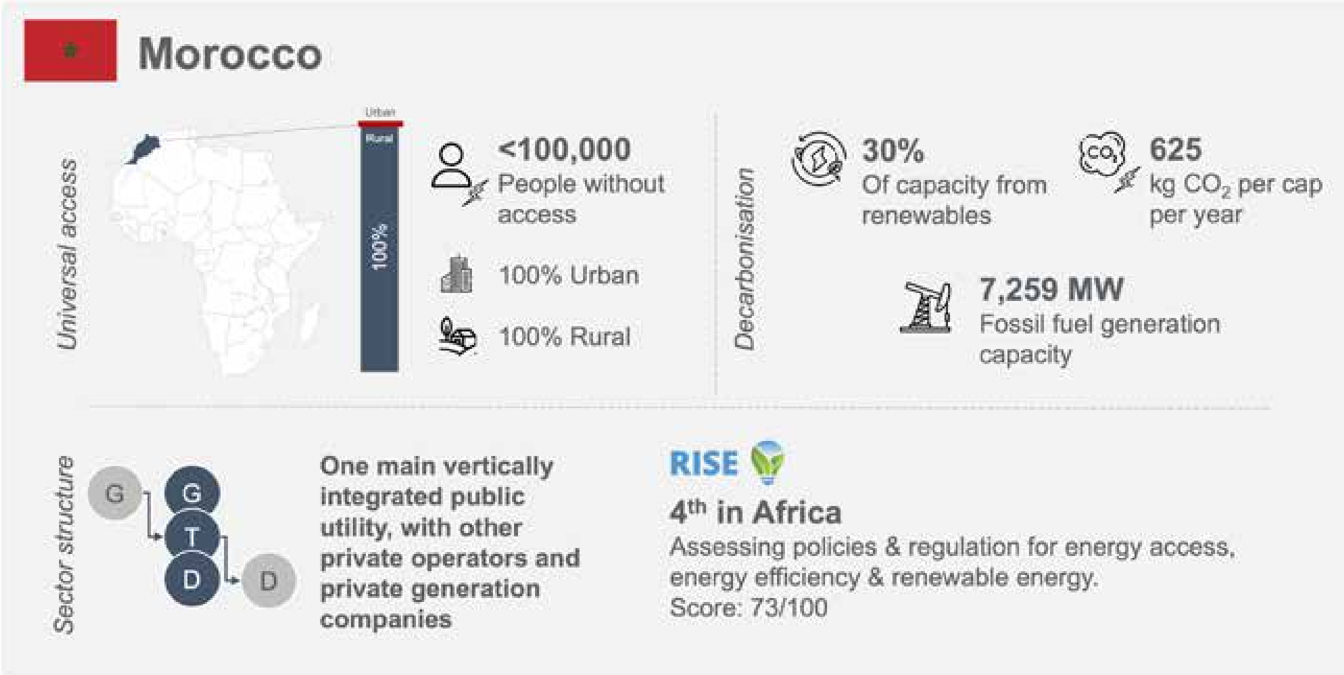
Natural gas represents 37 per cent of the country’s installed capacity, supplied by a combination of IPPs and EDG. Hydropower otherwise dominates the electricity mix, with around 60 per cent of installed capacity (IRENA, 2020c). IPPs supply more than 50 per cent of total electricity, and Guinea’s mines are major industrial sources of electricity demand.

Unfortunately, no detailed greenhouse gas emissions data related to electricity is available. However, considering the low absolute installed fossil fuel capacity, and given a population of over 10 million (World Bank, 2020), per capita emissions are likely to be comparatively low.

Guinea’s preferred technology for new power generation has traditionally been natural gas, due to hydropower’s seasonality, high investment costs and long lead times. However, the 2012 National Energy Policy and the newer Plan National de Développement Economique et Social prioritise reduced dependency on fossil fuels and increased hydropower generation. Guinea is now building two large hydropower projects with Chinese financial and technical support (Climatescope, 2019). As in most African countries, solar power also offers an attractive alternative to hydropower, with faster build times.

The financial weaknesses of the offtaker (EDG) – due to tariffs below cost-reflective levels – hinder the rapid development of renewable energy projects by IPPs (IDA, 2018). Moreover, Guinea scores 35 out of 100 in the World Bank RISE study, with particular room for improvement on renewable energy regulatory frameworks and energy efficiency.

The renewable energy targets in Guinea’s NDC include the development of 1,650 MW of hydropower, 47 MW of solar and 3 MW of biofuels by 2030. The NDC also mentions 40 ktoe of butane and biogas, although it does not specify the share for each source. Based on IRENA analysis, Guinea would need to commission an additional 1,700 MW of renewable electricity capacity compared to 2016 - amounting to 2,100 MW in 2030 – to meet the targets set in the NDC. To meet this target, renewable electricity capacity needs to grow at an average annual growth rate (CAGR) of 13 per cent through 2030.



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Sources: IEA (2019b), RISE (n.d.), Trimble et al (2016), IRENA (2020b), World Bank (n.d.)

Figure 50 – Snapshot of energy transition urgency in Morocco

Morocco

Whereas almost 100 per cent of Moroccan households have access to mostly reliable electricity, concerted efforts are needed to reduce carbon dependency in the power system. Morocco currently has around 7,259 MW of installed fossil fuel capacity (IRENA, 2020b), with more natural gas power plants in planning and under construction. However, Morocco is among the African countries with a relatively high share of installed renewable energy capacities and a long-term strategy for an energy transition towards a renewable-based power system.

Access to electricity

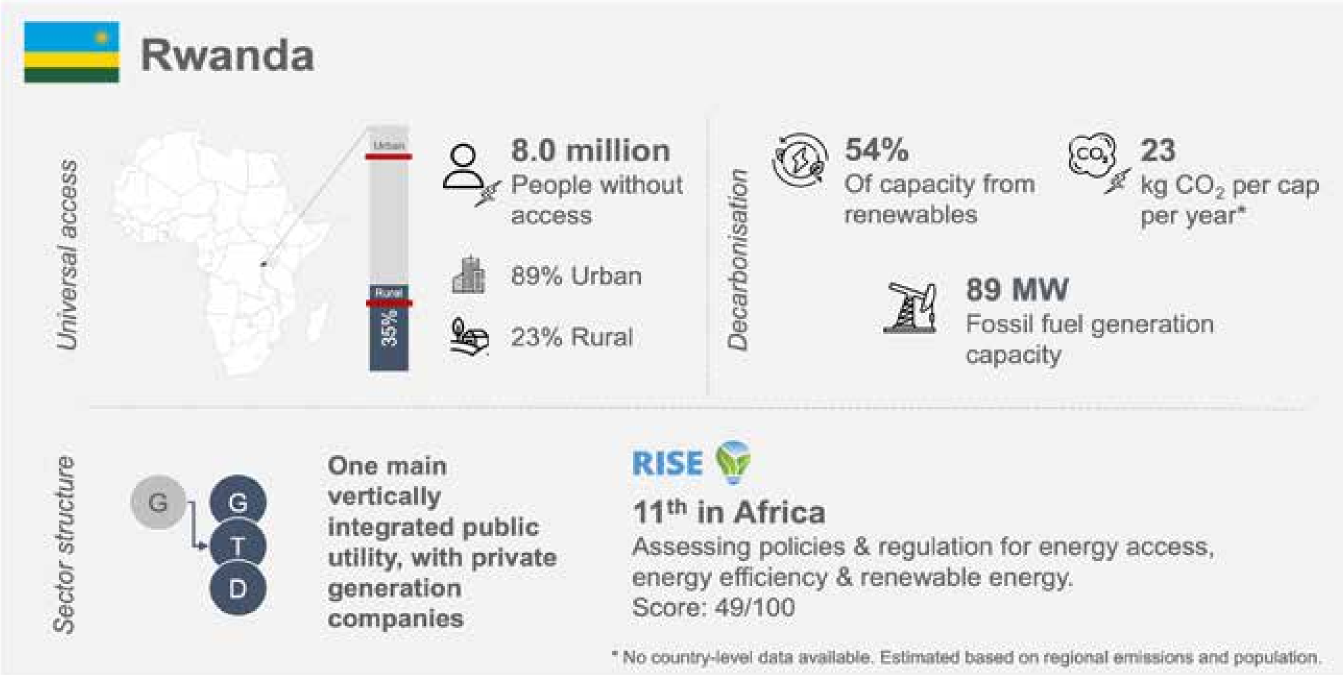
Morocco is one of the few countries in Africa to have achieved near-universal access to electricity, including in rural areas. Owing to a stable supply situation and a comparatively strong national grid, Morocco's security of supply is also good by regional standards.

Decarbonisation path

The share of renewables in Morocco´s generation mix has reached 30 per cent of installed capacity, mainly thanks to hydropower (1,306 MW), onshore wind energy (1,225 MW) and solar energy (530 MW CSP; 204 MW solar PV). Recent expansions of renewable generation capacity have been based on competitive bidding for utility-scale IPP projects. The Moroccan government's success in enabling private sector participation in renewable energy generation is further demonstrated by the fact that the country has received the fourth-best RISE score on the continent.

Still, the power sector is dependent on fossil fuel generation (4,700 GWh in 2018) and coal (26,900 GWh in 2018) (IRENA 2020b), and the national utility (ONEE) plans to add another 1,200 MW of natural gas capacity by 2030. Whereas the general framework conditions seem favourable for investments in renewable energy, and while acknowledging that natural gas can play a flexibility-provider role in integrating variable renewable energy into Morocco's power system, full decarbonisation by 2050 would require concerted efforts to decommission existing fossil fuel power plants, disincentivise the addition of new fossil fuel generation capacity and increase the uptake of renewables. In this context, the development of a green hydrogen industry is currently being explored, see box, p. 43.

Two current interconnections between the Moroccan and the Spanish grids have allowed Morocco to increase the amount of electricity it exports to Europe, from 8 GWh in 2017 to 1,207 GWh in 2019 (REE, 2020). Morocco has successfully attracted international public investments to support renewables particularly from the World Bank and European development banks. From 2000 to 2018, USD 5.1 billion were invested in Morocco (IRENA, 2020c), mostly in solar energy project, including CSP (USD 3.7 billion). The renewable energy targets in Morocco's NDC include reaching 52 per cent of renewable electricity installed capacity by 2030, of which 20 per cent will come from solar, 20 per cent from wind and 12 per cent from hydropower. Morocco's 2030 NDC targets are divided into unconditional and conditional, and IRENA (2019) estimates that about 5,200 MW of renewables will be added by 2030 if the conditional targets are implemented – that is, if the country receives international support.



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Sources: IEA (2019b), RISE (n.d.), Trimble et al (2016), IRENA (2020b), World Bank (n.d.)

Figure 51 – Snapshot of energy transition urgency in Rwanda

Rwanda

Around 35 per cent of the Rwandan population still does not have access to electricity, and a substantial share of the total installed generation capacity comes from fossil fuels. Rwanda faces the twin challenges of fostering access to electricity while ensuring renewables play a leading role in electricity sector expansion.

Access to electricity

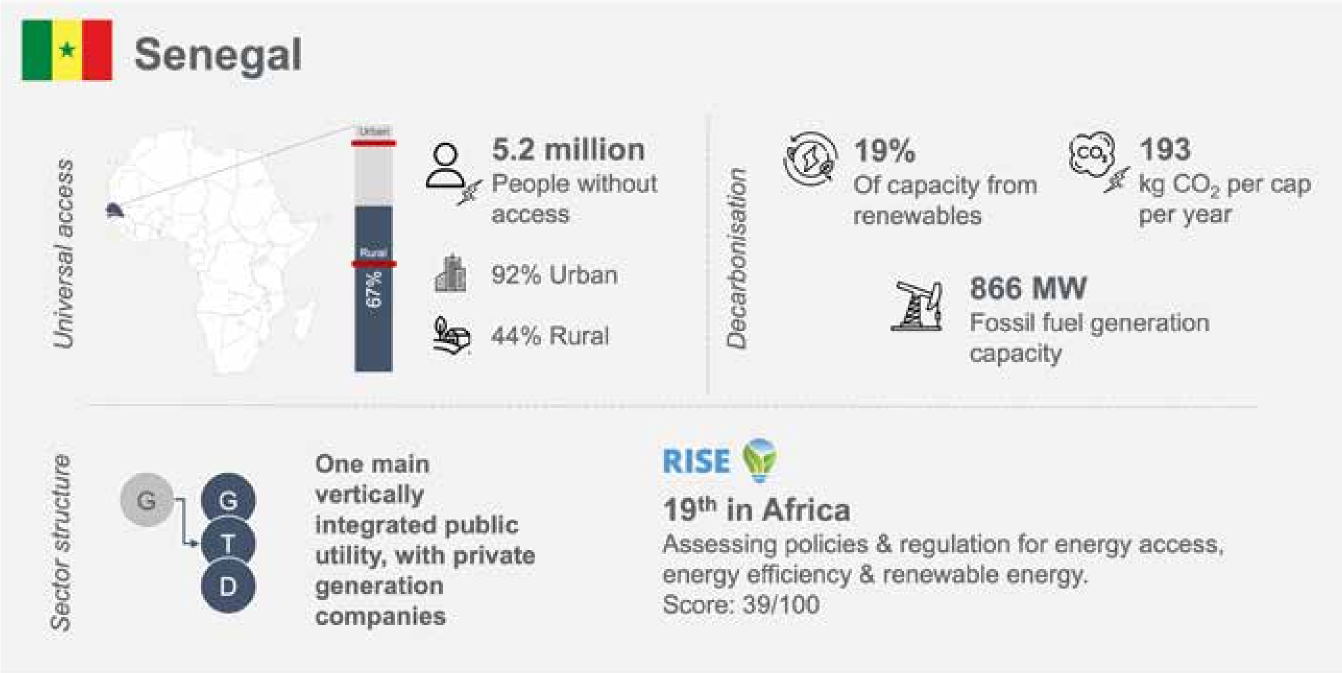
Rwanda has seen a rapid increase in its electricity access rate – from around 10 per cent in 2010 to around 35 per cent in 2018. Much of this success can be attributed to the Electricity Access Roll-out Program, which the government established in 2010 to finance and implement rural electrification projects. Even so, most rural households (77 per cent) remain without access to electricity.

Over the last ten years, outages have become shorter and much less frequent (World Bank, 2019b). End-user tariffs for electricity in Rwanda are among the highest on the continent and serve as a constraint on the country's economic and industrial development. While recent programmes have been successful in connecting more people and increasing security of supply, making universal energy access a reality by 2030 will require concerted efforts from both the government and development partners (Rwanda's Energy Sector Strategic Plan aims for universal energy access by 2024).

Decarbonisation path

Around 54 per cent of the installed capacity in Rwanda´s power system is renewable – mainly hydropower (IRENA 2020b). Many of these power plants are small, with capacities ranging from 0.1 to 12 MW. Rwanda ratified the Paris Agreement in October 2016 and submitted an updated NDC in May 2020. The renewable energy targets in Rwanda's NDC include the development of 156 MW of hydropower and 68 MWp of solar mini-grids by 2030. The NDC also mentions installing solar lights and solar thermal water heaters as well as increasing the use of solar water pumps for irrigation and increasing the coverage of off-grid solar and rooftop solar PV panels. Based on IRENA's analysis, these renewable energy targets would translate into a renewable electricity installed capacity of 333 MW by 2030. As a result, renewable installed capacity would have to grow at 11 per cent CAGR between 2020 and 2030 – well above the current rate of 6 per cent, registered over 2016-2019 (IRENA, 2020c).

Installed fossil fuel-based generation capacity mainly consists of diesel or heavy fuel oil, which is costly and polluting, although small in absolute terms. The government's ambitious generation expansion plans mainly include renewable energies such as hydropower, geothermal and solar. However, there are also plans to expand generation based on highly polluting peat-fired power and a general need to avoid additional investment in fossil fuel-based generation capacity as demand grows. Incentives may be required for early decommissioning of existing fossil fuel generation, seeing as 44 per cent of existing fossil capacity was commissioned from 2015 through 2019 and has an economic lifetime beyond 2050. Rwanda ranks 11th among all African countries in the RISE study.



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Sources: IEA (2019b), RISE (n.d.), Trimble et al (2016), IRENA (2020b), World Bank (n.d.)

Figure 52 – Snapshot of energy transition urgency in Senegal

Senegal

Senegal benefits from relatively high levels of electricity access and has a rapidly growing industrial base driving significant increases in electricity demand. The country has set ambitious renewable energy targets, and in recent years has emerged as one of the front runners for grid-connected renewables (mainly solar, but also wind) in West Africa.

Access to electricity

Currently, 67 per cent of people in Senegal have access to electricity, with near-universal access in urban areas (92 per cent). However, with a 44 per cent access rate in rural areas, around 5.2 million people in Senegal remain without access. The reliability of the power supply in urban areas has improved substantially in the past five years but remains a significant issue in rural areas (Financial Times, 2019).

Since 2008, the Senegalese government has followed a unique "two-pronged" concessionaire model for rural electrification. Private utility companies can apply for large-scale concessions under the Rural Electrification Priority Programme, while smaller, locally owned organisations can apply for small-scale concessions under the Local Initiative for Rural Electrification project, with significant state and donor subsidies on offer under both systems. The Senegalese Agency for Rural Electrification administers the issuing of concessions and associated subsidies.

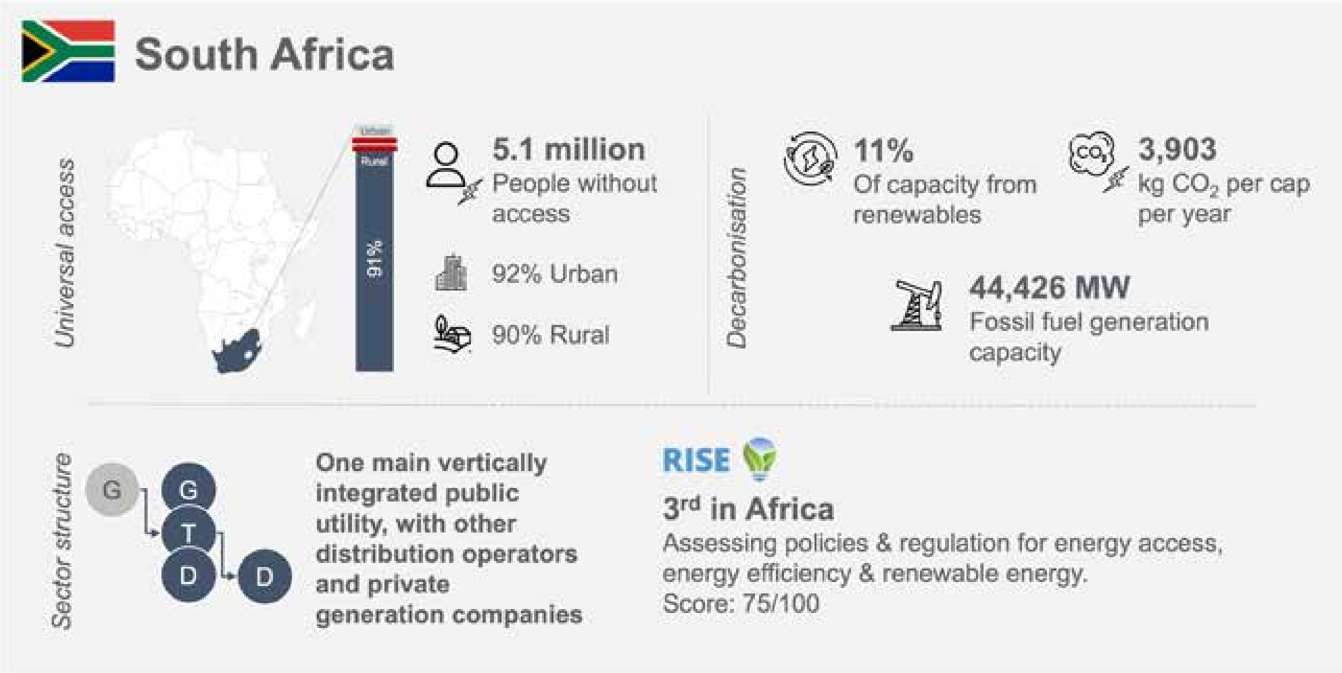
Solar home systems and mini-grids dominate decentralised renewable energy solutions in Senegal, benefitting 1.5 million people in 2018. Senegal has more mini-grid beneficiaries (78,000) than most other West African countries (ESMAP, 2019).

Decarbonisation path

Senegal relies heavily on fossil fuel generation, particularly from imported heavy fuel oil, which represents 80 per cent of the current capacity mix. The renewable energy targets in Senegal's NDC include developing 360 MW of solar PV, 350 MW of wind, 199 MW of hydropower, 165 MW of biomass and 55 MW of CSP, as well as 5,392 solar mini-grids and 73,500 biodigesters.

The following projects have brought Senegal closer to its renewable energy targets: (i) 100 MW of IPP solar power plants, developed both privately and under the World Bank Scaling Solar programme, as well as (ii) West Africa's largest wind farm (158MW) and (iii) hydroelectric power imports via the WAPP. From 2016 to 2019, fossil fuels grew by 41 MW, while renewables grew by 141 MW. In addition, electricity generation from renewables more than tripled in 2018, as compared to 2016, while electricity generation from fossil fuels remained more or less the same (IRENA, 2020c). These achievements will have to be supported with further action if the country is to pursue a sustained low-carbon development path – not least in light of the fact that Senegal is planning to begin production from offshore oil fields in 2022.

Based on IRENA's analysis, meeting these renewable energy targets would result in an additional 1,400 MW of renewables, bringing Senegal's installed capacity up to 1,500 MW in 2030. In other words, by implementing the NDC targets, renewable installed capacity in Senegal is expected to grow at an average annual rate (CAGR) of 24 per cent through 2030. This is well below the 45 per cent growth rate recorded from 2016 to 2019. Senegal scores in the lower 50 per cent of countries ranked in the RISE study. Making these goals a reality will therefore require improving the enabling framework.



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Sources: IEA (2019b), RISE (n.d.), Trimble et al (2016), IRENA (2020b), World Bank (n.d.)

Figure 53 – Snapshot of energy transition urgency in South Africa

South Africa

While electrification rates in South Africa are high, the country faces considerable challenges in terms of security of supply. Furthermore, South Africa has among the highest installed fossil fuel capacities of any African country. Major efforts are underway to build out new renewable energy capacity, driven mainly by IPPs.

Access to electricity

Nearly all South Africans (91 per cent) have access to electricity, but quality and security of supply remain major challenges. Generation deficits of up to 6,000 MW were recorded in 2019, partly due to outages among the aging fleet of coal-fired power stations owned and operated by the public utility (Eskom). The South African Council for Scientific and Industrial Research estimates that the resulting outages reduced GDP by USD 6 billion (Bloomberg, 2020). Eskom's financial sustainability is suffering from tariffs below cost-reflective levels as well as municipal distribution companies in arrears. The utility has taken on high levels of debt (around USD 30 billion in 2019), which makes it difficult to finance required investments and maintenance, further weakening security of supply. As such, there is an urgent need to intervene when it comes to the reliability of energy supply if South Africans are to have sufficient, reliable electricity access by 2030.

Decarbonisation path

South Africa's reliance on fossil fuel generation sources (including 36,500 MW of coal power) means that emissions from the power sector in 2017 were higher than those in Germany. On top of this, Eskom has two coal-fired power stations under construction (Medupi and Kusile), with a combined future installed capacity of around 9,600 MW.

At the same time, South Africa has so far been the continent's biggest market for renewable energy IPPs, mainly due to the Renewable Energy Independent Power Producer Procurement Programme (REIPPPP). Since 2011, the REIPP has awarded 112 IPP Projects in 5 tender rounds with two more rounds to come. South Africa has established itself as a leader in terms of policies and regulations for energy efficiency and renewable energy, gaining the third-highest RISE score on the continent.

In July 2020, South Africa had 1,980 MW of installed wind capacity across 22 projects, with 12 projects under construction. At the end of 2019, 1,474 MW of solar PV were also in place.

The renewable energy target in South Africa's NDC includes the development of 11,500 MW of new capacity. However, in 2019, the country updated its Integrated Resource Plan for Electricity, setting a goal of 39.7 per cent of renewable electricity generation by 2030. This is to be achieved by installing 17,700 MW of wind, 8,300 MW of solar PV, 4,600 MW of hydropower and 600 MW of CSP (Engineering News, 2020). Based on projections included in the IRP, renewable installed capacity should reach 37.3 GW in 2030, up from 6.1 GW installed at the end of 2018. Hence, the country's renewable installed capacity is expected to grow at a CAGR of 16 per cent through 2030, well above the 2 per cent annual growth rate recorded in the last year (IRENA, 2020c). As of the end of 2019, the total renewable installed capacity had reached 6,200 GW (IRENA, 2020c).

While improved framework conditions for renewable energy and energy efficiency are driving the establishment of a renewable energies market, decommissioning almost 45,000 MW of fossil fuel capacity by 2050 is an enormous challenge. Incentives for decarbonisation and further efforts to increase the share of renewable energy are required to achieve this target.

Note on sector structure: G – Generation; T – Transmission; D – Distribution. Blue (grey) circles indicate public (private) ownership.
Sources: IEA (2019b), RISE (n.d.), Trimble et al (2016), IRENA (2020b), World Bank (n.d.)

Figure 54 – Snapshot of energy transition urgency in Togo

Togo

Togo's urban centres benefit from near-universal access but much work remains to be done in rural areas, where 78 per cent of the population remains without access to electricity. Electricity imports from neighbouring countries meet most domestic electricity demand, and installed fossil fuel generation capacity is small.

Access to electricity
Urban access rates in Togo – especially in the capital, Lomé – have leapt to near-universal levels since the early 2000s, although supply is often unreliable. The rural supply situation remains patchy however, and only around 22 per cent of the rural population has access. In total, 3.8 million people in Togo remain without access to electricity.

Togo has a national strategy for achieving universal electricity access by 2030 and is developing a new legal framework to promote both renewable energy and off-grid rural electrification (USAID, 2020d). The aim is to pave the way for a large increase in public and private investment in electrification.

Decarbonisation path
Most electricity consumption in Togo is met with power imports via interconnectors between Ghana, Nigeria and Côte d'Ivoire, which are on the rise (World Bank, 2017b). Unusually, Togo has a bi-partite transmission utility called CEB, which it shares with Benin. CEB operates a regional high-voltage network and sells energy to Compagnie Energie Electrique du Togo.

Consequently, the installed generation capacity – both fossil fuel (158 MW) and renewable (67 MW of hydropower and 3 MW of solar PV) – is relatively small (IRENA 2020b), resulting in the lowest per capita greenhouse gas emissions from the electricity sector among the CwA countries (3 kilos per person per year). IPPs and the national utility company (CEET) own the means of generation.

Between 2015 and 2019, the country added only 1 MW of renewable energy capacity, leaving 207 MW to be installed over the next decade if Togo is to meet the capacity projections in the 2015 Plan d'Actions National des Énergies Renouvelables. Based on this plan, renewable energy installed capacity is expected to grow at a (CAGR of 10 per cent over the next decade – well above the 0.4 per cent recorded between 2015 and 2019 (IRENA, 2020b).

To improve national energy security and attract private investment, Togo has established a new regulatory body, passed a public-private partnerships law and a public procurement decree, and established an agency to promote rural electrification. Togo is also a member of the IFC Scaling Solar Program, with the aim of developing 90 MW of solar PV power and recently launched a tender for 80 MW of new solar generation capacity (Scaling Solar, n.d.). To date, a 30 MW project has been approved for a site in Blitta, in the centre of the country (PV Magazine, 2019a). Due to reasonably high levels of energy access and recent regulatory reforms, Togo scores in the mid-level of the RISE rankings (18th on the African continent).

Note on sector structure: G – Generation; T – Transmission; D – Distribution. Blue (grey) circles indicate public (private) ownership.
Sources: IEA (2019b), RISE (n.d.), Trimble et al (2016), IRENA (2020b), World Bank (n.d.)

Figure 55 – Snapshot of energy transition urgency in Tunisia

Tunisia

Tunisia benefits from universal access to electricity, albeit with some weaknesses in the grid. However, the country´s heavy reliance on fossil fuels for electricity generation means that per capita emissions are high compared to other African countries.

Access to electricity
Tunisia is a middle-income country with effectively universal access to electricity. According to the World Bank's Global Electrification Database, only around 25,000 people do not have access to electricity, and most of them live in remote mountainous areas. Grid outages are reportedly mainly due to maintenance, overload and high voltage drops.

Decarbonisation path
Tunisia is the third-largest emitter among the 13 countries assessed, with approximately 762 kilos of electricity-related CO_2 emitted per capita every year. Only 6 per cent of installed capacity (373 MW) comes from renewables (IRENA 2020b). Installed fossil fuel generation capacity comprises 4,800 MW of natural gas (imported) and 800 MW of coal, with most production controlled by the vertically integrated state-owned utility, STEG.

However, due to regional instability and the accompanying risks to the gas supply, the Tunisian government is highly focused on increasing national energy security and renewable generation. Tunisia's NDC includes a target of 30 per cent renewable electricity generation by 2030, which is in line with the national Plan Solaire Tunisien (PST). This is to be achieved through the development of 3,815 MW of renewables, including 1,755 MW of wind power, 1,510 MW of grid-connected solar PV, 450 MW of concentrated solar power and 100 MW of biomass power. A recently concluded tender for solar concessions resulted in 500 MW being awarded to IPPs at very low prices (USD 0.25/kWh) (PV Magazine, 2019b).

On this basis, the country's renewable installed capacity is expected to grow at an average annual rate (CAGR) of 19 per cent through 2030, well above the 2 per cent CAGR recorded from 2016 to 2019 (IRENA, 2019a; IRENA, 2020b).

Based on the RISE scores, Tunisia is leading the African continent in policy and regulation around energy access, energy efficiency and renewable energy – indicating a generally favourable environment for renewables and for private investments. Despite this high score, Tunisia has no independent regulatory authority.

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Publisher / Author
KfW Development Bank
Palmengartenstraße 5-9
60325 Frankfurt am Main
Phone +49 69 7431-0
Fax +49 697431-2944
KC-Energie@kfw.de
www.kfw.de

Deutsche Gesellschaft für
Internationale Zusammenarbeit (GIZ) GmbH
Dag-Hammarskjöld-Weg 1-5
65760 Eschborn
Phone +49 61 96 79-0
Fax +49 61 96 79-11 15
info@giz.de
www.giz.de

IRENA
Masdar City
P.O. Box 236, Abu Dhabi
United Arab Emirates
Phone +97 124179000
info@irena.org
www.irena.org

Editorial office
Alissa Jones Nelson, KfW Development Bank

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KfW Development Bank
Palmengartenstraße 5-9
60325 Frankfurt am Main
Phone +49 69 7431-0
Fax +49 697431-2944
KC-Energie@kfw.de
www.kfw.de

Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH
Dag-Hammarskjöld-Weg 1-5
65760 Eschborn
Phone +49 61 96 79-0
info@giz.de
www.giz.de

IRENA
Masdar City
P.O. Box 236, Abu Dhabi
United Arab Emirates
Phone +97 124179000
info@irena.org
www.irena.org