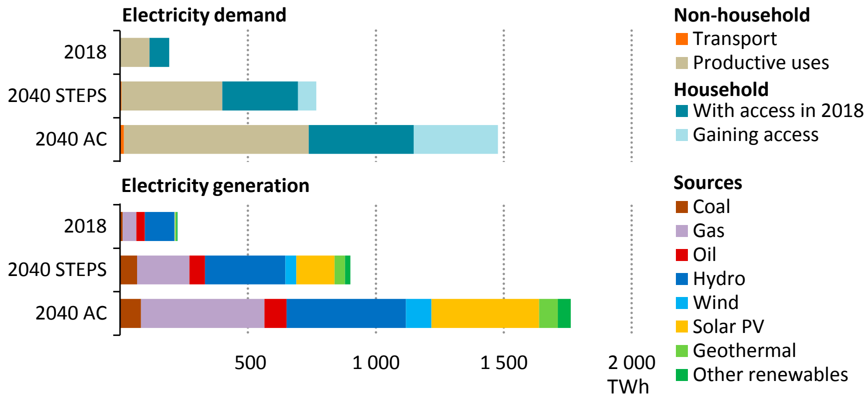
Access to electricity and reliable power

Generating a brighter future for Africa

S U M M A R Y

- Today, 600 million people in sub-Saharan Africa (one-out-of-two people) do not have access to electricity, according to our latest country-by-country assessment. A number of countries make important headway in the Stated Policies Scenario, with South Africa, Ethiopia, Ghana, Kenya, Rwanda and Senegal reaching full access by 2030. This allows around 20 million people to gain access every year. Yet progress is uneven: 530 million people (one-out-of-three people) remain without electricity in 2030. Annual gains in access would need to triple to reach universal access by 2030.
- South Africa differs from its sub-Saharan African peers with its mature economy, successful access programmes and integrated policy making. Competitive auctions for renewables are stimulating private investment. The financial health of the state-owned utility remains vulnerable, strengthening its commercial and operational performance is essential to the future well-being of the power sector.

Figure 10.1 ▷ Electricity demand and generation in sub-Saharan Africa (excluding South Africa) **by scenario, 2018 and 2040**



Demand quadruples by 2040 in the Stated Policies Scenario and increases almost eightfold in the Africa Case, renewables and gas rise to meet demand growth

Note: STEPS = Stated Policies Scenario; AC = Africa Case.

- Electricity demand in the rest of sub-Saharan Africa is set to quadruple by 2040, driven by rising incomes and industrialisation. However, per capita demand remains low, at less than 15% of today's global average. Accelerated economic development and universal access to electricity in the Africa Case push demand to almost 1 500 terawatt-hours (TWh) by 2040, with households in urban areas approaching the ownership and consumption levels of middle-income countries.

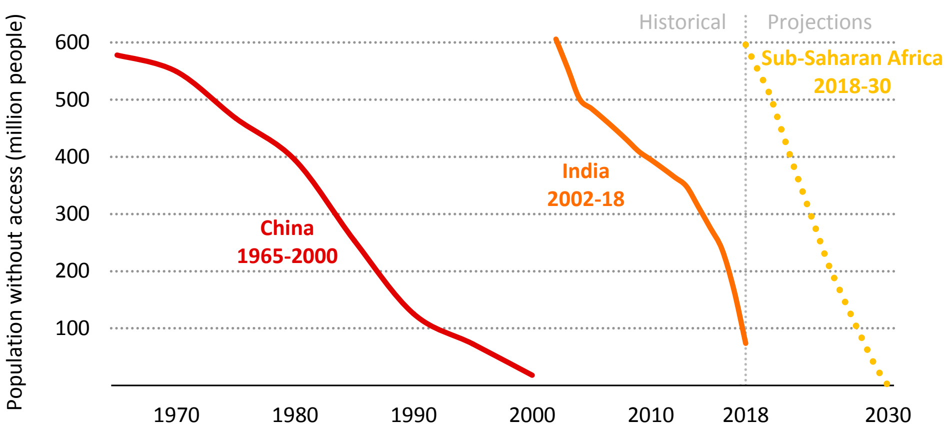
- Keeping pace with soaring needs, electricity supply in the rest of sub-Saharan Africa increases fourfold in the Stated Policies Scenario. Generation capacity triples to 270 gigawatts (GW) by 2040, but this is far short of the 600 GW reached in the Africa Case. The expansion is achieved through a combination of renewables and natural gas. Solar photovoltaics (PV) plays a key role in delivering access and becomes the largest source in terms of installed capacity in the mid-2030s in the Stated Policies Scenario, and in the mid-2020's in the Africa Case, overtaking hydropower.
- While hydropower generation grows in both scenarios, new detailed analysis on its vulnerability to climate change shows increased variability of outputs and the need to plan for long-term resilience with a diverse power mix and regional co-operation.
- The expansion of generation capacity is not sufficient to provide reliable and affordable electricity. Around 80% of sub-Saharan African businesses recently suffered from electricity disruptions, leading to average annual losses of around 8% of sales. Sustaining economic growth of 7.3% per year in the Africa Case requires continuous focus on transmission and distribution assets to reduce the incidence of power outages by over three-quarters and take network losses to below 10% (from 18% today) improving economic outcomes for companies, including power utilities.
- Focus on improved network management, densification and extensions see the grid provide about 70% of the 230 million new connections expected by 2030 in the Stated Policies Scenario. In the Africa Case, mini-grids and stand-alone systems, mostly based on renewables, are essential to bridge the gap to achieve universal access; they are the least-cost solutions for over two-thirds of the additional people that attain access, connecting almost 450 million people by 2030 in the Africa Case.
- Investment in the power sector in sub-Saharan Africa averages more than $45 billion per year over the outlook period in the Stated Policies Scenario (compared to $21 billion today). The Africa Case requires a fivefold increase to ensure reliable and affordable power for all (over $100 billion per year). In both scenarios, half of the total investment goes to expansion, reinforcement and maintenance of grids, increasingly for mini-grids and cross-border infrastructure. Investment in low-carbon generation accelerates, driven by a rise in spending on solar PV projects, which reaches almost $25 billion per year on average in the Africa Case.
- Most power sector investment in Africa today is underpinned by public funds, with heavy reliance on international development finance. Given the financial constraints of utilities and limited fiscal capacity of governments, private sources of finance will be essential to bridge investment gaps. Policy and regulatory improvements are needed to address investment risks, facilitate a more effective use of public funds and help reduce the cost of capital. Four areas are crucial to foster a more self-sustaining environment for investment: better financial performance of utilities; improvements in procurement frameworks; more sustainable business models for the decentralised sector; and strengthened provision of long-term finance.

10.1 Introduction

The achievement of universal access to reliable electricity is vital if Africa is to thrive, and that means providing access for the first time to the 600 million people currently deprived of electricity, electrifying schools and hospitals, and ensuring that electricity is available for companies and entrepreneurs. China and India faced similar challenges and it took them 35 and 16 years respectively to reach a 95% access level and to connect as many people as now need to be connected in sub-Saharan Africa (Figure 10.2). More decentralised and modular technologies are now available and they are reducing the length of time it takes to provide access and the costs of doing so.

The regional and country-by-country projections for the Stated Policies Scenario and the Africa Case are described in this chapter. We analyse the electricity demand and supply outlook and their drivers, the changing electricity generation mix by technology and access solution, and the implications for affordability, reliability and investment needs.

Figure 10.2 ▷ Reaching universal access to electricity in sub-Saharan Africa compared with achievements in China and India



Achieving access for all in sub-Saharan Africa in only twelve years will require an unprecedented effort

An increasing number of countries are implementing policies with a view to meet the United Nations Sustainable Development Goal 7[1] by 2030, resulting in substantial progress in the Stated Policies Scenario. New technologies and business models are attracting investment from donors, development banks and increasingly the private sector. Nonetheless, without a significant step up in efforts, the population without access to electricity will remain as high as 530 million in 2030 in sub-Saharan Africa.

[1] Sustainable Development Goal 7: Ensure access to affordable, reliable, sustainable and modern energy for all.

In the Africa Case, we examine by country, and for sub-Saharan Africa as a whole, the range of technologies, policies and investment frameworks needed to achieve the universal electricity access target. Our least-cost analysis points to the best way forward as being comprehensive policies that make use of all solutions, centralised and decentralised, with mini-grids and stand-alone systems providing power to more than half of the population gaining access by 2030.

We go beyond looking at the achievement of universal access and also examine what it would take to develop a reliable, affordable and sustainable power system capable of making the African Union's Agenda 2063 a reality (see Part B introduction, Box B.2). Reliable electricity is an essential element of a thriving economy, and Africa has the opportunity to be the first continent to industrialise and build resilient and reliable power systems based on cleaner sources, with a combination of readily available renewables and natural gas now looking like the most competitive way to provide electricity.

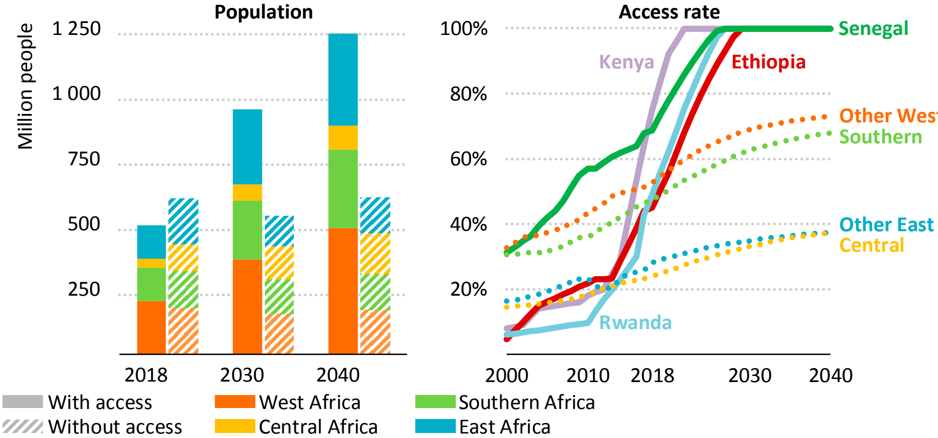
10.2 Outlook for electricity access

While more than 99% of the population in North Africa has access to electricity, the situation is very different in the rest of the continent. In the Stated Policies Scenario, the number of people without access to electricity across sub-Saharan Africa declines slightly to 530 million by 2030, but increases after that to 600 million as rapid population growth outruns efforts to increase access (Figure 10.3). Many countries on the continent are putting in place policies which, if effectively implemented, will allow around 20 million people to gain access to electricity each year by 2030, a rate similar to what the region has witnessed since 2013 (see Chapter 8).[2] However, the rate is less than a third of what would be needed to reach full access by 2030. The share of the population with access to electricity in sub-Saharan Africa rises from 45% today to nearly 65% in 2030 in the Stated Policies Scenario, with over 230 million people gaining access.

Projected progress in the Stated Policies Scenario is most rapid in East Africa, as it moves from a regional access rate of 43% today to more than 70% by 2030. Kenya, Ethiopia and Rwanda are all set to achieve universal access before 2030 (Table 10.1). Ethiopia brings access to the highest number of people in the region by 2030 (more than 70 million). Tanzania also sees rapid progress, with its electrification rate climbing to around 70% in 2030 from less than 40% in 2018. Progress is also made in West Africa and Southern Africa, where the regional access rates reach over 60% by 2030. South Africa and Ghana, which achieved two of the highest access rates on the continent in 2018 after two decades of effective government leadership, are expected to reach full electrification by 2030. Senegal is expected to achieve universal access in 2025. Strong efforts in Nigeria and Côte d'Ivoire result in their rates of access increasing to 80% and more than 90% respectively by 2030. Countries across Central Africa see limited progress under the Stated Policies Scenario, but there are some bright spots: Gabon and Cameroon both reach more than 90% by 2030.

[2] The investment and financing implications are discussed in sections 10.7 to 10.8.

Figure 10.3 ▷ Electricity access progress in sub-Saharan Africa in the Stated Policies Scenario



Strong policy support is instrumental to drive the rapid increase in access rates observed in several countries, but many struggle to provide access to increasing populations

Table 10.1 ▷ Electricity access policies and targets in selected countries

Country	Target	Implementation measures
Kenya	Full access by 2022	Kenya National Electrification Strategy (2018): investment of $2.8 billion from 2018-22. Kenya Off-grid Solar Access Project: distribute 250 000 solar home systems to power households, schools, health facilities and agriculture by 2030.
Ethiopia	Full access by 2025	Electrification Program (2017): geospatial least-cost roll-out plans, fast-paced extension of the grid to reach 65% of the population with the grid and 35% with decentralised systems by 2025; public-private off-grid programme for 6 million households.
Rwanda	Full access by 2024	Energy Sector Strategic Plan and Rural Electrification Strategy: connect 52% households to the grid and 48% to decentralised systems by 2024; connect all productive users; cut by half the duration and number of interruptions; introduction of appliance efficiency standards.
Senegal	Full access by 2025	National Rural Electrification Program (PNER), aiming to electrify 95% of rural clients through grid extension, 4% through solar only or solar-diesel hybrid mini-grids, and the rest through solar home systems.
Côte d'Ivoire	Connect all areas by 2025	Programme Electricité pour Tous: electrify 1 million households. Programme National d'Electrification Rurale: connect all towns above 500 inhabitants by 2020, and all areas by 2025. Tariff reductions for poor households.

Despite this impressive projected progress in a number of countries, around 20 countries, accounting for 30% of the population of sub-Saharan Africa in 2030, still have less than half of their population with access to electricity in 2030 on the basis of current and stated policies. Across sub-Saharan Africa, 36% of the population have no access to electricity in 2030, of which three-quarters, or more than 400 million people, live in rural areas.

Achieving full access by 2030 would require tripling the current rate of annual connections to reach over 60 million people on average each year. This would mean finding ways to connect people living "under the grid" but lacking access (see Spotlight in Chapter 8, section 8.2.2). It would also mean accelerating the deployment of mini-grids and stand-alone systems, which are the least-cost way to provide power to more than half of the population gaining access by 2030 (see section 10.4.2). In 2030, around 50% of the population without access in the Stated Policies Scenario live in the Democratic Republic of the Congo (DR Congo), Nigeria, Uganda, Niger, and Sudan: scaling up efforts in these countries is particularly important.

Delivering access to electricity in an integrated way would support economic growth and overall development. Access could bring new sources of productive employment to remote populations, in particular for women. Less time to complete domestic chores provides more time for paid jobs. Access to electricity also benefits women-owned businesses, helping women to move from extreme poverty to near middle-class status, as shown within areas connected by a mini-grid company in Ghana (Power Africa, 2019). A recent study shows that the decentralised renewables sector is beginning to support employment at a similar scale to the traditional utility sector, with strong potential for future growth (Power for All, 2019).

10.3 Outlook for electricity demand

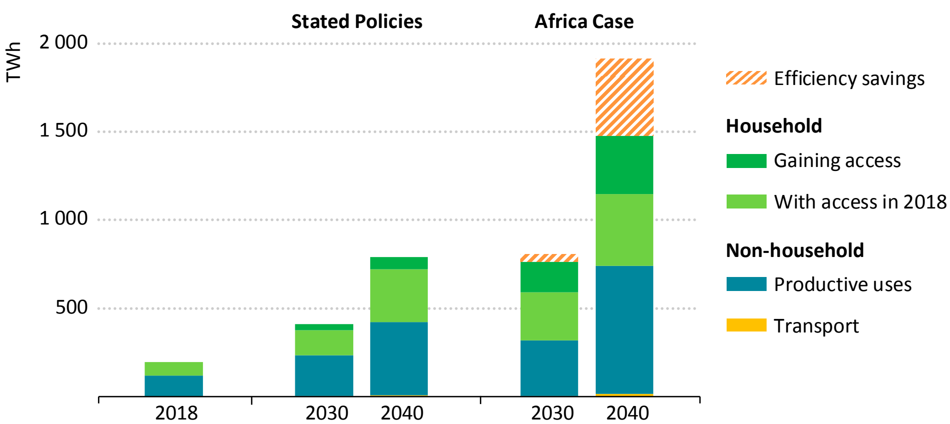
Electricity demand[3] in Africa today is 700 terawatt-hours (TWh), with South Africa and the North African countries accounting for over 500 TWh of this total. Yet it is the sub-Saharan Africa countries (excluding South Africa) that see the fastest growth in electricity demand in the Stated Policies Scenario, with demand increasing at an average annual rate of 6.5%, the highest rate of any region worldwide. By 2040, electricity demand in sub-Saharan Africa, excluding South Africa, reaches 770 TWh under current and stated policies, four-times today's level. Electricity demand per capita increases from an average of 185 kilowatt-hours (kWh) today to over 430 kWh in 2040, but still represents less than 15% of today's global average of over 3 000 kWh.

Low per capita electricity demand masks large inequalities that seem likely to persist. About 440 million people across sub-Saharan Africa (excluding South Africa) live in households that have access to electricity today, predominantly in urban areas. In the Stated Policies Scenario, households with access today and new ones in areas with existing

[3] Electricity demand is defined as total gross electricity generated less own use generation, plus net trade (imports less exports), less transmission and distribution losses.

access to electricity consume an additional 220 TWh by 2040. This compares to an increase of only 70 TWh in order to provide access to electricity for the first time to 320 million people in this scenario. Growth in electricity demand from an emerging middle-class and newly connected households goes hand-in-hand with growth in demand from the productive sectors of the economies (Figure 10.4). Demand from industry and the services sectors more than triples to 390 TWh by 2040 in the Stated Policies Scenario, fuelled by domestic consumption and economic growth. Electricity demand from agriculture increases by 150%, but still accounts for only 6 TWh in 2040.

Figure 10.4 ▷ Electricity demand by scenario in sub-Saharan Africa (excluding South Africa)



Demand quadruples by 2040 in the Stated Policies Scenario and increases almost eightfold in the Africa Case. Demand would be even higher without efficiency savings.

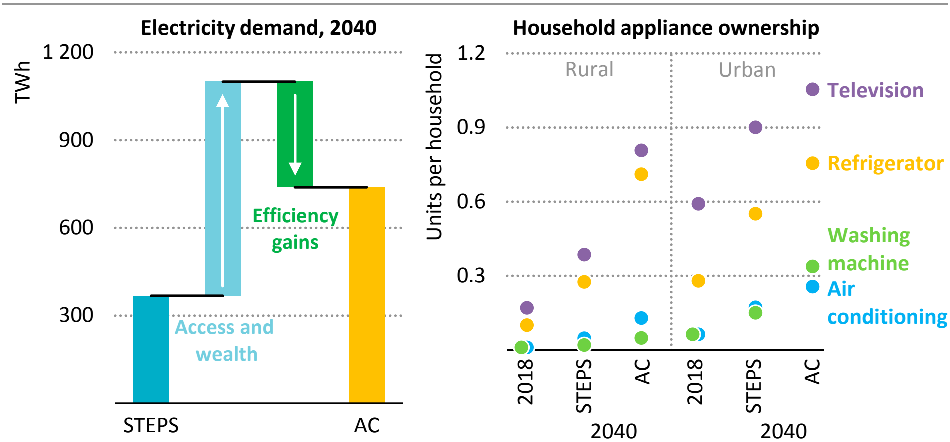
The Africa Case sees national strategic plans and the Agenda 2063 ambitions realised in full, with important implications for electricity demand. A virtuous cycle emerges in which electricity demand growth is fuelled by the development of local industries and services, increasing employment and incomes, and this in turn increases the consumption of locally produced goods and services. Electricity demand in the Africa Case grows at close to 10% per year to reach almost 1 500 TWh in 2040. Extension of electricity access to all households in the Africa Case adds 260 TWh of demand relative to the Stated Policies Scenario by 2040. Nonetheless, achieving universal electricity access still accounts for only a quarter of demand growth to 2040.

The electricity demand growth rate in sub-Saharan Africa (excluding South Africa) would reach 11% per year in the Africa Case without efficiency improvements in appliances and equipment. Energy efficiency measures are essential to achieve the vision of the Africa Case, helping to improve the competitiveness of local industries and reduce the impact of increases in energy services on electricity bills (see section 10.6). A handful of countries in sub-Saharan Africa are already leaders in energy efficiency when it comes to the residential appliances that accompany decentralised models of electricity access. Extending innovations of this kind to the wider appliance market is central to the savings achieved in the Africa Case.

10.3.1 Electricity demand growth by sector

The residential sector is the largest contributor to electricity demand growth, accounting for some 50% of the growth to 2040 in sub-Saharan Africa (excluding South Africa) in both the Stated Policies Scenario and Africa Case (Figure 10.5). As income levels increase across Africa, households increasingly own appliances such as refrigerators, washing machines and phones: the wealthier ones also own cooling devices. Domestic appliances are the biggest contributor to growth in residential electricity demand in the Stated Policies Scenario, adding 175 TWh to demand by 2040. Space cooling adds another 40 TWh, with the number of air conditioners across the region expected to increase almost sixfold to about 45 million by 2040. In the Africa Case, universal access to electricity is achieved by 2030 and household incomes rise more rapidly. As a result, residential electricity demand is 370 TWh higher in 2040 relative to the Stated Policies Scenario, with the increase equally split between rural and urban areas.

Figure 10.5 ▷ Residential electricity demand and household appliance ownership by scenario in sub-Saharan Africa
(excluding South Africa)



In the Africa Case, an increase in residential demand stemming from better access to electricity and increased ownership of appliances is partially offset by efficiency gains

Notes: STEPS = Stated Policies Scenario; AC = Africa Case. Access and wealth refers to the increase in demand associated with higher electricity access and higher average household incomes in the Africa Case relative to the Stated Policies Scenario. Efficiency gains refers to the reduction in electricity demand due to efficiency gains in the Africa Case relative to the Stated Policies Scenario.

By 2040, the urban population in sub-Saharan Africa (excluding South Africa) more than doubles to over 900 million, and average incomes in urban households increase by close to 40%, driving up appliance ownership rates. In the Stated Policies Scenario, on average 90% of urban households own a television and 55% a refrigerator by 2040. Ownership of air conditioners triples by 2040, but even in urban areas air conditioner ownership rates remain among the lowest in the world, despite the hot climate in many areas (see Chapter 9). Average urban household incomes are more than twice as high in the Africa Case relative to the Stated Policies Scenario, which leads to urban households purchasing more appliances, and electricity demand in urban areas increases at 10% per year, compared with 7.4% in the Stated Policies Scenario. More people own air conditioners in the Africa Case, but two-thirds of urban households remain without in 2040.

In the Africa Case, universal access to electricity in rural areas of sub-Saharan Africa (excluding South Africa) results in an additional 210 TWh of electricity demand by 2040. Rural households also benefit from higher levels of appliance ownership, roughly doubling the average number of televisions, refrigerators and washing machines in the Africa Case relative to the Stated Policies Scenario. Rural ownership of air conditioners remains uncommon. The impact of universal access and higher incomes is enough to see average per capita consumption in rural areas increase ten-fold to 320 kWh in the Africa Case, compared to only 100 kWh in the Stated Policies Scenario.

The services sector benefits from increasing electrification which contributes to economic growth. Electrification of the services sector is often a by-product of household electrification efforts, but it can also be an objective in itself: in Rwanda, the Energy Sector Strategic Plan announced in 2018 aims to bring electricity access by 2024 to all public infrastructure, schools, health facilities, small businesses and administrative offices, in addition to households. In the Stated Policies Scenario, electricity demand from the services sector reaches 170 TWh in sub-Saharan Africa (excluding South Africa) by 2040, with the majority of growth stemming from demand for cooling and appliances. Achievement of the electrification and economic growth targets in the Africa Case sees demand from the sector increase by a further 170 TWh.

Industry contributes to around 30% of the growth in electricity demand to 2040 in the Stated Policies Scenario. Electricity demand from industry increases at an annual average of 6%, which is a third faster than the rate of growth of total industry sector energy demand. Much of the growth comes from the use of electric motors in processing, manufacturing and other light industries. The Africa Case sees a step up in the rate of electricity demand growth in industry to 7.5%, driven by the modernisation of industry and increasing domestic demand for locally produced goods as well as expanding exports. Improvements in industrial energy efficiency in the Africa Case temper demand growth as well as helping to improve the competitiveness of industry. By 2040, electricity demand from industry exceeds 340 TWh, 100 TWh higher than the Stated Policies Scenario.

The agricultural sector sees increasing electricity demand for irrigation (some of it met through the use of stand-alone solar photovoltaic [PV] powered pumping systems) and for cooling (to support refrigerated storage of produce). The expansion of irrigation and cooling leads to important productivity gains,[4] and these bring further increases in electricity demand. Electricity demand for agriculture increases from about 3 TWh today to over 6 TWh in the Stated Policies Scenario, while in the Africa Case it rises to 36 TWh as a result of a larger increase in value added in the sector and a bigger shift from other sources of energy to electricity.

The electrification of transport struggles to get started in the Stated Policies Scenario: there are very few policies that support electric vehicles (EVs) (cars, buses, trucks and two/three-wheelers) and electricity accounts for only 0.5% of transport energy demand by 2040. Progress is faster in the Africa Case, but electricity still powers less than 1% of cars by 2040, together with around 18% of two/three-wheelers. By 2040, electricity demand for transport reaches 15 TWh in the Africa Case: this is almost triple the level in the Stated Policies Scenario.

The limited electrification of transport even in the Africa Case is a result of the size of the power requirements for EV charging, relative to other uses. Designing the extension of electricity access with the electrification of transport in mind would significantly increase the costs of achieving universal access. Concerns over the reliability of electricity supply and the costs of EVs also hinder their uptake. Conditions for the electrification of transport are more favourable in urban areas with existing grid connections: as a result, the majority of EV uptake in Africa is concentrated in cities, with almost 30% of the urban two/three-wheeler fleet electrified by 2040.

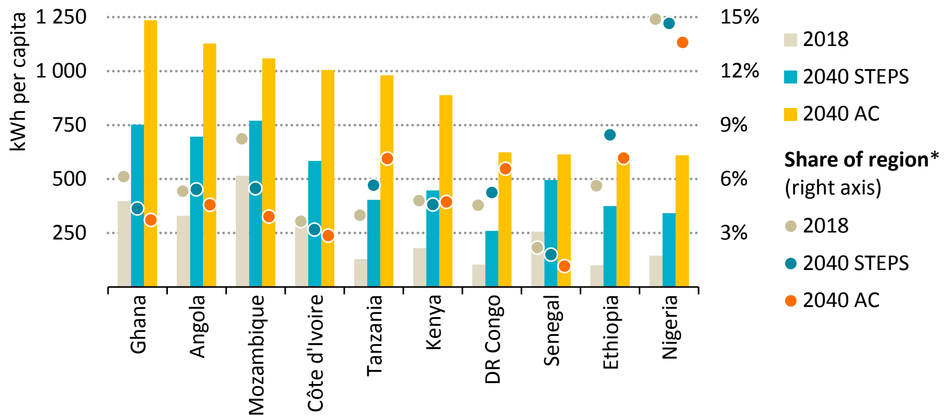
10.3.2 Electricity demand growth by region

The evolution of electricity demand is far from homogenous across African countries; it ranges from 4.5% to 8.5% per year through to 2040 in the Stated Policies Scenario, reflecting disparities in economic developments and the rate of progress in improving electricity access. Kenya, Ghana and Ethiopia all reach universal access to electricity before 2030, raising average per capita electricity demand to 450 kWh, 750 kWh and 375 kWh respectively in 2040. Per capita electricity demand growth is more limited in countries with lower average incomes today, and in those that experience the fastest population growth or make slower progress on electricity access, such as DR Congo and Nigeria (Figure 10.6).

While higher than average incomes contribute to higher per capita electricity demand by 2040 in Angola, Ghana and Côte d'Ivoire relative to the regional average, it is the larger economies that lead total electricity demand growth. About 15% of the increase in total electricity demand in the Stated Policies Scenario across sub-Saharan Africa (excluding South Africa) comes from Nigeria. Ethiopia accounts for a further 9%, with Tanzania, DR Congo and Angola not far behind. Overall, just seven sub-Saharan African countries account for over half of demand growth over the outlook period in the Stated Policies Scenario.

[4] Chapter 4 of *Energy Access Outlook 2017: From Poverty to Prosperity* takes an in-depth look at how energy can improve agricultural productivity in Africa (IEA, 2017).

Figure 10.6 ⊳ **Electricity demand per capita and share of regional electricity demand by scenario, 2018 and 2040**



Electricity demand per capita rises fastest in the Africa Case, but in 2040 it is still only around a third of today's average in other developing countries

* Region = sub-Saharan Africa excluding South Africa.

Note: STEPS = Stated Policies Scenario; AC = Africa Case.

In the Africa Case, even those countries that have lower average incomes and currently are making slow progress on access to electricity see a jump in per capita electricity demand, thanks to the combined impacts of universal access to electricity and accelerated economic growth across all sectors of the economy. In DR Congo, for example, electricity demand is 625 kWh per capita in 2040 in the Africa Case, more than double the level in the Stated Policies Scenario as a result of a near 9% gross domestic product (GDP) growth rate and the electrification of an additional 120 million people. In absolute terms, this translates to an additional 55 TWh of electricity demand in 2040, enough to see DR Congo's share of total electricity demand in sub-Saharan Africa (excluding South Africa) increase from 5% in the Stated Policies Scenario to 7% in the Africa Case.

Box 10.1 ⊳ **Electricity in South Africa – deep transformation ahead?**

South Africa's energy landscape looks different from that of other sub-Saharan countries. The country has a more mature economy than its neighbours and a history of relatively low energy prices, in particular for coal and electricity. The competitiveness of electricity relative to other fuels results in a share of electricity in final energy consumption of 25% today, which is high by international standards. This has favoured the development of energy-intensive industries and the extensive electrification of energy use in buildings. South Africa currently accounts for over half of all electricity consumed in sub-Saharan Africa.

Competitive electricity prices and the coupling of clean cooking efforts with electrification mean that around 85% of South African households cook with electricity today. Electrifying cooking increased residential electricity demand, but the largest consumer of electricity in South Africa remains the industry sector, which accounts for 60% of demand.

In the Stated Policies Scenario, South Africa sees further electrification of the economy with electricity demand growing at nearly 2% per year to reach 320 TWh by 2040, equivalent to demand in the United Kingdom today. Average residential electricity consumption reaches nearly 1 400 kWh per capita in 2040, the same level as Korea today and seven-times higher than the average for the rest of sub-Saharan Africa in 2040. Thanks to very proactive government programmes, only 5% of the population does not have access to electricity today, mainly in remote areas. South Africa is on track to achieve universal access well before 2030.

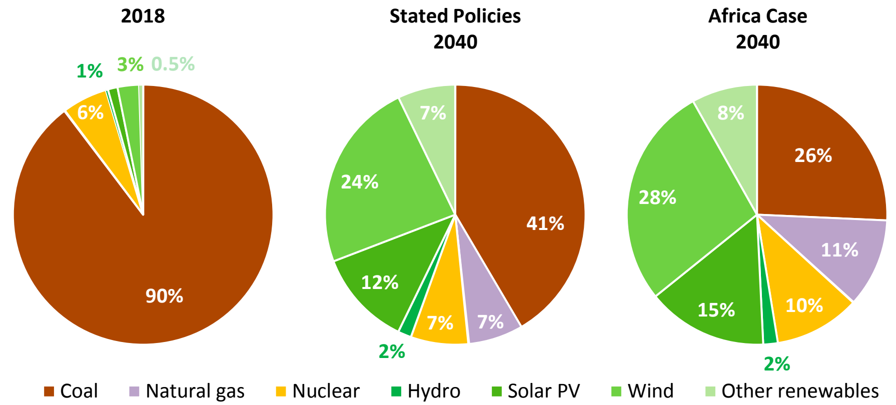
In the Africa Case, the impact of increased electrification across the economy (and more rapid economic growth) is offset by significant improvements in efficiency. The scope for further energy efficiency improvements remains large for motors in industry, heating in buildings and air conditioning. Maximising this potential moderates demand growth. By 2040, electricity demand in the Africa Case is 6% (20 TWh) lower than in the Stated Policies Scenario. Pulling the efficiency lever is central to ensuring reliable, secure and affordable electricity supply.

Although access to electricity has improved, the reliability of electricity supply has deteriorated over recent years with severe power disruptions. A shortage of generating capacity, mainly caused by disruptions and maintenance needs of old coal-fired power plants and delays in the construction of new thermal plants, has caused the vertically integrated state-owned utility, Eskom, to regularly resort to rotational load shedding.

South Africa's latest draft Integrated Resource Plan (IRP 2018) points to a new direction for the power sector, and opens the door for alternatives to coal-fired generation based on a market-based model. The government seeks to procure over 30 GW from independent power producers, half of which will come from the Renewable Energy Independent Power Producer Procurement Programme (REIPPPP). Falling costs are indeed making these solutions more competitive. The average levelised cost of electricity (LCOE) of renewable energy technologies in South Africa has declined substantially over the last five years – by an estimated 55% for utility-scale solar PV (about $90 per megawatt-hour [MWh] on average in 2018) and by more than 20% for onshore wind ($70/MWh). To date, the REIPPPP has attracted about $15 billion in investment in the power sector (20% foreign) and it is one of the most advanced private procurement programme for the power sector in Africa (see sections 10.7 and 10.8). Despite its early success, however, many projects found it difficult to get to the stage of triggering the release of funding, in part because of political uncertainty and the deteriorating performance of Eskom.

This shift away from coal reflects South Africa's goal of lowering carbon dioxide (CO_2) emissions and its commitment to the "peak, plateau and decline" emissions trajectory that led to the adoption of a Carbon Tax Act in 2019. This strategy implies a significant decline in the use of coal for electricity generation: its contribution shrinks in the Stated Policies Scenario from 90% today to just over 40% of in 2040 (Figure 10.7).

Figure 10.7 ▷ Electricity generation mix by scenario in South Africa



An extensive transformation of South Africa's electricity mix gives much more weight to renewables, but coal retains a significant share

About 85 GW of additional capacity is required by 2040 to meet growing demand and compensate for ageing coal plant retirements in the Stated Policies Scenario. Most additions are renewables units, led by wind and solar (about 25% each), making up close to 45% of electricity supply by 2040. South Africa is building two coal-fired power plants (Medupi expected to be completed by 2020 and Kusile by 2024) and despite the retirement of 30 GW of existing capacity over the period to 2040, coal remains the dominant fuel in terms of both capacity and generation.

In the Africa Case, the power sector in South Africa proceeds further and faster with diversification of the generation mix, driven by improved maintenance and management of the power system as well as the increased effectiveness of the procurement programme. The contribution of renewables to electricity supply grows at a much faster rate to provide over half of generation. By 2040, wind and solar PV become some of the most attractive options while generation costs from fossil fuel plants increase and wind overtakes coal as the primary source of electricity generation. Deeper regional co-operation and integration also sees South Africa benefit from competitive electricity imports, as large hydro projects such as Grand Inga in DR Congo move ahead more quickly.

Achieving the Stated Policies Scenario would require multiplying current investment levels by almost three (from $3.7 billion in 2018 to an average of almost $10 billion per year over the period to 2040). The Africa Case would require 8% less ($9 billion per year), aided by the impact of additional energy efficiency pushing down electricity demand. In both the Stated Policies Scenario and the Africa Case investment would need to shift away from coal (around 35% of total power sector investment in 2018) and focus more on low-carbon generation and on-grid extension and strengthening.

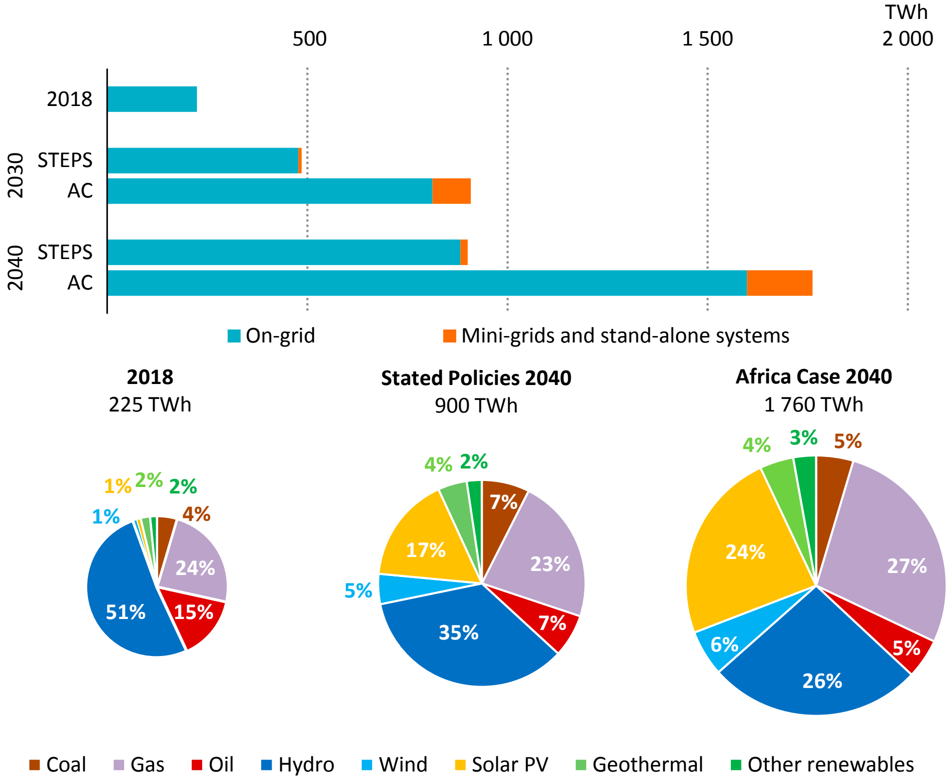
10.4 Outlook for electricity supply

Efforts to meet rapidly growing electricity demand lead to a significant expansion of the power system over the period to 2040 in the Stated Policies Scenario. Total power generation capacity in Africa (which includes on-grid, mini-grid, stand-alone systems and back-up generation capacity) more than doubles to reach 615 gigawatts (GW) in 2040. Natural gas remains the primary source of electricity generation, in particular in North Africa, while the contribution of coal gradually decreases as new projects are offset by ageing plants retirements in South Africa (Box 10.1). Many countries are actively developing their considerable renewable energy resource and over two-thirds of the additional power needs are met by renewables.

Excluding South Africa, the sub-Saharan Africa power sector is already relatively low-carbon and it remains so in the future in both scenarios (Figure 10.8). In the Stated Policies Scenario, electricity output increases fourfold, from around 225 TWh in 2018 to just over 900 TWh in 2040. On-grid supply continues to serve as the primary means of delivering electricity, but decentralised solutions for access play a larger role than anywhere else in the world, especially in the Africa Case. Although on-grid solutions have traditionally served as the most cost-effective option to supply electricity in areas close to an existing grid, the falling costs of stand-alone solar PV and battery storage technologies as well as new business models using digital and appliance innovations are making these solutions more competitive. In the Africa Case, mini-grids and stand-alone systems offer the least-cost solution to deliver over 160 TWh, or nearly 10% of electricity supply, enabling access to new or improved energy services to more than half of people gaining access by 2040.

In the **Stated Policies Scenario**, hydropower output almost triples over the period to 2040 and remains the largest source of electricity, although its share of supply declines from a half today to 35%. Natural gas provides more than a fifth of the additional generation to 2040, and retain a market share above 20%. Falling cost drives fast deployment of utility-scale and distributed solar PV, and also geothermal and wind: the combined contribution of these non-hydro renewable resources increases to over a quarter of overall supply. Coal-fired generation increases from a low base, providing cheap baseload power to meet fast-growing demand. Generation from oil increases in absolute terms, but its share in generation declines markedly to 7% in 2040, half its share in 2018.

Figure 10.8 ⊳ Electricity supply by type, source and scenario in sub-Saharan Africa (excluding South Africa), **2018 and 2040**



Most of the soaring electricity needs are met through new grid connections; renewable sources make the largest contribution, followed by gas

In the **Africa Case**, electricity output in sub-Saharan Africa (excluding South Africa) soars to 1 760 TWh by 2040, nearly twice the level in the Stated Policies Scenario and about eight-times 2018 levels. Renewables-based generation accounts for the largest share of the additional 860 TWh needed, bringing the total share of renewable-based generation to over 60%. On-grid hydropower and solar PV account for over 40% of the overall generation mix by 2040, but decentralised renewable solutions also play a much bigger role in delivering power, providing electricity access to 400 million people across sub-Saharan Africa (excluding South Africa) by 2040. The substantial increase in electricity demand also requires major new contributions from gas-fired generation, which account for over a third of the extra needs relative to the Stated Policies Scenario. With these additions, the share of gas in the electricity mix increases to nearly 30% in 2040 and it becomes the largest source of generation in the region. The share of coal declines compared to the Stated Policies Scenario, as does that of oil. Other renewable power sources such as geothermal and wind expand to significant levels in several countries benefiting from high quality sites.

Box 10.2 ▷ Geospatial estimation of the least-cost pathway to universal access to electricity

Over the years, our World Energy Model (WEM) has been expanded and coupled with other tools to provide a detailed outlook for electricity access in the next decades.[5] As part of this work, the IEA has been working closely with several leading universities, including the KTH Royal Institute of Technology (KTH), to analyse the least-cost route to achieve full access to electricity, using the most recent tools available. Analysis was done for a few individual countries in 2014 for our first focus report on Africa (Nigeria and Ethiopia) (IEA, 2014), and for all sub-Saharan African countries in *Energy Access Outlook 2017* (IEA, 2017).

For this *Special Focus on Africa*, the IEA refined its analysis using up-to-date datasets and the latest version of the Open Source Spatial Electrification Tool (OnSSET)[6], developed by KTH. The results provide detailed coverage of 44 countries in sub-Saharan Africa. Regional results are presented in section 10.4.2 and national results for 11 focus countries are shown in the country profiles (Chapter 12).

Overall electricity access objectives and demand projections are determined by country and region in the WEM based on population dynamics and economic growth for the Stated Policies Scenario and the Africa Case. They integrate the latest policy frameworks and national targets as well as technology and energy prices. Demand related to access is initially assumed at 250 kWh a year for rural and at 500 kWh for urban households, before growing over time to reach the national average.

Demand and other key drivers (e.g. technology and fuel costs) retrieved from WEM are then used in OnSSET in combination with several open access geospatial datasets. These include demographic indicators (e.g. population density and distribution), infrastructure (e.g. existing and planned transmission and distribution networks, roads), resources availability (e.g. solar, wind, hydro) and derivative layers (e.g. distance to the grid, to the closest road or city, diesel transportation cost) among others. The geospatial model runs a least-cost analysis mainly taking into account techno-economic factors and yields electrification investment outlooks. While grid densification (connecting areas close to the existing network) is prioritised, the geospatial model does not necessarily mirror the detail of government electrification plans (where they exist) or account for the financial and technical capacities of utilities.

10.4.1 On-grid supply

On-grid electricity supply dominates in urban areas and rural communities close to transmission lines and accounts for a majority of electricity consumption in sub-Saharan

[5] For the full WEM methodology, see www.iea.org/weo/weomodel/.

[6] For more details on the Open Source Spatial Electrification Tool, see www.onsset.org; for the latest OnSSET methodology update refer to Korkovelos, A. et al. (2019).

Africa (excluding South Africa) over the outlook period. The evolution and growth of grid supply by energy source varies across countries in sub-Saharan Africa, reflecting the differences in resources, costs and policies of each (Figure 10.9).

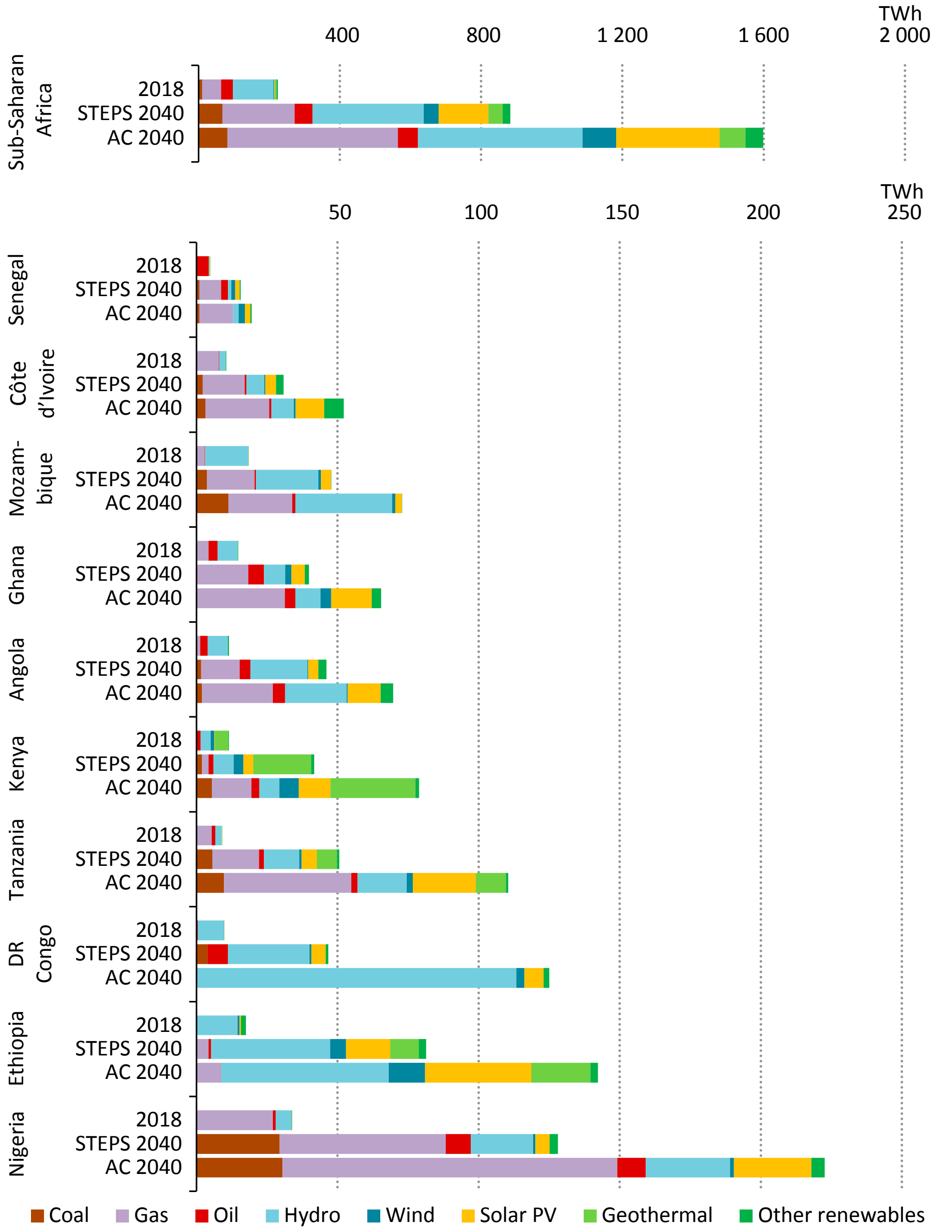
In the Stated Policies Scenario, total on-grid installed capacity in sub-Saharan Africa (excluding South Africa) increases to 270 GW by 2040, a threefold increase from the 80 GW of installed capacity in 2018. The power fleet steadily diversifies away from traditional sources of power and over half of the 190 GW of new plants commissioned over the period are non-hydro renewables (75% when hydropower is included). Gas-fired capacity expands, while the contribution of oil decreases.

In the Africa Case, the power sector proceeds further and faster with ensuring more reliable and affordable electricity for all (sections 10.5 and 10.6). The design of policies and the effectiveness of their implementation play a critical role in incentivising timely and adequate expansion of the physical infrastructure and in ensuring a better performing power sector. Deeper regional co-operation becomes more important. This all requires a steep increase in investment and a major reallocation of capital (sections 10.7 to 10.9). The generation fleet in sub-Saharan Africa (excluding South Africa) nearly doubles compared to the Stated Policies Scenario, reaching about 490 GW by 2040, driven by the substantial increase in electricity demand. The capacity mix diversifies further, with renewables accounting for over three-quarters of the additional installed capacity relative to the Stated Policies Scenario. Gas-fired generation takes on an increasingly important role in all areas and rises in tandem with renewables.

Hydropower remains a cornerstone of sub-Saharan Africa's power system (excluding South Africa) but its share declines as other renewable technologies and natural gas expand. Hydropower currently provides more than half of on-grid generation in sub-Saharan Africa (excluding South Africa) and over 80% of electricity supply in DR Congo, Ethiopia and Mozambique. In the Stated Policies Scenario, generation from hydropower almost triples by 2040. Over two-thirds of the 17 GW under construction today are scheduled to come online by 2025 including the Grand Renaissance Dam (6 GW) in Ethiopia. The Mambilla Dam (3 GW) in Nigeria helps alleviate local demand for fossil fuel resources and provide more reliable access to power. In Angola, the Laúca Dam (1 GW) is expected to be fully operational in early 2020 and the Caculo-Cabaca Dam (2.2 GW) in 2024. Construction of a major hydropower project (2.1 GW) was launched in Tanzania's Rufiji Basin in mid-2019.

In the Africa Case, better regional co-operation and integration of power networks is instrumental in unlocking a larger share of hydropower's huge potential. Larger markets absorb the power output from resources heavily concentrated in the Nile Basin and Congo River, making these resources more economical to develop. Generation from hydropower quadruples by 2040, led by DR Congo with (115 TWh) by 2040, with the completion of Stage V of Grand Inga and by Ethiopia with a quadrupling of output (60 TWh). Large hydropower projects are also developed in Mozambique (including the Mphanda Nkuwa Dam). These three countries become sizeable exporters to neighbouring countries and regions.

Figure 10.9 ▷ On-grid electricity generation by scenario in sub-Saharan Africa (excluding South Africa) and selected countries, 2018 and 2040



The fuel mix of on-grid electricity supply diversifies in all countries, with hydropower being increasingly complemented by gas, solar PV and geothermal

Note: STEPS = Stated Policies Scenario; AC = Africa Case.

In the Stated Policies Scenario and the Africa Case, the share of hydropower in total electricity generation declines by 15 and 20 percentage points, respectively, as alternatives become available. While hydropower remains an essential element of electricity supply, diversifying the electricity mix helps to reduce the risk of power disruptions during droughts and in the long term to strengthen resilience to changing climate conditions.

Natural gas use continues to increase: the size of the gas-fired power generation fleet in sub-Saharan Africa (excluding South Africa) more than doubles to 50 GW by 2040 as an additional 1.6 GW of capacity is added each year on average in the Stated Policies Scenario. A third of this expansion occurs among traditional gas producers, such as Nigeria, through increasing efforts to capture and make use of associated gas from oil production. Angola also expands gas-fired generation with the newly commissioned Soyo combined-cycle gas turbine plant.

In the Africa Case, gas-fired power generation overtakes hydropower in the 2030s to become the largest source of on-grid electricity generation in the region and accounts for nearly a third of the electricity mix. This expansion is also driven by additional growth in countries such as Senegal, Mozambique and Tanzania, which capitalise on newly developed domestic supplies of natural gas. These countries become pivotal actors in gas-fired generation as power sector governance improves and enhanced regional co-operation leads to the development of wider and deeper markets (see Chapter 11). Gas also plays an increasingly important role in providing back-up power during dry spells in countries that continue to depend on hydropower.

The deployment of **non-hydro renewables** accelerates to nearly 5 GW of new capacity per year between 2019 and 2040 in the Stated Policies Scenario. Solar PV represents 40% of all new capacity additions over the period. Geothermal resources play a central role in East African countries and particularly in Kenya where geothermal becomes the largest source of electricity in terms of both installed capacity and electricity production. The share of electricity from wind also increases in the Stated Policies Scenario although some of the best resources remain far from major load centres.

The uptake of these new alternative renewable sources is projected to keep pace with the higher electricity demand growth in the Africa Case and deployment accelerates to 10 GW of additional capacity each year over the period. The majority – over 70% – comes from solar PV. Installed solar PV capacity increases across the entire region to reach about 160 GW in 2040, overtaking hydropower and gas to become the largest source in terms of installed capacity (and the third-largest in terms of generation output).

Coal-fired power capacity also increases over the outlook, from around 3 GW today to 12 GW in 2040 in the Stated Policies Scenario and 17 GW in the Africa Case, as projects gradually come online in Zimbabwe, Senegal, Nigeria and Mozambique.

New **oil units** contribute to only 1% of total additions across the region in the Stated Policies Scenario, but almost 5% in Nigeria. This reflects the fact that only a few small projects are currently planned. In the Africa Case, the oil share shrinks further as programmes to convert oil-fired units to burn domestic gas accelerate, notably in Angola and Senegal.

S P O T L I G H T

Hydropower in Africa: strengthening resilience to a changing climate

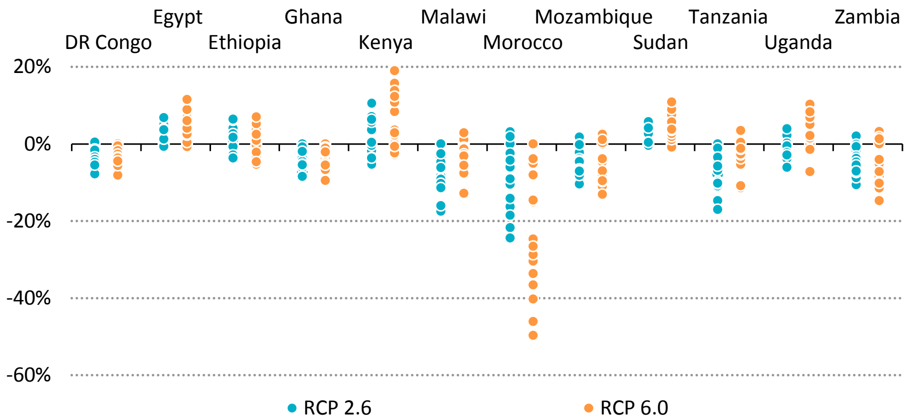
Hydropower is the most important source of low-carbon electricity globally, accounting for 16% of total electricity generation. In Africa, hydropower plays an even bigger role, accounting for 22% of electricity generation on average (excluding South Africa). The full technical potential for African hydropower is far greater – new analysis points to a total potential of around 1 120 TWh in just 12 countries (taking into account environmental constraints), which is over eight-times today's level of hydropower generation in all of Africa.

Increasing reliance on hydropower may pose risks for the power sector due to impacts of a changing climate. Changes in rainfall patterns and temperature may lead to changes in river flows, and in evaporation and transpiration, altering the resource potential for hydropower. More frequent and intense extreme weather events such as droughts and floods may also lead to more variability in generation output. While impacts are likely to vary by region and even locally, climate-related events have already had noticeable effects on power systems, for example in Zambia where a severe drought in 2015-16 led to a drop in usable capacity of the largest hydropower plant and to power blackouts.

New analysis carried out for this *World Energy Outlook* assessed future climate change impacts on hydropower outputs and potential in 12 African countries under various climate change scenarios to 2099. The analysis linked global circulation models with hydrological models to examine changes of hydropower availability at precise locations using high-resolution discharge and elevation data (Gernaat et al, 2017). Two Intergovernmental Panel on Climate Change (IPCC) climate scenarios were compared: one leading to a global temperature rise likely to be below 2 degrees Celsius (°C) by 2100 (Representative Concentration Pathway [RCP] 2.6), implying a peak in emissions in 2020 and subsequent decline; and the second leading to a global temperature rise of around 3 °C by 2100 (RCP 6.0), implying a continuing gradual rise in emissions before they peak well into the second-half of the century (IPCC, 2014).

The annual availability of hydropower (measured by capacity factors) becomes more uncertain in both scenarios, but year-to-year variability is higher in RCP 6.0, the scenario with more climate impacts (Figure 10.10). Average annual capacity factors decline by some 2 percentage points by 2099 in both scenarios. However, hydropower capacity factors show stronger fluctuation in RCP 6.0 than in RCP 2.6 for most of the plants analysed (55 out of 64). Several Nile Basin countries (notably Sudan, Uganda, Egypt and Kenya) experience more than 50% relative increase of annual variability in RCP 6.0 compared to RCP 2.6, as do Zambia, Mozambique and Morocco. Without planning to improve resilience, this increased variability could have critical impacts on the reliability of power systems that are heavily and increasingly reliant on hydropower.

Figure 10.10 ▹ Variability of annual hydropower capacity factors for selected African countries by climate scenario, 2020-2099



Increased greenhouse gas concentrations are associated with an intensification of year-to-year variability in hydropower generation

Note: RCP = Representative Concentration Pathway (IPCC, 2014).

Regional differences in hydropower availability also become more marked under the scenario with the higher global temperature rise (RCP 6.0). For example, hydropower in Morocco is projected to see a 9% decrease in capacity factors under RCP 2.6, while capacity factors in Nile Basin countries (Egypt, Kenya, Sudan and Uganda) would increase by 0-2%. In RCP 6.0, these differences are accentuated, with drier conditions leading to Morocco's outputs declining by 24% relative to today, compared to 4-8% increases in the Nile Basin. These striking regional differences underline the importance of developing enhanced interconnections and power pools that link countries and sub-regions together.

The sensitivity of African hydropower to rises in global temperature points to the importance of integrating climate resilience – the capacity to absorb, accommodate, adapt to and recover from climate change impacts – into planning for the construction and operation of future hydropower plants. For example, most planned hydropower projects do not currently take into account projected hydrological changes, relying instead on historical conditions (CDKN, 2015). This could lead to suboptimal operation of plants, at a time when many African countries are increasingly expecting hydropower to satisfy rapidly increasing power demand and to be a source of flexibility to support the integration of variable renewables such as wind and solar PV.

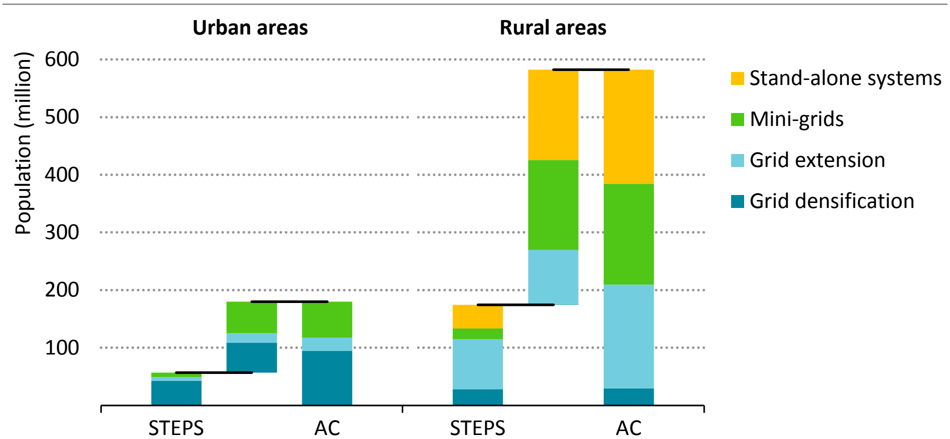
10

10.4.2 Role of decentralised systems to reach universal access to electricity

Geospatial analysis indicates that the least-cost way to reach full access by 2030 and to meet demand from newly connected households is to deploy mini-grids and stand-alone systems while also extending the main grid (Box 10.2). Providing electricity for all in sub-Saharan Africa would require an additional investment of around $25 billion per year above the level mobilised in the Stated Policies Scenario over the period to 2030.

In the Stated Policies Scenario, grid connections constitute the least-cost option for around 70% of the 230 million new connections that are expected to be achieved by 2030, mainly in areas that are close to a grid. A high proportion of the population lives close to a network (see Chapter 8), and grid densification connects around 70 million people, mainly in urban areas, while grid extension reaches more than 90 million, almost all living in rural areas. The number of people who gain access from decentralised solutions increases to almost 70 million over the period as technology costs continue to decline.

Figure 10.11 ▷ Solutions to provide electricity access by area and scenario in sub-Saharan Africa, 2019-2030



Access in urban areas will largely be via grid connections, while decentralised solutions are the least-cost option for about 370 million people in rural areas to reach full access

Sources: IEA analysis; KTH-dESA.

Decentralised systems are even more important to bring electricity to the 530 million additional people who need to be reached in the Africa Case in order to provide access to electricity for all. They represent the least-cost solution for more than two-thirds of these additional connections. Mini-grids play a major role in closing the gap in urban areas that cannot be reached by the grid before 2030, accounting for almost half of the additional urban connections. In rural areas, decentralised solutions provide more than three-quarters of additional connections, with mini-grids and stand-alone systems both having a role to play depending on population density (Figure 10.11). As a result, decentralised systems connect in total almost 450 million in the Africa Case by 2030. They can be installed quickly, providing valuable basic energy services to households who would otherwise need to rely on polluting and inefficient fuels. If deployed carefully, such systems can complement the grid, providing services immediately and preparing the way for later grid extension.

The best way to determine the optimal mix of solutions to provide access to all is to prepare integrated plans based on geospatial mapping. Such plans allow governments to develop a precise strategy, assess the investment needed, design adapted policies to reach all populations, and clarify the roles of different actors (government stakeholders, donors, private sector and non-governmental organisations). Turning such plans into actual investment flows and concrete progress on the ground raises some challenges (section 10.9), but they remain the best way to develop an integrated approach and to facilitate private sector participation.

Several countries, including Ghana, Senegal, Ethiopia, Nigeria and Rwanda, have developed long-term comprehensive strategies. As an example, the Ethiopian government announced plans in its 2019 National Electrification Plan to connect 100% of households by 2025 by connecting to the grid those 65% of households located less than 2.5 kilometres (km) from the existing network and putting in place decentralised solutions for the remaining 35%. By 2030, the government plans to extend the grid to reach households located between 2.5 km and 25 km from the existing grid. The 5% of households living farther than 25 km from the grid would have decentralised solutions over the long term.

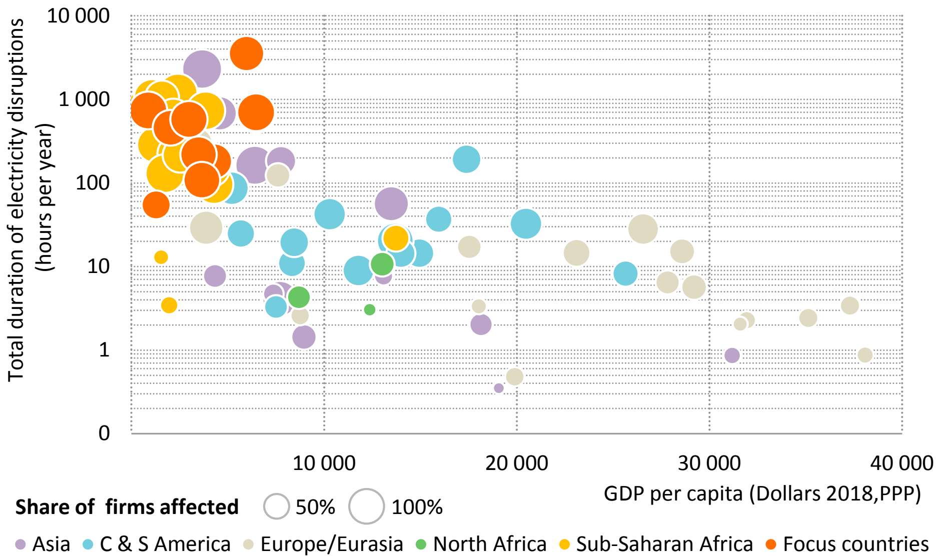
10.5 Reliability

The provision of high quality electricity services is essential to economic growth. An electricity supply that is unreliable acts as a brake on overall economic activity and welfare, and inhibits the output of individual firms. The provision of low quality or unreliable electricity supplies forces firms to manage gaps in supply or to turn to more polluting and expensive alternatives such as diesel generators. Both choices have detrimental effects on firm efficiency and undermine competitiveness.

Poor electricity infrastructure in low-income countries is a major cause of unreliability (Figure 10.12). Under-investment in existing transmission and distribution assets and the inability to meet peak load due to installed capacity deficit result in frequent service disruptions (unscheduled outages or regular load shedding), ranging from a few hours to a few days. Between 2006 and 2018, around 80% of sub-Saharan African firms suffered frequent electricity disruptions, typically six hours in length, imposing losses of around 8% of annual sales on average (World Bank, 2018). Outages tend to be most frequent and prolonged in Nigeria (see Chapter 8). By contrast, firms in Organisation for Economic Co-operation and Development (OECD) countries experience interruptions of around one hour per month on average.

Investment in power systems, combined with improvements in the performance of utilities, results in a decline in the number of outages in sub-Saharan Africa by the end of the projection period. In the Stated Policies Scenario, the number of hours lost as a result of

Figure 10.12 ▷ Electricity outages and GDP per capita in selected regions, 2017

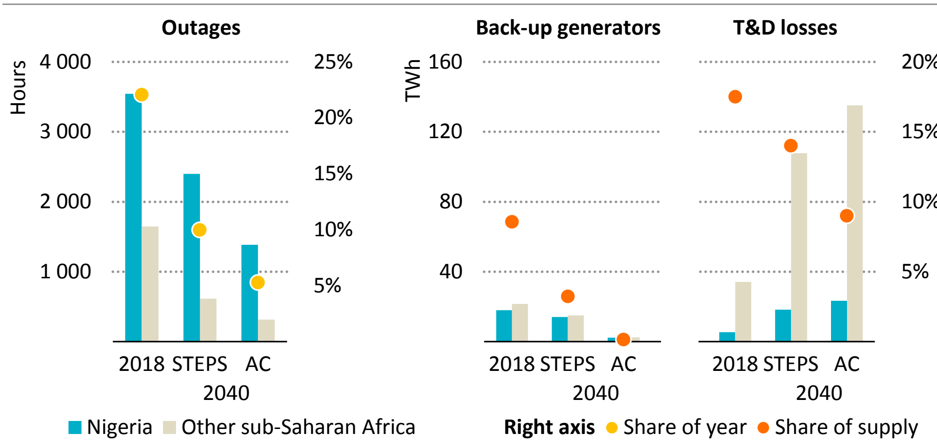


Frequent outages tend to be concentrated in low-income sub-Saharan countries

Notes: C & S = Central and South America. PPP = purchasing power parity. Focus countries are Angola, Côte d'Ivoire, DR Congo, Ethiopia, Ghana, Kenya, Mozambique, Nigeria, Senegal and Tanzania.

Source: IEA analysis based on World Bank (2019a).

Figure 10.13 ▷ Reliability indicators by scenario in sub-Saharan Africa (excluding South Africa), **2018 and 2040**



Major improvements in reliability in the Africa Case reduce the incidence of power outages by 60% in Nigeria and over three-quarters elsewhere; network losses shrink to below 10%

Note: T&D = transmission and distribution; STEPS = Stated Policies Scenario; AC = Africa Case.

outages declines to around 900 hours a year on average across the region; this ranges from below 1% of the year in Mozambique, Senegal, Kenya and Côte d'Ivoire up to nearly 30% in Nigeria, despite significant progress there. The number of outages declines even further in the Africa Case, falling to less than 500 hours a year on average and to about 15% of the year in Nigeria (Figure 10.13). As a result, the output of back-up generation declines in the Stated Policies Scenario from 40 TWh a year to around 30 TWh a year and to less than 5 TWh a year the Africa Case, reducing fuel and maintenance costs, noise and air pollution.

Inefficiencies arising from network losses can be very costly for utilities. Network losses are very high in sub-Saharan Africa (excluding South Africa) and at 18% are higher than in other developing regions (see Chapter 8). Investments in power systems result in losses falling to around 14% in the Stated Policies Scenario and to as low as 9% in the Africa Case.

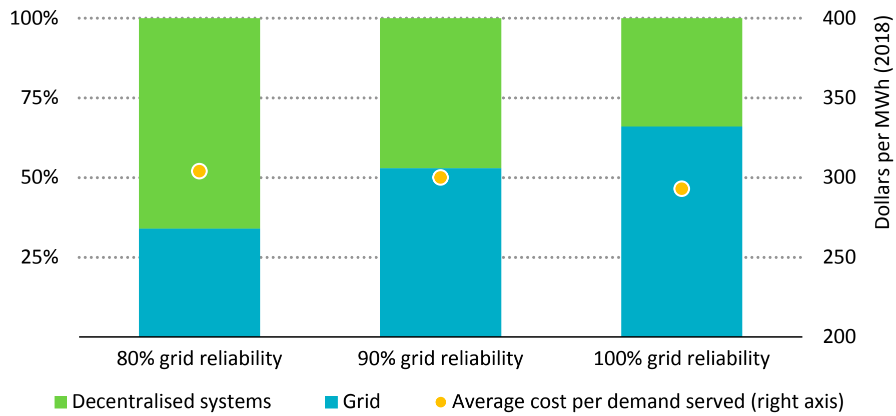
Box 10.3 ▷ Improving grid reliability: a pathway for lower cost electrification

Providing access to electricity is essential, but access has to bring with it a reliable supply of electricity if households, businesses and public services are to reap the full benefits. A lack of reliable electricity supply from the grid disrupts daily lives and activities, lowers trust and use of the grid, and increases costs for consumers and utilities. Grid reliability also influences the best mix of solutions to provide universal access to electricity, by improving the cost-effectiveness of extending the grid to connect more potential consumers. This in the end affects the overall cost of electrification.

To shed light on the relations between the least-cost pathway to universal access and grid reliability, we developed a new analysis in collaboration with the MIT-Comillas Universal Energy Access Lab. Using the Reference Electrification Model (REM), building level geospatial analysis informs network and mini-grid deployment and design to optimise electrification planning (MIT-IIT, 2019). Taking an excerpt from the National Electrification Plan of Rwanda as a test case, we considered a rural and peri-urban area of 30×60 km in the Nyagatare region, with some 48 000 buildings that represent about 22 different consumer profiles (from 100 Watts [W] to 300 kW peak demand). Through the REM, we examined the least-cost electrification solutions for these consumers at various levels of grid reliability, defined as the percentage of demand served. The results highlight the complementarity of on-grid and decentralised solutions at all grid reliability levels in the area analysed (Figure 10.14). Poor grid performance, similar to the situation currently observed in many countries, contributes to the attractiveness of decentralised solutions to connect up to two-thirds of those gaining electricity access. These solutions remain attractive even with reliability improvements, a trend accentuated by expected declines in costs of decentralised systems. Nonetheless, improving the reliability of the grid could facilitate optimising the infrastructure by connecting more consumers and increasing average consumption of electricity, in addition to removing a major obstacle to development of businesses and community services. The additional investments to improve reliability by installing sufficient generation capacity to cover peaks would be offset by a decline in the cost per unit of demand served.

Investing in better grid reliability to optimise grid utilisation, while deploying decentralised systems to reach populations distant from networks, appears to be the best way to provide improve access to electricity at the lowest cost.

Figure 10.14 ⊳ Connections by type to reach universal access to electricity with different grid reliability levels in a region of Rwanda



Even with high grid reliability, decentralised systems would be cost effective for many people; improving grid reliability can reduce the cost per demand served

Power sector regional integration

Increased power sector integration in sub-Saharan Africa can help with the goal of providing more affordable and reliable power. Affordability can be improved by reducing the need for investment: access to other markets allows countries to reduce the amount of installed capacity needed to meet peak demand, and sharing reserves between balancing areas means each can maintain less reserve capacity. Closer integration also enhances reliability by allowing the system to respond better to seasonal imbalances and unexpected shocks. Sub-Saharan African countries enjoy a diverse range of natural resources and have scope to benefit from the complementary nature of those resources.

Economies of scale achieved at a regional level may also enable countries to proceed with large projects that would not be justified based only on domestic power demand levels. Completion of Stage V of Grand Inga and associated interconnection projects in Southern African countries, for example, would allow the export of hydropower from DR Congo in the Africa Case and would significantly reduce average electricity generation costs in the region.

To realise these gains, governments and utilities across the region need to step up co-ordination in order to increase investment in transmission infrastructure, establish regional markets and improve regulation for cross-border trading (for example by defining and implementing regional transmission tariffs).

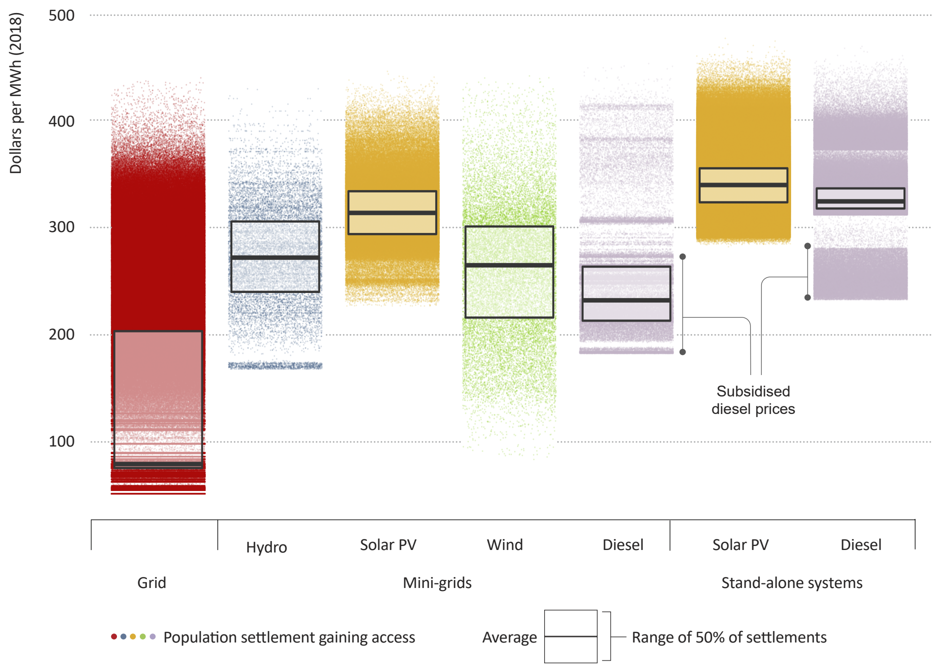
10.6 Affordability

The affordability of energy is a primary concern for policy makers, businesses and consumers. As discussed in Chapter 8, many households cannot afford the often very high upfront costs of grid connection, and current electricity tariffs make even basic energy services unaffordable for a large share of the population connected. However, the tariffs that constrain affordability for consumers are often set too low for utilities to be able to recoup their costs of supply. The risk is that this locks the power sector into a cycle of low revenue, high debt, inadequate maintenance, under-investment and poor quality of service. One of the biggest challenges of achieving universal access to electricity relates to the cost of providing power, which increases dramatically to supply sparsely populated and remote areas compared with households close to an existing grid. Our geospatial analysis shows that the least-cost option to provide access increases by a factor of four from easily accessible areas to the most remote ones (Figure 10.15). It is therefore inevitable that ensuring access to all requires government policies, subsidies and tax exemptions in one way or another. Much is already being done. In Togo, for example, the government recently announced its CIZO Plan to electrify 555 000 households with solar kits; the "CIZO solar cheque" will subsidise the hardware costs for households with a monthly payment, in partnership with a few licenced companies.

Supporting energy efficiency and productive uses can also help to improve affordability. Energy efficient appliances can enable consumers to access higher levels of energy services at lower costs, and so reduce the size (and the cost) of the system needed to support these services (IEA, 2017). Broadening the scope of electricity access plans to include the provision of energy for productive uses, such as agriculture or industry, can support the ability of end-users to pay while at the same time bringing down the cost of supply by increasing the load factor. Providing support for the acquisition of efficient equipment along with access to electricity can bring multiple benefits. A recent study from the World Bank (ESMAP, 2019) indicates that many productive tools and equipment appear to have a pay-back period of less than 12 months. Private companies including providers of mini-grid and solar home systems are starting to consider how best to support the development of commercial activities among electrified communities to ensure the sustainability of their projects. Success on this front will require cross-sectoral planning and co-ordination (for example between energy, water and agriculture ministries) as well as financial support.

Fossil fuel consumption subsidies have been used by a number of countries as a way of making electricity more affordable for citizens and companies (potentially helping them become more competitive). Some sub-Saharan countries, for example Ghana, subsidise certain fossil fuels as part of a strategy to promote switching from the use of traditional biomass. While fossil fuel subsidies – relatively more prevalent in North Africa – can help to support the use of energy services by the poorest households, they also create a substantial fiscal burden on what are often overstretched government budgets. We estimate the value of fossil fuel consumption subsidies in 2018 to have been $2.9 billion in Nigeria, $5 billion in Libya, $17 billion in Algeria and $27 billion in Egypt.

Figure 10.15 ▷ Levelised cost of electricity (LCOE) to achieve universal access to electricity by 2030 in sub-Saharan Africa, in the Africa Case



The cost of supplying electricity varies dramatically depending on household location; decentralised solutions are often the cheapest option for remote households

Notes: Each point represents an individual settlement in sub-Saharan Africa. It shows the LCOE of the least-cost solution determined for each settlement through our geospatial analysis (see Box 10.2).

Source: IEA analysis; KTH-dESA.

Amending current fossil fuel subsidy schemes is desirable for a number of reasons. These include: the need to reflect the true cost of electricity and remove distorted incentives (with implications for investment decisions); the need to reduce consumption of electricity from emissions-intense sources and encourage the use of more efficient and low-carbon sources; and the need to reduce the resultant fiscal burden that such subsidies cause.

Successful reform programmes broadly share the same key design and implementation features. They tend to focus in particular on being clear about the amount of the subsidy and the different categories of consumers who benefit from it. Obtaining wide understanding of, and support for, proposed reforms is essential: gradual implementation and assistance to the poorest households may be needed. There is plenty of experience in other countries to draw on and learn from. International development finance institutions can provide technical and financing assistance to help with fossil fuel subsidy reform.

10.7 Investment needs for reliable, sustainable and affordable power

The amount of investment needed for the provision of electricity in sub-Saharan Africa is substantial and well above the level of the current flows of capital into the region's power sector. Achieving the outcomes projected in the Stated Policies Scenario would require annual power sector investment in sub-Saharan Africa to more than double to around $46 billion per year, and would mean a cumulative total of more than $1 trillion in investment between 2019 and 2040 (1.6% of the regional GDP over the period). The Stated Policies Scenario would see the electricity access rate rise to 64% in 2030.

Reaching full access by 2030 and maintaining it to 2040, as in the Africa Case, would require multiplying current investment levels by five. The cumulative investment in this case would reach more than $2 trillion between 2019 and 2040 (2.7% of the regional GDP in the Africa Case over the period), or over $100 billion per year, more than doubling the capital needed under the Stated Policies Scenario (Table 10.2). Half of the investment needs would be spent on grid expansion, reinforcement and maintenance. Most of the rest would be for low-carbon power capacity, where solar PV takes an important role, reaching almost $25 billion per year on average. Cumulative investments in solar PV by 2040 in the Africa Case reach $535 billion. Decentralised solutions (mini-grids and stand-alone systems) would take an even more central role in this scenario, capturing a fourth of all investment in new capacity over the period to 2040.

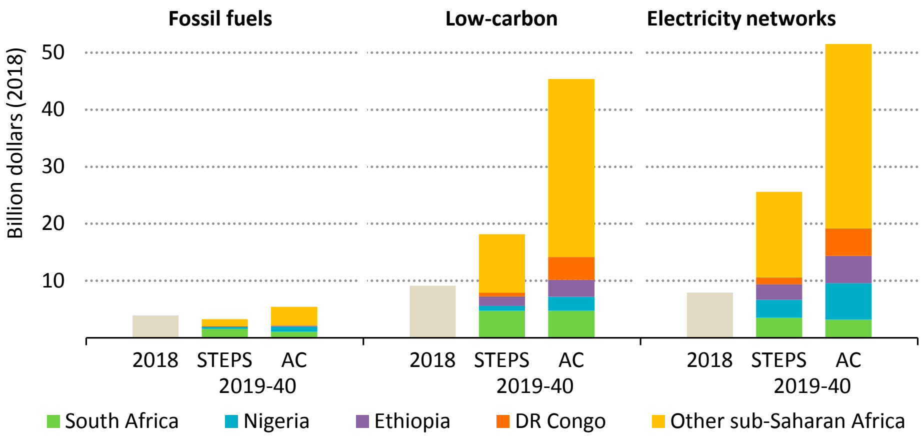
Table 10.2 ▷ Average annual power sector investment in sub-Saharan Africa by scenario, 2019-2040 (Billion dollars, 2018)

	Stated Policies Scenario			Africa Case		
	On-grid	Mini-grid and stand-alone	Total	On-grid	Mini-grid and stand-alone	Total
Total power plants	**19.3**	**1.7**	**21.0**	**34.1**	**16.8**	**50.8**
Coal	2.0	0.0	2.0	1.7	0.0	1.7
Natural gas	1.3	0.0	1.3	2.9	0.0	2.9
Oil	0.0	0.1	0.2	0.4	0.5	0.8
Hydro	4.4	0.0	4.4	7.7	0.0	7.7
Solar PV, wind, other low-carbon	11.6	1.6	13.2	21.4	16.3	37.7
T&D	25.3	0.2	25.5	49.0	2.5	51.5
Total	**44.6**	**1.9**	**46.5**	**83.1**	**19.3**	**102.3**

Note: T&D = transmission and distribution; Other low-carbon = bioenergy, nuclear and other renewables.

In addition to higher investment levels, a reallocation of capital would be needed across countries and technologies in both scenarios. In South Africa, a major reallocation of capital away from coal-fired power (currently around 35% of the investment) towards electricity networks and low-carbon generation would need to happen (Figure 10.16). Nigeria, Ethiopia and DR Congo are the other countries with the highest annual investment needs. Together, these four economies account for around 40% of the investment needs in both outlooks. In addition, investment in natural gas generation would also need to pick up and maintain the current investment pace. Average annual investment in natural gas in the 2019-40 period in the Africa Case is more than twice that of the Stated Policies Scenario and four-times the 2018 investment level. With more renewable plants and higher access levels, gas helps maintain security of supply at lower emission levels than other fossil fuels.

Figure 10.16 ▷ Annual average power sector investment by scenario in sub-Saharan Africa



The investment gap is particularly large for renewables and electricity networks in both outlooks, and needs to accommodate more capital for natural gas in the Africa Case

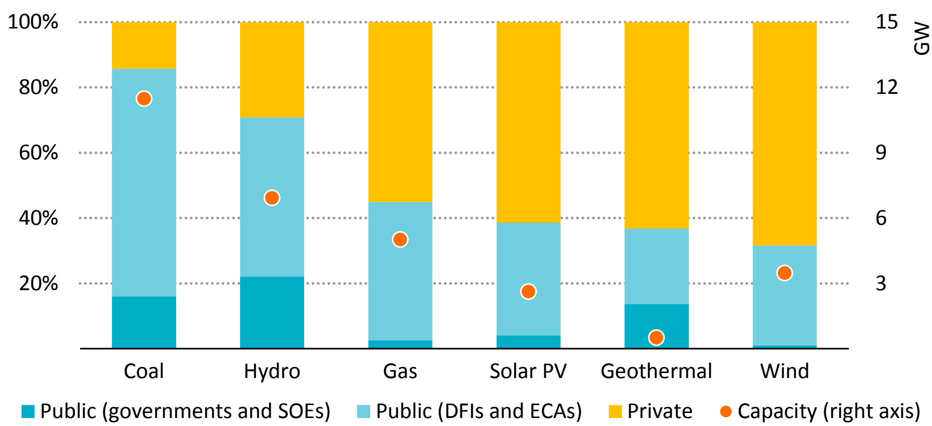
Notes: STEPS = Stated Policies Scenario; AC = Africa Case. Low-carbon generation includes renewables and nuclear (nuclear only projected in South Africa).

Who will supply the capital needed to enable this investment? While investments will inevitably be funded from a variety of sources and types of funds – international and local; private and public; equity and debt – the choice of capital provider and financing vehicle makes a big difference to the pace and affordability of Africa's shift towards more reliable, sustainable and affordable power. The approach taken needs to be informed by an analysis of the ways in which power sector investments have been financed in sub-Saharan Africa, the drivers for investment decisions, and the priority areas necessary to tackle investment risks. Such an analysis can help with the design or the re-evaluation of policies and regulations to ensure their ability to reduce the cost of capital, especially for renewables where financing costs account for around half of the LCOE. The first part of this section addresses this by presenting an overall picture of the financing of the power sector in sub-Saharan Africa and describes the role of private financing in particular. The second part identifies four priority areas that require further policy and regulatory interventions to reduce investment risks and scale up the funds needed to finance investments.

10.8 Sources of finance for power investment in sub-Saharan Africa

The majority of the power sector investment in sub-Saharan Africa has been financed by public funds, mainly from domestic governments or state-owned utilities, development finance institutions (DFIs) and export credit agencies (ECAs). Of the new projects with final investment decisions in the period 2014-18, two-thirds of the new generation capacity was publicly funded. The level of reliance on public funds was highest for large, conventional generation projects and lowest for renewable projects, in part because in South Africa all new renewable capacity since 2011 has been procured via a competitive tender programme (Figure 10.17). The role of DFIs and ECAs as financiers has been important across the board, but particularly so for large coal-fired generation and hydropower projects where they accounted for around 60% of funds raised. Chinese DFIs have played an especially visible role: between 2013 and 2017 over $10 billion of Chinese funds financed 80% of the total investment for ten hydropower projects (over 6 GW) and over $6 billion for five coal-fired plants.

Figure 10.17 ▷ Financing sources for power generation investment by share, type and capacity in sub-Saharan Africa, 2014-2018



Large-scale generation projects have been more reliant on public sources of finance, while renewables were financed more with private finances

Notes: DFIs = development finance institutions; ECAs = export credit agencies; SOEs = state-owned enterprises. Based on utility-scale projects that reached financial close between 2014 and 2018.

Sources: IEA analysis based on World Bank (2019) and IJ Global (2019).

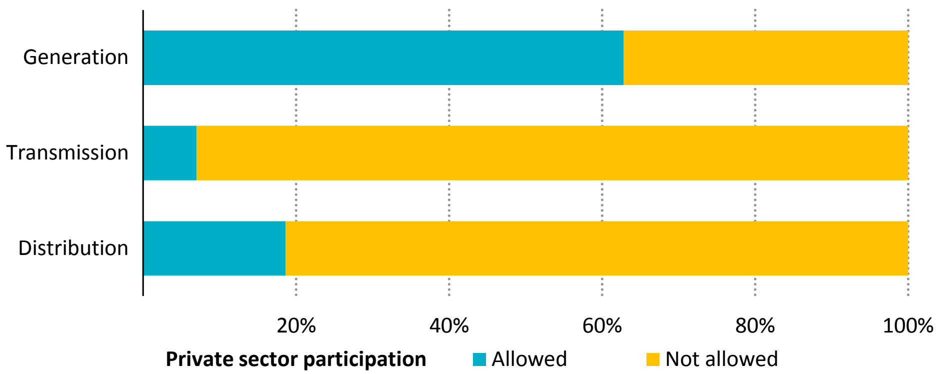
10.8.1 Investment framework and market structure

Private sector financing has been focused on generation (Figure 10.18), mainly through projects developed by independent power producers (IPPs).[7] In contrast, most of the

[7] IPPs are generation projects owned and operated by entities other than utilities, e.g. private developers.

investment in electricity networks has come from the public sector. To date, 16 of 43 sub-Saharan African countries do not allow for private sector participation in electricity generation or networks, and 18 others only allow it in power generation.

Figure 10.18 ▷ Private sector participation in electricity supply in sub-Saharan Africa by activity



In many countries there is no private sector participation allowed. Where it is allowed, it is mainly in the generation activity.

Notes: In the distribution category, decentralised solutions are not included. Based on 43 countries in sub-Saharan Africa.

Unlike power generation, transmission and distribution grids have monopolistic characteristics and are generally subject to strong regulation. In sub-Saharan Africa, private sector participation in transmission has come about mainly through "whole-of-grid concessions"[8], but these did not result in much investment and two-out-of-three were cancelled (World Bank, 2017). Private participation in distribution networks is more common, also under concessions, but it is still far from usual: fewer than ten countries in Africa allow it (Eberhard et al., 2016).

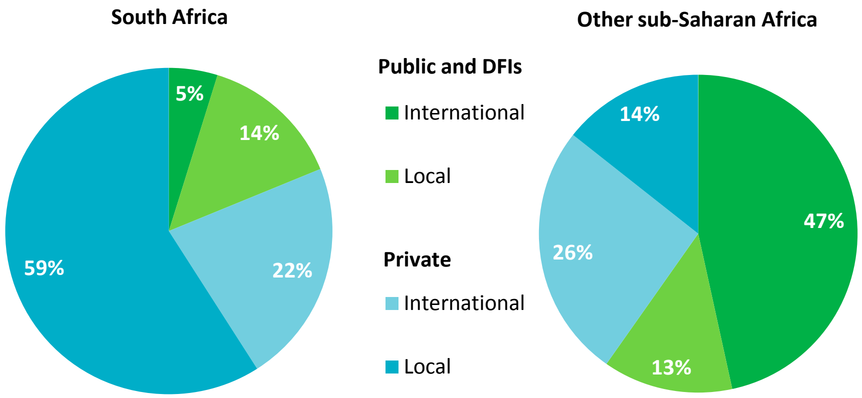
Supportive policies and regulations as well as maturing markets have helped attract private sector investment into mini-grids and stand-alone systems. The World Bank estimates that there has been almost $4 billion of cumulative investment in Africa to date in almost 1 500 mini-grids (ESMAP, 2019). Although the majority of mini-grids were financed and are operated by state-owned utilities (some installed long ago), the privately-financed market has been growing – there are about 480 mini-grid developers in the African market today. Estimates based on another study of the global solar market of stand-alone systems show that 75% of the total funds raised by top developers between 2012 and 2017 (almost $700 million) went to developers operating in East and West Africa (IFC, 2018).

[8] Whole-of-grid concessions are long-term contracts where a private company is responsible to operate and maintain the existing grid, as well as investing in new lines and ensuring quality of supply. The company's annual revenues are set by a regulatory authority and subject to periodic revisions.

10.8.2 Private financing is concentrated in IPPs, mostly in South Africa

For almost 90 utility-scale IPP projects that obtained financing between 2014 and 2018 in sub-Saharan African countries, more than 60% of the funds were from private sources (World Bank, 2019a). Improved policy frameworks helped reduce perceptions about risks and increase project bankability. Lenders were willing to lend more money and the average share of costs that they were willing to cover rose from an average of 67% in 2014 to 79% in 2018.

Figure 10.19 ▷ Sources of financing for independent power producers in sub-Saharan Africa financed between 2014 and 2018



Policy frameworks to underpin IPP projects are less developed in sub-Saharan Africa, other than South Africa, which limits the ability of public and development finance to catalyse private investment

Note: DFIs = development finance institutions; IPP = independent power producers.

Sources: IEA analysis based on World Bank (2019a) and IJ Global (2019).

South Africa alone attracted two-thirds of the private finance for IPPs, or almost $7 billion over the 2014-18 period. In South Africa, IPPs were less reliant on public funds and required lower shares of equity than in other countries, with the private sector providing more than 80% of funds for IPPs (Figure 10.19). A good enabling environment, combined with a well-developed financial sectoral and clear sector policies were critical factors. A notable example is the Renewable Energy Independent Power Producer Procurement Programme (REIPPPP), a competitive programme to tender all new renewable capacity introduced in 2011, which was instrumental in enhancing the bankability of renewable projects. However, delays in the recent rounds of the programme – driven by political uncertainty as well as the deteriorating financial performance of state-owned utility Eskom – have raised questions over the positioning of the REIPPPP in South Africa's overall power sector development.

The financing picture is very different in other parts of sub-Saharan Africa. In most other countries there has been a high degree of reliance on public funds to finance IPP projects, and public and development finance has not been as effective in catalysing private financing, though this has varied between countries. Between 2014 and 2018, every dollar funded by public and development finance was matched by one or more dollars of private funds in Namibia, Nigeria, Mozambique and Ghana, but slightly above half a dollar in Zambia, and less than that in other countries. On average, every dollar funded by public and development finance was matched by half a dollar of private funds, whereas in the case of South Africa each dollar was matched by almost four dollars of private finance.

Table 10.3 ▷ Selected large development finance initiatives supporting sub-Saharan Africa's power sector

Initiative	Main financiers	Committed funds (billion $)	Type of support by project phase		
			Preparation	Financing	Implemen-tation
Green Climate Fund	Mainly developed countries	5.2	●	●	●
Africa Renewable Energy Initiative	France, Germany and European Commission	10.0	●	●	●
Clean Infrastructure Funds	Developed countries	8.1		●	●
New Deal on Energy for Africa	African Development Bank	12.0	●	●	●

The World Bank Group, the African Development Bank (AfDB), European governments and institutions, and the United States and Japanese governments provided most of the public funds used in the sub-Saharan African power sector between 2008 and 2017. The majority of this went to transmission and distribution projects, then to renewable-based generation and last to non-renewable power. The three main recipient countries were Kenya, Tanzania and Ethiopia (OECD, 2019). Separately, DFI funding from China has been growing rapidly (Horn, Reinhard and Trebesch, 2019). Funding has come from other sources too: a diverse array of organisations have established initiatives and committed funds to support power infrastructure development or help with project preparation, financing and implementation support (Table 10.3). Some initiatives, like US-led Power Africa or the AfDB's New Deal on Energy for Africa, expect their commitments to bring in significant additional funds. For example, the AfDB's New Deal on Energy for Africa expects to leverage $45-50 billion in co-financing by 2020. Similarly, the Power Africa programme has supported power sector investments in Africa that, if fully realised, would total more than $50 billion.

Development finance support has been substantial across sub-Saharan Africa and, to various degrees, has helped to catalyse private funds. In many cases, the presence of DFIs, providing financing and risk mitigation measures, has been critical to obtain financing. Further commitments are expected in the coming years.

However, while public financing looks set to continue to play an important role, closing the very large investment gap requires a much bigger role for private financing: there are limits to what governments can do, given their fiscal constraints, and state-owned utilities are mostly in a weak financial position. Attracting larger amounts of private funds requires policy and regulatory improvements in the region, as well as project-specific measures to reduce investment risks. Such improvements could increase the catalytic effect and allow for a more effective use of public funds.

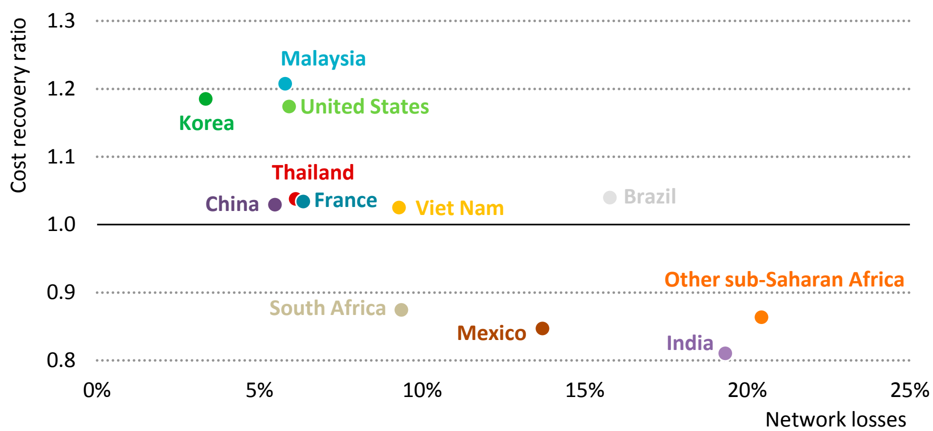
10.9 Closing the investment and financing gap

This section highlights four priority areas that will be vital to address to reduce risk perceptions, to obtain more and cheaper financing, and to bring new actors to the power sector.

10.9.1 Improve the financial and operational performance of utilities

Utilities in sub-Saharan Africa have high transmission and distribution losses (Figure 10.20). This, combined with tariffs below costs and low collection rates, results in utilities being generally short of cash and hampers their ability to raise funds. It is estimated that only 19 out of 39 utilities in sub-Saharan Africa earned enough revenues to cover operational expenses, and only four of these covered at least half of their capital expenses (Kojima, 2016). As utilities are the main counterpart to private investors in generation, this situation can raise concerns on the part of those investors about future payment and makes it more difficult to secure financing at low cost.

Figure 10.20 ▷ Electricity network losses versus cost recovery ratio for major utilities in selected markets



The weak financial and operational performance of utilities in sub-Saharan Africa hampers affordable financing in the power sector

Note: IEA analysis with calculations for cost recovery based on financial statements of reference utilities in each market.

Strengthening the governance framework of utilities is critical to improve operational and financial efficiencies. The World Bank study estimated that 11 utilities in the region could become financially viable if network losses dropped to 10%, cash collection rates increased to 100% and staff ratios matched those of efficient utilities in other regions (Kojima, 2016). Reducing network losses requires setting feasible targets, robust planning and a clear action plan to invest in infrastructure. Getting this done may come with challenges but there are positive examples in the region (Box 10.4). Moving towards cost recovery, which may require subsidies or cross-subsidisation, is also necessary to increase the pace of investment by easing perceived counterparty risks and allowing for increased financing at lower cost.

Box 10.4 ▷ Improving performance of a distribution utility: lessons from Uganda

The Government of Uganda initiated reforms in 1999 to unbundle the state-owned utility, Uganda Electricity Board. IPPs were introduced and the government awarded a concession to operate and maintain the generation assets. A state-owned transmission company was created and made responsible for planning, procurement and operation. Umeme, a private consortium, won a 20-year concession to operate and maintain the network.

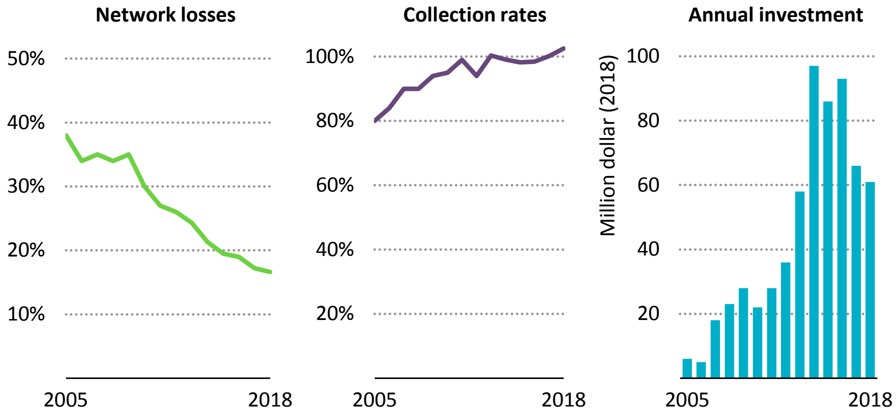
Improvements in operations were slow during the first few years of the concession, but Umeme was able to reverse the situation. Network losses halved from 38% in 2005 to 17% in 2018, driven by an increase in annual investment from an average of $16 million in the 2005-09 period to $81 million in the 2014-18 period, and an improvement in the power supply. In addition, the number of customers multiplied by four while collection rates increased by 20 percentage points (Figure 10.21).

Key factors included:

- Contract-based performance indicators. Indicators included loss reduction targets and investment obligations ($65 million by the end of the fifth year).
- Regulatory independence. The government agreed that the regulator would set annual tariff adjustments based on a methodology defined in the concession contract.
- Commercial efficiencies. Increased channels to pay bills (including mobile payments) and the roll-out of prepayment metering made a difference (which in 2018 represented 24% of revenues).
- Technical support from international donors.
- Various risk mitigation mechanisms established with DFI support. The security package included a payment guarantee and insurance to cover termination and other political risks.

The process was not always smooth. In 2006, the government and Umeme renegotiated the contract after a power crisis (one of the two original investors left the concession at this point). Improvements in electricity access were slow and, although access has increased recently, the percentage of those with access remains low (around 11% in rural areas). Quality of electricity supply also remains an issue for customers despite the reduction in losses.

Figure 10.21 ▷ Transmission and distribution network losses, collection rates and annual investments in Uganda, 2005-2018



After a period of slow progress, the private distribution company reduced network losses and increased collection rates, which supported increased investment

Note: Collection rates surpass 100% due to pre-paid metering.

Sources: IEA analysis based on World Bank (2014) and Umeme (2018).

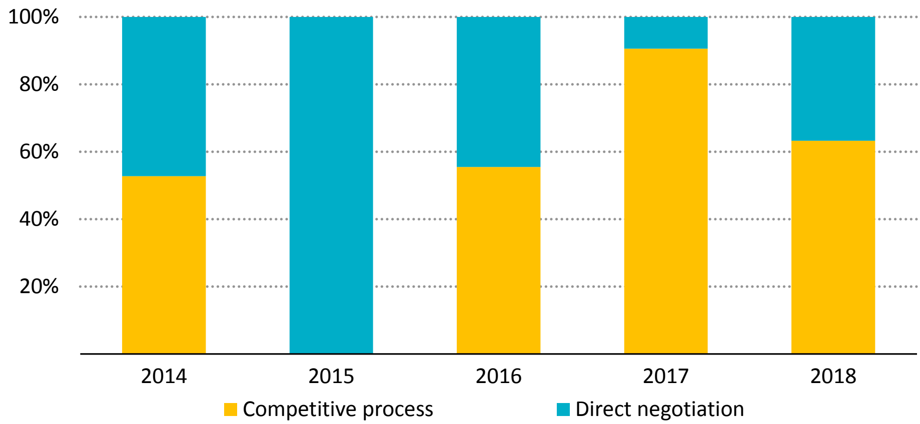
10.9.2 Enhance policy and regulatory frameworks to improve bankability

Robust procurement frameworks and well-designed contracts are crucial for project bankability. Competitive procurement is picking up in sub-Saharan Africa and is attracting strong interest from investors. Excluding South Africa, which largely acquires independent power projects through competitive tenders, half of the privately-financed IPP projects that reached financing in 2014-18 were competitively awarded (Figure 10.22).

Designing and conducting competitive tenders and auctions requires technical expertise and can take longer than direct negotiations. However, well-designed auctions bring a high degree of transparency and predictability, enhance market confidence and facilitate price discovery. Bid prices for solar PV under the REIPPP decreased by 80% between 2014 and 2018, while a programme to procure utility-scale solar PV in Zambia and Senegal together attracted almost 100 applicants and brought record low prices for the region of $48/MWh in 2017 and $43/MWh in 2018.

A key feature to ensure that procurement programmes translate into investments at scale is the bankability of the underlying contracts. Successful procurement programmes are accompanied by power purchase agreements that clearly define risks and responsibilities, e.g. clauses on dispute resolution, force majeure and termination. Credit enhancement mechanisms such as escrow accounts or public guarantees may also be necessary to mitigate payment risks and increase utilities creditworthiness. For example, the tenders in Zambia and Senegal had both sovereign and DFI-backed guarantees. Maintaining predictable, clear policies throughout the process is also important to preserve interest from private investors and lenders.

Figure 10.22 ▷ IPP capacity awarded by type in sub-Saharan Africa (excluding South Africa), **2014-2018**



Competitive procurement is increasing in sub-Saharan African countries, though almost half of privately-financed capacity was awarded by direct negotiation

Sources: IEA analysis based on World Bank (2019a).

10.9.3 Create supportive enabling environments for rural electricity access

As discussed in section 10.4, reaching access targets requires a combination of on-grid and decentralised solutions. Scaling up investments in decentralised solutions may come with a variety of challenges, many of which evolve around revenue and regulatory uncertainty.

Supportive policies, as well as low-cost financing from DFIs, foundations and impact investors i.e. those that invest in projects that have development benefits, have fostered private-led projects, but revenue uncertainty still presents a major challenge, especially as much of future electrification will take place in more rural and generally poorer areas (Table 10.4). Mini-grid developers cannot recover the high upfront investments if customers consume little, while retailers of solar home systems may need to anticipate longer repayment periods and higher default rates from the customers they provide loans. Consumers may be restricted by their ability to pay for electricity.

Table 10.4 ▷ Main risks and their underlying causes in deploying mini-grids and solar home systems

	Mini-grids	Solar home systems
Revenue risk		
Low demand	Inability/delay to recover high upfront investment due to electricity demand lower than expected (over-sized mini-grid).	Low sales due to limited ability to pay, restricting demand to low-end solar home systems.
Low affordability	Customers with low and unpredictable income.	
Tariff level and subsidies	Dependence and uncertainty regarding subsidies (especially if tariffs required to be set at national uniform levels); difficulty to maintain support for and collect cost recovery tariffs (high compared to the grid), if allowed tariffs not capped.	Prices of solar home systems are generally unregulated, but developers may face uncertainty regarding regulation of subsidies (when applied), dependence on mobile services and regulation of interest rates of loans.
Regulatory risk		
Registration and licensing	Unclear rules on licensing and registration of assets and delays to obtain such permits.	Generally none.
Tariff setting	Incomplete/unpredictable tariff setting methodology. Delays to obtain tariff approvals.	N/A
Interaction with central grid	Weak/incomplete specifications of what happens when the central grid arrives to an area where a mini-grid operates (e.g. mini-grid becomes SPP or SPD; financial conditions in case of asset buy-out by utility).	N/A

Note: N/A = risk does not arise given technological and commercial characteristics; SPP = small power producer; SPD = small power distributor.

A study in rural Rwanda shows that households that received a free small PV kit used it intensively and reduced their kerosene and energy consumption: it also found that children studied longer (Grimm et al., 2016). Other studies also support the hypothesis that consumers are cash and credit constrained, and that social benefits, when fully internalised, exceed the investment costs. This points to the need for some sort of government or public support to realise these benefits.

Electricity subsidies, or similar financing mechanisms, could help rural households overcome the affordability constraint. They could also increase the sustainability of the decentralised electricity sector and encourage private companies to expand to more rural areas. Subsidies could be provided to households in the form of lower tariffs or help with connection costs or they could go to developers in the form of grants for capital expenses or concessional financing. Whatever option is chosen, subsidies need to be clear, predictable and well targeted.

Even if subsidies are expanded successfully, increased consumption will still be critical. Annual electricity demand per person in sub-Saharan Africa currently stands at around 190 kWh (excluding South Africa). This is one of the lowest levels of demand in the world. In some countries, increasing electricity access has led to increasing consumption as well, but at lower rates. For example, while access grew at an annual rate of 3.5% in Ghana between 2000 and 2018, per capita consumption grew by 1.5% per year. In Kenya, the growth in the access rate was four-times the growth in per capita consumption. Policies to increase productive uses and higher industrialisation could help reverse this trend.

Those countries where private mini-grid developers are most active, such as Tanzania, Nigeria, Kenya and Rwanda, are also those that have the best-developed regulatory frameworks. A strong and well-articulated regulatory framework that is clear about the most important issues will help to attract private investors. The issues that need to be covered include tariffs levels, subsidies and tariff setting; regulation of entry; and what happens when the central grid arrives. Tanzania's mini-grid regulation provides four alternatives on this last point: mini-grids can become small power producers (SPPs) selling electricity to the grid; they can become small power distributors (SPDs) buying electricity from the grid; they can combine the two (SPP+SPD); or they can sell the mini-grid assets to the utility. Lack of clarity over compensation issues, and concerns about enforcement of the regulation still appear to be causing concern to developers.

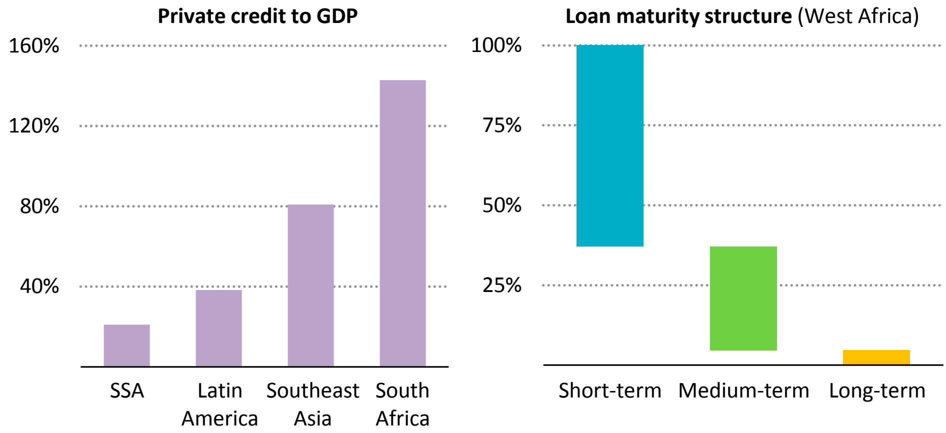
10.9.4 Strengthen provision of long-term finance

Given the long-lived and capital-intensive nature of power projects, the availability of long-term finance is crucial for power sector investment. In most of sub-Saharan Africa, however, access to long-term finance is severely constrained. It relies heavily on international development finance. Given the substantial risks associated with currency fluctuations, the local financial sector has a central part to play in ensuring a steady flow of long-term financing to power projects: a mismatch between revenues in local currency and costs in foreign currency (for equipment, borrowing, prices for power purchase agreements) can weigh heavily on the finances of state-owned utilities. While access to local banks in sub-Saharan Africa expanded over the past decade, it still compares unfavourably with access in other developing economies, with the exception of South Africa; and the majority of loans are still for short-term investments (Figure 10.23).

Developing the local financial sector and its ability to extend long-term finance has the potential to make a big difference to secure private investment in the power sector. DFIs can help by acting as a catalyst, for example by providing guarantees, refinancing or on-lending mechanisms. The refinancing of the Kenya Power and Lighting Company, the company that owns and operates the majority of the electricity network in Kenya, is a good example of how DFIs can strengthen the role of local banks and help utilities access cheaper and longer term finance ($500 million of commercial debt was restructured for longer term and lower cost commercial debt). Domestic pension and sovereign wealth funds could also play a more important role in financing power investments. Senegal's

Sovereign Fund for Strategic Investments, FONSIS, which has provided equity for solar PV plants in Senegal, is leading the way.

Figure 10.23 ⊳ Level of private credit and loan maturity of the local banking sector in sub-Saharan Africa, 2016-2017

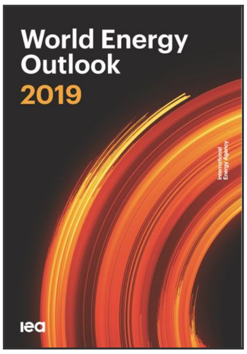


The local financial sector is playing a limited role in power sector financing other than in South Africa; the provision of long-term finance is particularly constrained

Notes: SSA = sub-Saharan Africa (excluding South Africa). Long-term loan has a maturity more than five years; medium-term loan between one and five years; and short-term loan less than one year.

Sources: IEA analysis based on World Bank (2019b) and BCEAO (2018).

Domestic policies outside the power sector also matter. Policies on issues such as the repatriation of funds, tax incentives and the regulation of public-private partnerships all affect the overall enabling environment and the regulatory framework for financiers. Clear economic policies that are conducive to private sector participation have an important role to help scale up power sector investment in Africa.



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