Implications for Africa and the world

Introduction

How the African energy system evolves over the next two decades, and what it will look like in 2040, are vitally important questions not only for Africa but also the rest of the world. The future pathway is far from certain but, whatever the policy choices, the implications of those choices will resonate throughout Africa and beyond. We have outlined possible pathways for the continent's energy development to 2040 as described in detail in Chapters 9, 10 and 11. These pathways are based on an in-depth, sector-by-sector and country-specific analysis of Africa's energy sector opportunities: to the best of our knowledge, this is the most comprehensive such analysis undertaken to date.

The chapter consists of two sections:

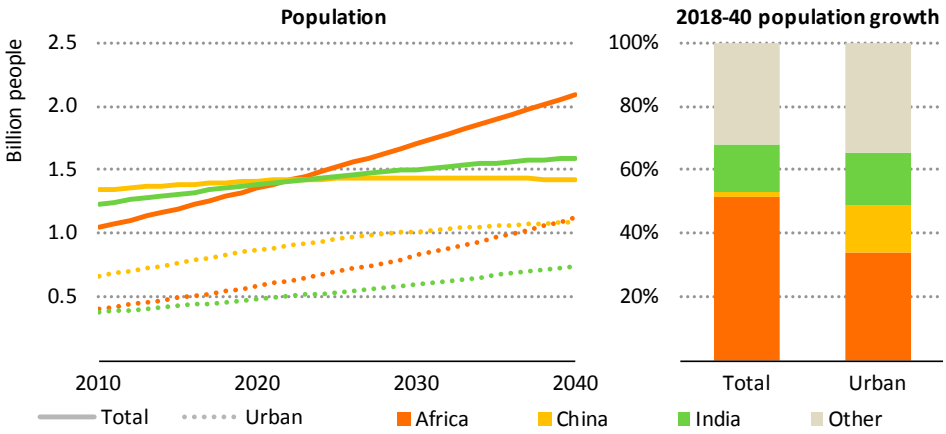
- **A discussion of the policy implications and outcomes of the analysis in the global context**: This section provides a brief summary of what the future might hold for Africa's energy sector, and what it might mean for global energy and emissions trends, looking in particular at two scenarios. The first is the Stated Policies Scenario, which takes account of existing plans and announced intentions, and the second is the Africa Case, which is based on the Agenda 2063 vision agreed by African leaders (see Box B.2 in the introduction to Part B).
- **Detailed regional and country energy profiles**: The second part presents the results of the Stated Policies Scenario and Africa Case for sub-Saharan Africa as a whole as well as for eleven countries in this region: Angola, Côte d'Ivoire, Democratic Republic of the Congo, Ethiopia, Ghana, Kenya, Mozambique, Nigeria, Senegal, South Africa and Tanzania. The countries covered represent three-quarters of sub-Saharan Africa's gross domestic product (GDP) and energy demand today, and two-thirds of population. The profiles aim to provide decision makers with a data-rich set of information on the potential energy pathways for each country, considering their unique energy demand and supply needs and stages of development.

Implications for the world

Africa's population is among the fastest growing and youngest in the world, and this trend is set to continue in the period to 2040. One-in-two people added to the world population by 2040 are African, and a third of global urban population growth occurs in Africa (Figure 12.1).

Over the next 20 years, total population growth in Africa is more than double the combined population growth of China, India and Southeast Asia. In the coming years, Africa overtakes both China and India in terms of total population. This large increase (mostly occurring in cities) will be a major force driving Africa's energy demand growth.

Figure 12.1 ▷ Total and urban population in Africa, China and India, and share in global growth, 2018-2040



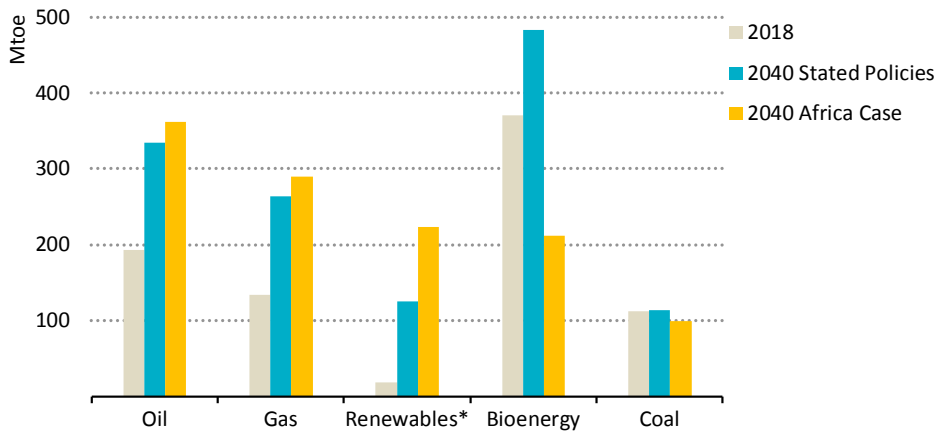
One-in-two people added to the world population and one-in-three people added to urban populations in the period to 2040 are African

Africa as a key driver for global energy demand growth

A rapidly rising population and growing pace of urbanisation make Africa a key driver of global energy demand growth. In the Stated Policies Scenario, total primary energy demand in Africa grows by 2% per year between 2018 and 2040, double the pace of global demand growth. At the same time, the composition of energy consumption in Africa increasingly moves away from the traditional use of biomass to modern and more efficient energy sources, notably electricity, natural gas and oil products.

Effective energy policy choices are essential not only to bring to fruition the continent's growth ambitions (including those contained in Agenda 2063), but also to support other economic and developmental goals. These goals include building a sustainable energy system, managing the rapid pace of urbanisation, scaling up industrial capacity and maximising the value of the continent's natural resources. As a tangible representation of the Agenda 2063 vision, the Africa Case incorporates policies to build the African energy sector in a way that allows higher economic growth to be sustainable and inclusive. It shows that achieving the goals of Agenda 2063 does not necessarily require more energy-intensive economies, compared with the Stated Policies Scenario. There is a considerable reduction of bioenergy use in the Africa Case, and growth in demand for other sources of energy is moderated by strong efficiency improvements. There is also a significant increase in electricity demand, but additional demand is mostly met by renewables. As a result, overall primary energy demand in 2040 in the Africa Case is 10% less than in the Stated Policies Scenario (Figure 12.2).

Figure 12.2 ▷ Total primary energy demand by fuel and scenario in Africa



Achieving the outcome of the Africa Case adds only marginal amounts to demand for oil and gas relative to the Stated Policies Scenario while reducing the use of bioenergy

* Excludes bioenergy.

Africa emerges as a key source of **global oil demand** growth in our projections. At present, car ownership levels in Africa – especially in sub-Saharan Africa – are very low (in Ethiopia, for example, less than 2-out-of-1 000 people own a car). Oil demand grows as the size of the car fleet expands, and as liquefied petroleum gas (LPG) is increasingly used for clean cooking.

In the Stated Policies Scenario, the size of the car fleet in Africa more than doubles by 2040. This contributes to an increase of oil demand by 3.1 million barrels per day (mb/d) over the period, higher than the projected growth in China and second only to that of India. However, average car ownership levels in sub-Saharan Africa (excluding South Africa) in 2040 are still equivalent only to 60% of the level in India today. The lack of policies both for new and second-hand vehicles means that most cars have low fuel efficiency and are not subject to emissions standards that are common in many parts of the world.

In the Africa Case, the number of cars increases further to nearly 80 million by 2040, but improved vehicle efficiency offsets the expansion of car stocks and the numbers of kilometres driven. An increase in oil demand in this scenario relative to the Stated Policies Scenario is rather driven by the residential sector, where progress towards clean cooking creates additional demand for LPG.

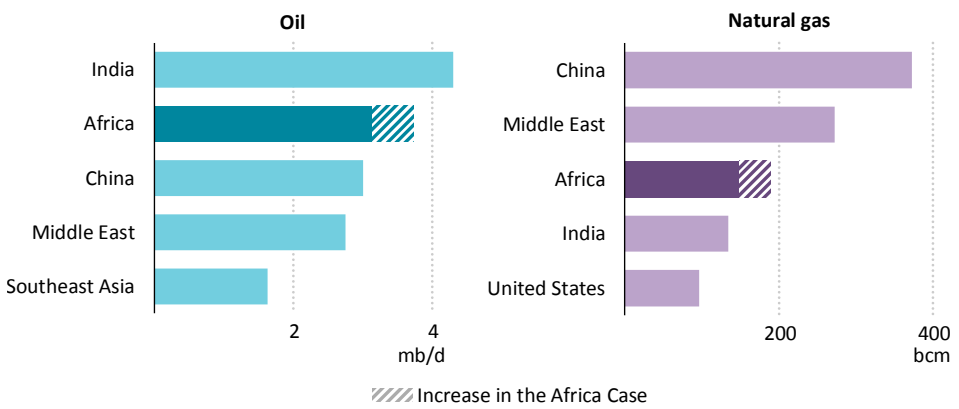
Africa's growing weight is also felt in **natural gas markets**. The combination of renewables and natural gas provides a good fit for the development vision that African leaders signed up to in Agenda 2063. In the power sector, natural gas can help satisfy the growing appetite for baseload electricity and complement the rapid expansion of renewables, especially in those countries with large gas resources. There are also many energy uses that are hard to

electrify (for example, industrial processes such as steel making) that are likely to see demand growth as African industry supports the continent's growth in urbanisation and infrastructure. In many cases, the choice for these uses is between gas and other (more polluting) fossil fuels rather than between gas and renewables.

The challenges for natural gas development relate to infrastructure, affordability and business models. A number of major gas discoveries (representing over 40% of global gas discoveries between 2011 and 2018) have been made in recent years, but the extent to which they will provide fuel for African development, as well as revenue from export, is uncertain. Making the most of these resources would require new pipeline infrastructure, although small-scale liquefied natural gas (LNG) technologies are allowing a new approach to distribute gas to consumers. Much will depend on the strength of Africa's policy push to displace polluting fuels from its energy mix, or to prevent them gaining a stronger foothold, and on the availability of finance to support the expansion of gas infrastructure.

In the Stated Policies Scenario, the share of gas in sub-Saharan Africa's energy mix rises from 5% today (one of the world's lowest) to just under 10% in 2040. In the Africa Case, it reaches almost 20% in 2040. In both scenarios, Africa becomes the third-largest source of additional gas demand globally between today and 2040, following China and the Middle East (Figure 12.3). Thanks to the emergence of new producers, notably Mozambique, Tanzania, Senegal and Mauritania, Africa also strengthens its position in global export markets.

Figure 12.3 ▷ Growth in oil and natural gas demand by region in the Stated Policies Scenario and Africa Case, 2018-2040



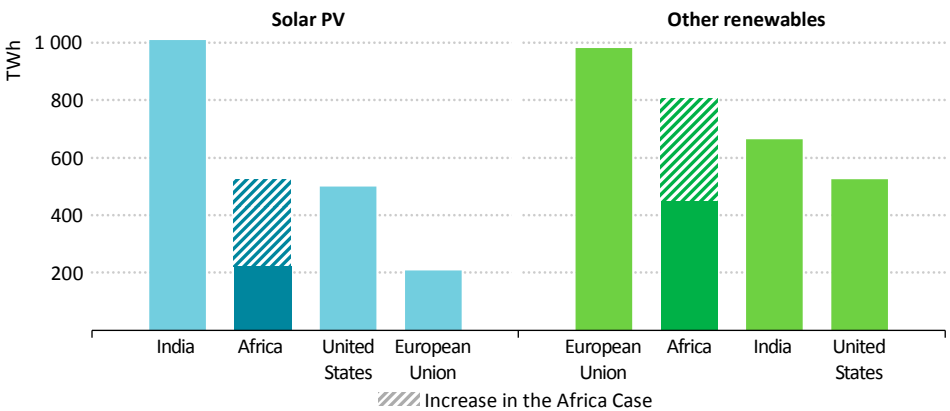
Africa emerges as a key source of demand growth for oil and natural gas. The growth in oil demand is second only to India; the growth in gas demand is the third-largest in the world

Reliable electricity supply plays a central role in meeting rising energy demand in Africa. Electricity demand in Africa is set to increase strongly, more than doubling from 700 terawatt-hours (TWh) today to over 1 600 TWh in 2040 in the Stated Policies Scenario

and to 2 300 TWh in the Africa Case. Renewables make a major contribution to the additional generation required. Falling costs drive the fast deployment of utility-scale and distributed solar photovoltaics (PV), and deployment of geothermal and wind also picks up sharply: in the Stated Policies Scenario, the combined contribution of these non-hydro renewable resources increases from less than 5% today to around 30% of Africa's total power generation in 2040. Hydropower also remains a cornerstone of sub-Saharan Africa's power system – notably in the Democratic Republic of the Congo (DR Congo), Ethiopia and Mozambique – and generation almost triples by 2040. Better regional co-operation and integration of power networks is instrumental in unlocking hydropower's huge potential.

The scale of deployment of non-hydro renewables is even more significant in the Africa Case. A large part of this comes from solar PV, which overtakes hydropower and natural gas to become the largest electricity source in Africa in terms of installed capacity (and the second-largest in terms of generation output). Solar PV deployment between today and 2040 amounts to almost 15 gigawatts (GW) a year, equivalent to the amount of solar PV capacity the United States adds every year over the same period. Wind also expands rapidly in several countries benefiting from high quality wind resources, notably Ethiopia, Senegal and South Africa, while Kenya is at the forefront of geothermal deployment. The growth in overall renewable-based electricity generation in African countries is higher than in the European Union (Figure 12.4).

Figure 12.4 ▷ Growth in renewables-based electricity generation in selected regions, 2018-2040



Renewables account for three-quarters of additional electricity generation in the Africa Case, and bring Africa to centre stage in global renewables markets

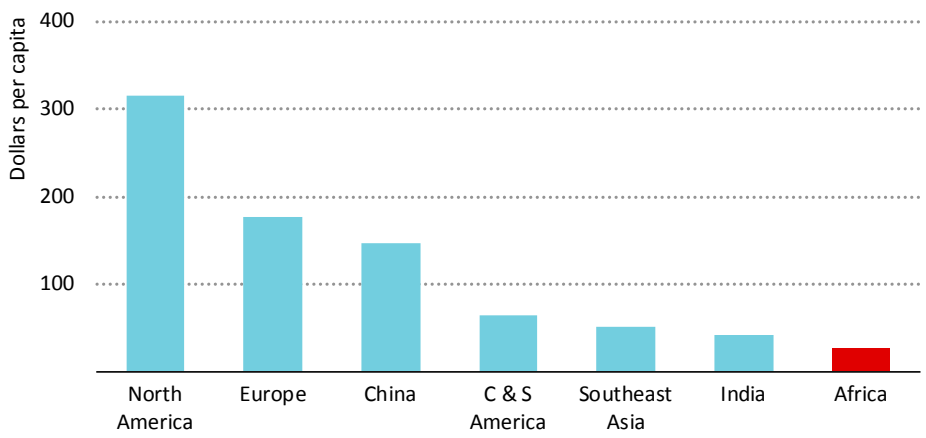
Note: Other renewables include hydro, wind, geothermal, concentrating solar power and biomass.

Achieving this level of deployment would require the development of efficient supply chains and the physical infrastructure necessary to facilitate smooth trade in goods and technologies between countries (as envisaged in the African Continental Free Trade Area). A favourable regulatory environment which reduces risks and the cost of finance would also be essential, as would the technical capacity to underpin a large-scale installation and maintenance sector.

Mobilising investment for reliable power supply: challenging but achievable

Africa needs to expand its energy infrastructure, especially in the power sector, to serve its growing population. Despite being home to 17% of the world's population, Africa currently accounts for just 4% of global power supply investment. On a per capita basis, power supply investment in Africa ranks among the lowest in the world (Figure 12.5). In sub-Saharan Africa, power generation capacity per capita has shown little or no growth since 1990 while that of India and Southeast Asia has grown fourfold.

Figure 12.5 ▷ Per capita power supply investment by region, 2018



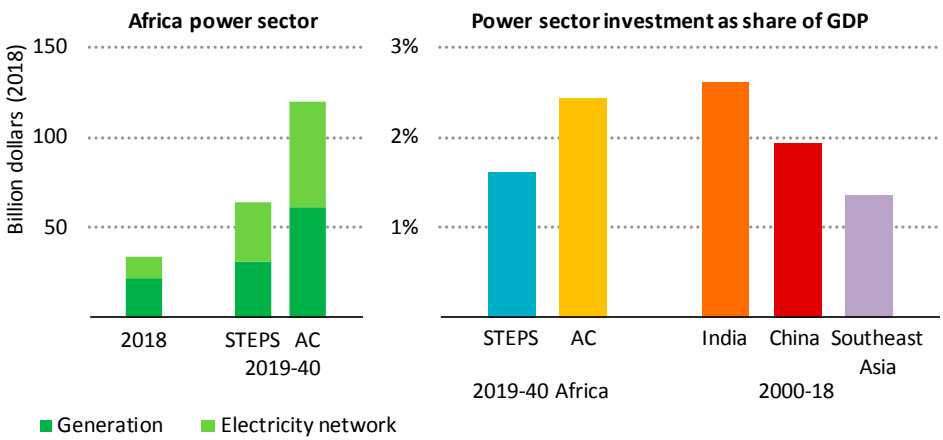
Africa's per capita investment in power supply ranks among the lowest in the world

Note: C & S America = Central and South America.

Addressing the deficit of power infrastructure in Africa will require a significant ramp-up in spending. Investments in power supply need to double through to 2040 in the Stated Policies Scenario to around $65 billion per year. The Africa Case requires a further doubling to around $120 billion per year to ensure reliable and affordable power for all and to serve an economy growing at over 6% a year. Nigeria, South Africa, DR Congo and Ethiopia are among the countries with the highest investment needs. Half of the investment is needed to expand and upgrade electricity networks – including mini-grids – and most of the rest is needed to increase low-carbon generation capacity where solar PV plays an important role. Investment needs in solar PV in sub-Saharan Africa amount to almost $25 billion per year on average in the Africa Case – almost double the level of investment in the European Union today.

The cumulative investment in Africa's power supply between 2019 and 2040 reaches $1.4 trillion in the Stated Policies Scenario (1.6% of the continent's GDP over the same period) and $2.6 trillion in the Africa Case (2.4% of GDP). Mobilising these levels of investment is a significant undertaking, but it is achievable if concerted efforts are made by African governments and the global community. There are some precedents. India, for example, has invested the equivalent of 2.6% of GDP in the power sector since 2000 and China has invested 1.9% of GDP over the same period (Figure 12.6).

Figure 12.6 ▷ Average annual power supply investment in Africa by scenario and historical power sector investment in selected regions



Scaling up power supply investment is challenging but achievable if concerted efforts are made to establish a favourable investment climate and reduce investment risks

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

To date, investment in power supply in Africa has relied largely on state budgets with significant contributions from development finance institutions (DFIs). The prominent role of these public sources is likely to continue. Against a backdrop of growing fiscal deficits in many countries and tightening donor resources, however, it is critical that public spending is supplemented by private capital and that funding from DFIs is used to catalyse private financing.

Mobilising private capital requires concerted efforts from both African governments and international DFIs. A large number of countries in Africa limit private participation in the power sector: 16-out-of-43 sub-Saharan African countries do not allow private participation in both generation and electricity networks. Establishing a framework for private capital is clearly a necessary first step. Many of the utilities are loss-making and have low operational efficiency: 19-out-of-39 utilities in sub-Saharan Africa are not able to recover enough cash to cover operational expenses (Kojima, 2016). Together with below-cost tariffs and low collection rates, this raises investment risks and makes it difficult to secure financing at

affordable costs. Improving the financial and operational performance of utilities and moving towards cost-recovery are therefore essential to attract financing. Robust procurement frameworks (using competitive auctions, for example) and well-designed contracts are also crucial to enhance project bankability.

There is scope for international DFIs to help scale up investment and catalyse more private capital. Between 2013 and the first half of 2018, power sector investments based on private participation in infrastructure models in sub-Saharan Africa amounted to around $4.5 billion per year on average (less than 10% of the annual power sector investment needs between today and 2040), with South Africa accounting for more than half. Outside South Africa, each dollar of public funding (from DFIs and state budgets) attracted $0.6 of private capital either directly (via equity and direct loan) or indirectly (via guarantee) – the figure is $0.4 for renewables. This compares unfavourably with $0.9 for Southeast Asia and more than $4 for South Africa. It is therefore important for international DFIs not only to scale up direct investments but also to encourage private sector investment through targeted interventions (such as risk sharing, liquidity support and take-out financing). There is also a need to nurture the local financial sector to provide a sustained flow of long-term financing to infrastructure projects.

The prospects for Africa's power supply investment will be stronger if governments in African countries take account of what have worked well (and what have not) in other countries. India provides some instructive lessons. In the 2000s, the Indian government introduced a number of measures to establish a policy and regulatory framework to attract private capital, including model architecture for public-private partnerships (PPP) and financial instruments (such as an on-lending facility) to induce local financial institutions to invest in infrastructure. This contributed to a significant scale-up of private investment in power infrastructure and India was recognised as the highest recipient of PPP investments worldwide (World Bank, 2015). However, scrutiny of the commercial viability of projects was sometimes insufficiently rigorous, there were frequent construction delays, and the availability of fuel was often limited: this led to many projects performing less well than expected, and emphasises that there are potential pitfalls to manage even where the overall framework is a strong one.

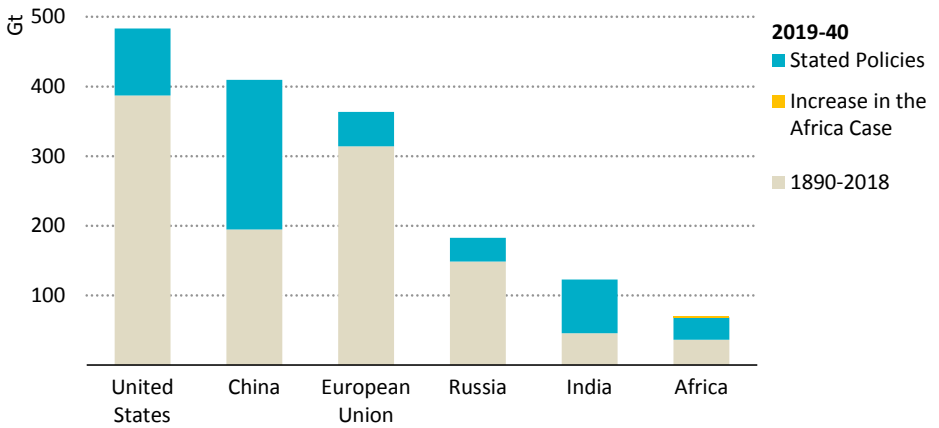
Not a major emitter, but climate change matters greatly for Africa

Africa has not been a significant contributor to global greenhouse gas (GHG) emissions during the age of industrialisation. Energy-related carbon dioxide (CO_2) emissions in Africa accounted for only 2% of global cumulative emissions from 1890 to today (Figure 12.7). Although Africa experiences rapid economic growth in the Stated Policies Scenario (by two-and-a-half times from today to 2040), its contribution to global energy-related CO_2 emissions increases to just 4.3% over the period to 2040.

Realising the outcomes in the Africa Case would increase total CO_2 emissions over the period to 2040 by around 2 gigatonnes (Gt) (or 100 million tonnes (Mt) per year) relative to the Stated Policies Scenario, raising Africa's contribution to 4.5%. Although this is not a

major increase globally, it is highly desirable – and in line with the vision in Agenda 2063 – that they are attained in a way which takes full account of the importance of sustainability, with a very strong role for clean energy sources. Looking beyond CO_2, the transition away from the inefficient combustion of biomass for cooking in the Africa Case leads to same levels of GHG emissions as in the Stated Policies Scenario as the increase in CO_2 emissions is offset by reductions in other GHGs (methane and nitrous oxide).

Figure 12.7 ▷ Cumulative energy-related CO_2 emissions by region and scenario



Africa has accounted for a very small share of global CO_2 emissions to date, and that does not change to 2040

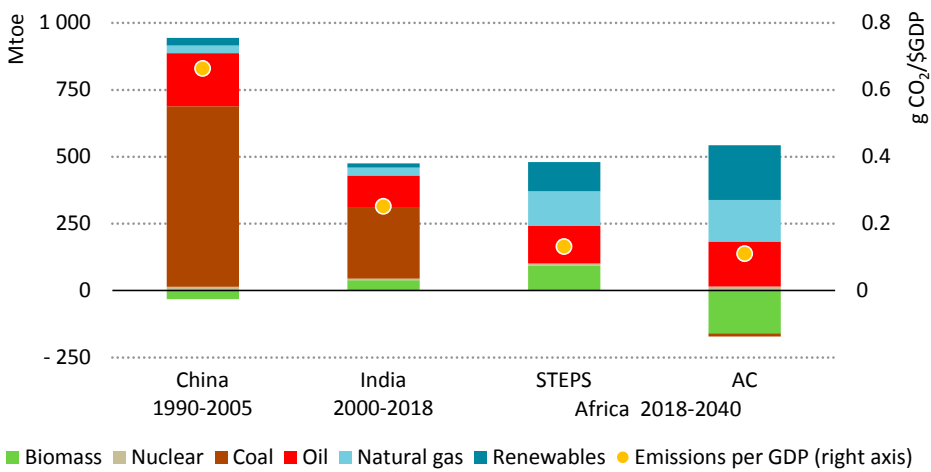
Thanks to technology improvements and resource endowments, Africa has the opportunity to pursue a much less carbon-intensive model of development than seen in many other parts of the world. For example, China relied heavily on coal (and oil to a lesser extent) to replace bioenergy and meet rapidly growing energy demand between 1990 and 2005 when its economy registered a fourfold growth. This resulted in cumulative emissions of around 50 Gt CO_2, meaning that China incurred around 660 grammes of carbon dioxide (g CO_2) emissions to generate one dollar of GDP over this period. India has similarly relied on coal, oil and (to a lesser extent) natural gas to serve its expanding economy over the two decades since 2000. This was accompanied by cumulative emissions of around 28 Gt CO_2 or 250 g CO_2 per dollar of GDP.

In our projections, however, Africa follows a different pathway, with much stronger shares of renewables and natural gas in the energy mix. In the Stated Policies Scenario, the share of renewables (excluding bioenergy) and natural gas grows significantly to 10% and 20% respectively by 2040, while the reliance on traditional uses of bioenergy and coal diminishes. As a result, only 130 g of CO_2 emissions are incurred to generate one dollar of GDP between today and 2040, while the economy grows at a rate of 4% per year.

In the Africa Case, the size of the economy almost quadruples in the period to 2040, but the continent consumes less energy overall with a higher share of cleaner energy sources. The shares of renewables and natural gas expand further to 20% and 25% by 2040, while the share of traditional uses of bioenergy declines. The emissions associated with economic growth are 15% lower in this case, at around 110 g CO_2 per dollar of GDP (Figure 12.8). These emissions relative to economic growth are lower than the figures observed in advanced economies between 2000 and 2018.

With the appropriate policies to support a strong expansion of clean energy and sufficient emphasis on energy efficiency improvements, Africa could be the first continent to achieve a significant level of industrialisation with cleaner energy sources playing a prominent role, requiring much less energy and emissions to deliver economic growth than other economies in the past.

Figure 12.8 ▷ Changes in primary energy demand by fuel and associated emissions per GDP in China, India and Africa



Africa could be the first continent where renewables and gas play a prominent role in supporting a shift away from bioenergy and underpinning economic and industrial growth

Notes: STEPS = Stated Policies Scenario, AC: Africa Case. Emissions per GDP = cumulative CO_2 emissions / cumulative GDP during the indicated period. Renewables exclude bioenergy.

While Africa is responsible for a relatively small portion of global CO_2 emissions, its ecosystems already suffer disproportionately from global climate change, and future impacts are expected to be substantial. The continent therefore not only needs to adapt to the warming already experienced but also to prepare for the intensification of climate change impacts (World Bank, 2018). Temperatures in Africa are likely to rise faster than the global average during the 21st century. Climate change and climate variability are likely to

multiply existing threats and pose increased risks to food, health and economic security in Africa (IPCC, 2014).

This underlines the importance of ensuring that new infrastructure in Africa is climate-resilient. For example, only 30% of the buildings that are likely to exist in 2040 have already been built. If building codes are implemented for new buildings to optimise the use of natural light and ventilation for passive cooling, this could reduce the need for cooling systems (fans and air conditioners) and avoid the potential heat islanding effects that could occur in cities (see Spotlight in Chapter 9). Today, a quarter of the global population living in areas that are hot enough to require cooling systems live in Africa, and this share increases to 30% by 2040 in all scenarios. As new cities are built or existing cities grow larger, smart planning is essential to ensure that buildings are highly energy efficient and to facilitate sustainable modes of public transport.

Climate change is also likely to affect the availability of hydro resources. Detailed new analysis in this report shows the negative impacts of climate change on the availability and variability of hydropower outputs in a number of countries. While hydropower remains an essential element of sub-Saharan Africa's electricity supply, diversifying the electricity mix would help to mitigate the risk of power disruptions during droughts and strengthen resilience to changing climate conditions.

In contrast to many other regions, the energy sector is not the biggest contributor to total GHG emissions in Africa. It represents around a third of total GHG emissions (compared to more than two-thirds at the global level). In sub-Saharan Africa (excluding South Africa), land use and forestry[1] (LULUCF), agriculture and waste contribute most towards total GHG emissions. The reduction in the size of Africa's forests, which are natural carbon sinks, is the primary reason for the growth of GHG emissions in Africa: some countries have seen their forest area decrease by more than half over the last 25 years (Box 12.1), highlighting the importance of deforestation for climate policies.

While the ecological and environmental toll of reliance on fuelwood for cooking cannot be exactly quantified, the traditional use of solid biomass for cooking comes at a large cost to human health and wellbeing. Air pollution in Africa is one of the leading causes of premature deaths. Around 500 000 premature deaths are attributed to smoky indoor air arising from the use of solid biomass for cooking while 300 000 premature deaths are linked to outdoor pollution in cities.

In the Stated Policies Scenario, premature deaths owing to household air pollution decrease slightly over the outlook period as a consequence of efforts to bolster access to clean cooking through LPG stoves, improved biomass stoves or biodigesters. There is a much greater adoption of these cleaner technologies in the Africa Case: over 1.1 billion people move away from traditional use of solid biomass by 2030, and the number of premature deaths from household air pollution falls by two-thirds.

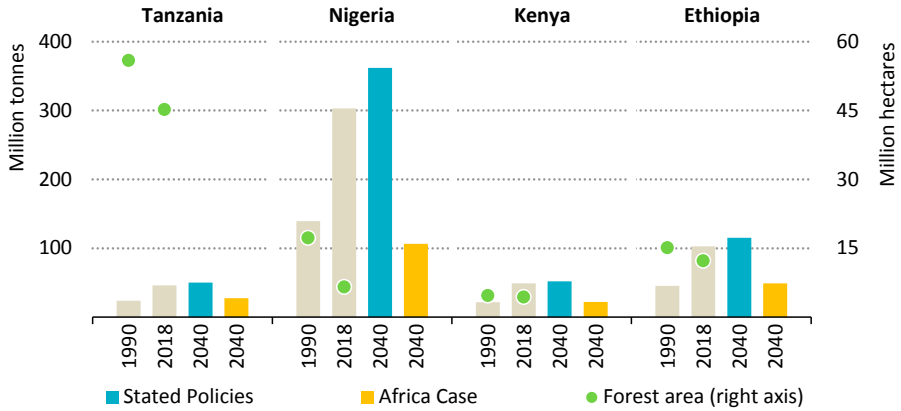
[1] LULUCF refers to land use, land-use change and forestry.

Box 12.1 ▷ Implications of unsustainable bioenergy use

Since 1990, the total forest area in Africa has fallen by 85 million hectares (ha), which is more than the total land area of Mozambique (Figure 12.9). Some countries have been more affected than others. For instance, Nigeria has lost 60% of its forest cover since 1990, while Tanzania and Ethiopia have lost almost 20% of their forest areas (FAO, 2019).

Conversely, fuelwood consumption (directly used by households for cooking or to produce charcoal) has doubled in sub-Saharan African countries (excluding South Africa) over the same period. While the relationship between deforestation and growing demand for fuelwood is difficult to quantify, efficiency improvements across the various bioenergy value chains could play a significant role in protecting forests, biodiversity and carbon sinks.

Figure 12.9 ▷ Fuelwood consumption in the Stated Policies Scenario and the Africa Case, and forest area in selected African countries



Making fuelwood consumption more sustainable is key to tackling deforestation in many sub-Saharan African countries

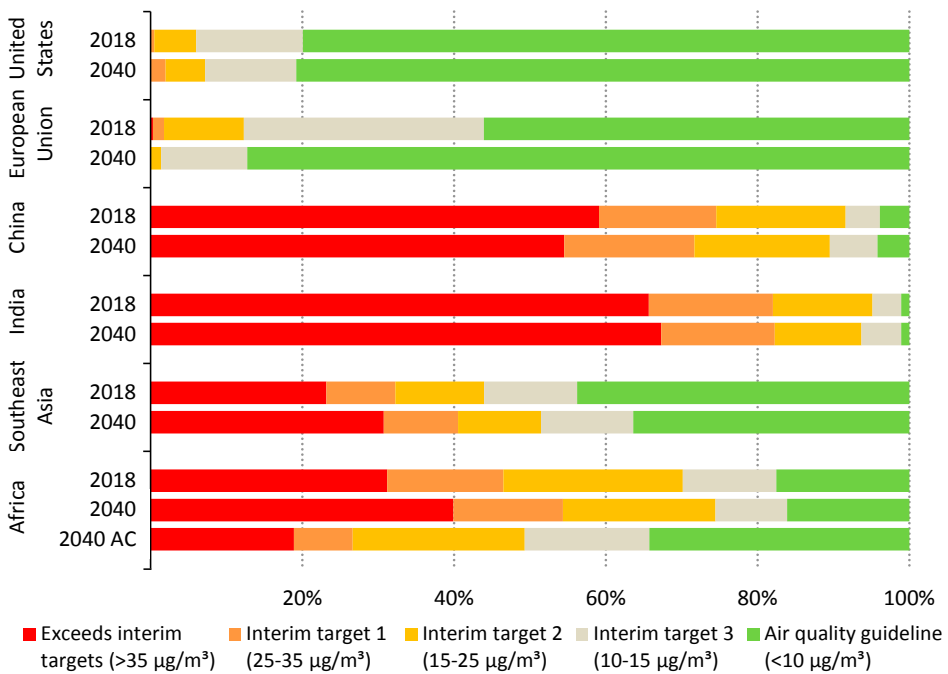
A number of countries have already made commitments to address deforestation in their updated Nationally Determined Contributions. Nigeria acknowledges the need to halt deforestation, conserve remaining natural forests and reverse forest degradation. Others, including DR Congo, have pledged to commit efforts to reforestation activities. Converting these ambitions into actions and extending them across the continent would make the African biomass industry more sustainable.

The increase in demand for energy services brought about by the fast-growing and rapidly urbanising population across the continent will have significant implications for air quality in cities. The increase in the overall level of air pollutant emissions in the Stated Policies

Scenario is not a surprise, given the exceptionally low baseline for current energy consumption. The mix of technologies and fuels chosen by consumers can however play an important part in mitigating the increase of pollutant emissions, which will ultimately have wide-ranging implications for the health and wellbeing for millions of people.

In the Stated Policies Scenario, sulfur dioxide (SO_2) emissions decrease by a quarter across Africa by 2040. There is an increase in industrial emissions but this is more than offset by a significant decrease in emissions from coal-fired power plants, mainly in South Africa. Emissions of nitrogen oxides (NO_x) increase by one-quarter, mainly from the incomplete combustion of fuels in cars, despite a significant fall in emissions in the power sector during the period to 2040. In the Africa Case, improved emissions standards for passenger vehicles result in emissions from this segment falling, despite the increased number of cars on the road.

Figure 12.10 ▷ Population exposed to fine particulate pollution ($PM_{2.5}$) in selected regions in the Stated Policies Scenario and Africa Case



Proportion of the population in Africa exposed to high levels of $PM_{2.5}$ pollution drops in the Africa Case and remains lower than in some Asian countries in the Stated Policies Scenario

Notes: AC = Africa Case; µg/m^3 = micrograms per cubic metre. Interim targets and Air Quality Guideline refer to World Health Organization exposure thresholds.

Source: International Institute for Applied Systems Analysis

Higher emissions of NOx and $PM_{2.5}$ also take a considerable toll on health and wellbeing. In the Stated Policies Scenario, the increasing concentration of $PM_{2.5}$ by 2040 means that the number of premature deaths associated with outdoor air pollution increases by almost 60%, reaching 480 000 in 2040. In the Africa Case, emissions of the three major air pollutants decline sharply from the current levels. Reduced exposure to $PM_{2.5}$ is particularly important: despite a significant increase in energy services, the number of premature deaths associated with outdoor air pollution in 2040 is almost 30% lower than in the Stated Policies Scenario.

Achieving global sustainable development goals requires the success of Africa

In many areas, global energy transition goals are closely linked to successful growth and development in Africa. The continent's economic and social prosperity are in turn closely linked to successful global energy transitions. Two examples highlight the interlinkages between the world and Africa: first, access to modern energy services; and second, Africa's role as a major supplier of the minerals necessary to achieve the global energy transition.

More than two-thirds of the world's population without access to electricity and around a third of the population without access to clean cooking live in Africa. By 2030 in the Stated Policies Scenario, most of the remaining population without access to electricity and clean cooking remain concentrated in Africa. Addressing energy access in Africa is therefore of paramount importance to solving this global concern.

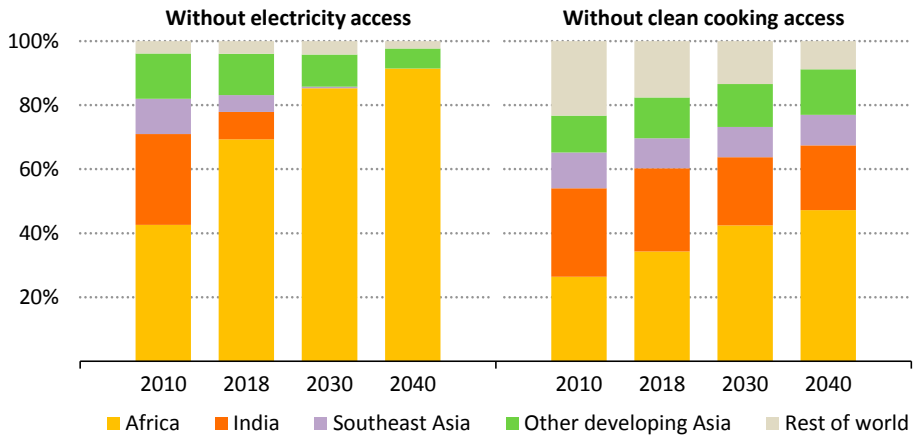
Boosting energy access rates in Africa brings huge benefits in terms of reduced poverty, lower air pollution and increased economic prosperity. Access to electricity is crucial to the provision of essential services: in health centres, for instance, it is vital for the use of efficient modern equipment, the storage and preservation of vaccines and medicines, and the ability to conduct emergency medical procedures, for example during child birth. Access to clean cooking is essential to reduce the health impacts and the number of premature deaths related to household air pollution.

In the Stated Policies Scenario, around 20 million people are connected to the electricity network each year, which is less than a third of what would be needed to reach full access by 2030. By 2030, 85% of all people without access to electricity live in Africa (Figure 12.11). In DR Congo, for example, the projected number of people without access to electricity increases by 30% in this scenario, as policies fail to keep pace with population growth. Reaching full electricity access by 2030 as envisaged in the Africa Case requires a tripling of efforts to extend connection to over 60 million people each year. Reaching this level of access would need an additional push for decentralised renewables in the context of a comprehensive set of policies and investments that makes use of all available solutions, with mini-grids and stand-alone systems providing power to more than half of those gaining access by 2030. Energy efficiency also has an important part to play.

Delivering access to clean energy in an integrated way would also support economic growth and overall development. Research suggests that access could bring new avenues of productive employment to remote populations, particularly for women. In addition to

freeing up time by speeding up domestic chores and giving women more time to engage in paid jobs, access to electricity can have a particular impact on female-owned businesses, helping them to transition from extreme poverty to near middle-class status, as shown recently in Ghana (Power Africa, 2019).

Figure 12.11 ▷ Share of population without access to electricity and clean cooking by region in the Stated Policies Scenario



Those without access to electricity and clean cooking are increasingly concentrated on the African continent

Moreover, electricity can also play an important role in improving agricultural productivity through advanced irrigation techniques, as several successful examples of stand-alone solar water pumps have demonstrated. Cold storage powered by renewable electricity could also reduce post-harvest losses of agricultural outputs, which are currently estimated at 20-50% of the food produced in sub-Saharan Africa (depending on the food type).

In the Stated Policies Scenario, Africa is one of the few regions where the number of people without access to clean cooking increases, as the expansion of clean cooking is unable to keep pace with rapid population growth, and around half of the global population without access to clean cooking in 2040 lives in Africa. There are exceptions: Ghana sees a visible improvement in this area, but many other countries are not set to emulate this example. While urbanisation increases the use of alternative options such as LPG and natural gas in many regions, solid biomass (in the form of charcoal) remains the preferred option for cooking in African cities. The Africa Case sees all households across the continent gain access to clean cooking by 2030. This reduces significantly the number of premature deaths linked to indoor air pollution.

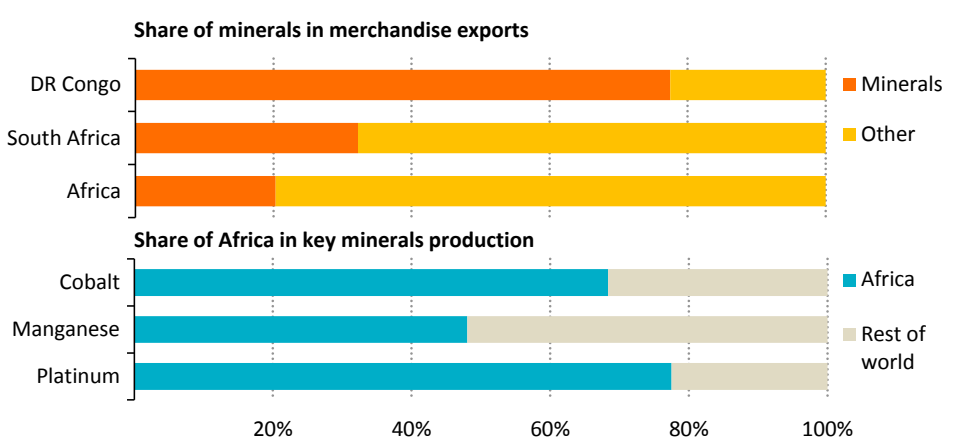
Resource development, minerals in particular, is another area where Africa and the world share a common interest. From cobalt and manganese for batteries to chromium and neodymium for wind turbines, and to platinum for hydrogen fuel cells, minerals are a

critical component in many clean energy technologies. As energy transitions accelerate, demand for minerals is set to grow significantly. For example, demand for cobalt from deployment of electric vehicles increases to around 170 kilotonnes per year (kt/year) in 2030 in the Stated Policies Scenario, higher than today's supply capacity, and to almost 360 kt/year in the case of higher electric vehicle uptake (IEA, 2019). Africa is a major producer of many of these minerals: DR Congo accounts for two-thirds of global cobalt production and South Africa produces 70% of the world's platinum.

In 2017, net income from mineral production was equivalent to around 2% of sub-Saharan Africa's GDP and minerals accounted for some 20% of total merchandise exports in Africa (77% in the case of DR Congo). Rising demand for minerals means that successful global energy transitions offer an opportunity for economic growth in mineral-rich countries in Africa. For example, if DR Congo were to maintain today's share in global production, growing global demand for cobalt would bring additional revenue of $4-8 billion to the country in 2030 (based on today's prices), equivalent to around 3-6% of the country's projected GDP in that year.

However, there are large question marks over whether African countries can keep up with rising global demand in a timely and sustainable manner. Current practices are often inefficient, polluting and subject to social protests. Given that African countries account for a large proportion of the global production of key minerals, failure to keep up with demand could not only hamper Africa's economic outcomes but also hold back the pace of global energy transitions (Figure 12.12).

Figure 12.12 ▷ Composition of Africa's merchandise exports, 2017, and key minerals production, 2018



Responsible and sustainable development of Africa's mineral resources is vital for Africa's economic prosperity and global energy transitions

Source: IEA analysis based on UNCTAD Stats (2019) and USGS (2019).

Putting in place structures and governance arrangements to ensure responsible minerals development would help guard against a range of potential problems. Robust regulatory and oversight mechanisms would be needed to ensure that impacts on local environments are minimised and that revenues are used in a transparent manner. There is also a need for careful scrutiny of how minerals are sourced and how supply chains are managed. Those who use minerals can play a helpful role, as can international financial institutions. For example, BMW, BASF and Samsung recently launched a pilot initiative to support sustainable and fair cobalt mining in DR Congo, which aims to improve working and living conditions for small-scale mining operations and surrounding communities. The World Bank has launched the Climate-Smart Mining Facility to help minimise the environmental and climate impacts of mining activities. As in so many other areas, the future of Africa's development and the prospects for global sustainable growth are closely interlinked.

Regional and country energy profiles

Introduction

The following section presents the results of the Stated Policies Scenario and Africa Case for the sub-Saharan region as a whole as well as for the following eleven countries:

Together these eleven countries accounted for three-quarters of sub-Saharan Africa's gross domestic product (GDP), two-thirds of its population and three-quarters of its energy demand in 2018. The profiles presented in this section aim to provide decision makers with a data-rich set of information on potential energy pathways that reflect each country's unique energy demand and supply needs and regional characteristics. The policy, technology and economic assumptions that underpin both the Stated Policies Scenario and the Africa Case are described in the introduction to the Special Focus on Africa and discussed on a regional basis in Chapters 9, 10 and 11, with the implications presented in the first part of this chapter.

How to read the profiles:

We use a standard format to present the country and regional profiles. Each profile contains a set of figures and tables corresponding to the following categories:

- Key characteristics of the country's energy system.
- Major macroeconomic indicators, including GDP and population growth, carbon dioxide (CO_2) emissions and data for electricity access and clean cooking access by scenario.
- Description of energy-related policy initiatives, including specific performance targets.
- Outlook of how primary energy demand and GDP (based on GDP expressed in year-2018 dollars in purchasing power parity [PPP] terms) evolve to 2040 and the role of each fuel in delivering the alternative energy futures.
- View of how the electricity mix changes over time to meet growing electricity demand.

- Final energy consumption by scenario, showing the potential efficiency gains achieved by implementing more stringent fuel economy standards, building codes, equipment and appliance efficiency requirements.
- Fuel and technology mix[2] used in cooking in 2018 and in 2030 by scenario.[3]
- The trajectory for demand and production of major fossil fuels, highlighting trade balances.
- Cumulative investment by sector required to meet the growth in energy demand and supply in both the Stated Policies Scenario and the Africa Case.[4]

Notes to profiles:

Scenarios: AC = Africa Case; **STEPS** = Stated Policies Scenario.

End-use sectors are industry (including manufacturing and mining), transport, buildings (including residential and services) and other (including agriculture and non-energy use).

Traditional use of solid biomass refers to the use of solid biomass with basic technologies, such as a three-stone fire, often with no or poorly operating chimneys.

Productive uses refers to energy used towards an economic purpose. This includes energy used in agriculture, industry, services and non-energy use. Some energy demand from the transport sector (e.g. freight-related) could be considered as productive, but is treated separately.

GIS maps for each country or region contained in these profiles were developed in collaboration with the Royal Institute of Technology (Sweden) – Division of Energy Systems Analysis (KTH-dESA). The maps detail the least-cost pathway to deliver universal electricity access by means of a combination of on-grid, mini-grid and stand-alone systems.[5]

Units and terms: GDP = gross domestic product; CAAGR = compound average annual growth rate; PPP = purchasing power parity; Mt CO_2 = million tonnes of carbon dioxide; Mtoe = million tonnes of oil equivalent; GW = gigawatt; TWh = terawatt-hour; kV = kilovolt; LPG = liquefied petroleum gas; mb/d = million barrels per day; Mtce = million tonnes of coal equivalent; bcm = billion cubic metres, PV = photovoltaics, GHG = greenhouse gas.

Investment data are presented in real terms in year-2018 US dollars.

[2] *Other clean* includes electricity, natural gas, biogas and biofuels. *Charcoal and other solid biomass* refer to the combustion of these fuels in inefficient stoves.

[3] More detailed information on the methodology can be found in Chapter 9.

[4] Investment in electricity networks and generation excludes investment in electricity access, which is counted separately in this figure.

[5] More detailed information on the methodology can be found in Chapter 10, Box 10.2.

12.1 Sub-Saharan Africa[1]

Fastest growing population **Strong** economic growth **Major** commodities exporter

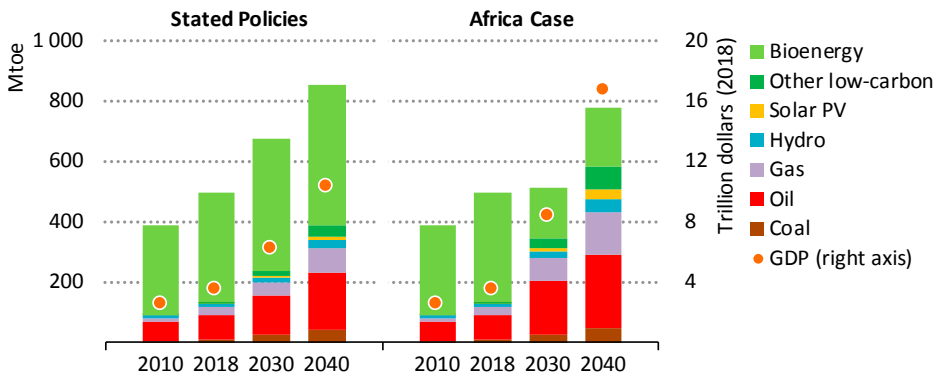
Table 12.1A ▷ Sub-Saharan Africa key indicators and policy initiatives

			Stated Policies		Africa Case		CAAGR 2018-40	
	2000	2018	2030	2040	2030	2040	STEPS	AC
GDP ($2018 billion, PPP)	1 375	3 536	6 161	10 346	8 381	16 683	5.0%	7.3%
Population (million)	626	1 034	1 404	1 761	1 404	1 761	2.5%	2.5%
with electricity access	20%	43%	62%	66%	100%	100%	2.0%	4.0%
with access to clean cooking	6%	13%	31%	51%	100%	100%	6.3%	9.6%
CO_2 emissions (Mt CO_2)	130	312	534	843	762	1 154	4.6%	6.1%

Policy	Key targets and measures
Regional Strategies	▪ Agenda 2063: A prosperous Africa based on inclusive growth and sustainable development. ▪ African Continental Free Trade Area: accelerating intra-African trade and boosting Africa's trading position in the global market by strengthening Africa's common voice and policy space in global trade negotiations.

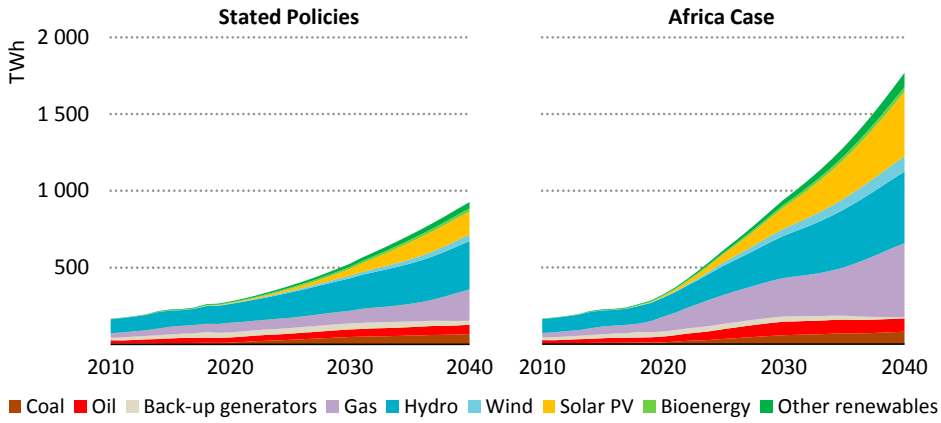
- Drastic efficiency improvements, in part due to the accelerated move away from solid biomass, result in primary energy demand being lower in the AC than in the STEPS even though GDP is 60% higher in the AC.
- Supply from natural gas and renewable sources expand in both scenarios to meet rising demand for energy as the sub-Saharan economy expands.
- Electricity access and clean cooking facilities for all are achieved by 2030 in the AC.

Figure 12.1A ▷ Sub-Saharan Africa primary energy demand and GDP



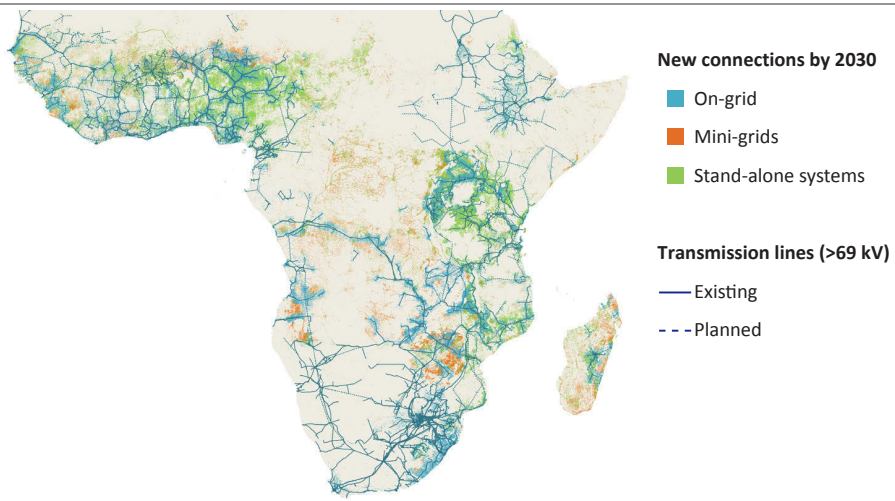
[1] Excluding South Africa.

Figure 12.1B ▷ Sub-Saharan Africa electricity generation by technology



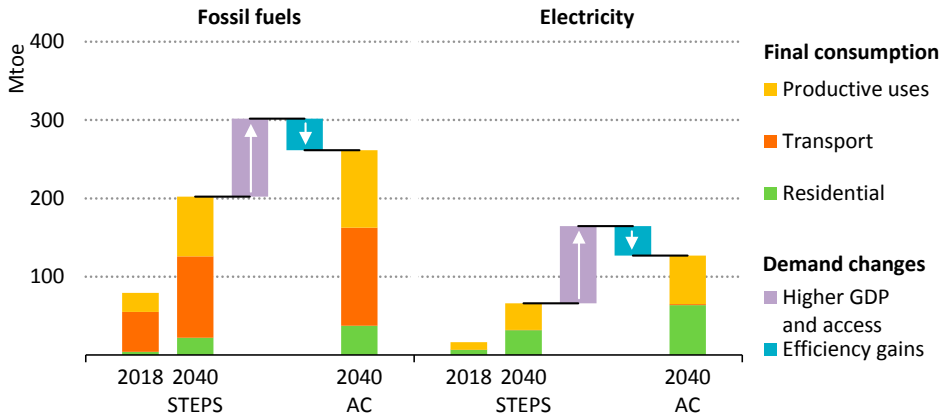
- Today's power mix, dominated by hydro, gradually diversifies as solar PV and natural gas increasingly make inroads into the power system. In the STEPS, the combined share of solar PV and natural gas reaches the level of hydro by 2040.
- In the AC, natural gas (27%) passes hydropower (26%) as the largest source of power supply by 2040 while the share of solar PV rises to 24%.

Figure 12.1C ▷ Sub-Saharan Africa electricity access solutions by type in the Africa Case



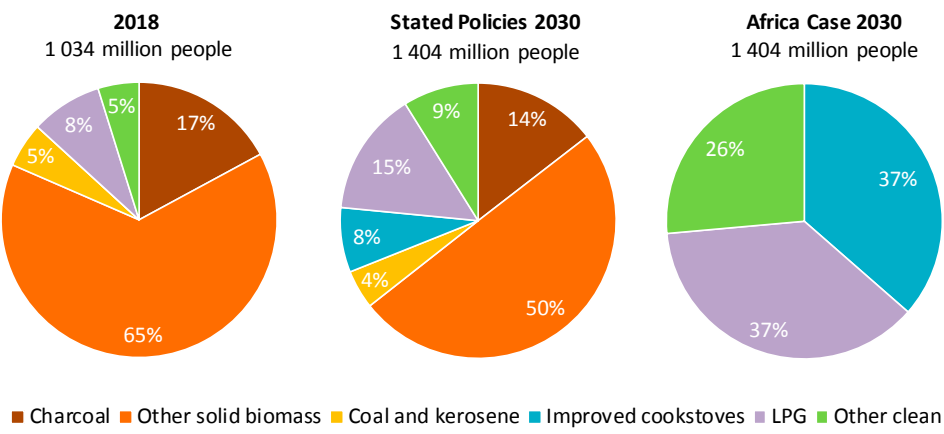
- In the STEPS, the main grid connects around 70% of the 230 million people gaining electricity access by 2030, alongside decentralised options for the remainder in more remote areas. In 2030, 530 million people remain without access.
- In the AC, decentralised solutions are the least-cost option for more than two-thirds of the 530 million additional people connected by 2030 to reach full access.

Figure 12.1D ▷ Sub-Saharan Africa final energy consumption



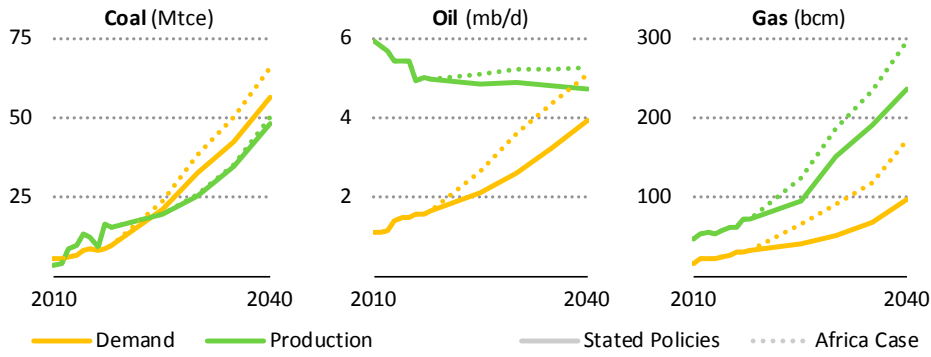
- Growing trends of urbanisation and industrialisation drive strong energy consumption growth for transport and productive uses in both the STEPS and the AC, increasing oil demand the most, especially in the AC, which sees faster economic growth.
- Electricity consumption is very low today, but quadruples through to 2040 in the STEPS, with demand growth led by light industry, appliances and cooling systems. Demand rises further in the AC.

Figure 12.1E ▷ Sub-Saharan Africa fuels & technologies used for cooking



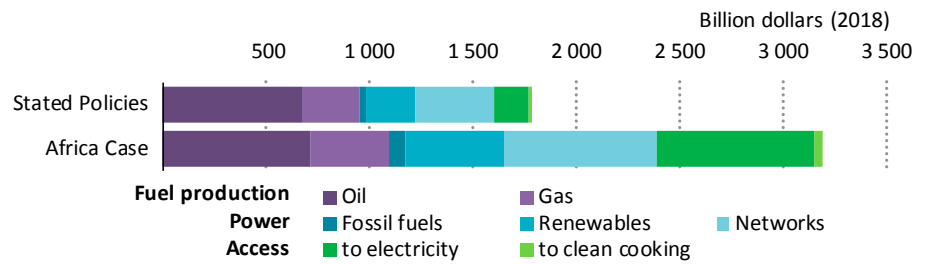
- In the STEPS, more people gain access to clean fuels and technologies for cooking by 2030, but 70% of the population still lack access.
- To bridge the gap and achieve full access to clean cooking for all in the AC, liquefied petroleum gas (LPG) is the most scalable solution for urban settlements, with improved biomass cookstoves doing most to provide access in rural areas.

Figure 12.1F ▷ Sub-Saharan Africa fossil fuel demand and production



- Rapidly growing oil demand and stagnating domestic oil production reduce net oil exports in the STEPS; exports are further reduced by faster economic growth in the AC.
- Gas demand and production increase by 2040 in the STEPS, but both grow more rapidly in the AC and the region becomes a major supplier of gas to global markets.

Figure 12.1G ▷ Sub-Saharan Africa cumulative investment needs, 2019-2040



- In the STEPS, $1.8 trillion of cumulative energy supply investment is needed, with upstream oil and gas and power each accounting for around half of this.
- The AC requires 80% more capital with a stronger emphasis on power sector investments, including a doubling of spending in renewables and electricity networks.

Sub-Saharan Africa policy opportunities

- Enhanced power sector integration in sub-Saharan Africa could help to deliver more affordable and reliable power and reduce average electricity generation costs.
- Challenges relating to infrastructure, affordability and business models must be overcome if the region is to capitalise on the potential of natural gas.
- More efficient use of energy across end-use sectors such as fuel economy standards for cars and two/three-wheelers, building codes for new buildings, and more efficient industrial processes and efficiency standards for appliances and cooling systems would support wider economic development and offset growth in energy demand.

12.2 Angola

Second-largest oil producer **Oil** accounts for 90% of exports **Luanda:** future megacity

Table 12.2A ▷ Angola key indicators and policy initiatives

			Stated Policies		Africa Case		CAAGR 2018-40	
	2000	2018	2030	2040	2030	2040	STEPS	AC
GDP ($2018 billion, PPP)	72	199	287	404	349	625	3.3%	5.3%
Population (million)	16	31	45	60	45	60	3.1%	3.1%
with electricity access	12%	44%	57%	65%	100%	100%	1.7%	3.8%
with access to clean cooking	37%	50%	58%	66%	100%	100%	1.3%	3.2%
CO_2 emissions (Mt CO_2)	5	17	20	33	27	48	3.1%	4.8%

Policy	Key targets and measures
Performance targets	▪ Establish targets for renewable energy sources to 2025: 100 MW of solar PV; 370 MW of small and medium hydro; 500 MW of biomass; 100 MW of wind. ▪ Up to 35% (unconditional) to 50% (conditional) reduction in GHG emissions by 2030 as compared to the business-as-usual scenario.
Industrial development targets	▪ National Development Plan of Angola 2018-2022: Lessen economic dependence on oil and natural gas revenues, strengthen the business environment, increase energy efficiency and achieve middle-income status by 2022.

- Angola could supply an economy three-times larger than today's in the AC with only twice the amount of energy.
- Oil remains an important energy source, but end-use tariffs that are more reflective of costs reduce its share of the overall energy mix and help diversification towards natural gas and renewables in the AC.

Figure 12.2A ▷ Angola primary energy demand and GDP

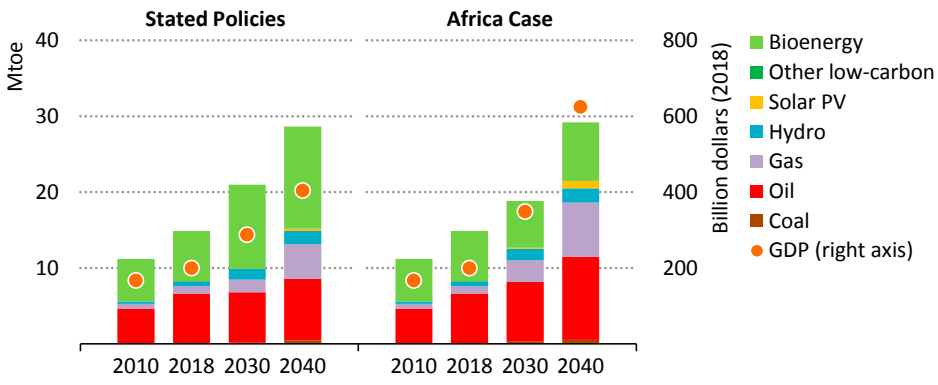
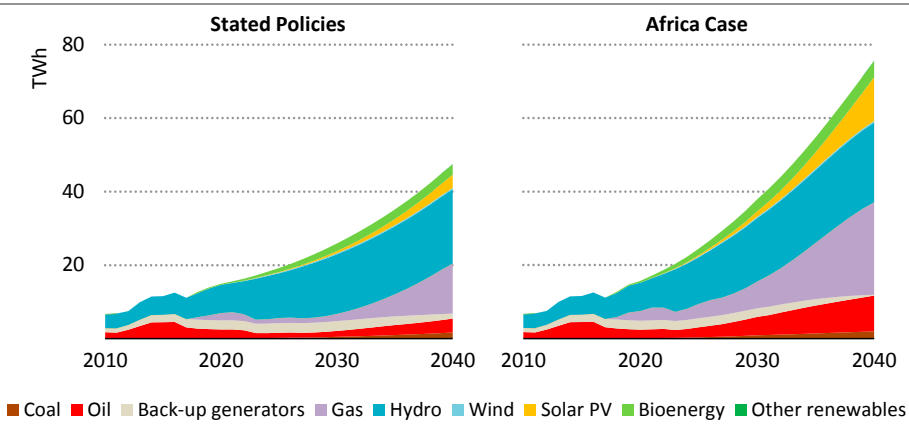
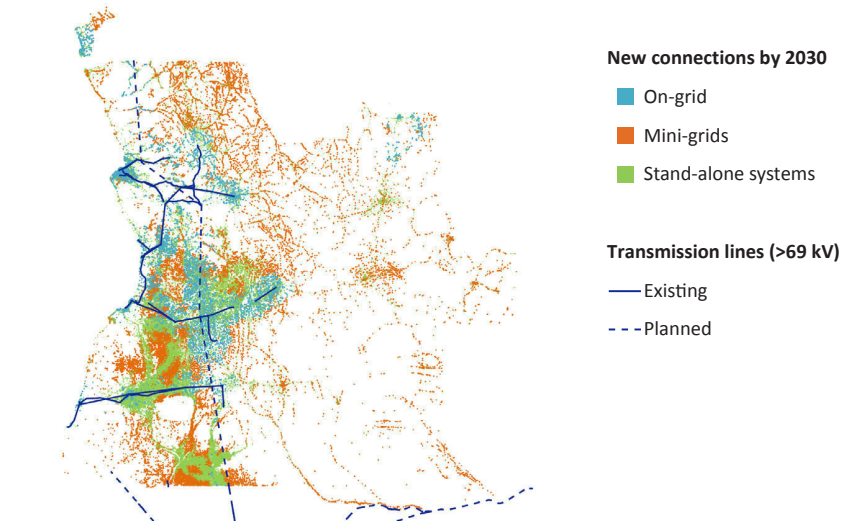


Figure 12.2B ▷ Angola electricity generation by technology



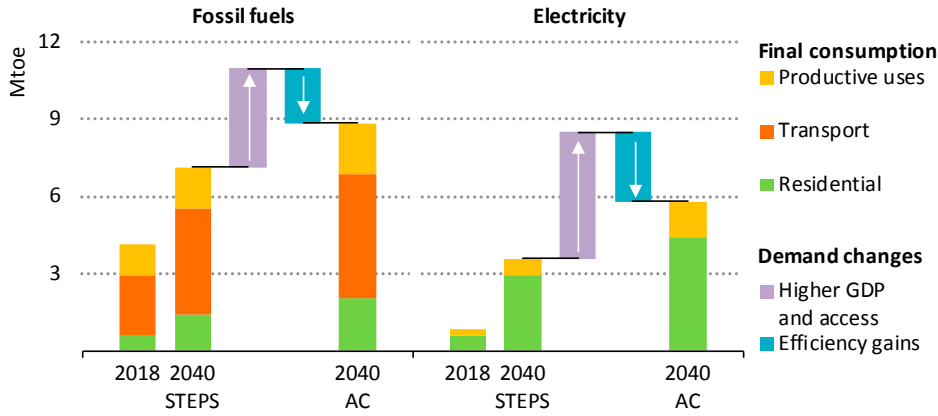
- Angola currently relies mostly on hydropower and oil (including diesel) for power generation.
- Providing access to all increases electricity demand sevenfold in the AC. Gas and comparatively cheap hydropower play key roles in meeting this growth along with solar PV.

Figure 12.2C ▷ Angola electricity access solutions by type in the Africa Case



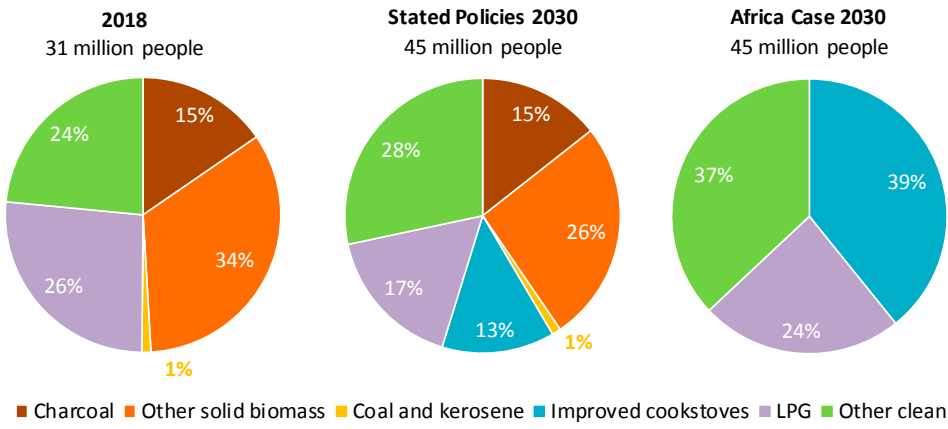
- The electricity access rate in Angola is 44% today, with most of the population currently without access located in the west of the country.
- The least-cost path to full access to electricity in the AC is mini-grids (46%), alongside grid connections for a large part of the population (38%) living near the existing and planned grids; stand-alone systems help to reach the most remote areas.

Figure 12.2D ▷ Angola final energy consumption



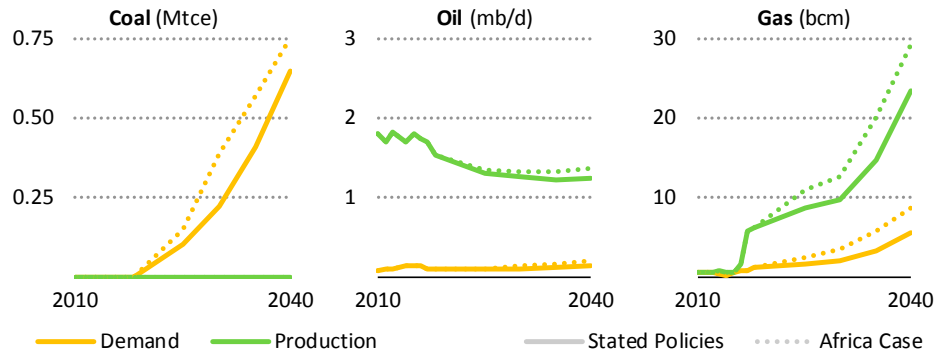
- The number of cars expands from 0.4 million in 2018 to 1.1 million in 2040 in the STEPS, and rises further in the AC. The associated increase in oil demand can be mitigated to an extent by improving fuel economy standards.
- Angola could meet nearly all of its cement demand domestically before 2040 in both scenarios provided a reliable supply of gas and electricity is available.

Figure 12.2E ▷ Angola fuels and technologies used for cooking



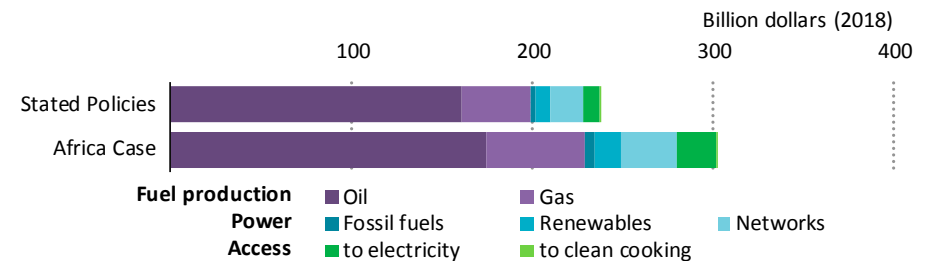
- Angola has one of the highest shares of access to clean cooking in sub-Saharan Africa, thanks to government policies supporting LPG and natural gas.
- A further push on access policies adapted to rural conditions could help provide clean cooking to 90% of people in rural areas through improved biomass cookstoves in the AC.

Figure 12.2F ▷ Angola fossil fuel demand and production



- Recent policy reforms in the oil and gas sector help stabilise the outlook for oil production in both scenarios.
- Growing population and stagnant oil production reduce per capita net income from oil and gas production in both scenarios, increasing the need for economic diversification.

Figure 12.2G ▷ Angola cumulative investment needs, 2019-2040



- Around $240 billion of cumulative energy supply investment is needed in the STEPS, of which over 80% goes to upstream oil and gas.
- The AC requires around 25% more capital than the STEPS, with a strong emphasis on investments in upstream gas, electricity access and networks.

Angola policy opportunities

- Angola's natural gas resources could underpin a domestic industrial base that would have the added benefit of diversifying the economy away from oil exports.
- Angola would benefit from sustaining and strengthening recent reforms in the oil and gas sector, including efforts to streamline investment procedures and restructure the role of the national oil company.
- The availability of domestic natural gas presents a significant opportunity for efficient and dependable electricity generation.

12.3 Côte d'Ivoire

Largest cocoa exporter **Rapidly** expanding economy **Diversity** of resources

Table 12.3A ▷ Côte d'Ivoire key indicators and policy initiatives

			Stated Policies		Africa Case		CAAGR 2018-40	
	2000	2018	2030	2040	2030	2040	STEPS	AC
GDP ($2018 billion, PPP)	56	107	221	330	264	569	5.3%	7.9%
Population (million)	17	25	34	42	34	42	2.4%	2.4%
with electricity access	50%	63%	94%	100%	100%	100%	1.1%	1.1%
with access to clean cooking	18%	30%	59%	71%	100%	100%	4.0%	5.7%
CO_2 emissions (Mt CO_2)	6	11	19	24	21	33	3.7%	5.1%

Policy	Key targets and measures
Performance targets	▪ Increase electricity generation to 4 000 MW by 2020 and 6 000 MW by 2030. ▪ *Programme National d'Électrification Rurale*: connect all localities with more than 500 inhabitants by 2021 and all areas by 2025.
Industrial development targets	▪ Achieve emerging economy status by end of 2020 while ensuring that industry accounts for 40% of the economy. ▪ Accelerate the structural transformation of the economy through industrialisation, develop infrastructure throughout the country and protect the environment. ▪ Rise in investment rate from 19.3% in 2015 of GDP to 24.5% in 2020 with significant contribution from private sector.

- Rapid industrialisation in the AC could yield an economy that is five-times larger than today but with energy efficiency the country consumes only twice as much energy.
- Natural gas has a key role to play in electricity generation in the AC. Promoting its use could see its share of the energy mix rising by eleven percentage points more than STEPS.

Figure 12.3A ▷ Côte d'Ivoire primary energy demand and GDP

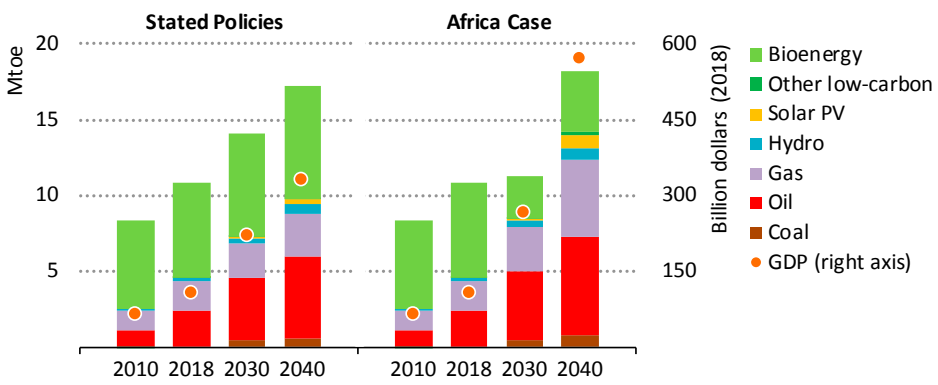
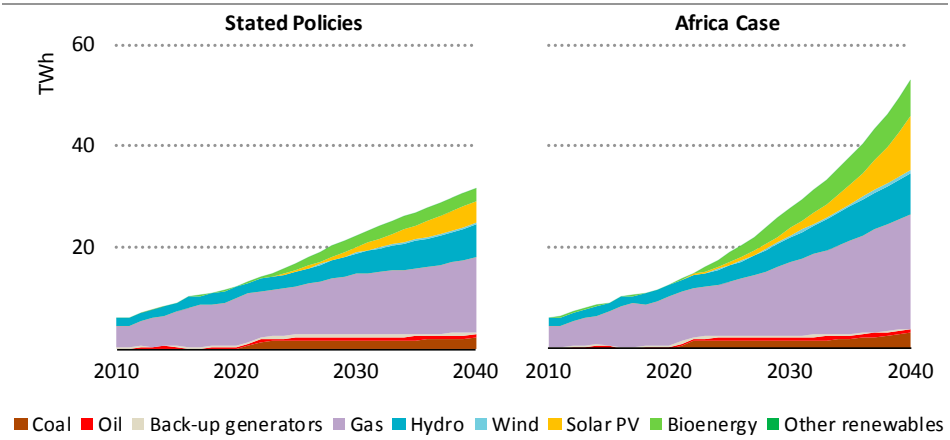
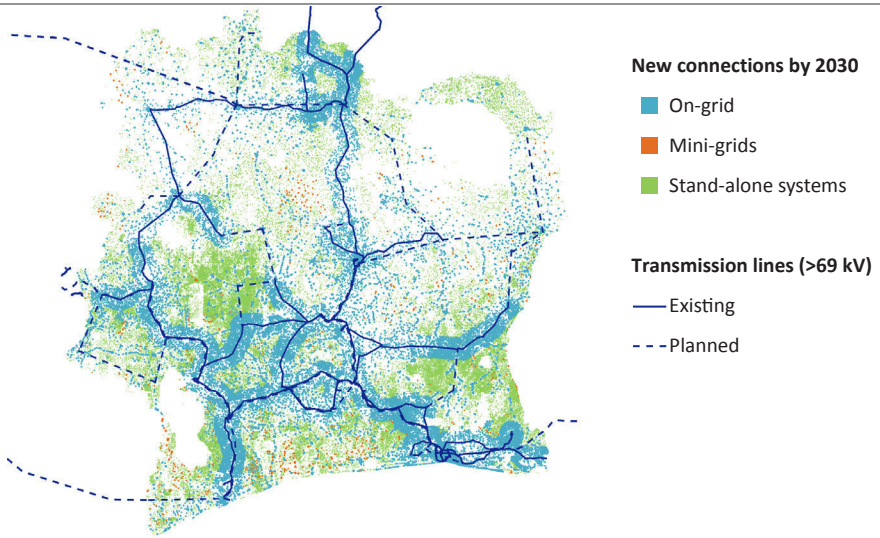


Figure 12.3B ▷ Côte d'Ivoire electricity generation by technology



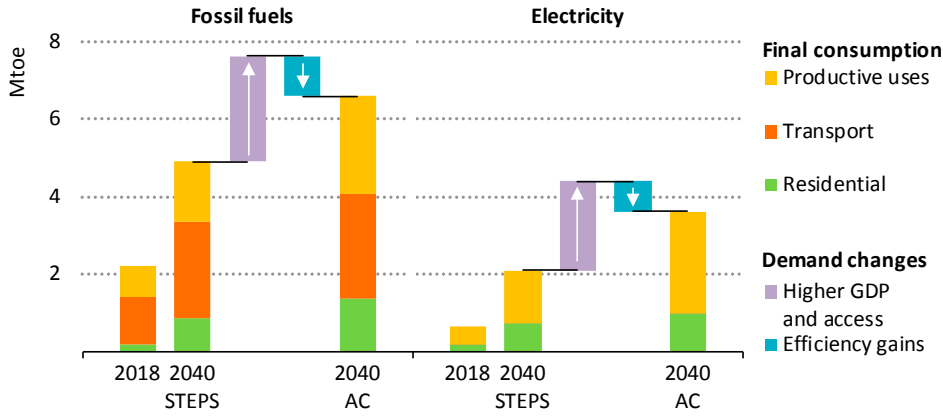
- Providing access to all and increasing industrialisation in the AC raises electricity demand sixfold compared to today.
- Gas continues to play a large role in power generation, but its share is reduced from three-quarters today to around 45% as solar and bioenergy increase in both scenarios.

Figure 12.3C ▷ Côte d'Ivoire electricity access solutions by type in the Africa Case



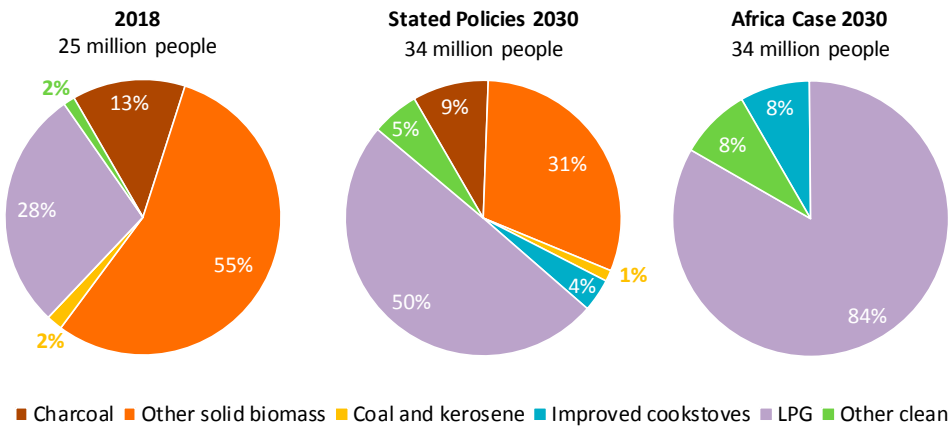
- Effective programmes supporting electrification of villages and households connect more than 90% of the population by 2030 in the STEPS.
- Given the current coverage of the grid network, grid densification and grid extension are the least-cost solution for around 40% of the population in the AC.

Figure 12.3D ▷ Côte d'Ivoire final energy consumption



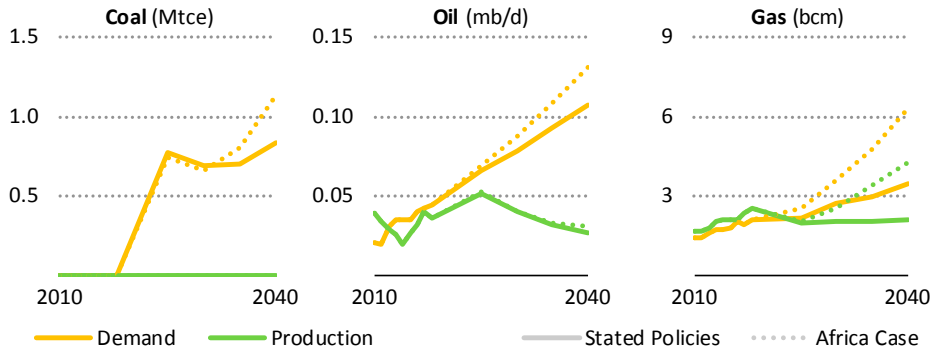
- The number of cars grows fivefold and related oil consumption fourfold in the AC, but the growth could be almost 20% larger without fuel economy standards.
- Côte d'Ivoire electrifies much of industry, with electricity displacing oil to become the major fuel. Electricity demand for residential cooling increases by almost 2 TWh in the AC.

Figure 12.3E ▷ Côte d'Ivoire fuels and technologies used for cooking



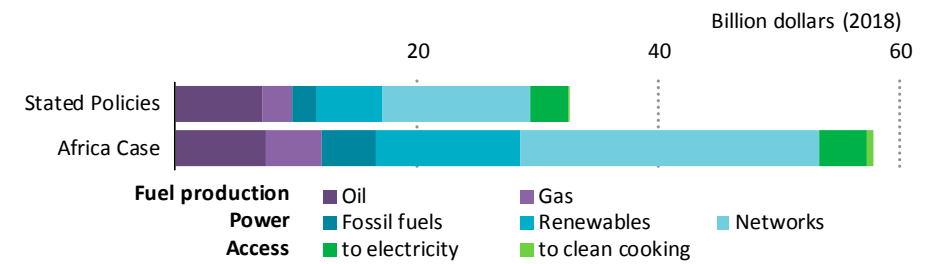
- With strong policy support, LPG is the preferred solution to improve access to clean cooking, reducing the use of traditional stoves with charcoal and other solid biomass.
- The AC sees further use of LPG and improved biomass cookstoves, particularly in rural areas, to bring access to clean cooking to all.

Figure 12.3F ▷ Côte d'Ivoire fossil fuel demand and production



- Rapidly rising passenger car stocks and declining production lead to expanding import requirements for oil in both scenarios.
- Given the important share of gas in the power mix, strong growth in electricity demand underpins rapid growth in gas demand, especially in the AC.

Figure 12.3G ▷ Côte d'Ivoire cumulative investment needs, 2019-2040



- Energy investment needs amount to $33 billion through to 2040 in the STEPS, with spending on electricity networks representing almost 40% of the total.
- The AC requires investment to increase by a further 80%, with more emphasis on gas-related spending (upstream and generation), renewables and electricity networks.

Côte d'Ivoire policy opportunities

- Increased production of natural gas provides a significant opportunity for it to be used extensively in power generation and industry.
- Prioritising energy efficiency is essential to helping Côte d'Ivoire make the most of its limited resources. With the anticipated increase in demand for cooling and other household uses, efficiency standards for appliances would materially impact the rate of energy demand growth.
- Expanding power generation capacity is crucial.

12.4 Democratic Republic of the Congo

Largest producer of cobalt **Kinshasa:** an African megacity **Most ambitious** hydro plan

Table 12.4A ▷ DR Congo key indicators and policy initiatives

			Stated Policies		Africa Case		CAAGR 2018-40	
	2000	2018	2030	2040	2030	2040	STEPS	AC
GDP ($2018 billion, PPP)	29	73	132	238	195	455	5.5%	8.7%
Population (million)	47	84	120	156	120	156	2.8%	2.8%
with electricity access	7%	9%	16%	21%	100%	100%	4.1%	11.7%
with access to clean cooking	3%	3%	4%	5%	100%	100%	2.0%	17.1%
CO_2 emissions (Mt CO_2)	1	3	10	16	18	18	8.7%	9.2%

Policy	Key targets and measures
Performance targets	▪ Complete the construction of Inga 3 Basse-Chute dam. ▪ Reduce GHG emissions by 17% by 2030 compared to the business-as-usual scenario (430 Mt CO_2-equivalent), equivalent to slightly more than a 70 Mt CO_2 reduction. ▪ Plant about three million hectares of forest by 2025.
Industrial development targets	▪ Achieve high-income status by 2050 by means of rigorous implementation of the National Strategic Plan for Development.

- In the AC, DR Congo supports an economy six-times larger than today's with only 35% more energy by diversifying its energy mix away from one that is 95% dependent on bioenergy.
- The power sector sees more growth than any other sector; a big increase in the use of hydropower leads to its share of the overall energy mix increasing to 23% in the AC.

Figure 12.4A ▷ DR Congo primary energy demand and GDP

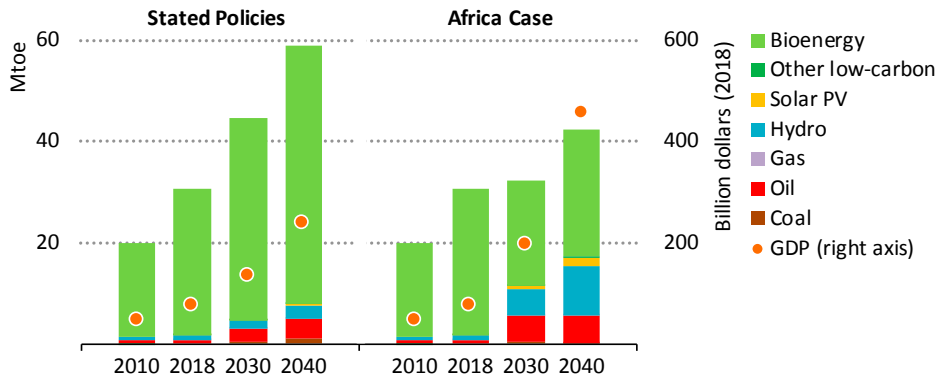
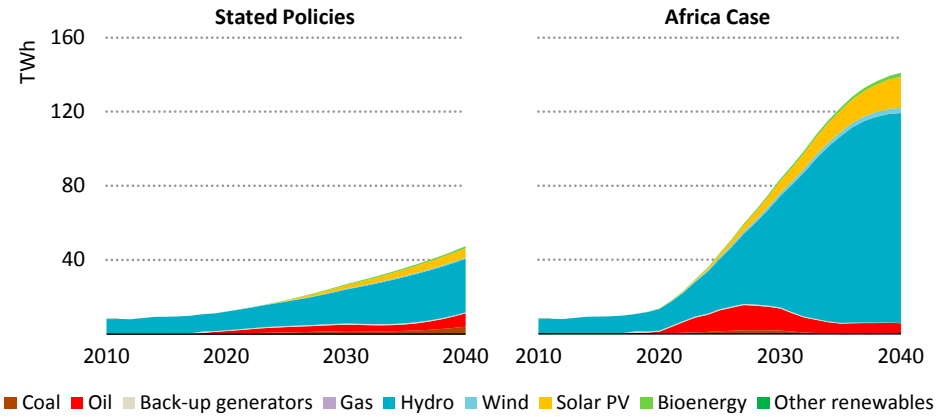
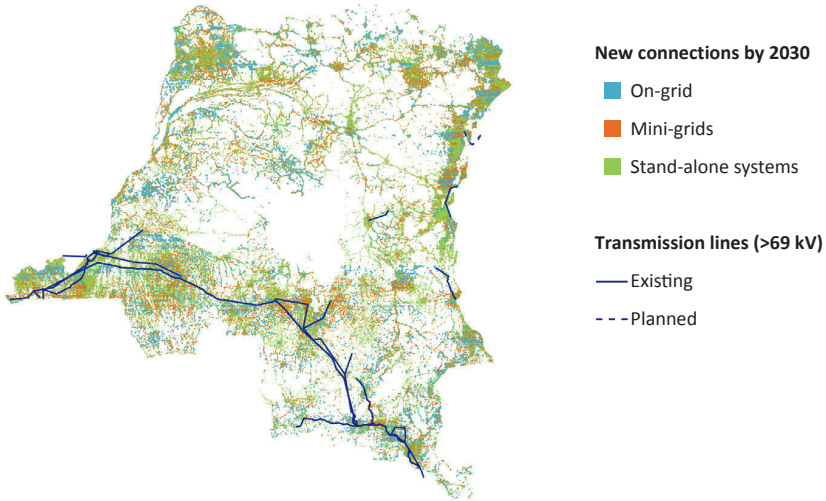


Figure 12.4B ▷ DR Congo electricity generation by technology



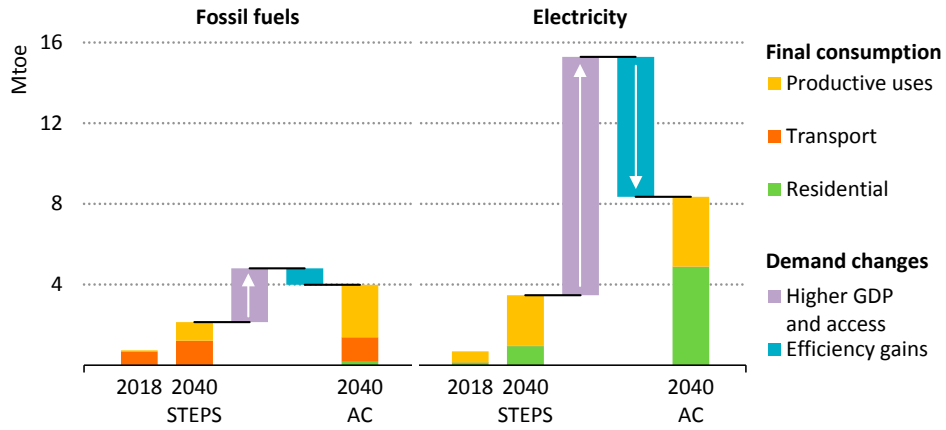
- Almost all electricity generation today comes from hydropower and the Inga project has the potential to provide much more. If network constraints are addressed, DR Congo could become an electricity exporter.
- In the AC, Phase 5 of the Inga project enables DR Congo to meet an eleven-fold increase in electricity demand; this increase is the result of achieving full access to electricity and of the growing electrification of productive uses.

Figure 12.4C ▷ DR Congo electricity access solutions by type in the Africa Case



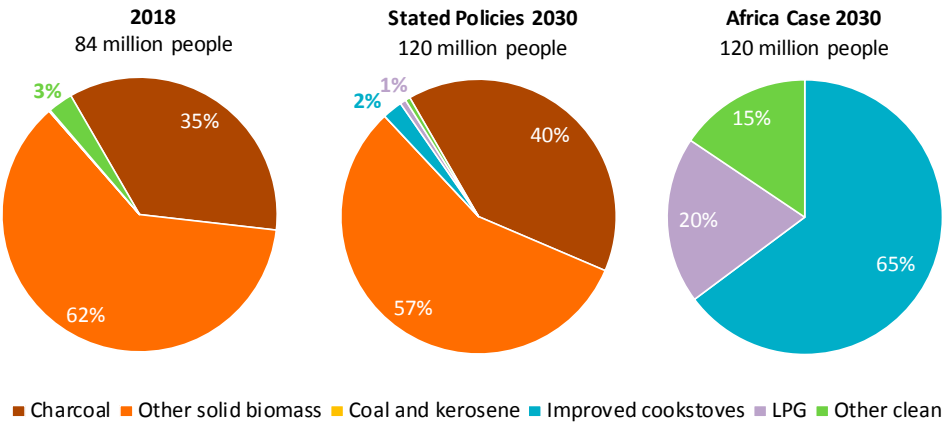
- Less than 10% of the population has access to electricity today, making DR Congo the country with the largest number of people without access in Africa after Nigeria.
- Mini-grids account for more than half of all new connections in the AC.

Figure 12.4D ▷ DR Congo final energy consumption



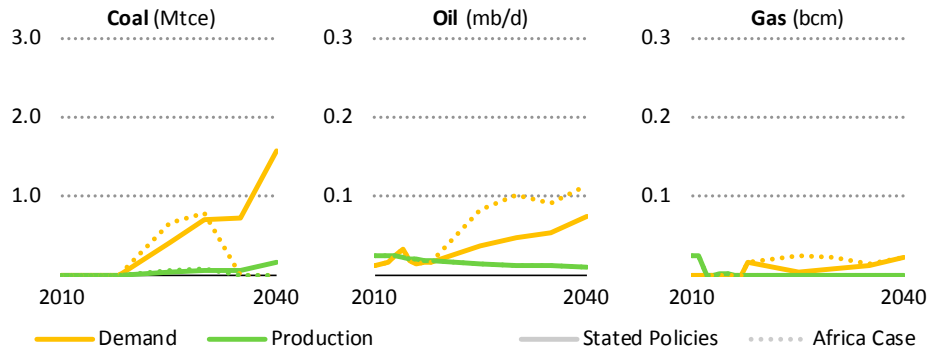
- Oil use in industry increases significantly in the AC with manufacturing and mining chiefly responsible for this growth.
- Electricity consumption is low today but is set to increase significantly in the AC as household incomes rise, access to electricity improves and mining activities increase.

Figure 12.4E ▷ DR Congo fuels and technologies used for cooking



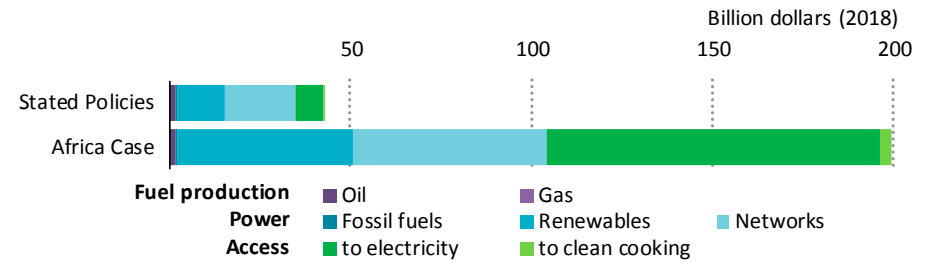
- Given the availability of fuelwood in rural areas and the affordability of charcoal in urban areas, almost all people cook with traditional stoves in 2030 in the STEPS.
- In the AC, improved cookstoves are the preferred option to provide clean cooking access in both urban and rural areas. In parallel, kilns for making charcoal are improved to increase their efficiency.

Figure 12.4F ▷ DR Congo fossil fuel demand and production



- Fossil fuel consumption is at a low level, but growing, and almost reliant on imports in both scenarios. Further industrial development depends on a large increase in imports.
- DR Congo is a major producer of minerals. It accounts for almost two-thirds of global cobalt production; this gives it a crucial role in global clean energy transitions.

Figure 12.4G ▷ DR Congo cumulative investment needs, 2019-2040



- The AC requires a quadrupling of investment compared with the STEPS, with emphasis on renewables, power networks and access to electricity and clean cooking.
- Investment opportunities in the AC are likely to be realised only if sound structures to regulate the sector and manage revenues from mineral production are in place.

DR Congo policy opportunities

- Cobalt mining activities will drive an increase in electricity demand. Meeting this through renewable hydropower would help to develop low-carbon electricity for DR Congo and a low-carbon value chain for the global electric vehicle fleet.
- Given the country's dispersed population centres, decentralised solutions offer the lowest cost way to overcome grid limitations and provide electricity access to the huge share of the population currently without it.
- Increased regional co-operation could help realise the potential of Inga, which has the potential to provide large quantities of reliable low-carbon electricity to DR Congo and its neighbours.

12.5 Ethiopia

Geothermal potential | **Large** hydro capacity | **Strong progress** on access

Table 12.5A ▷ Ethiopia key indicators and policy initiatives

			Stated Policies		Africa Case		CAAGR 2018-40	
	2000	2018	2030	2040	2030	2040	STEPS	AC
GDP ($2018 billion, PPP)	47	220	493	870	610	1 445	6.5%	8.9%
Population (million)	67	108	143	173	143	173	2.2%	2.2%
with electricity access	5%	45%	100%	100%	100%	100%	3.7%	3.7%
with access to clean cooking	1%	7%	34%	56%	100%	100%	9.7%	12.6%
CO_2 emissions (Mt CO_2)	3	14	29	46	32	52	5.5%	6.2%

Policy	Key targets and measures
Performance targets	▪ Increase generating capacity by 25 000 MW by 2030: 22 000 MW of hydro; 1 000 MW of geothermal; and 2 000 MW of wind by 2030. ▪ National Electrification Program (2017): 100% electrification in 2025, with 35% off-grid and 65% grid, while extending the grid to reach 96% grid connections by 2030.
Industrial development targets	▪ Achieve an annual average real GDP growth rate of 11% within a stable macroeconomic environment and become a lower middle-income country by 2025. ▪ Focus on ensuring rapid, sustainable growth by enhancing the productivity of the agriculture and manufacturing sectors, and stimulating competition in the economy.

- Ethiopia could supply a much larger economy than today in the AC, using only twice the energy, were it to diversify its energy mix and implement efficiency standards.
- In the AC, this diversification comes about as a result of a substantial expansion of geothermal energy along with increased use of oil within industry and for cooking.

Figure 12.5A ▷ Ethiopia primary energy demand and GDP

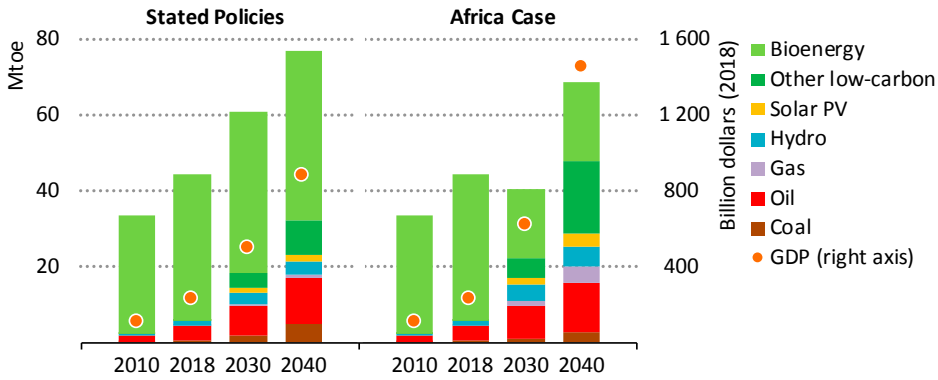
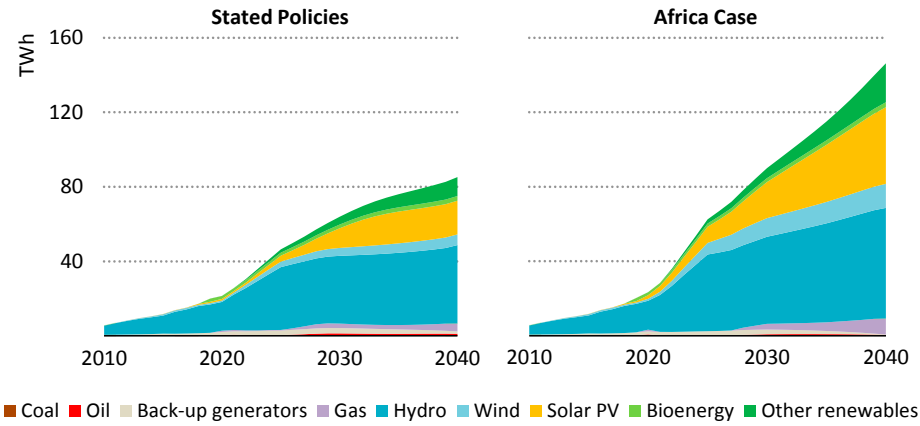
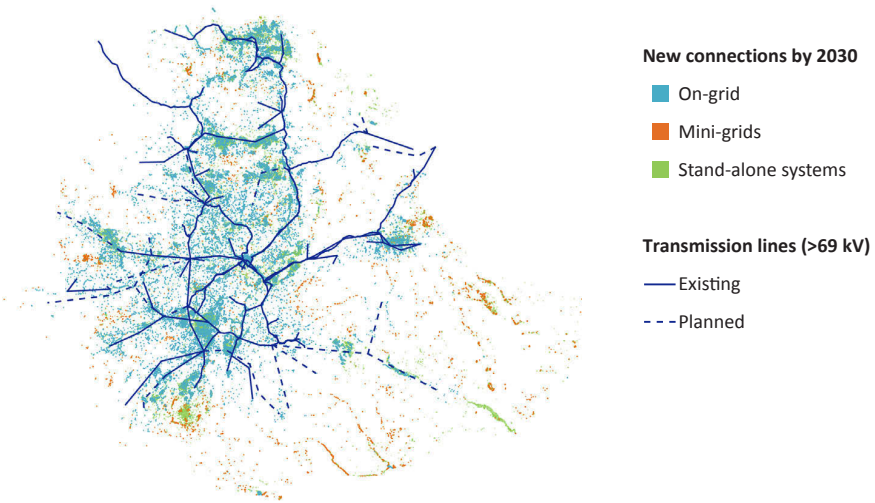


Figure 12.5B ▷ Ethiopia electricity generation by technology



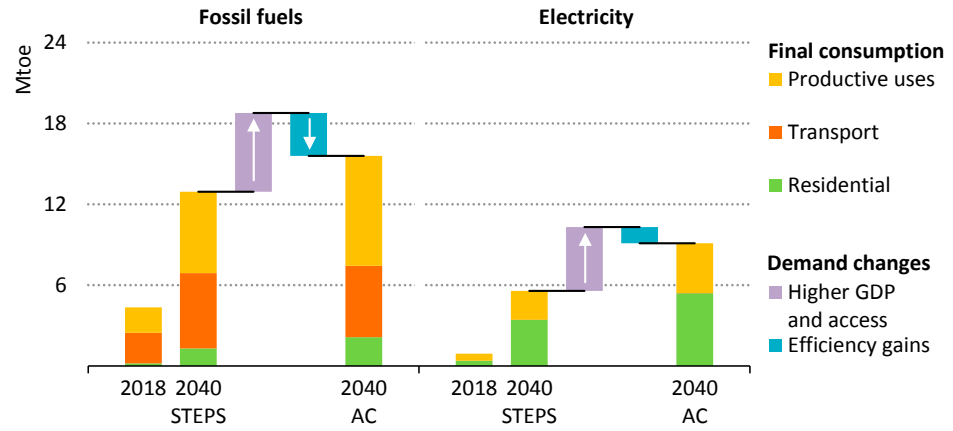
- Ethiopia is currently heavily reliant on hydropower; plans to increase capacity to 13.5 GW by 2040 would make Ethiopia the second-largest hydro producer in Africa.
- Providing electricity access to all and electrifying productive uses will lead to a fivefold increase in generation in the STEPS, and an even bigger increase in the AC; solar PV and geothermal account for almost 45% of the power mix by 2040 in the AC.

Figure 12.5C ▷ Ethiopia electricity access solutions by type in the Africa Case



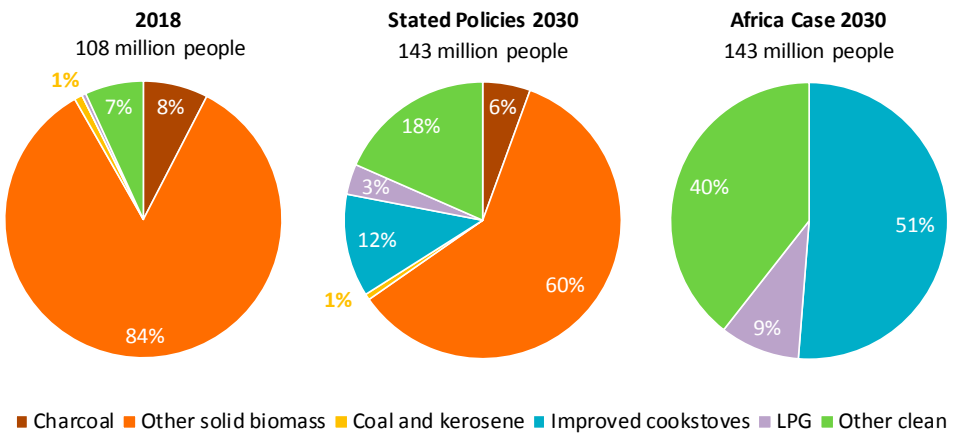
- Ethiopia currently has an electricity access rate of 45%, 11% of its population already have access through decentralised solutions. Strong government commitment to reach full access before 2030 in the STEPS.
- In both scenarios, around 80% of new connections are cost effectively delivered by grid densification and extension as a large part of the population lives close to the grid.

Figure 12.5D ▷ Ethiopia final energy consumption



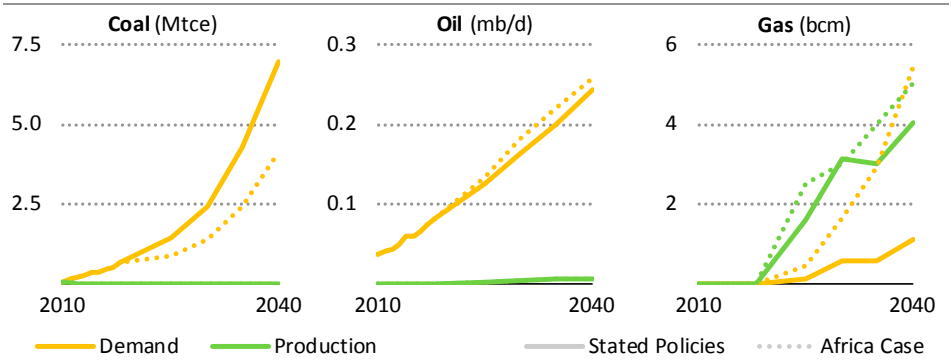
- Increased affluence in the STEPS results in a more than fourfold increase of the private vehicle stock with the number of cars reaching 700 000 by 2040. This results in a 300% increase in related oil consumption.
- To meet the needs of its growing population, Ethiopia remains a large producer of cement causing energy demand to increase significantly in both scenarios.

Figure 12.5E ▷ Ethiopia fuels and technologies used for cooking



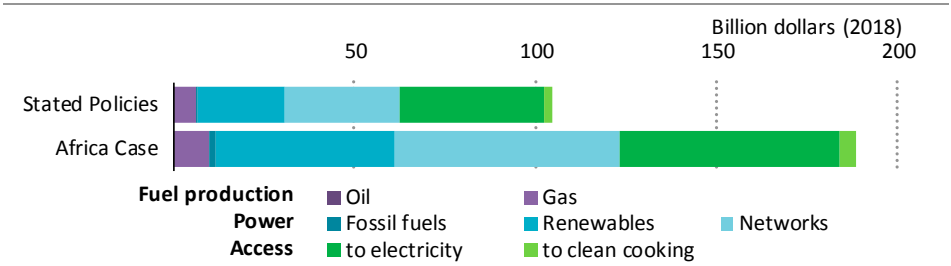
- In the STEPS, a push on improved and advanced biomass cookstoves alongside more access through LPG and electricity increases the population with access by 40 million by 2030, with 60% of this increase takes place in rural areas.
- In the AC, increased efforts using the same solutions bring access to clean cooking by 2030 to the remaining 95 million people that rely on the traditional use of biomass.

Figure 12.5F ▷ Ethiopia fossil fuel demand and production



- Growing fossil fuel consumption is met almost entirely by imports in both scenarios.
- A high degree of dependency on imported fuels in both scenarios and a range of infrastructure development challenges underline the case for the development of hydropower and other renewables.

Figure 12.5G ▷ Ethiopia cumulative investment needs, 2019-2040



- Cumulative energy investment of $100 billion is needed in the STEPS, with electricity access and networks taking the majority.
- The AC needs around 80% more capital, including a doubling of investments in renewables and electricity networks compared with the STEPS.

12

Ethiopia policy opportunities

- Ethiopia will remain heavily dependent on fossil fuel imports. In both scenarios, imports of oil and coal increase; a significant increase in gas consumption (and imports) would help the country to make the most of its industrial potential.
- The need for energy imports could be reduced by a determined push to develop the country's formidable hydro resources and accelerate electrification, as well as by development of its more limited natural gas reserves.
- Continuing progress on access means that fully achieving SDG 7 is well within Ethiopia's reach. Most of the additional connections to 2025 can be made through extending the current grid.

12.6 Ghana

Oil and gas producer **Strong** access record **Steel** producer

Table 12.6A ▷ Ghana key indicators and policy initiatives

			Stated Policies		Africa Case		CAAGR 2018-40	
	2000	2018	2030	2040	2030	2040	STEPS	AC
GDP ($2018 billion, PPP)	63	191	322	438	403	728	3.9%	6.3%
Population (million)	19	29	37	44	37	44	1.9%	1.9%
with electricity access	45%	84%	100%	100%	100%	100%	0.8%	0.8%
with access to clean cooking	6%	25%	58%	73%	100%	100%	5.0%	6.5%
CO_2 emissions (Mt CO_2)	5	15	25	33	32	49	3.6%	5.4%

Policy	Key targets and measures
Performance targets	▪ Accelerate the displacement of light crude oil by natural gas in electricity generation. ▪ Achieve 10% renewable energy in the national energy mix and 20% solar energy in agriculture by 2020. ▪ 15% (unconditional) to 45% (conditional) reduction in GHG emissions by 2030 compared to the business-as-usual scenario (around 74 Mt CO_2-equivalent).
Industrial development targets	▪ Produce and process estimated reserves of 300 million barrels of oil and gas by 2040. ▪ In accordance with the *One District, One Factory Initiative*, build a factory in each of the 216 districts across the country.

- Supplying an economy that is four-times the size of today's could require only three-times more energy with the implementation of efficiency standards in the AC.
- Oil remains the largest energy source in both scenarios, with nearly two-thirds of it consumed in the transport sector.

Figure 12.6A ▷ Ghana primary energy demand and GDP

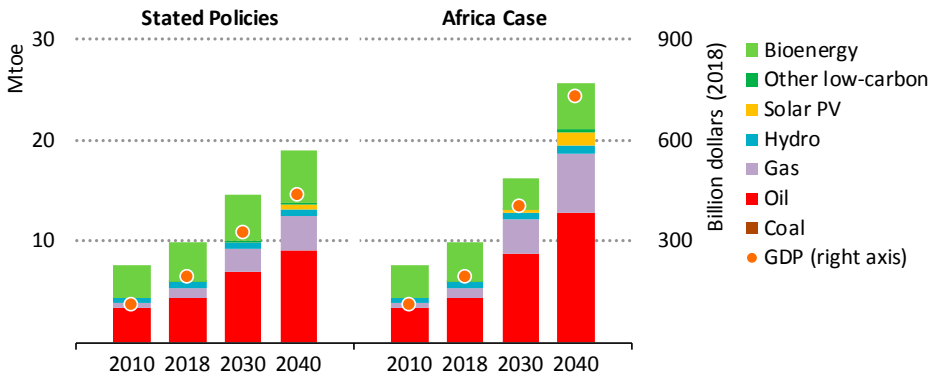
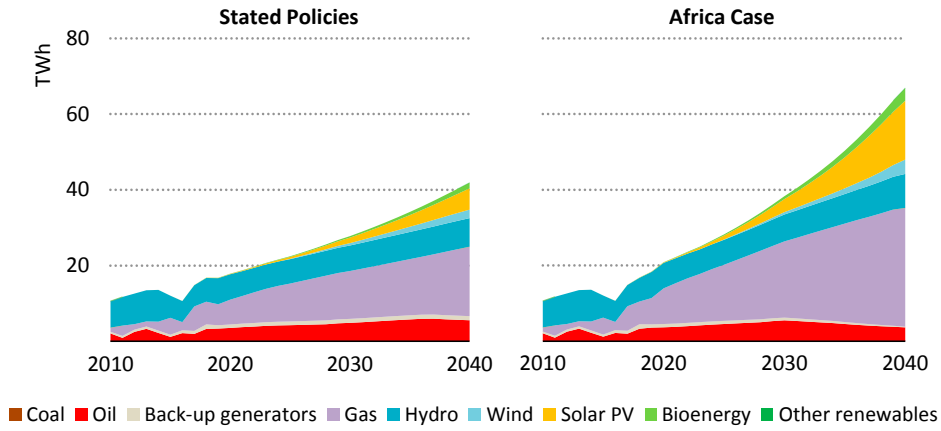
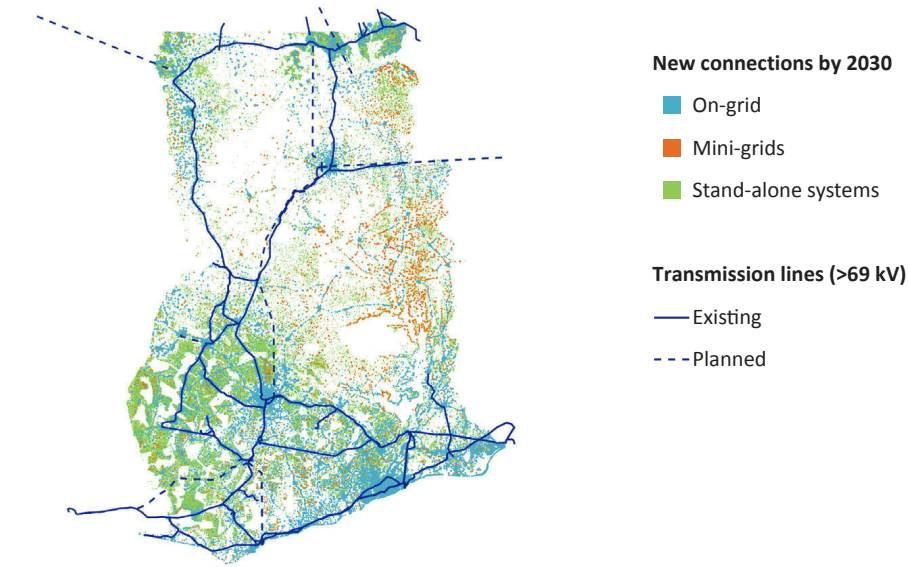


Figure 12.6B ▷ Ghana electricity generation by technology



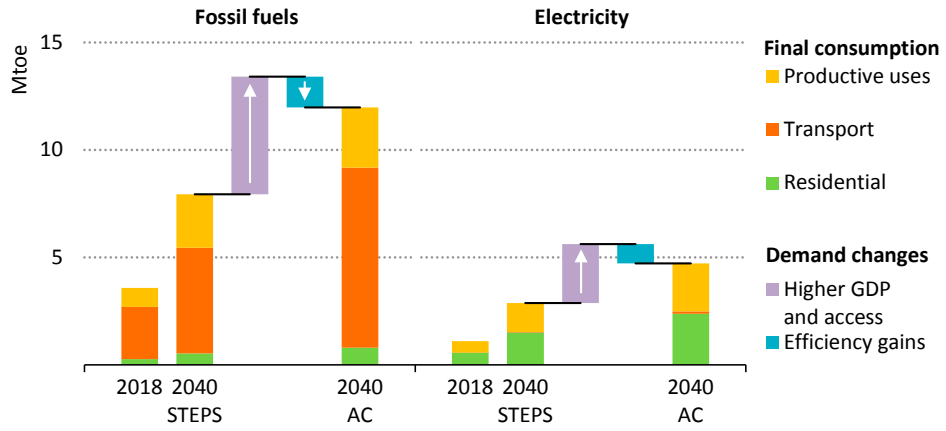
- Almost half of today's electricity comes from hydropower; the rest comes from domestically produced gas (30%) and oil (23%).
- The 350% increase of electricity demand in the STEPS is met by increasing generation from gas, which accounts for nearly half of the power mix by 2040, and from solar PV.

Figure 12.6C ▷ Ghana electricity access solutions by type in the Africa Case



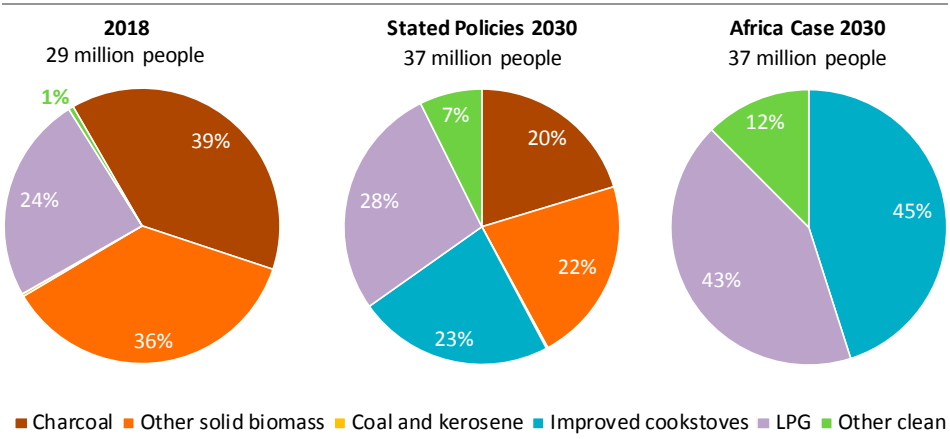
- Thanks to strong government leadership since the 1990s, Ghana had an electricity access rate of 84% in 2018, one of the highest in sub-Saharan Africa.
- To reach the remaining population, grid densification (58% of the new connections) and stand-alone systems (27%) are the two main least-cost solutions in both scenarios.

Figure 12.6D ▷ Ghana final energy consumption



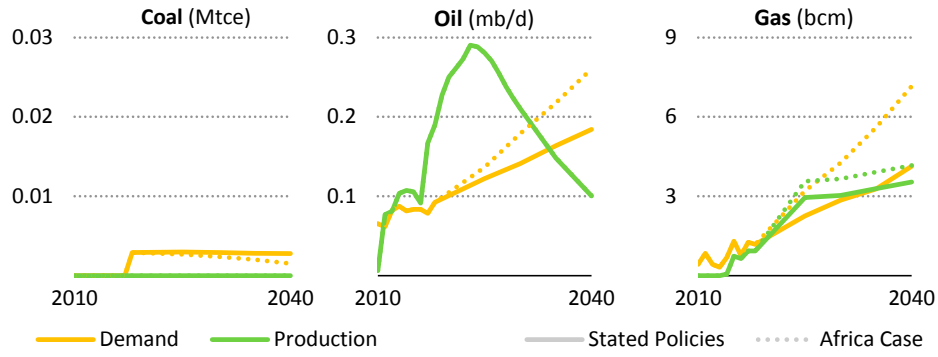
- Two/three-wheelers remain important for passenger transport; in the STEPS, an increasing number of buses accounts for nearly 70% of oil demand growth for transport.
- Millions of additional appliances and cooling systems together with the further development of bauxite mining, and steel and aluminium industries are responsible for two-thirds of the additional 45 TWh of electricity demand in the AC; around 10 TWh are avoided thanks to efficiency standards.

Figure 12.6E ▷ Ghana fuels and technologies used for cooking



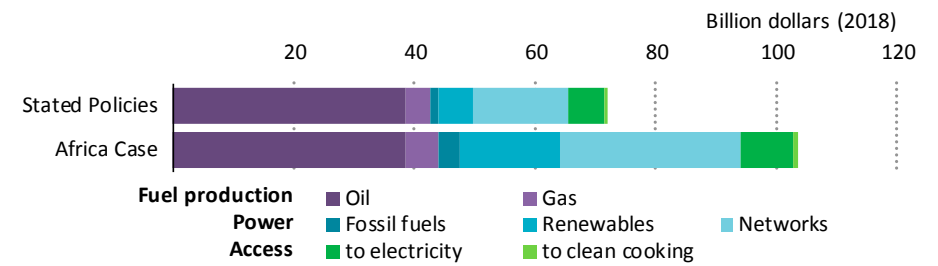
- In the STEPS, strong policies support the provision of clean cooking fuels to more than half of the population mainly through deployment of LPG and improved cookstoves.
- In the AC, 16 million people who still lack access to electricity in 2030 under the STEPS gain access through LPG, biogas or improved cookstoves.

Figure 12.6F ▷ Ghana fossil fuel demand and production



- Ghana remains a relatively minor producer of oil and gas in Africa.
- Gas demand grows strongly in the AC, lowering oil use in the power and industry sectors; this increases the need for imports of gas.

Figure 12.6G ▷ Ghana cumulative investment needs, 2019-2040



- Around $70 billion of cumulative energy supply investment is needed in the STEPS, 60% of which is for upstream oil and gas.
- Investment ramps up by nearly 45% in the AC, with a strong emphasis on renewables and electricity networks.

Ghana policy opportunities

- Thanks to notable efforts on electrification, the goal of full access is within grasp in Ghana. A mix of grid extension and stand-alone solutions would be the least-cost way to reach the decreasing share of the population that remains without access.
- Taking action to arrest (and reverse) declining oil output would reduce Ghana's reliance on imports to meet its growing future demand while a renewed push on developing domestic natural gas resources would help Ghana meet its accelerating industrial power needs.
- The government needs to develop and implement stronger efficiency policies if the potential savings identified in the AC are to be realised.

12.7 Kenya

Major access improvements **Large wind power** producer **Largest geothermal** producer

Table 12.7A ▷ Kenya key indicators and policy initiatives

			Stated Policies		Africa Case		CAAGR 2018-40	
	2000	2018	2030	2040	2030	2040	STEPS	AC
GDP ($2018 billion, PPP)	76	177	358	627	453	1 176	5.9%	9.0%
Population (million)	31	51	66	79	66	79	2.0%	2.0%
with electricity access	8%	75%	100%	100%	100%	100%	1.3%	1.3%
with access to clean cooking	3%	15%	46%	70%	100%	100%	7.2%	9.0%
CO_2 emissions (Mt CO_2)	8	16	27	40	33	60	4.3%	6.2%

Policy	Key targets and measures
Performance targets	▪ National Electrification Strategy: achieve universal electricity service to all households and businesses by 2022 at acceptable quality of service levels. ▪ Produce 100 000 barrels of oil per day from 2022 and develop 2 275 MW of geothermal capacity by 2030.
Industrial development targets	▪ Increase the contribution of the manufacturing sector share of GDP to 15% by 2022. ▪ Develop domestic iron and steel industries by 2030. ▪ Achieve middle-income status by 2030.

- In the AC, Kenya could supply an economy six-and half times larger than today using little more than twice its current energy consumption, if it were to move away from bioenergy and improve energy efficiency.
- Two-thirds of Kenya's energy currently comes from bioenergy. This share shrinks to 15% by 2040 in the AC thanks to increased use of geothermal resources and oil.

Figure 12.7A ▷ Kenya primary energy demand and GDP

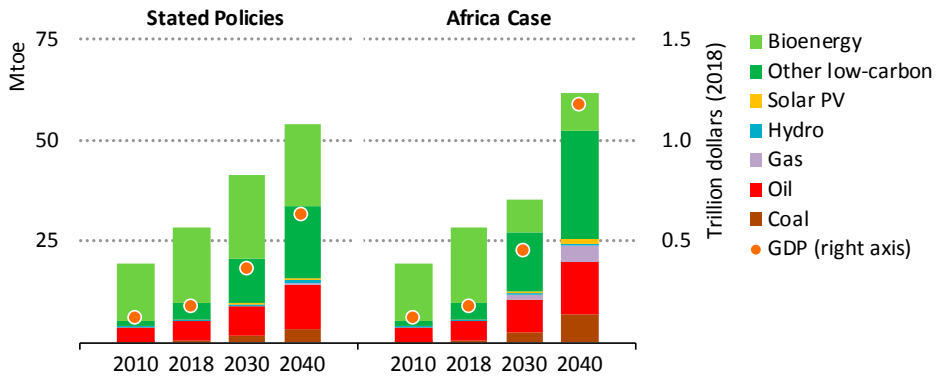
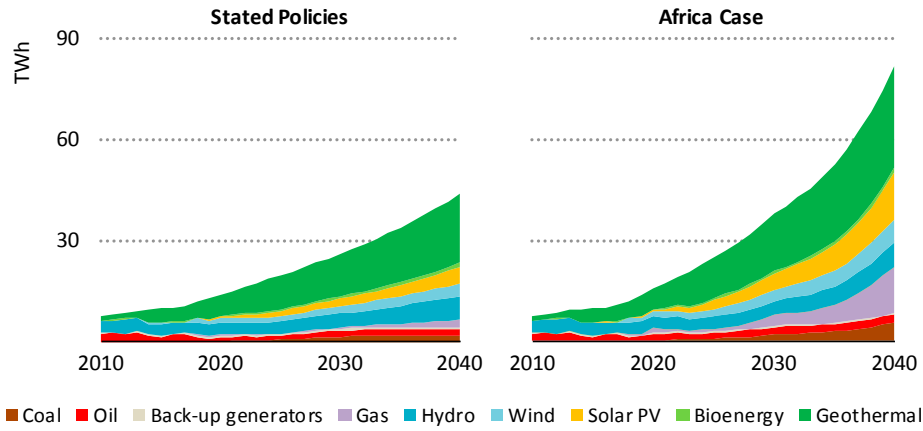
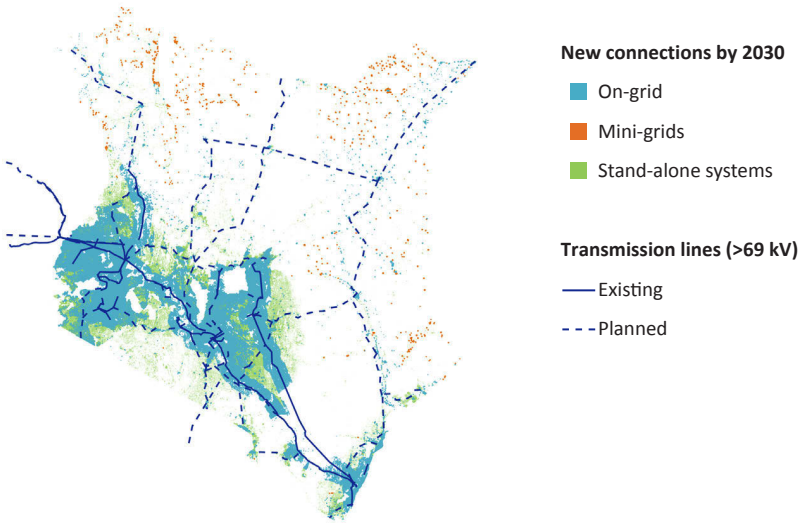


Figure 12.7B ▷ Kenya electricity generation by technology



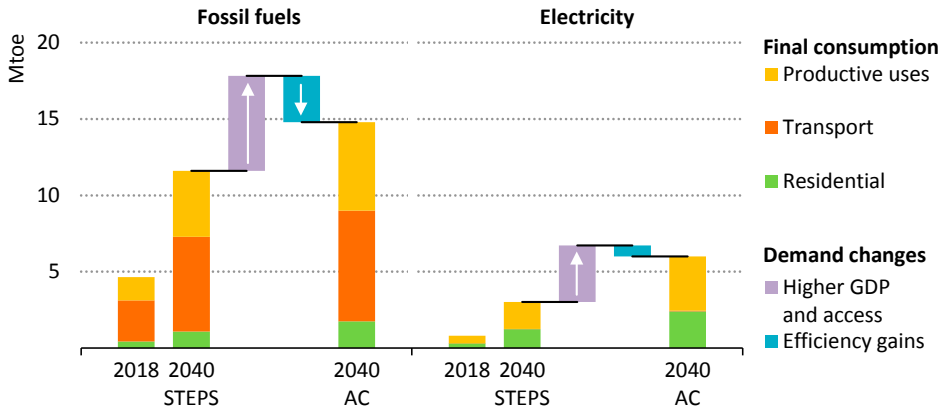
- Kenya is one of the few countries to develop geothermal energy: by 2040, it accounts for almost 50% of Kenya's power generation in the STEPS.
- The sevenfold increase in electricity demand in the AC relies on expansion of geothermal production (an increase to 4 GW) and new solar PV and gas capacity.

Figure 12.7C ▷ Kenya electricity access solutions by type in the Africa Case



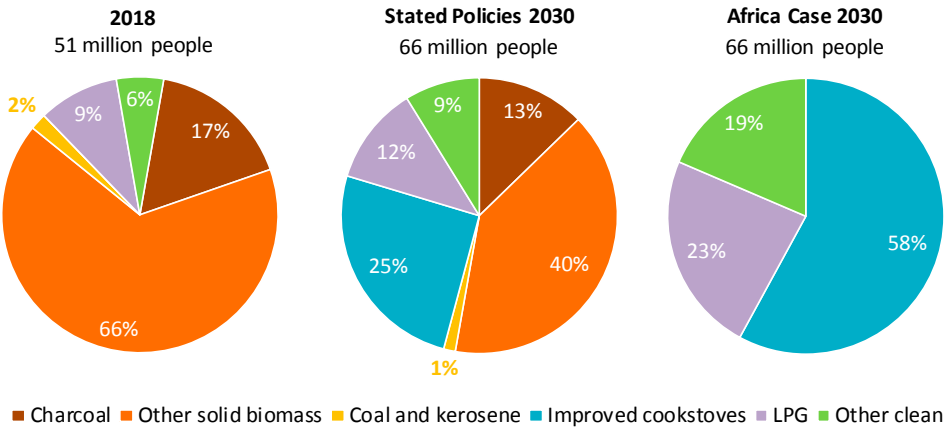
- Kenya has seen one of the fastest increases in electrification rates within sub-Saharan Africa since 2013: by 2018, 75% of the population had access.
- Kenya aims to reach full access by 2022; the grid would be the principal least-cost solution for the majority of the population (mainly in the south) still lacking access.

Figure 12.7D ▷ Kenya final energy consumption



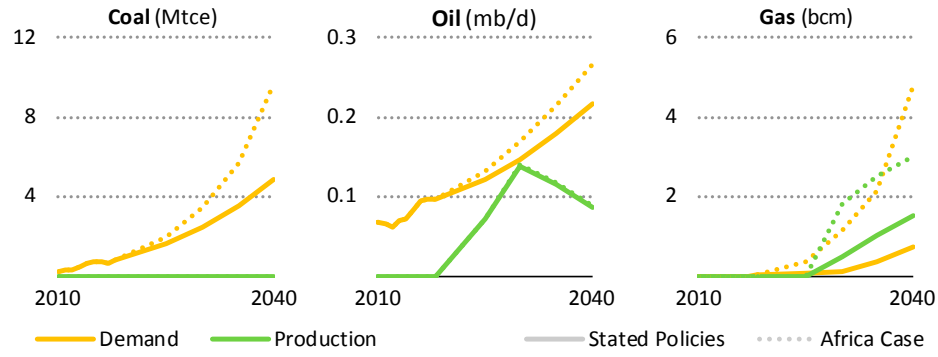
- Oil remains by far the dominant fuel in end-use sectors, and its use triples in road transport in the AC, with five million additional vehicles being added to the fleet.
- Electricity demand reaches nearly 70 TWh in the AC, as light industry grows and as ownership of household appliances and cooling systems increases; efficiency standards avoid a further 8 TWh of demand.

Figure 12.7E ▷ Kenya fuels and technologies used for cooking



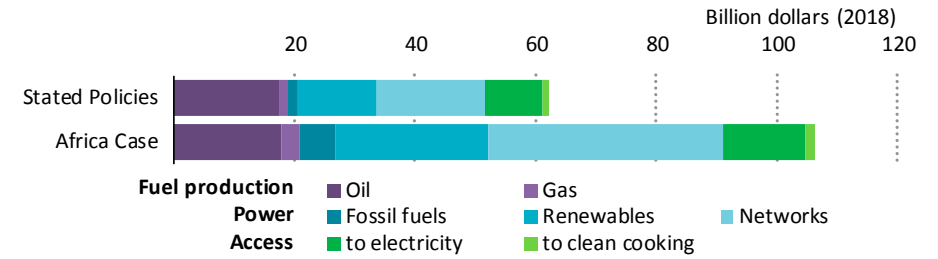
- Today three-stone fires are still used for most cooking, fuelled mostly by charcoal in urban areas and by wood in rural areas. In the STEPS, government initiatives lead to 26% of the population having access to clean cooking by 2030.
- In the AC, everybody gains access to clean cooking by 2030. Most of the 25 million people otherwise without access in rural areas gain access primarily through improved and advanced cookstoves; LPG is the least-cost fuel for most of the urban population.

Figure 12.7F ▷ Kenya fossil fuel demand and production



- Kenya is not a notable oil and gas producer today, but it takes some steps to develop its relatively modest resources.
- Higher economic growth underpins strong growth in fossil fuel demand in the AC. Oil demand almost triples as it expands its share of the overall energy mix.

Figure 12.7G ▷ Kenya cumulative investment needs, 2019-2040



- Energy investment amounts to around $60 billion through to 2040 in the STEPS, with renewables and electricity networks accounting for half of this.
- Investments in renewables and electricity networks need to double in the AC.

Kenya policy opportunities

- Kenya is on the cusp of reaching universal access to electricity. Concerted government policy could help reach this aim through grid and stand-alone connections in roughly equal measure.
- Kenya has made notable progress in deploying renewables in large part because it has successfully attracted the necessary private investment for renewables projects. Further development of these resources would help it meet demand growth.

12.8 Mozambique

Large hydro potential **Important gas** discoveries **Second-largest coal** producer

Table 12.8A ▷ Mozambique key indicators and policy initiatives

			Stated Policies		Africa Case		CAAGR 2018-40	
	2000	2018	2030	2040	2030	2040	STEPS	AC
GDP ($2018 billion, PPP)	11	39	74	140	98	219	6.0%	8.1%
Population (million)	18	31	43	55	43	55	2.7%	2.7%
with electricity access	6%	29%	60%	72%	100%	100%	4.2%	5.8%
with access to clean cooking	4%	6%	11%	22%	100%	100%	5.7%	13.4%
CO_2 emissions (Mt CO_2)	1	8	21	43	38	66	6.8%	9.9%

Policy	Key targets and measures
Performance targets	▪ Promote the construction of electricity infrastructure that is resilient to climate change. ▪ Ensure sustainable and transparent management of the natural resources and the environment.
Industrial development targets	▪ Five-Year Plan 2015–2019 focuses on empowering women and men for gender equity and equality, poverty reduction, economic development, and food security and nutrition. ▪ Expand and modernise roads, bridges, water, ports and other key infrastructure.

- Mozambique could supply an economy more than five times larger than today in the AC with four-times the energy demand if it were to diversify away from bioenergy and improve energy efficiency.
- Bioenergy, including the traditional use of biomass, currently accounts for more than 60% of primary energy supply, but recent discoveries of gas enable the energy mix to be diversified with gas accounting for 45% of the primary mix by 2040 in the AC.

Figure 12.8A ▷ Mozambique primary energy demand and GDP

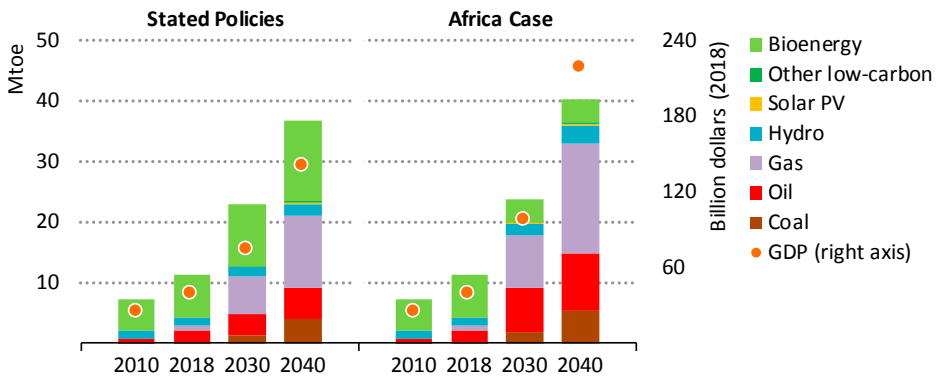
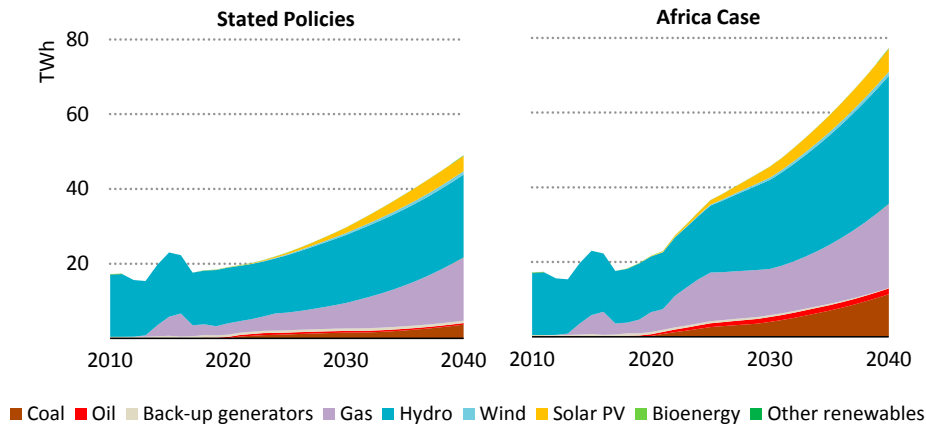
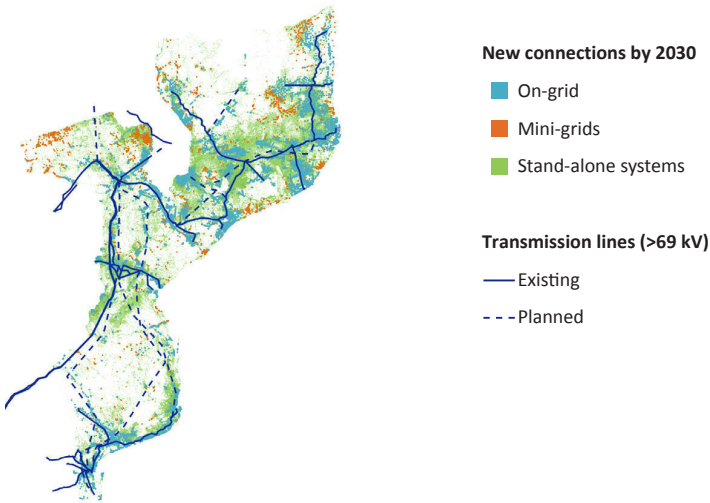


Figure 12.8B ▷ Mozambique electricity generation by technology



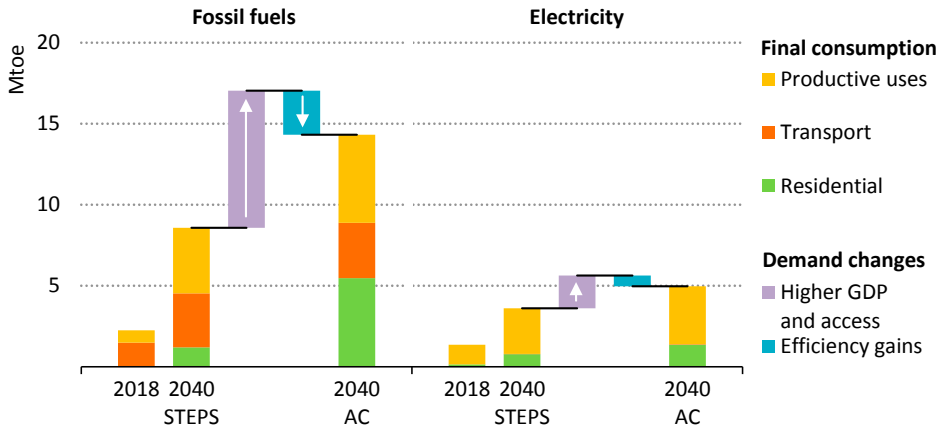
- Providing access to all and increasing electrification of productive uses almost quadruples electricity demand in the AC.
- Hydropower remains an important source of electricity in each scenario, but its share of generation declines from four-fifths today to more than 40% in the AC; gas grows in importance as increasing use is made of domestic resources.

Figure 12.8C ▷ Mozambique electricity access solutions by type in the Africa Case



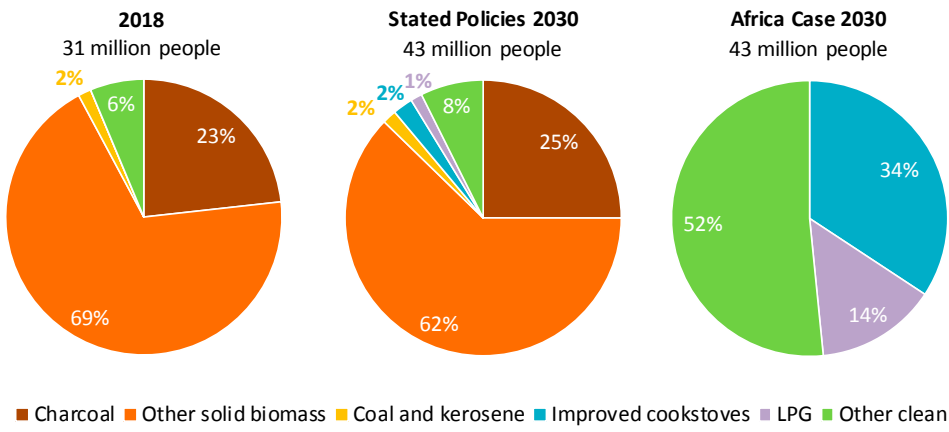
- Currently 71% of the population lacks access to electricity; decentralised solutions are the least-cost option for 55% of the new connections in the AC.
- In the AC, grid connections are the least-cost solution for the remaining 45% of new connections: a large share of the population lives close to existing and planned grids.

Figure 12.8D ▷ Mozambique final energy consumption



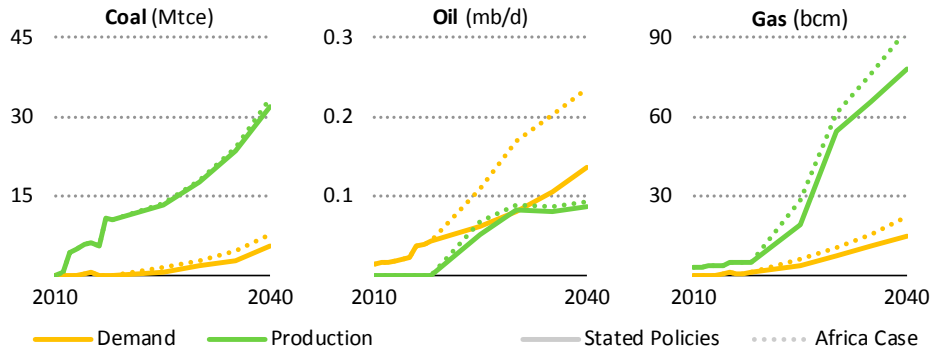
- Oil remains the major fuel used in end-use sectors, with demand growing as a result of increased use of LPG for cooking, while gas consumption exceeds electricity by 2040 in both scenarios.
- In the AC, recent gas discoveries trigger a massive increase in overall industrial gas demand: Mozambique increases production of aluminium more than fivefold by 2040, becoming a significant exporter.

Figure 12.8E ▷ Mozambique fuels and technologies used for cooking



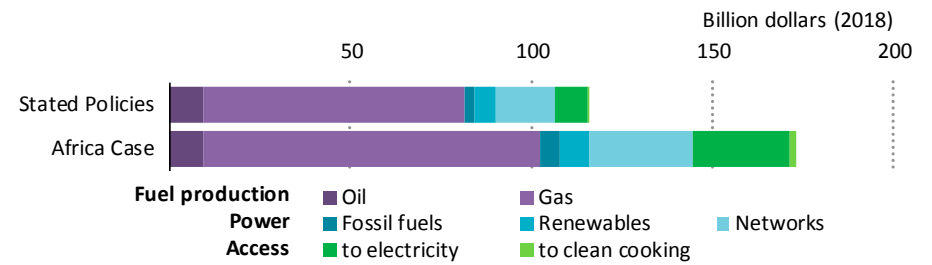
- In the STEPS, the proportion of the population relying on traditional uses of biomass decreases from 92% to 87% by 2030.
- In the AC, natural gas is the least-cost option for a quarter of the 38 million people without access in 2030; with improved cookstoves and LPG providing access for others.

Figure 12.8F ▷ Mozambique fossil fuel demand and production



- The recent massive gas discoveries in Mozambique becoming the largest gas producer in sub-Saharan Africa by 2040 in the AC.
- While the bulk of the production is destined for export, domestic demand also grows as a result of efforts to foster gas-based industries and expand infrastructure in the AC.

Figure 12.8G ▷ Mozambique cumulative investment needs, 2019-2040



- Energy investment needs amount to $115 billion through to 2040 in the STEPS, more than 60% of which goes to gas production and infrastructure.
- The AC requires nearly 50% more capital to promote renewables in tandem with gas infrastructure.

Mozambique policy opportunities

- Mozambique's ambitions for economic and social development depend in large measure on its ability to develop its large natural gas resources.
- In addition to providing valuable export revenue, its abundant gas resources could be used to generate electricity, act as a catalyst for domestic industrial development, and to support clean cooking.
- Large industrial consumers of gas could act as anchors for smaller industries looking to increase their use of gas. The aluminium industry could be one such anchor consumer. The success of a domestic aluminium export business will depend heavily on its ability to secure affordable gas feedstock.

12.9 Nigeria

Largest population **Largest** economy **Large** chemicals producer

Table 12.9A ▷ Nigeria key indicators and policy initiatives

			Stated Policies		Africa Case		CAAGR 2018-40	
	2000	2018	2030	2040	2030	2040	STEPS	AC
GDP ($2018 billion, PPP)	392	1 169	1 636	2 420	2 258	3 678	3.4%	5.3%
Population (million)	122	196	263	329	263	329	2.4%	2.4%
with electricity access	40%	60%	80%	85%	100%	100%	1.6%	2.3%
with access to clean cooking	1%	10%	28%	38%	100%	100%	6.4%	11.2%
CO_2 emissions (Mt CO_2)	37	83	134	191	181	257	3.8%	5.3%

Policy	Key targets and measures
Performance targets	▪ 20% (unconditional) to 45% (conditional) reduction in GHG emissions by 2030 compared to the business-as-usual scenario. ▪ Increase oil production to 2.5 mb/d and become a net exporter by 2020, and end gas flaring by 2030.
Industrial development targets	▪ Dedicate at least 30% of the federal budget to capital expenditure. ▪ Achieve GDP growth of 7% and create over 15 million jobs by 2020 and double manufacturing output to 20% of GDP by 2025.

- Nigeria remains Africa's largest economy: in the AC, supplying an economy three-times larger than today would require less energy demand if the energy mix were to be diversified.
- In the AC, gas meets a growing share of energy demand, supported by the implementation of the government's gas masterplan.

Figure 12.9A ▷ Nigeria primary energy demand and GDP

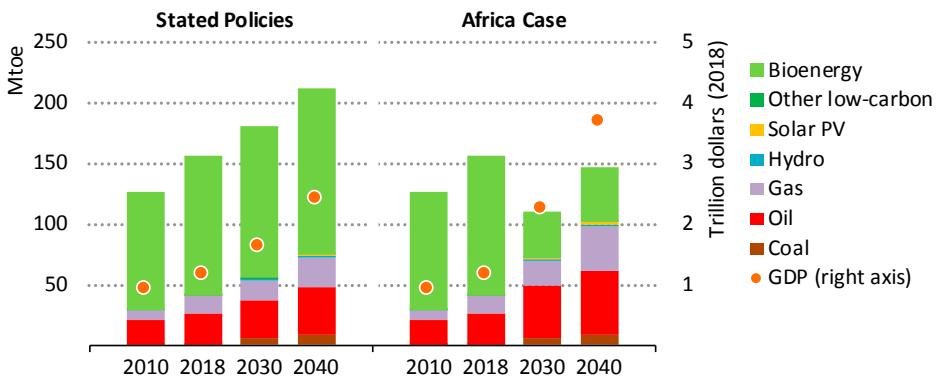
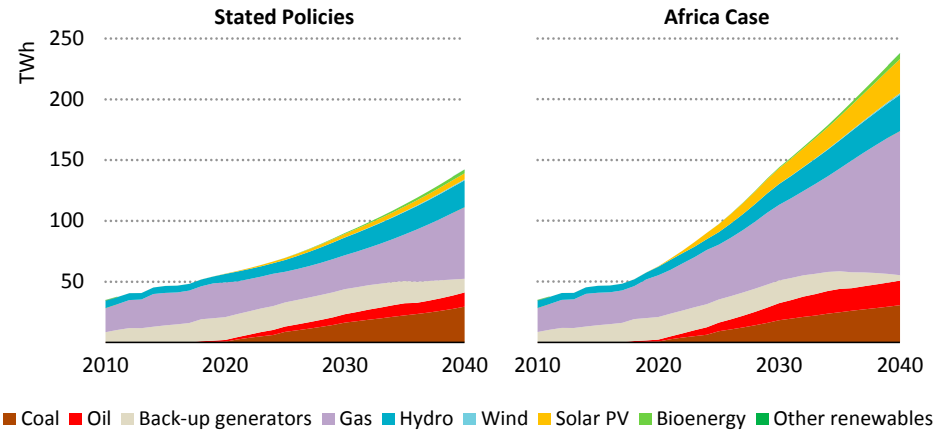
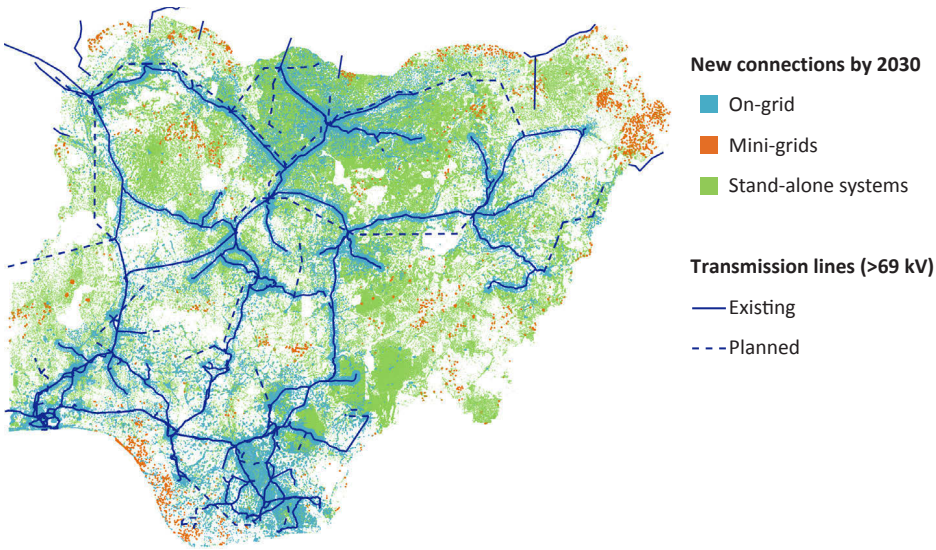


Figure 12.9B ▷ Nigeria electricity generation by technology



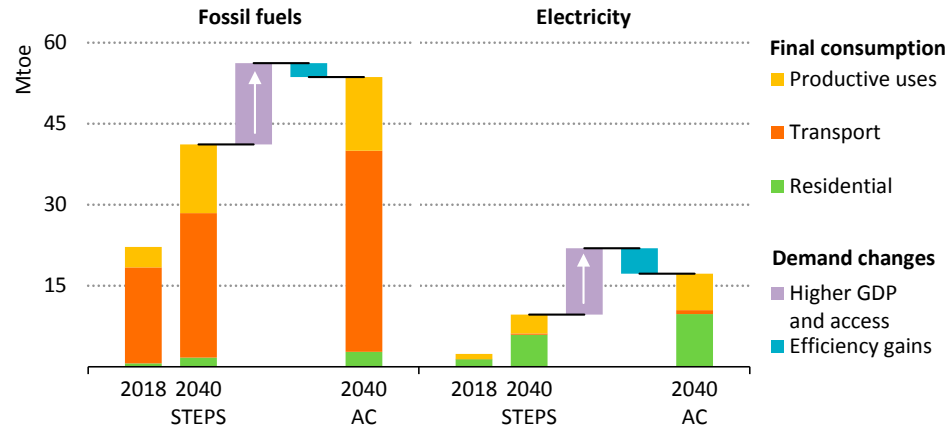
- Today, 80% of power generation comes from gas; most of the remainder comes from oil, with Nigeria the largest user of oil-fired back-up generators on the continent.
- Natural gas remains the main source of power in the AC, although there is a shift towards solar PV as the country starts to exploit its large solar potential.

Figure 12.9C ▷ Nigeria electricity access solutions by type in the Africa Case



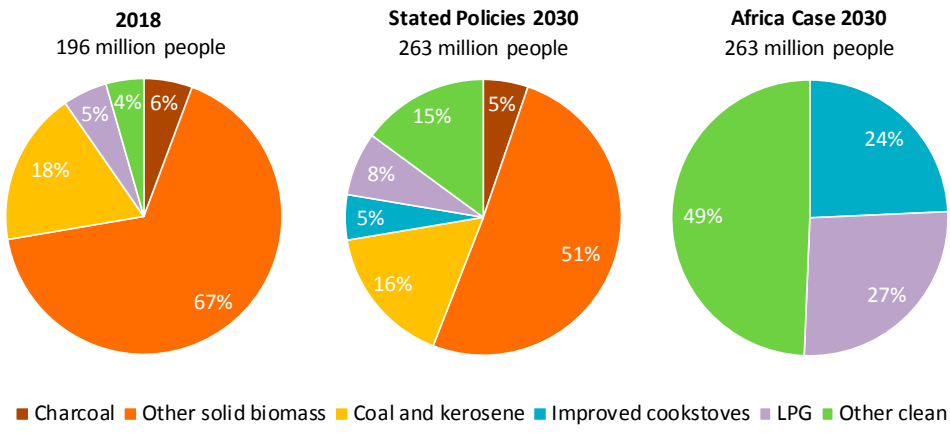
- Provided that reliability and supply improve, the grid could become the optimal solution to provide almost 60% of people with access to electricity in each scenario.
- In the AC, Nigeria achieves universal access by stepping up efforts to provide off-grid solutions to those populations that live far from a grid.

Figure 12.9D ▷ Nigeria final energy consumption



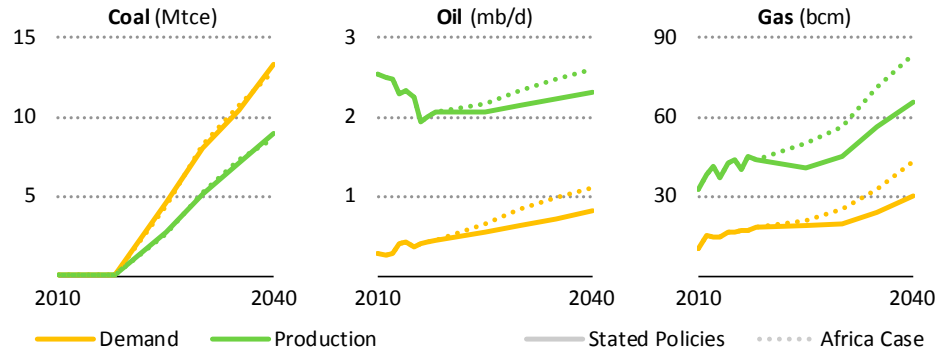
- Nigeria is a major industrial producer and large chemical exporter. In the AC, it triples chemicals production by 2040 with new gas-based methanol and ammonia plants.
- Nigeria has the second-largest vehicle stock in sub-Saharan Africa: the number of vehicles could grow from 14 to 37 million in the AC by 2040 with only two-times more oil consumption if more stringent fuel economy standards were introduced.

Figure 12.9E ▷ Nigeria fuels and technologies used for cooking



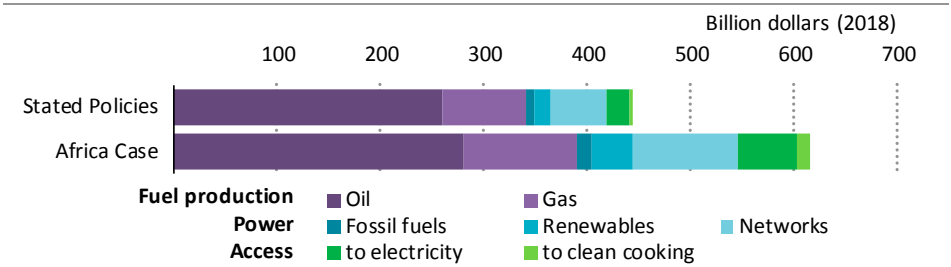
- In the STEPS, there is progress on access to clean cooking services but almost three-quarters of the population still lack access in 2030.
- In the AC, universal access is achieved through greater household access to gas networks and LPG in the main cities, and to improved cookstoves in rural areas.

Figure 12.9F ▷ Nigeria fossil fuel demand and production



- Delayed reforms and growing competition in international oil markets means that it takes time for oil production to revive.
- In both scenarios, gas demand grows strongly in the industry and power sectors, leading to action to increase production and reduce gas flaring.

Figure 12.9G ▷ Nigeria cumulative investment needs, 2019-2040



- Cumulative energy supply investment of $445 billion is needed in the STEPS, almost 80% of which goes to upstream oil and gas.
- The AC requires a significant ramp up in power sector investment. Spending on electricity networks and renewables increases by 85% and 165% respectively, compared to STEPS.

Nigeria policy opportunities

- Oil sector reforms would help to revive oil production while successful implementation of the gas masterplan would foster gas-to-power, industrial development and expansion of the gas network to industrial hubs.
- Improved power sector management and governance would help to reduce outages and transmission losses. Failure to do so would impede industrial growth and would mean continued high levels of use of polluting back-up generation.
- Reducing bioenergy use across all sectors would bring a number of benefits, not least because its use is strongly linked to deforestation and air pollution.

12.10 Senegal

Emerging local gas market **New** oil and gas discoveries **Ambitious** renewables plan

Table 12.10A ▷ Senegal key indicators and policy initiatives

			Stated Policies		Africa Case		CAAGR 2018-40	
	2000	2018	2030	2040	2030	2040	STEPS	AC
GDP ($2018 billion, PPP)	27	60	154	237	176	370	6.5%	8.7%
Population (million)	10	16	22	28	22	28	2.5%	2.5%
with electricity access	31%	69%	100%	100%	100%	100%	1.7%	1.7%
with access to clean cooking	32%	30%	47%	52%	100%	100%	2.6%	5.7%
CO_2 emissions (Mt CO_2)	4	9	19	30	19	32	5.7%	5.9%

Policy	Key targets and measures
Performance targets	▪ Start producing 100 000 barrels of oil per day from 2022. ▪ Achieve 200 GWh hydropower production in electricity generation output. ▪ Reach universal access to electricity by 2025, with 95% of rural connections provided by the grid.
Industrial development targets	▪ The overall goal of *Le Plan Sénégal Emergent* 2023 is to achieve, through structural transformation of the economy, strong, inclusive and sustainable growth for the well-being of the people and reach middle-income status by 2035.

- Senegal's economy could grow six-times larger in the AC while limiting growth in energy demand to three-times its current level by utilising new gas resources and boosting the use of renewables in power.
- In the AC, gas meets a growing share of energy demand while traditional use of biomass starts to decline in rural areas.

Figure 12.10A ▷ Senegal primary energy demand and GDP

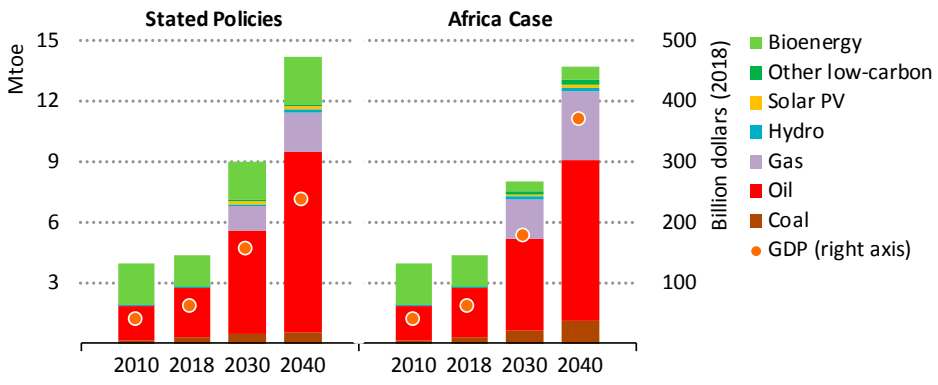
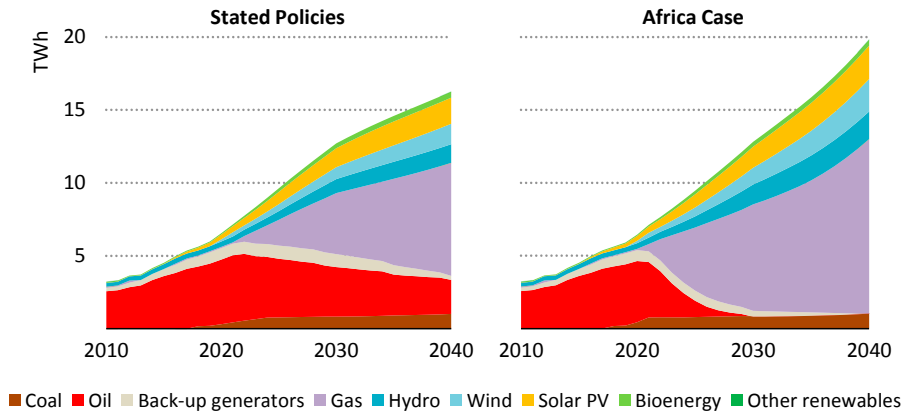
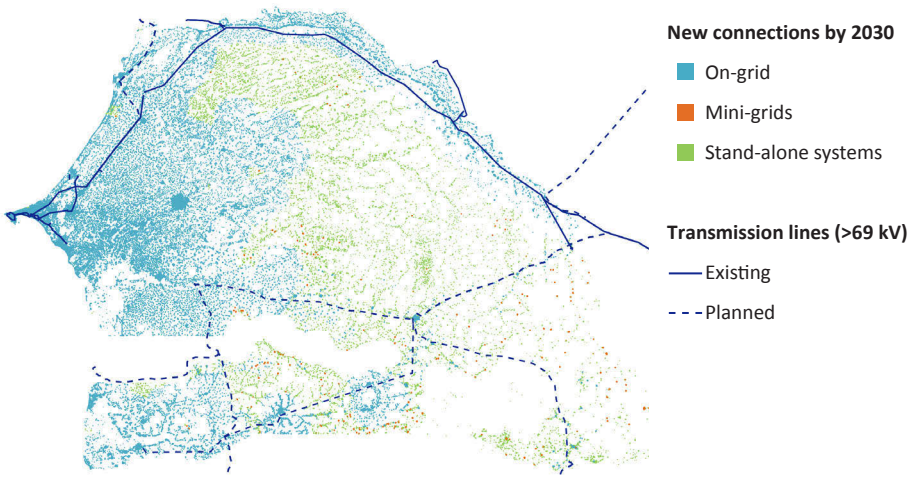


Figure 12.10B ▷ Senegal electricity generation by technology



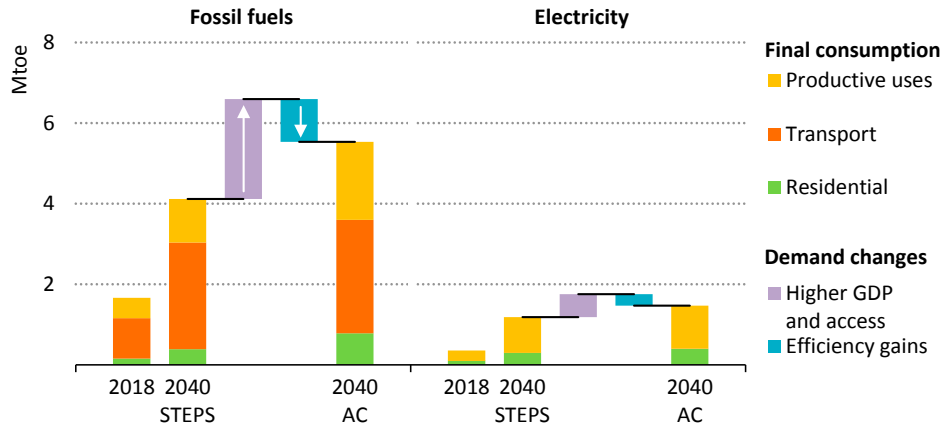
- Electricity demand increases sharply in both scenarios, while the power mix changes, with gas playing an increasingly important role and investments in wind and other renewables bringing more diversification.
- Plans to phase out heavy fuel oil in the AC hinge on successful implementation of new gas-to-power plans.

Figure 12.10C ▷ Senegal electricity access solutions by type in the Africa Case



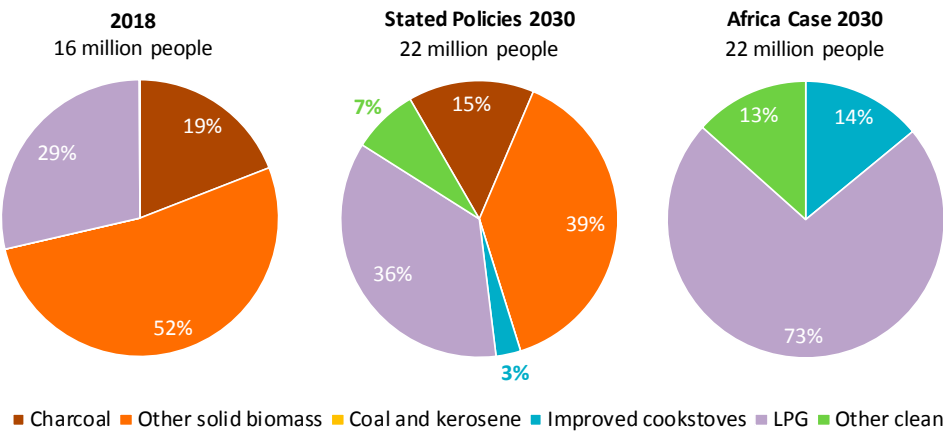
- Thanks to successful access policies, almost 70% of the population is connected today; with adoption of a comprehensive integrated plan full access is achieved by 2025.
- The grid represents the least-cost option for the majority of the population currently without electricity access today, with decentralised solutions reaching the most remote populations.

Figure 12.10D ▷ Senegal final energy consumption



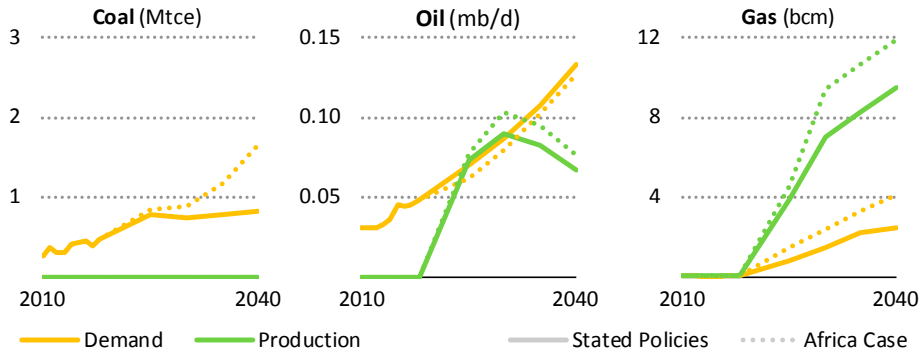
- Senegal's stock of two/three-wheelers is set to grow strongly in both scenarios and its electrification would help to free oil for other productive uses.
- In the AC, cement production could more than double to 2040, although the availability of fuels, including domestic gas, will be critical for this and for wider future industrial development.

Figure 12.10E ▷ Senegal fuels and technologies used for cooking



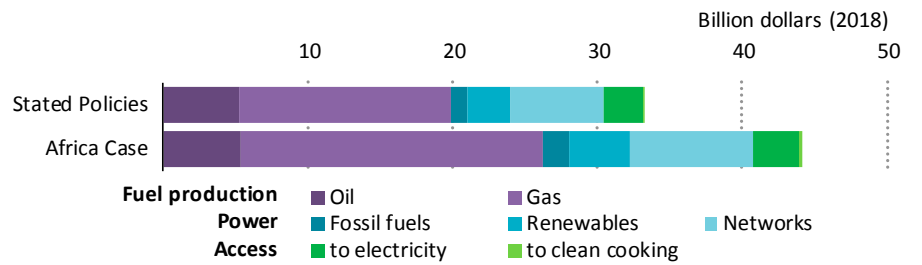
- LPG is used for cooking by almost 30% of the population today, one of the highest shares in sub-Saharan Africa. It is expected to remain the main clean cooking fuel in 2030.
- In the AC, LPG is the least-cost option in both rural and urban areas for more than 70% of the population currently still lacking access.

Figure 12.10F ▷ Senegal fossil fuel demand and production



- Senegal is not a fossil fuel producer today, but the major gas discoveries are expected to change the picture and to lead to gas production of 9.5 bcm in 2040 in the STEPS.
- The greater availability of gas helps displace oil use in power generation in domestic markets while also bringing considerable export revenues.

Figure 12.10G ▷ Senegal cumulative investment needs, 2019-2040



- Energy investment needs amount to $33 billion through to 2040 in the STEPS, mainly to unlock the potential for gas, expand power networks and increase electricity access.
- The AC sees this level of investment increase by a third, with more emphasis on gas and renewable generation.

Senegal policy opportunities

- Implement a robust and transparent framework for resource management and design of local content rules would help Senegal to make the most of its natural resources.
- The development of natural gas strategies that cover the entire value chain, including end-uses (gas-to-power or gas-to-industry), would help Senegal to maximise the benefits of its natural gas.
- Senegal's power sector would be strengthened by continued diversified investment in power, including renewables and natural gas, while phasing out heavy fuel oil.

12.11 South Africa

Africa's only nuclear power **Major** commodity exporter **Coal-fired** power sector

Table 12.11A ▷ South Africa key indicators and policy initiatives

			Stated Policies		Africa Case		CAAGR 2018-40	
	2000	2018	2030	2040	2030	2040	STEPS	AC
GDP ($2018 billion, PPP)	491	789	1 010	1 348	1 174	1 600	2.5%	3.3%
Population (million)	46	57	66	71	66	71	1.0%	1.0%
with electricity access	77%	95%	100%	100%	100%	100%	0.2%	0.2%
with access to clean cooking	81%	91%	93%	95%	100%	100%	0.2%	0.4%
CO_2 emissions (Mt CO_2)	280	420	321	279	289	187	-1.8%	-3.6%

Policy	Key targets and measures
Performance targets	▪ The National Development Plan 2030 envisages that adequate investment in energy infrastructure will promote economic growth and development. ▪ Decommission 35 GW (of 42 GW currently operating) of coal-fired power capacity and supply at least 20 GW of the additional 29 GW of electricity needed by 2030 from renewables and natural gas.
Industrial development targets	▪ Secure primary steel production capability and support the downstream steel sector. ▪ Automotive Masterplan 2020: raise domestic vehicle production to 1% of global output including building 20% hybrid electric vehicles by 2030.

- The economy could double in the AC with less primary energy demand compared to today by increasing the share of renewables and gas in the energy mix.
- In the AC, the role of coal in South African industry and power generation is already decreasing, while that of gas and renewables is increasing.

Figure 12.11A ▷ South Africa primary energy demand and GDP

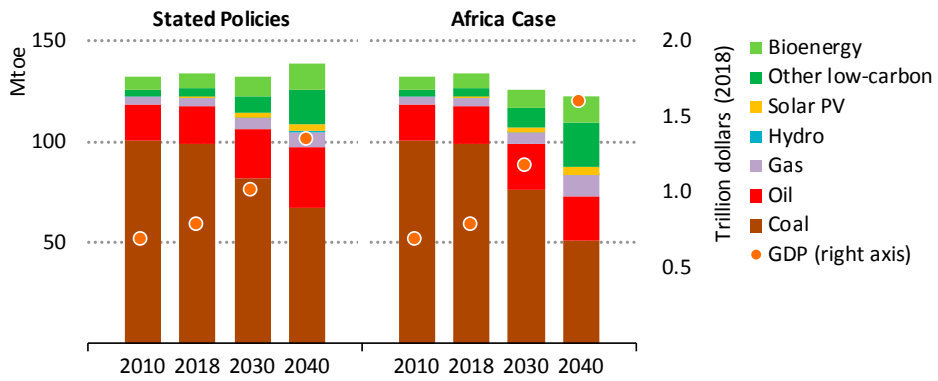
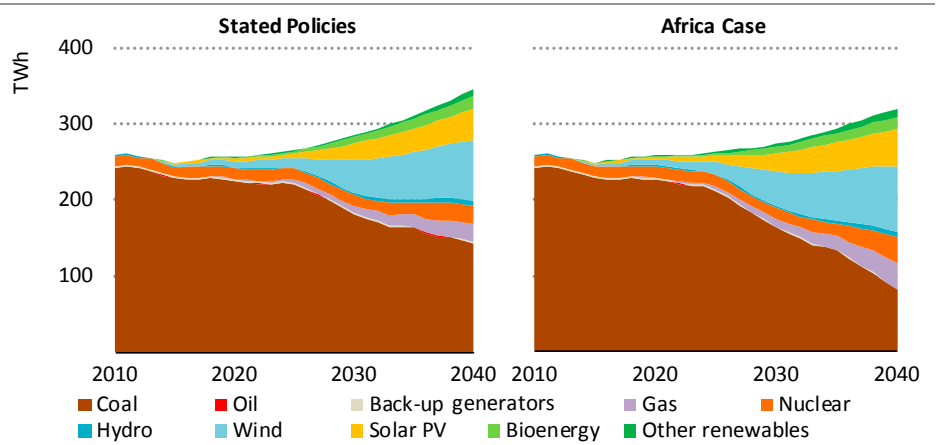
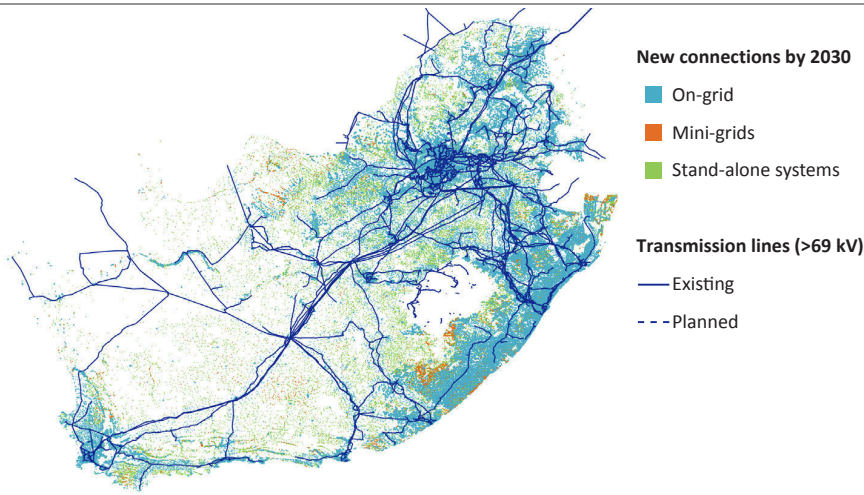


Figure 12.11B ▷ South Africa electricity generation by technology



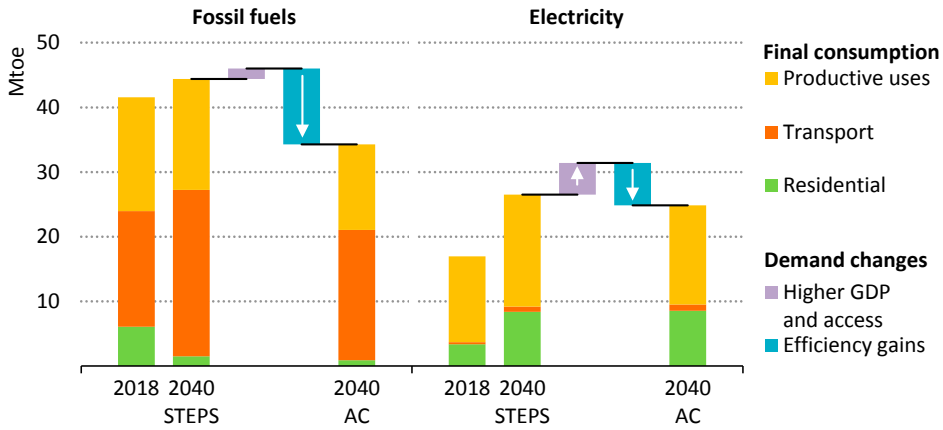
- South Africa is reliant on coal but is making efforts to diversify as its coal-fired fleet is ageing; new projects will not fully compensate for the decline of the existing fleet.
- The government is focussing on diversifying the power mix by introducing natural gas and renewables, including concentrating solar power (CSP); South Africa has excellent natural resources for CSP development.

Figure 12.11C ▷ South Africa electricity access solutions by type in the Africa Case



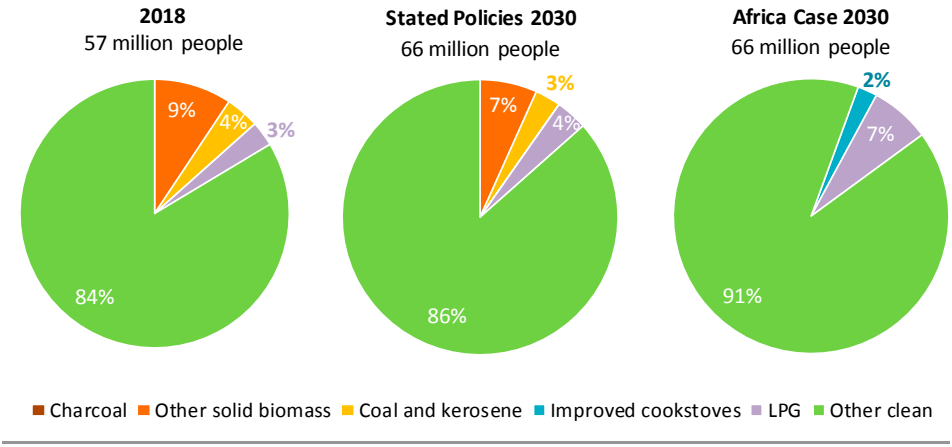
- South Africa has a well-developed electricity network and one of the highest rates of electricity access in sub-Saharan Africa.
- The least-cost way to connect those without access is in most cases via the grid (81%) with the residual population served by mini-grids (12%) and stand-alone systems.

Figure 12.11D ▷ South Africa final energy consumption



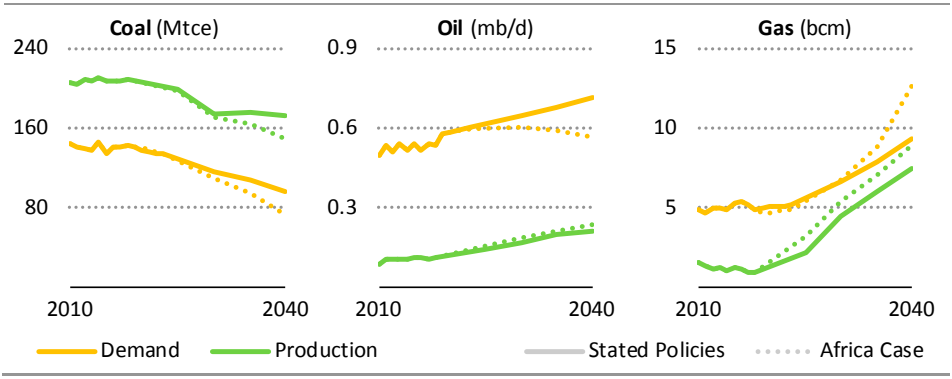
- Oil is the largest fuel in the end-use sectors; more stringent fuel economy standards would mean that a 25% increase in demand could be met with a slight increase in the amount of oil used.
- The role of coal in South African industry dwindles in the AC as gas and bioenergy are increasingly used, especially in steel production and in light industries.

Figure 12.11E ▷ South Africa fuels and technologies used for cooking



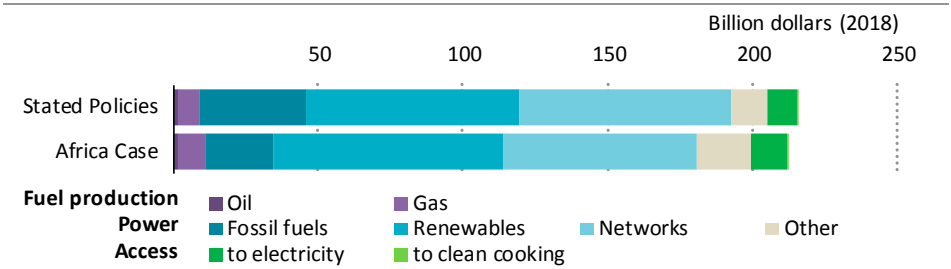
- In both urban and rural areas, electricity is the favourite option for cooking in South Africa, but more than 4 million living mainly in rural areas continue to use fuelwood for heating and cooking in 2030 in the STEPS.
- Improved cookstoves and LPG would help close the gap between the STEPS and the AC and eliminate the use of traditional biomass, reducing household premature deaths by 80% in 2030.

Figure 12.11F ▷ South Africa fossil fuel demand and production



- South Africa continues to dominate coal production in Africa. Despite declining production, falling domestic demand boosts export volumes in both scenarios.
- South Africa also relies on oil and gas for its energy needs, but recent gas discoveries could reduce its import needs.

Figure 12.11G ▷ South Africa cumulative investment needs, 2019-2040



- Nearly $220 billion of cumulative energy investment is needed in the STEPS, with renewables and electricity networks accounting for the majority.
- The AC requires more investment in gas production, but overall efficiency improvements moderate the additional spending needs.

South Africa policy opportunities

- Diversifying energy supply away from coal would have many benefits, including a reduction in the number of premature deaths from pollution, but the social implications of changes would need careful management.
- Reforming and restructuring ESKOM would strengthen the reliably of the power system, support increased industrialisation and help efforts to diversify the energy mix.
- Strengthening efficiency throughout the economy would reduce demand for both materials and energy, while the implementation of minimum energy performance standards for electric motors in the industry and mining sectors would be an important first step towards unlocking further efficiency gains.

12.12 Tanzania

Strong economic growth **Major** gas discovery **Plans** for urban transport

Table 12.12A ▷ Tanzania key indicators and policy initiatives

			Stated Policies		Africa Case		CAAGR 2018-40	
	2000	2018	2030	2040	2030	2040	STEPS	AC
GDP ($2018 billion, PPP)	57	176	314	585	475	1 233	5.6%	9.3%
Population (million)	34	59	83	108	83	108	2.8%	2.8%
with electricity access	11%	37%	70%	80%	100%	100%	3.6%	4.7%
with access to clean cooking	2%	6%	46%	76%	100%	100%	12.2%	13.7%
CO_2 emissions (Mt CO_2)	3	12	24	41	36	74	5.9%	8.9%

Policy	Key targets and measures
Performance targets	▪ Reduce GHG emissions by 10-20% by 2030 compared to the business-as-usual scenario (138-153 Mt CO_2-equivalent gross emissions). ▪ Increase electricity generation capacity from 1 500 MW in 2015 to 4 910 MW and achieve 50% energy from renewable energy sources by 2020.
Industrial development targets	▪ Raise annual real GDP growth to 10% by 2021. ▪ Build a semi-industrialised country by 2025 in which the contribution of manufacturing to the national economy reaches at least 40% of GDP.

- With annual GDP growth of more than 9% in the AC, Tanzania's economy could be seven-times larger in 2040 than today, but with an increase in energy demand limited to 150% driven by fuel efficiency gains.
- In the AC, diversifying the energy mix and improving energy efficiency are the keys to achieving economic growth while limiting growth in energy demand, with oil, gas and geothermal reducing the share of bioenergy in the energy mix.

Figure 12.12A ▷ Tanzania primary energy demand and GDP

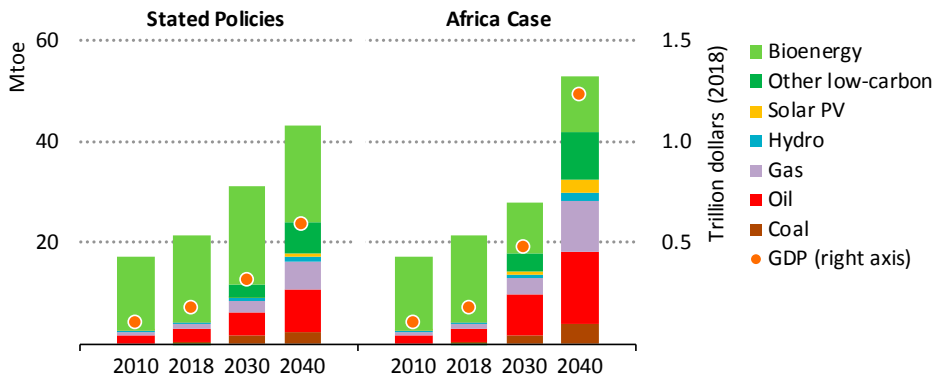
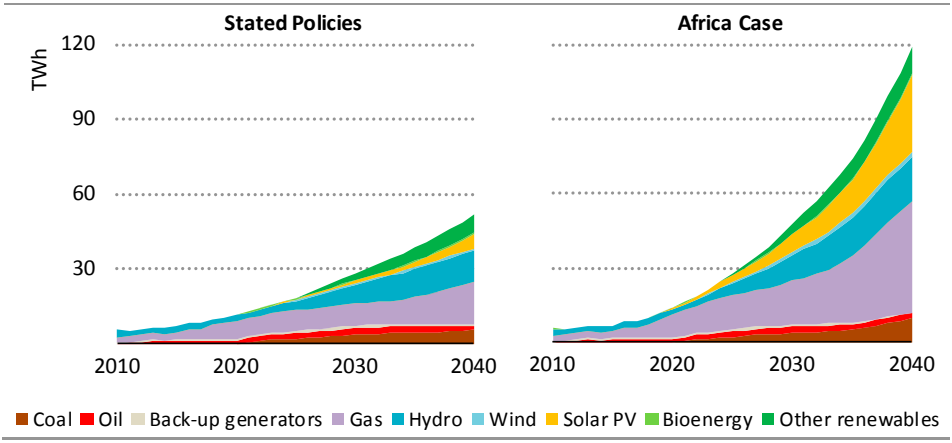
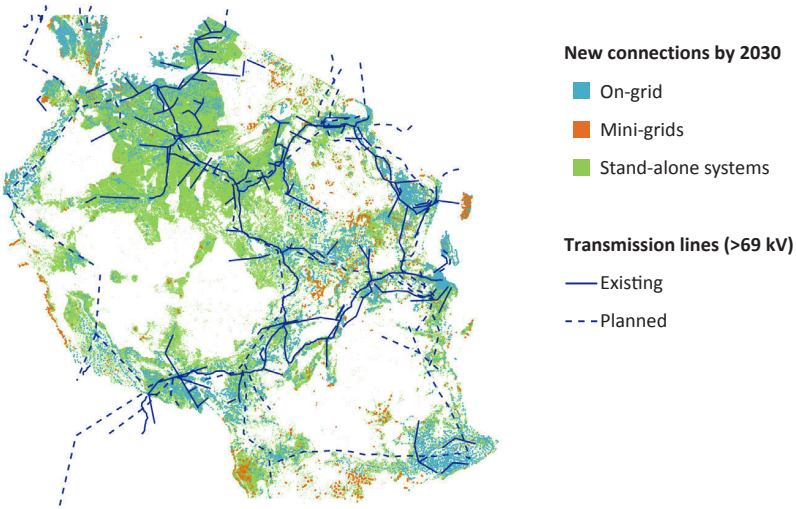


Figure 12.12B ▷ Tanzania electricity generation by technology



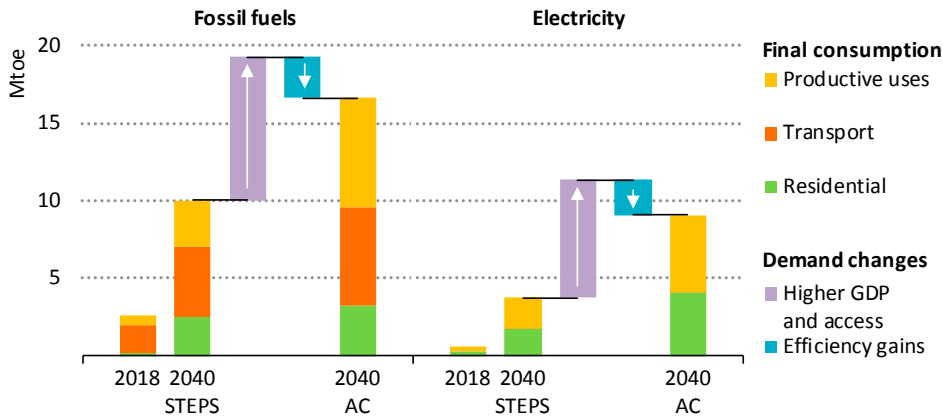
- Gas accounts for more than half of current power generation, with the remainder coming from hydropower and oil, the latter used mostly for back-up generators.
- Providing access for all and a growth in productive uses lead to a thirteen-fold increase of electricity demand by 2040 in the AC: this is met with an expansion of gas, hydropower and solar PV.

Figure 12.12C ▷ Tanzania electricity access solutions by type in the Africa Case



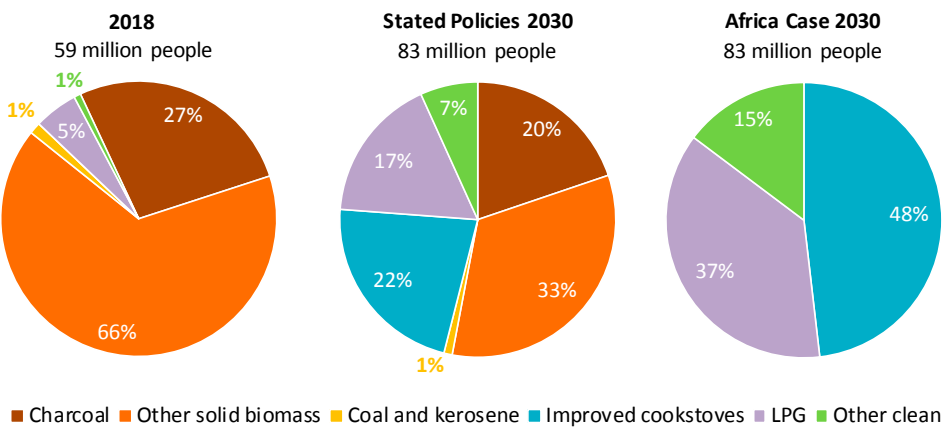
- Despite the low access rate (37%) today, the grid represents more than half of new connections by 2030 in the AC given its existing and planned coverage.
- In the AC, around one-third of the remaining population, mainly located in sparsely populated areas far from the grid, would be best reached by stand-alone systems.

Figure 12.12D ▷ Tanzania total final consumption



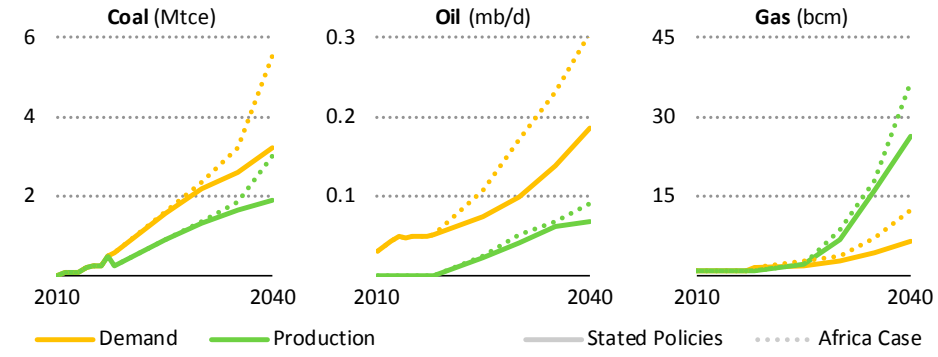
- Oil continues to play an important role in end-use sectors, not least as a result of its use by the increasing number of buses on the road as Tanzania has a large bus fleet.
- Gas and electricity use in industry is growing strongly, especially in manufacturing industries, but in the AC, energy efficiency measures have prevented consumption from being 20% higher than current levels.

Figure 12.12E ▷ Tanzania use of fuels and technologies for cooking



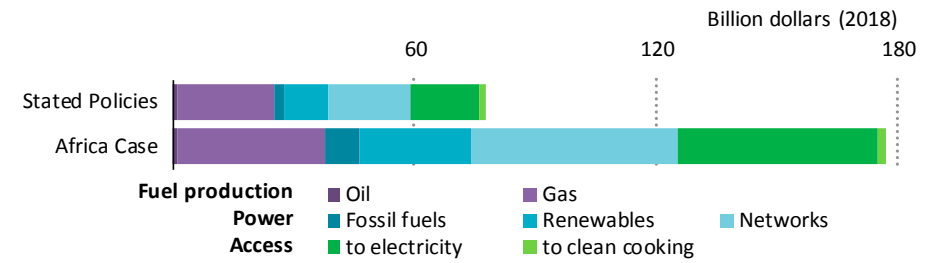
- Despite policies to promote clean cooking solutions, the number of people relying on traditional use of biomass for cooking declines from 55 million people today to 44 million in 2030 as efforts to improve access outrun by high population growth in STEPS.
- In the AC, LPG and biogas are the least-cost options for almost half of the population, with improved cookstoves the main way to extend access in rural areas.

Figure 12.12F ▷ Tanzania fossil fuel demand and production



- Recent large discoveries push up gas production to almost 30 bcm by 2040 in the STEPS. Existing infrastructure helps Tanzania to increase domestic gas consumption.
- Gas demand in 2040 is twice as high in the AC, helped by efforts to promote the use of gas to displace traditional biomass and by support for gas-based industries.

Figure 12.12G ▷ Tanzania cumulative investment needs, 2019-2040



- Almost $80 billion of cumulative energy supply investment is needed in the STEPS, with most of it being used to widen access to gas and electricity.
- This level of investment doubles in the AC, with higher amounts of capital allocated to electricity access and networks.

Tanzania policy opportunities

- A rapid development of offshore resources would help to ensure greater availability of gas, and a robust framework to use export revenues in an effective manner would help to ensure that the country makes the most of those revenues.
- Maintaining investment in public transport, notably in Dar es Salaam, but also in other cities and between cities and rural areas, would help to facilitate economic growth. Government should also ensure public transport is affordable for all.