Clean Energy Transitions in the Greater Horn of Africa

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About this report

The future of Africa's energy sector is important globally. The International Energy Agency (IEA) is actively supporting evidence-based energy policy making in African countries with the aim of achieving affordable and clean energy, in line with United Nations Sustainable Development Goal (SDG) 7. This includes ensuring universal access for all, promoting increased energy security and affordability, and accelerating the development of clean energy systems across Africa, through a sustainable and accelerated regional energy system transformation.

The IEA is committed to developing clean, reliable and affordable energy systems, which are essential for achieving sustainable development objectives. It is also committed to helping African countries use energy sector transformation to cope with and recover from crises such as the Covid-19 pandemic and the Russian Federation's ("Russia" hereafter) invasion of Ukraine, which have destabilised economies and energy systems. This can be done by improving data, informing decision making and guiding policy implementation, in collaboration with local, regional and international institutions.

This report focuses on the eight countries in the greater Horn of Africa region, here defined as Djibouti, Eritrea, Ethiopia, Kenya, Somalia, South Sudan, Sudan and Uganda. It recommends pathways to accelerate clean energy transitions and analyses energy trends across the region. It also highlights policy-relevant best practices for accelerating energy access, energy sector development and transition to cleaner energy sources. The report includes key policy recommendations and identifies opportunities that can help policy makers design clean, cost-effective and efficient energy systems for the future.

The IEA will present the findings of this report at an event in October 2022, with participants from the eight countries. Participants will have the opportunity to discuss clean energy transition pathways, best practices, success stories, lessons learned and recommendations. The aim is to spur political will for accelerated transitions to clean energy and robust interregional stakeholder dialogues, to help country policy makers make effective, high-impact policies.

This report is part of an IEA initiative to promote clean energy transitions in Africa through enhanced regional energy collaboration. The initiative focuses on three regions (North Africa, the Sahel and the greater Horn of Africa), and includes technical workshops and reports that assess energy sector conditions and propose pathways for accelerated transformation. A financial contribution by the Netherlands Ministry of Foreign Affairs made this study by the IEA Clean Energy Transitions Programme possible.

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Executive summary

The greater Horn of Africa is growing rapidly, but secure, affordable, and sustainable energy development lags

The greater Horn of Africa – defined in this report as Djibouti, Eritrea, Ethiopia, Kenya, Somalia, South Sudan, Sudan and Uganda – represents nearly a quarter of sub-Saharan Africa's GDP, and is home to some of the fastest growing economies, but also many areas that face ongoing conflict and instability.

Energy consumption has grown at 3% per year over the last decade, but the region remains energy-deprived. Half the region's population lacks access to electricity and only one in six people have access to modern cooking fuels. However, averages mask large disparities in the region – Kenya has one of the highest access rates in sub-Saharan Africa, while other countries lack centralised grid infrastructure altogether. Total energy demand in the region was 120 Mtoe in 2020 – less than the combined energy consumption of Belgium and the Netherlands but with ten times the number of people. Bioenergy – often in the form of gathered firewood and agricultural waste – meets around 80% of demand.

Most modern energy demand is met through oil products, largely for transport, and electricity, largely in households and industry. The region's power sector has doubled its output over the past decade, and is one of the world's most renewable systems today, with over 85% of generation coming from renewables. Large hydropower projects in Ethiopia, Sudan, and Kenya dominate the power mix today; the region has massive, under-utilised potential for solar, wind, and geothermal as well. Many of the region's smaller countries, historically dependent on imports, are installing their first large-scale solar PV projects, such as the Juba PV farm in South Sudan.

Energy infrastructure has struggled to keep pace with the region's growth – grids remain unreliable, many countries remain dependent on costly fuel imports, and utilities are in financial duress. Adequate energy planning has been undermined by a lack of data – a challenge addressed in part by IEA training programmes in the region, and this report's unprecedented detail and analysis on the region's energy system.

Future economic growth will rely on expanding energy use

The greater Horn of Africa is set to continue its growth. By 2030, the population is set to increase by 25%. Economic growth follows alongside, but is beset by many challenges ranging from pervasive poverty, conflict, instability, a changing climate, and not least, record-high prices for energy and food driven by Russia's invasion of Ukraine. The region is also in the midst of its worst drought in 40 years – a phenomenon set to worsen with climate change.

A lack of energy infrastructure remains a formidable hurdle to development. Overcoming these barriers holds out the promise of stronger economic growth. Such a pathway is explored in the **Africa Case**, where the greater Horn reaches universal access in 2030 and securely and sustainably energises an economy twice the size as it was in 2020. However, realising this scenario requires increased efforts, as Africa is not set to realise these ambitions under today's policies, reflected in the **Stated Policies Scenario** (STEPS).

In the STEPS, modern energy grows from around 25 Mtoe to over 70 Mtoe by 2030 – nearly 3-times larger than the greater Horn's energy use today. To realise the Africa Case's vision of universal access and economic prosperity, modern energy demand grows to over 150 Mtoe. Oil demand nearly doubles over 2020 levels in both scenarios, but the Africa Case sees a much faster uptake of renewable electric generation – more than six-fold – and a huge reduction in the use of gathered bioenergy in cooking, displaced by modern fuels as part of the drive for universal access.

Faster progress on electrification vital to achieve universal access by 2030

Today, 140 million people in the greater Horn lack access to electricity – more than the population of Mexico. Strong improvements have been made since 2010, with 8 million people gaining access annually in average. Kenya and Ethiopia lead the way, and connected close to 35 million people each since 2000 – roughly 80% of those gaining access in the region in that same timespan.

However, this progress has stagnated with utilities facing climbing debt burdens, as they took on losses to keep bills affordable through the Covid-19 pandemic and now are confronted by high energy prices caused by Russia's invasion of Ukraine. Consumers as well are facing decreasing purchasing power, slowing the adoption of off-grid solutions. We estimate that around 5 million more people live without access as of 2021 than did before the pandemic.

However, there is cause for hope. The greater Horn is a world-leader in off-grid access companies. Ethiopia and Kenya together accounted for 30% of global solar home systems and solar appliance sales in 2021. These countries, along with Uganda, are front-runners in Africa for mini-grid expansion. Somalia, a country without a national grid, has developed an active off-grid market, and Eritrea has reached nearly universal access in cities.

The road to universal access to clean cooking is even steeper

Today, more than 250 million people in the region rely on traditional cooking fuels, with few countries having national clean cooking rates exceeding 10%. In rural areas, the problem is even more acute. Recent price spikes in liquefied petroleum gas (LPG) are pushing many households to return to cooking with polluting fuels like charcoal or other gathered traditional biomass. This burden falls on the women in the household, thereby limiting their ability to pursue schooling, other work, and community participation.

However, the region is home to some of the few success stories in Africa for clean cooking. Access rates in Sudan and Kenya increased by 20 and 10 percentage points, respectively, between 2010 and 2020. They are also among the few countries in Africa with a target to reach universal access to clean cooking services by 2030. Sudan has the highest access rate of over 50%, followed by Kenya, Djibouti and Eritrea.

Achieving universal energy access will bring huge benefits

Under today's policies in STEPS, 110 million people still live without electricity in 2030. Only Kenya provides electricity to its entire population, while Ethiopia nears 90% of electricity access. 240 million still lack clean cooking solutions by 2030. Access to clean cooking in 2030 remains elusive in most countries, although there is some progress, with two-thirds of the population of Sudan using clean fuels by 2030, one-half in Kenya and one-third in Ethiopia.

The Africa Case shows a brighter future, achieving universal access in electricity and clean cooking by 2030. This requires expanding on- and off-grid connections to over 20 million people and providing clean cooking fuels and devices to more than 30 million people every year. Near-term actions can immediately spur increased progress: removing import duties and other taxes on access equipment, expanding affordability support to off-grid systems, and putting the legal frameworks in place to tap into international climate finance streams. However, long-term planning backed by concerted government and international support will be needed to reach these levels of progress.

The greater Horn of Africa's plentiful renewables outcompete other forms of power generation

Electricity becomes one of the fastest growing parts of the Horn's energy system to 2030. Installed capacity triples in STEPS in 2030, and grows five-fold in the

Africa Case. The share of electricity in total final consumption rises to 15% by 2030 in the Africa Case, up from 4% in 2020.

Renewable power sources out-compete most other sources. In the Africa Case, solar PV capacity increases 25-fold, geothermal power tenfold, and wind and hydropower fivefold over the 2020-2030 period. Hydropower remains the most important source, accounting for two-thirds of power generated, while geothermal accounts for about one-fifth.

Policies to attract and enable investment are required to cater for this massive uptake of renewable energy. Project developers often face barriers in financing the early stages of projects, going through lengthy approval processes. Greater attention on strengthening existing grid infrastructure, interconnecting regional grids, and expediting renewable generation projects also helps to reduce the risks of new project development.

Improving efficiency can play a key role in tempering energy demand growth

Energy efficiency can be a key lever to reduce strains on a growing energy system, relieving pressures on consumer bills, managing fuel import burdens, limiting the scale of expensive new infrastructure, and lessening the risk of dumping inefficient appliances and vehicles. The Africa Case envisions far greater focus on efficiency between now and 2030, with 30% less demand than in STEPS. To achieve this goal, the region's energy intensity needs to improve annually by about 6%. This pace is challenging but achievable and comparable to that of the People's Republic of China over the period 1990-2000.

The greatest gains are in the buildings sector. Improving the efficiency of cooking, cooling, and appliances saves the most energy to 2030. Key initiatives are contributing to these efforts today, such as the Uganda Building Act, the Energy Efficiency Lighting and Appliance project in East Africa, or plans to harmonise Minimum Energy Performance Standards within Eastern and Southern Africa.

Transport efficiency offers the next largest opportunity. Energy demand for mobility doubles in the Africa Case and the number of cars more than triples. Stricter standards on vehicles and adoption of electric two- and three-wheelers save nearly 4 Mtoe by 2030 compared with in STEPS, also reducing the region's oil import burden. In the Africa Case, increasing transportation use are largely met by oil, but restrictions on the sale of inefficient vehicles, new and used, help to improve efficiency. Electric vehicles meet only a small share of growth due to high costs and limited grid reliability. However, electric two- and three-wheelers take off and increase electricity demand by 10 TWh in 2030 in the Africa Case.

Universal access and faster economic growth can be achieved with only modest growth in emissions to 2030

Despite being one of the regions globally that is most vulnerable to the impacts of climate change, the greater Horn has one of the lowest levels of emissions per capita. In 2020, the greater Horn contributed 57 Mt CO_2 to global emissions – roughly that of New York City. The Africa Case envisions an economy twice as big as today but with lower emissions than in the STEPS, thanks to greater focus on efficiency and power sector renewables. Emissions grow to around 130 Mt CO_2 in the Africa Case, mostly from oil in road transport, then industry. All countries in the region have submitted nationally determined contributions under the Paris Climate Agreement, committing to take measures for mitigation, but include conditional requests for international support for those measures alongside climate adaptation.

Stepping up clean energy deployment will require new models of project financing

In sub-Saharan Africa, total energy investment has been declining since 2014. To achieve universal energy access, support economic development and adhere to countries' climate targets, total energy investment more than doubles by 2030 in Africa, with clean energy accounting for roughly 70% of spending. Achieving full access to modern energy across the continent by 2030 would require investment of USD 25 billion per year - comparable to the cost of just one large LNG terminal investment. Current investments fall far short of these levels. In 2019, they amounted to just 13% of the average needs for 2022-2030 in the case of electricity and 6% for clean cooking.

Achieving the Africa Case in the greater Horn relies on improving the investment environment and creating a pipeline of bankable projects. Cumbersome and inefficient bureaucracy, a lack of clear energy sector planning, and limited technical expertise all contribute to significant cross-cutting risks for investors, although the severity of these risks varies drastically across region. Attracting more energy investment requires better leveraging of limited sources of concessional public financing to attract more private capital. New sources of finance specific to clean energy can help: climate finance, carbon credits, renewable energy certificates, and sustainable or diaspora bonds. These sources can also help cultivate stronger local capital markets, and play a growing role in financing the region's energy sector.

The greater Horn of Africa can achieve development goals through far-sighted policymaking and regional integration

The greater Horn has immense potential for clean and sustainable energy development. Strong efforts on the ground, coupled with international financial support, can bring the region on track to reach full energy access, provide economic and employment opportunities (including for women and youth) and align with climate targets. Actions need to reflect the different starting points of the diverse countries in the region.

Regional integration under the auspices of the Intergovernmental Authority on Development, through power pools and East-African organisations, and in the context of the African Continental Free Trade Area can accelerate economic and industrial development and lead to a more inclusive and sustainable energy future. The dynamism of the region's energy sector, the increasing availability of competitive clean energy technologies, and lessons learned across the continent and locally offer opportunities to support economic growth and accelerate progress towards the targets of United Nations Sustainable Development Goal 7.

Introduction

Context

For the purposes of this report, the greater Horn of Africa region comprises eight countries: Djibouti, Eritrea, Ethiopia, Kenya, Somalia, South Sudan, Sudan and Uganda.

These eight countries constitute the members of the Intergovernmental Authority on Development (IGAD), one of Africa's regional economic communities. Nevertheless, the countries belong to more than one regional group. All except Eritrea are part of the Eastern Africa Power Pool; all are Common Market for Eastern and Southern Africa member states; three (Kenya, South Sudan and Uganda) are members of the East African Community, another regional economic community; and all but Djibouti, Eritrea (observer status) and Somalia are members of the Nile Basin Initiative.

The greater Horn countries account for about 20% of the GDP of sub-Saharan Africa (excluding South Africa), 25% of its total final consumption and close to 30% of its population without access to energy. The region's annual population growth rate is one of the highest in the world: 2.5%, which is comparable to that of sub-Saharan Africa. Over 50% of the people in the greater Horn region lack access to electricity, and over 85% lack access to clean cooking systems – defined as cooking solutions that release less-harmful pollutants, and which are more efficient and environmentally sustainable than traditional cooking options that use solid biomass (e.g. a three-stone fire), coal or kerosene[1].

Structure

The report is organised as follows.

Chapter 1 looks at the greater Horn of Africa's regional context.

Chapters 2, 3 and 4 cover the subjects of three SDG 7 targets, and include trends and status, projections to 2030 and recommendations. Chapter 2 focuses on access to electricity and clean cooking (SDG Target 7.1), Chapter 3 delves into deployment of renewable sources of energy (SDG Target 7.2) and Chapter 4 explores improving energy efficiency (SDG Target 7.3).

[1] IEA definition of access to clean cooking and taxonomy of cooking facilities can be found on IEA website.

Chapter 5 discusses investment trends and needs, focusing on fuels (upstream, midstream and downstream), electricity capacity and infrastructure, end use, financing sources, investment instruments and frameworks.

The report also touches on issues such as gender, youth, employment and displaced communities, highlighting the links between energy and a wide range of socio-economic insecurities. It includes data-driven analyses that quantify and explain how energy systems have evolved, where they stand today and how they could evolve by 2030 under different scenarios. The report also documents regional energy policies, case studies, good practices and recommendations for national policy makers, international stakeholders and investors.

Data sources

This first such IEA analysis shows the latest picture of the energy systems of the greater Horn countries. The energy data in this report are the result of a massive effort to collect, review and validate the energy balances of the target countries. Project teams from governments of the eight focus countries and the IEA Energy Data Centre used complementary sources and expert interventions from different partner organisations and countries. The annexes present detailed national and regional energy balances as figures, data and country profiles.

The IEA's databases of energy and economic statistics provide most of the data used for the report. IEA statistics on energy supply, transformation and demand, CO_2 emissions from fuel combustion, end-user prices and splits of energy demand form the bedrock of the modelling and analysis carried out.[2]

The IEA's energy data-collection effort for Africa benefits from a fruitful and long-lasting co-operation with the African Energy Commission. However, robust or recent energy demand data are hard to find for some countries covered in this report, especially Djibouti, Eritrea and South Sudan. In many cases, the level of detail is not sufficient to give a clear picture of the energy landscape. The IEA's energy access database has been updated based on inputs from the eight countries and contains the latest country-level data on the share of national, urban and rural households with electricity and clean cooking access up to 2020. There has been a strong IEA effort for reinforcing national capacities for energy statistics and for standardising electricity access data jointly with the European Commission and the US Agency for International Development.

[2] Please refer to Annex B for references on IEA databases and publications, as well as external databases used for the purposes of this report.

Bioenergy consumption is an area that is difficult to measure.[3] There is a systematic lack of data throughout Africa, with the reported data often not harmonised within regions or collected from outdated surveys. The IEA, the Food and Agriculture Organization of the United Nations and the African Energy Commission have been jointly improving data for solid biofuels. Consultations with countries have taken place for the purposes of this report.

Ultimately, the analysis in this report fills energy data gaps in the region and the countries under study, where datasets are typically scarce, and provides insights that can inform policy making on clean energy transitions. Specific data on all energy sectors, including supply and demand, were gathered for the report (see Annex B on data references). The IEA aims to develop and broaden energy data exchanges by strengthening its relationships with the countries in the greater Horn.

Understanding the scenarios

This report analyses the energy sector of the greater Horn of Africa region. It provides projections under two main scenarios in a bid to enhance decision making by governments, companies and other energy-related entities. These two scenarios consider 2020-2030 as the time horizon used for projections, unless specified differently.

The **IEA's Stated Policies Scenario (STEPS)** assesses where 2020's policy frameworks and announced national policies, along with evolving technologies, could lead the energy sector in the greater Horn region over the next decade. Since announced policies are, by definition, not yet fully reflected in legislation or regulation, their likelihood and timing depend on evaluating pertinent political, regulatory, market, infrastructure and financial constraints. This scenario is not based on a particular outcome, but on announced policies.

The **IEA's Africa Case Scenario (Africa Case)** examines what it will take to realise the African Union's vision for faster economic development (especially for the greater Horn countries), as well as universal access to electricity and clean cooking solutions by 2030. It is based on Agenda 2063, which is a blueprint for transforming Africa into a global economic powerhouse. Given the cost-effectiveness of low-carbon energy solutions over the next decade, this scenario relies on meeting additional demand with primarily low-carbon energy sources, notably in the power sector and electrifying end-use sectors. This keeps CO_2 emissions growth to 2030 under that of the STEPS, consistent with decarbonising

[3] Bioenergy is the energy content in solid, liquid and gaseous products derived from biomass feedstocks and biogas. It covers solid biofuels (fuelwood, charcoal, agricultural residues, wood waste and other solid waste), liquid biofuels (liquid fuels, including ethanol and biodiesel) and biogas.

efforts reinforced by the region's unconditional NDCs – all countries in the Greater Horn of Africa have submitted NDCs within the Paris Agreement.

The report also draws on other IEA reports and analyses, relevant for the greater Horn of Africa and where another scenario is used:

The IEA's **Sustainable Africa Scenario** sets out a pathway that achieves all Africa's energy-related development goals. These include universal access to modern energy services by 2030 and all the nationally determined contributions and announced African net zero emissions pledges on time and in full. It considers international financial flows consistent with African nations' conditional nationally determined contributions. It also considers national and corporate commitments to increase climate finance flows and to cease financing certain fossil fuel projects. In the rest of the world, it is assumed that all announced global commitments to reach net zero emissions are fully implemented. Accordingly, the Sustainable Africa Scenario depicts a more accelerated shift to clean energy than the Africa Case, but similarly achieves Agenda 2063 objectives and universal access by 2030. This scenario is assessed in the IEA's Africa Energy Outlook 2022.

Chapter 1. Regional overview

Key findings

Countries in the greater Horn of Africa region are diverse in terms of size, population and economic structure. Economic growth is uneven and coupled with strong social inequalities; opportunities for women and youth empowerment are scarce. Employment patterns show that many energy-related workers come from the informal sector (collecting wood for instance), and are more likely to be women than men. However, there has also been major positive economic development in recent years, with unprecedented diversifying economic growth in Ethiopia and Kenya.

Although it is one of the regions contributing the least to global warming, the greater Horn is particularly vulnerable to the impacts of climate change, leading to high numbers of displaced people. This can lead to rapidly evolving and complex political dynamics that destabilise the countries in the region.

Growing population, continued GDP growth and rapid urbanisation have been key drivers for energy demand over the past 20 years, and will continue to be so in the future. When coupled with effective regional integration, energy systems should meet efficiently a growing energy demand, thus ensuring energy security. Strengthening regional co-operation for homogenous regional energy management is important. However, this is far from being achieved, as much more could be done to develop the region’s power pool. In addition, integrating the water-energy-food nexus in a co-ordinated approach is crucial to the future of the region.

Based on recent trends, access to modern energy uses will grow by 2030. In the Africa Case Scenario (Africa Case), universal access is achieved with substantially less energy demand than in the Stated Policies Scenario (STEPS), with bioenergy requiring most of the total energy supply. Traditional use of biomass is replaced by larger shares of modern uses of bioenergy. The buildings sector has the greatest share of the final energy consumption. The final energy consumption of the transport and industry sectors doubles. Clean energy transitions in the region rely mainly on more hydropower deployment, which already dominates the power sector.

The greater Horn accounts for 6.5% of all energy-related CO_2 emissions in sub-Saharan Africa (excluding South Africa) and 0.1% of global emissions in 2020. All countries in the region have submitted nationally determined contributions to the United Nations Framework Convention on Climate Change, with targets to limit emissions. The Africa Case achieves a significantly lower level of CO_2 emissions than STEPS while also achieving stronger economic growth and universal access to energy. However, the challenge lies in mobilising international climate finance in a context where developed countries, which usually provide these funds, are focused on recovery from the Covid-19 pandemic and other national matters.

1.1. Regional context

The region is heterogenous, moving on a path to sustained economic growth

With its distinctive horn-shaped formation jutting out into the Indian Ocean at the eastern edge of Africa's mainland, the greater Horn of Africa region is a vast land mass stretching over 5.2 million km^2. As defined in this report, it encompasses Djibouti, Eritrea, Ethiopia, Kenya, Somalia, South Sudan, Sudan and Uganda. These eight countries are member states of IGAD, one of Africa's eight regional economic communities.

The greater Horn of Africa is home to 290 million people, but countries differ significantly in terms of population size. Ethiopia, the second most populous nation in Africa, has 115 million inhabitants or 40% of the greater Horn's population. By contrast, Djibouti has the region's smallest population with 1 million inhabitants.

Major economic developments have occurred in the region over the 2000s and 2010s. Countries have attracted foreign direct investments in oil and gas, minerals, transport and electricity infrastructure. The region has experienced some of the highest GDP growth rates in Africa, with Ethiopia and Kenya rapidly rising in the ranking of the continent's economic heavyweights.

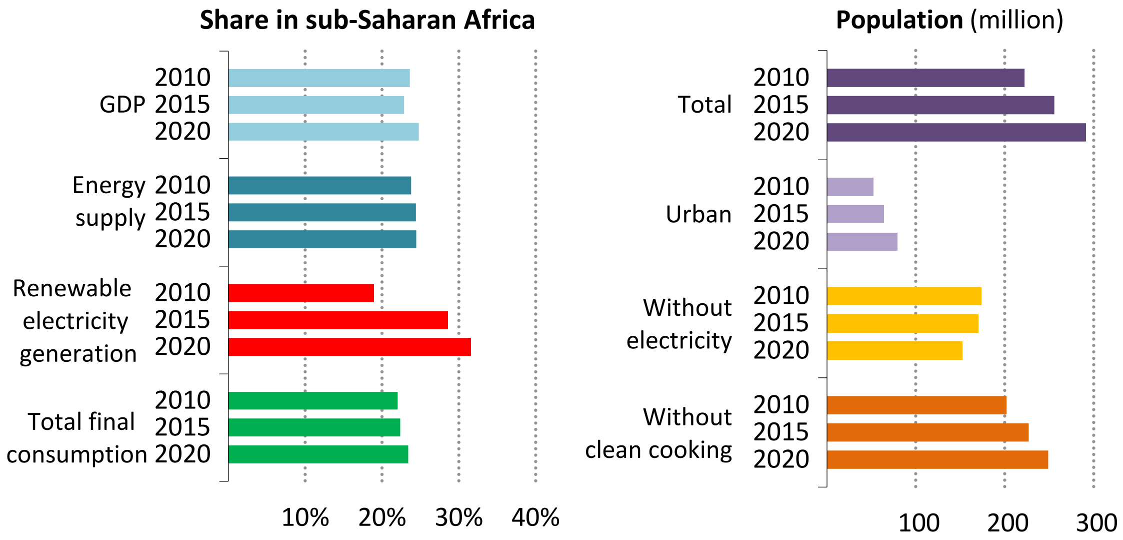
However, dynamic, economic growth is uneven across the region. Conflict has led to the South Sudanese economy shrinking, while that of Somalia is growing at a slow pace. In Ethiopia, Eritrea, Somalia and South Sudan, GDP per capita is less than USD 800.

Agro-pastoralism represents a major income source for a large part of the region's population, despite it being mainly unregulated and informal. The United Nations Economic Commission for Africa estimated nearly 40 million people in the region were pastoralists in 2015 (15% of the total population).

The region has some of the world's fintech and mobile money success stories. Following rapid adoption of technology, Kenya soon emerged as the world's pioneer in mobile money and a continental leader in the digital space, which have revolutionised its payments and financial system over the last two decades. Similarly, with over 70% of its population using mobile money services, Somalia has become a dynamic market for international mobile money transfers, through which the remittances are channelled back into the country. Ethiopia's emergence as regional power, aviation and manufacturing hubs, with substantial investments in airport and cargo infrastructure, and aircraft part manufacturing, and Djibouti's aspiration to become the region's top maritime centre, are testaments to the region's dynamism. Investments have also been directed towards the renewable energy sector, with large- and small-scale clean energy power projects, in particular with hydropower (the Grand Ethiopian Renaissance Dam), and solar and wind power plants coming on line.

Over the 2010s, the region has experienced major developments that are shaking up the energy sector, as oil and gas reserves have been discovered. Additionally, there have been significant efforts to improve substantially electricity access using on- and off-grid connections and systems. Yet, about 50% of the population still lives without electricity and 85% without clean cooking solutions.

Evolution of selected economic, energy and population indicators in the greater Horn of Africa region since 2010



Source: IEA (2022), World Energy Balances (database).

Despite a recent increase in power generation capacity, which almost doubled between 2010 and 2020, and improved communication infrastructure, the region lags other developing regions in terms of adequacy and quality of its infrastructure. Regional key infrastructure systems (transport, energy, water and energy) rank low on the Africa infrastructure development index of the African Development Bank when compared with other regions of the continent. This exacerbates the effects of isolation and impedes trade and investment. Infrastructure roll-out has failed to keep up with population growth and rapid urbanisation. City centres are increasingly being forced to accommodate the huge rural-urban migratory movements that have outpaced available public services and infrastructure systems. This can leave cities unable to cope with the exponential demand for water and sanitation services, housing and modern energy systems.[4]

Greater efforts are required to make the region's economic growth equitable, inclusive and sustainable, despite some notable performances in several countries. Particular attention needs to be paid to eliminating fragility triggers, such as internal disputes, and providing opportunities for the increasing and youthful population. Weak governance and regulatory frameworks at national and subnational levels continue to impede performance in the energy sector. Cumbersome bureaucracies, high political and security risks, and lack of regional integration continue to deter foreign investment and business creation.

Multifaceted and deep-rooted vulnerabilities are hindering the region's development

The region is facing social vulnerability, political turmoil driving insecurity and high vulnerability to climate change impacts, thus exacerbating exposure to external shocks.

The United Nations classifies seven out of eight countries in this region as least developed countries. Pervasive poverty and economic underdevelopment, and recurrent political crises, conflicts and extreme weather events, continue to drive food and human insecurities, massive migration and displacements of people within and outside the region.

All countries in the region have relatively low human development index scores, below 0.6, with Kenya ranking the best at 143 out of 189 countries in the world, and South Sudan ranking at 185 out of the 189 countries. The gender gap remains large throughout the region, with limited opportunities for women.

Similar disparities are observed in the education sector. Kenya scores highest in adult[5] literacy, with four adults out of five being literate, followed by Eritrea and Uganda where three adults out of four are literate. In contrast, only one adult out of three of South Sudan's population is literate. Most of the region's population has access to primary school education, but secondary education is generally less available.

The region has one of the youngest populations in the world, with some 40% of the regional population being 14 years old or younger. This is the same as the African average, but way higher than the global average of 25%. Youth are better

[4] Modern energy systems are often identified in terms that contrast them with traditional energy systems such as those derived from the burning of biomass in open fires. Examples include electricity from solar home systems for lighting and natural gas burned in modern stoves for cooking.

[5] Here, "adult" accounts for people aged 15 years and older according to the definition of the United Nations Educational, Scientific and Cultural Organization.

educated than ever before, but large gaps remain between the urban population and that of the drylands. Unemployment or underemployment remains the case for a lot of youth: in Kenya in 2017, 55% of 18-35 year olds were unemployed, and that unemployment was twice as likely in the 18-25 year age bracket than in the 26-35 year age bracket. Vocational training and programmes are offered to the youth of the region at the national level or through non-profit organisations. While youth entrepreneurship is gaining momentum, strong barriers exist for the poorer populations, including access to digital services.

Poverty is prevalent in the region, although unevenly spread. In South Sudan, almost 80% of the population is under the international poverty line while this share is 40% in Uganda, and around 15% in Djibouti, according to the latest data available referring to 2016 and 2017. Monthly earnings in Uganda reach only half the average in East Africa, and 20% of Africa's average.

Rapidly evolving and complex (internal and external) political dynamics continue to destabilise the region. There are several ethnic, national and transnational conflicts, some of which have existed for decades (e.g. the Somali Conflict). National and transnational political tensions around hydropower deployment in Ethiopia and Sudan have had controversial effects on geopolitical stability. Growing insecurity within individual countries can affect the entire region, putting extra pressure on scarce resources and triggering tensions.

Socio-political upheavals and ensuing conflict have triggered a large-scale humanitarian crisis and displacements in the region. By the end of 2021, the East and Horn of Africa and Great Lakes region hosted about 4.9 million refugees and asylum-seekers, and 12 million people were internally displaced[6]. The ongoing political turbulence and insecurity have been cited as major factors for the serious downgrading of some countries' credit ratings by major international credit rating agencies.

The region is already experiencing some of the most acute effects of climate change. It is likely to encounter even more severe impacts as global surface temperatures continue to rise. With 70% of the region's land regarded as arid or semi-arid (receiving less than 600 mm of rain annually), land degradation and desertification are serious concerns. The heavy reliance of economic structures on climate-sensitive sectors, such as rain-fed agriculture, pastoralism and fishing, makes them extremely vulnerable to extreme weather events caused by climate variability.

[6] The East and Horn of Africa and Great Lakes region includes countries not included in IEA Greater Horn of Africa region, such as Burundi and Rwanda.

Countries in the region experienced acute food shortages in 2018, with more than 20 million people in Ethiopia, South Sudan and Sudan at risk of hunger. Harvest and livestock losses since then have raised food prices and reduced food security, with 13 million Ethiopians, Kenyans and Somalians requiring humanitarian assistance, even before Russia's invasion of Ukraine.

Weather-related extreme events are a major driver of migration and displacement in the region, in addition to other factors such as political instability. The Covid-19 pandemic has dampened growth prospects too over the last couple of years, leading to a reversal of many positive development trends. The 2019-2020 locust invasion in East Africa has been described as the worst in 25 years for Ethiopia and Somalia, and the worst in 70 years for Kenya. Russia's invasion of Ukraine and the recent spikes in energy prices since then has left countries in the greater Horn of Africa exposed to high food and energy prices. In Ethiopia, the combination of conflict and drought has caused inflation to soar. As of April 2022, the food price index in Ethiopia was up by 45% compared to the same month in 2021. Prices for vegetable oil and cereals are up by around 90% and 40% year on year.

Russia's invasion of Ukraine: Food, energy and security crises for the greater Horn of Africa

Russia's invasion of Ukraine has heightened the vulnerability of the region's population, which is already fragile. In addition to the immediate and significant logistical disruptions in the energy, food and fertiliser sectors, the increase in fossil fuel prices and commodities on global markets has caused problems for the greater Horn of Africa. This is because most countries are net oil and gas importers. High prices have a direct damaging impact on the population, which must spend a higher percentage of its income on fuel (primarily needed for cooking and transport), thus worsening the energy poverty.

The greater Horn region relies on Russia and Ukraine for its wheat and maize imports. Disruptions and shortages in cereal supply and the rise in food prices therefore risk pushing large amounts of the region's population into poverty. Ethiopia and Kenya are particularly vulnerable to the pass-through effect of rising global energy prices into domestic food prices, as most of their staple foods are imported.

Action Against Hunger estimates the number of undernourished people globally is set to increase by 150 million between 2019 and 2022. To prevent worsening of the situation, the African Development Bank has approved USD 1.5 billion funding to the African Emergency Food Production Facility. This initiative intends to provide certified seeds and technology to farmers so they can rapidly produce 38 Mt of food.

1.2. Energy drivers

Population, urbanisation and economic growth are long-term drivers of energy demand in the region

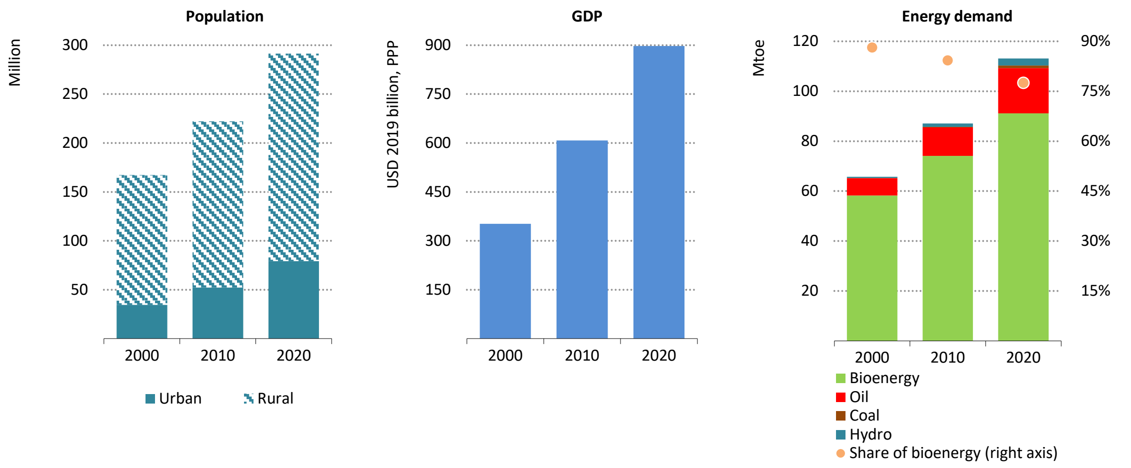
The greater Horn's GDP has more than doubled over the past 20 years, with the fastest growth rates in Africa.[7] Its growth rate was 4.6% in 2019, before dipping to a low 0.7% in 2020 then increasing again to 5.0% in 2021. Disparities in terms of GDP are observed within the region. Djibouti, Kenya and Sudan are top, with GDPs per capita up to five times larger than those of Eritrea, Somalia and South Sudan.

Population in the region grew by 75% over two decades, reaching 290 million in 2020, up from 167 million in 2000. Disparities in terms of population growth are also noted. Uganda's annual population growth was 3,3% in 2020, more than double that of Djibouti's at 1.5%. The eight countries in the region also differ in population density, which ranges from 213 people/km^2 in Uganda, to just 17 people/km^2 in South Sudan.

Countries have also experienced rapid urbanisation, driven in part by economic growth that has attracted rural youth to city centres. In 2020, one in four people lived in urban areas, while this share was one in five in 2000. Country urbanisation rates also vary. Less than one-third of the populations of Ethiopia, Kenya and Uganda are living in urban areas, whereas the urban shares[8] are higher in countries with smaller populations such as Djibouti (80%), Somalia (45%) and Eritrea (40%). Most capital cities have doubled or tripled in population size since 2000. Today, Khartoum is the region's first metropolis (ranked seventh on the continent) with more than 6 million residents; Nairobi (eighth) and Addis Ababa (tenth) both exceed 4 million residents.

[7] IMF is the source for GDP historical data, and economic growth assumptions for the short to medium term developed by IEA are broadly consistent with the latest assessments from the IMF.
[8] The urban share is defined here as the ratio of total urban population to total population.

Trends in population, GDP and energy demand in the greater Horn of Africa region, 2000-2020

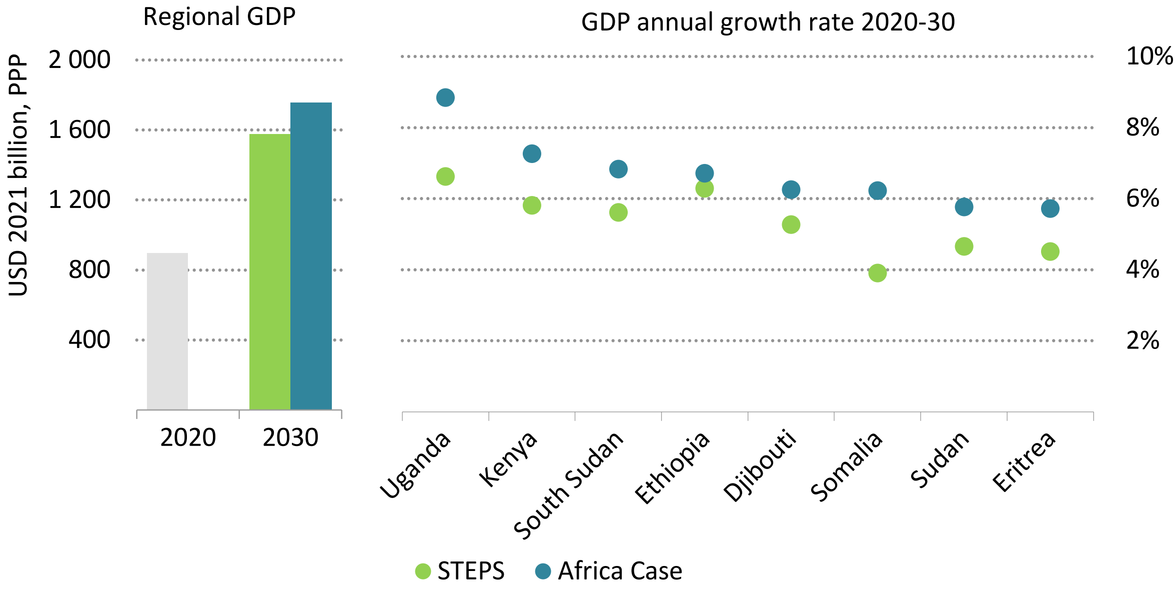


Sources: United Nations, Department of Economic and Social Affairs, Population Division. IMF International Financial Statistics (database). IEA (2022), World Energy Balances (database).

Population, urbanisation and economic growth continue to drive the energy demand of the future in STEPS and in the Africa Case. Total population is projected to reach 370 million people by 2030, growing by about 30% in 10 years. Of the 15 countries that will have the highest population growth worldwide, three are in the greater Horn region: Ethiopia, Kenya and Uganda. By 2030, the region's total urban population is set to grow by 40 million people over 2020's level. This is an urbanisation pace that exceeds Africa's average, where one in three people will be living in urban areas. This continued urbanisation will increase demand for energy services for buildings, transport, industry and other sectors, and it will drive a growing need for construction materials such as cement and steel.

STEPS assumes the regional economy expands by about 75% between 2020 and 2030, resulting in a regional GDP of about USD 1 550 billion. The Africa Case focuses on inclusive growth and social and economic development. It envisions the economy doubling over the course of 10 years, with Uganda having the highest growth rate. The GDPs of Ethiopia, Kenya and South Sudan will increase annually by around 7%, while that of Uganda will grow by 9%.

GDP in the greater Horn of Africa region, 2020, and in the Stated Policies Scenario (STEPS) and Africa Case Scenario, 2020-2030



Note: The right chart displays 2020-2030 compounded average annual GDP growth rate.
Source: IEA (2022), World Energy Balances (database).

Per capita income increases in both scenarios over the next decade. Djibouti, Kenya and Sudan have a per capita income exceeding USD 5 000, while Eritrea, Somalia and South Sudan are likely to stay below USD 2 000. The Africa Case projects an additional USD 1 000 per capita income over STEPS in Djibouti, Kenya and Uganda, which means higher purchasing power, and therefore increasing demand for energy.

Regional co-operation is essential to achieve SDG 7 objectives

Regional co-operation and integration can help tackle many of the challenges faced by countries in the region. It can stimulate inflows of capital, labour, goods and services to these countries. Such co-operation and integration are particularly relevant in the power sector. Regional power integration is high on the agendas of IGAD and countries in the region. Through increased co-operation and trade, governments have the potential to provide clean, reliable and affordable electricity access throughout the region by generating economies of scale, mobilising infrastructure financing, and enabling synergies and the sharing of resources. Power integration could therefore end energy poverty and ensure energy security to countries in the region.

Increased interconnection among the region's countries, notably by expanding transmission capacity between the different countries, is a key enabler of greater penetration of renewable sources of energy in the region's generation mix. This can be done by balancing the region's hydropower, geothermal and variable renewable energy resources. Disparities in supply and demand that might occur in individual countries can thus be offset by regional dispatch through a broader pool. This could pave the way to integrating additional variable renewable energy sources, which can displace more expensive generation based on fossil fuels.

Integrating large amounts of variable renewable energy sources into the power system requires flexibility [9] to ensure grid frequency stability, a constant equilibrium between supply and demand, and adequate reserve capacity to account for the intermittency of such sources.

National power systems are gradually being integrated into regional power pools through interconnections, in line with the objectives of the Africa Union's Agenda 2063. Interconnections are already in place and are crucial to some countries. Djibouti relies heavily on imported electricity, 80% of which is supplied from Ethiopia's hydropower. Electricity imports into Djibouti from Ethiopia are supplied through a 230 kV interconnector built in 2011. More recently, financing for the second Ethiopia-Djibouti power interconnection was secured with USD 84 million from the African Development Bank in 2021 and USD 55 million from the World Bank in 2022 to support constructing interconnector and transmission lines, and building and restoring substations. This will add further renewable power to Djibouti's national grid, thus providing additional power supply and stability. However, regional power interconnection projects risk delays. The Covid-19 pandemic has significantly strained the revenues of national power utilities and the fiscal space of countries and their ability to raise financing for power infrastructure. This may affect the pace of electrification in the region, potentially delaying regional power interconnection projects and interconnecting neighbouring markets for exports.

The IGAD energy sector strategy for 2050 envisages an interconnected system that harnesses the abundant renewable resources within its member states. In 2018, the authority developed its Regional Infrastructure Master Plan with the main objective of providing a strategic framework for cross-border infrastructure development in the transport, energy, transboundary water resources, and information and communications technology sectors. The energy plan, to be

[9] Flexibility is broadly defined as the capability of a power system to maintain the required balance of electricity supply and demand in the face of uncertainty and variability in supply and demand.

implemented in three phases (2020-2024, 2025-2030 and 2031-2050) focuses on building cross-border power transmission, interconnectors and a regional power grid.

To strengthen regional energy co-operation, regional institutions have been established with the aim of providing support for policy formulation, capacity building, knowledge management and regulatory oversight to the energy sector, and for promoting renewable energy and energy efficiency deployment in member countries. These include the Regional Center for Renewable Energy and Energy Efficiency for North Africa, RECREEE (Djibouti, Somalia, South Sudan and Sudan are within its mandate) and the East African Centre of Excellence for Renewable Energy and Energy Efficiency, EACREEE (with Kenya, South Sudan and Uganda as member states in the region).

Other regional organisations are tackling regional integration around specific issues. The Energy Regulators Association of East Africa aims to harmonise national energy regulatory frameworks and accelerate the region's energy union. The Regional Association of Energy Regulators for Eastern and Southern Africa seeks to support the Common Market for Eastern and Southern Africa (COMESA). In 2020, it developed a framework for the regulatory oversight of cross-border power trade in the eastern Africa, southern Africa and Indian Ocean regions, spanning five regional economic communities (East African Community, COMESA, IGAD, Indian Ocean Commission and Southern Africa Development Community [SADC]).

Institutions have been working jointly on several interconnection projects, some of which are listed in the table.

Key energy infrastructure projects in the greater Horn of Africa region

Initiative	Project	Estimated cost	Description
African Union's Programme for Infrastructure Development in Africa (PIDA) Priority Action Plan	Grand Ethiopian Renaissance Dam	USD 8 000 billion	- Involves COMESA and IGAD - Engagement of Ethiopia, Kenya, Sudan and Uganda as well as Burundi, Democratic Republic of the Congo, Egypt, Rwanda and United Republic of Tanzania.
	North South Power Transmission Corridor	USD 6 000 billion	- Involves COMESA, EAC, SADC and IGAD. - Engagement of Ethiopia, Kenya, Malawi, Mozambique, South Africa, Tanzania, Zambia and Zimbabwe.

Initiative	Project	Estimated cost	Description
African Union's Programme for Infrastructure Development in Africa (PIDA) Priority Action Plan	Uganda-Kenya Petroleum Products Pipeline	USD 150 million	- Involves COMESA and EAC
	Central Africa Interconnections	USD 10 500 million	- Engagement of Ethiopia Angola, Gabon, Namibia and South Africa
Horn of Africa Initiative	Second Ethiopia-Djibouti Power System Interconnection Project	USD 123 million	- Transfer capacity of 140 MW - Length of 292 km
	Ethiopia-Eritrea Transmission Interconnector Project	USD 222 million	- Transfer capacity of 100 MW - Length of 200 km - Engagement of Eritrea, Ethiopia, Djibouti, Kenya and Somalia.
	Somalia Power Transmission Backbone	USD 1.3 billion.	- Connection of all major load centres in Somalia to major generation sources - Aims at realising power trade with neighbouring countries
Desert to Power Initiative	Desert to Power Project	USD 47.5 million	- 10 GW solar capacity by 2030 - Engagement of Djibouti, Eritrea, Ethiopia and Sudan
	East Africa Regional Energy Project	USD 5.5 million	- Involves IGAD and the Eastern Africa Power Pool - Engagement of Djibouti, Eritrea, Ethiopia and Sudan - Financial support of USD 5.5 million from AfDB.

Initiatives in the region are also targeting concerted and homogeneous efforts to deploy energy-efficient measures for the countries. The Energy Efficient Lighting and Appliances in East and Southern Africa project (implemented jointly by the United Nations Industrial Development Organization, EACREEE, and the Southern African Development Community Centre for Renewable Energy and Energy Efficiency, SACREEE) seeks to improve regional co-operation for the uptake of energy-efficient measures. Launched in June 2019, the project plans to support the emergence of markets for energy-efficient lighting and appliances in the eastern and southern Africa regions over the next 5 years. It is undertaking regional harmonisation of Minimum Energy Performance Standards (MEPS) and so far, MEPS for lighting appliances have been concluded. The two regional economic communities (East African Community and Southern Africa Development Community) have also developed a MEPS compliance framework.

The Intergovernmental Authority on Development established its Climate Prediction and Application Centre in 1995. In 2014, it became the World

Meteorological Organization's regional climate centre of excellence, providing climate services to national and regional users of eastern Africa, based in Nairobi. The centre provides climate services, primarily climate monitoring, forecasting and early warning of climate-related events, to member states and institutions across the region, while ensuring integration of regional and national climate information systems. Furthermore, it aims to build the capacity of its stakeholders through training workshops.

To promote a co-ordinated approach to disaster management throughout the continent, the centre will be linked to the African Centre of Meteorological Applications for Development, based in Niamey, Niger, and the Africa Multi-hazard Early Warning and Early Action Systems Situation Room at the African Union Headquarters in Addis Ababa, Ethiopia. The overall goal of such climate centres in the region is to reduce disaster risk and strengthen the resilience of vulnerable communities across Africa, especially in the Sahel and greater Horn of Africa.

Eastern Africa Power Pool

As regional integration is key to clean energy transitions, the Eastern Africa Power Pool (EAPP) has a critical role to play. The EAPP, one of Africa's five regional power pools, was established in 2005 with the aim of facilitating cross-border power trade and interconnections among 11 participating nations. Seven countries of the greater Horn of Africa region (Djibouti, Ethiopia, Kenya, Somalia, South Sudan, Sudan and Uganda) are members while Eritrea has expressed its interest in joining. The goals of the pool are to optimise energy usage and production, interconnect national power systems and facilitate the emergence of a regional power market to guarantee supply of cheap and adequate electricity across East Africa. Given the dominance of hydropower in the greater Horn region, it is crucial to build the resilience of the pool, including through integrating a diversified mix of renewable energy resources.

However, little has been accomplished since creation of the pool, as there are technical and political barriers to its operationalisation. Power grids are in poor condition and need upgrading at the national level before being linked to interconnections. Politically, the history of conflicts among countries of the region has been a constant barrier to developing interconnection projects, from cross-border civil wars to sensitivities around the use of the Nile River for hydropower generation. The pool is therefore not as operational and integrated as other African regional power pools such as the Southern Africa Power Pool (SAPP), and there have been limited advances in regional transmission integration.

There are plans to enhance integration and donor support with projects aiming to contribute to operationalising a regional power market. In particular, a transmission interconnector between Tanzania and Zambia, through a multidonor trust fund and support from the World Bank, would achieve market integration between the EAPP and SAPP.

The SAPP is the most advanced power pool in the continent. There are several transmission lines between most of its members, as well as a functioning trading system. The interconnection of the two pools could therefore be beneficial for both. The EAPP often has an excess of supply given the number of hydropower plants. The SAPP could absorb this, as the southern region often lacks supply to meet its high demand for power.

African Development Bank's Desert to Power Initiative

The Desert to Power Initiative is a flagship renewable energy and economic development initiative of the African Development Bank. It aims to accelerate deploying solar PV systems with associated battery energy storage at scale in the 11 countries of the Sahel region (Burkina Faso, Chad, Djibouti, Eritrea, Ethiopia, Mali, Mauritania, Niger, Nigeria, Senegal and Sudan). These countries, which have some of the world's best potential for solar energy, have the lowest electricity access rates globally.

The business models will combine on- and off-grid public and private projects expected to connect over 160 million (on-grid) and 90 million (off-grid) people across the region by 2030. The initiative applies a programmatic approach across five priority-intervention areas, notably expanding grid-connected solar generation capacity, strengthening and expanding national grids and regional networks, deploying decentralised energy solutions, improving utilities' efficiency and enhancing the enabling environment for increased private sector investments.

The East African Regional Energy Project, as part of the Desert to Power Initiative, is a regional programme to be implemented through partnership with regional institutions such as the Intergovernmental Authority on Development and the Eastern Africa Power Pool. The project seeks to develop and harmonise a renewable energy policy for the East Africa Sahel countries, notably Djibouti, Eritrea, Ethiopia and Sudan, with the financial support of USD 5.5 million from the African Development Bank. The project will develop studies, strengthen the Intergovernmental Authority on Development's technical capacity and set indicative renewable energy targets at a regional level that will be harmonised with national targets. It will also propose a portfolio of policy measures, laws, regulations and incentives to be implemented at national and – where appropriate – regional levels in the East Africa Sahel region.

The East African Regional Energy Project is expected to contribute to expanded electricity access in Djibouti, Eritrea, Ethiopia and Sudan through regional on-grid solar energy electricity projects with associated battery storage to stabilise grid interconnectivity. It will also help reduce GHG emissions in these countries, enabling them to achieve their mitigation targets for the energy sector as outlined in their nationally determined contributions under the Paris Agreement.

1.3. Energy trends

Total energy supply in the Africa Case Scenario is lower than in the Stated Policies Scenario, despite higher economic growth

Over two decades, the total energy supply of the greater Horn of Africa increased by an average of 3% annually, from 65 Mtoe in 2000 to 120 Mtoe in 2020. This growth rate was slightly higher than the average of sub-Saharan Africa at 2%.

In 2020, traditional biomass[10] had the major share of the total energy supply in the region, accounting for about 75%. Traditional use of bioenergy constitutes up to 90% of the total energy supply in some countries, and still about 50% in the countries with a more modern energy mix. Oil was second (15%) followed by geothermal (4%) and hydro (2%). The share of other modern renewables (solar and wind) accounted for barely 0.2%. The region had no recorded natural gas in its mix and coal accounted for less than 1%.

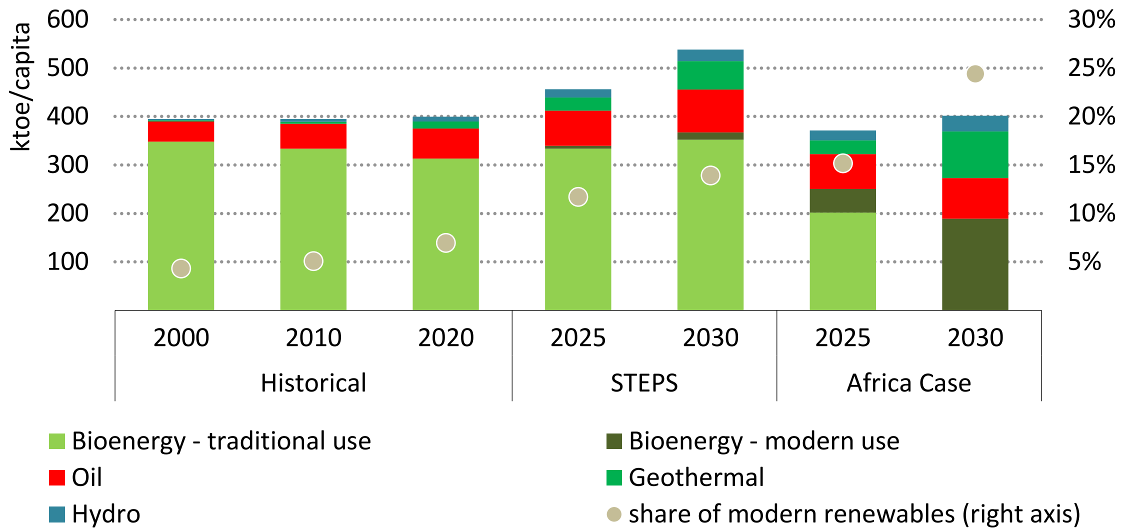
In STEPS, the total energy supply reaches 200 Mtoe by 2030, an increase of 70% above the 2020 level. Although traditional biomass continues as the major energy source in the mix, its share decreases to 65% and the share of modern bioenergy use increases. The share of modern renewables increases to 15%, with geothermal power developed in Kenya making up 10% of the region's total energy mix by 2030. The share of oil remains the same as today's level.

In the Africa Case, the total energy supply in 2030 reaches 150 Mtoe, 25% lower than in STEPS, despite a higher economic growth and universal access to energy. Supply is met with a more diverse fuel mix than in STEPS. Oil meets a fifth of the final energy supply, slightly above 2020's level, while the share of modern energy expands, with all modern renewables making up a third of the total energy supply. The shares of solar, wind and gas expand, the share of hydro increases threefold

[10] It is considered that all biomass was traditional up to 2020.

and geothermal increases sevenfold above 2020's level. As cooking shifts to improved stoves, modern bioenergy represents about half of the mix.

Total energy supply per capita and per fuel in the greater Horn of Africa region, historical (2000-2020) and in the Stated Policies Scenario (STEPS) and Africa Case Scenario, 2025 and 2030



Source: IEA (2022), World Energy Balances (database).

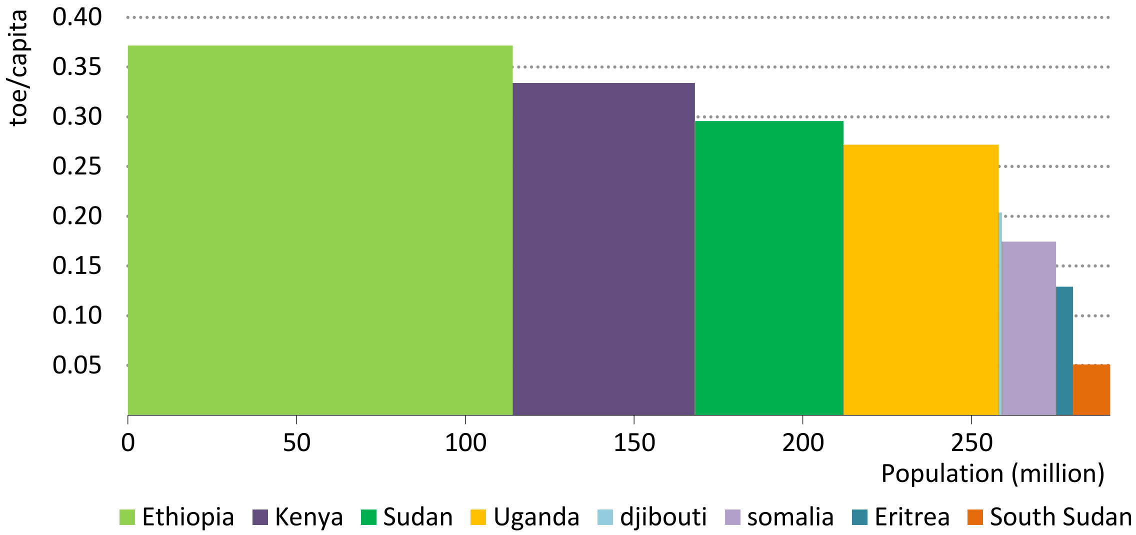
The buildings sector dominates total final energy consumption

The region's final energy consumption has increased by 85% or about 3% per year over the last two decades. It is 90 Mtoe in 2020, of which 80% was traditional use of bioenergy,[11] mainly to meet household cooking needs. Electricity has a limited share in total final consumption (less than 4%) and is mainly used in the buildings sector (about 3% of buildings' needs), and, to a lower extent, in industry.

There are large country disparities across the region in terms of final energy consumption per capita: Ethiopia tops the list, with an average final energy consumption representing seven times that of South Sudan. The observed disparities in total final energy consumption among countries are closely linked to their specificities in terms of GDP, population and urbanisation, which are driving energy consumption.

[11] For historical data, it is considered that all bioenergy used is traditional.

Final energy consumption per capita and population in the greater Horn of Africa region, 2020



Source: IEA (2022), World Energy Balances (database).

The final energy consumption of the region's buildings sector increased by 65% between 2000 and 2020, as the population almost doubled over the same period. The sector still has the largest share of final energy consumption at around 80%. It still has a strong demand for traditional bioenergy, in particular the residential sector for household uses, representing almost 90% of energy use.

The transport sector – despite experiencing the highest increase over the past two decades – accounts for about 10% of the total final energy consumption in the region. Oil products represent most of the energy used in the transport sector.

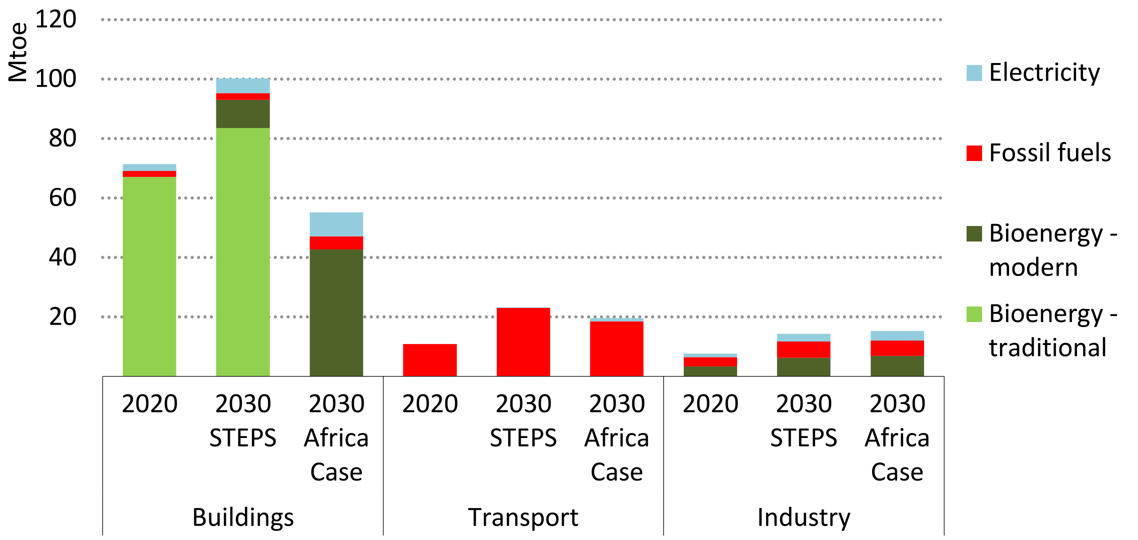
The industry sector represents less than 10% of the total final energy consumption in the region. It relies on a more balanced mix of energy sources than other sectors, including bioenergy at about 45%, oil at 30%, electricity and coal at 15% each (coal is mainly used to power Ethiopia's industries). More than 85% of Ethiopia's industrial energy needs are met by oil products and coal, since most of the power generation is from on-site fossil fuel generators. While there is no formal record, traditional bioenergy is also used in the industry sector.

Rapid demand growth in industry and transport is prominent in STEPS and in the Africa Case, with the transformation of energy use in the buildings sector being the most notable divergence between the two scenarios. Demand for energy in industry has a higher growth in the Africa Case, driven by strong economic growth, which then fuels an increasing demand for steel and non-metallic minerals. While efficiency remains important, a shift from oil to electricity is notable. These shifts improve efficiency and cost-effectiveness, reduce industry emissions intensities and improve air quality.

In STEPS, in the buildings sector, final energy consumption increases by 40% above 2020's level, but traditional use of bioenergy only increases by 25%. Modern bioenergy and increased use of electricity support about half of the additional consumption in 2030. Energy consumption of the transport and industry sectors almost doubles by 2030. The transport sector remains supported by fossil fuels, and the industry sector relies equally on increased consumption of electricity, modern bioenergy and fossil fuels.

In the Africa Case, demand for energy in the buildings sector decreases by one-quarter by 2030, while demand for bioenergy decreases by one-third because of better access to clean cooking solutions and increased electrification. Similar to under STEPS, the energy consumption of the transport and industry sectors doubles under the Africa Case compared to today's levels. The demand for transportation services is higher in the Africa Case than in STEPS, but energy consumption is lower. This underscores the consistent emphasis of the Africa Case on efficiency, as evidenced by policies limiting import of inefficient vehicles, such as higher excise taxes on used cars or enforcement of a maximum age limit for used car imports. Electricity use into the transport sector will be developed, representing 5% of the total final consumption, with the remainder being fossil fuels. The total final energy consumption of the industry sector will be mainly supported by increased use of modern bioenergy, electricity and fossil fuels.

Total final energy consumption by selected end-use sector and fuel in the greater Horn of Africa region, 2020, and in the Stated Policies Scenario (STEPS) and Africa Case Scenario, 2030



Source: IEA (2022), World Energy Balances (database).

Energy demand in the informal sector of the greater Horn of Africa

The informal sector is defined as that which generates legally produced goods and services without adhering to government regulations. The economies of countries in the greater Horn region are dominated by the informal sector, which comprises small-scale business owners who play a largely service-oriented role. These include food preparation, brewing, brick laying, grain milling, carpentry, metal working and vehicle repairs. Energy consumption varies in each of the subsectors, although bioenergy (wood, charcoal and grass), coal and kerosene are more prevalent than liquefied petroleum gas (LPG) or electricity. In Ethiopia for instance, charcoal is commonly used in brick laying, bakeries, tea farms and catering schools.

However, it is difficult to obtain data on the informal sector size and its energy consumption owing to unavailable official records. Some informal enterprises can transition from traditional to modern energy sources, but many others continue to use traditional energy sources because they meet needs. Overall, the energy consumption patterns of the informal sector will have an impact if this sector continues to grow. In smaller cities, for example, where the supply of wood and charcoal is already inadequate, the informal sector will face more pressure as the economy grows, increasing demand for scarce resources.

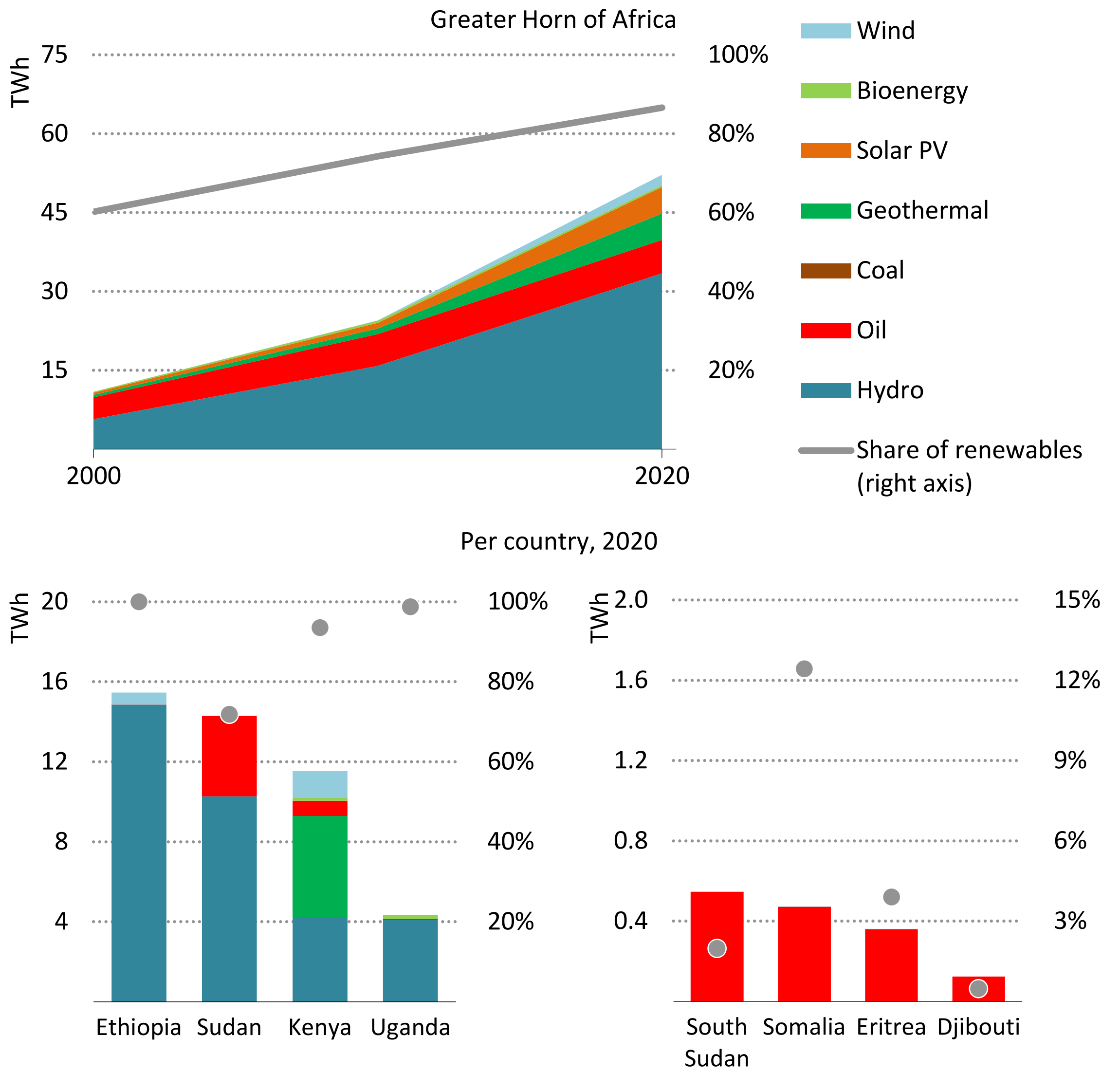
Hydropower dominates the power sector

Electricity generation in the region has grown steadily since 2000, exceeding 45 TWh in 2020, with 15 GW of installed capacity.

With about 7 GW of installed capacity, hydropower is the major source of power generation in the region, accounting for over 70% (30 TWh) of electricity production. Oil is the second-largest source of power, generating 6 TWh with 4 GW of installed capacity. Compared to the installed capacity, oil output is low, in part because of declining production in oilfields, such as in South Sudan.

Electricity generation capacity varies significantly by country across the region. Ethiopia and Sudan have the largest power generating systems, followed by Kenya and Uganda.

Electricity generation by fuel in the greater Horn of Africa region, 2000-2020, and per country, 2020



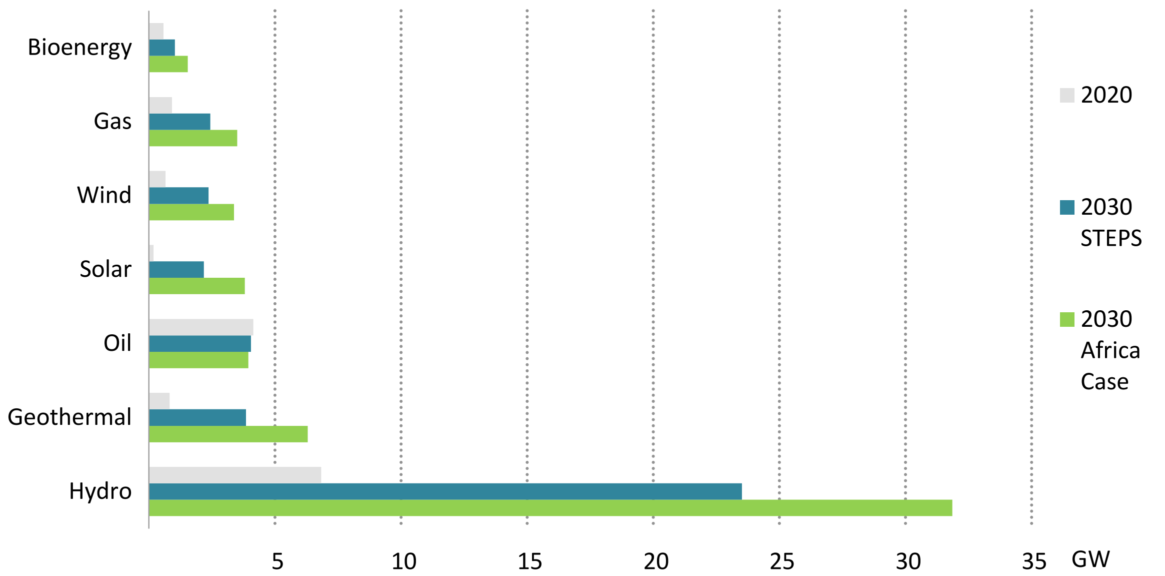
Source: IEA (2022), World Energy Balances (database).

Renewables account for most of the generating capacity additions during the period leading to 2030 in both scenarios, with hydropower capacity showing the fastest growth of all renewables.

In STEPS, the region generates three times electricity by 2030 than it does in 2020. Geothermal and solar power continue to grow 15% and 30% per year, respectively, but fossil fuel output remains unchanged.

The potential for additional capacity and generation, as envisioned in the Africa Case, is much higher than in STEPS. Electricity output would more than quadruple by 2030, and the region would have nearly 55 GW of installed capacity. Hydropower would still be the backbone of generating capacity, with over 30 GW, including 25 GW of newly installed capacity (after 2020). Some 15 GW of wind, solar and geothermal power would be included in the energy mix, including 12 GW of new addition. As a result, modern renewables would add over 150 TWh of electricity to regional power grids. The share of gas in the total installed capacity would stagnate at 6% with an added capacity of 2.5 GW. This considers project developments mainly in Kenya and Sudan, and to a lower extent in Ethiopia. In the meantime, the share of oil would fall from 30% to about 5% in the Africa Case and to 10% in STEPS. In both scenarios, the installed power capacity increases.

Installed power capacity by fuel in the greater Horn of Africa region, 2020, and in the Stated Policies Scenario (STEPS) and Africa Case Scenario, 2030



Source: IEA (2022), World Energy Balances (database).

The oil and gas landscape in the greater Horn of Africa

Until 2006, Sudan, and later South Sudan, was the only country with proven oil and gas reserves in the region. This resulted in almost negligible use of natural gas and most final oil products being imported. The recent onshore (Uganda) and offshore (Kenya and Somalia) discoveries of fields offer potential to change the region's energy landscape. The region is attracting multinational companies, including Chinese oil companies, looking to invest in exploring the reserves.

However, these discoveries come at a time when global calls for energy transitions away from oil and gas and other polluting forms of energy are becoming stronger due to the climate crisis. This diminishes the ability for such projects to attract financing. Moreover, the region does not have robust upstream or midstream infrastructure, compared with other producing nations that already have these foundations in place.

With the abundance of low-cost resources, renewable electricity is set to play a more prominent role in achieving universal access goals than natural gas in Africa. However, demand for LPG for clean cooking and transport fuels grows in both scenarios, as does gas in the industry sector.

The declines in long-term global demand for fossil fuel imports projected in climate-driven scenarios mean countries need to carefully plan how to manage the risks of volatility and uncertain income streams. This comes at a time when countries are looking to develop their fossil fuel resources to meet rising domestic demand and generate export revenue.

New projects with long lead times risk failing to recover their upfront costs, if the world is successful in bringing down gas demand in line with reaching net zero emissions by mid-century. Optimising costs, avoiding schedule delays and reducing supply chain emissions are prerequisites for new projects to secure financing.

1.4. Climate change

The greater Horn region is hard hit by extreme and repeated weather events, with devastating implications for its key development sectors and the livelihoods of its vulnerable communities. It therefore needs to devise adequate approaches and solutions to adapt to the new climate reality.

Despite contributing only 0.1% of all energy-related global CO_2 emissions in 2020, the region's countries face a common challenge: their heightened vulnerability to climate change. Constrained socio-economic development and access to basic services and resources are strongly correlated with human vulnerability to climate hazards.

Eritrea, Somalia, Sudan and Uganda are ranked in the top ten most vulnerable countries to climate change globally, while Ethiopia and Kenya are among the top 40. These countries are also the most likely to have high costs for adapting to and mitigating the effects of climate change. For instance in Eritrea, expected climate adaptation costs could be almost one-quarter of its GDP. Climate-related disasters, whether sudden onset (e.g. floods, storms and wildfires) or slow onset (e.g. major droughts developing into famines), are leading to dwindling water resources, and climate-triggered energy and food insecurity.

Weather patterns induced by climate change, including extreme weather events, are exacerbating an already dire water situation. The region is experiencing prolonged low precipitation and the worst drought in 40 years. This is causing severe water shortages, thus increasing the risk of water insecurity, which has consequences on agriculture and food and energy security.

As the share of hydropower in the region's power generation remains important over the next decade, climate hazards and water availability may affect electricity generation. Climate-related power crises have shown the region's limited adaptability and weak energy security. The loss of Mount Kenya's glacier by 2030 would lead to river shrinkage, affecting up to 85 000 people annually, reducing hydropower generation capacity and costing Kenya some 6 billion Kenyan shillings every year, or around USD 50 million.

All countries in the region have submitted nationally determined contributions

All countries in the region have submitted their nationally determined contributions (NDCs) to the United Nations Framework Convention on Climate Change. All except Djibouti and Eritrea have submitted an updated first NDC or a second NDC.

Mitigation efforts in the region focus on emissions reduction in the energy sector, with an increase in the share of renewable energy by 2030, and expanding and rehabilitating forests. For adaptation, countries have set their own objectives in the key development sectors and country-specific priority areas. Africa's call for prioritising adaptation in revised NDCs stems from the need to enhance resilience and human security. In the September 2022 Africa Adaptation Summit, African leaders called to raise pledges of some USD 250 million in capital to attract investors in adaptation programmes.

Somalia, for example, has raised its climate ambitions. The country's updated first NDC has set a mitigation target of 30% GHG emissions reduction by 2030 against a forward looking business as usual scenario, and identified 16 priority areas for adaptation, encompassing a wide range of areas including food security, water, energy and disaster management.

Given the challenges to mobilising international climate finance, all countries in the region have defined conditional targets to achieve further mitigation and adaptation in their NDCs. The conditional component of these NDCs calls for international support such as finance, technology transfer and capacity building, whereas the unconditional component uses countries' domestic resources.

The Covid-19 pandemic has negatively affected the already strained climate budgets of these countries, diverting funds away from climate actions, regionally and internationally.

Summary of nationally determined contributions (NDCs) of countries in the greater Horn of Africa region

Country	First NDC (GHG reduction target)	Updated first or second NDC (GHG reduction target)	Finance requested for adaptation to 2030** (2021 USD billion)	Finance requested for mitigation to 2030** (2021 USD billion)
Djibouti	-40% unconditional and -60% conditional by 2030(*)	No updated NDC	-	USD 2 billion
Eritrea	-12% unconditional and -26.5% conditional by 2030(*)	No updated NDC	USD 5 billion	USD 4 billion
Ethiopia	-64% unconditional by 2030(*)	-4% unconditional and -55% conditional by 2030(*)	USD 32 billion	USD 220 billion
Kenya	-30% unconditional by 2030(*)	-7% unconditional and -25% conditional by 2030(*)	USD 40 billion	USD 14 billion
Somalia	Sectoral actions / reductions	-30% conditional by 2030(*)	USD 48 billion	USD 7 billion
South Sudan	Sectoral actions / reductions	Sectoral actions / reductions	USD 93 billion	
Sudan	Sectoral actions / reductions	Sectoral actions / reductions	USD 10 billion	USD 4 billion
Uganda	-22% total by 2030(*) with unconditional and conditional components	-5.9% unconditional and -18.8% conditional by 2030(*)	USD 15 billion	USD 9 billion

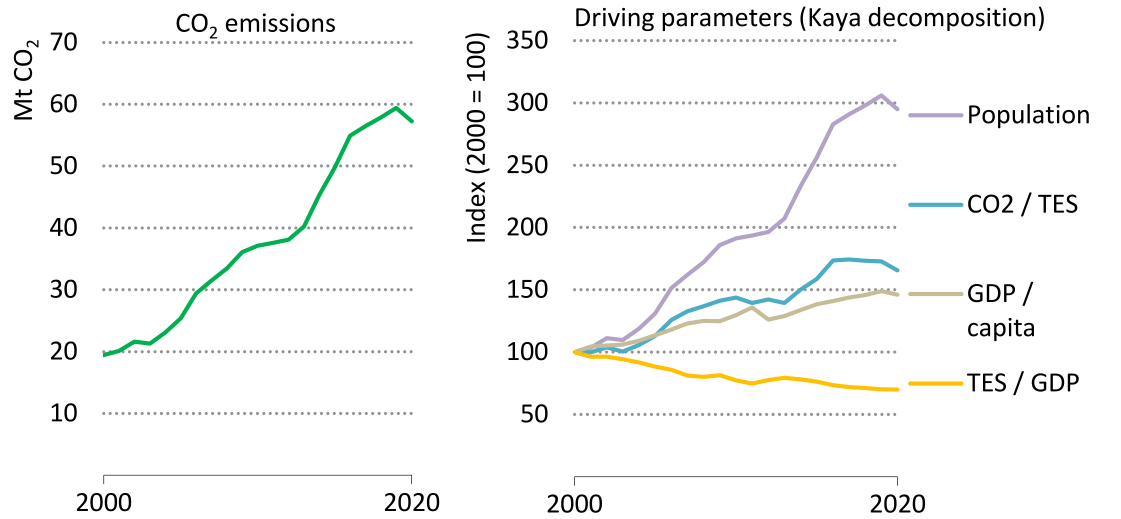
Notes: (*) compared to a forward-looking BAU scenario. (**) from latest submitted NDC.
Source: IEA analysis based on UNFCCC (2022).

The transport sector dominates energy-related CO_2 emissions

While the region is highly vulnerable to the impacts of climate change, it is one of the regions contributing the least to global warming. It accounts for 6.5% of all energy-related CO_2 emissions in sub-Saharan Africa (excluding South Africa) and 0.1% of global emissions in 2020. However, energy-related CO_2 emissions in the greater Horn of Africa increased until 2019, growing at an average annual rate of 7% since 2000, driven by rising population and GDP, and higher CO_2 intensity of the energy mix. They decreased in 2020 as a result of the Covid-19 pandemic, which also caused a drop in GDP.

In 2020, Sudan's energy sector has the highest CO_2 emissions in the region, with 19 Mt, followed by Ethiopia and Kenya each with 15 Mt. These three countries accounted for over 85% of the region's total energy-related emissions.

Energy-related CO_2 emissions and drivers in the greater Horn of Africa region, 2000-2020



Notes: TES refers to total energy supply. It represents domestic demand only and is broken down into electricity and heat generation, other energy sectors and total final consumption. Index (2000 = 100) means that 2000 is taken as a reference year for which the reference value is 100.
Sources: IEA (2022), World Energy Balances (database), Greenhouse Gas Emissions from Energy (database).

In 2020, about 60% of the region's energy-related carbon emissions come from transport. The industry sector accounted for 20%, and the power sector was responsible for nearly 15%. South Sudan and Eritrea have the highest electricity carbon intensities,[12] of 0.80-0.85 kg CO_2/kWh, as most of their energy supplies are from oil sources. Ethiopia, Kenya and Uganda all have intensities close to or equal to zero. The regional average is 0.15 kg CO_2/kWh, recording a 60% decrease from the 2000 average.

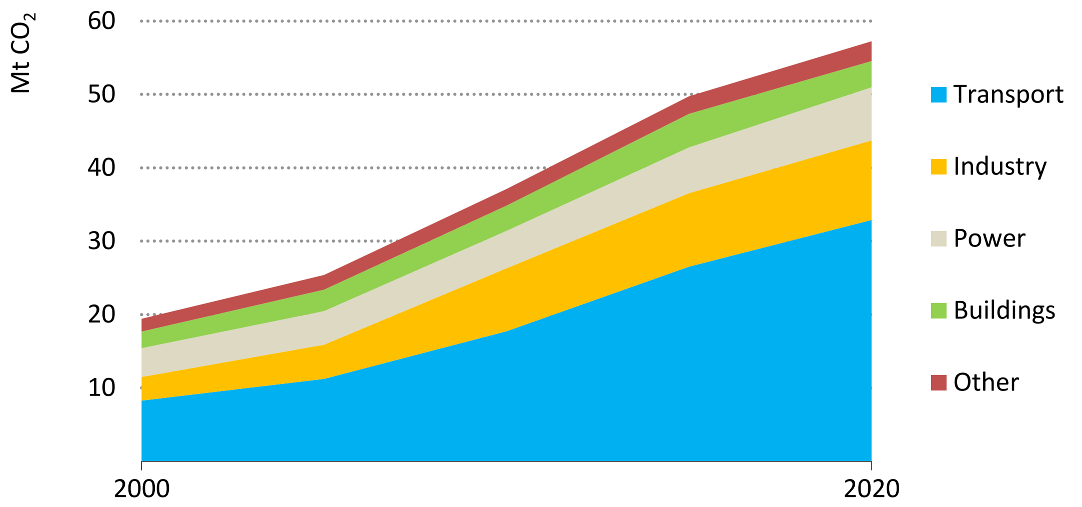
By 2030, emissions in the region increase from 57 Mt CO_2 today to about 108 Mt CO_2 in STEPS and 100 Mt CO_2 in the Africa Case. The increased LPG consumption for clean cooking and rising emissions from the industry sector are responsible for higher emissions in the building and industry sectors. A reduction in transport-related emissions coupled with improved efficiency allows for offsetting the overall

[12] Carbon intensity in the power sector is defined as CO_2 emissions divided by the total electricity generated.

increase. The Africa Case has a 7% lower level of CO_2 emissions than STEPS while achieving stronger economic growth and universal access.

Under STEPS, transport accounts for nearly 65% of emissions by 2030, while industry accounts for 20% and buildings for less than 10%. Under the Africa Case, emissions are more balanced as transport accounts for about 55% of emissions, industry for about 20% and buildings for nearly 15%.

CO_2 emissions by sector in the greater Horn of Africa region, 2000-2020



Note: "Other" covers transport and agriculture.
Source: IEA (2022), Greenhouse Gas Emissions from Energy (database).

The water-energy-food nexus approach will help adaptation and management of scarce resources

Using the water-energy-food nexus approach aids understanding the constraints and interdependencies among the vital sectors of water, energy and agriculture. The goal is to identify synergies and efficient use of natural resources.

Such an approach is crucial for achieving the Sustainable Development Goals (SDGs). It is also vital for improving the livelihood of the most vulnerable populations in the region, where the three natural resources are scarce, and even more so in light of the ongoing multiple crises and the deep-rooted vulnerabilities exacerbating marginalisation of poor people and refugees.

Operationalising the nexus approach comes with multiple benefits for achieving SDGs, including those on gender equity, poverty and climate change. An integrated policy approach is necessary for addressing the multiple challenges of climate change, natural resources use and human well-being.

Taking a co-ordinated approach for the three sectors is critical to enhancing the security of supply of water, energy and food, as there are clear synergies and connections among them. However, in practice, it can be difficult for governments to implement such a holistic approach. Some challenges are common and observable in many regions, such as a tendency to look at each of the sectors separately for the purposes of planning and strategic vision.

In a 2019 workshop on the water-energy-food security nexus, organised by the United Nations Educational, Scientific and Cultural Organization in co-operation with other partners, participants from the East African Community and the Intergovernmental Authority on Development member states expressed that in their countries, planning and implementation related to the three sectors are often done in a siloed way.

However, there are some common opportunities for actions that can counter these tendencies and support implementing an integrated approach. Although specific recommendations may vary from country to country, there are broad considerations that can contribute to enhancing the nexus approach.

Promoting intergovernmental co-ordination and communication is critical. The resources are often under the purview of different ministries/government agencies. Creating opportunities for interaction, joint planning and intervention at the project assessment and evaluation phase are critical to enable linkages and co-ordination at strategic and operational levels.

Collecting data on national resources and understanding their linkages is a foundational need. Data are the basis for knowledge and action. Understanding the resources available, and their interactions and mutual effects, is essential for defining a holistic approach based on those linkages.

Integrating local communities whose livelihoods depend on these resources needs to be at the heart of actions. Ensuring the buy-in and acceptance of infrastructure projects in any of these critical sectors by affected local communities is critical for the success of a particular project. It is also important to safeguard the balance of local ecosystems and synergies across sectors. A co-ordinated approach can contribute to identifying complementarities among different projects and initiatives, especially in sectors sometimes perceived to be in competition.

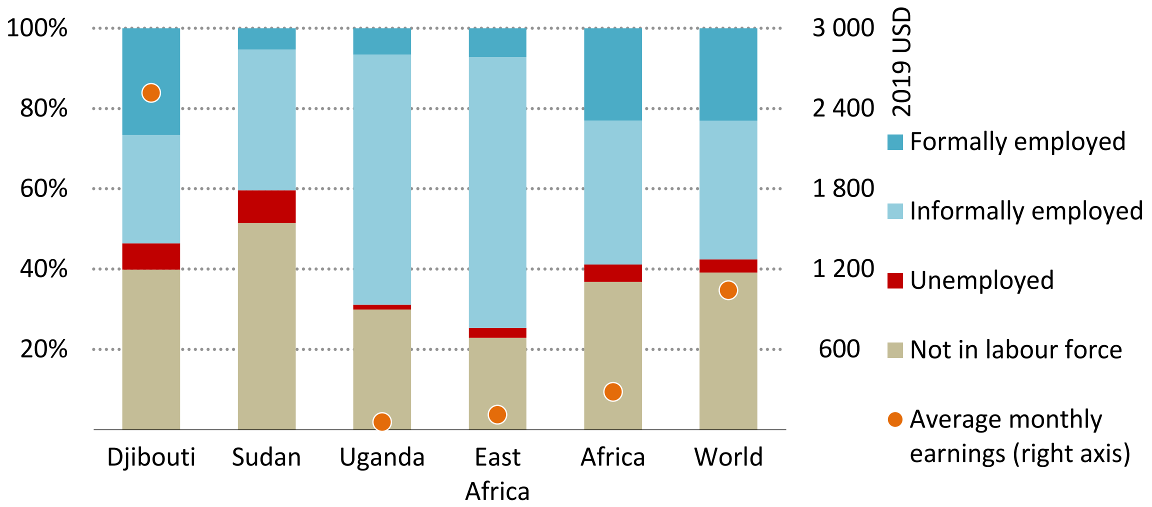
1.5. Social factors: Employment and gender

Creating productive and well-paid jobs in African countries facing rising populations and widespread underemployment is an urgent priority. Most African countries are characterised by underemployment, widespread informal employment and limited social system protection.

Over 80% of employed Africans work in the informal sector, where wages are low and jobs less secure than in other sectors. This share varies widely across the greater Horn region, depending on socio-economic structure. The nature of employment in Djibouti is similar to the global average, whereas the share of those unemployed and not in the labour force in Sudan is 50% higher than the African average.

Developing Africa's energy system offers major opportunities to stimulate creation of decent jobs that require wide-ranging skills. As per official data, the energy sector employed around 2 million Africans in 2019, about 0.5% of the total labour force. However, many energy-related workers are informal, particularly for low-skilled labour sectors such as commercial collection and sale of biomass. Based on economy-wide ratios between formal and informal employment, there may be up to 11 million energy-related workers in Africa.[13]

Employment rate and earnings in selected countries and regions, 2019



Note: earnings data for Sudan not available
Source: IEA (2022), Africa Energy Outlook.

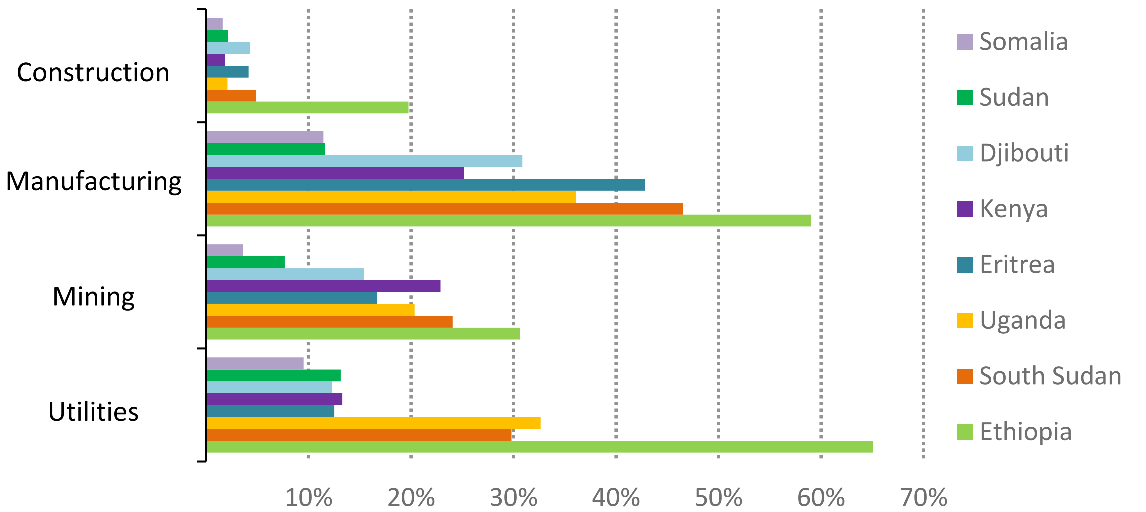
Across Africa, women make up around 43% of employed persons in the entire economy. This average rate of participation is on a par with that in advanced economies, but it varies significantly across sectors, especially several energy-related sectors. Women workers are almost as present as men in manufacturing, with a 44% employment rate, but they occupy only 5% of the jobs in construction, 15% in mining and 22% in utilities. There are also disparities among countries

[13] Employment data are based on IEA analyses conducted in the Africa Energy Outlook 2022

according to cultural norms: in North Africa, women have only one out of five jobs, whereas the rate is close to one out of two in sub-Saharan Africa (excluding South Africa).

Similar variations are observed in the greater Horn region. In 2019, 73% of Ethiopian women over the age of 15 years were employed, compared to 22% of Somali and 29% of Sudanese women. Kenya, South Sudan and Uganda have an almost equal gender balance in economy-wide employment and a high women participation rate in manufacturing. Ethiopia rates best in the energy-related sector, and women represent almost two-thirds of employment in utilities.

Women's share of employment by economic activity in the greater Horn of Africa region, 2019



Source: IEA (2022), Africa Energy Outlook.

High rates of participation should not conceal that women are more likely than men to work in the informal sector, thereby working in jobs that are usually less stable and with lower wages. This is due to women's limited access to education, their household and childcare responsibilities, and their concerns about safety, especially when commuting to work.

When attempting to enter the workforce, including in the energy sector, women need to overcome many barriers such as gender stereotyping and bias, and lack of training, mentorship and networking. Although women are increasingly obtaining diplomas in fields related to science, technology, engineering and mathematics, their employment in the electricity sector has barely risen. Women with such qualifications and technical training therefore often end up working in unrelated fields, thus underutilising their skills.

Improving women's employment in Africa's energy sector necessitates overcoming several obstacles that would bring multiple benefits. Increasing gender equality would improve countries' GDPs, energy sector performance and women's economic empowerment.

Access to energy programmes increasingly aim to encourage women to build careers in the energy sector, by supporting entrepreneurship or offering opportunities for networking, training in technical skills and apprenticeships. Local energy access companies often rely on sales agent staff who are women, as they generally perform better at convincing households and communities to adopt clean energy solutions and teaching people how to operate and maintain solar home systems.

Improving access to energy, specifically to efficient cooking equipment, also supports gender parity in other ways. It reduces health risks related to indoor air pollution and frees up time for activities other than time-consuming fuel collection and cooking tasks that mostly fall to women and girls.

Chapter 2. SDG 7.1 – Ensuring universal energy access

Key findings

There is still a long way to go to achieve universal electricity access in the greater Horn of Africa, with half its population still lacking access. Disparities among countries are wide. Kenya has an access rate of 80%, Eritrea and Ethiopia have access rates of 50%, while in South Sudan, it is under 10%. Country level disparities also exist, for instance between rural and urban populations.

On- and off-grid solutions have been deployed to increase equity and bridge the electricity access divide. However, the region faces the challenge of struggling public utilities. Affordability of energy systems is a barrier to universal electricity access, given the rising prices caused by the ongoing shortage of raw materials, and the supply chain disruptions caused by the Covid-19 pandemic.

Access to clean cooking is still a major issue in the region, with nearly 250 million people relying on traditional cooking solutions. Except for Kenya and Sudan, countries have less than 10% of their national population with access to clean cooking. Nevertheless, the policy framework in the region is relatively enabling, with most countries tracking clean cooking access progress or integrating it into their national planning. Rising liquefied petroleum gas (LPG) prices are a real setback in the region's effort to switch to clean cooking. Many people are reverting to cooking with polluting fuels like charcoal or other cheaper and more available fuels.

Considerable efforts are still needed to achieve universal energy access by 2030. Closing the electricity access gap requires connecting to 20 million people each year, with a combination of expanding the national grid and providing off-grid solutions. Supporting a diversity of clean cooking solutions (including the use of LPG, ethanol, efficient biomass stoves and electric cooking) and addressing the infrastructure bottlenecks, especially for LPG, are pivotal to establishing a trustworthy and regulated market.

Enabling policy frameworks are crucial, from developing national targets to offering financial incentives for energy access. Private sector investment is key to reaching the ambition of universal energy access. Innovative business models such as pay-as-you-go solutions are already playing a central role and must expand, especially for people living in remote areas.

2.1. Electricity access status

Electricity access is improving, but keeping up with population growth is challenging

About 40% of the sub-Saharan Africa population lives in the greater Horn of Africa. In 2020, half of them, or 150 million people, are without access to electricity[14].

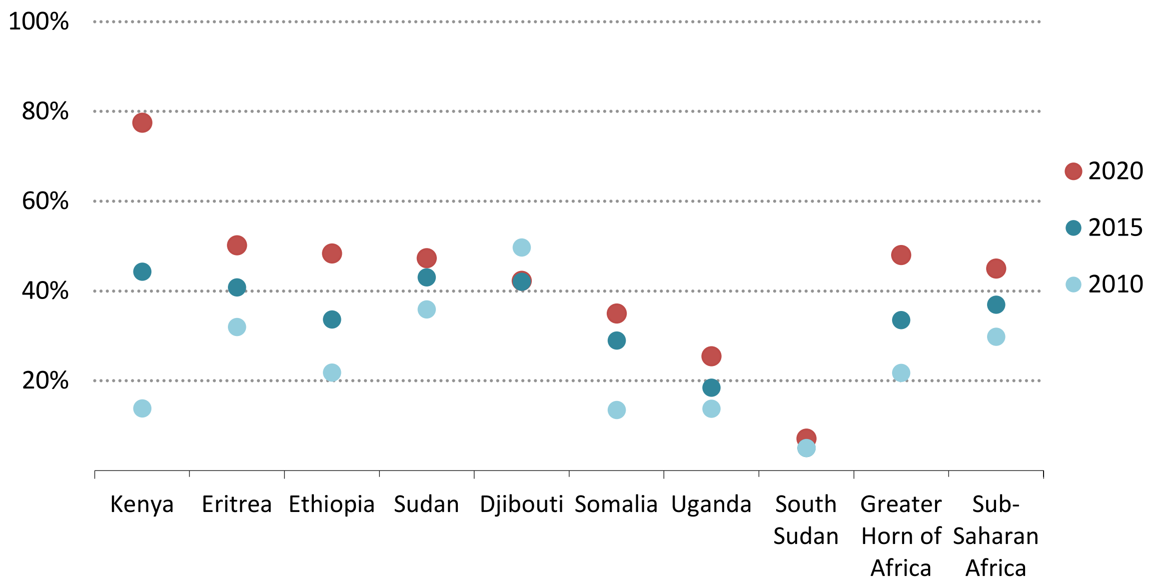
Rates of access to electricity in the greater Horn have improved considerably since 2000. Then, one in ten people had access to electricity, whereas today, it is one in two, which is comparable to the sub-Saharan Africa average (excluding South Africa). An additional 90 million people have gained access to electricity between 2010 and 2020. This progress has mainly been driven by the two economic powerhouses in the region: Ethiopia and Kenya. Both these countries have made spectacular progress, raising the electrification rate by over 6 percentage points every year, and representing 80% of people gaining access during the same period.

Although Kenya missed its ambitious target of reaching universal access by 2020, access rates increased from less than 14% in 2010 to almost 80% in 2020. Efforts geared towards grid expansion and densification, as well as the roll-out of off-grid solutions, contributed to the increase in access. In contrast, less than 10% of the population of South Sudan has access to modern electricity services, despite steady but slow progress in 2020. Although progress has been impressive, in Ethiopia, there were still 60 million people without access to electricity in 2020, making it the third-highest access deficit country worldwide in terms of absolute numbers, followed by Uganda ranking sixth and Sudan eighth.

Despite rapid progress in the electrification rate between 2010 and 2019, the access rate stagnated in 2020, most likely because of the impacts of the Covid-19 pandemic. The slowdown in Ethiopia's access rate, mainly as a result of massive displacements of people caused by conflict and political unrest starting in 2019, also affected the regional access rate. The country registered one of the world's highest number of internally displaced people, close to 1.8 million in 2020. Another under-reported, yet significant development is the destruction of major infrastructure including power systems due to violence and conflict in the north of Ethiopia. This caused huge losses to the country costing billions of dollars.

[14] Electricity access entails a household having enough electricity to power an "essential bundle" of services within a household: four light bulbs for 4 hours per day, a fan for 3 hours per day and a television for 2 hours per day. The IEA also considers an "extended bundle" to include services provided in the essential bundle, plus one refrigerator, power for the four light bulbs for 4 additional hours per day (8 hours per day in total), the fan for 3 additional hours per day (6 hours per day in total) and the television for 2 additional hours per day (4 hours per day in total).

Electricity access rates in the greater Horn of Africa region and sub-Saharan Africa



Source: IEA (2022), World Energy Balances (database).

Bridging the electricity access divide requires action that leaves no-one behind to reach energy equity

In the greater Horn countries as elsewhere, electricity access rates are higher in urban than in rural areas. In urban settlements, four out of five people have electricity access in 2020, but only one out of three in rural areas.

Kenya leads the effort in the region. It has achieved universal electricity access in urban areas since 2018, and more than two-thirds of the population has access in rural areas. Ethiopia and Eritrea follow closely with nearly full access in cities, and rates of 35% and 20%, respectively, in rural areas. Somalia is the only country in the region where the rural access rate, at almost 40%, is higher than the urban access rate of 30%. In South Sudan, where the national electricity access rate is below 10%, fewer than 15% of people living in urban areas have access to electricity, and around 5% of people living in rural areas have access.

Refugees and forcibly displaced people are usually not included in the delivery of essential services, including energy services. Additional data are required for robust analysis of whether refugees and forcibly displaced persons have electricity access rates similar to their host communities, but recent analysis suggest that displaced communities are likely to have half the access rates to electricity as nearby host communities. Data from 27 sites in Ethiopia and five in Sudan showed displaced communities have far lower access rates.

Initiatives are taking place to bring energy to refugee camps, including the Humanitarian Energy Exchange Network, the United Nations Global Platform for Action on Sustainable Energy in Displacement Settings, the Smart Communities Coalition Innovation Fund and the Moving Energy Initiative.

Gender equity in access to electricity efforts requires special attention. Electrification and access to electricity would lead to positive externalities and equity gains for women in the region in four dimensions: alleviating time poverty, expanding labour market opportunities, improving maternal health and women's safety, and changing social norms.

Within their household, women in the region tend to be responsible for collecting energy (fuels and biomass) and conducting energy-intensive tasks such as food processing and water collection. When electrification occurs, it is used mainly to power small appliances such as phones and radios, and for lighting, but not as a substitute for biomass. In addition, women are usually the primary energy users in a household, but rarely have a deciding voice in energy purchasing decisions. For example, in Kenya, a survey found that for 82% of respondents, the electricity supply contract was in a man's name.

Providing power access can facilitate women's economic empowerment. Time gained as a result of electrification can instead be put towards entering the labour market. Electrification benefits women as consumers but also as suppliers. Small-scale clean energy technology for electricity or cooking offers the potential to develop women-owned small-scale enterprises, especially through mobile money business models.

It is crucial to include a gender component when developing policies, especially to change gender-neutral assumptions in energy planning and development. The Last Mile Connectivity Program in Kenya has a built-in gender component. From the design phase, gender was taken into account and consideration developed along the way, with capacity building for the personnel of Kenya Power and Lighting Company (the state utility) and gender mainstreaming workshops.

Several countries are enhancing on-grid solutions, but the Covid-19 pandemic has hampered these

Countries in the region are increasingly adopting strategies to enhance the last-mile connectivity of their power grids.

Kenya launched its Last Mile Connectivity Program in 2015, with the goal of closing the electricity access gap by connecting around 2.8 million rural and low-income people to the national grid. The Kenya Power and Lighting Company implemented the project, and the government of Kenya financed it, along with several other institutions including the African Development Bank and European bilateral and multilateral development financial institutions. The total budget was USD 900 million, and the project involved installing new transformers and extending the low-voltage network. This programme has been successful in terms of the progress in electricity access achieved in Kenya: three out of four people now have access to electricity. However, it has also exacerbated the financial burden on the Kenya Power and Lighting Company.

Ethiopia launched its national Electrification Program in 2017. This sets the target of universal access to electricity by 2025 with a focus on last-mile electrification (on and off grid). The last mile connectivity is financed through connection fee subsidies on and off grid, and has benefited 14 million people in gaining electricity connections. One priority of the programme is to provide reliable electricity to schools and healthcare centres. The government of Ethiopia has also implemented system-wide institutional reforms, including promoting gender equity and encouraging women’s access to managerial positions.

In Sudan, grid expansion enabled electricity to be provided to an estimated 560 000 people every year between 2014 and 2019. However, population growth has outpaced progress, and additional connections have occurred at the expense of the utility’s financial health. As power is generated with high operational costs, each new connection leads to financial losses. Under a decentralised approach, each state within the country is responsible for investing in the distribution network. The end customer bears the cost of grid extension, with varying levels of connection fees depending on the length of the line. However, the subsidies schemes make the system financially unsustainable.

As a complement to large-scale grid capacities, smaller projects closer to specific demand centres could help expand access. The size of solar PV sites is easy to modulate, and small-scale wind and hydropower plants also present great opportunities.

The Covid-19 pandemic has significantly affected distributed renewable energy systems and energy companies, especially electricity utilities, across Africa. Financial and logistical challenges have slowed expansion and maintenance of the energy infrastructure. Adding to that, many utilities suffer from poor governance, underinvestment, and low-cost recovery and revenue collection. The lack of reliable grid electricity is partly because of the infrastructure decline, exacerbated by weather conditions and vandalism. Countries experience frequent grid downtime. Although efforts may have improved reliability in recent years, Kenya and Ethiopia used to experience four and eight outages a month respectively, each lasting over 5 hours.

The pandemic further compounded problems by causing reduced revenues due to economic slowdown. In Uganda, for example, utilities reported drops of 25% in revenues 18 months following the onset of the pandemic in March 2020. This was largely because of a sharp decline in electricity consumption in the industrial and commercial sectors. Most African utilities were affected by emergency relief programmes, which cancelled, reduced or deferred electricity bills from pandemic-affected customers.

Electricity outage indicators in selected countries in the greater Horn of Africa, 2013-2018

Country	Average number of electrical outages per month	Average duration of an electrical outage (hours)
Kenya (2018)	4	5.8
Ethiopia (2015)	8	5.8
South Sudan (2014)	2	4.7
Sudan (2014)	3	2.5
Uganda (2013)	6	10.0

Source: World Bank (2022), Enterprise Surveys (database).

Off-grid solutions are a crucial part of the solution to provide electricity access

The greater Horn region has been at the heart of the off-grid industry in Africa. Kenya, Ethiopia and Uganda are the top African adopters of decentralised solutions.

Off-grid solutions have gained traction in recent years because of their potential for providing access to reliable, clean and affordable electricity. Ethiopia and Kenya have by far the most attractive markets for off-grid solutions in the region, accounting for close to 30% of the world’s off-grid solar market in 2021. These two countries are in the global top three in terms of people connected to off-grid solar solutions today, with 19 million in Kenya and 8 million in Ethiopia.

Ethiopia and Kenya are aiming to accelerate electricity access through off-grid connections to reach large swathes of their underserved communities. Ethiopia’s Electrification Programme was updated in 2019 and aims to expand its off-grid plan to 35% of the country's population by 2025 thanks to public and private investments, according to Ethiopia’s 10-year development plan 2021-2030. The role of off-grid technologies is being formally integrated into government planning through geospatial least-cost grid expansion studies and national electrification strategies. Ethiopia, which is targeting universal access by 2025, is aiming to achieve this by reaching 35% of its population through off-grid solutions.

Governments have made conscious efforts to provide supportive regulatory and policy frameworks for the off-grid sector, which have led to a high uptake of stand-alone solar systems, from lanterns to multi-appliance solar and battery systems. The Kenya Off-Grid Solar Access Project and Ethiopia's national policy framework to use off-grid solar solutions as a solution for universal access are good illustrations. Both countries have adopted tax regimes to further encourage the uptake of off-grid solar use.

Mini-grids are an option in areas not served by national grids, mainly in rural and peri-urban areas, offering the opportunity for rapid connections. The 2.25 MW solar-powered mini-grids in Areza and Maidma in the south of Eritrea have come on line, supplying electricity to 33 off-grid settlements nearby. The government is also using these initiatives to make energy access inclusive and community driven. In the above cases, the community was involved in putting up the solar distribution poles and providing land. The government of Eritrea, the United Nations Development Programme and the European Union jointly financed the USD 13 million project. The initiative has provided access to over 40 000 people, while creating opportunities for over 500 small businesses and improving service in schools and hospitals. Similarly, Kenya's government provided attractive investment incentives and instituted mini-grid standards that have encouraged private sector involvement in the sector.

The uptake of solar home systems has been nearly exponential in sub-Saharan Africa. Kenya leads the market in the greater Horn region, as this is where innovative phone-enabled business models such as pay as you go have been implemented strongly. Solar home systems are large enough to power a few essential appliances. In Kenya, the growth of installed solar home systems far exceeds new grid connections, and shows a stronger acceleration trajectory than solar PV capacity additions.

Countries in the region have diverse policy and regulatory stances towards energy access. In some countries, such as Ethiopia, Kenya, Sudan and Uganda, policies, regulations and national strategies including targets are in place for on- and off-grid connections. In addition, their governments have managed to create enabling environments for the private sector to thrive and accelerate electricity access.

However, the situation is different in other countries in the region. For example, South Sudan does not have policies in support of on- and off-grid electrification, or for planning of its energy sector. Eritrea and Somalia have started to develop regulatory frameworks for electricity access, but still lack a few provisions. These include electrification plans and policy support for stand-alone systems for Eritrea, and a minimum service level and support schemes for grid connection for Somalia.

Electricity access: Regulatory indicators for sustainable energy in the greater Horn of Africa region, 2018

Electricity access regulatory provisions	Eritrea	Ethiopia	Kenya	Somalia	South Sudan	Sudan	Uganda
Is there an up-to-date electrification plan?	–	✓	✓	✓	–	✓	✓
Does the plan set a minimum service level?	✓	✓	–	–	–	✓	–
Are funding support schemes for grid connection available?	✓	✓	✓	–	–	✓	✓
Are mini-grids included in policy support schemes?	✓	✓	✓	✓	–	✓	✓
Are stand-alone systems included in policy support schemes?	–	✓	✓	✓	–	✓	✓
Are affordability provisions available?	–	✓	✓	–	–	✓	✓

Note: Data are unavailable for Djibouti.
Source: ESMAP (2021), ESMAP-RISE indicators.

Rising energy prices and affordability impacts

All electrification options, on and off grid, face the same obstacle: high electricity costs. Until recently, mini-grid and off-grid solar systems gained popularity as a result of decreasing component costs. However, this trend has been highly compromised due to the Covid-19 pandemic and its impacts on global value chains. The costs of solar home systems have risen since 2020, owing to higher raw material prices, supply chain disruptions and unfavourable currency exchange rates. Polysilicon prices have increased reaching in May 2022 a level 3.5 times higher than in 2019. Additionally, the prices of most electronic devices have risen, thus increasing the costs of solar products. Pay-as-you-go business models and consumer finance projects offer options to spread costs over periods of time, but this can put companies at risk of increased financial challenges.

Before these latest crises, the cost of an unsubsidised, well-designed mini-grid was expected to fall below USD 0.20 per kWh by 2030 due to technological advances and economies of scale. Subsidies can lower retail tariffs. Demand-side constraints should not be overlooked in favour of lower supply costs. Results-based financing for off-grid options would also be a flexible source of funding for companies and could mitigate the rising cost of off-grid technologies in the region. As the costs of solar power and batteries in the medium term are expected to fall globally, new business models and efficient devices such as electric pressure cookers can also help increase access to clean cooking.

The African average for electricity prices is USD 0.14 per kWh for grid-connected electricity. However, across the continent as well as in the greater Horn region, prices within countries vary highly. In many countries with low energy access, lack of economies of scale, suboptimal generation mix decisions and independent power producer contracting deficiencies cause high generation costs. Reducing costs for generating, transmitting and distributing electricity will improve reliability and lower tariffs. In Somalia, the absence of a national grid causes high costs that can exceed USD 1.0 per kWh in some areas. This is one of the world's highest prices and well above those of its neighbouring countries. For example, Djibouti's electricity price is almost four times lower, at USD 0.28 per kWh.

Electricity prices in the greater Horn of Africa region

Country	Electricity price (USD per kWh)		
	Household tariff	Business tariff	Social tariff
Djibouti	0.55	0.87	0.22
Eritrea	0.24	0.24	
Ethiopia	0.04	0.05	
Kenya	0.14	0.14	0.09
Somalia	0.32	0.44	
South Sudan	0.27	0.37	
Sudan	0.59	0.59	
Uganda	0.20	0.16	0.06

Note: price data are average values based on 2015-2020 prices.

Electrifying health centres

Almost 60% of health centres across sub-Saharan Africa do not have access to electricity. As several medicaments, such as Covid-19 vaccines, need to be cooled for storage, access to electricity becomes even more crucial. Other electricity-dependent medical services are also limited, thus affecting mortality rates (e.g. one in 13 children under the age of 5 years die).

This could be prevented by providing adequate health services with reliable power infrastructure. Access to electricity will be a key enabler in achieving Sustainable Development Goal (SDG) 3, the goal of ensuring good health and well-being. Advances in off-grid solutions, including off-grid refrigeration units, could help.

Electrifying health centres across the region is likely to significantly improve health-care services while strengthening the resilience of health centres and communities alike. Governments across the region could facilitate electrifying health facilities by ensuring supportive policy, regulatory and business environments. In addition, international development partners can play a key role by bringing technical and financial support

Sources: USAID (2021), Power Africa Off-Grid Project - Health Facility Electrification; SEforALL (2021), Power Africa, SEforALL to accelerate health facility electrification in Sub-Saharan Africa.

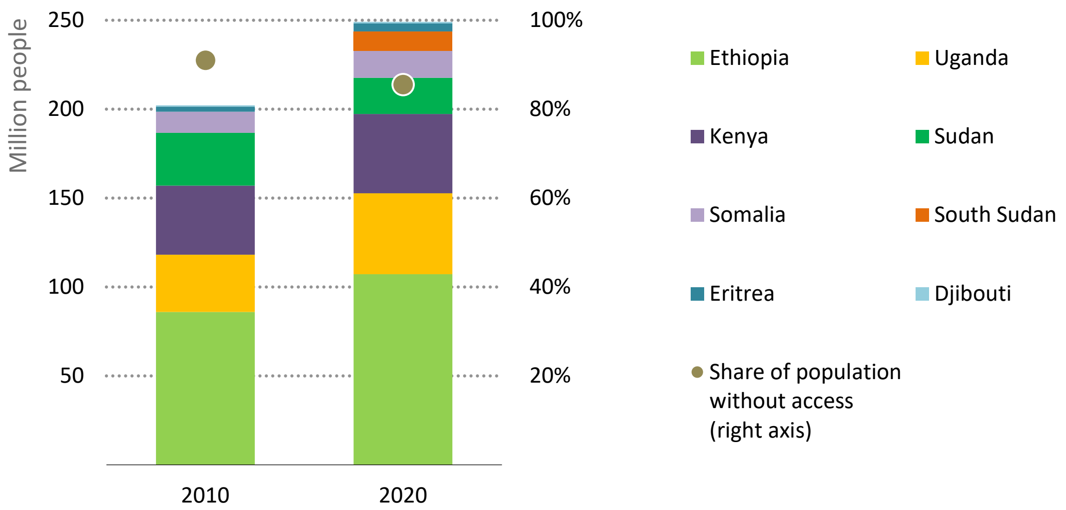
2.2. Clean cooking access status

Progress is insufficient as the number of people without access keeps increasing

In the greater Horn region, nearly 250 million people rely on traditional cooking solutions, such as the use of wood and charcoal as cooking fuels.

Access to clean cooking lags far behind access to electricity throughout the region. The share of the population with access to clean cooking systems has steadily increased from about 10% in 2010 to 15% in 2020. However, the number of people relying on traditional cooking solutions grew by 20% or about 50 million people during the same period due to population growth outpacing access gains. While no country experienced a reduction in the total number of people without access, around 1 million people shifted to modern fuel each year. In addition, six out of the eight countries managed to improve their overall access rate.

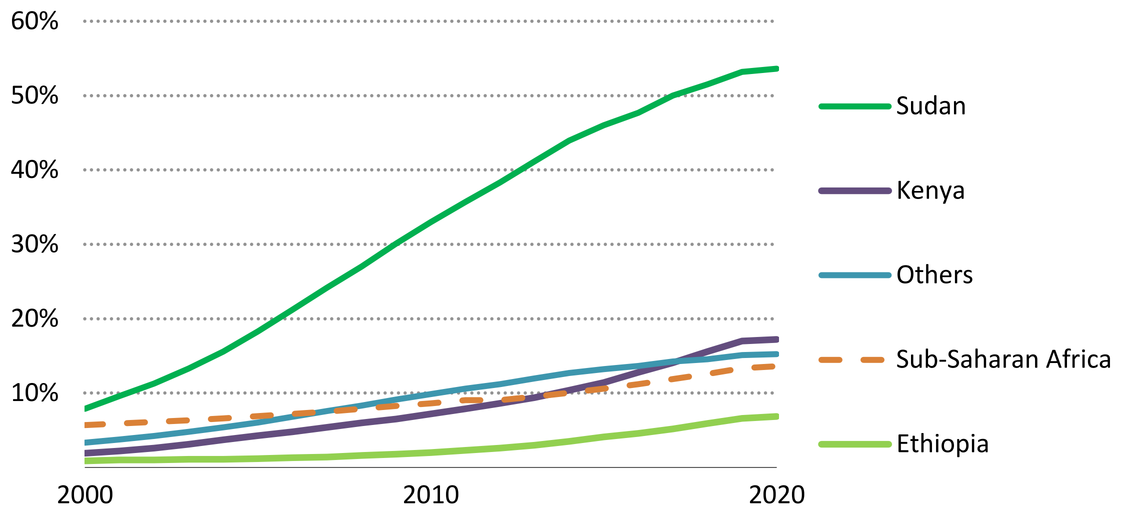
People without access to clean cooking by country in the greater Horn of Africa region, 2010 and 2020



Sources: IEA analysis based on World Health Organization (WHO) (2022), Household Air Pollution Data.

There are noticeable disparities among countries in the region. Sudan and Kenya in particular both increased their access rates by 20 and 10 percentage points, respectively, between 2010 and 2020. These two countries track above the sub-Saharan Africa average with 55% and 17% access rates, respectively, for clean cooking. All other countries of the region are trailing far behind with access rates of less than 10%. Uganda, a country with a population size comparable to that of Sudan has an access rate of less than 1%. Ethiopia has one of the largest populations without access, at above 110 million people, while Kenya and Uganda together account for 90 million people without access.

Access to clean cooking rates in selected countries in the greater Horn of Africa region and sub-Saharan Africa, 2000-2020



Notes: Sub-Saharan Africa excludes South Africa. "Others" comprises Djibouti, Eritrea, Somalia, South Sudan and Uganda.
Sources: IEA analysis based on World Health Organization (WHO) (2022), Household Air Pollution Data.

Urban access to clean cooking grew faster than rural access over the last two decades, outpacing the urbanisation rate from 2012 onwards. Improved biomass cookstoves are supporting the expansion of access in rural areas where distribution infrastructure for LPG does not yet exist.

Policy frameworks for clean cooking vary across countries

Countries have enacted clean energy policies and strategies to assist them in attaining their clean cooking targets. Kenya has a stated goal of achieving universal access to clean cooking services by 2028 through a push to adopt clean cooking technologies in rural and urban areas. Ethiopia is targeting universal access to clean energy services – clean cooking and electricity – by the end of the decade, through increasing use of renewables in the overall energy mix, the expansion and upgrade of energy infrastructure and energy efficiency improvements.

Clean cooking access: Regulatory indicators for sustainable energy in the greater Horn of Africa region, 2018

Clean cooking regulatory provisions	Eritrea	Ethiopia	Kenya	Somalia	South Sudan	Sudan	Uganda
Does the government track household level data on cooking solutions?	✓	✓	✓	–	✓	–	✓
Is clean cooking included in national planning?	–	✓	✓	–	–	✓	✓
Is there a dedicated institutional framework for clean cooking?	✓	✓	✓	✓	–	–	✓
Are there standards for clean cooking solutions (efficiency, emissions and safety)?	–	✓	✓	–	–	–	✓
Is there any labelling scheme on clean cooking products for efficiency and emissions?	–	✓	✓	–	–	–	–
Is there any financial incentive for the uptake of clean cooking solutions?	–	✓	✓	✓	–	✓	✓

Note: Data are unavailable for Djibouti.
Source: ESMAP (2021), ESMAp-RISE indicators

Somalia's updated nationally determined contribution outlines the country's strategy to shift towards the use of clean cooking systems. In its contribution to climate mitigation efforts, the country has identified the promotion of clean and fuel-efficient cooking as a pathway for reduced carbon emissions and energy transitions. In its proposed adaptation actions, it is considering increasing the production of non-forest fuel briquettes, including from agricultural residues and waste.

In addition to providing incentives, governments should focus on synergy between electrification and clean cooking. Some countries in the region, notably Ethiopia and Kenya, have linked clean cooking access with electricity access provision, by incentivising the use of electric appliances to drive demand for electric cooking.

In Kenya, the Kenya Power and Lighting Company is promoting use of electric pressure cookers to bring cooking costs down for households. In Ethiopia, measures such as social tariffs, providing credit for the purchase of domestic and productive appliances, will increase consumption and improve services. This is particularly interesting for mini-grid operators and utilities to scale up demand and their services. Husk Power, which provides credit for appliances, has already been successful in India and is operating 15 sites in Africa.

Energy prices are rising and affecting affordability of clean cooking

Governments of the greater Horn countries have become increasingly concerned about energy affordability over the last 3 years. Uneven global economic recovery and disruption of supply chains and investment cycles have raised energy prices. The access of rural and poorer communities to clean fuels has slowed because of high costs, low demand and irregular supply. Higher energy costs are therefore lowering people's living standards and undermining universal access to energy.

Rising LPG prices are hindering efforts to use it as a clean cooking fuel. Since December 2019, international LPG prices have risen by more than 60%, increasing LPG cylinder prices from 40% to 60%. Cylinder prices in Kenya have risen from 4.5% to 6% of the monthly income of poor households. Many people are thus reverting to cooking with polluting fuels like charcoal or other gathered fuels, with charcoal prices in the informal market also increasing.

Clean cooking access targets in Kenya and Uganda have encouraged the use of LPG through subsidised gas refiling initiatives that allow LPG distributors to operate during Covid-19 confinement periods. However, in the wake of the Covid-19 pandemic, some countries lacked such programmes or the funds to administer them. Several plans to eliminate fuel subsidies in response to multilateral lender demands have coincided with rising LPG prices. In June 2021, Sudan ended fuel subsidies. This has affected the affordability of clean cooking fuels.

Electricity access and electric cooking in Kenya

Generally, households newly connected to the electricity grid tend to underconsume and are in the lowest tariff band, making it difficult for utilities to recover investment costs. Adopting efficient electric cooking appliances increases demand, as consumers rely less on biomass and more on electricity. It also increases revenue, thus accelerating cost recovery for energy distributors. For grid-connected households, cooking with electricity saves money compared with purchasing other fuels.

Electric cooking is becoming more popular in Kenya due to improved electricity access, reliability and generation capacity. The Kenya Power and Lighting Company wants to increase domestic demand to use excess power. Some 80% of households use polluting fuels despite three-quarters having reliable, low-cost electricity. The company is considering on-bill repayment for electric cooktops to encourage switching.

This is in line with Kenya's announcement for developing the first national electric cooking strategy in Africa. Kenya's goal is to have universal clean cooking by 2028.

The strategy aims to boost electric cooking in urban and rural areas by overcoming cultural barriers through cooking classes, recipes for local cuisine using electric cookware, time-saving techniques and dish-preparation contests. The Kenyan electric cooking campaign, Pika Na Power, uses television adverts, social media campaigns and live cooking classes to promote electric cooking. Uganda introduced a cooking tariff corresponding to usual cooking hours for encouraging cooking with electricity in 2022, following Kenya's lead.

Electric cooking is a clean and efficient option for households in the greater Horn of Africa, and is part of the solution for achieving SDG 7. Traditional cooking uses polluting fuels like firewood, charcoal and kerosene. Cookstoves cause indoor pollution, leading to premature deaths (mainly among women and children) and deforestation. Electric cooking can reduce carbon emissions from biomass and fossil fuels, and also reduce forest destruction.

In Kenya, where electricity access was 78% and clean cooking was only 17% in 2021, there is an enormous opportunity to encourage the adoption of electric cooking. LPG is the preferred cooking fuel in Kenya, but electricity is slowly gaining popularity. Its outlook appears even brighter following Kenya's recent fuel price hike, the reimposition of value-added tax on LPG in July 2021, and the 15% electricity price cut in January 2022. As more Kenyan households are connected to modern energy and use electric appliances, new opportunities arise for electric cooking.

To advance electric cooking in the region, there is a need for concerted actions and synergies among all stakeholders. These include governments, non-state actors, the private sector and targeted communities. While widely used for electricity access, integrated energy planning, including geospatial analysis to develop cost-efficient analysis, is needed for uptake of clean cooking. Importantly, the transition to clean cooking should be supported by a combination of domestic and international funding.

Source: IEA (2022), Africa Energy Outlook.

2.3. Energy access outlook

Considerable efforts are needed to ensure progress on SDG Target 7.1 in the region. All eight greater Horn countries have set targets for access to electricity, but not systematically for access to clean cooking.

Energy access targets for the greater Horn of Africa region

Country	Electricity access targets	Clean cooking targets
Djibouti	100% by 2035	
Eritrea	75% by 2030	60% by 2030
Ethiopia	100% by 2025	100% by 2030
Kenya	100% by 2026	100% by 2028
Somalia	45% by 2024	20% by 2030
South Sudan	20% by 2025	
Sudan	100% by 2031	
Uganda	80% by 2040	50% by 2025

Source: IEA, data provided by government officials at Nairobi consultation workshop in May 2022.

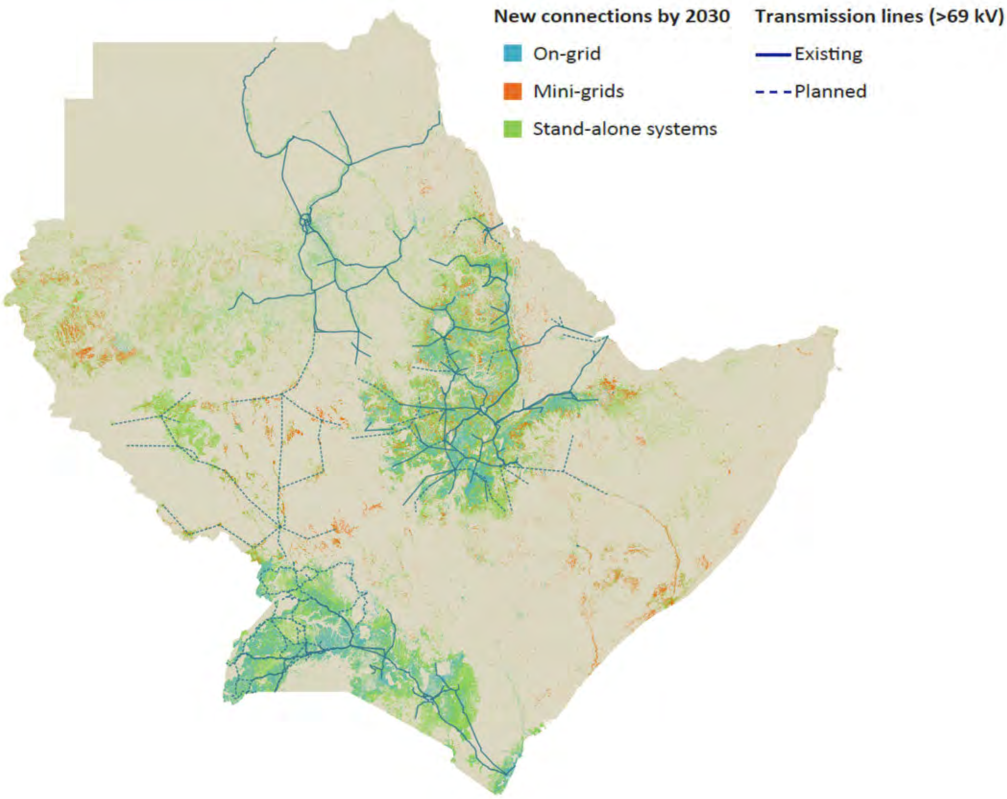
In the Stated Policies Scenario (STEPS),[15] 115 million people still lack access to electricity by 2030. Kenya is the only country to succeed in achieving universal electricity access by 2030, while Ethiopia is likely to reach an access rate higher than 90% by the same time. Integrating off-grid technologies (including mini-grids and off-grid solar solutions in the Ethiopian national Electrification Program) is central to achieving the country's universal electrification.

The Africa Case envisions universal access to electricity by 2030. Based on IEA geospatial analysis, solutions to achieve this goal include grid expansion, and development of mini-grids and stand-alone systems. Almost 60% of the greater Horn's population gaining access to electricity for the first time does so via grid connection in 2030 under the Africa Case. They are mainly urban dwellers and rural communities living within reach of existing or planned grids. Expanding the grid would be the least-cost electrification solution. For the remaining 40%, as they are location far from the grids, mini grids and stand-alone systems are the preferred solutions to achieve universal access.

The ways that new connections are made vary substantially among the different countries in the Africa Case. Today, in Sudan, a country with a relatively high demand projection and an existing grid infrastructure, almost 80% of new connections are linked to the national grid. In Somalia, two-thirds gain access using off-grid solutions, which is indicative of the active off-grid market, with the remaining third to be connected to grids.

[15] STEPS does not take access targets set by countries at face value.

Electricity access solutions to provide universal access by type in the greater Horn of Africa region in the Africa Case



Note: This map is without prejudice to the status of or sovereignty over any territory, to the delimitation of international frontiers and boundaries and to the name of any territory, city or area.
Source: IEA (2022), World Energy Balances (database).

Private sector investment is key to achieving the universal energy access ambition. Somalia has no national grid, yet the country has registered an impressive increase in electricity access, mainly due to active involvement of the private sector while the government has provided incentives including subsidies and tax exemptions. Using digital payments and control systems, pay-as-you-go models have the potential to make off-grid solar solutions and clean cooking technologies accessible to customers with low financial capacity. Utilising mobile penetration and connectivity, this business approach has successfully expanded in several countries of the region and offers models to follow.

Access to clean cooking remains challenging in the region, as in other parts of the world. In STEPS, despite a 20 percentage-point increase in the access rate between today and 2030, two-thirds of the population or 240 million people still rely on traditional cooking solutions for their daily needs by 2030. In Sudan, two-thirds of the population have access to clean cooking by 2030, while it is half in Kenya. In Kenya, the adoption of LPG as a clean cooking solution lags the country's 2030 development goal, despite several government initiatives.

Infrastructure bottlenecks exist with bringing LPG into the country, including for port facilities, storage capacity and bottling plants. The government's strategy has focused on reducing the cost of LPG and increasing its use among lower-income Kenyans, and encouraging the uptake of electric cooking. Incentivising the private sector could help remove the bottlenecks and lead to stronger processes. Women's lack of control over family finances and their limited earning potential are constraining their ability to switch to modern forms of energy for cooking, so developing a gender-focused mechanism may help.

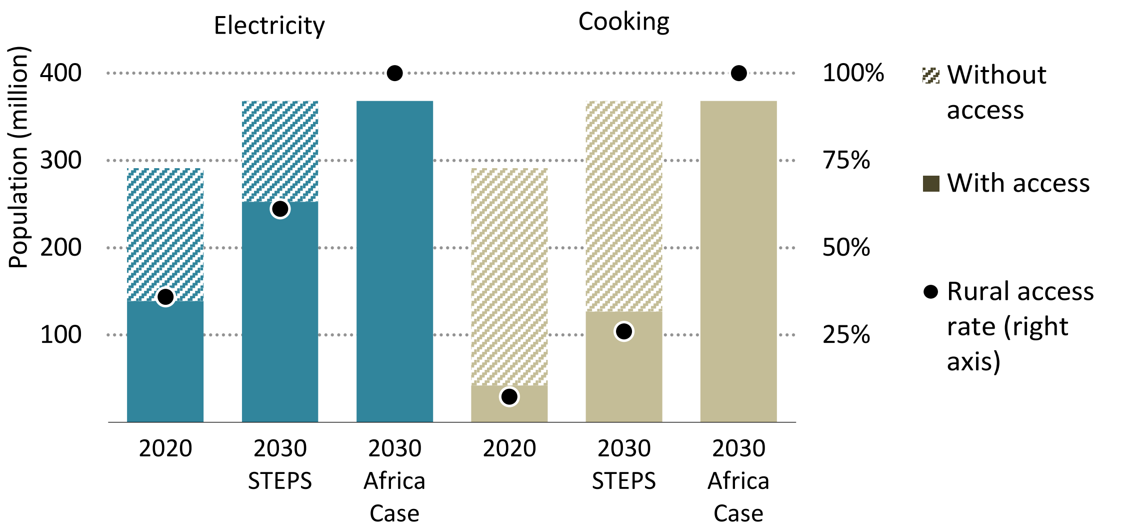
The Africa Case points to a brighter future, achieving universal access to clean cooking by 2030. Like elsewhere across Africa, this requires unprecedented acceleration of action across the region. In Africa, around 40% of the people gaining first-time access to clean cooking during 2022-2030 do so with the use of solid biomass in improved biomass cookstoves. This is generally the most practical means in rural areas since it does not require expanding fuel supply markets to remote villages, as people often do not have the means to afford other types of fuels. In the greater Horn of Africa, a same share of 40% gains access with modern use of biomass, while a third of the people gaining access do so by using LPG. In urban areas, LPG represents the easiest and quickest clean cooking solution. The rest of the population gains access via electric cooking, biogas and ethanol.

Providing universal access to clean cooking across Africa would also reduce GHG emissions. Cooking a meal with biomass on a traditional stove emits on average 1 kilogramme of carbon dioxide equivalent (kg CO_2-eq), in the form of CH_4 and N_2O. However, if fuelwood is harvested unsustainably, emissions can be as high as 10 kg CO_2-eq (as also the CO_2 emitted shall be accounted for). This means that, on average, traditional use of unsustainably[16] harvested biomass for cooking produces around 60% more GHG emissions than cooking the same meal using LPG and around 40 times more than using biogas.

Sustainable uptake is accelerated by taking vigorous regulatory steps to reduce consumer price and minimise unlicensed LPG sales. Measures on the supply side include lower value-added tax on LPG, reduced import duties for clean cooking solutions and appliances, and standards to ensure high-quality products. In addition, financing options, including providing credit, are being developed to support the demand side and make upfront costs manageable for consumers. Similarly, promoting increased LPG uptake by upper- and middle-income groups, together with tighter control of LPG sales to protect consumers from illegal traders, will boost progress in clean cooking access. Indeed, market growth is often stymied by poor practices because of lack of oversight and regulation.

[16] Emissions from biomass cooking are mostly CH_4 and N_2O, while CO_2 is counted only when unsustainable collection happens.

Access to energy in the greater Horn of Africa region, 2020, and in the Stated Policies Scenario (STEPS) and Africa Case Scenario, 2030



Source: IEA (2022), World Energy Balances (database).

Ethiopia's power and digital transformation for expanding energy access

Ethiopia's reform of its telecommunications monopoly may boost mobile penetration, connectivity and digital infrastructure investment in one of Africa's least connected countries. For a population of over 100 million, the country's 2020 Internet connectivity rate was 24%, lower than that of Kenya (30%) and the sub-Saharan Africa average (30%).

Ethiopia aims to provide universal electricity access by 2025 using on- and off-grid renewable energy. It also recently launched the Digital Ethiopia 2025 Strategy and National Digital Payment Strategy 2021-2024. Liberalising its telecommunications sector is expected to accelerate energy access and provide adequate and reliable power, which will then unleash greater mobile connectivity.

Despite doubling its electricity coverage over the last decade (close to 50% by 2020), the country still has a significant access deficit. Expanding electricity access will require digital tools to speed up renewable system deployment. East Africa is a good example of successfully integrating digital technology and renewable energy. Smart metering and data analytics are reshaping the off-grid clean energy market, while innovative mobile payment systems, such as pay-as-you-go technology, are hastening off-grid product adoption.

Likewise, Ethiopia's digital agenda needs reliable and affordable electricity. This applies to data centres, which are at the core of the digital industry. By 2020, Africa's data centres needed 600 MW of reliable power, costing USD 1 billion. Powering the mobile and digital infrastructure using renewable solutions, namely solar energy, will go a long way in addressing the power-digital nexus and provide a cost-effective pathway for transformation in both sectors.

Chapter 3. SDG 7.2 – Accelerating deployment of renewables

Key findings

Modern renewable energy represents only 10% of the greater Horn of Africa's total energy consumption, given the prevalence of the traditional use of biomass in the region. The share of renewable energy grows under the Stated Policies Scenario (STEPS) and more so in the Africa Case Scenario, where it reaches 25% by 2030. Main drivers of such growth include the reduction of traditional and inefficient use of biomass in rural areas and the increase of the share of renewable energy sources in the electricity mix.

Power generation more than triples by 2030 in both scenarios. The share of renewable energy continues to increase, mainly due to hydro and geothermal power. The individual electricity mix of countries in the region varies significantly, but hydro is by far the region's primary source. It is followed by geothermal, while wind and solar PV also increase in both scenarios. All these resources offer huge potential for the region but are currently underexploited.

Hydropower is the backbone of power systems in the region. Hydropower-based electricity generation has more than doubled over the last decade. It now represents 80% of the electricity mix, of which Ethiopia produces half. However, water stress in the region calls for reinforcing the resilience of hydropower systems. For rural communities, small hydropower technologies offer cost-effective electrification options.

Geothermal use has grown fivefold since 2010. In Kenya, it accounts for 45% of the country's electricity generation. Wind provides around 5% of the region's installed capacity, mostly from wind farms in Eritrea, Ethiopia and Kenya. All countries in the region, with the exception of Sudan, have solar power generation capacity.

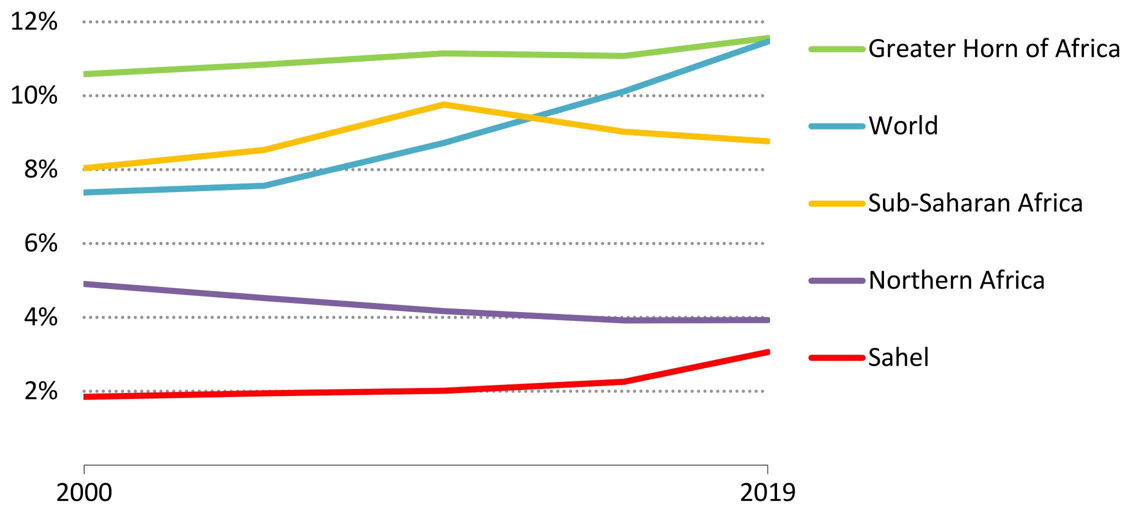
Several challenges hinder the development of renewables in the region, such as heavy bureaucracy, lack of adequate infrastructure and capacity, land ownership and property issues, and security concerns. These challenges often translate into delays in project implementation and discourage private sector investment in the region. To attract the necessary investment and to secure long-term access gains, each country will need clear policies and strategies, as well as a sound set of regulations. Stronger regulatory and policy frameworks need tailoring to each country's context.

3.1. Renewable energy status

Renewable technologies are cost-effective and diverse, can support expanding power systems that are already low-carbon (such as in Ethiopia, Kenya and Uganda) and help reduce the region's demand for oil, which represents about 20% of the total final consumption in 2020. Lower dependency on fossil fuels, whose prices fluctuate, brings multiple benefits including reinforcing energy security, curbing emissions, and cutting import costs.

The share of renewables in total energy consumption in the greater Horn of Africa is similar to the world average, 2.5 percentage points above the sub-Saharan African average, and more than 3 times higher than the one of North Africa and the Sahel.

Share of modern renewables in the total final energy consumption of selected regions, 2000-2019

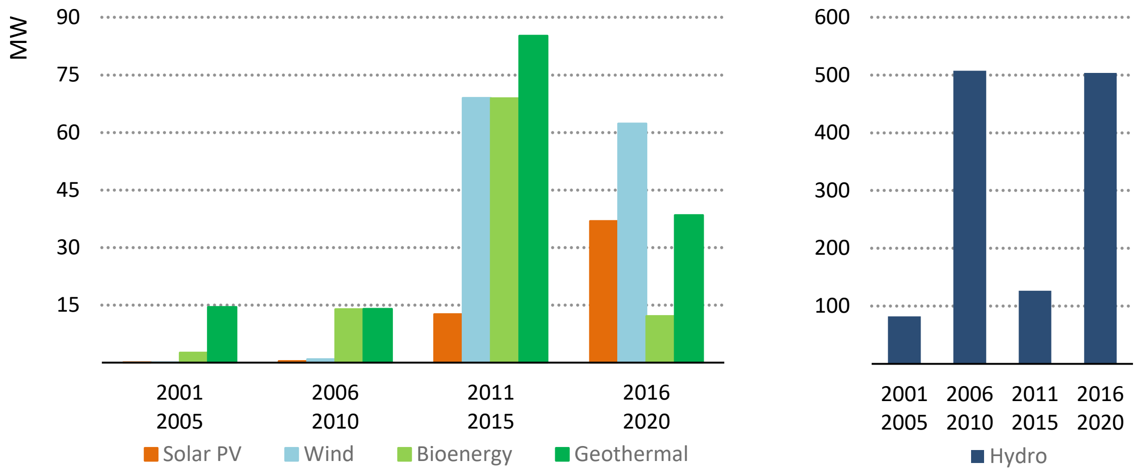


Note: Modern renewables includes all uses of renewable energy except traditional use of solid biomass.
Source: IEA (2022), World Energy Balances (database).

In the power sector, renewable sources generate over 40 TWh or nearly 90% of the electricity produced regionally. This share is far higher than the average of around 60% in sub-Saharan African (excluding South Africa) and three times above the average in other developing economies. In the greater Horn of Africa, electricity generation from renewables has increased more than sixfold since 2000, a time when oil-powered thermal plants used to produce 40% of all electricity. Over the last decade, renewables have increasingly supplanted oil-fired power plants and on-site diesel generators, concentrated in Djibouti, Eritrea, Somalia, South Sudan and Sudan. This has increased even faster since 2018, with a significant number of renewable power plants coming on line.

The total installed renewable power capacity reached close to 10 GW in 2020. This was a fivefold increase over the last two decades, representing more than 60% of the overall installed power capacity. The fast development of hydropower, wind and geothermal power projects in Ethiopia, Kenya and Sudan was the main driver of this substantial increase. Together, these three countries generate 80% of regional electricity, with 100% (Ethiopia), 90% (Kenya) and 70% (Sudan), respectively, of power from renewable sources. Meanwhile, renewables represent less than 1% in Djibouti and South Sudan, where the dominant source of energy is oil.

Average annual renewables capacity additions by source in the greater Horn of Africa region, 2001-2020



IEA (2022), World Energy Balances (database).

Small- scale hydropower has a great potential to expand electrification

Hydropower has been the most important source for electricity generation in the region since 2000, representing a share of 55-70% of the total regional power generation, and 80% of the renewable mix today. In 2020, the region has nearly 8 GW of installed hydropower capacity, which equals half the region's overall installed capacity.

Out of the 33 TWh of hydropower generated in the region, Ethiopia generates close to one-half and Sudan one-third. Major hydropower plants in Ethiopia include the 420 MW Gilgel Gibe II and the 1 870 MW Gilgel Gibe III power stations on the Omo River. The weight of hydropower in the renewable energy mix varies widely among countries. While Sudan's only source of renewable electricity generation is hydropower, Kenya's renewable energy mix is more diversified.

The greater Horn is one of the most climate-vulnerable regions in the world, and may eventually face a water crisis. The correlation between water, energy and climate change is now firmly established. With well-functioning regional co-operation, regional challenges can be mitigated, leading to huge opportunities for managing and investing shared resources, unlocking multiple benefits for the region's countries.

Hydropower is highly vulnerable to climate change. For example, the drop in Lake Victoria's water levels in Uganda between 2004 and 2006 led to the underperformance of the hydropower stations by 50 MW, lowering GDP growth from 6.2% to 4.9%. Governments focus on incorporating climate impacts into dam planning to build resilient hydropower infrastructure and systems while also seeking to diversify their energy mix by using other clean energy sources and to accelerate regional interconnections is crucial. This would require planning and management capacities of the different sources of energy. Furthermore, a better co-ordination helps to avoid geopolitical tensions in managing watersheds, which can slow hydropower project development, as with the Grand Ethiopian Renaissance Dam project.

As the region has many areas with low population density and most people living far away from centralised grid-based power systems, the use of small-scale hydropower dams could be an option to expand electrification. Small hydropower, with less than 10 MW generation capacity, is a cost-effective technology to connect rural populations to decentralised grid-based power systems. Unlike large-scale hydropower plants, small hydropower does not require a long gestation period or considerable financial outlay. Kenya has the highest small hydropower potential in the region, but comes second in terms of installed capacity (40 MW), behind Uganda (52 MW), which has the highest capacity of small hydropower in the region.

The region's governments have tried to create a conducive investment and policy environment for developing the small hydropower sector. A good example is the Gura small hydropower project in Kenya, launched in 2017, in a bid to supply tea factories in the district with nearly 6 MW of reliable electricity. Similarly, independent power producers, such as Magiro Power, are entering the small hydropower market, providing affordable electricity in rural Kenya.

However, countries are still facing challenges in their efforts to scale up small hydropower. Bureaucracy and non-streamlined approval of power purchase agreements can be a deterrent and therefore hinder growth. The existence of limited incentives, such as low feed-in tariffs, can discourage investments and a lack of adequate power infrastructure or interconnections pose a risk to independent power producers looking to invest in the region. Security concerns and lack of clear policies compound to this and create additional constraints for the development of small hydropower. These factors are not all present in every single country in the region, and some are less of a consideration for a given country, as each faces different challenges and constraints.

Ethiopia's power system expansion

The Grand Ethiopian Renaissance Dam is Ethiopia's flagship power project. It aims at providing universal access to electricity and assist the country in reaching climate neutrality by 2025.

When fully operational, it will be Africa's largest hydropower plant with a planned output capacity of 5 150 MW. The dam is located on the Blue Nile River in the northern region of Benishangul Gumuz, 30 km from the Sudanese border. The project, which includes a water reservoir with a capacity of 74 billion m^3 and two power stations, is expected to produce close to 15 TWh of electricity per year, and will be owned and operated by the Ethiopian Electric Power company.

Construction, which began in 2012, is estimated to cost USD 5 billion, financed primarily from domestic resources, Ethiopian diaspora contributions and a grant of USD 1 billion from the Export-Import Bank of China. However, construction delays risk increasing the cost.

Ethiopia initiated filling in 2020, and the final completion date is set for 2023. At the time of its inauguration in February 2022, the dam was 85% complete and its reservoir filled with 18.5 billion m^3. The third filling of the reservoir was completed in August 2022. However, the political concerns of neighbouring countries, including geopolitical tensions, could hinder development.

The project is at the heart of Ethiopia's power system development, but it is complemented by other projects. For example, the Koysha (Gibe IV) hydropower plant is the second-largest addition to Ethiopia's capacity up to 2030 with 1.5 GW.

Kenya is leading geothermal power production, but this technology also has great potential in other countries

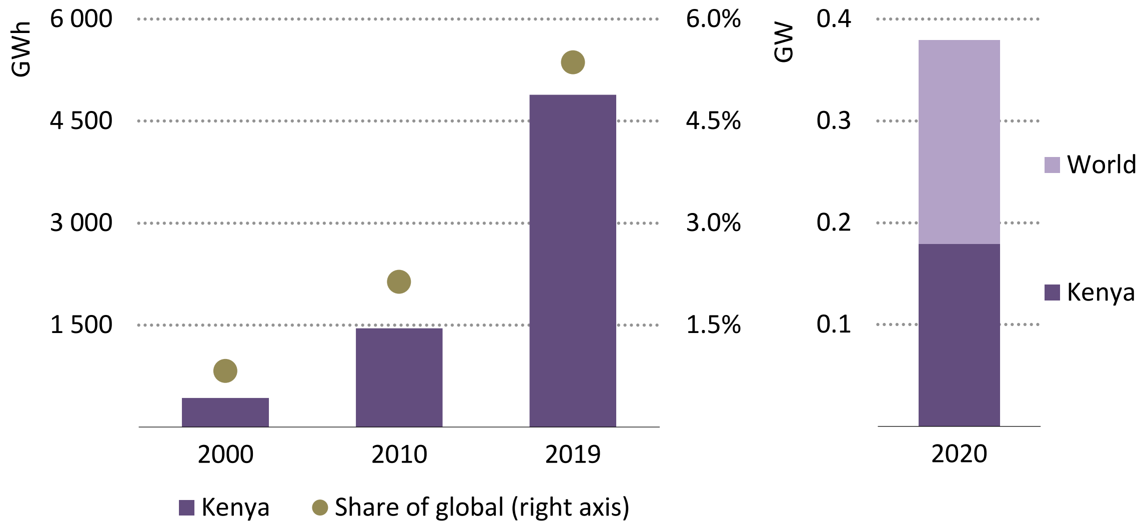
The greater Horn is the only African region generating geothermal power. With over 5 TWh generated, geothermal is the second most important source of renewable electricity in the region. Kenya has nearly all of the regional geothermal power capacity (830 MW), which was 200 MW in 2010. Major geothermal plants in Kenya include the 140 MW Olkaria IV and Longonot, 140 MW Olkaria I units 4 and 5, 165 MW Olkaria V and 330 MW Suswa plants. This technology provides

45% of the national electricity. The country also accounted for 5% of global geothermal-based electricity production in 2019 and half of all capacity added globally in 2020.

Kenya was the first and only African country to launch geothermal energy production in 1986, until Ethiopia followed in 1998. The region's total installed geothermal capacity is now shared between these two countries only, despite massive potential throughout the region. Kenya continues to invest in the technology, allocating over USD 150 million of its 2022/2023 national budget for geothermal power development. In Ethiopia, there are three projects under construction, and the country plans to increase its geothermal power capacity to 10 GW by 2030.[17] Plans to develop geothermal energy are also under consideration in Djibouti and Eritrea.

Like hydropower, geothermal power offers baseload power generation, which makes it a great option to complement the intermittent power supply from solar and wind. In addition, geothermal power benefits from a smaller capital investment and shorter development timelines.

Geothermal electricity generation in Kenya and globally, 2000-2019 (left) and added capacity, 2020 (right)



Source: IEA (2022), World Energy Balances (database).

The availability of vast geothermal resources can also stimulate regional co-operation. Led by Kenya, countries in the region are joining together to form an alliance for geothermal development. Such projects tend to be small scale, which

[17] In the STEPS and Africa Case, capacities of these projects are not taken at face value.

reduces opportunities for export to other countries. Nevertheless, the potential for export of expertise – as well as power – is significant.

Closing the gender gap in the geothermal sector

Geothermal energy projects affect communities living near development sites in many ways. Aside from bringing power within their reach, these communities also face specific risks in relation to land and natural resource use, employment and economic opportunities.

Women tend to be differently affected by energy projects than men, with the geothermal sector being no exception. Unfavourable land tenure systems prevent women from owning land as in the Afar (Ethiopia) and Maasai (Kenya) communities. Coupled with their weak negotiation position in compensation and resettlement matters, women often find themselves excluded them from the benefits of geothermal projects.

Integrating gender considerations into the design of the region's geothermal projects can help ensure the inclusion and economic empowerment of women. For example, Ethiopia has committed to ensuring fair compensation to women during resettlement, increasing women's employment in the power sector by 30%, providing leadership training and preparing the future female workforce. And Kenya has set a quota for employment and training of women in the sector.

Geothermal energy can also create new business opportunities. Geothermal heat could be used in the agri-food value chain for greenhouse farming, post-harvest processing (crop drying and fruit dehydration) and aquaculture. For example, Kenya's Menengai pilot project has shown a range of useful applications of geothermal heat for women-led businesses such as milk pasteurisation, fish farming, greenhouse irrigation of vegetables and laundry.

Although starting from low levels, wind and solar power have been the fastest growing power sources since 2010, yet their potential remains untapped

The region is particularly well endowed with high-quality wind resources, with a mean wind speed exceeding 8 m/s. Nevertheless, wind energy remains largely untapped, despite an onshore generation potential of around 200 000 TWh/year.

Wind makes about 5% of the electricity generated in the region in 2020, and 5% of the installed power capacity, or 660 MW. The largest share of installed wind capacity is distributed between Ethiopia and Kenya. Kenya is the regional leader, with 335 MW of installed wind capacity, most of which comes from a single project (Lake Turkana Wind Plant). Wind accounts for over 10% of the country's energy mix. Ethiopia is second in the region, with 4% of wind-based electricity generation. These levels compare favourably with sub-Saharan Africa (excluding South Africa) where wind provides than 1% of power generated. South Africa, which implemented supportive policies, concentrates 2 GW of installed wind capacity that exceed 2.5% of the country mix.

One of the major challenges hindering development of wind power projects relates to the issue of land rights. In some areas, land is owned by local communities, and the government has no power for managing them. This can lead to delays in project implementation.

Solar potential is largely untapped, as Africa has some of the best conditions in the world for developing this technology. Despite accounting for 60% of the best solar resources, the continent is home to only around 6 GW of solar PV installed capacity, less than that of the United Kingdom. Africa generated only 10 TWh of solar power in 2019, which is less than 0.01% of its estimated potential.

The greater Horn region is particularly well endowed for solar energy, even when compared with the rest of Africa. It has a global horizontal irradiance level of 5.2-6.7 kWh/m^2. Solar power is part of the power mix of all countries in the region, except Sudan. It has slowly increased over the last two decades and yet still only makes up 0.3 TWh or 1% of the regional power output. In Somalia, it represents about 10% of the electricity produced. In the other countries, it is below 1%.

At the country level, governments are pushing for wider adoption of solar PV technologies, both for utility-scale and decentralised stand-alone solutions. In 2021, the Sudanese government called for bids to install almost 1 200 solar-powered irrigation pumps in the farms of two regions. South Sudan, which is dependent on imported oil products for electricity production, is transitioning towards renewable power by constructing its first large-scale solar PV farm close to Juba. The project comprises a 20 MW plant and a 35 MWh storage system that will improve grid balance and mitigate 10 kt CO_2-eq every year.

Examples of major recent solar PV and wind developments in the greater Horn of Africa region

Country Project	Technology	Capacity	Status	Financial close date	Ownership and investors
Djibouti Ghoubet Wind Farm	Onshore wind	59 MW	Financing secured / under construction	Feb-20	Financed via a public-private partnership (PPP) between the government and a group of investors led by Africa Finance Corporation and FMO

Country Project	Technology	Capacity	Status	Financial close date	Ownership and investors
Ethiopia Assela Wind Farm	Onshore wind	100 MW	Under construction	Jun-20	Sponsored by the Ethiopian government and the Danish International Development Agency; debt provided by Danske Bank
Ethiopia Ayisha Wind Farm	Onshore Wind	120 MW	Under construction	2017	Export-Import Bank of China (85%) and Ethiopian Electric Power (15%)
Kenya Kesses 1	Solar PV	55 MW	Financing secured / under construction	Feb-22	Alten Energías Renovables; financed primarily via debt from Standard Bank and the Emerging Africa Infrastructure Fund
Kenya Lake Turkana Wind Power Project	Onshore wind	310 MW	Operational	Dec-14	Six shareholders: Anergi Turkana Investments Limited, KP&P Africa B.V., Danish Climate Investment Fund I K/S, Vestas Eastern Africa Limited, Finnfund – the Finnish Fund for Industrial Cooperation and Sandpiper Ltd
Sudan Dongola Wind Farm	Onshore wind	100 MW	Pre-financing		Owned by the Sudanese Ministry of Water, Resources, Irrigation and Electricity
Uganda Kabulasoke Solar Power Park	Solar PV	20 MW	Operational	Feb-19	Financed by Great Lakes Africa Energy, Xsabo Power Limited and an undisclosed local bank

Note: In the STEPS and Africa Case, capacities of these projects are not taken at face value.
Sources: IJ Global (2022); Clean Energy Pipeline (2022).

Renewables are key for an energy transition beyond the power sector

While deploying renewables is more streamlined in the power sector than in other sectors, there are applications in several other end-use sectors. Modern bioenergy expands massively for cooking and for mobility and industrial needs under a Sustainable Africa Scenario that looks at the African continent as a whole.

Biofuels such as ethanol and biodiesel – which account for only 0.1% of road energy use today in Africa – could play a significant role in providing alternatives to fossil fuels in the transport sector. Given the size of the agriculture sector in many African countries, there is enormous potential to increase production of biofuels, which could provide cheaper and locally produced alternatives. Such potential is tempered by concerns over food security, which often prevent governments from harnessing investment to scale up biofuel production. Although non-food crop alternatives exist, such as urban and industrial waste and other types of biomasses, many governments consider these options through the power sector lens and not necessarily for other productive uses such as producing biofuels.

Other uses of bioenergy include renewable heating solutions such as converting solar PV to heat. This comprises PV modules directly (and solely) connected to an electric resistance water heater using direct current power without inverters. This solution is being deployed in South Africa, where almost 12 000 systems have been installed in less than 5 years. And although there are specificities to the context of South Africa – led by a mandate to limit the share of fossil fuels in water heating – the simplicity of installation, reliability and cost-competitiveness of PV-to-heat systems offer perspectives for wider deployment on the continent.

Developing the commercial biogas sector in sub-Saharan Africa

As a by-product of the anaerobic digestion of organic materials, processed using biodigesters, biogas is a valuable source of energy that can be harnessed for electricity, cooking and heating. It has the advantage of being easily stored and can therefore be used on demand.

Biogas has been heralded as a great opportunity for small- and medium-scale energy generation options in remote, rural areas. This is because it is generated through the decomposition of materials such as feedstock manure and other biomass sources. In addition to energy generation, it has the advantage of also producing fertilisers (the digestate) as a by-product of the chemical process whereby biogas is generated. Such fertilisers can be used in agricultural activities to enhance crops.

Development agencies and governments, particularly through a partnership called Energising Development – which includes some European governments and agencies – have propelled pilot projects aiming to support developing a commercial biogas sector in some countries of the greater Horn region.

An initial project called the Africa Biogas Partnership Programme led to the construction of about 45 000 biogas plants in Ethiopia, Kenya and Uganda, providing approximately 250 000 people with access to a sustainable source of energy between 2017 and 2019.

Building on the results of such a project, Energising Development launched the African Biodigester Component project in 2021. It aimed to develop and strengthen demand and supply to create sustainable biodigester markets in targeted countries, by installing at least 50 000 small-scale biodigesters by 2025 across five countries. A key expected result of the initiative is to provide energy access for at least 250 000 people.

The project includes a results-based finance tool that will be applied in Kenya, the biggest market of the pool of countries. This will provide what is expected to be the tipping point for the biodigester market to reach a critical mass of clients within Kenyan farmers and thus enable suppliers of small-scale biodigesters to achieve economies of scale and reach market maturity.

3.2. Renewables deployment outlook

All countries in the region have set targets to accelerate the uptake of renewables and reduce net GHG emissions.

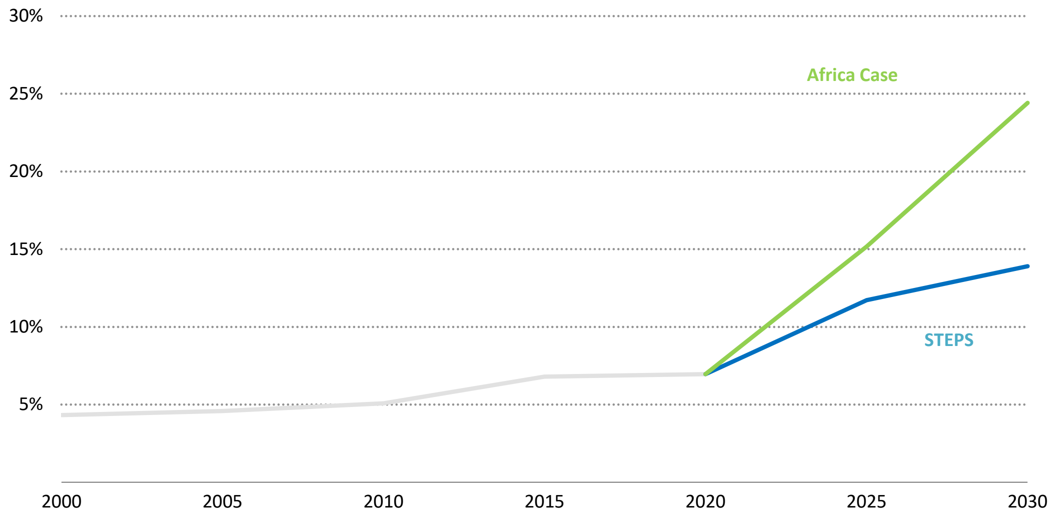
National renewable energy targets in the greater Horn of Africa region

Country	National renewable energy targets
Djibouti	100% renewables for its electricity generation by 2035
Eritrea	50% of electricity generated by renewables by 2030
Ethiopia	100% of renewable electricity generation capacity by 2030
Kenya	100% of electricity generated by renewables by 2030
Somalia	35% of electricity generated by renewables by 2030
South Sudan	30% of electricity generated by renewables by 2030
Sudan	20% of electricity generated by renewables by 2030
Uganda	100% of electricity generated by renewables by 2050

Note: East African Community is a regional economic community that encompasses seven member countries including Kenya, South Sudan and Uganda.
Source: Workshop with countries, May 2022.

The share of modern renewables in total final energy consumption grows under both scenarios by 2030, reaching 15% in STEPS and almost 23% in the Africa Case. Main drivers include reducing traditional and inefficient use of biomass in rural areas and the growing share of renewable electricity.

Share of modern renewables in the total final energy consumption in the greater Horn of Africa region, 2000-2020, and in the Stated Policies Scenario (STEPS) and Africa Case Scenario, 2030



Note: Modern renewables includes all uses of renewable energy except traditional use of solid biomass.
Source: IEA (2022), World Energy Balances (database).

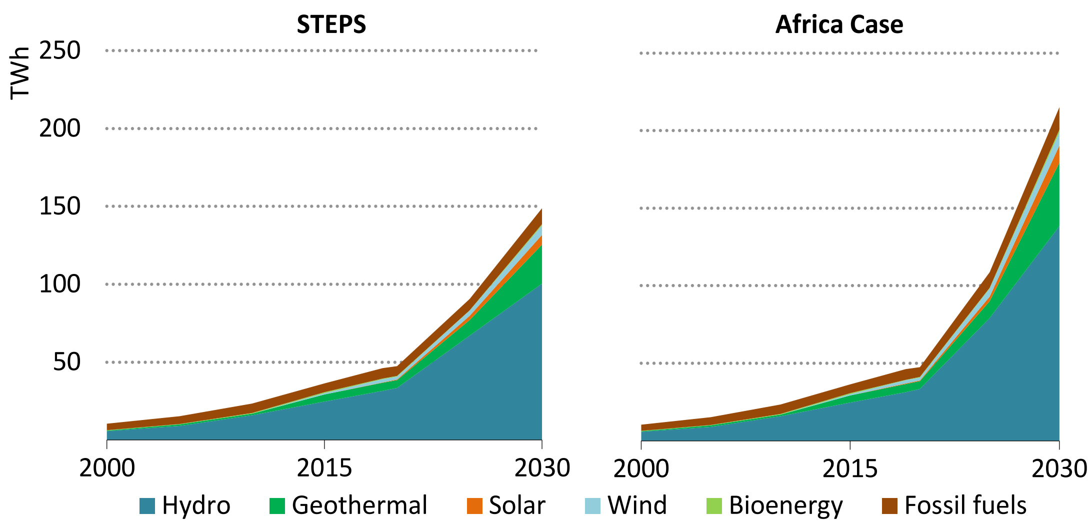
In STEPS, power generation reaches about 150 TWh by 2030 (almost triple the level in 2020). In the Africa Case, it increases by over 4 times to 215 TWh to meet the target of universal electricity access. The share of modern renewable energy in the power generation mix grows from 85% in 2020 to around 95% by 2030 in STEPS and the Africa Case.

The increase is mainly because of hydropower, which remains the primary source of power generation in both scenarios by 2030, accounting for about 65% of the mix. It is also the result of added power generation of 48 TWh in STEPS and 80 TWh in the Africa Case from the Grand Ethiopian Renaissance Dam project in Ethiopia. Geothermal power generation also increases significantly in both scenarios: it increases fivefold under STEPS and eightfold under the Africa Case.

There is a substantial increase in solar power between 2020 and 2030 in both scenarios. It rises from 0.3 TWh in 2020 to over 6 TWh in STEPS and to 11 TWh in the Africa Case by 2030. This increase takes into account projects in the pipeline in Sudan (total added capacity of 1.2 GW, including the 1 GW solar PV project in Khartoum) and around 1.8 GW in Ethiopia, which includes the 600 MW Reyrich Plastic Company solar power plant project. Governments across the region are taking steps to increase solar energy use. Nairobi is mandating the use of water heating installations powered by solar PV on large buildings in a bid to reduce grid-based energy demand pressure. Similarly, Sudan is planning to deploy solar home systems by 2030.

In both scenarios, the relative use of oil in generation of power in the region decreases threefold by 2030. It is surpassed as the second most important energy source for power generation, and replaced by geothermal power in STEPS and by geothermal and solar in the Africa Case. The share of geothermal power is above 15% in STEPS and close to 20% in the Africa Case in the overall electricity generation mix. STEPS considers introducing coal based on the existing pipeline of projects in Kenya and Sudan, but with a share of less than 1%, whereas it is fully phased out in the Africa Case by 2030.

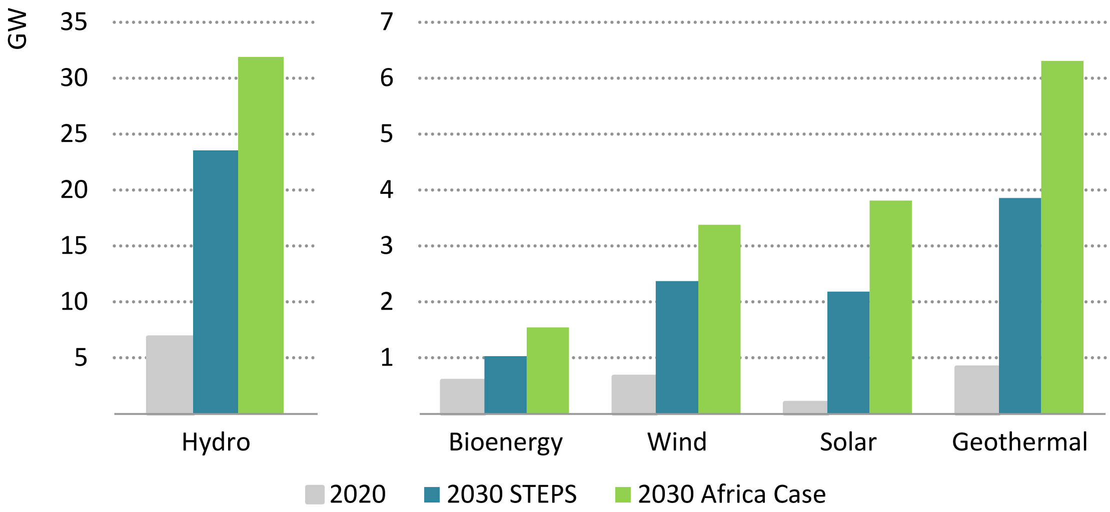
Power generation by fuel in the greater Horn of Africa region, 2000-2020, and in the Stated Policies Scenario (STEPS) and Africa Case Scenario, 2030



Source: IEA (2022), World Energy Balances (database).

Installed capacity in the region grows about threefold in STEPS and fourfold in the Africa Case by 2030, while doubling across Africa as a whole. The greater Horn's abundant hydroelectric potential makes it attractive for large-scale, uninterrupted, long-term, low-carbon electricity generation. Hydropower remains the most important source of renewable power generation, with additions of installed capacity of close to 17 GW in STEPS and 25 GW in the Africa Case.

Installed renewable power capacity in the greater Horn of Africa region, 2020, and under the Stated Policies Scenario (STEPS) and Africa Case Scenario, 2030

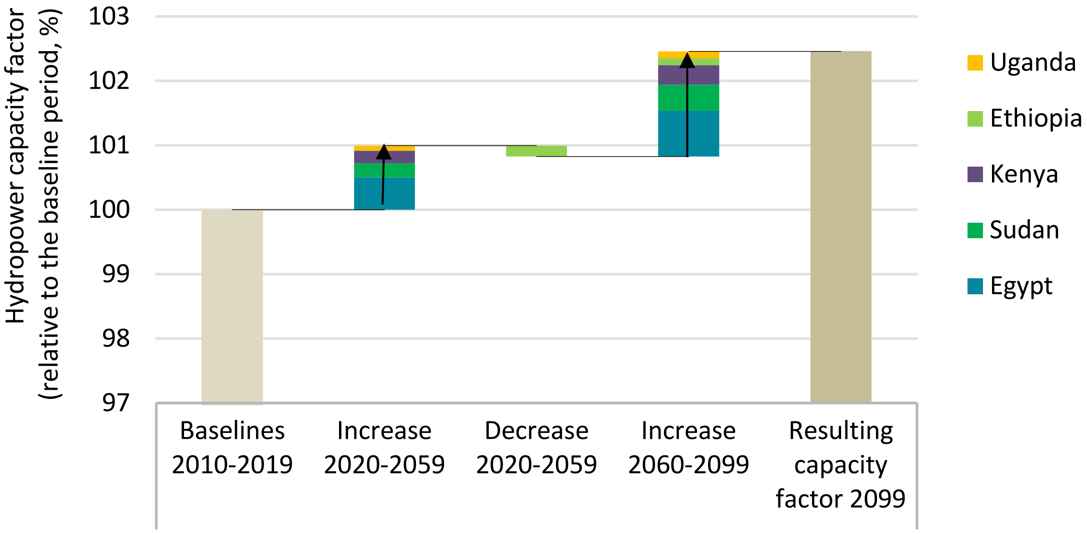


Source: IEA (2022), World Energy Balances (database).

At the continent level too, hydropower is to dominate electricity mix and could help eradicate energy poverty. With a 23% increase in generation capacity by 2040 from the 2019 level, it is to remain Africa's main source of renewable electricity.[18] Despite a 3% projected decline on average in hydroelectric production in Africa between 2010 and the end of the century, East Africa – particularly the Nile River Basin countries (Ethiopia, Kenya, Sudan and Uganda) – is likely to experience increased hydroelectricity generation. Under scenarios assuming global warming below 2° and 3°[19] respectively, Kenya dams' capacity factor could be up to 20% above or 5% below current level depending on the years. In Uganda, such annual variations could range from +11% to -8%. However, the challenges and uncertainty around hydropower future capacity factors may limit achieving the full potential of this technology. For instance, competition for scarce resources such as water and pastureland for livestock is driving the tensions that are rampant in parts of Djibouti and Eritrea, northern Ethiopia, northern Kenya and north-eastern Uganda (Karamoja).

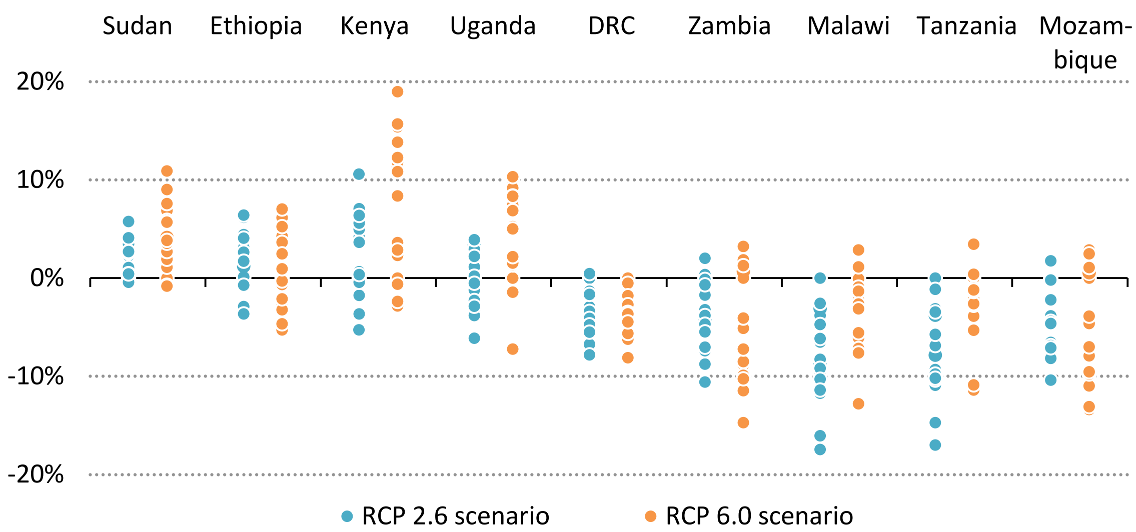
[18] These findings are the results of a separate modelling exercise run by the IEA and exposed in the Hydropower Special Market Report. In that report, the IEA has thoroughly explored the possible long-term impacts of climate change on hydropower capacity factors in Asia, Latin America and Africa.
[19] These scenarios assume global warming below 2°C and 3°C, respectively.

Hydropower capacity factor in selected countries of the Nile basin, 2010-2099



Note: these projections are under the "Around 3°C scenario".
Source: IEA (2020), Climate Impact on African Hydropower.

Annual hydropower capacity factors for selected greater Horn of Africa countries by climate scenario RCP 2.6 and RCP 6.0, 2020-2099



Notes: Representative concentration pathway (RCP) is a GHG concentration trajectory adopted by the Intergovernmental Panel on Climate Change. RCP 2.6 and RCP 6.0 are two pathways describing different climate futures depending on the volume of GHGs emitted in the years to come.
Source: IEA (2020), Climate Impact on African Hydropower.

In the Africa Case, geothermal capacity reaches 6.3 GW by 2030, about 2.4 GW more than in STEPS.

The majority of countries in the region are endowed with geothermal resources. Such resources could be utilised to create alternative livelihoods through direct uses. However, a strong policy support is needed and costs remain significantly high.

For countries with limited resources, international co-operation will be key to developing geothermal energy. Eritrea, which almost entirely relies on imported fuel for its electricity, is looking to develop its geothermal potential with confirmed exploitable resources around the Alid and Nabro-Dubbi volcanic areas. The European Union provided the country with initial funding of USD 9 million for geothermal exploration in 2016. The Eritrean government now intends to start exploitation. Djibouti also initiated exploring its vast geothermal resources in the Lake Assal region with financial support from the African Development Bank. The country's potential is estimated to be 0.5-1 GW

Wind and solar capacities in the greater Horn reach 3.4 GW and 3.8 GW, respectively, by 2030 in the Africa Case. The increase in capacity needed in both technologies is significant: 20 times more solar and more than 4 times more wind compared to in 2020. Correctly assessing the renewable energy potential is critical to attracting projects and investments.

For instance, a 2002 study on Eritrea's wind energy potential analysed 25 sites across the country and identified the southern part of the coastal region as the most suitable for wind development. This kind of site-specific work shows that studies should lead rapidly to concrete projects and thus accelerate energy transitions. In Sudan, the 100 MW Dongola Wind Farm is used by the government as a showcase to attract new investment.

Wind and solar power are key components of countries' renewable power generation and carbon reduction strategies. Kenya, which aims at 100% renewable energy by 2030, has developed the largest wind farm in sub-Saharan Africa (Lake Turkana Wind Farm with a capacity of 310 MW). Djibouti, which intends to reach full renewable capacity by 2035, is building its first wind farm on the shores of Lake Assal (60 MW). This project will double the installed power generation capacity and will support the energy demand of large transport infrastructure projects such as the Djibouti International Free Trade Zone and Damerjog Industrial Park.

Chapter 4. SDG 7.3 – Making progress in energy efficiency

Key findings

Improvement in energy intensity has been particularly slow in sub-Saharan Africa, whereas energy efficiency measures and supporting policies can bring benefit. Nevertheless, since 2000, the greater Horn of Africa region has improved faster than in other African regions, at a rate of 2% per year.

The buildings sector accounts for most of the increase in energy demand in the region, driven by growing population and rapid urbanisation. Energy demand in the transport sector is also likely to increase, especially for personal vehicles. With the sector relying overwhelmingly on oil consumption, there is ample opportunity for energy efficiency gains.

Energy efficiency gains in the Africa Case Scenario (Africa Case) would lead to the region using 30% less energy by 2030 than in the Stated Policies Scenario (STEPS), while supporting 10% more economic activity. The Africa Case projections show an annual improvement in the region's energy intensity of 6%, which is eight times higher than in STEPS.

Policy-driven energy efficiency measures are pivotal to achieving Sustainable Development Goal (SDG) 7. Supporting the emergence of markets for energy-efficient lighting and appliances and harmonising Minimum Energy Performance Standards (MEPS) are critical within the region. Energy-efficient appliances bring many benefits, decreasing energy bills for low-income households while providing better energy services.

Major gains can also be made in the residential sector to compensate for population growth and rapid urbanisation, primarily with a switch from traditional to modern and efficient cooking systems. Focusing on buildings, and particularly new constructions, is also pivotal, as buildings lock in energy use for their lifetime of around 40 years. In the transport sector, energy consumption is to increase more than threefold in the Africa Case. Stricter efficiency standards for importing used vehicles and large-scale adoption of electric vehicles (EVs), especially two- and three-wheelers, are key to optimising the energy efficiency of the sector. In the industrial and services sector, higher economic growth can be achieved with a decrease in energy intensity thanks to a shift to cleaner technologies.

4.1. Energy efficiency status

Improving energy efficiency is a cheap, clean and rapidly deployable approach for optimising energy use. Energy efficiency gains can contribute to achieving universal energy access and reducing GHG emissions. Energy efficiency applies to all sectors and relies on existing and cost-effective technologies, such as efficient appliances, electric motors and EVs. Central to the energy transitions, this "very first fuel" has the capacity to eliminate wastage. By freeing up scarce public resources and energy production capacity, energy efficiency relieves pressure on national grid systems, reduces countries' fossil fuel imports and allows supply of energy to underserved sectors and sections of the population.

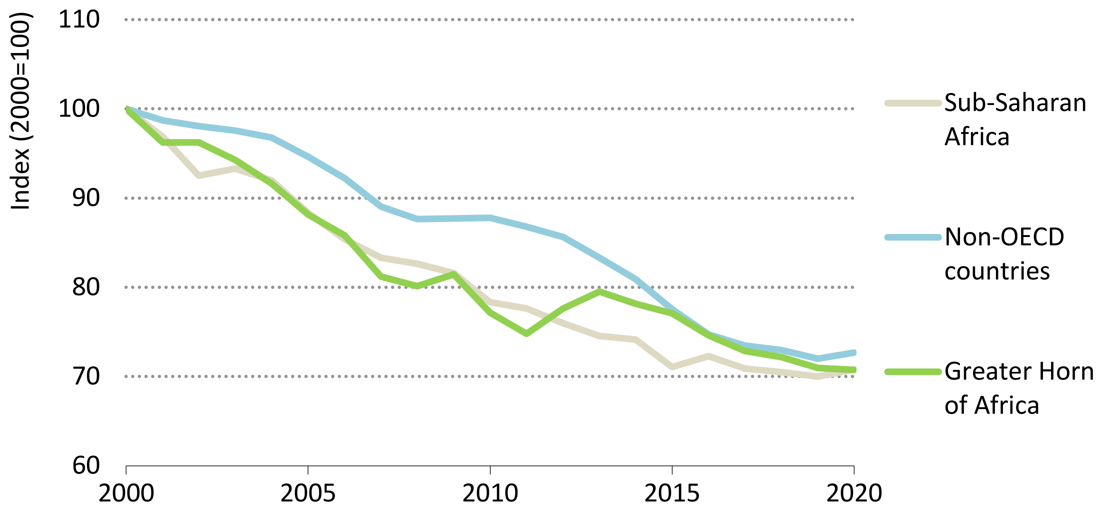
The Covid-19 pandemic and high energy prices have created an opportunity to build momentum and push the energy efficiency and transitions agenda forward. Energy efficiency gains can enhance economic competitiveness with the potential to generate multiple benefits for the environment, businesses, communities and employment. A co-ordinated approach to energy efficiency is required to promote the sharing of best practices and lessons learned, as well as to scale up regional energy efficiency efforts and initiatives.

As the first but basic indicator of energy efficiency, energy intensity measures the level of energy use in economic activities. In sub-Saharan Africa (excluding South Africa), the average energy intensity is about 140 toe per million USD in 2020. It slightly decreased over the last decade at a rate of 1.4%. Although comparisons require assessing the specificities of each economic structure, the sub-Saharan African energy intensity is twice that in Latin America and the Caribbean, but the progress made is only half that in South-eastern Asia. Sub-Saharan Africa's relative intensive use of energy for economic output is indicative of its over-reliance on biomass energy and requires better energy efficiency policies.

Energy intensity in the greater Horn is similar to the sub-Saharan African average. Over the past two decades, the energy intensity in the greater Horn has gradually declined, with an average improvement rate of 2% per year, which is above the average in non-OECD countries over this period. In the services sector, which creates half the regional income, the energy intensity dropped by almost 20% over the last decade. In industry, a sector that accounts for one-fifth of the regional GDP, the energy intensity almost halved over two decades.

Improvements achieved in other countries and regions offer best practices that could be replicated in the greater Horn region, to help accelerate progress towards efficiency. Worldwide, an estimated annual improvement rate of 3.2% is required by 2030 to meet SDG Target 7.3.

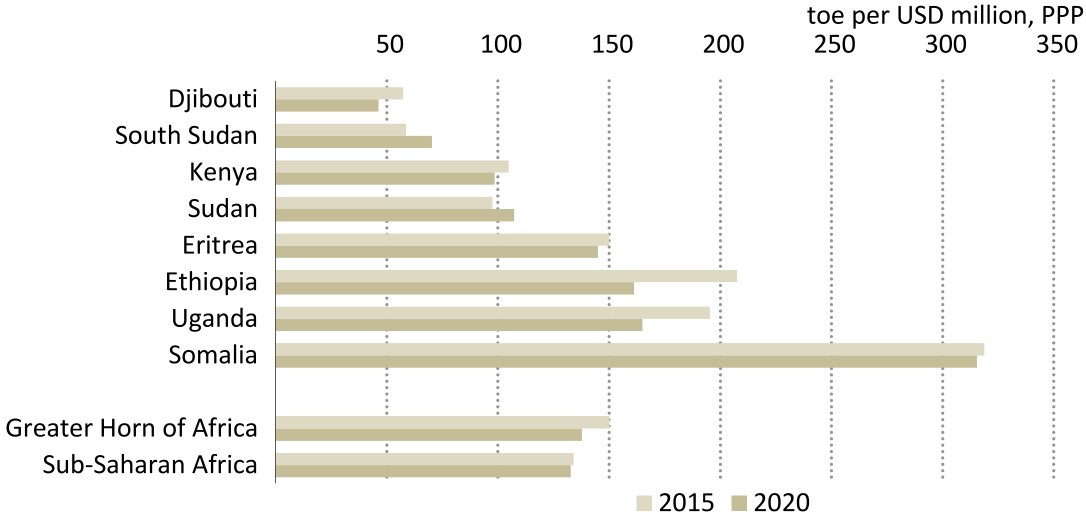
Energy intensity in selected regions, 2000-2020



Note: Index (2000=100) refers to 2000 as a base year and having the value of 100.
Source: IEA (2022), World Energy Balances (database) and IEA analysis.

The regional energy intensity of about 140 toe per million USD – slightly above that of sub-Saharan Africa (excluding South Africa) – varies significantly across countries in the greater Horn. Reflecting the diverse economic structures, it ranges from a low of 50 toe per million USD in Djibouti, a country where services make up nearly 90% of the national income, to 160 toe per million USD in Ethiopia, where the value added from the industry sector accounts for a quarter of the national GDP at USD 70 billion (2021 USD billion, Purchasing Power Parity [PPP]). In Somalia, where the agriculture sector prevails and the power system is based on inefficient and carbon-intensive generators, the national energy intensity is above 300 toe per million USD. Since 2015, Ethiopia and Uganda have significantly reduced the amount of energy used per economic output, while improvements also occurred in Djibouti, Eritrea, Kenya and Somalia. In contrast, energy intensity has increased in South Sudan and Sudan.

Energy intensity in the greater Horn of Africa and sub-Saharan Africa, 2015 and 2020



Note: Energy intensity is calculated as the total energy supply per GDP and expressed in toe per USD million, PPP.
Source: IEA (2022), World Energy Balances (database) and IEA analysis.

Improving energy efficiency brings benefits at all levels of the economy by creating local jobs, reducing energy bills, decreasing GHG emissions and mitigating the challenges of energy security. Using technologies that are already cost-effective, the world can double its efficiency by 2040. Each dollar invested will pay back on average three times in energy saved over the lifetime of equipment.

In sub-Saharan Africa, improving energy efficiency can play a particularly important role in enhancing security of supply as electrification rates increase and in minimising exposure to volatile energy prices of imported fuels. Energy efficiency can be leveraged to optimise power production and consumption, while alleviating the pressure of peak demand. By lowering the demand, energy efficiency can also make the transitions to clean energy easier, as it lowers the burden on new technologies.

The IEA energy efficiency policy toolkit, consisting of a combination of three main instruments (regulations, information and incentives) can be tailored to countries in the greater Horn of Africa region and applied across the economy and the different sectors. Each of these tools can play an important role in driving energy efficiency improvements, while creating jobs, energy bill savings and other benefits.

Regulatory measures (such as MEPS for appliances and buildings energy performance codes) or vehicle fuel efficiency standards play an important role to "push" up the efficiency across the market. Financial incentives such as grants, rebates, auctions, tax incentives, low-interest loans, on-bill finance, floor-space incentives (for buildings) or recognition programmes, together with providing information, help to provide a "pull" factor to encourage consumers to go beyond purchasing minimum standard or average efficiency products and services.

Developing energy services companies can be a relevant measure to accelerate adoption of efficiency practices in all sectors. There are successful cases globally; for example, in India, Energy Efficiency Services Limited has supported major efficiency programmes. Efforts to create and scale up energy services companies in Africa are also gaining momentum.

For example, in October 2021, Kenya announced a plan to create a super energy services company, domiciled at the Kenya Power and Lighting Company. This company will develop energy efficiency projects for the public and the private sectors. Regional centres for efficiency include the East African Centre of Excellence for Renewable Energy and Energy Efficiency,[20] the Regional Center for Renewable Energy and Energy Efficiency[21] and the Southern African Development Community Centre for Renewable Energy and Energy Efficiency. Such centres can contribute directly to building momentum, leveraging partnerships with continental players such as the African Development Bank, and facilitate peer to peer learning.

Appliances and products present ample opportunities for improving energy efficiency

Efficient appliances tend to enhance quality of life and lower electricity costs, particularly benefiting lower-income households. There are ample opportunities for improving the energy efficiency of appliances.

Super-efficient Equipment and Appliance Deployment[22] is a global initiative pushing for the roll-out and wide adoption of energy-efficient appliances. In East Africa, it aims to collaborate with the Energy Efficient Lighting and Appliances project and the United for Efficiency initiative with the view of using the most energy-efficient lighting and cooling appliances in national energy systems in the region.

[20] Including Kenya, South Sudan and Uganda from the greater Horn of Africa region.
[21] Encompassing Djibouti, Somalia and Sudan from the greater Horn of Africa region.
[22] Founded in 2009 under the Clean Energy Ministerial, this initiative is co-ordinated by the IEA and aims to support appliance energy efficiency policies in its member countries and wider. Ahead of the 26th Conference of the Parties, the United Kingdom and the IEA have launched a call to action to strengthen the Initiative to support countries in achieving raised ambition more quickly, easily and at a lower cost.

The roll-out of technologies such as energy-saving lamps and energy-efficient appliances (electric cooking appliances), together with the switch to solar-powered stand-alone solutions (water heating and air conditioners), will go a long way in expanding access and reducing pollution, emissions and waste in the region. These will benefit households, public facilities and businesses alike.

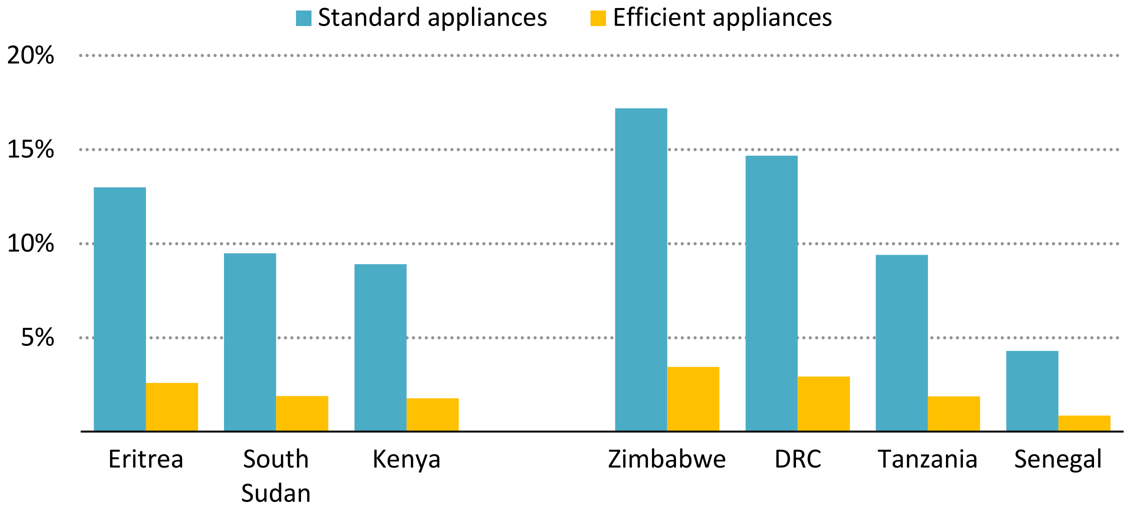
MEPS are policy instruments coupled with standards and labelling programmes designed to promote quality and energy-efficient appliances to discourage markets from sub-standard energy products. They help to unlock the largest, and often cheapest, amounts of energy savings across the economy by removing the worst-performing products and practices from the market, thus improving energy productivity and the need for future energy generation and distribution expenditure.

Developing and implementing MEPS at the regional level are particularly important, since harmonised standards are likely to help lift trade barriers, reduce implementation costs and promote the sharing of best practices and lessons learned. Additionally, they could help to achieve economies of scale and cost savings for consumers.

Using efficient appliances could reduce the financial burden of some vulnerable populations and cut energy bills fivefold. This is considerable knowing that a standard liquefied petroleum gas (LPG) cylinder costs about 10% of the poorest people's monthly income. Furthermore, improved efficiency entails increased productivity, greater grid stability and reduced levels of pollution and emissions. For instance, phasing out inefficient cooling solutions and widely adopting energy-efficient systems could significantly lower a region's energy demand and GHG emissions while saving electricity.

MEPS are in force or under development in Kenya and Uganda. Since 2013, Kenya has proposed mandatory MEPS for air conditioners and refrigerating appliances. Since 2011, Uganda has implemented voluntary MEPS for air conditioners and refrigerating appliances.

Electricity expenses required to power basic appliances as a percentage of household revenues for the poorest 40% of people in selected countries, 2018



Notes: Electricity consumption is based on a basic bundle of energy services, equating to around 500 kWh per household annually with standard appliances and 100 kWh with highly efficient appliances. This delivers four light bulbs operating for 4 hours per day, a mobile phone charger, a fan operating for 3 hours per day and a television operating for 2 hours per day. The household revenue is the average gross national income per household for the bottom 40% of households and is computed using the World Development Indicators.

Source: IEA (2019), Africa Energy Outlook.

Efficiency gains for lighting appliances: Light-emitting diode technology

Several countries in the greater Horn of Africa have set clear ambitions with energy efficiency policies, including for lighting appliances.

In Sudan, the Ministry of Energy and Petroleum has placed energy efficiency solutions at the centre of the Electricity Sector Reform and Recovery Strategy 2022-2026. A national efficient lighting programme targets replacing 7.5 million incandescent lamps by high-quality, efficient light-emitting diode (LED) lamps.

The Sudan Electricity Holding Company Ltd is implementing the plan, in collaboration with the Sudanese Electricity Distribution Company Ltd. It includes several measures to ensure electricity savings: importing LED lamps, inspecting pre-shipment quality, monitoring LED lamp performance through quality processes, establishing exchange points at the Sudanese Electricity Distribution Company's customer centres with a disposal mechanism for incandescent lamps, and promoting behavioural change through public communications campaigns. The programme is expected to serve 2.3 million grid-connected households and 50 000 grid-connected public buildings.

India has been successful with large-scale deployment of LED technologies for lighting, saving around 55 TWh per year according to government estimates. More than 350 million LEDs have been distributed to domestic consumers under the flagship Unnat Jyoti by Affordable LEDs for All programme launched in 2015. The government-owned energy services company Energy Efficiency Services Limited is an example of a super energy services company. It is the largest developer of small-scale clean energy in India, active in areas such as lighting, smart meters and buildings. The company used its balance sheet and development bank funding to invest nearly USD 0.2 billion annually during 2017 and 2018, and aims to increase spending to over USD 0.8 billion annually, partly for EV charging stations.

LED technology also offers immense opportunities for street lighting. Globally, more than 300 million streetlights consume as much power as Germany, and can make up to 40% of consumption and 65% of budgets in some cities. Smart LED systems that adjust output to light levels and vehicle flows could reduce electricity use by up to 80%. An Indian national programme has enabled installing over 12 million LED smart streetlights in municipalities in the last 5 years. For countries such as those in the greater Horn region where streetlights are not yet largely deployed, adopting digitally enabled poles can be key to tempering electricity demand growth, while improving road and city safety

Energy consumption is set to rise the most in the buildings sector, so measures to optimise energy use are crucial

Most of the increase in energy demand in the greater Horn region will come from the buildings sector in both scenarios. Planning for energy-efficient building designs will be crucial to respond to the challenges of rapid urbanisation. Innovations that combine techniques, technologies and materials that reduce the carbon intensity of the buildings sector and that optimise lighting, heating and cooling systems will be key to transforming the sector.

Countries in the region should enact policies to promote efficiency in the buildings sector. Some of the measures that are likely to boost energy efficiency in new and old buildings include developing building codes and retrofitting programmes that target the most inefficient buildings. Placing minimum requirements on the energy performance of buildings linked to building certification, promoting the use of better materials and innovative solutions, and devising energy performance codes for the delivery of cost-effective energy services are other such measures.

Programmes such as buildings ratings can support both sides of the market. They can assist consumers in understanding the energy performance and the costs of the building they are looking to purchase or lease. They can also provide building owners with proof of their energy efficiency investments when dealing with potential buyers or tenants. Furthermore, energy audits, as well as training and certification in energy management systems, are proven means to identify and improve the energy efficiency of the buildings sector.

Rising urbanisation in the greater Horn region and the long-life span of buildings highlight the importance of optimising energy use for heating and cooling. Effective energy efficiency and decarbonisation policies mentioned in the GlobalABC Roadmap for Buildings and Construction could easily be applied to the region. These consist of a policy toolkit with a combination of regulations, information and incentives (e.g. floor-space incentives and tax incentives). On a global scale, these measures could reduce global CO_2 emissions by 6.5 t per year by 2040. In 2022, Uganda has embarked on developing guidelines for energy efficiency in buildings under the Buildings Act.

In the transport sector, the overwhelming reliance on oil and imported used vehicles offers ample opportunities for efficiency gains

Rapid demographic growth and urbanisation in countries in the greater Horn region are likely to drive a dramatic increase in energy demand in the transport sector, especially for personal vehicles. There is ample opportunity for sizeable energy efficiency gains in the sector, given that transport is oil based and the sector with the highest CO_2 emissions. Furthermore, given the reliance of countries in the region (like elsewhere in Africa) on imported used cars for public and private use, countries can design specific policies and regulations to limit the amount of low efficient imported used vehicles. Efforts can also be directed towards the improvement of public transport.

Countries in the region can resort to policy measures to incentivise energy efficiency in the transport sector. For instance, setting and raising fuel efficiency standards for personal vehicles, enforcing mandatory fuel economy standards and developing rapid fleet renewal systems will contribute to enhancing energy efficiency in the sector.

Emergence of Kenya as the EV hub of the greater Horn of Africa

Close to 65% of Africa's annual vehicle fleet growth comes from used car imports. Despite having a relatively young and clean fleet compared to other countries in the greater Horn, 95% of Kenya's added fleet hitting the roads every year are used cars sourced from Japan, with an average age of 7 years. In comparison, in Uganda, the average age of imported used vehicles is above 15 years. The older the vehicle, the higher the CO_2 emissions.

In recent years, Kenya has taken measures to shift to cleaner transport systems. For instance, the country is enforcing a maximum age limit of 8 years for used car imports. And Ethiopia began imposing higher excise taxes on used car imports in 2020. It is also set to phase out imported used cars by 2026 to support local car assembly manufacturers instead.

Other initiatives include the use of liquid biofuels (ethanol and biodiesel) to power Kenya's transport system. However, success has been limited in this area. EV deployment appears to be the most promising opportunity for the region. Countries are taking steps to switch to electric mobility by electrifying public transport systems. For example, Uganda's Makerere University, together with Kira Motors Corporation, piloted the first solar-powered electric bus in 2018. In June 2022, the government of Uganda with support from the German Agency for International Cooperation GmbH launched four electric mobility charging stations for electric motorcycles (*bodabodas*) on a road out of Kampala to promote electric mobility. Deploying electric buses aims to replace diesel-based school buses and airport shuttles.

Similarly, the private sector is becoming increasingly active in Kenya's public transport. BasiGo, an EV and finance start-up, is working to bring electric buses to public bus operators in Nairobi. Bus owners would then use the pay-as-you-go model to pay for battery charging. ROAM, a Swedish-Kenyan company initially focusing on domestic production of electric motorcycles and off-road vehicles, recently introduced its first African designed and manufactured electric bus in Kenya. Further to the private sector role, the government of Kenya, in its National Energy Efficiency and Conservation Strategy 2020, has set the target of electrifying 5% of its vehicle stock by 2025.

By investing in local manufacturing and assembly of two- and three-wheelers, including motor and pedal ones, countries could create millions of green jobs for their young populations. However, serious challenges still need addressing in the EV sector. Strengthening and improving the reliability of the distribution grid is a major one.

In addition to tax incentives for the import of EVs and their components, measures in support of a conducive EV start-up ecosystem are likely to scale up growth and catalyse investment in the EV sector.

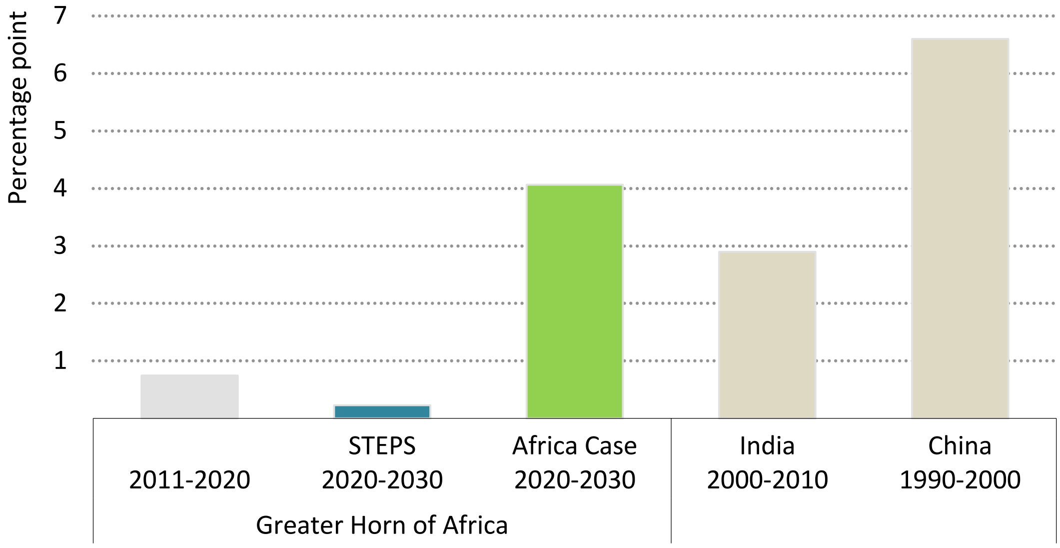
4.3. Energy efficiency outlook

The Africa Case shows the region could use 40% less energy by 2030 than in STEPS, while supporting 10% more economic activity. This is because of the increase in energy efficiency.

The Africa Case shows an annual improvement in the region's energy intensity of 6% by 2030, which is much higher than in STEPS (0.7%). When compared with other regions, the improvement rate in the greater Horn is consistent with that of the Sahel (4-5% annual improvement), as well as with other rapidly modernising economies such as that of the People's Republic of China, which had an annual intensity improvement of almost 7% over the period 1990-2000.

The improvement is a result of policy-driven energy efficiency, primarily targeting phasing out inefficient use of solid biomass for cooking. Using LPG or electricity for cooking is four to eight times more efficient than relying on a three-stone, wood-based cooking fire.

Energy intensity average annual improvement in the greater Horn of Africa region, 2000-2019, and in the Stated Policies Scenario (STEPS) and the Africa Case Scenario, 2020-2030 and in other regions



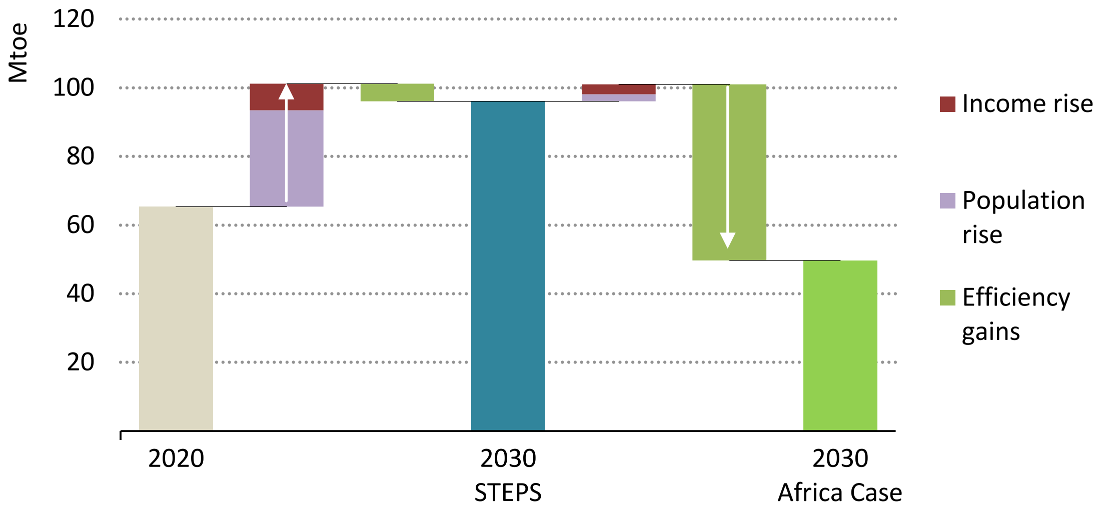
Note: Energy intensity improvement is defined as the compound annual average decrease rate of energy intensity.
Source: IEA (2022), World Energy Balances (database) and IEA analysis.

In the Africa Case Scenario, the phase-out of inefficient use of traditional biomass and improved thermal insulation of buildings drive energy efficiency

Major gains in energy efficiency in the residential sector in the greater Horn region by 2030. In STEPS, population growth and the rise in income levels drive up demand for thermal energy in the residential sector by around 40 Mtoe. Efficiency gains in this scenario have a limited impact on thermal energy consumption.

In the Africa Case, efficiency gains largely compensate thermal energy demand, cutting it by half (i.e. by 50 Mtoe). Universal access to clean cooking is achieved by 2030, rising from 15% in 2020. This is driven by a major switch from traditional cooking systems (~20% efficiency) to modern biomass cookstoves (~35% efficiency), as well as to LPG (~56% efficiency) and electric (85% efficiency) cooking systems to a certain extent, including electric pressure cookers (which reduce cooking time and hence energy needs). The average cooking efficiency therefore jumps from 21% to 37% on average over the period 2020-2030.

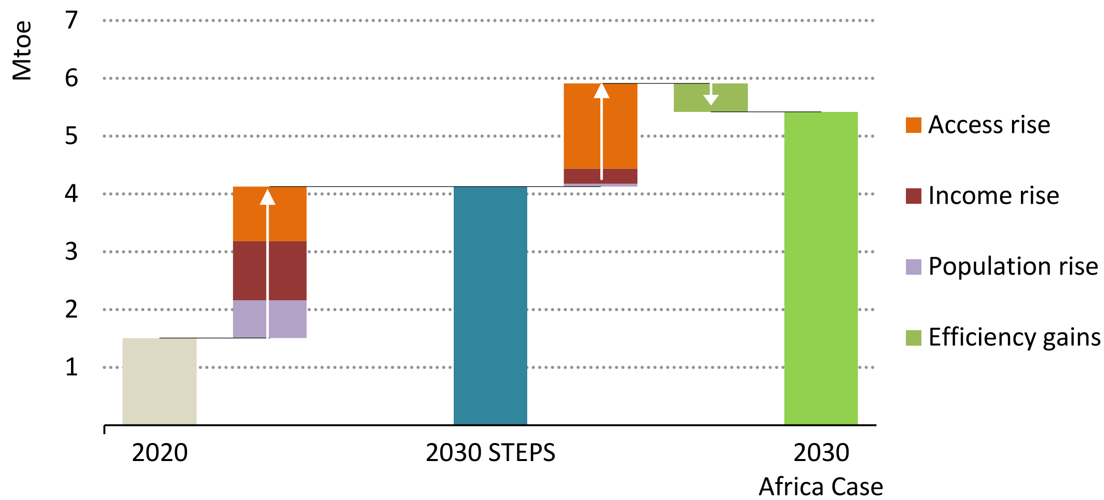
Thermal energy consumption in the residential sector, 2020, and in the greater Horn of Africa in the Stated Policies Scenario (STEPS) and Africa Case Scenario, 2030



Source: IEA (2021), World Energy Balances (database).

Electricity consumption in the residential sector is higher in the Africa Case than in STEPS. This is because of universal energy access, which in the Africa Case is predicated on a higher penetration and use of appliances. In this scenario, adopting energy policies such as MEPS is likely to generate efficiency gains, keeping electricity demand lower than it might have been otherwise. Information programmes also play important complementary roles. For example, energy labelling and rating for appliances and vehicles help consumers to factor energy performance and operating costs into their purchasing decisions.

Electricity consumption in the residential sector, 2020, and in the greater Horn of Africa in the Stated Policies Scenario (STEPS) and Africa Case Scenario, 2030

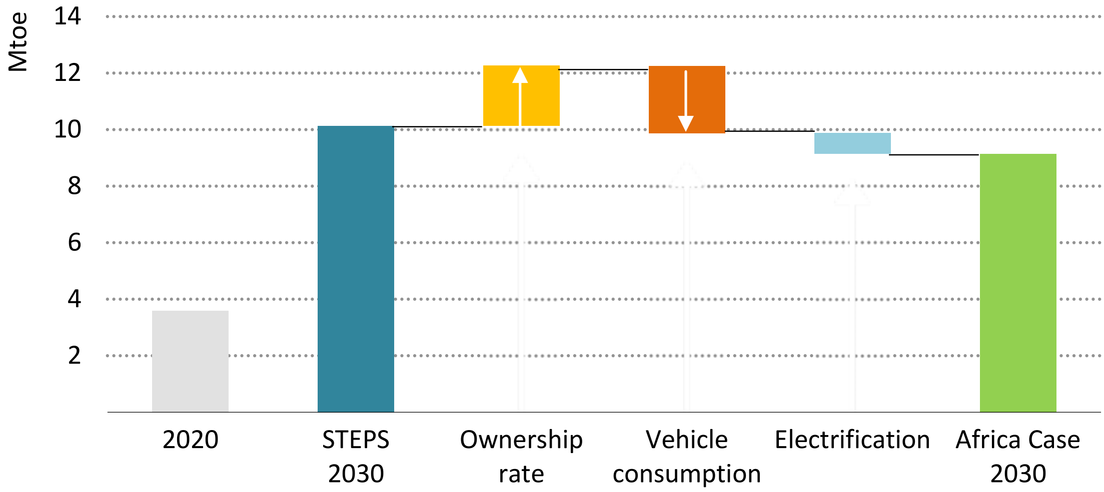


Source: IEA (2022), World Energy Balances (database).

In the transport sector, stricter standards on vehicles and adoption of electric two- and three-wheelers play a role in tempering energy demand growth

Energy consumption by private passenger vehicles increases nearly threefold in both scenarios by 2030. Despite a higher increase in ownership rate because of better incomes, the Africa Case records a lower energy consumption than STEPS in private vehicle use. Energy consumption by vehicles is lower in the Africa Case, and electrification is higher. The transport sector's energy use can be optimised by making major efficiency gains through stricter efficiency standards for used car imports, more widely adopting EVs driven by rapid electrification of the region, especially for mass transit systems, and using alternative fuels. Stricter standards on vehicles and adoption of electric two- and three-wheelers save nearly 3 Mtoe by 2030 in the Africa Case compared with in the STEPS.

Energy consumption in private passenger vehicles, 2020, and in the greater Horn of Africa in the Stated Policies Scenario (STEPS) and Africa Case Scenario, 2030

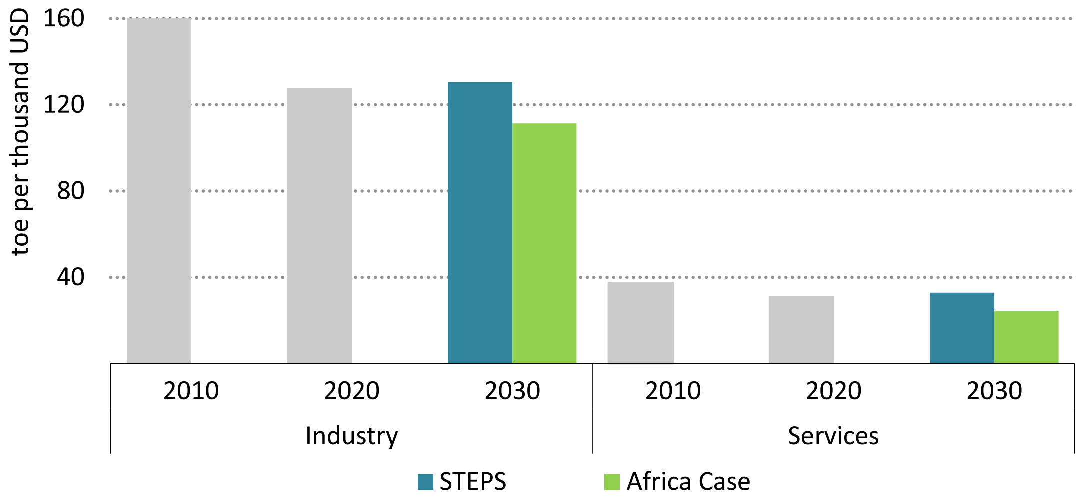


Source: IEA (2022), World Energy Balances (database).

In the industry and services sector, adequate measures have significant impact on improving efficiency

In STEPS, energy intensity increases in the industry and services sectors. However, in the Africa Case, there is a decrease, despite higher economic growth thanks to implementing energy efficiency measures. The shift to clean energy, especially through increased hydropower and mini-grid connections, the use of solar pumps in agriculture, and a higher uptake of modern energy technologies, including electric appliances, contributes to significant efficiency gains in both sectors.

Energy intensity in the industry and services sectors in the greater Horn of Africa, 2010 and 2020, and in the Stated Policies Scenario (STEPS) and Africa Case Scenario, 2030



Note: USD are 2015 USD.
Source: IEA (2022), World Energy Balances (database).

Efficiency gains with benefits for gender, employment and the environment: The case of the textile industry

The textile industry has long been prominent in Ethiopia. The first garment factory was established 80 years ago, and over recent years, more than 65 international textile investment projects have been licensed for foreign investors. The industry is a light industry offering significant opportunities for efficiency gains, for cutting energy demand but also bringing massive employment opportunities and for reducing demand for resources such as water.

Boosting energy efficiency in the textile process is instrumental to improving sector competitiveness and profitability. This can unlock job creation, especially for women who have most of the textile jobs, thereby empowering women and helping to lower unemployment of women, which is often higher than that of men.

In India, the textile sector is the second-largest employer after agriculture. The government has developed an energy efficiency policy package for medium-sized textile companies. The Bureau of Energy Efficiency has identified processes with the largest energy-saving potential. The spinning industry has about 52 million spindles and electricity accounts for up to 15% of the overall cost. Ring frame machines are the main energy consumers, and energy savings potentials have been identified for high-speed ring frame machines and invertors for suction motors. Efficiency measures can also be implemented in the weaving industry or in the dyeing processing industry, which is highly energy and water intensive.

Chapter 5. Energy investment

Key findings

Total energy investment in sub-Saharan Africa has been declining since 2014, with 2020 recording a particularly significant fall.[23] Within the greater Horn of Africa, countries vary greatly in terms of market readiness. Some have innovative business models, such as pay-as-you-go systems, which are emerging to attract more private capital. But the context in others makes it difficult to appreciate the market potential. Improving the investment environment is therefore vital, particularly to reduce the cost of capital in the region.

The Covid-19 pandemic and Russia's invasion of Ukraine have led to governments in the greater Horn region raising significant public debt, putting six of the countries at high risk or in debt distress. This has a significant impact on the energy sector where governments play an outsized role compared to in advanced economies. Governments are now not so able to invest in the sector, but equally the higher level of perceived country risk can translate into a higher cost of capital. Any rise in financing costs makes it more challenging for projects to be considered bankable, particularly in the capital-intensive power sector.

Countries across Africa, including in the greater Horn region are continuing to invest in the oil and gas sector. Russia's invasion of Ukraine has led to African reserves becoming more attractive, thus speeding up investment decisions. Governments are also becoming increasingly involved in critical minerals, which could represent a more sustainable investment as they are integrated in clean energy value chains.

Clean energy investment makes up the bulk of spending to 2030, and under STEPS it increases 2.5-fold from today's levels. Investments in efficiency and electrification increase fourfold under the same scenario and timeframe. However, attaining Sustainable Development Goal (SDG) 7 by 2030 requires a substantial increase in spending. In 2019 (latest data), just over USD 3 billion was spent on access to electricity and clean cooking, but roughly USD 22 billion per year will be needed to reach universal energy access by 2030. Attracting private capital is crucial to reaching these investment levels, particularly to harness all available sources of financing and to switch from relying heavily on public sources.

Countries across the continent also need to substantially increase debt financing opportunities, which is challenging in high-risk areas such as some of the

[23] The IEA investment model is run at sub-Saharan Africa level. Where more granular data was not available, this report cites sub-Saharan Africa figures to indicate the general regional trend and then uses qualitative examples to add more specificity to the Greater Horn region.

countries in the greater Horn. Governments therefore need to maximise the catalytic potential of public finance while not crowding out private capital. They can benefit from diverse sources of financing, grant funding, concessional financing, climate finance, carbon or renewable energy credits, green or diaspora bonds and mobilising domestic institutional investors. Highly concessional debt and equity offerings will also be crucial. A blended finance approach, with emphasis on private capital, is key to ensuring efficient use of public funds and proving commercial viability of clean energy projects.

5.1. Investment overview

There needs to be a fundamental change in the way energy projects are financed so African countries can meet climate targets and secure universal energy access by 2030. Under IEA Sustainable Africa Scenario, total energy investment in sub-Saharan Africa doubles from today's level to 2030, with clean energy accounting for over 70% this amount. Mobilising this level of investment will require risk reduction and greater efforts to attract a broad range of capital providers, notably private capital and domestic financial institutions.

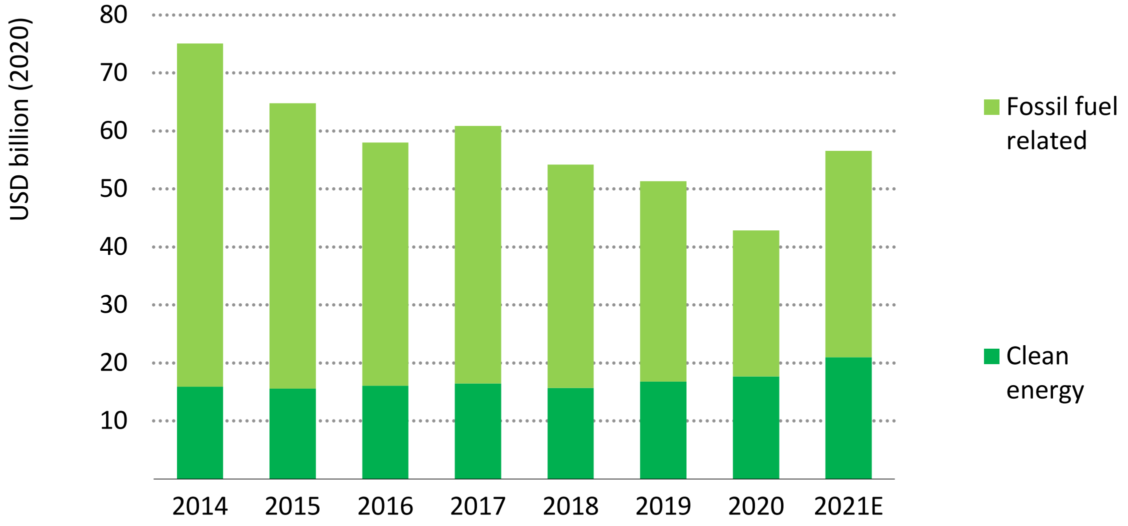
Investment in the energy sector needs to increase dramatically and evolve to include more private capital

Energy investment into sub-Saharan Africa fell by over 16% in 2020 as a result of the Covid-19 pandemic. This was a greater decrease than that of the global average energy investment of 13%. Although investment spending is estimated to have returned to pre-pandemic levels in 2021, it is still far below the highs seen in 2014. After the oil price fell in 2014, oil and gas companies shifted focus away from exploration. This resulted in a fall in investment in Africa that has not been substituted by spending elsewhere in the energy sector. Historically, fossil fuel supply has accounted for most energy investment in sub-Saharan Africa (60% over 2017-2021), largely driven by oil production predicated on foreign off-take.

The clean energy transitions will require a shift away from fossil fuels. This should occur at a slower rate in sub-Saharan Africa than in other parts of the world, reflecting the need to ensure the clean energy transitions do not stifle economic development. Under IEA Sustainable Africa Scenario, by 2030, fossil fuel supply investments still account for about 20% of the total in sub-Saharan Africa as compared to only 13% in advanced economies.

The move away from fossil fuels is accompanied by a significant rise in clean energy spending, which increases 4.5-fold by 2030. Much of this clean energy investment is in the power sector, including in electricity networks, where efforts to support universal access and economic growth spur electricity demand increases. By 2030, investments in the power sector quadruple, with end-use investments, such as efficiency and electrification, increasing sixfold.

Annual energy investments in sub-Saharan Africa, 2014-2021E



Notes: Excluding South Africa. "2021E" denotes estimates.
Source: IEA (2022), Africa Energy Outlook.

To support the massive increase in spending, the type of capital needs to evolve. Energy investments in sub-Saharan Africa have relied heavily on public sources of finance from state-owned enterprises and international financial organisations. State-owned enterprises have dominated oil and gas investments in producer economies and the power sector, particularly electricity grids where private participation is often restricted.

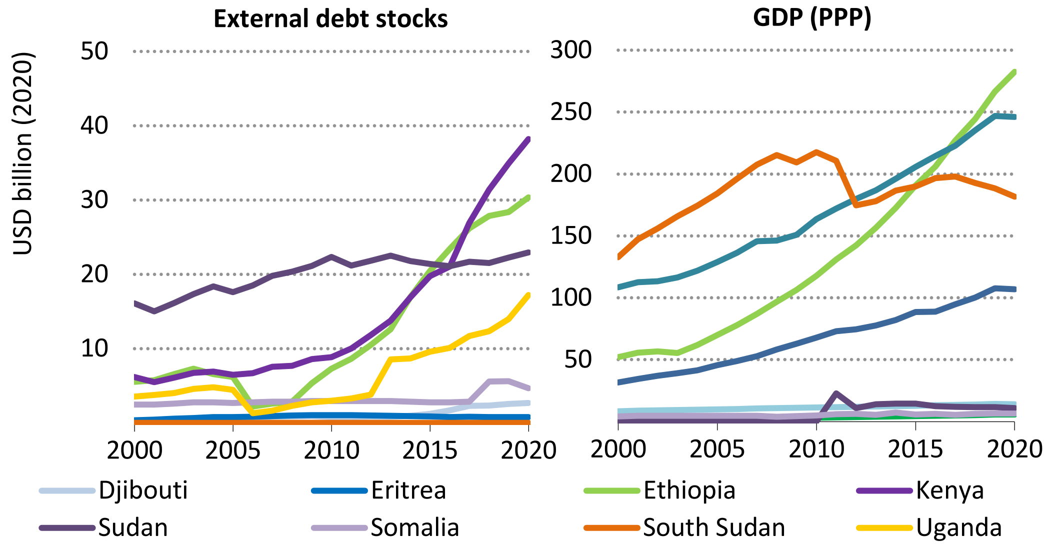
Clean energy transitions rely on a major shift towards private capital. Globally, over 70% of clean energy investment comes from private sources over the 2016-2030 period in IEA Sustainable Africa Scenario. While a sizeable share of this financing is from international private investors, such as power developers, it also relies on increasing the role of domestic financial systems. Domestic banking systems in Africa tend to focus on short-term loans and have limited technical experience with the energy sector. Nevertheless, institutional investors such as pension funds have been growing and can provide long-term capital that is well aligned with energy assets.

Improving the investment environment will be vital to attracting enough affordable capital to the greater Horn of Africa

The Covid-19 pandemic and the economic fallout from Russia's invasion of Ukraine have set back progress on economic and social development across emerging and developing countries, including in the greater Horn of Africa. GDP has fallen across the region; to respond to the pandemic, governments have raised significant public debt.

This increase in debt has left six countries in the region either at high risk or in debt distress as of April 2022.[24] High commodity prices, adding to the supply chain shortages already present at the end of 2021, are driving surging inflation and higher costs of living. Major economies have responded by increasing their interest rates. Countries with high levels of debt are therefore now facing a combination of rising debt service costs, worsened by a strengthening US dollar (which most public debt is denominated in), and surging bond yields.

Key economic indicators of countries in the greater Horn of Africa region, 2000-2020



Source: World Bank (2022), External debt stocks and GDP.

This worsening macroeconomic environment reduces governments' abilities to invest in their energy sector, and also reduces the appeal to private sector investors. High levels of country risk in the greater Horn already limit the involvement of private sector investors, who will be further concerned about the

[24] Eritrea is not included in the International Monetary Fund analysis.

possibility of rising food and fuel prices triggering short-term social unrest in countries with ongoing conflicts or a recent history of instability.

Beyond concerns about stability, investors are also often deterred by the lack of fully developed energy sector regulation or cumbersome bureaucratic processes. The region is often perceived as having long project lead times, which risks resulting in higher costs and lack of government enforcement or implementation capacity. There are also concerns around higher corruption and contract instability risks than in investors' home markets and other regional markets.

Alongside these cross-cutting risks, there are also often specific concerns in each market, such as the chronic foreign currency shortages in Ethiopia. However, countries are taking steps to resolve regulatory obstacles and improve the investment environment. For example, in 2020, the Ethiopian government authorised non-financial firms to offer mobile money services, which will support off-grid solar developments that often rely on pay-as-you-go models. There are also examples of governments reviewing the level of private participation in grid networks. For instance, in January 2022, Africa50 and Power Grid Corporation of India signed an agreement with the Kenyan government to develop the first Independent Power Transmission project in Africa.

The high level of perceived and actual risks in the greater Horn has implications, notably pushing up the cost of capital and raising the bar for projects to be considered viable by financiers. The weighted average cost of capital for energy projects in the region varies. In African countries, higher risk levels result in the economy-wide cost of capital being up to seven times higher than in Europe and North America. This has a detrimental effect on power investments, which are more capital intensive than other energy sectors but where costs are then offset by lower operating expenditure.

Given the higher costs of capital, financing capital-intensive power projects in Africa becomes more expensive and makes it harder for projects to be considered bankable. This is particularly so for projects with smaller transaction sizes that already struggle to attract finance from major international capital providers. Ensuring African governments can access affordable capital, as well as strengthen their own domestic capital markets, will be fundamental to achieving the goals laid out in Sustainable Africa Scenario.

5.2. Extractives sector investments: Hydrocarbons and minerals

Countries in the greater Horn region are exploring for fossil fuels or have undeveloped oil and gas reserves. South Sudan and Sudan are the only countries in the region exporting oil and gas, although Kenya and Uganda have made oil discoveries that are in various stages of development. Most oil and gas projects across Africa are export oriented and are therefore vulnerable to volatility in the market. Recent geopolitical tensions following Russia's invasion of Ukraine have led to an increased call for African resources in the near term. Current high prices may help speed up investment decisions.

There is a risk that long project lead times prevent governments from capitalising on the high prices, and that any projects pushed through now may become unprofitable in a lower price environment. Equally, from a longer-term view, net zero commitments are becoming increasingly widespread among financiers, which may make it harder to access capital for fossil fuel developments in the future. It is therefore important for countries to assess the potential benefits and trade-offs involved in developing the oil and gas sector compared with other sectors. Critical minerals – some of them already exploited in the region – could offer more sustainable opportunities for long-term revenues and further integration into global clean energy technology value chains.

Oil and gas developments are facing an increasingly tight financing environment as capital providers commit to net zero

Uganda, Kenya South Sudan and Sudan all expect oil to play a significant role in their economies over the coming years. Exploration activity is continuing in the region, particularly in the waters off Kenya and Somalia; meanwhile, progress is being made on onshore oil developments in Uganda.

Undeveloped reserves and exploration activity in selected countries in the greater Horn of Africa region

Country	Project	Year of discovery	Stage of development
Uganda	Albertine Graben Oil Fields	2006	Total and China National Offshore Oil Corporation signed an agreement with the Tanzanian and Ugandan governments in April 2021 to build the export pipeline, but financing is yet to be fully secured. First production from Tilenga and Kingfisher projects is planned for 2025. A 60 000 b/d refinery is scheduled to start operations in 2027.
Kenya	Lokichar South Basin	2012	Tullow Oil and Africa Oil have presented a field development plan to the Kenyan government but are seeking further strategic partners before reaching a financial investment decision. Plans for an export pipeline to Lamu are still in the design phase. Poor road quality and quantity limitations have hampered attempts to export oil via trucks to Mombasa.

Country	Project	Year of discovery	Stage of development
Ethiopia	Hilala Complex	1973	Gas was first discovered in the Ogaden region in the 1970s, but operators POLY-GCL signed a production sharing agreement with the government only in 2013. The development plan includes an export pipeline through Djibouti to an export terminal due to be constructed in Damerjog. Commercial production is not expected before 2024.
Offshore Kenya	Lamu Basin	-	After initial optimism, Eni confirmed an offshore oil strike was commercially unviable. The Kenyan government is looking to sign further licence agreements in the area.

Note: The Somali government is seeking to restart offshore exploration activity, which has stalled since companies with blocks in the region declared force majeure in 1991. No notable discoveries have been made in recent years.

These activities are occurring at a time when the global attitude to oil and gas is changing. Historically, fossil fuel supply has accounted for most energy investment in sub-Saharan Africa, largely driven by oil production. However, capital spending on fossil fuel supply in sub-Saharan Africa (excluding South Africa) fell by over 45% between 2014 and 2019, following collapse of the oil price and the subsequent shift to less-risky projects elsewhere.

Attracting capital to fossil fuel projects is becoming increasingly difficult, with more than 80 countries worldwide and the European Union committing to reach net zero emissions by around mid-century. This presents the possibility of a slowdown in global demand for oil and gas, and also reduces the number of public finance entities that invest in fossil fuel projects.

Institutional investors and banks are also committing to net zero targets, notably under the auspices of the Glasgow Financial Alliance for Net Zero, which is a coalition of financial institutions launched in 2021. As evidence of this tightening environment, the East African Crude Oil Pipeline – set to carry Uganda's oil to export via Tanzania – has struggled to raise a necessary USD 5 billion loan. Civil society groups have campaigned against the project and at least 20 major banks, including some of the largest lenders to Total (the main developer of the project) have stated they will not be involved in the pipeline. As options reduce, the pipeline is likely to attract less-favourable financing terms as well as continued delay to its construction.

Countries seeking to develop or maximise (in the case of South Sudan and Sudan) their oil and gas resources need to move rapidly. Commodity prices are currently high, and there is a window of opportunity for Africa to capitalise on global efforts to move away from Russian gas. However, project development timelines in the region have been slow, with a World Bank study finding that project development timelines were over 70% longer than initially projected for oil and gas discoveries in sub-Saharan Africa.

Projects that include significant gas reserves are likely to be appealing to investors, with demand for gas expected to remain relatively robust. Gas projects are also excluded from some fossil fuel financing restrictions if they replace a fuel that is more carbon intensive, which would be the case if they focus on meeting domestic demand and replacing diesel generators.

Given the volatility in global markets, if countries push ahead with oil and gas developments, it will be crucial to ensure the domestic market benefits without resulting in high debt burdens or preventing clean energy developments. Examples of African domestic gas developments already exist, including Tanzania's Songo Songo field and associated gas-to-power project.

In this way, the fossil fuel sector will complement broader economic development rather than risking governments becoming dependent on unreliable revenue from foreign off-take. History suggests that, after major discoveries, some countries have quickly scaled up public investment and accumulated excessive debts based on unrealised future revenues, damaging their economic performance in the process. Avoiding this so-called "pre-source curse" is essential if income from hydrocarbon development is to provide maximum benefit to countries.

Energy transitions in producer economies of South Sudan and Sudan

South Sudan and Sudan face distinct challenges in relation to their fossil fuel reserves. Oil accounts for roughly one-third of South Sudan's GDP, 90% of the government's budget and more than 95% of the country's exports. Oil played a similar role in Sudan before South Sudan's independence. But in 2020, Sudan produces only around 60 000 b/d compared to South Sudan's 160 000 b/d. Production from both countries is

expected to have declined in 2021 and 2022 as a result of OPEC+[25] production cuts, restrictions related to Covid-19 limiting machinery movement and social unrest at Port Sudan.

Neither country has been able to fully exploit its oil reserves. Sudan faced economic sanctions from the United States from 1997 to 2017, which prevented US companies investing in the country. Over the two years that followed independence in 2011, the outbreak of conflict in South Sudan resulted in a halving of production levels. The inability to increase production combined with accusations of mismanaging revenue and high instability risks has meant oil reserves have not translated into broader

[25] The OPEC+ group includes the 13 Organization of the Petroleum Exporting Countries (OPEC) members and ten other oil producing countries including Azerbaijan, Bahrain, Brunei Darussalam, Kazakhstan, Malaysia, Mexico, Oman, Russia, South Sudan and Sudan.

economic development. Oil production has also been destined almost exclusively for foreign markets, meaning it has not contributed to meeting local demand.

Producer economies globally are now facing the need to reassess their economic development pathways. Managing existing oil revenues in a transparent and efficient manner is vital. In South Sudan, loans were raised against future oil sales, and in May 2022, the Central Bank of South Sudan confirmed oil had been sold in advance up to 2027. The terms of the oil-backed loans have not been made public, but it is clear they will severely hamper the government's ability to use oil revenue to support developing other sectors, which is a key priority if climate change targets are to be met.

Given the highly constrained government finances in South Sudan and Sudan, support from international financial institutions and bilateral development assistance will be essential to kick-start developing other sectors, particularly agriculture and electricity.

The critical minerals sector represents large opportunities for economic development

Minerals are essential components in several clean energy technologies – from electricity networks to wind turbines and electric vehicles (EVs). As some countries globally have set net zero objectives, clean energy transitions are gaining momentum, thereby calling for massive deployment of clean energy technologies. The demand for minerals such as rare earth elements for wind turbines, silicon and silver for solar panels, and copper and aluminium for power grids is therefore set to increase up to five times over the next two decades in IEA Sustainable Africa Scenario.

Although there is no shortage of resources in general, questions arise whether supplies of minerals will be available at the right time and at affordable prices. The sector faces several challenges including declining resource quality, long lead times to develop new projects, growing scrutiny of environmental and social performance, and lack of geographical diversity in extraction and processing operations. The production capacity does not yet match the political ambitions of the energy transitions.

Several African states are uniquely positioned to ensure reliable supplies, as they have significant reserves of the needed mineral and metal ores. For example, South Africa is responsible for 70% of global production of platinum and one-fifth of that of manganese. The Democratic Republic of the Congo provides 70% of global cobalt production.

Countries in the greater Horn region are also endowed with considerable mineral resources, and the extractives sector is already a significant source of national revenues. Around 15% of Africa's gold production, or 3% of the world's total, comes from Sudan. Eritrea makes a major contribution to Africa's production of several minerals, accounting for around 20% and 10% of silver and zinc production respectively. Eritrean production of zinc, a resource critical for renewable technologies such as wind turbines, reached 125 kt annually between 2018 and 2020, or 1% of the global production.

To unlock the potential for economic growth of mineral resources, significant investments in exploration, development and associated supply chains are required. These investments decisions must carefully assess and manage the environmental and social impacts of mineral development. These impacts apply for example to emissions from mining and processing, improper waste and water management, inadequate worker safety, abuses of human rights, and corruption.

A complex task is to ensure that local communities benefit from mineral wealth, especially in countries where artisanal and small-scale mining are wide-spread. Supply chain due diligence can be a vital tool for identifying, evaluating, and mitigating risks, and for increasing traceability and transparency from mining operations. Innovation in production technologies, including those that help to reduce water use and energy consumption and to limit waste, play a major role as these will bring operational benefits and contribute to improving the global competitiveness of the region's resources.

Titanium production and geothermal technologies in Kenya

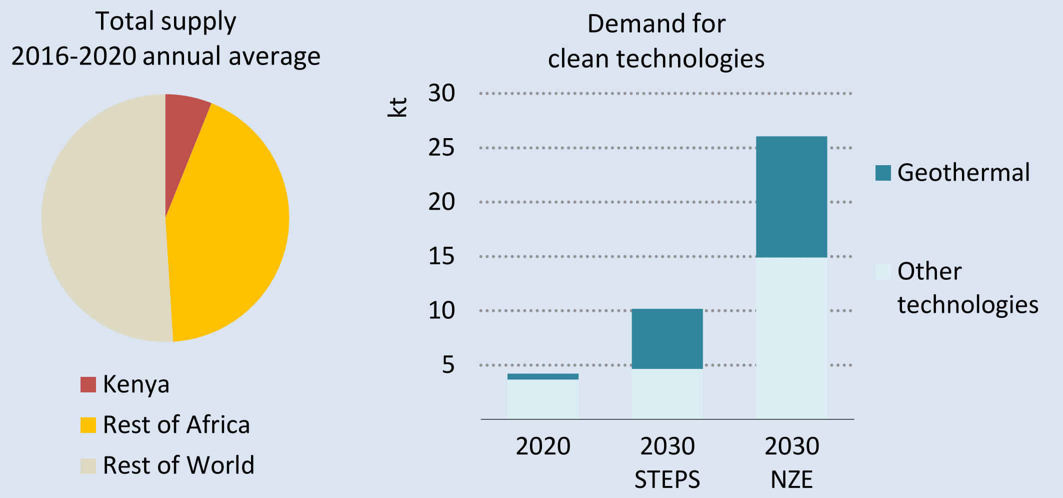
Titanium is used in technologies employed in high-temperature and high-corrosive environments, such as geothermal power plants. These plants generate electricity by powering turbines using underground hydrothermal resources (steam or hot water) piped to the surface. To withstand the harsh operating environment of geothermal reservoirs, specialised steels high in chromium, molybdenum, nickel and titanium are used.

Titanium production has been concentrated in a limited number of countries, with Australia, Canada and South Africa together making up 40% of the global production. In addition, Africa has several producing countries such as Madagascar, Mozambique, Senegal and Sierra Leone, as well as Kenya. The entire African continent produces roughly half the world's titanium. Kenya began extracting titanium in 2014. Since then, it has produced between 5% and 7.5% of global output; it is in the top four African producers and top seven global ones.

The demand for titanium is expected to rise significantly, especially for clean energy technologies such as geothermal. Around 16 GW of geothermal capacities are located in geo-hotspots such as Iceland, Indonesia, the Philippines, Turkey and the United States, as well as Kenya. This technology, providing a low-carbon baseload, is set to increase significantly at the global level and in the greater Horn region.

In IEA climate-driven scenarios, mineral demand from geothermal technologies grows more than seven times over the coming two decades, and geothermal power becomes a major source of demand for nickel, chromium, molybdenum and titanium. This could offer further opportunities for Kenya. It is a country with a well-established geothermal industry and ambitious plans to develop it, where annual production of titanium has reached 250-350 kt in recent years.

Titanium historical total production and projected demand for clean technologies in the Stated Policies Scenario (STEPS) and Net Zero Emissions by 2050 (NZE) Scenario, 2030



Note: Supply is for mined production, which serves to meet demand together with secondary supply sources (e.g. scrap).

Source: IEA analysis based on USGS (2021), IEA (2021), The Role of Critical Minerals in Clean Energy Transitions.

5.3. Clean power, access and end-use investments

Clean power is central to meeting global climate change goals, accounting for the largest part of emissions reductions. In Sustainable Africa Scenario, power sector investments in Africa quadruple by 2030 compared to 2021. Over a third of these investments are spent on access to energy. More than 153 million people across the greater Horn region are still in need of access to affordable, reliable and sustainable electricity. Bridging this gap while simultaneously supporting ambitious economic growth targets will require a mix of on- and off-grid solutions. Solutions present different investment challenges and needs that will require attracting a broad spectrum of capital providers.

Renewable projects have good potential in the greater Horn of Africa, but risk being stifled by utility and network financing challenges

On-grid power supplies in the greater Horn countries already include a large share of renewable power, with hydropower and geothermal resources providing baseload power. There is also great potential across the region to develop solar PV and wind power. The region has already achieved successes in this area. For example, Kenya's Lake Turkana Wind Power Project is the largest onshore wind development in Africa. Falling manufacturing operating costs for solar and wind projects combined with regulatory developments in the region present an opportunity to rapidly scale up the number of renewable projects.

The investment characteristics of renewables projects vary significantly across the region. The level of market readiness influences them considerably, in terms of the renewable sector and the supporting grid infrastructure. There is also a large variance in market readiness across the region. This ranges from countries like Kenya that have developed experience in this area through to Somalia or South Sudan, which have limited grid infrastructure and where security risks have hindered electricity sector development.

The sector therefore requires a range of investors, and will need an increase in private investment. Private developers are playing an increasing role in solar PV and wind power at the utility scale and off grid. Transmission and distribution grids have monopolistic characteristics and depend on state-owned enterprise balance sheets and regulatory planning.

Addressing the risk and return proposition for investing in clean power will be critical to attracting capital. This depends on efforts to improve investment conditions that help to support predictable pipelines of bankable projects and better access to new sources of finance. Given the size of the investment gap and the limits of public balance sheets in the region's countries, clean energy transitions hinge on the ability of these economies to attract much higher levels of private capital and build local capacity for project development. This should be supported by targeting policy and financial efforts in the following areas.

Market planning and regional co-ordination. Conducting market and technology studies is a vital starting block, allowing for creating integrated energy policies and targeted regulatory reforms. Projecting future demand needs, including growth in electric cooking, allows planners to ensure electricity systems are compatible with the associated higher power loads. This can allow for more targeted financial assistance. For example, the East African Rift presents significant geothermal potential, but exploration costs are high and can prohibit investment. The Geothermal Risk Mitigation Facility – funded by African and European donors – is a mechanism that co-finances surface studies (up to 80% of the cost) and drilling programmes (up to 40%) across eastern Africa. Co-ordinating development plans across the region can also ensure the most efficient use of resources. Initiatives such as the African Development Bank's Desert to Power Initiative can support existing co-operation among countries in the region.

Support power utilities. Improving the financial health of power utilities is essential for providing reliable grid electricity services. Half of Africa's utilities are unable to cover their operating costs owing to high network losses, underpricing and poor revenue collection mechanisms. Many are also facing the threat of insolvency. Most countries in the region need comprehensive market reforms to support further investments, including extending connections to new customers. A key element of reforms is including the private sector, to add capital and competition, which can help drive innovative service delivery models. Equally, reforms can support stronger financial governance of utilities, particularly via introducing mechanisms that allow for cost-reflective tariff design. In the meantime, debt restructuring and financial support for providing metering to improve revenue collection may be necessary to free up capital in the short term.

Strengthen transmission and distribution networks. Distribution and transmission networks are often state monopolies. These can act as bottlenecks to development, particularly given the growth in debt. Grants from bilateral and multilateral donors can support network expansion. An example is the World Bank's Somali Electricity Sector Recovery Project, which will use grant financing to reconstruct distribution networks, among other goals. Achieving the necessary scale of investment will require attracting significant private investment that allows for network expansion, while also reducing the burden of maintenance from the utility. This can be achieved via multiple business models, most notably via public-private partnerships or privatisation. The only private company operating in this space in the greater Horn region is Umeme. It holds a concession from the Uganda Electricity Distribution Company Limited to invest, operate and maintain the distribution network for 20 years.

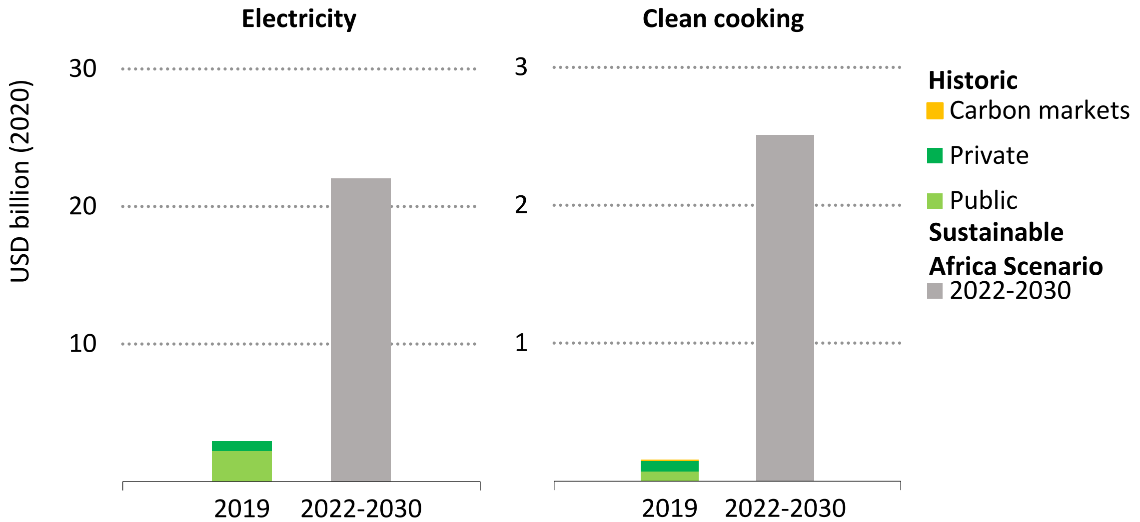
Financial barriers for off-grid projects need reducing. Off-grid projects make up an important part of the renewable power ecosystem in the region. In many cases, they provide the cheapest opportunity to expand access to electricity. However, off-grid developers often struggle to access affordable local currency finance, and therefore face foreign currency exchange risks, particularly in today's strong dollar environment. Development finance institutions can either provide low-cost debt or guarantees to reduce the cost of capital. Equally, concessional finance providers can offer technical assistance grants to improve the energy expertise within local lending institutions and within energy regulators. Not all countries across the region have comprehensive off-grid regulations. This presents instability risks to developers that are also often reflected in higher capital costs.

Meeting ambitious energy access targets requires a considerable effort to increase public and private capital

Although the number of people without access to energy has been decreasing globally since 2013, the Covid-19 pandemic has reversed this trend in 2020-2021. Achieving universal access will require improving financing options and boosting investments, particularly in mini-grids and stand-alone systems. In the greater Horn of Africa, these are the cheapest electricity options for two-thirds of the population without access.

Achieving full access to modern energy in Africa by 2030 would require investing USD 25 billion per year under IEA's Sustainable Africa Scenario. This is equal to around a quarter of the current total energy investment in Africa, but less than 2% of total energy investment globally. Almost half of this investment is needed in just five countries: Democratic Republic of the Congo, Ethiopia, Nigeria, Tanzania and Uganda. Electricity connections alone require USD 22 billion per year in capital spending on grids (mainly distribution networks), generating plants and off-grid solutions. Clean cooking requires just under USD 3 billion per year of investment in clean cookstoves and other end-use equipment. Current investment falls far short of these levels. In 2019, it amounted to just 13% of the average needs for 2022-2030 in the case of electricity and 6% for clean cooking.

Average annual investment in providing access to modern energy in Africa, historic (2019) and under a Sustainable Africa Scenario (2022-2030)



Source: IEA (2022), Africa Energy Outlook.

Ramping up financial flows to these investments will require much stronger local government and international development support, including concessional finance. Multiple high-level commitments on development support have been made, including at the United Nations High-level Dialogue on Energy in September 2021. Governments, private actors, international organisations, non-governmental organisations and other stakeholders committed a total cumulative of over USD 566 billion towards achieving SDG 7 targets by 2030. This represents a substantial increase on previous commitments, though some had already been announced and many do not directly address first-time access in developing economies.

Alongside concessional international public funding, private capital has also played an increasing role thanks to innovative business models. These include pay-as-you-go systems where private companies lease solar products to customers who make periodic payments and can take ownership of the system once the loan is repaid (also known as lease-to-own models). Private actors are involved in solar home systems and mini-grids, although mini-grids are marginally riskier as they rely on broader customer demand and tariff levels. Governments can incentivise private sector involvement via reforms, such as those seen in Ethiopia that led to the first private mini-grid licence being issued in 2019.

Alongside the challenge in raising enough capital for access, finding the projects and facilities by which to disburse this finance in the next 8 years will be difficult, especially given the limited number of projects ready to be financed on the ground. Capacity building will therefore also be a vital focus area, including strengthening capacity in rural electrification and clean cooking agencies. Donor governments can have a significant impact by providing training and funding positions within these agencies, which are often understaffed. Funding the set-up of field offices in rural provinces can also improve the standing of programmes among the local population, who may be mistrustful of centralised efforts.

Regulations to encourage energy-efficient appliances and buildings will support a reduction in the emissions intensity of rising energy demand

Improving energy efficiency and applications that support electrification are a vital part of the energy transitions, by reducing the emissions associated with rising demand. At a global level, the IEA's Sustainable Recovery Plan highlights that one-third of the USD 1 trillion financing required would go into efficiency. However, while energy efficiency investments are often the most cost-effective way to reduce emissions, they can be difficult to finance because of their small-scale nature.

Investments in energy efficiency focus on green buildings, efficient appliances, electric transportation and related infrastructure, and industry. Buildings make up the largest share of energy efficiency investments in sub-Saharan Africa under IEA Sustainable Africa Scenario. This is still a relatively nascent space in the greater Horn, although in Uganda, for example, the government has started developing energy efficiency guidelines to be integrated into Building Control Regulations.

Generally, in the greater Horn region, most emphasis is placed on efficient appliances that can make delivering electricity access or clean cooking more affordable to households. Energy savings more than offset the cost of efficient appliances. Governments can support the roll-out of efficient appliances and equipment via regulations on efficiency labelling and standards.

For example, Kenya introduced product labelling on items such as compact fluorescent lamps and domestic refrigerators in 2014. The East African Community and Southern Africa Development Community are also involved in a joint project, funded by the Global Environment Facility, the Clean Cooling Collaborative and the UK government, to develop a regional policy framework for efficiency standards and labels for cooling equipment, notably lighting appliances (concluded in 2022) and refrigerators and air conditioners (recently launched). Meanwhile, concessional finance providers can give grants or results-based financing programmes, such as the Global LEAP Awards and associated financing programmes, to support developing efficient appliance companies.

Many end-use and efficiency investments depend on the balance sheet of consumers and companies. Therefore, alongside policy developments, governments and donors may also need to focus on providing financial support to consumers to invest in appliances. This can take the form of direct financial support to households, efforts to improve access to affordable local financing, or via pilots for innovative business models within the private sector.

Creating super energy services companies – government bodies that act as an energy services company in public facilities while also supporting the growth of private energy services companies – can be particularly helpful to kick-start energy efficiency projects. The Kenyan government announced the first super energy services company in the greater Horn region in October 2021 with support from the African Development Bank and the United Nations Environment Programme.

5.4. Sources of finance

Mobilising finance from international partners will be essential, given the scale of investment needed to support rising demand and universal access in the greater Horn of Africa. The type of financial involvement from partners will vary. It will be based primarily on the level of market readiness of countries, with those that have a track record in clean energy developments able to access a broader range of capital providers. Ensuring the right providers of capital are matched with risk levels (i.e. avoiding using concessional public capital where commercial capital is available) will allow for the most growth in investment.

Maximising available public finance, including via blended finance mechanisms, will be crucial to support the massive ramp-up of investment

Maximising the catalytic potential of public finance while not crowding out private capital is crucial to financing clean energy projects in Africa. Highly concessional capital, particularly grants, has been used for kick-starting projects that have struggled to reach bankable status in developing countries. Countries in the greater Horn region that do not yet have well-developed electricity sectors and accompanying regulations are likely to be heavily reliant on grant funding to kick-start the sector. This can take the form of technical assistance and knowledge-sharing grants or grants to fund demonstration pilot projects. International partners have developed specialist funds tailored to these challenging investment environments that can provide this type of highly concessional finance, such as the Global Environment Facility's Least Developed Countries Fund.

Multilateral partners such as the World Bank and the Green Climate Fund, as well as bilateral donors, have facilities that offer grants accessible to countries in the region. Highly concessional debt and equity offerings are also pivotal in new sectors or less-developed markets. International partners offer a broad range of mechanisms to access this type of capital, including options tailored to small- and medium-sized enterprises, which can struggle to access international finance because of their smaller size. For example, a group of international donors and foundations launched the Nordic Greater Horn of Africa Opportunities Fund that offers loans to small- and medium-sized enterprises in Somalia, including in the renewable energy space.

Countries where electricity sectors are more developed or that have a strong track record with off-grid investments can use models that rely on a mix of concessional and commercial financing. By emphasising the need to mobilise private capital, these blended finance approaches can ensure the most efficient use of public funds while simultaneously proving commercial viability of clean energy projects.

These types of mechanisms are already widely used in Kenya and Uganda, which were two of the largest recipients of blended finance in 2021. They range from guarantees to first-loss debt and equity. Notable examples include the GET FiT programme in Uganda, which offers blended capital at the project level, or the innovative use of blending approaches of the Eastern and Southern Trade and Development Bank Group, which uses a mix of public and commercial finance in its own lending base and its investments. These mechanisms are most likely to succeed in countries with clear energy sector strategies and regulations, alongside well-resourced regulators to oversee the sector.

Governments can take advantage of a growing range of financing sources for clean energy projects

Mobilising the required level of finance will mean taking advantage of new sources of financing for clean energy. Global climate commitments have resulted in a new avenue for energy transition financing since the signing of the Paris Agreement in 2015. Economic development in many African countries is increasing the pool of available domestic capital, although most domestic financial markets remain underdeveloped and ill equipped to channel this capital into clean energy projects.

Climate finance. Developed countries jointly provided and mobilised just under USD 80 billion in climate finance in 2019, of which about USD 5 billion, or 6%, went to energy projects in Africa. African governments can benefit from climate finance via several channels, notably bilateral support, multilateral development bank financing, climate-specific funds such as the Green Climate Fund and mobilised private capital. Climate finance has already been used to support projects in the region. These include grants to support the Ugandan government in creating a framework to increase private investment in off-grid projects, a grant as part of a broader financing package for the Assela Wind Farm in Ethiopia and debt instruments for the Kenyan government to reinforce the transmission network. Within the greater Horn region, Kenya has been the largest recipient of climate finance flows so far, likely because of the country's more developed financial system and lower perceived risks. Other countries are increasingly taking advantage of the opportunity presented by increased attention on climate finance, particularly given the co-benefits of many climate-related projects including around health and biodiversity. Outside of the energy sector, countries already experiencing the severe impacts of climate change, including Sudan, are benefiting from adaptation finance via mechanisms such as the Green Climate Fund.

Carbon or renewable energy credits. As companies around the world pledge to reduce their carbon footprints, the market for renewable energy certificates (tradeable market-based instruments that demonstrate property rights over renewable power generation) has grown significantly. Over the last 5 years, several new forms of initiatives have emerged to expand the sellers of these certificates, which are generally large projects. In 2017, Energy Peace Partners launched Peace-Renewable Energy Certificates that specifically support high-impact renewable energy projects in fragile, energy-poor countries. A Peace-Renewable Energy Certificates agreement was signed to finance a solar plant, managed by the International Organization for Migration, to power a hospital in Malakal, South Sudan, in 2022. In January 2021, a group of multiple stakeholders led by South Pole and Positive Capital Partners launched the Decentralised-

Renewable Energy Certificates initiative that allows corporations to buy certificates from verified decentralised energy providers. Beyond renewable energy certificates, countries in the greater Horn region can also benefit from the development of international carbon markets, specifically those outlined under Article 6 of the Paris Agreement. Countries can use the sale of carbon credits to fund mitigation and adaptation projects, but governments first need to create the necessary regulations to oversee the verification and monitoring of projects. Tapping into the growing body of climate mitigation and adaptation financing could be useful for some of the most complex investment environments in the region.

Domestic banks and institutional investors. African capital markets remain small, with many financial systems lacking the depth and technical expertise to provide long-term financing to clean energy projects. Nevertheless, institutional investor capital is growing in Africa, particularly via pension funds, whose long-term investment outlooks are well aligned with the needs of the energy sector. The African Union has endorsed this approach, calling for institutional investors to allocate 5% of their portfolios to infrastructure assets. However, achieving this requires regulatory changes. For example, in Kenya, the Retirement Benefit Authority increased the threshold for pension fund allocations to infrastructure assets from 5% to 10% in 2021. This resulted in the Kenya Pension Funds Investment Consortium committing to spending over Kenyan shillings 25 billion (about USD 230 billion) on infrastructure over 2021-2026. Donors can also provide technical assistance grants to increase the expertise at the necessary investors and regulatory agencies.

Sustainable or diaspora bonds. The sustainable debt market, led by green bonds and loans, grew to over USD 1.7 trillion globally in 2021. This is a massive increase from less than USD 100 billion in 2015. While clean power has been a focus area for sustainable debt, there is not yet a strong correlation between sustainable debt issuances and clean energy investment. Clean energy investment has not experienced the same rapid growth, and sustainable debt issuances are heavily weighted to advanced economies. Sustainable bonds and loans can serve as an effective way for local finance institutions, utilities or energy companies to raise lower-cost debt. Several financial institutions in West Africa have successfully launched such issuances, notably the West African Development Bank in Togo, which raised EUR 750 million under a sustainability bond at the lowest interest rate the bank had ever achieved in the bond market. Equally, African governments have sought to harness diaspora capital for strategic projects via diaspora bonds. These efforts have had mixed results so far, with the most successful example being in 2017 when the Nigerian government raised USD 330 million via diaspora bonds for infrastructure projects. Clean energy investments are well suited to this type of financing. The Kenyan government's plan to issue a diaspora bond for green infrastructure in the coming years will likely provide a yardstick for the potential of this type of financing.

Annex A. Region & country profiles

Regional profile

Greater Horn	Historical Data 2000	2010	2019	2020	STEPS 2025	2030	2020-2030 CAAGR	Africa Case 2025	2030	2020-2030 CAAGR
Energy Demand										
Total Energy Supply (Mtoe)	66	88	117	118	150	202	6%	122	145	2%
Total Energy Supply (PJ)	2 768	3 685	4 902	4 927	6 289	8 448	6%	5 112	6 055	2%
Total Final Consumption (Mtoe)	49	68	88	90	119	154	5%	96	104	1%
Share of renewables in TES	89%	84%	80%	81%	77%	75%	-1%	72%	65%	-2%
Share of modern renewables in TFC	4%	5%	6%	7%	11%	13%	7%	15%	23%	13%
Total energy supply (Mtoe)	**66**	**88**	**117**	**118**	**150**	**202**	**5%**	**122**	**145**	**2%**
Coal	0.1	0.2	0.8	1.0	1.1	1.8	0.1	0.9	1.4	4%
Oil	6.9	11.4	18.5	18.1	28.0	38.4	0.1	26.7	36.6	7%
Gas	-	-	-	-	0.2	0.5		0.2	0.8	
Hydro	0.5	1.4	2.7	2.9	4.7	6.9	0.1	6.1	10.0	13%
Bioenergy	58.3	74.1	90.3	91.2	109.3	134.8	0.0	78.1	68.1	-3%
Wind	-	0.0	0.2	0.2	0.1	0.5	0.1	0.3	0.9	19%
Solar PV	0.0	0.0	0.0	0.0	0.2	0.4	0.3	0.5	0.7	39%
Geothermal	0.4	0.9	4.5	4.4	6.6	18.5	0.2	9.3	26.0	20%
Total energy supply / capita	**0.4**	**0.4**	**0.4**	**0.4**	**0.5**	**0.5**	**3%**	**0.4**	**0.4**	**0%**
Power generation output (TWh)	**10**	**23**	**46**	**47**	**74**	**123**	**9%**	**95**	**179**	**13%**
Coal	-	-	-	-	0.2	0.7		-	-	
Oil	4.2	6.0	6.8	6.3	6.0	6.3	0%	4.0	8.0	2%
Gas	-	-	-	-	0.9	2.5		1.0	3.9	
Hydro	5.7	15.8	31.4	33.4	54.9	80.8	9%	71.0	116.1	13%
Bioenergy	0.2	0.4	0.3	0.3	0.1	0.7	8%	0.1	1.2	14%
Wind	-	0.0	2.2	1.9	2.7	4.9	10%	5.3	8.6	16%
Solar	0.0	0.0	0.3	0.3	1.2	5.4	32%	3.1	11.0	42%
Geothermal	0.4	1.1	5.2	5.1	7.6	21.5	16%	10.9	30.2	20%
Final energy consumption (Mtoe)										
Total final consumption	**49**	**68**	**88**	**90**	**119**	**154**	**5%**	**96**	**104**	**1%**
Coal	0.1	0.2	0.8	1.0	1.0	1.6	5%	0.9	1.4	4%
Oil	5.2	10.5	16.2	15.4	26.2	36.6	9%	25.4	34.5	8%
Electricity	0.7	1.5	3.3	3.3	6.0	10.0	12%	8.0	15.0	16%
Bioenergies	43.2	55.8	68.1	70.5	85.9	105.8	4%	61.4	53.3	-3%
Industry	**3**	**5**	**7**	**8**	**11**	**15**	**7%**	**11**	**16**	**8%**
Coal	0.1	0.2	0.8	1.0	1.0	1.6	5%	0.9	1.4	
Oil	0.9	2.4	2.3	2.1	3.9	4.9	9%	4.0	5.3	
Electricity	0.3	0.5	1.1	1.1	1.8	2.8	10%	1.9	3.4	
Bioenergies	1.7	2.4	2.7	3.4	4.0	5.5	5%	4.0	6.1	
Transport	**3**	**6**	**11**	**11**	**19**	**27**	**8%**	**17**	**23**	**6%**
Oil products	2.7	5.8	11.3	10.9	18.8	26.9		16.7	21.5	
Electricity	-	-	-	-	0.0	0.2		0.3	1.1	
Other					0.0	0.0		0.0	0.0	
Buildings & Agriculture	**43**	**56**	**70**	**71**	**82**	**102**	**4%**	**61**	**57**	**-2%**
Oil	1.2	1.7	2.1	2.0	1.2	2.2		2.5	4.8	
Electricity	0.4	1.0	2.2	2.2	3.0	5.1	8%	4.7	8.6	13%
Bioenergies	41.5	53.4	65.4	67.1	78.1	94.6		54.3	43.4	
Non-Energy Uses	**0**	**1**	**0**	**0**	**1**	**1**		**1**	**1**	
Oil	0	1	0	0	1	1		1	1	
CO2 Emissions										
Total CO2 Emissions (Mt)	**19**	**37**	**59**	**57**	**78**	**108**	**6%**	**76**	**100**	**5%**
CO2 Emission Intensities										
TES CO2/GDP (tCO2 per $1000, PPP)	0.06	0.06	0.07	0.06	0.07	0.07	0%	0.06	0.06	-1%
TFC CO2/GDP (tCO2 per $1000, PPP)	0.04	0.05	0.06	0.06	0.06	0.06	1%	0.06	0.05	-1%
TES CO2/capita (tCO2)	0.12	0.17	0.21	0.20	0.24	0.29	3%	0.23	0.27	2%
Power sector intensity (g CO2/Wh)	0.37	0.22	0.17	0.15	0.08	0.06		0.08	0.05	
CO2 emissions by sector										
Power sector	4	5	8	7	6	8	0%	8	10	2%
Final demand	15	31	51	50	71	99	6%	68	90	5%
CO2 -energy emissions by fuel										
Oil	19	36	56	53	71	97	5%	71	97	5%
Gas			0	0	0	1		0	1	
Coal	0	1	3	4	6	9	10%	6	9	10%

Sources: IEA (2022), World Energy Balances (database), Greenhouse Gas Emissions from Energy (database).

Country profile: Djibouti

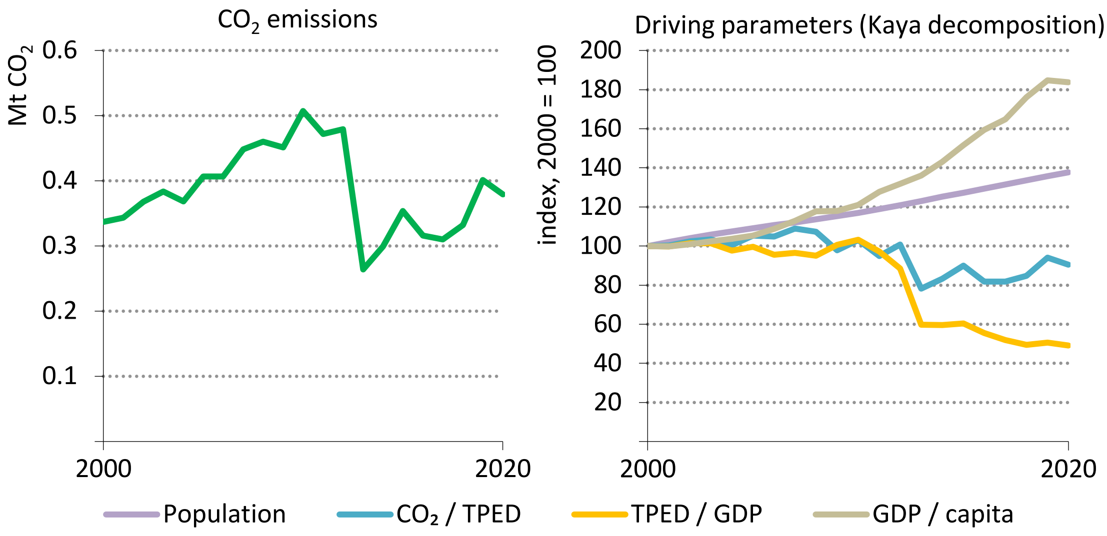
Djibouti	Energy supply (ktoe)						Shares (%)
	2000	2005	2010	2015	2019	2020	2020
Total energy supply	**214**	**245**	**313**	**250**	**272**	**267**	**100%**
Coal	-	-	-	-	-	-	0%
Oil	117	139	196	123	138	131	49%
Natural gas	-	-	-	-	-	-	0%
Hydro	-	-	-	-	-	-	0%
Bioenergy	97	106	118	127	134	135	51%
Total final consumption	**128**	**136**	**180**	**169**	**206**	**201**	**100%**
Coal	-	-	-	-	-	-	0%
Oil	73	70	103	78	104	97	48%
Electricity	11	19	25	34	43	44	22%
Bioenergy	44	47	52	56	59	60	30%
Industry	**-**	**-**	**-**	**-**	**-**	**-**	**0%**
Coal	-	-	-	-	-	-	0%
Oil	-	-	-	-	-	-	0%
Electricity	-	-	-	-	-	-	0%
Bioenergy	-	-	-	-	-	-	0%
Transport	**27**	**27**	**37**	**37**	**48**	**42**	**100%**
Oil	27	27	37	37	48	42	100%
Buildings	**96**	**103**	**112**	**127**	**152**	**154**	**100%**
Oil	41	37	35	37	50	50	32%
Electricity	11	19	25	34	43	44	29%
Bioenergy	44	47	52	56	59	60	39%

Djibouti	Electricity generation (GWh)						Shares (%)
	2000	2005	2010	2015	2019	2020	2020
Total generation	**180**	**298**	**379**	**178**	**126**	**125**	**100%**
Coal	-	-	-	-	-	-	0%
Oil	180	298	379	177	125	125	100%
Natural gas	-	-	-	-	-	-	0%
Renewables	-	-	-	1	1	1	0%
Hydro	-	-	-	-	-	-	0%
Bioenergy	-	-	-	-	-	-	0%
Wind	-	-	-	-	-	-	0%
Solar PV	-	-	-	-	-	-	0%

Djibouti	CO_2 emissions (kt)						Shares (%)
	2000	2005	2010	2015	2019	2020	2020
Total CO_2	**337**	**407**	**507**	**354**	**401**	**379**	**100%**
Coal	-	-	-	-	-	-	0%
Oil	337	407	507	354	401	379	100%
Natural gas	-	-	-	-	-	-	0%
Power sector	**142**	**220**	**298**	**138**	**112**	**107**	**28%**
Final consumption	**195**	**186**	**209**	**216**	**290**	**272**	**72%**

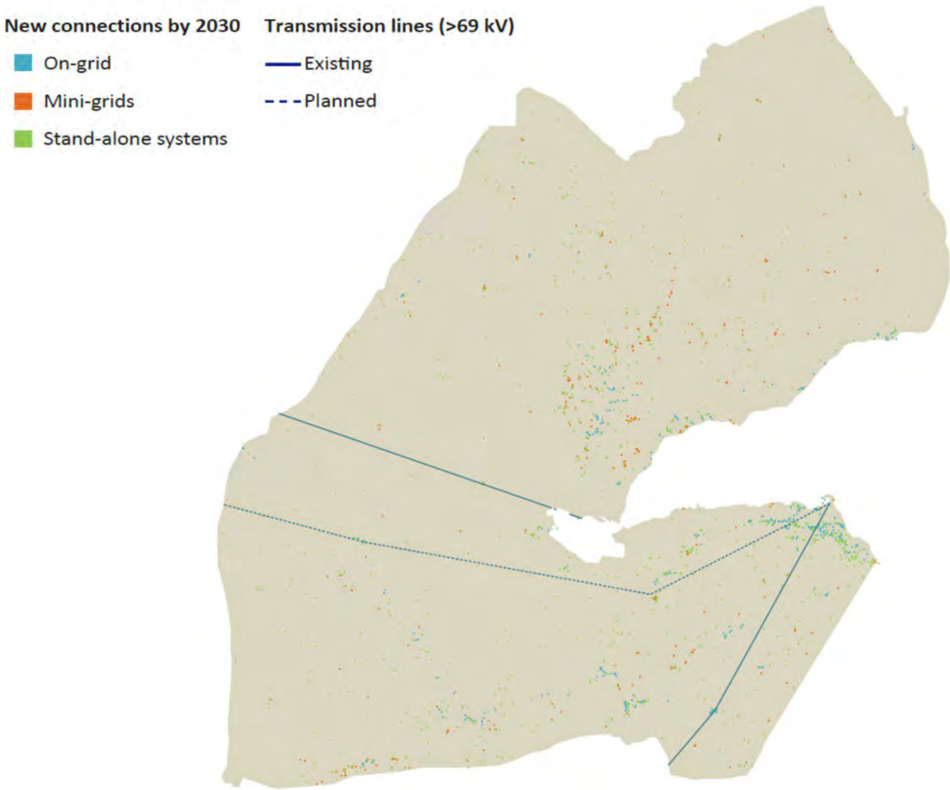
Sources: IEA (2022), World Energy Balances (database), Greenhouse Gas Emissions from Energy (database).

Energy-related CO_2 emissions and driving parameters, Djibouti



Source: IEA (2022), Greenhouse Gas Emissions from Energy (database).

Electricity access solutions by type in the Africa Case, Djibouti



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Source: IEA (2022), World Energy Balances (database) and IEA analysis

Country profile: Eritrea

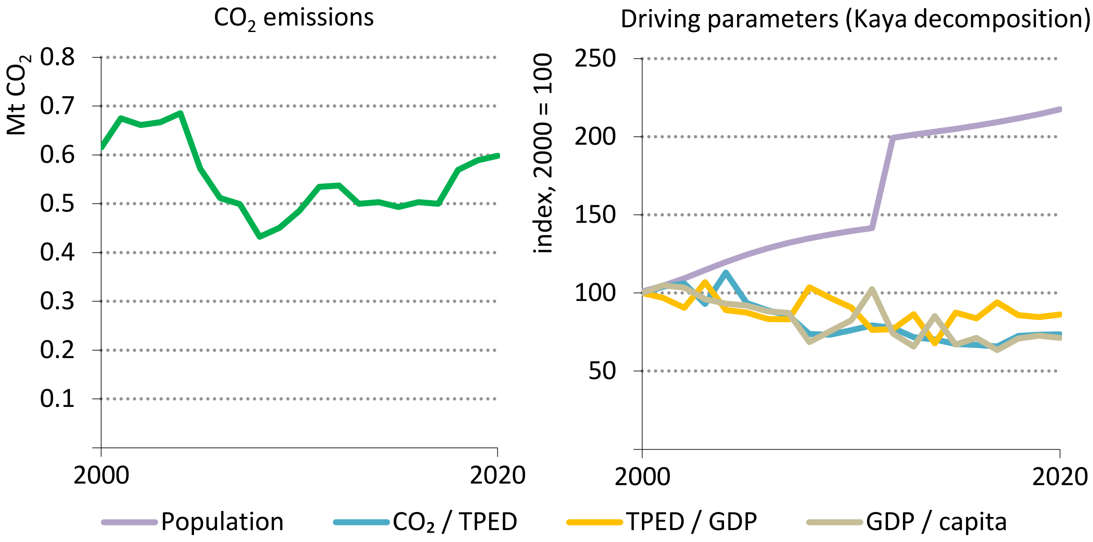
Eritrea – Energy supply (ktoe)	2000	2005	2010	2015	2019	2020	Shares (%) 2020
Total energy supply	**708**	**703**	**733**	**844**	**924**	**936**	**100%**
Coal	-	-	-	-	-	-	0%
Oil	200	203	152	163	196	198	21%
Natural gas	-	-	-	-	-	-	0%
Hydro	-	-	-	-	-	-	0%
Bioenergy	508	500	581	680	726	737	79%
Total final consumption	**533**	**477**	**492**	**560**	**632**	**638**	**100%**
Coal	-	-	-	-	-	-	0%
Oil	113	113	75	89	104	102	16%
Electricity	14	19	22	20	26	27	4%
Bioenergy	405	344	396	451	502	509	80%
Industry	**18**	**15**	**11**	**12**	**12**	**12**	**100%**
Coal	-	-	-	-	-	-	0%
Oil	12	10	6	7	7	7	60%
Electricity	6	5	6	5	5	5	40%
Bioenergy	-	-	-	-	-	-	0%
Transport	**67**	**59**	**46**	**62**	**73**	**71**	**100%**
Oil	67	59	46	62	73	71	100%
Buildings	**443**	**387**	**432**	**482**	**540**	**548**	**100%**
Oil	30	28	20	16	17	17	3%
Electricity	8	14	17	15	21	22	4%
Bioenergy	405	344	396	451	502	509	93%

Eritrea – Electricity generation (GWh)	2000	2005	2010	2015	2019	2020	Shares (%) 2020
Total generation	**218**	**297**	**323**	**271**	**363**	**375**	**100%**
Coal	-	-	-	-	-	-	0%
Oil	217	296	319	264	350	361	96%
Natural gas	-	-	-	-	-	-	0%
Renewables	1	1	4	7	13	15	4%
Hydro	-	-	-	-	-	-	0%
Bioenergy	-	-	-	-	-	-	0%
Wind	-	-	2	2	2	2	1%
Solar PV	-	-	-	-	-	-	0%

Eritrea – CO_2 emissions (kt)	2000	2005	2010	2015	2019	2020	Shares (%) 2020
Total CO_2	**615**	**572**	**486**	**493**	**589**	**598**	**100%**
Coal	-	-	-	-	-	-	0%
Oil	615	572	486	493	589	598	100%
Natural gas	-	-	-	-	-	-	0%
Power sector	**283**	**274**	**267**	**233**	**294**	**309**	**52%**
Final consumption	**332**	**298**	**218**	**260**	**295**	**289**	**48%**

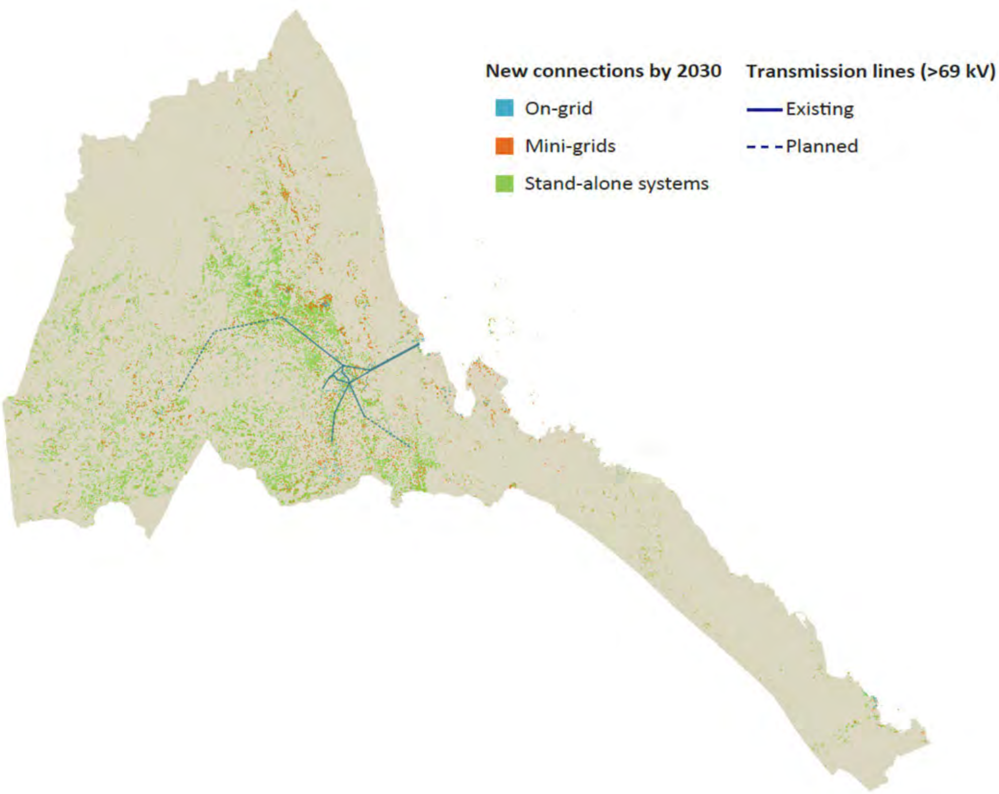
Sources: IEA (2022), World Energy Balances (database), Greenhouse Gas Emissions from Energy (database).

Energy-related CO_2 emissions and driving parameters, Eritrea



Source: IEA (2022), Greenhouse Gas Emissions from Energy (database).

Electricity access solutions by type in the Africa Case, Eritrea



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Source: IEA (2022), World Energy Balances (database) and IEA analysis.

Country profile: Ethiopia

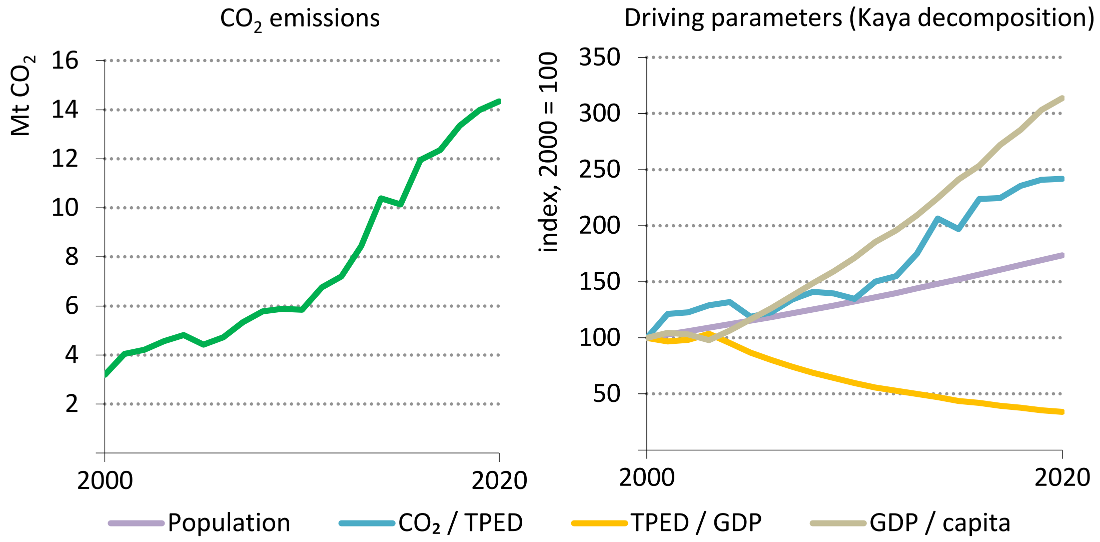
Ethiopia							
	Energy supply (ktoe)						Shares (%)
	2000	2005	2010	2015	2019	2020	2020
Total energy supply	**24 608**	**28 679**	**33 342**	**39 551**	**44 638**	**45 578**	**100%**
Coal	-	-	31	292	450	477	1%
Oil	1 087	1 488	1 874	2 956	4 008	4 085	9%
Natural gas	-	-	-	-	-	-	0%
Hydro	142	244	424	832	1 239	1 277	3%
Bioenergy	23 375	26 947	30 998	35 405	38 887	39 683	87%
Total final consumption	**23 393**	**27 269**	**31 489**	**37 154**	**41 604**	**42 697**	**100%**
Coal	-	-	31	292	450	477	1%
Oil	1 080	1 486	1 883	2 966	4 007	4 086	10%
Electricity	122	201	330	642	922	965	2%
Bioenergy	22 191	25 582	29 245	33 253	36 224	37 168	87%
Industry	**297**	**445**	**640**	**1 225**	**1 817**	**1 876**	**100%**
Coal	-	-	31	292	450	477	25%
Oil	250	363	489	737	1 014	1 024	55%
Electricity	47	81	120	196	353	374	20%
Bioenergy	-	-	-	-	-	-	0%
Transport	**524**	**693**	**884**	**1 541**	**2 356**	**2 430**	**100%**
Oil	524	693	884	1 541	2 356	2 430	100%
Buildings	**22 528**	**26 080**	**29 899**	**34 294**	**37 330**	**38 292**	**100%**
Oil	263	378	444	594	536	533	1%
Electricity	75	119	210	446	569	591	2%
Bioenergy	22 191	25 582	29 245	33 253	36 224	37 168	97%

Ethiopia							
	Electricity generation (GWh)						Shares (%)
	2000	2005	2010	2015	2019	2020	2020
Total generation	**1 674**	**2 845**	**4 980**	**10 455**	**15 038**	**15 496**	**100%**
Coal	-	-	-	-	-	-	0%
Oil	23	12	31	4	5	5	0%
Natural gas	-	-	-	-	-	-	0%
Renewables	1 651	2 833	4 949	10 451	15 033	15 491	100%
Hydro	1 646	2 833	4 931	9 674	14 404	14 850	96%
Bioenergy	-	-	-	-	-	-	0%
Wind	-	-	-	759	609	608	4%
Solar PV	5	-	18	-	-	-	0%

Ethiopia							
	CO_2 emissions (kt)						Shares (%)
	2000	2005	2010	2015	2019	2020	2020
Total CO_2	**3 201**	**4 428**	**5 841**	**10 140**	**13 988**	**14 339**	**100%**
Coal	-	-	122	1 157	1 782	1 890	13%
Oil	3 201	4 428	5 719	8 983	12 206	12 449	87%
Natural gas	-	-	-	-	-	-	0%
Power sector	**19**	**10**	**55**	**3**	**4**	**4**	**0%**
Final consumption	**3 182**	**4 418**	**5 786**	**10 137**	**13 984**	**14 335**	**100%**

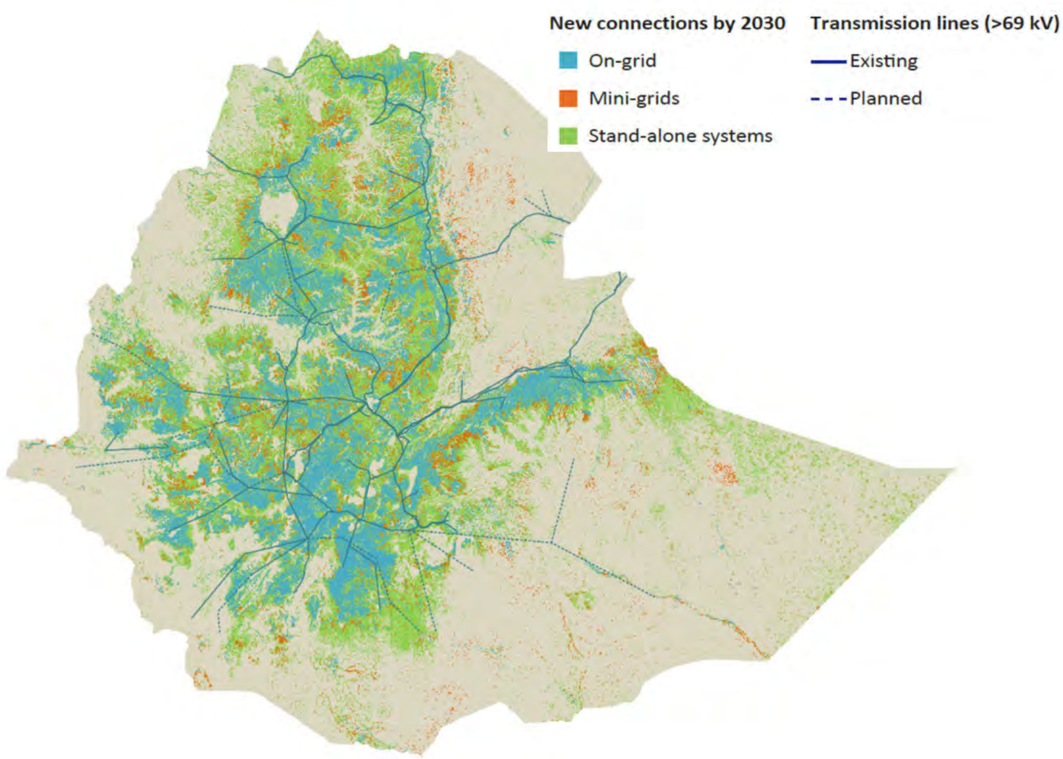
Sources: IEA (2022), World Energy Balances (database), Greenhouse Gas Emissions from Energy (database).

Energy-related CO_2 emissions and driving parameters, Ethiopia



Source: IEA (2022), Greenhouse Gas Emissions from Energy (database).

Electricity access solutions by type in the Africa Case, Ethiopia



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Source: IEA (2022), World Energy Balances (database) and IEA analysis.

Country profile: Kenya

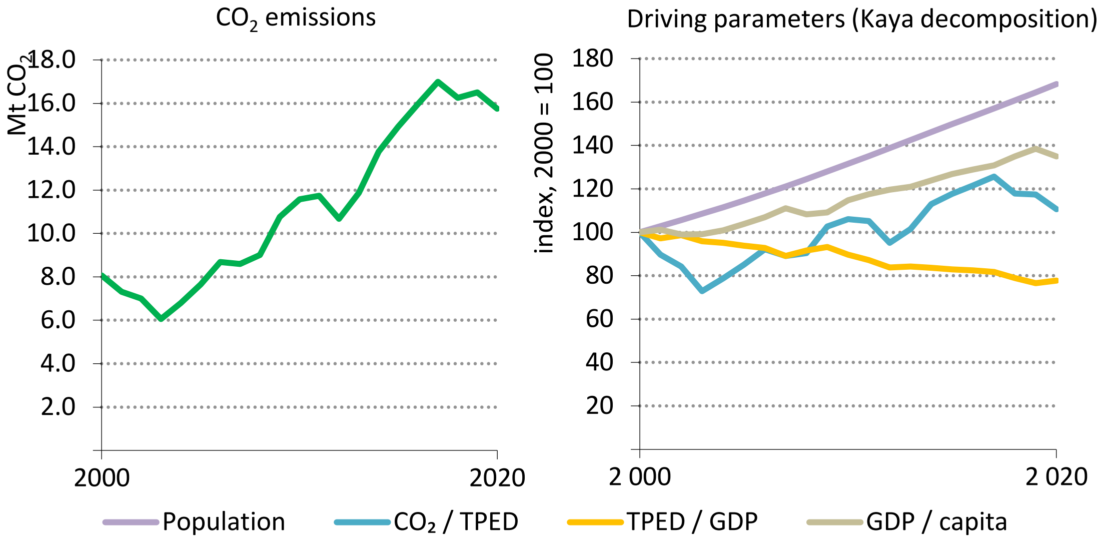
Kenya							
	Energy supply (ktoe)						Shares (%)
	2000	2005	2010	2015	2019	2020	2020
Total energy supply	**14 087**	**16 171**	**19 497**	**25 469**	**28 436**	**28 590**	**100%**
Coal	66	89	165	495	364	515	2%
Oil	2 587	2 409	3 717	4 368	5 163	4 838	17%
Natural gas	-	-	-	-	-	-	0%
Hydro	114	261	277	298	276	364	1%
Bioenergy	10 951	12 550	14 426	16 411	17 991	18 399	64%
Total final consumption	**9 561**	**10 723**	**13 036**	**16 028**	**17 797**	**17 951**	**100%**
Coal	66	89	165	495	364	515	3%
Oil	1 912	1 912	2 808	3 957	4 706	4 440	25%
Electricity	315	396	507	691	774	770	4%
Bioenergy	7 268	8 326	9 556	10 885	11 953	12 225	68%
Industry	**638**	**824**	**1 038**	**1 387**	**1 133**	**1 110**	**100%**
Coal	66	89	165	495	364	515	46%
Oil	392	485	582	527	375	212	19%
Electricity	180	250	291	365	395	382	34%
Bioenergy	-	-	-	-	-	-	0%
Transport	**899**	**954**	**1 637**	**2 651**	**3 560**	**3 449**	**100%**
Oil	899	954	1 637	2 651	3 560	3 449	100%
Buildings	**7 952**	**8 901**	**10 305**	**11 910**	**13 003**	**13 296**	**100%**
Oil	550	429	533	699	671	682	5%
Electricity	135	145	216	325	379	388	3%
Bioenergy	7 268	8 326	9 556	10 885	11 953	12 225	92%

Kenya							
	Electricity generation (GWh)						Shares (%)
	2000	2005	2010	2015	2019	2020	2020
Total generation	**4 011**	**5 710**	**7 157**	**9 736**	**11 557**	**11 614**	**100%**
Coal	-	-	-	-	-	-	0%
Oil	2 124	1 506	2 586	1 412	1 313	754	6%
Natural gas	-	-	-	-	-	-	0%
Renewables	1 887	4 204	4 571	8 324	10 243	10 860	94%
Hydro	1 325	3 039	3 224	3 463	3 205	4 233	36%
Bioenergy	133	163	270	230	148	147	1%
Wind	-	-	17	60	1 563	1 331	11%
Solar PV	429	1 002	1 057	4 521	5 235	5 060	44%

Kenya							
	CO_2 emissions (kt)						Shares (%)
	2000	2005	2010	2015	2019	2020	2020
Total CO_2	**8 059**	**7 650**	**11 575**	**14 931**	**16 508**	**15 755**	**100%**
Coal	261	354	654	1 960	1 440	2 042	13%
Oil	7 798	7 296	10 921	12 971	15 068	13 713	87%
Natural gas	-	-	-	-	-	-	0%
Power sector	**1 930**	**1 371**	**2 350**	**1 285**	**1 246**	**709**	**4%**
Final consumption	**5 872**	**6 070**	**9 022**	**13 646**	**15 262**	**15 046**	**96%**

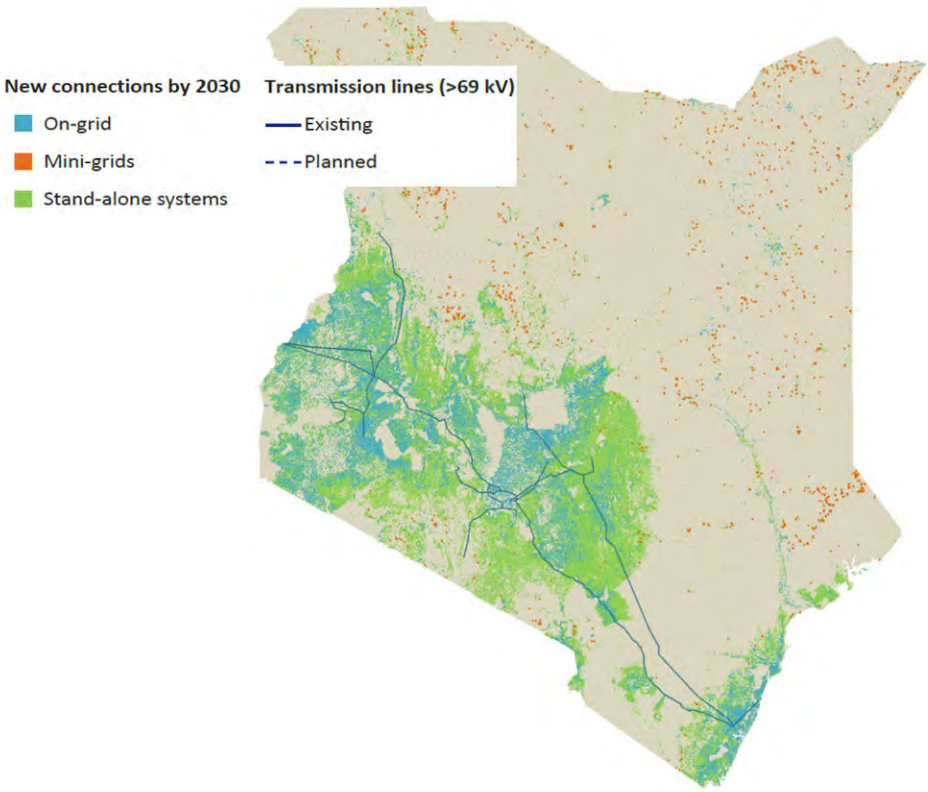
Sources: IEA (2022), World Energy Balances (database), Greenhouse Gas Emissions from Energy (database).

Energy-related CO_2 emissions and driving parameters, Kenya



Source: IEA (2022), Greenhouse Gas Emissions from Energy (database).

Electricity access solutions by type in the Africa Case, Kenya



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Source: IEA (2022), World Energy Balances (database) and IEA analysis.

Country profile: Somalia

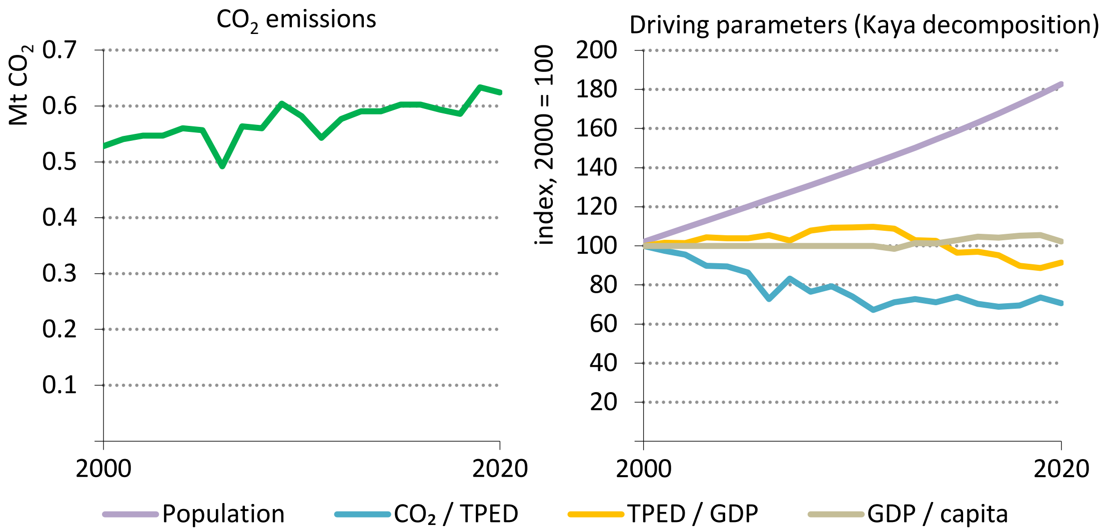
Somalia							
	Energy supply (ktoe)						Shares (%)
	2000	2005	2010	2015	2019	2020	2020
Total energy supply	**2 641**	**3 228**	**3 925**	**4 078**	**4 303**	**4 422**	**100%**
Coal	-	-	-	-	-	-	0%
Oil	173	182	190	190	208	205	5%
Natural gas	-	-	-	-	-	-	0%
Hydro	-	-	-	-	-	-	0%
Bioenergy	2 468	3 046	3 735	3 887	4 092	4 211	95%
Total final consumption	**1 682**	**1 935**	**2 209**	**2 444**	**2 707**	**2 775**	**100%**
Coal	-	-	-	-	-	-	0%
Oil	102	101	103	93	94	93	3%
Electricity	10	12	13	17	21	22	1%
Bioenergy	1 570	1 823	2 093	2 334	2 592	2 660	96%
Industry	**39**	**38**	**50**	**48**	**49**	**49**	**100%**
Coal	-	-	-	-	-	-	0%
Oil	35	34	44	41	41	41	83%
Electricity	3	4	4	5	6	7	14%
Bioenergy	1	1	1	2	2	2	4%
Transport	**46**	**46**	**41**	**37**	**29**	**28**	**100%**
Oil	46	46	41	37	29	28	100%
Buildings	**1 597**	**1 851**	**2 119**	**2 359**	**2 629**	**2 698**	**100%**
Oil	21	21	17	15	24	24	1%
Electricity	7	8	9	12	15	16	1%
Bioenergy	1 569	1 822	2 092	2 332	2 590	2 658	99%

Somalia							
	Electricity generation (GWh)						Shares (%)
	2000	2005	2010	2015	2019	2020	2020
Total generation	**235**	**273**	**310**	**390**	**495**	**539**	**100%**
Coal	-	-	-	-	-	-	0%
Oil	235	273	310	383	453	472	88%
Natural gas	-	-	-	-	-	-	0%
Renewables	-	-	-	7	42	67	12%
Hydro	-	-	-	-	-	-	0%
Bioenergy	-	-	-	-	-	-	0%
Wind	-	-	-	-	2	2	0%
Solar PV	-	-	-	-	-	-	0%

Somalia							
	CO_2 emissions (kt)						Shares (%)
	2000	2005	2010	2015	2019	2020	2020
Total CO_2	**528**	**557**	**582**	**603**	**633**	**625**	**100%**
Coal	-	-	-	-	-	-	0%
Oil	528	557	582	603	633	625	100%
Natural gas	-	-	-	-	-	-	0%
Power sector	**221**	**253**	**272**	**320**	**345**	**339**	**54%**
Final consumption	**307**	**304**	**310**	**283**	**289**	**285**	**46%**

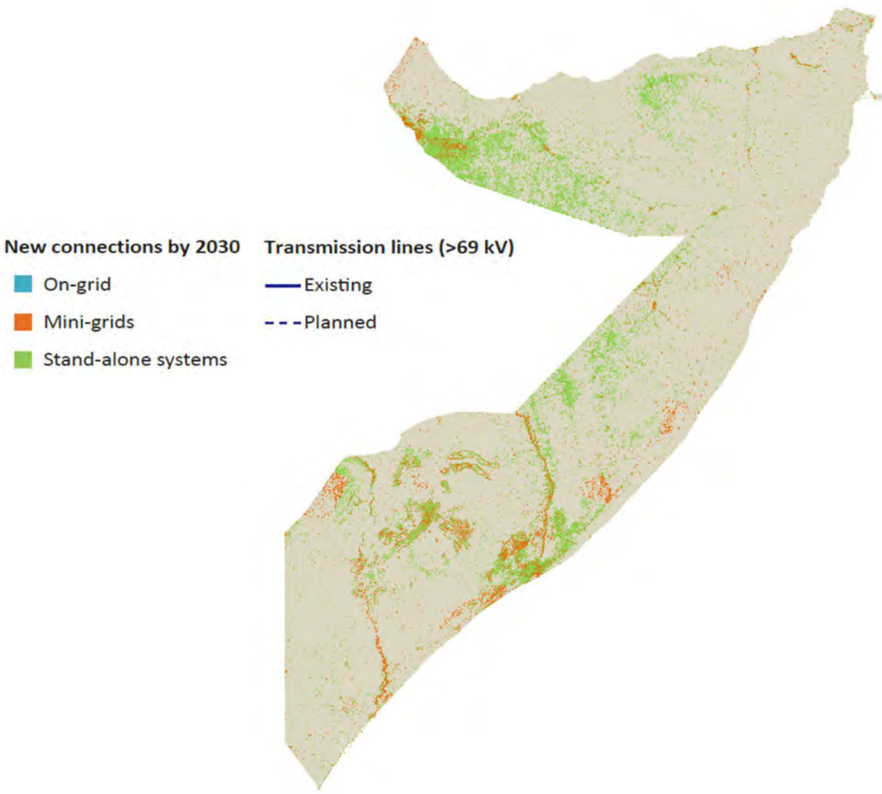
Sources: IEA (2022), World Energy Balances (database), Greenhouse Gas Emissions from Energy (database).

Energy-related CO_2 emissions and driving parameters, Somalia



Source: IEA (2022), Greenhouse Gas Emissions from Energy (database).

Electricity access solutions by type in the Africa Case, Somalia



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Source: IEA (2022), World Energy Balances (database) and IEA analysis

Country profile: South Sudan

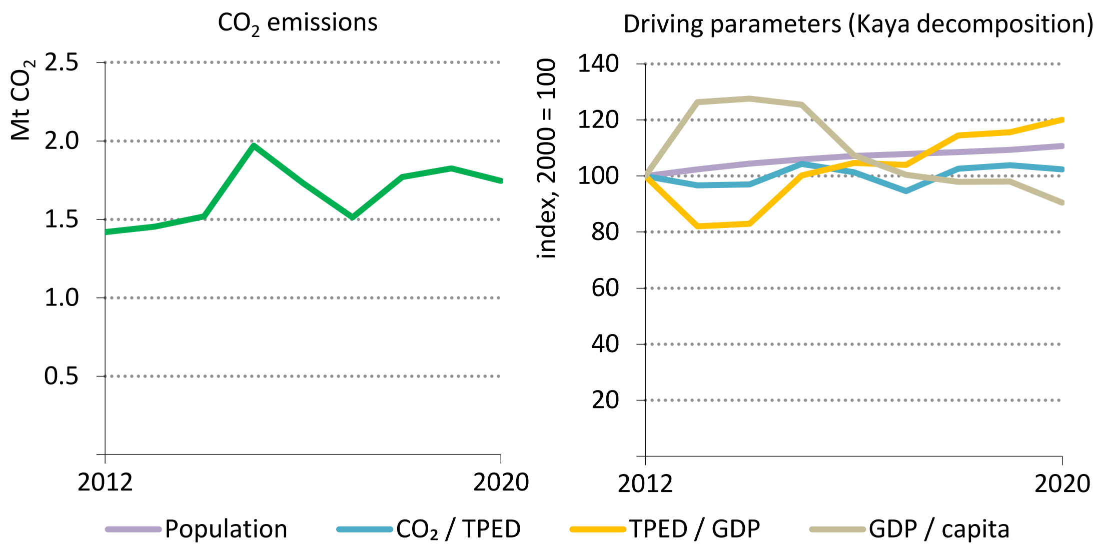
South Sudan Energy supply (ktoe)	2012	2015	2019	2020	Shares (%) 2020
Total energy supply	638	**849**	**790**	**766**	**100%**
Coal	-	-	-	-	0%
Oil	445	646	598	572	75%
Natural gas	-	-	-	-	0%
Hydro	-	-	-	-	0%
Bioenergy	193	202	191	194	25%
Total final consumption	536	**585**	**593**	**571**	**100%**
Coal	-	-	-	-	0%
Oil	339	379	362	339	59%
Electricity	33	45	45	44	8%
Bioenergy	164	161	186	188	33%
Industry	6	**8**	**27**	**26**	**100%**
Coal	-	-	-	-	0%
Oil	6	8	10	9	37%
Electricity	-	-	17	16	63%
Bioenergy	-	-	-	-	0%
Transport	**310**	**334**	**315**	**294**	**100%**
Oil	310	334	315	294	100%
Buildings	**220**	**243**	**251**	**251**	**100%**
Oil	23	37	37	35	14%
Electricity	33	45	28	27	11%
Bioenergy	164	161	186	188	75%

South Sudan Electricity generation (GWh)	2012	2015	2019	2020	Shares (%) 2020
Total generation	445	**578**	**557**	**558**	**100%**
Coal	-	-	-	-	0%
Oil	443	576	546	547	98%
Natural gas	-	-	-	-	0%
Renewables	2	2	11	11	2%
Hydro	-	-	-	-	0%
Bioenergy	-	-	-	-	0%
Wind	-	-	-	-	0%
Solar PV	2	2	11	11	0%

South Sudan CO_2 emissions (kt)	2012	2015	2019	2020	Shares (%) 2020
Total CO_2	1 419	**1 969**	**1 825**	**1 746**	**100%**
Coal	-	-	-	-	0%
Oil	1 419	1 969	1 825	1 746	100%
Natural gas	-	-	-	-	0%
Power sector	180	**596**	**469**	**470**	**27%**
Final consumption	**1 040**	**1 161**	**1 110**	**1 039**	**60%**
Other energy industries	-	**212**	**246**	**237**	**14%**

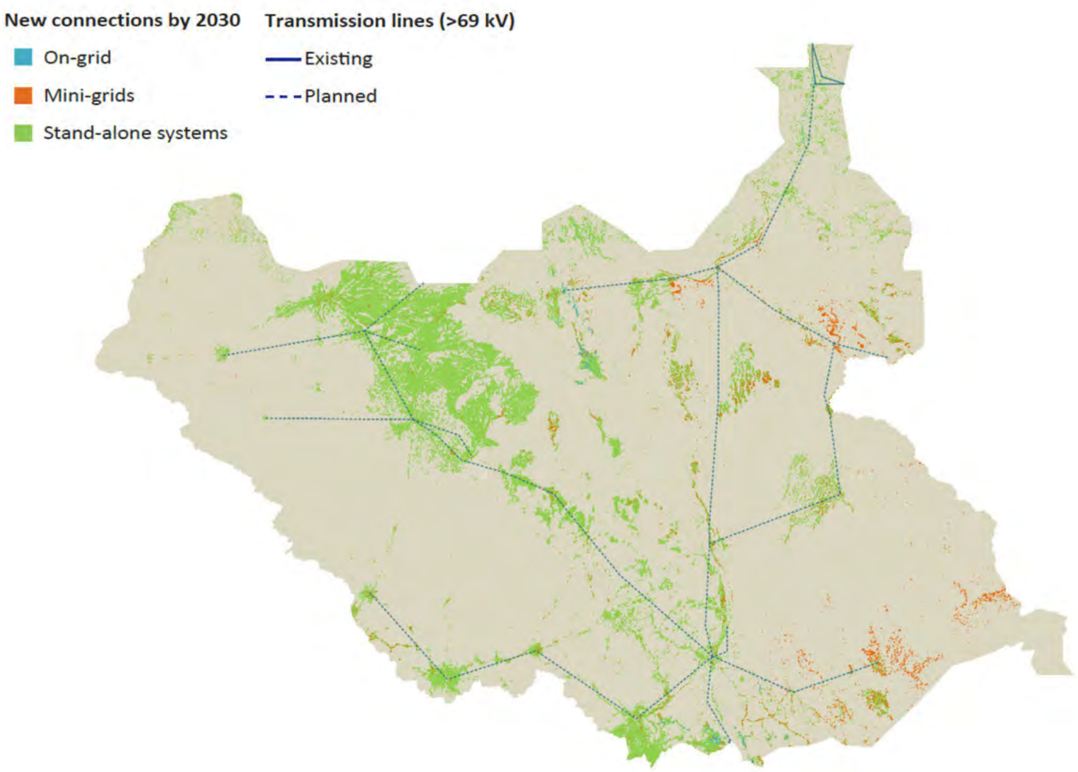
Sources: IEA (2022), World Energy Balances (database), Greenhouse Gas Emissions from Energy (database).

Energy-related CO_2 emissions and driving parameters, South Sudan



Source: IEA (2022), Greenhouse Gas Emissions from Energy (database).

Electricity access solutions by type in the Africa Case, South Sudan



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Source: IEA (2022), World Energy Balances (database) and IEA analysis.

Country profile: Sudan

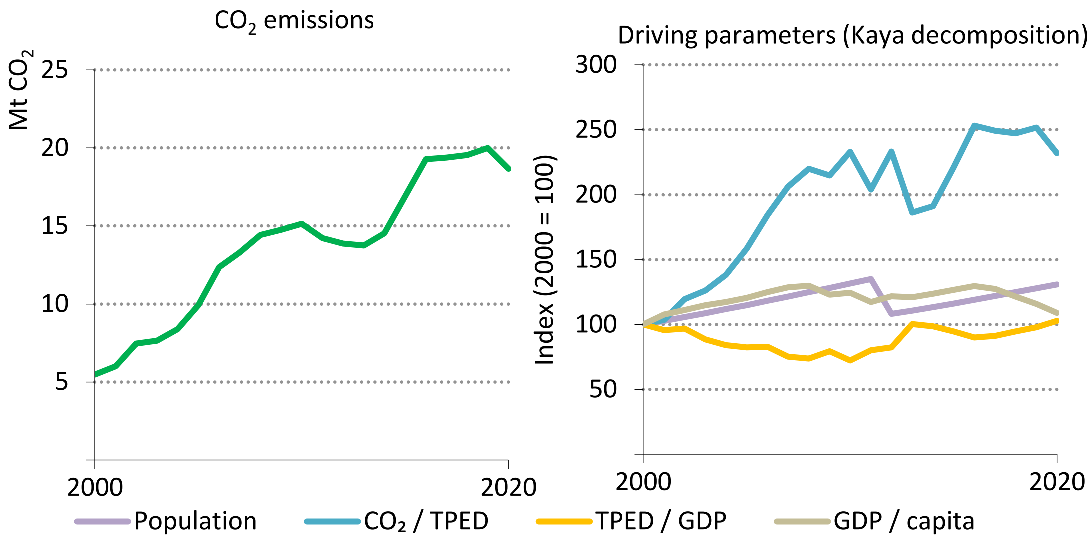
Sudan Energy supply (ktoe)	2000	2005	2010	2015	2019	2020	Shares (%) 2020
Total energy supply	**13 296**	**15 186**	**15 745**	**18 536**	**19 265**	**19 501**	**100%**
Coal	-	-	-	-	-	-	0%
Oil	2 329	3 694	4 168	6 452	6 387	6 334	32%
Natural gas	-	-	-	-	-	-	0%
Hydro	102	108	533	724	842	883	5%
Bioenergy	10 865	11 383	11 043	11 360	12 036	12 283	63%
Total final consumption	**7 481**	**9 299**	**11 909**	**12 087**	**13 283**	**12 959**	**100%**
Coal	-	-	-	-	-	-	0%
Oil	1 484	2 511	4 754	4 350	4 966	4 512	35%
Electricity	185	260	518	958	1 184	1 184	9%
Bioenergy	5 811	6 528	6 637	6 778	7 133	7 263	56%
Industry	**1 198**	**1 210**	**1 915**	**1 336**	**1 351**	**1 272**	**100%**
Coal	-	-	-	-	-	-	0%
Oil	169	304	1 061	465	495	448	35%
Electricity	53	43	76	130	151	145	11%
Bioenergy	975	864	778	741	704	679	53%
Transport	**869**	**1 583**	**2 770**	**3 178**	**3 771**	**3 427**	**100%**
Oil	869	1 583	2 770	3 178	3 771	3 427	100%
Buildings	**5 265**	**6 357**	**6 840**	**7 433**	**8 010**	**8 121**	**100%**
Oil	297	476	539	568	548	498	6%
Electricity	132	217	442	828	1 033	1 038	13%
Bioenergy	4 836	5 664	5 859	6 037	6 429	6 585	81%

Sudan Electricity generation (GWh)	2000	2005	2010	2015	2019	2020	Shares (%) 2020
Total generation	**2 569**	**3 826**	**7 499**	**11 165**	**13 680**	**14 296**	**100%**
Coal	-	-	-	-	-	-	0%
Oil	1 386	2 565	1 297	2 745	3 892	4 025	28%
Natural gas	-	-	-	-	-	-	0%
Renewables	1 183	1 261	6 202	8 420	9 788	10 271	72%
Hydro	1 183	1 261	6 202	8 420	9 788	10 271	72%
Bioenergy	-	-	-	-	-	-	0%
Wind	-	-	-	-	-	-	0%
Solar PV	-	-	-	-	-	-	0%

Sudan CO_2 emissions (kt)	2000	2005	2010	2015	2019	2020	Shares (%) 2020
Total CO_2	**5 486**	**9 928**	**15 132**	**16 902**	**19 998**	**18 674**	**100%**
Coal	-	-	-	-	-	-	0%
Oil	5 486	9 928	15 132	16 902	19 998	18 674	100%
Natural gas	-	-	-	-	-	-	0%
Power sector	**1 319**	**2 378**	**1 087**	**3 953**	**5 254**	**5 290**	**28%**
Final consumption	**4 020**	**7 179**	**13 488**	**12 770**	**14 585**	**13 245**	**71%**

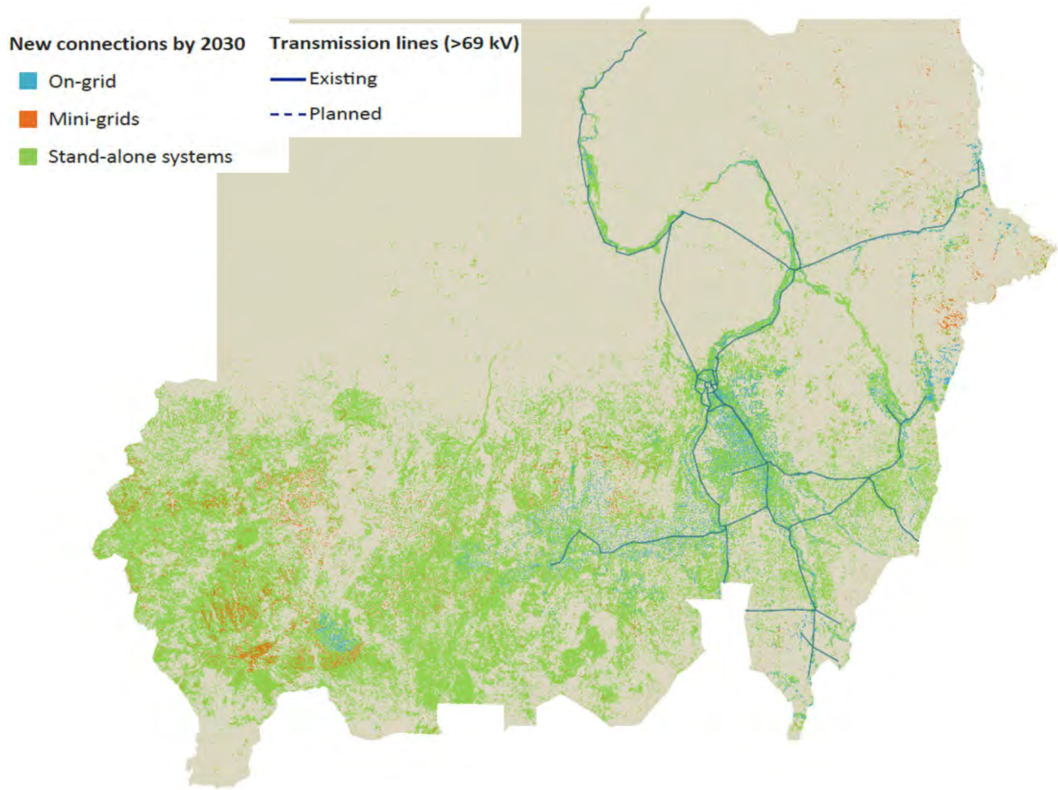
Sources: IEA (2022), World Energy Balances (database), Greenhouse Gas Emissions from Energy (database).

Energy-related CO_2 emissions and driving parameters, Sudan



Source: IEA (2022), Greenhouse Gas Emissions from Energy (database).

Electricity access solutions by type in the Africa Case, Sudan



Note: This map is without prejudice to the status of or sovereignty over any territory, to the delimitation of international frontiers and boundaries and to the name of any territory, city or area.
Source: IEA (2022), World Energy Balances (database) and IEA analysis.

Country profile: Uganda

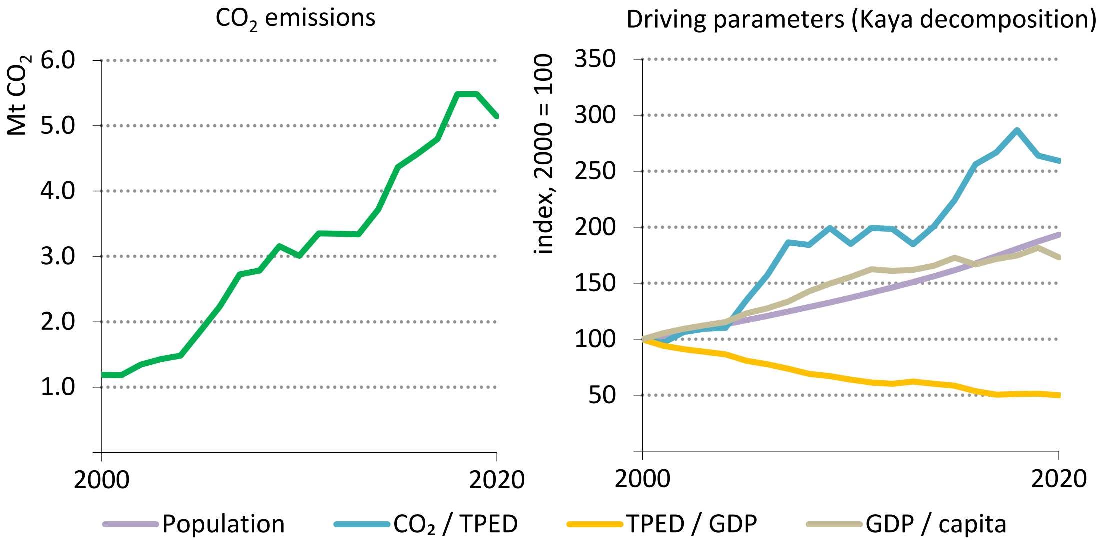
Uganda – Energy supply (ktoe)	2000	2005	2010	2015	2019	2020	Shares (%) 2020
Total energy supply	**10 566**	**12 271**	**14 449**	**17 286**	**18 467**	**17 621**	**100%**
Coal	-	-	-	-	-	-	0%
Oil	439	602	1 094	1 463	1 850	1 730	10%
Natural gas	-	-	-	-	-	-	0%
Hydro	133	158	128	266	347	351	2%
Bioenergy	9 994	11 510	13 226	15 554	16 259	15 530	88%
Total final consumption	**6 390**	**7 471**	**8 626**	**10 962**	**11 533**	**12 431**	**100%**
Coal	-	-	-	-	-	-	0%
Oil	402	599	748	1 450	1 829	1 716	14%
Electricity	62	40	47	216	278	281	2%
Bioenergy	5 925	6 832	7 831	9 296	9 425	10 435	84%
Industry	**827**	**1 296**	**1 796**	**2 970**	**2 585**	**3 274**	**100%**
Coal	-	-	-	-	-	-	0%
Oil	78	159	198	350	387	377	12%
Electricity	35	10	11	136	186	187	6%
Bioenergy	715	1 128	1 586	2 484	2 012	2 710	83%
Transport	**302**	**339**	**421**	**915**	**1 175**	**1 131**	**100%**
Oil	302	339	421	915	1 175	1 131	100%
Buildings	**5 250**	**5 825**	**6 370**	**7 027**	**7 709**	**7 966**	**100%**
Oil	13	90	90	135	203	147	2%
Electricity	27	30	35	80	92	94	1%
Bioenergy	5 211	5 704	6 245	6 812	7 414	7 725	97%

Uganda – Electricity generation (GWh)	2000	2005	2010	2015	2019	2020	Shares (%) 2020
Total generation	**1 587**	**1 958**	**2 772**	**3 556**	**4 346**	**4 445**	**100%**
Coal	-	-	-	-	-	-	0%
Oil	6	68	1 109	79	89	58	1%
Natural gas	-	-	-	-	-	-	0%
Renewables	1 581	1 890	1 663	3 477	4 257	4 387	99%
Hydro	1 551	1 839	1 485	3 092	4 036	4 081	92%
Bioenergy	30	47	156	353	104	188	4%
Wind	-	-	-	-	-	-	0%
Solar PV	-	-	-	-	-	-	0%

Uganda – CO_2 emissions (kt)	2000	2005	2010	2015	2019	2020	Shares (%) 2020
Total CO_2	**1 190**	**1 860**	**3 009**	**4 363**	**5 484**	**5 142**	**100%**
Coal	-	-	-	-	-	-	0%
Oil	1 190	1 860	3 009	4 363	5 484	5 142	100%
Natural gas	-	-	-	-	-	-	0%
Power sector	**3**	**58**	**779**	**59**	**78**	**51**	**1%**
Final consumption	**1 187**	**1 802**	**2 229**	**4 304**	**5 406**	**5 092**	**99%**

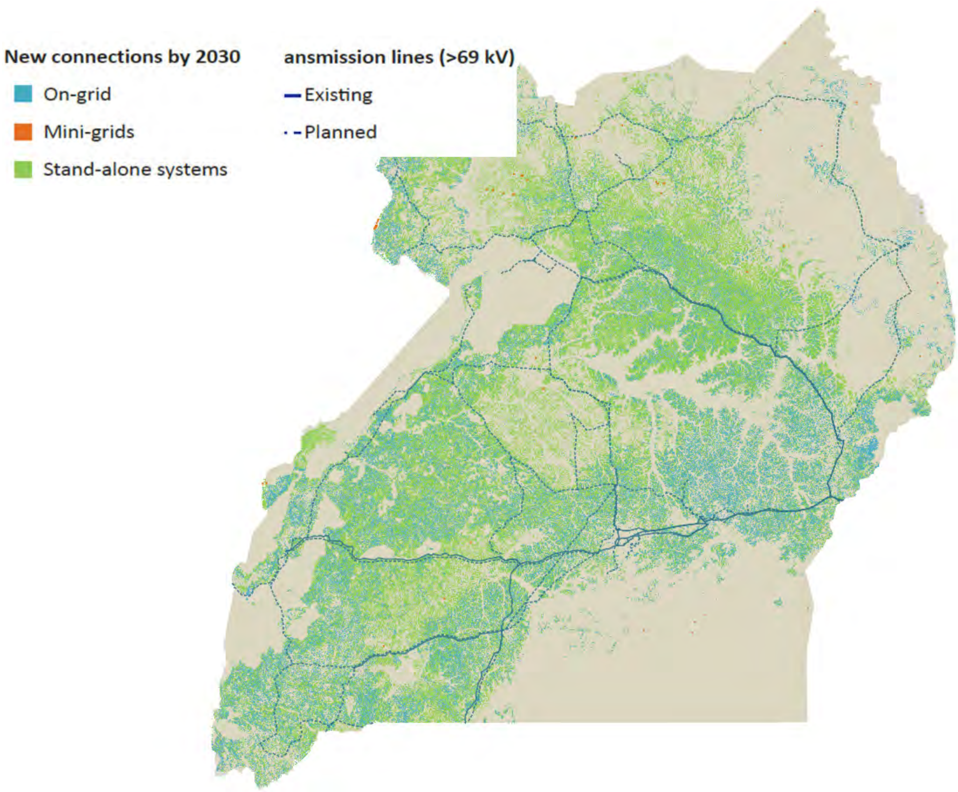
Sources: IEA (2022), World Energy Balances (database), Greenhouse Gas Emissions from Energy (database).

Energy-related CO_2 emissions and driving parameters, Uganda



Source: IEA (2022), Greenhouse Gas Emissions from Energy (database).

Electricity access solutions by type in the Africa Case, Uganda



Note: This map is without prejudice to the status of or sovereignty over any territory, to the delimitation of international frontiers and boundaries and to the name of any territory, city or area.
Source: IEA (2022), World Energy Balances (database) and IEA analysis

Annex B. Data references

Eritrea

Data for Eritrea are available starting in 1992. Prior to 1992, data are included in Ethiopia. At the time of preparation of the 2022 edition of the World Energy Statistics and Balances, no official data were available from Eritrea from 2019 to 2020. Official data were also not available for most products and flows for 2018. As a consequence, the statistics and balances for 2018 to 2019 have been mostly estimated based on data from the United Nations Statistical Division (UNSD). Data for 2020 have been estimated based on population growth for biomass and household consumption, and GDP growth for other products. In the 2022 edition of the World Energy Statistics and Balances, most products and flows were revised from 2011 to 2017 based on new data provided by the Ministry of Energy and Mines.

Sources 2011 to 2020

Direct communication with the Ministry of Energy and Mines, Asmara.

The United Nations Energy Statistics Database, United Nations Statistical Division (UNSD), New York.

OAG (2021), *Origin-Destination of Commercial Flights* (database), OAG Aviation, Luton, www.oag.com/analytics/traffic-analyser.

The African Statistical Yearbook, African Development Bank Group, Abidjan, 2021.

AFREC Energy questionnaire, African Energy Commission (AFREC), Algiers, 2011 to 2019.

Renewable Energy Statistics 2021, International Renewable Energy Agency (IRENA), Abu Dhabi, 2021.

IEA Secretariat estimates.

Sources 1992 to 2010

Direct communication with the Ministry of Energy and Mines, Asmara.

IEA Secretariat estimates.

Ethiopia

Data for Ethiopia are available starting in 1971. Ethiopia is one of the ten countries that benefit from EU Support to IEA Data for Affordable and Sustainable Energy System for Sub-Saharan Africa. Ethiopia energy data include Eritrea from 1971 to 1991. From 1992 onwards, the two countries are reported separately. Data are reported according to the Ethiopian financial year. For instance, 2020 data refers to the fiscal year starting on 1st of July 2020 and ending on 30th of June 2021, or 2013 in Ethiopian fiscal years. At the time of preparation of the 2022 edition of the World Energy Statistics and Balances, limited 2020 data were available from official sources. 2020 data for several products are therefore entirely estimated by the IEA Secretariat based on economic indicators.

Sources 2012 to 2020

Direct communication with the Ministry of Water, Irrigation, and Energy, Addis Ababa.

Annual Report, National Bank of Ethiopia, Addis Ababa, various editions up to 2020-2021.

Supply and Sales Data, Ethiopian Petroleum Supply Enterprise, Addis Ababa, accessed May 2022: http://epse.gov.et/web/guest/supply-facts-and-figures.

Renewable Energy Statistics 2021, International Renewable Energy Agency (IRENA), Abu Dhabi, 2021.

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Annual Report, International Civil Aviation Organization (ICAO), 2020, United Nations, New York.

Existing Power Plants, Ethiopian Electric Power Corporation, online database, 2014, Addis Ababa.

Biomass Energy Strategy Formulation for Ethiopia, European Union Energy initiative, in cooperation with the Ethiopian Ministry for Water and Energy, Germany, 2013.

IEA Secretariat estimates.

Sources 1992 to 2012

Direct communication with the Ministry of Mines and Energy, Addis Ababa.

Direct communication with the Energy Development Follow-up and Expansion Department of the Ministry of Infrastructure, Addis Ababa, 2004 and 2005.

Direct communication with the Ministry of Finance and Economic Development, Addis Ababa, 1998 to 2003.

The United Nations Energy Statistics Database, United Nations Statistical Division, New York.

IEA Secretariat estimates.

Sources up to 1991

Ten Years of Petroleum Imports, Refinery Products, and Exports, Ministry of Mines & Energy, Addis Ababa, 1989.

Energy Balance for the Year 1984, Ministry of Mines & Energy, Addis Ababa, 1985.

1983 Annual Report, National Bank of Ethiopia, Addis Ababa, 1984.

Quarterly Bulletin, National Bank of Ethiopia, Addis Ababa, various editions from 1980 to 1985.

Sources for biofuels and waste

Direct communication with the Ministry of Water, Irrigation, and Energy, Addis Ababa.

Biomass Data 2007-2012, Ministry of Water and Energy, Addis Ababa, 2012.

IEA Secretariat estimates up to 2006 based on 1992 data from Eshetu and Bogale, *Power Restructuring in Ethiopia*, AFREPREN, Nairobi, 1996.

IEA Secretariat estimates.

Kenya

Data for Kenya are available starting in 1971. Kenya is one of the ten countries that benefit from EU Support to IEA Data for Affordable and Sustainable Energy System for Sub-Saharan Africa. In the 2022 edition of the World Energy Statistics and Balances, electricity data were revised from 2003 to 2019 to be reported on a calendar year basis. In previous editions, electricity data were reported on a fiscal year basis, beginning on 1 July and ending on 30 June of the subsequent year. In the 2022 edition of the World Energy Statistics and Balances, oil product data were revised to more accurately reflect the final consumption by sector reported by the Kenya National Bureau of Statistics.

Sources 2005 to 2020

Economic Survey, Kenya National Bureau of Statistics, Nairobi, various editions up to 2021.

Annual Report and Financial Statements, Kenya Power, various editions up to 2020.

Renewable Energy Statistics 2021, International Renewable Energy Agency (IRENA), Abu Dhabi, 2021.

Annual Report, International Civil Aviation Organization (ICAO), 2020, United Nations, New York.

Direct communication with AFREPREN and Petroleum Institute of East Africa, Nairobi, up to 2008.

Kenya, Facts and figures, 2006 Edition, Central Bureau of Statistics, Nairobi.

Annual Report and Accounts, 2006/07 to 2018/19, the Kenya Power & Lighting Company Limited, Nairobi.

IEA Secretariat estimates.

Sources 1992 to 2004

Direct communication with the Ministry of Energy, Nairobi.

Economic Survey, 1995 to 2004, Central Bureau of Statistics, Nairobi.

Annual Report and Accounts, 2001/02, 2002/03, 2003/04, 2004, 2005, the Kenya Power & Lighting Company Limited, Nairobi.

The United Nations Energy Statistics Database, United Nations Statistical Division, New York.

Sources up to 1991

Economic Survey, Government of Kenya, Nairobi, 1989.

Economic Survey 1991, Ministry of Planning and National Development, Central Bureau of Statistics, Nairobi, 1992.

Kenya Statistical Digest, Ministry of Planning and National Development, Central Bureau of Statistics, Nairobi, 1988.

Sources for biofuels and waste

Economic Survey, Central Bureau of Statistics, Nairobi, various editions up to 2021.

Forestry Statistics, Food and Agriculture Organisation (FAO), Rome, accessed November 2020: http://www.fao.org/faostat.

Sustainability of sugarcane bagasse briquettes and charcoal value chains in Kenya, United Nations Environment Programme (UNEP), 2019.

Data for 2000 are based on research carried out by the Ministry of Energy on consumption of solid biofuels. The results of this research were published as part of a National Energy Policy initiative.

IEA Secretariat estimates.

South Sudan

Data for South Sudan are available from 2012. Prior to 2012, they are included in Sudan. In the 2022 and 2021 editions of the World Energy Statistics and Balances, the IEA Secretariat did not receive data related to 2020 or 2019 at the time of the publication; supply, transformation and use of energy have been estimated by the IEA Secretariat for 2020 and 2019. In the 2022 edition of the World Energy Statistics and Balances, multiple products and flows were revised for 2018 based on new data provided by the African Energy Commission (AFREC).

Sources 2012 to 2020

Africa Energy Database, African Energy Commission, Algiers, accessed in May 2022: https://au-afrec.org/en/energy-browser.

Renewable Energy Statistics 2021, International Renewable Energy Agency (IRENA), Abu Dhabi, 2021.

The African Statistical Yearbook, African Development Bank Group, Abidjan, 2020.

AFREC Energy questionnaire, African Energy Commission, Algiers, 2012 to 2017.

Direct communication with the Ministry of Electricity, Dams, Irrigation and Water Resources, Juba, South Sudan, up to January 2019.

IEA Secretariat estimates.

Sudan

Data for Sudan are available starting in 1971. South Sudan became an independent country on 9 July 2011. From 2012 onwards, data for South Sudan are reported separately and therefore, breaks in the Sudan time series may occur between 2011 and 2012. The IEA Secretariat could not obtain official balances from Sudan for data after 2012. In the 2022 edition of the World Energy Statistics and Balances, data from the Joint Organisations Data Initiative (JODI) Oil World database replaced oil product estimates when available for 2013 to 2018. After 2018, most of the oil products data are estimated based on Organization of Arab Petroleum Exporting Countries (OAPEC) data, while some flows such as kerosene consumption and diesel exports and bunkers have been estimated based on macroeconomic indicators.

Sources 1992 to 2020

Annual Statistical Report, Organization of Arab Petroleum Exporting Countries (OAPEC), Kuwait, various editions up to 2021.

JODI Oil World database, Joint Organisations Data Initiative (JODI), Riyadh, accessed May 2022: https://www.jodidata.org/oil/.

The African Statistical Yearbook, African Development Bank Group, Abidjan, various editions up to 2020.

Africa Energy Portal, African Development Bank Group, Abidjan, accessed May 2022: https://africa-energy-portal.org/.

Foreign Trade Statistical Digest, Central Bank of Sudan, Khartoum, various editions up to 4th Quarter 2020.

OAG (2021), *Origin-Destination of Commercial Flights* (database), OAG Aviation, Luton, www.oag.com/analytics/traffic-analyser.

Statistical Bulletin, Arab Union of Producers, Transporters and Distributors of Electricity (AUPTDE), Amman, various editions up to 2019.

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Sudanese Petroleum Corporation Statistics, Ministry of Petroleum, Khartoum, May 2012.

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IEA Secretariat estimates.

Sources up to 1991

Foreign Trade Statistical Digest 1990, Government of Sudan, Khartoum, 1991.

Sources for biofuels and waste

Direct communication with the Ministry of water resources, Irrigation & Electricity, Khartoum.

IEA Secretariat estimates based on 1990 data from Bhagavan (ed.) *Energy Utilities and Institutions in Africa*, AFREPREN, Nairobi, 1996.

Uganda

Uganda data are available from 1971 onwards. In the 2022 edition of the World Energy Statistics and Balances, more detailed information on fuel consumption by industry sub-sector was provided by the Ministry of Energy and Mineral Development for 2020. For electricity and primary solid biofuels, all industry consumption is allocated to non-specified industry consumption up to 2020. It is disaggregated into specific sub-sectors in 2020, creating a break in the time series between 2019 and 2020. For charcoal, liquefied petroleum gases, motor gasoline, other kerosene, and gas/diesel oil, industry consumption was re-allocated from non-specified industry to the sub-sector identified in the new 2020 data for the whole time series.

Sources 1971 to 2020

Direct communication with the Ministry of Energy and Mineral Development, Kampala.

Statistical Abstract, Ministry of Energy and Mineral Development, Kampala, various editions up to 2020.

Africa Energy database, African Energy Commission, Algiers, accessed in April 2021.

Renewable Energy Statistics 2021, International Renewable Energy Agency (IRENA), Abu Dhabi, 2021.

Energy Statistics Yearbook 2016, United Nations, New York, 2019.

Origin-Destination of Commercial Flights database, 2018, OAG Aviation, Luton, http://www.oag.com/analytics/traffic-analyser.

Forestry Statistics, FAO, Rome, accessed in April 2022: http://www.fao.org/faostat.

IEA Secretariat estimates.

Djibouti and Somalia

Data for Djibouti and Somalia have not been published by the IEA in the 2022 edition but have been used in this report for analysis.

Djibouti Sources

Annuaire des Statistiques Commerce Extérieur, Institut de la Statistique de Djibouti, Djibouti-ville, various editions up to 2021.

Annuaire Statistique, Institut de la Statistique de Djibouti, Djibouti-ville, various editions up to 2021.

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Africa Energy Database, African Energy Commission, Algiers, accessed in May 2021: https://au-afrec.org/en/energy-browser.

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Somalia Sources

Direct communication with the Ministry of Energy and Water Resources, Mogadishu.

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Africa Energy Database, African Energy Commission, Algiers, accessed in November 2021: https://au-afrec.org/en/energy-browser.

Renewable Energy Statistics 2021, International Renewable Energy Agency, Abu Dhabi, 2021.

Forestry Statistics, Food and Agriculture Organisation, Rome, accessed in October 2020: http://www.fao.org/faostat.

Abbreviations and acronyms

AEO	Africa Energy Outlook
CAAGR	Compounded Average Annual Growth Rate
CAGR	Compound annual growth rate
COMESA	Common Market for Eastern and Southern Africa
COVID-19	Coronavirus disease of 2019
ESMAP	Energy Sector Management Assistance Program
EU	European Union
EV	Electric Vehicles
FAO	Food and Agriculture Organization
FiT	Feed-in-Tariff
GDP	Gross Domestic Product
GET FiT	Global Energy Transfer Feed-in Tariff
GHG	Greenhouse Gas
GlobalABC	Global Alliance for Buildings and Construction
IEA	International Energy Agency
IGAD	Intergovernmental Authority on Development
IMF	International Monetary Fund
IRENA	International Renewable Energy Agency
LEAP	Lighting and Energy Access Partnership
LED	Light Emitting Diode
LPG	Liquefied petroleum gas
MEPS	Minimum energy performance standards
NDCs	Nationally Determined Contributions
NZE	Net Zero Emissions scenario
OECD	Organisation for Economic Cooperation and Development
OPEC	Organization of the Petroleum Exporting Countries
RCP	Representative Concentration Pathway
SADC	Southern Africa Development Community
SDG	Sustainable Development Goal
SEforALL	Sustainable Energy for All
STEPS	Stated Policies Scenarios
UK	United Kingdom
UN	United Nations
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change
US	United States
USAID	United States Agency for International Development
USD	United States Dollar

Glossary

bbl	barrel
bbl/d	barrels per day
°C	Celsius
gCO_2	gram of carbon dioxide
gCO_2/kWh	grams of carbon dioxide per kilowatt-hour
GJ	gigajoule
GW	gigawatt
GWh	gigawatt hour
ktoe	kilotonnes of oil equivalent
kWh	kilowatt-hour
lge	litres of gasoline
MW	megawatt
Mtoe	million tonnes of oil equivalent
ppm	parts per million

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