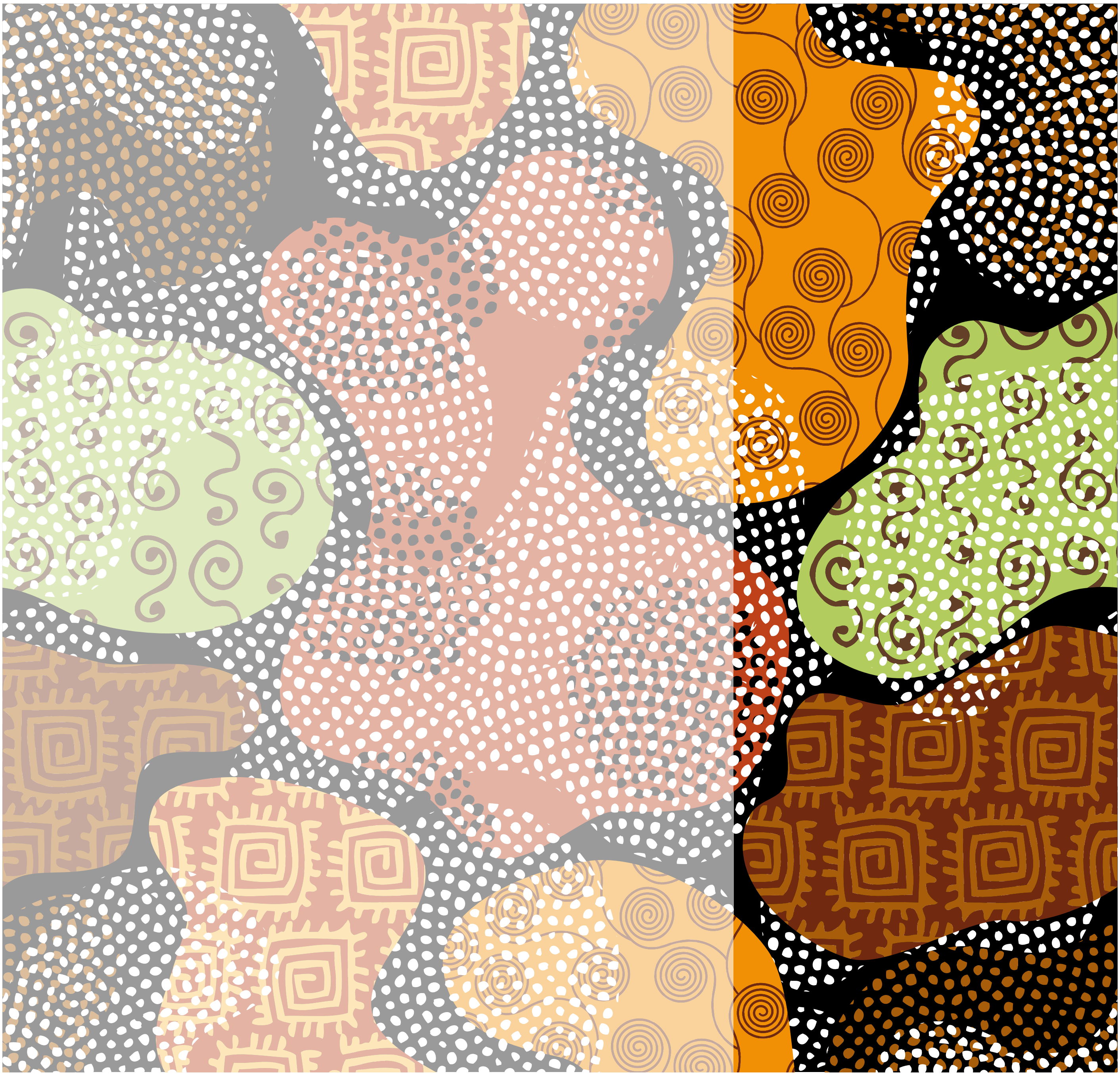
IRENA

International Renewable Energy Agency

SUB-SAHARAN AFRICA

POLICIES AND FINANCE FOR RENEWABLE ENERGY DEPLOYMENT



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ABOUT IRENA

The International Renewable Energy Agency (IRENA) serves as the principal platform for international co-operation, a centre of excellence, a repository of policy, technology, resource and financial knowledge, and a driver of action on the ground to advance the transformation of the global energy system. A global intergovernmental organisation established in 2011, IRENA promotes the widespread adoption and sustainable use of all forms of renewable energy, including bioenergy, geothermal, hydropower, ocean, solar and wind energy, in the pursuit of sustainable development, energy access, energy security, and low-carbon economic growth and prosperity.

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01 INTRODUCTION

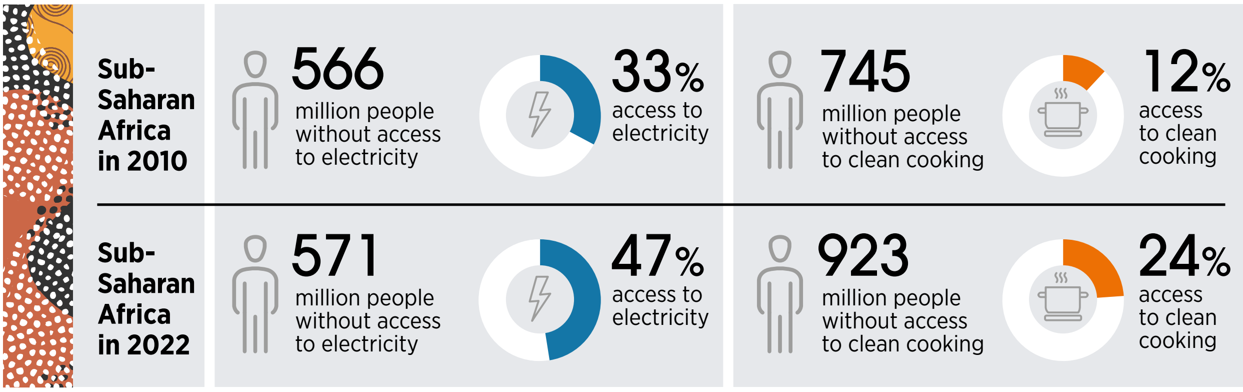
Africa is a continent rich in land and energy resources, with a young and fast-growing population. Already the world's youngest continent, by 2050 it is expected to grow to nearly 2.5 billion people, 80% of them in Sub-Saharan Africa (UNPD, 2019). Geographies, climates, and levels of human and economic development vary widely across the continent, as does access to reliable, affordable and sufficient modern energy, which is crucial to support industrialisation and development goals. Energy consumption in the region is extremely low amid a large gap in access to modern energy. In 2020, the African continent as a whole accounted for only about 6% of the world's total final energy consumption, despite being home to over 20% of the world's population (IEA *et al.,* 2023).

Access to modern energy is still lagging across the region

Despite huge progress in access to modern energy over the past decades, energy access remains low in many parts of Sub-Saharan Africa. Some 571 million people in the region still lacked access to electricity in 2022 (Figure 1) (IEA *et al.*, 2024). Access to clean cooking fuels and technologies is even lower; 923 million people were still using only basic stoves and traditional fuels for cooking in 2020 – and this number grew over the past decade due to population growth and lagging infrastructure development. All of this makes Sub-Saharan Africa home to the world's largest population without access to modern energy.

Beyond electricity access, the affordability and reliability of electricity supply and higher quality fuels are major issues across the continent. This comes at a significant economic cost, hindering the development of local industries and the delivery of crucial public services, including education and health care. Historically, even fossil-fuel-exporting countries in the region have continued to experience large energy access deficits, especially in rural areas. The success of the energy transition in Sub-Saharan Africa will therefore depend on the extent to which modern energy systems include those communities, farms or public facilities most likely to be left behind.

Figure 1 Access to electricity and clean cooking in Sub-Saharan Africa



Source: (IEA et al., 2024).

Most used sources of energy: fossil fuels, bioenergy and hydropower

Fossil fuels have played an important role across Sub-Saharan Africa, as the most important sources of primary energy and electricity supply. Coal, natural gas and oil together account for over 60% of Sub-Saharan Africa's total electricity generation capacity in 2023 (IRENA, 2024b). A number of African countries produce oil and gas using fossil fuels both as a source for domestic energy and an export commodity. Nigeria and Angola are among the world's 20 largest oil producers; Nigeria is also among the world's 20 largest producers of natural gas (IEA, 2021a). Major new natural gas developments in Mozambique, Senegal, South Africa and the United Republic of Tanzania have turned the region into an emerging market for natural gas production (Anwar, Neary and Huxham, 2022). Several African countries also produce coal. These include Botswana, Mozambique, South Africa and Zimbabwe; South Africa is the largest in the region (EIA, 2019).

Despite Sub-Saharan Africa's high degree of reliance on fossil fuels, bioenergy remains the most widely used source of energy; it accounts for almost 50% of the region's energy supply (IEA *et al*., 2023; IRENA, 2024b). The majority of this use relates to the traditional use of bioenergy for cooking in households, ranging from traditional biomass to improved traditional biomass technologies,[1] and only limited modern bioenergy.[2] Population growth, lack of productive uses outside the home and unsustainable harvesting practices render biomass a highly unsustainable energy source in Sub-Saharan Africa. Deforestation amid overreliance on fuelwood, and inter-communal conflict over access to woodlands, both are major sources of environmental and social concern across the region. Added to these are the health effects of incomplete combustion in traditional stoves, particularly among women and children (FAO, 2021; IRENA, 2019a).

Bioenergy is also used to produce power, although it represented only about 1% of Sub-Saharan Africa's total installed electricity generation capacity in 2023. Of this total, 1.4 gigawatts (GW) were grid-connected and another 93 megawatts (MW) were off-grid (IRENA, 2024a). Most of this capacity is based on bagasse, although a few countries (especially in Eastern and Southern Africa) have begun to use biogas, besides wood fuel and waste (IRENA, 2024a).

Hydropower plays a large role in the continent's power mix

Hydropower is the largest renewable energy source used for electricity generation in Sub-Saharan Africa, which had over 31 GW of hydropower capacity, just over 24% of the continent's total installed electricity generation capacity

1 Improved traditional biomass technologies employ direct combustion of biomass; examples are improved kilns and cookstoves.
2 Modern bioenergy technologies include, among others, liquid biofuels produced from bagasse and other plants, biorefineries, biogas produced through anaerobic digestion of residues and wood pellet heating systems (IRENA, 2020a).

in 2023 (IRENA, 2024a).[3] In the same year, hydropower accounted for 11 % of the total electricity generation capacity in Southern Africa, but almost two-thirds of such capacity in Central Africa (Figure 2), and more than that in some countries.

In several African countries with large rivers crossing through their territory, hydropower accounts for half or more of the total electricity generation capacity. Chief among these countries are Angola, the Democratic Republic of the Congo, Ethiopia, Gabon, Guinea and Uganda (IRENA, 2024a).

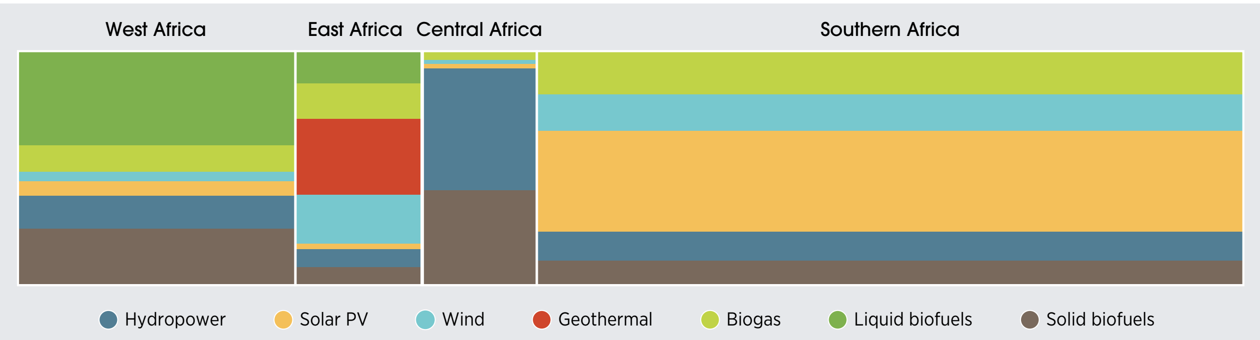
Yet there is still much untapped hydropower potential, across the continent. IRENA estimates that Africa as a whole (including North Africa) has close to 131 GW of hydropower capacity across existing, committed, planned and candidate hydropower plants (IRENA and AfDB, 2022). The largest committed projects in the region include Ethiopia's Renaissance hydropower project (at about 6 GW, the largest hydropower project in Africa as of 2023), the 3 050 MW Mambilla project in Nigeria, the 2 160 MW Cacula Cabasa project and the 2 071 MW Lauca project in Angola, and the 1 500 MW Mphanda Nkuwa hydropower plant in Mozambique. Candidates for the largest capacity additions are the DR Congo, Ethiopia, Cameroon, Nigeria, Angola and Mozambique.

At the same time, hydropower is not without challenges. Climate risks are of particular concern in the coming decades, with Sub-Saharan Africa among the regions most susceptible. Changing rainfall and temperature patterns due to climate change are expected to adversely affect hydropower generation capacity in Sub-Saharan Africa this century. The continent's increased exposure to climate hazards compound the need for thorough impact assessments before countries invest in new hydropower capacity (IEA, 2020). Further exploitation of hydropower, especially at a large scale, also involves significant environmental and human rights concerns, as well as potential cross-border conflict (Agrawal *et al.*, 2023; EBRD, n.d.; International Hydropower Association, 2020). For this reason, further hydropower development requires careful consideration, and must include environmental and social impact assessments to ensure projects remain sustainable while vulnerability to climate impacts is reduced.

The potential for solar and wind energy is significant

Wind and solar power deployment has begun to pick up in recent years, primarily driven by a handful of countries, in particular South Africa. On average, however, Sub-Saharan Africa's installed renewables-based electricity generation capacity represents less than 3% of the global total (IRENA, 2021a). Southern Africa had 6.7 GW of installed capacity in 2022; this is the region's largest installed solar capacity, representing over 80% of Sub-Saharan Africa's total (IRENA and AfDB, 2022). The same is true for wind power; almost three-quarters of the region's wind power capacity, or some 3 GW, is installed in Southern Africa – in particular, South Africa – followed by 800 MW in East Africa (IRENA and AfDB, 2022), which is the continent's sole producer of geothermal power, some 870 MW in total, all of which is in Kenya (Figure 2).

Figure 2 Renewable electricity generation by technology and region (%), 2021



Source: (IRENA and AfDB, 2022).
Note: PV = photovoltaic.

3 *Installed electricity generation capacity for hydropower excluding storage.*

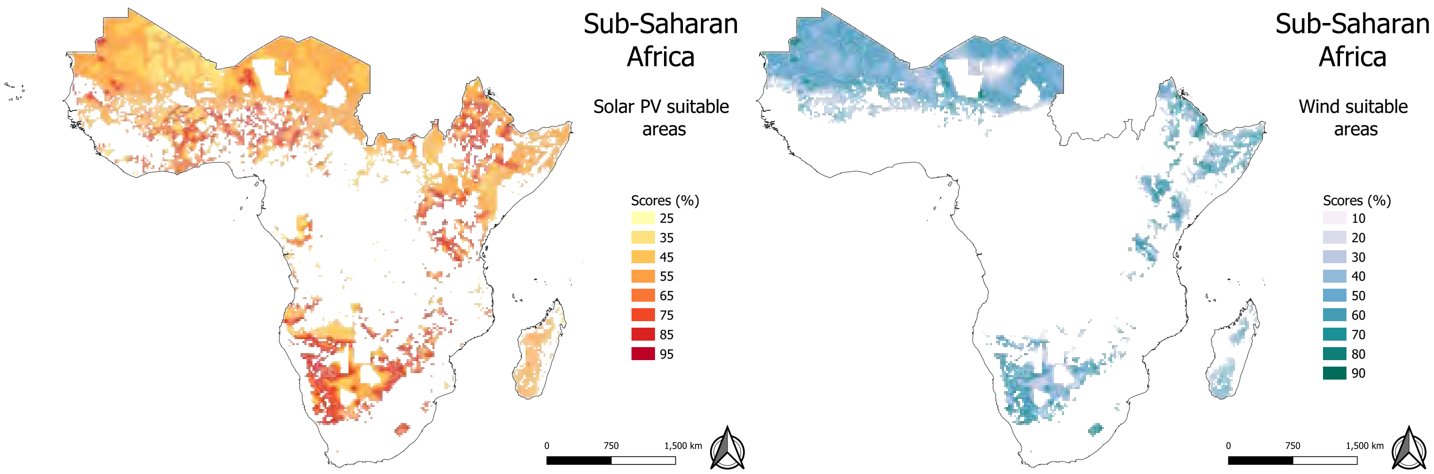
Sub-Saharan Africa possesses particularly large potential for solar power generation. The continent receives annual average solar irradiation of 2 119 kilowatt hours per square metre per year (kWh/m²/year), and most countries across West and Southern Africa receive in excess of 2 100 kWh/m²/year annually on average (IRENA and AfDB, 2022). This abundant renewable resources, coupled with ample available land, show a clear path for the continent's successful transition from conventional power sources to renewable ones.

Figure 3 shows the areas suitable for utility-scale project development. IRENA estimates the region's vast solar technical potential at 4 988 GW (assuming a 1% land utilisation factor (IRENA and AfDB, 2022). Wind power facilities are distributed unevenly across the region; their distribution is tied to the geography of wind resources. Nevertheless, IRENA estimates the region's technical potential for wind power at 237 GW (assuming a 1% land utilisation factor), with Mauritania, Niger, Mali, Chad, Ethiopia and Namibia possessing the greatest potential.

Egypt and Algeria stand out as major consumers of primary energy and electricity in Africa. This trend reflects their large populations, historically high rates of access to modern forms of energy and energy-intensive industries. Egypt takes the lead as the largest electricity producer in North Africa, and is also one of the largest electricity markets on the Africa continent as a whole. Its capacity, in excess of 64 gigawatts (GW), serves a population of more than 100 million (Figure 1). Egypt is followed by Algeria (50 GW) and Libya (14 GW) (IRENA, 2023), although Libya's electricity grid and power generation infrastructure has suffered significantly since the onset of political instability in the 2010s.

Algeria, Egypt and Libya have traditionally relied on fossil fuels for virtually all their energy needs. The significant role hydropower has played Egypt's power sector since the 1960s is a notable exception.

Figure 3 Most suitable areas in Sub-Saharan Africa for utility-scale solar photovoltaic and wind



Source: IRENA Global Atlas for Renewable Energy (IRENA, 2021b); Base map: UN boundaries.
Note: PV = photovoltaic.

Disclaimer: This map is provided for illustration purposes only. The boundaries and names shown on the map do not imply the expression of any opinion on the part of IRENA concerning the status of any region, country, territory, city or area, or of its authorities, or concerning the delimitation of frontiers or boundaries.

Modern renewable energy, such as that harnessed from the sun and wind, presents an enormous opportunity for Sub-Saharan Africa. Beyond the electricity sector, renewable energy can be a core part of Africa's structural economic transformation; it will play a fundamental role as green industries with immense potential are developed, reducing dependencies of different forms, including structural, technological and those related to single-commodity trade (IRENA and AfDB, 2022). Modern renewable energy can also play a central role in managing the environmental impacts of growing populations and economies, notably through reduced reliance on fossil-fuel-based power generation and traditional biomass (wood fuel and charcoal) for heating and cooking.

Because some renewable energy projects - especially large-scale hydropower dams - can impact biospheres and the traditional land management practices of local communities, increased deployment of these technologies will require a careful mix of policies to maximise benefits and minimise harm to the environment, indigenous peoples and local communities (see Box 10).

Unlocking the potential of renewable energy as a lever of socio-economic development will require a structural shift in national energy policies, institutional capacity and well-honed policy tools, in addition to international co-operation. The following chapters examine more closely the trends of renewable energy investment and finance in Sub-Saharan Africa (Chapter 2), driven by regional and national plans, targets, and strategies for the sector (Chapter 3), and the policy environment for renewables in the region (Chapter 4).

02 RENEWABLE ENERGY INVESTMENT AND FINANCE

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Sub-Saharan Africa received less than 1.5% of the USD 2.8 trillion invested globally in renewable energy projects over 2000-2020 (IRENA and AfDB, 2022) and its share reduced further in 2021 and 2022, to less than 1% of the global total, as investments dropped from USD 5.3 billion in 2019 to less than USD 3.6 billion in 2022. Investments need to be scaled up considerably if the continent is to realise its enormous renewable energy potential and close the vast energy access deficit.

Moreover, renewable energy investments in the region are unevenly distributed; most investments tend to go to economies with relatively advanced policy, regulatory and investment frameworks. For instance, the top three recipients – South Africa, Nigeria and Kenya – received more than two-thirds of all renewable energy investments going to Sub-Saharan Africa in 2021-2022 (BNEF, 2023).

Conversely, the 33 least-developed countries in Africa received only 37% of the renewable energy commitments in the continent over 2010-2019 and their share has since declined further. These countries, which are often unable to attract private investments, require more public investment, primarily in the form of international support. Public investment is needed to develop infrastructure, build an enabling policy environment, mitigate risks, strengthen institutional capacity and eventually develop effective markets, which can subsequently attract private investors. In this way, directing financial commitments to least-developed countries can help foster an equitable energy transition resulting in transformative socio-economic development for underserved populations. This needs to be accompanied by robust policy support that considers countries' context-specific needs.

This section is divided as follows. Renewable energy investment up to 2020 – both public and private – is discussed in section 2.1. These data come from Bloomberg New Energy Finance (BNEF) and include investments in both utility-scale and small-scale renewable energy projects, but have no coverage of large hydropower (larger than 50 MW), which plays a crucial role in the region. Public financing up to 2021 is analysed in section 2.2 using data from IRENA and OECD (2021). Unlike the BNEF data, these data cover large hydropower, as well as financial commitments towards an enabling environment through capacity building and technical assistance, besides other non-technological investments coming from public institutions (donors, governments and multilateral development banks [MDBs]). A key point of difference between the two datasets is that the BNEF data are based on projects reaching financial close, whereas the IRENA and OECD data are based on commitments. The actual flows or disbursement of money typically sit somewhere between the two. Section 2.3 examines investments in off-grid renewables up to 2021 in more detail. It analyses these investments based on data from Wood Mackenzie (2022). Since the data providers adopt different methodologies and methods, trends are examined without making comparisons between the various data sources.

2.1. RENEWABLE ENERGY INVESTMENTS (EXCLUDING LARGE HYDROPOWER)

Between 2000 and 2020, the African continent attracted almost USD 60 billion in investment in renewables (excluding large hydropower). Over 90% (some USD 55 billion) was committed between 2010 and 2020 - most of it to a handful of countries (including in North Africa).

In Sub-Saharan Africa, investments in the 2000s were generally flat. The 2010s, by contrast, saw increased investment driven by structured renewable energy procurement programmes in the power sector such as feed-in-tariffs and auctions supported by credit-enhancement structures provided by development finance institutions (DFIs) and MDBs. This is consistent with global trends, as solar power deployment, in particular, began to take off after 2010 (IRENA and AfDB, 2022).

Over this period, investments in the region followed a sinusoidal pattern (*i.e.* peaks followed by troughs). Investment peaked in 2012, and again in 2018, with significant variation in the years between, as the peaks were often driven by individual, large-scale projects (Figure 4). During this time, almost two-thirds of investments in Sub-Saharan Africa went to Southern Africa, mostly to South Africa, followed by East Africa and in particular, Kenya, which received about a quarter of the total investment (Figure 5).

Figure 4 Annual investments in renewable energy in Sub-Saharan Africa by region (current USD billion), 2000-2020

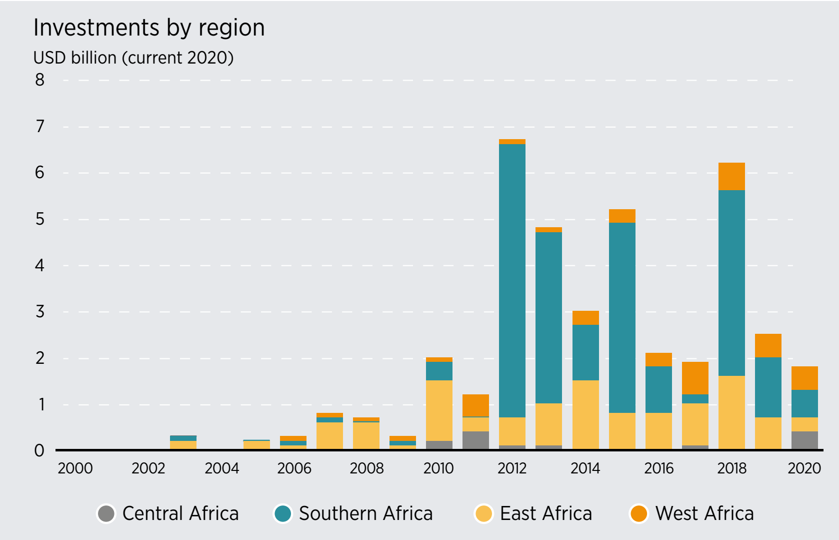
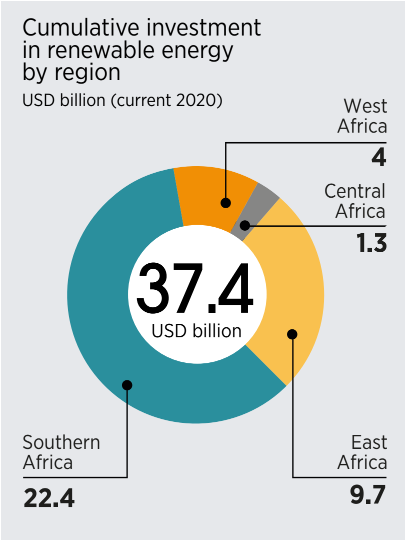


Figure 5 Cumulative investments in renewable energy by region (current USD billion), 2010-2020



Source: (IRENA and AfDB, 2022) based on (BNEF, 2021).

Solar photovoltaic (PV) and wind power received the most investment in Sub-Saharan Africa over 2010-2020 (Figures 6 and 7). Investments in solar PV were valued at USD 12.3 billion – about a third of the total – followed by investments in wind, at USD 11 billion, and in solar thermal, at USD 5.4 billion. Together, these three technologies account for more than three-quarters of the total investments in the region.

Unlike investments in solar PV, investments in solar thermal and wind power vary considerably from year to year, driven by single large projects reaching financial close. These large investments tend to also be concentrated in a handful of countries. For example, in 2018, South Africa received more than USD 1 billion for five wind farms, totalling almost 750 MW (Hill, 2018).[4]

Compared with solar and wind investments, investment in bioenergy, geothermal and small hydropower remained low; geothermal investments were concentrated in Kenya, with a few recent investments in Djibouti, Ethiopia and Zambia. Yet Sub-Saharan Africa accounted for 14% of global geothermal investments in 2010-2020, as opposed to a 7% share for on-shore wind and 3% for solar PV.

Figure 6 Annual investments in renewable energy in Sub-Saharan Africa by technology (USD million), 2010-2020

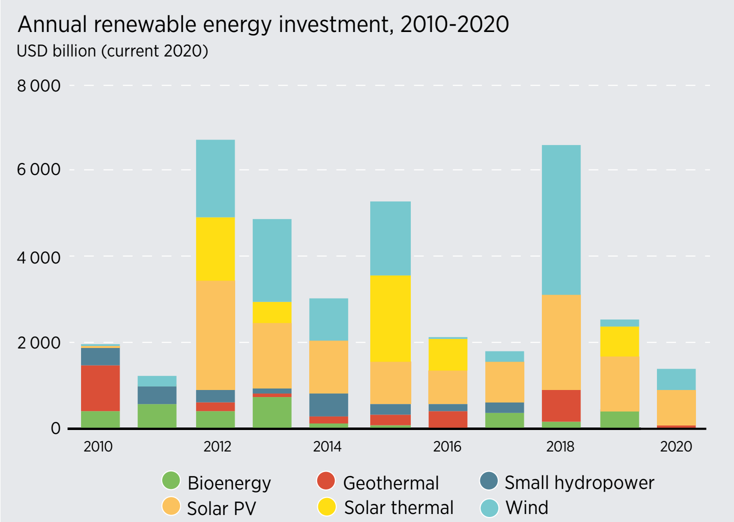
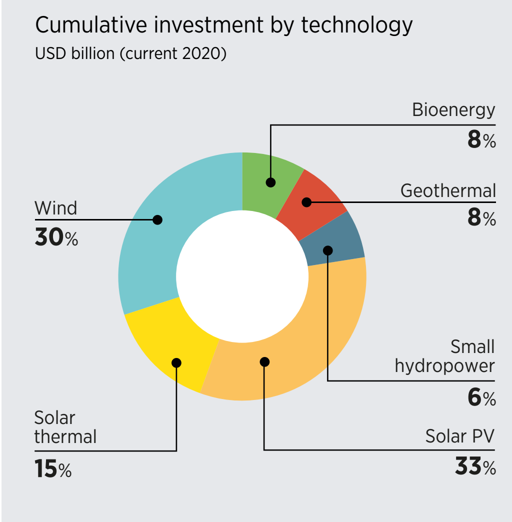


Figure 7 Cumulative investments in renewable energy in Sub-Saharan Africa by technology (USD million), 2010-2020



Source: (BNEF, 2021).
Note: PV = photovoltaic.

A substantial portion of investments go to large hydropower, which plays a crucial role in the region. However, since BNEF data on large hydropower are limited, they are not reflected in Figures 6 and 7. The IRENA and OECD (2021) data have a relatively more complete coverage of large hydropower and show public financial commitments of USD 32 billion in hydropower-related projects in the region over 2010-2020 (62% of all public financial commitments towards renewables). Since hydropower tends to be largely public financed, this explains its larger commitment share compared with that of solar PV and on-shore wind, which are mainly privately financed, even in Sub-Saharan Africa (IRENA and CPI, 2023). The most notable large hydropower commitment in the region was for the USD 5 billion Mambilla Hydroelectric Plant, funded by Ex-Im Bank of China, co-financed with the Government of Nigeria in 2017. Data on large hydropower are further discussed in section 2.2.

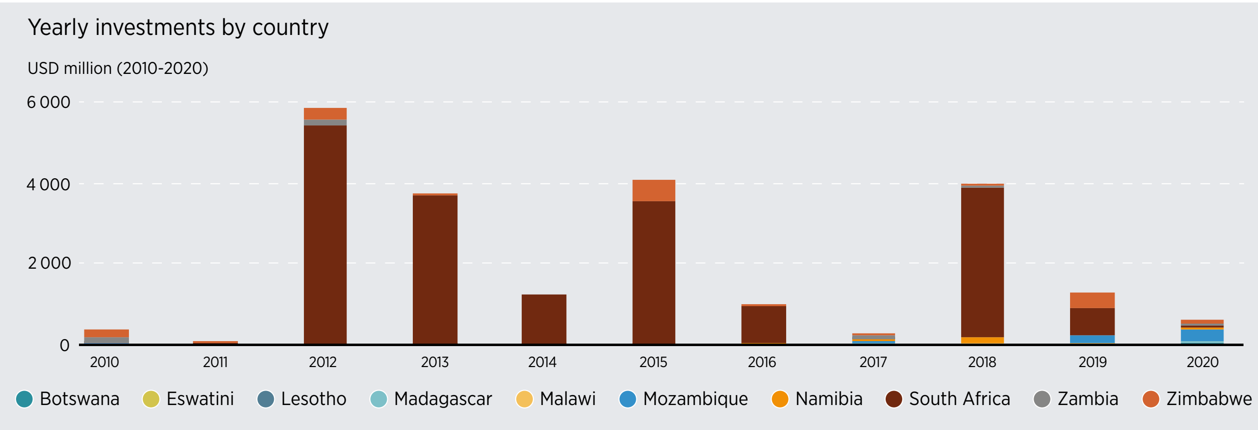
4 *All of these plants have been commissioned as of June 2022 and includes the Garob Wind Farm (144.9 MW), Karusa Wind Farm (140MW) - Nxuba Wind Farm (148.1MW) Oyster Bay Wind Farm (140 MW), and Soetwater Wind Farm (140 MW).*

Only half of the investments in Sub-Saharan Africa between 2013 and 2020 came from domestic sources; this highlights the region's dependency on international capital. By contrast, at least more than three-fourths of investments in Europe and North America came from domestic sources over the period (IRENA and CPI, 2023).[5] Moreover, Sub-Saharan Africa faces some of the highest costs of financing in international capital markets, in the absence of public support in the form of risk mitigation and concessional financing, especially compared with more developed markets and economies.

Southern Africa

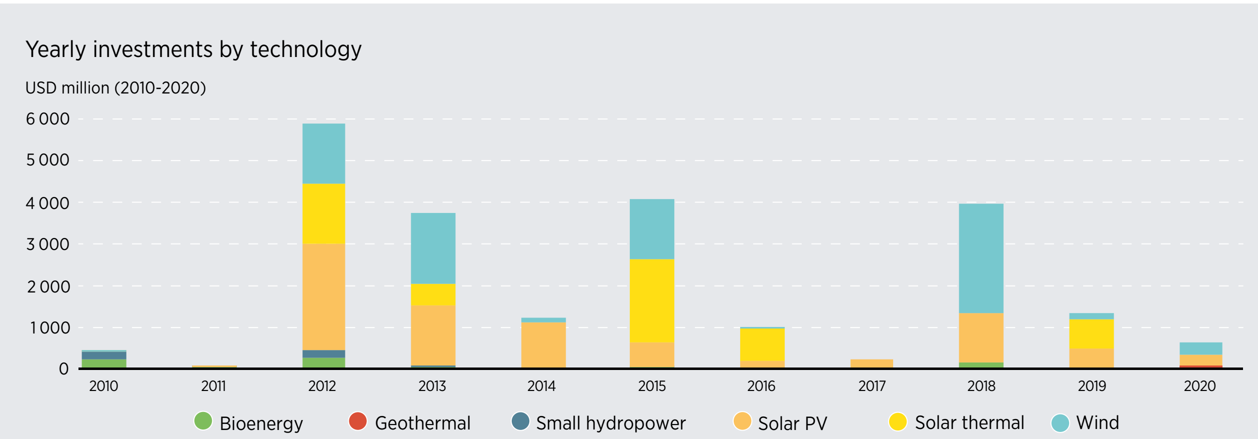
Southern Africa attracted the largest share of cumulative renewable energy investments in Sub-Saharan Africa over 2010-2020, totalling USD 22.4 billion. Almost 90% of this investment was in South Africa, with the rest flowing into Zimbabwe (7%), Mozambique (2%), Zambia (2%) and Namibia (1%) (Figure 8). Most investments went into solar PV (36%), followed by wind energy (34%) and concentrated solar power (24%) (Figure 9); other renewable energy technologies received only marginal attention.

Figure 8 Yearly investments in renewable energy in Southern Africa by country (USD million), 2010-2020



Source: (BNEF, 2021).

Figure 9 Yearly investments in renewable energy in Southern Africa by year and technology (USD million), 2010-2020



Source: (BNEF, 2021).
Note: PV = photovoltaic.

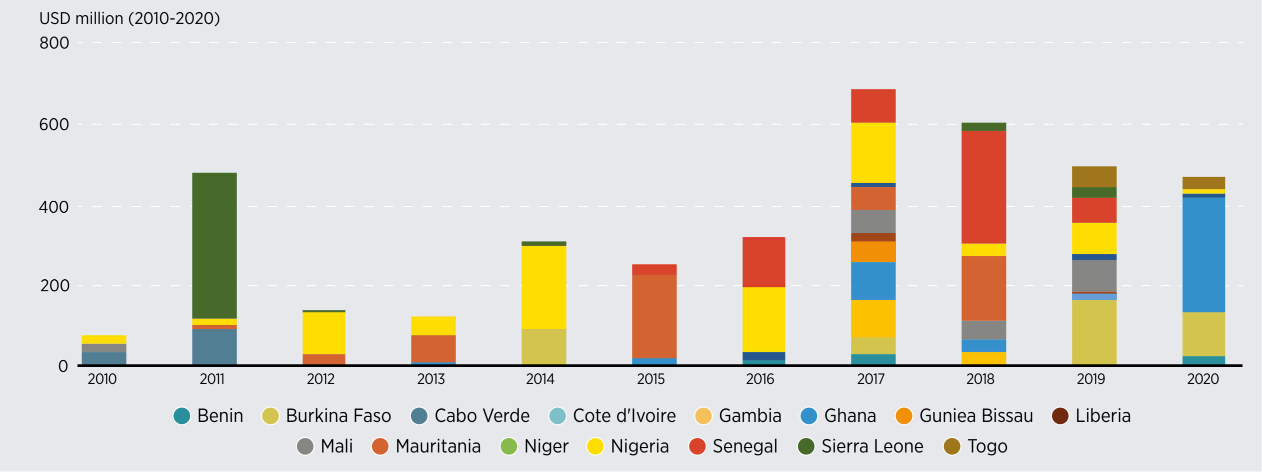
5 *It should be noted that public financing is essential to mobilising private investments, and for that purpose, the region has received a large share of public financing, especially for solar energy, compared with the global average.*

West Africa

Investment is far more spread out among countries in West Africa. Nigeria received the region's highest investment commitments over 2010-2020, at 21% of West Africa's total. It was followed by Senegal and Mauritania (14% each), Ghana and Sierra Leone (11% each) and Burkina Faso (10%), while all other countries received smaller investments. Investment volumes vary considerably across years; 2017 was a peak year for renewable energy investments – smaller investments were received by a larger number of countries. The single-largest investment for a project, at USD 365 million, was in Sierra Leone in 2011, for the Addax Makeni Bioethanol and Power Plant (Figure 10). However, in July 2015, the plant's operations were suspended due to financial constraints.

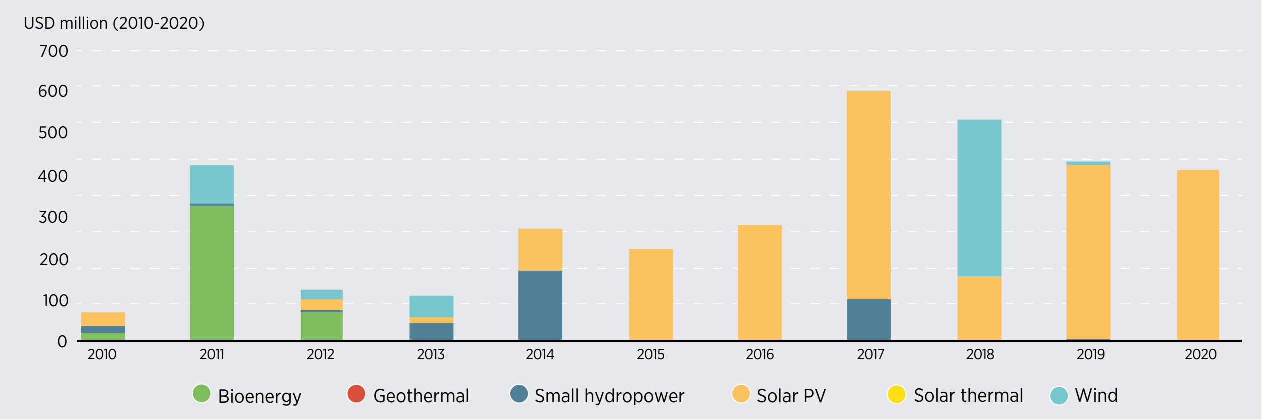
Solar PV represented the largest share of overall investments, at 62%, followed by wind (16%), bioenergy (12%) and small hydropower (10%). Solar energy, and to some extent wind, have notably become the most important renewable energy technologies based on investment flows since the second half of the 2010s; they replaced investment in other technologies, especially bioenergy, although small hydropower also received some investment (Figure 11).

Figure 10 Yearly investments in renewable energy in West Africa by country (USD million), 2010-2020



Source: (BNEF, 2021).

Figure 11 Yearly investments in renewable energy in West Africa by technology (USD million), 2010-2020



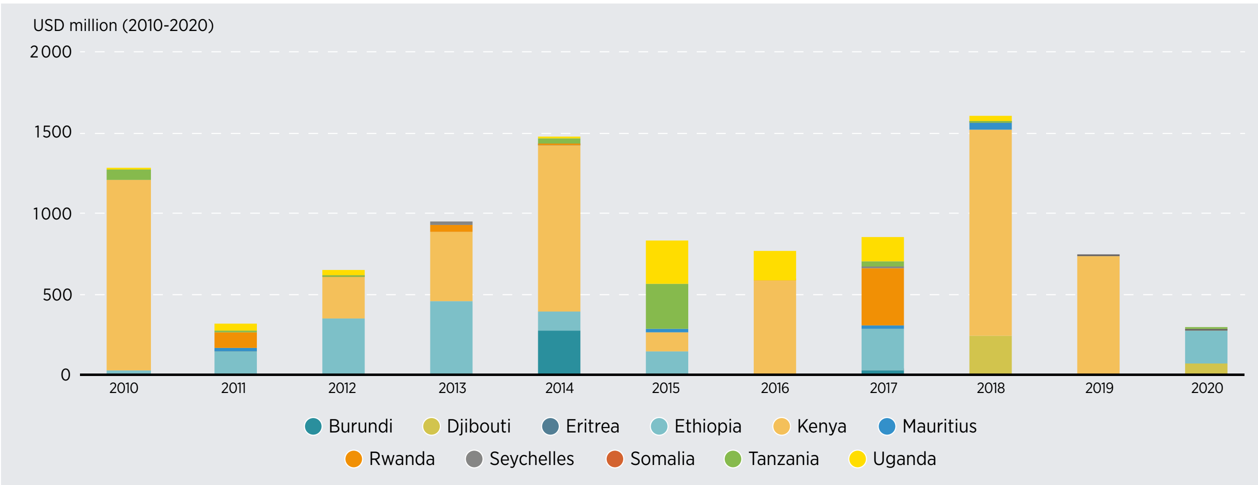
Source: (BNEF, 2021).
Note: PV = photovoltaic.

East Africa

Renewable energy investments in East Africa over 2010-2020 were highly concentrated in a few countries, in particular Kenya, which alone accounted for almost 60% of overall renewable investments. Another 17% went to Ethiopia, followed by Uganda (7%), Tanzania (5%), and Djibouti and Burundi (3% each). Investment in other countries was negligible (Figure 12). Overall investment was spread out across a range of technologies, including geothermal (30%, almost all of which in Kenya), wind (29%), bioenergy (20%), solar PV (12%) and small hydropower (less than 50 MW) (10%) (Figure 13).

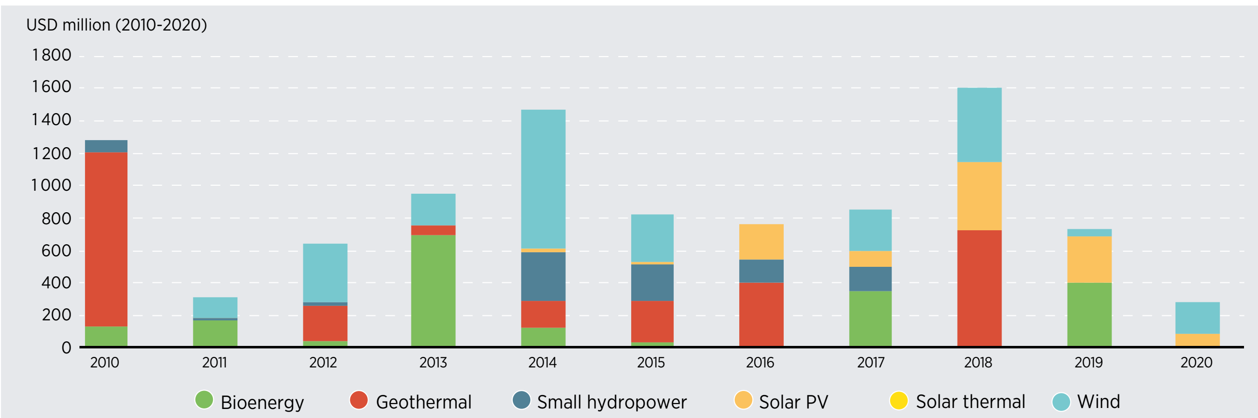
Notable in East Africa is the very large influence of Kenya on the regional investment numbers, which explains the prominent role of geothermal in the region's investment picture. Unlike in other parts of Africa, solar energy has been less prominent than other renewable energy technologies, including wind and bioenergy, in East Africa. The total investment in solar PV in East Africa over 2010-2020 was almost half that in West Africa, and less than one-fifth that in Southern Africa. In turn, wind investment was four times that in West Africa, driven also by Kenya, especially the Lake Turkana Wind Park, Africa's largest wind farm outside South Africa to date.

Figure 12 Yearly investments in renewable energy in East Africa by country (USD million), 2010-2020



Source: (BNEF, 2021).

Figure 13 Yearly investments in renewable energy in East Africa by technology (USD million), 2010-2020

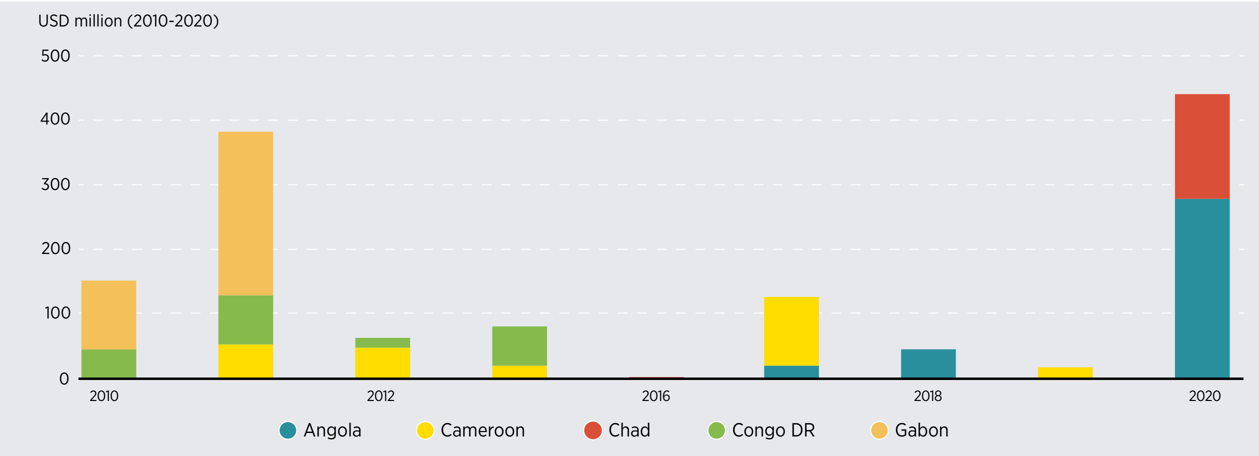


Source: (BNEF, 2021).
Note: PV = photovoltaic.

Central Africa

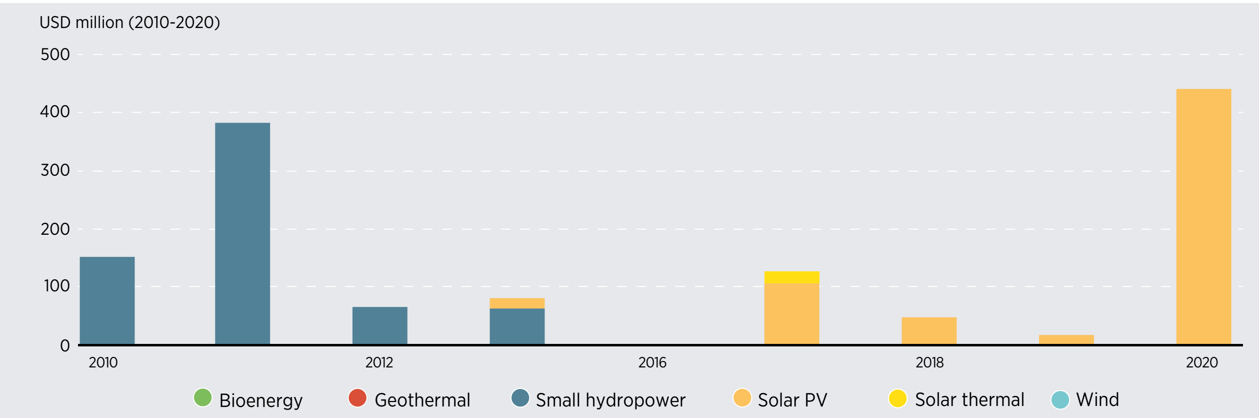
Of all parts of Sub-Saharan Africa, Central Africa has received the least investment in renewable energy – less than 2% of the total since 2000. Gabon received the most, accounting for 28% of the regional total over 2010-2020, most of which was committed in 2010 and 2011 to small hydro (Figure 14). Gabon was followed by Angola, which accounted for 26% of the total. Most of the investment was committed in 2020, and went into solar PV (Figure 14), making Angola the most important destination for renewables investment in recent years. Small hydro and solar PV have been the two largest renewable energy technologies by investment in Central Africa over the past decade; they received almost equal amounts of investment, although the most recent years show a notable shift, towards solar PV – almost to the exclusion of hydro (Figure 15). Other technologies received only marginal attention.

Figure 14 Yearly investments in renewable energy in Central Africa by country (USD million), 2010-2020



Source: (BNEF, 2021).

Figure 15 Yearly investments in renewable energy in Central Africa by technology (USD million), 2010-2020



Source: (BNEF, 2021).
Note: PV = photovoltaic.

2.2. PUBLIC FINANCIAL COMMITMENTS TO RENEWABLE ENERGY

Globally, renewable energy has been financed predominantly by the private sector; public finance has accounted for just over 30% of direct investments in renewable energy assets in 2020 (IRENA and CPI, 2023). But public financing plays a more dominant role in Sub-Saharan Africa, where, except in a few countries, projects are not able to attract private capital owing to mainly financial, political, legal and economic risks.

Between 2000 and 2021, public financial institutions committed almost USD 60 billion to renewables (including large hydropower) in Sub-Saharan Africa, mainly in East and West Africa (see section 2.2.1). More than 80% of the total was committed between 2010 and 2021 (IRENA and OECD, 2021). Of this, hydropower accounted for USD 23.5 billion (55% of the total), solar for USD 7 billion (19%), wind for USD 2.3 billion (5.6%) and geothermal for USD 2.4 billion (6%). The largest commitments came from China (54% of the total), the International Development Association (6.6%), the United States (5%) and the International Bank for Reconstruction and Development (5%).

These commitments go beyond investments in energy assets and include feasibility studies (*e.g.* the Kodeni and Pa solar power plants in Burkina Faso), technical assistance (*e.g.* Ethiopia's Investment Advisory Facility by the United Kingdome's Department for International Development) and training (*e.g.* feasibility, pilot and training for cashew fuel for cooking in Mozambique). Most of the capital was provided by bilateral donors and DFIs using debt and grants, with the use of equity, guarantees and mezzanine financing having increased in recent years.

Public financial flows, particularly from international donors and financing institutions, play a key role in financing Africa's renewable energy sector (see section 2.2.2). Public investments have been successful in catalysing private investment, mainly in the power sector, through support from DFIs and MDBs (see section 2.2.3). In addition, several investment funds support renewables in the region (see section 2.2.4).

2.2.1 Public financial commitments by destination

West Africa received USD 17.5 billion worth of public commitments in the renewable energy sector between 2010 and 2021. Hydropower and solar had 70% and 18% shares, respectively, followed by wind. Almost two-thirds of the funds were committed since 2017, owing to increased public investment in renewable energy in Ghana, Guinea and Nigeria.

In East Africa, of the USD 17 billion public commitments made in 2010-2021, hydropower accounted for 45%, followed by solar at 15%, geothermal at 14.4% and wind at 9%. Ethiopia, Kenya and Uganda are among the countries receiving the greatest shares. Since the 2000s, renewables have continued to dominate public financial commitment portfolios, when compared with fossil fuel commitments over the same period.

In 2010-2021, Central Africa received a total of USD 4.16 billion, of which 87% went into hydropower. Besides hydropower, more public commitments have begun to go into solar in recent years. Cameroon has led the way in this regard, followed by smaller commitments in countries such as the Central African Republic. The Southern Africa region received USD 3.7 billion, primarily accounted for by solar (58%) and some share of wind (8%). The public commitments were concentrated in four countries: South Africa, Zambia, Mozambique and Zimbabwe. A substantial portion of commitments also went to multiple renewable technologies, although the exact category was difficult to discern.

2.2.2 Public financial commitments by type of institution and financial instrument

Public financial flows, especially from governments and international financing institutions, including regional actors such as the African Development Bank (AfDB), play an increasingly key role in financing Africa's renewable energy sector. The number of active donors increased from 26 in 2010 to 39 in the peak year, 2017. Of about 50 donors active over the past decade, eight provided over 85% of the public funding for renewables in Africa between 2010 and 2019. These included bilateral donors (such as China, the United States, France and Germany) and institutions such as the International Finance Corporation and International Development Association (IEA, IRENA, UNSD, World Bank and WHO, 2021; IRENA and OECD, 2021).

China is a key player in Africa and alone has provided about half of all public financial commitments (mainly for hydropower). These commitments came mainly from the Ex-Im Bank of China, which has provided about USD 26.5 billion for renewable energy projects across more than 20 countries since 2010. The bank committed an additional USD 18.6 billion for fossil fuel projects in the same period (IRENA and OECD, 2021). With China's announcement to halt overseas financing for all new overseas coal projects, more public financial capital could be made available for renewable energy projects in the region.

Debt is the most utilised public financing instrument across the region. In 2010-2019, for example, it made up 86% of all public financing, followed by grants, at 11%. This relative share has continued in the years since then. Within debt, standard loans have been the long-standing instrument, although concessional loans have recently begun to play a larger role, particularly in North, East and Southern Africa. Risk mitigation instruments such as liquidity facilities and guarantees are being employed with increasing frequency in West, East and Southern Africa. These instruments help reduce the cost of financing and help mobilise private investment (IRENA *et al.*, 2023; IRENA and CPI, 2023).

Although this section has focused exclusively on commitment levels, which are a reliable indicator of ambition, the commitment-disbursement gap can reveal how these commitments have translated into actual flows. Sustainable Energy for All (SEforAll) tracked this gap in 20 high-deficit countries between 2013 and 2018; 13 of these countries are in Africa and received a third of the committed amount. The analysis found that in the eight African countries that could be analysed further (thanks to sufficient data), approximately 51% of the projects and 64% of the financing were delayed. The delays were mainly due to poor stakeholder co-ordination, policy and regulatory bottlenecks, limited access to local matching finance and technical issues related to project design (SEforAll, 2020).

2.2.3 Role of DFIs and MDBs in Africa's IPP investments

Development finance plays a critical enabling role in Sub-Saharan Africa, including for the facilitation of independent power producers (IPPs) in the renewable energy sector. Finance can come from a variety of sources, including global MDBs, regional MDBs active in Africa, national DFIs from within African countries and other national DFIs from outside Africa that are active on the continent.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Privately developed, financed, built, owned and operated utility-scale (5 MW+) projects (IPPs) are among Africa's fastest-growing sources of investment. They have gradually spread across the continent, propelled by the restructuring of power markets (see section 4.2.1)

The surge was spurred by the introduction of structured procurement programmes such as feed-in tariffs and auctions (see section 4.1.1). As a result of these programmes, 85% of the IPPs that have reached financial close since 2010 are renewables based, amounting to more than 12 GW of installed capacity.

About a third of the direct investments in IPPs made between 2000 and 2020 came from DFIs and MDBs such as FMO (the Dutch Entrepreneurial Development Bank); Proparco (a subsidiary of the French Development Agency); the International Finance Corporation; the European Bank for Reconstruction and Development; the European Investment Bank and KfW (the German state-owned investment and development bank). By developing, financing and de-risking IPPs, these agencies have played an increasingly important role in mobilising investments over the past two decades.

Support for IPPs from DFIs and MDBs takes many forms, including direct investment (equity and debt), technical assistance and risk mitigation, and structured procurement programmes combining all these instruments (see section 4.1.1). Development support in the form of loans or grants, often paired with technical assistance, can support IPPs at an early stage of development. Prominent examples are the US Trade and Development Agency and the Sustainable Energy Fund for Africa (managed by AfDB); both have provided development grants, typically around USD 1 million, for many utility-scale, renewables-based IPPs. The technical and financial feasibility assessments and detailed environmental and social impact studies facilitated by development funds have been critical in developing an initial IPP pipeline to accelerate sustainable market growth.

Examples of technical assistance include initiatives such as the United States Agency for International Development's Power Africa programme, which has provided technical assistance to a host of African renewable energy projects. Such projects include the 29 MW Senergy 1 solar project in Senegal, where it supported a bankability assessment of the project finance model and power purchase agreement. Also the 158.7 MW Taiba N'Daiye windfarm in the same country, where it provided technical assistance on financing, insurance, negotiation and land rights issues.

About 30% of the finance mobilised for African IPPs engaged in energy generation has been contributed or arranged by DFIs in the form of direct investment (equity and debt). Over 100 IPPs (through direct negotiations and international competitive bidding) have benefitted from these funds, especially since 2012. DFIs have thus been instrumental in attracting finance from private equity partners and commercial debt providers, thanks to their experience in Africa, understanding of the risks involved, access to risk mitigation instruments and the accompanying "halo effect", which may discourage creeping expropriation and payment defaults. Between 2015 and 2020, African DFIs – in particular the AfDB and the West African Development Bank – became more prominent investors in African IPPs; they provided finance to seven of the 13 Sub-Saharan projects that reached financial close in 2020.

Although DFIs have leaned towards renewable energy investments in recent years, motivated by global climate imperatives and sustainability commitments, investments in conventional IPPs were still considerable in 2020. Co-ordinated international support aimed at boosting renewable energy investments further could form a key pillar for a future Green Deal for Africa – underpinning the next stage of the region's development.

DFIs occasionally provide a basket of instruments to support IPPs participating in structured procurement processes; these include technical assistance, financing and de-risking instruments. Technical assistance could be in the form of prefeasibility studies for IPPs (including, for example, site studies and resource analyses) and support in the design of the procurement process, and advice on proposal evaluation and contract negotiations. The provision of bespoke financing and risk mitigation packages effectively increases the bankability of contracts in these programmes and the competitiveness of the bidding process. Examples include the Scaling Solar Programme.

2.2.4 Investment funds in support of renewables in Africa

Several investment funds support renewables in the region. Some are small and focused on a niche set of countries and technologies, while others are large and target a wide range of projects across the continent. These funds are often supported by governments and DFIs and have had some impact on Africa's renewable energy landscape. Examples are provided in Table 1.

Table 1 Investment funds supporting renewable energy deployment in Sub-Saharan Africa

Name	Purpose
Africa Renewable Energy Fund (AREF)	AREF's goal is to improve energy supply in Sub-Saharan Africa, by investing in renewable energy projects that have a track record of successful deployment of mature technologies. The fund size is USD 200 million, and it seeks to have a controlling position at all development stages in projects with 5 MW and 50 MW of installed capacity (Berkeley Energy, 2021).
Beyond the Grid Fund for Africa (BGFA)	Established through an initiative of the Swedish International Development Cooperation Agency, BGFA aims to provide 6 million people in Burkina Faso, Liberia, Mozambique, Uganda and Zambia with access to clean and affordable off-grid energy by 2025. The fund provides financing for companies offering off-grid solutions and offers technical assistance and capacity building for local energy authorities (BGFA, 2022).
Clean Technology Fund (CTF)	CTF is part of the USD 8.5 billion Climate Investment Fund established in 2008 by donor countries and implemented by six multilateral development banks to provide financing and technical assistance for programmes in clean technology, energy access, climate resilience and sustainable forests (CIF(Climate Investment Funds), 2021a). The USD 5.4 billion CTF aims to facilitate the scale-up of low-carbon technologies that result in long-term greenhouse gas savings (CIF, 2021a).
Green Climate Fund (GCF)	GCF, the world's largest climate fund, was established in 2010 within the framework of the United Nations Framework Convention on Climate Change to help developing countries meet their Nationally Determined Contributions and finance climate change mitigation and adaptation. The GCF aims for at least a 50% allocation to climate adaptation investments in the least-developed countries, small island developing states and African states (CIF, 2021b). As of July 2021, the GCF had approved 70 projects in Africa worth USD 3.29 billion – and another USD 7.7 billion in co-financing.
Renewable Energy Challenge Fund (RECF)	RECF is managed by the United Nations Capital Development Fund and funded by the Embassy of Sweden in Uganda. It provides co-financing for decentralised solar photovoltaic solutions in Uganda and prioritises underserved, low-income customers in rural and peri-urban areas. The fund's goal is to help 153 000 Ugandans transition to renewable energy while creating 1 000 new jobs. Grants range from USD 100 000 to USD 500 000 per project (UNCDF, 2021).
Sustainable Energy Fund for Africa (SEFA)	SEFA is a USD 95 million fund managed by the African Development Bank and funded by the governments of Denmark, Italy, Norway, Spain, Sweden, the United Kingdom, and the United States. Its goal is to help unlock private finance for small- to medium-scale renewable energy and energy efficiency in Africa (SEFA, 2020) projects in Africa.

2.3. INVESTMENTS IN OFF-GRID RENEWABLE ENERGY

Decentralised renewable energy solutions, specifically standalone solar home systems (SHSs) and mini-grids, can be a cost-effective way of providing electricity access in Sub-Saharan Africa, especially in rural areas, where grid expansion may not be viable. For that reason, off-grid investments in Sub-Saharan Africa have shown resilience, despite the initial setbacks due to the pandemic during the beginning of this decade (IRENA and AfDB, 2022). Africa as a whole represented 70% of the global off-grid investments over 2010-2021, attracting USD 2.2 billion (Wood Mackenzie, 2023).

Despite the COVID-19 pandemic and its economic fallout, investments in off-grid renewable energy reached a record high of USD 404 million in 2021 from just above USD 0.5 million in 2010. Investments showed strong resilience to the pandemic-triggered disruptions, which exposed companies to a range of financial and operational risks. Supply chain disruptions had an inflationary impact on consumer prices as manufacturing and distribution costs, especially for SHSs, rose across the sector. At the same time, pandemic-related economic impacts depressed household incomes (ESMAP *et al.*, 2022). Many customers defaulted on their bills, leaving companies to identify new ways to secure cash flows while a significant portion of their capital was locked in (IRENA and AfDB, 2022).

However, current investment levels fall far short of the USD 15 billion needed in off-grid solar products and mini-grids to achieve universal access between 2021 and 2030 (ESMAP, 2019; ESMAP *et al.*, 2022).

2.3.1. Investment trends by region

The African continent captures over 70% of the global investments in off-grid renewable energy – because significant portions of its populations lack electricity access. It captured USD 2.2 billion in investments over 2010-2021 (Figure 16).

Within Sub-Saharan Africa, East Africa attracted 43% of the total cumulative investments, receiving USD 952 million (Table 2). East Africa was home to three of the top five recipient countries, namely, Kenya, the United Republic of Tanzania and Rwanda. Investment in these destinations benefited from the existing mobile money ecosystem, which was leveraged by the pay-as-you-go (PAYG) business model. Approximately 78% of the total cumulative commitments in off-grid renewables in 2010-2021 (or USD 2.4 billion) involved the funding of companies or projects using PAYG. East Africa accounted for USD 917 million.

Over 2018-2021, West Africa saw more investment than East Africa. With PAYG sales starting to surpass cash-based sales, the region is witnessing a growing ecosystem of local retailers and international companies (ESMAP *et al.*, 2022). Nigeria is driving this growth as the largest single recipient country in Sub-Saharan Africa as well as globally, having attracted USD 287 million in 2010-2021. Besides a large untapped market and rising diesel prices, this is linked to the implementation of the Nigeria Electrification Program by the Rural Electrification Agency with World Bank and AfDB funding (ESMAP *et al.*, and a regulatory framework for mini-grids. Moreover, Burkina Faso and Mali (two conflict-affected states) have seen positive signs in their off-grid solar sector as governments and development partners are frequently supporting market development through subsidies and result-based financing mechanisms (ESMAP *et al.*, 2022).

Central and Southern Africa together attracted a total of USD 93 million in 2018-2021, as investments picked up over this period. Given the relative nascency of these two markets, public policy and development finance support remains crucial in driving investments. For example, Mozambique's 50% off-grid electrification target (by 2030) has helped attract USD 13 million since 2017. Targeted grants and result-based financing initiatives such as the BRILHO programme (financed by the United Kingdom and Swedish Aid) have helped create an enabling regulatory environment and de-risk investments; in turn, more than 306 000 people and 5 000 small businesses could be provided access through the deployment of SHSs, green mini-grids and improved cooking solutions (SNV, 2021).


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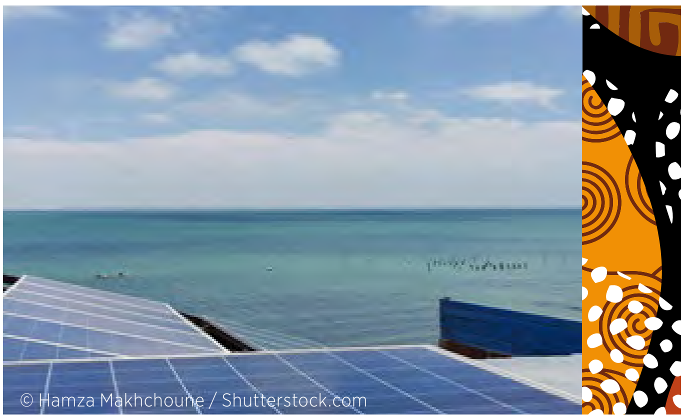
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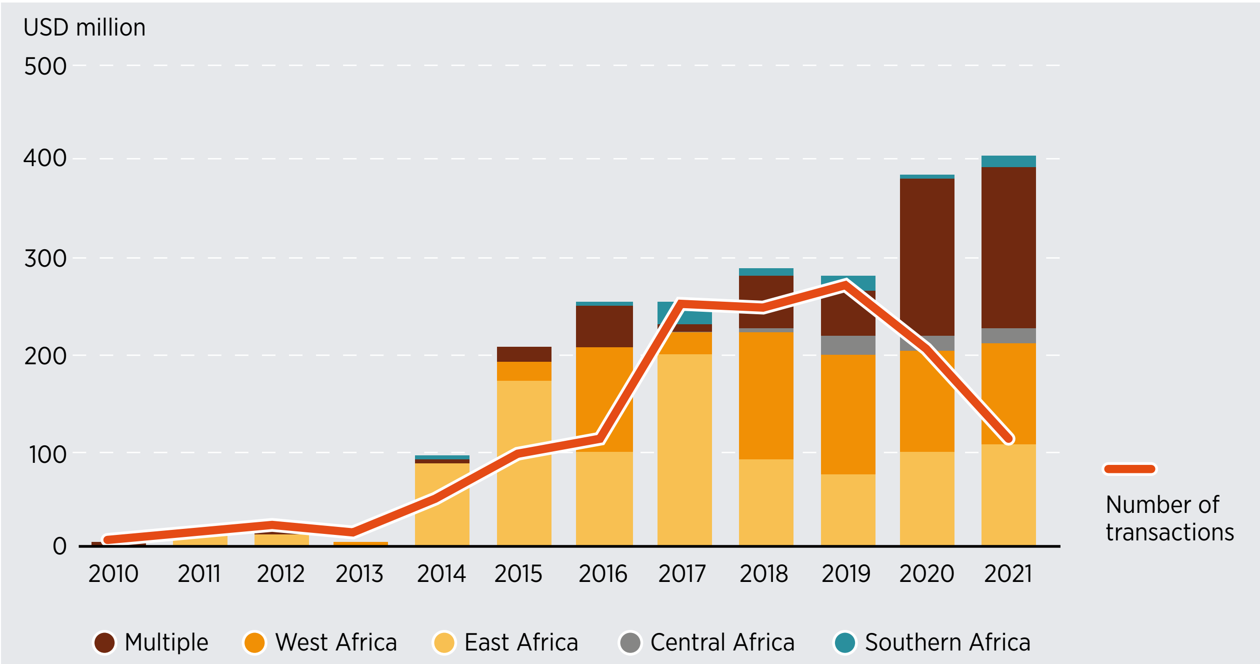
Table 2 Off-grid renewable energy investments in Africa, 2010-2021

(2020 constant USD billion 2010-2021)		2010-2021	Share of global/Africa (%)
USD 2.2 billion Africa's share of global investments: 71%	Global	3 093	
	Africa (% of global)	2 189	71
	Central Africa	54.077	2
	East Africa	951.89	43
	Multiple (including North Africa)	498.12	23
	Southern Africa	63.99	3
	West Africa	620.66	28

Source: Based on: (Wood Mackenzie, 2022).

Figure 16 Investments in off-grid renewable energy technologies in Africa (USD million), 2010-2021



Source: (IRENA and CPI, 2023) based on (Wood Mackenzie, 2022).
Note: 'Multiple' refers to investments going to more than one region in Africa. These investments could not be further disaggregated and have therefore been classified accordingly.

2.3.2. Investments by energy uses and systems

Over 2010-2021, 63% (USD 1.2 billion) of off-grid renewable energy investments in Sub-Saharan Africa was directed to residential energy uses – that is, to provide basic energy access to households in remote areas. The priority given to residential purposes is not surprising given the large number of people still without energy access. About a third of residential commitments went specifically to access-deficit countries, while an additional unidentifiable share went to a combination of countries that may include access-deficit countries.

The past three years (2019-2021) have witnessed a surge in investments in off-grid renewables for commercial and industrial uses; investments have been USD 100 million on average each year, compared with just USD 14 million over the preceding three years (2016-2018). West Africa, particularly Nigeria, is attracting more investments in mini- and micro-grids, which mainly tend to serve the demand arising from commercial and industrial uses,[6] in

6 *Investments for commercial and industrial purposes include decentralised solutions for powering small businesses, solar pumps for irrigation and solar fishing lights.*

addition to residential and community-based activities (*e.g.* schools and hospitals). The regulations launched by the Nigerian Electricity Regulatory Commission in 2017 have facilitated investments in mini-grid projects (IRENA, 2018a). These solutions improve working conditions and promote economic growth, especially in remote areas, advancing progress towards Sustainable Development Goal (SDG) 8 on decent work and economic growth and SDG12 on responsible consumption and production (United Nations, n.d.).

Commitments to off-grid renewable energy solutions for communities and other economic activities remained low throughout the decade, averaging just over USD 5 million per year. These commitments include financing for streetlights as well as for decentralised systems to power hospitals and schools. In 2021, at least USD 3.9 million (or 76% of the investments in this category) were committed to ensuring reliable solar power supply for health centres in various Sub-Saharan African countries in response to the COVID-19 emergency.

Finally, investments in support infrastructure and services, including smart meters and voltage converters, accounted for only 1.5% of the total commitments in Sub-Saharan Africa in 2010-2021. In terms of energy systems, SHSs received the most investments – USD 1.45 billion over 2010-2021, or 66% of the total investments in off-grid energy, mainly for residential energy uses. They are the preferred choice for providing energy access to households in remote areas (up to Tier 3),[7] enabling them to power home appliances such as a refrigerator and a television.

At the same time, the investment mix shifted to more debt and less equity financing (in both absolute and relative terms), indicating a shift in investors' preferred financing source for the solar home systems (SHS) sector. In addition, SHS sales in the two regions also remained strong, even reaching record levels in West Africa in 2020.

Micro- and mini-grids attracted about 17% of the total commitments in 2010-2021, or USD 367 million. The level of investment in such projects increased over time, especially during 2019-2021, due to a surge in demand from commercial and industrial uses. Compared with SHS, micro- and mini-grids can help provide energy access up to a more advanced level (up to Tier 5), and they represent the preferred alternative for commercial and productive energy uses.

Investments in other solar applications, including solar lights, remained low over the decade; they averaged less than USD 5 million per year. Potential for these products remains limited due to their ability to provide only Tier 1 level of energy access (USAID, 2021).

2.3.3. Sources of investments in off-grid technologies

About 57% of the financing directed to off-grid renewables in Sub-Saharan Africa in 2010-2021 came from the private sector; the public sector accounted for about 38%.[8] In 2021, the public sector represented 55% of commitments, up from 33% in 2019, suggesting the need for greater support to the industry during the COVID-19 pandemic, as private investment activity, especially from private equity, and venture capital declined.

As the off-grid renewable energy sector advances, the purpose and share of public investments will shift – the share declining in some regions while increasing in others. In West and East Africa, where investments have been concentrated so far, continued public sector support will be needed to reach remote populations and close affordability gaps. In Central and Southern Africa, where the off-grid industry is still at an early stage, public support is crucial in catalysing the sector's growth by supporting enabling policies and regulations, and through other measures to de-risk investments and encourage market development. Public support represented 61% of the total commitments in Central Africa in 2010-2021 and 45% in Southern Africa. One example of public support is the AfDB's Leveraging Energy Access Finance Framework (LEAF) (Box 1).

7 This refers to the Multi-Tier Framework developed by the World Bank, in which levels of energy access are measured in tiers ranging from Tier 0 (no access) to Tier 5 (highest level of energy access). More details are available in Chapter 6 of this report and at www.esmap.org/node/55526.
8 The remaining 5% could not be attributed to either the public or the private sector alone.

Box 1 The African Development Bank's leveraging energy access finance framework

African governments are partnering with bilateral and multilateral institutions, in addition to the private sector, to finance energy sector development through public-private initiatives. In 2022, the African Development Bank approved a new mechanism to support countries in reaching this goal, the Leveraging Energy Access Finance Framework (LEAF). Under the new framework, the African Development Bank will commit up to USD 164 million to promote decentralised renewable energy in six African countries: Ghana, Guinea, Ethiopia, Kenya, Nigeria and Tunisia. Over six years, LEAF will deploy concessional finance, credit enhancement instruments and technical assistance to crowd in private sector investors, including local banks, to finance and accelerate efforts to power the continent.

A total of 18 decentralised renewable energy projects are expected to be financed; 6 million people and businesses will be provided access, resulting in greenhouse gas emission reductions of 28.8 million tonnes of carbon dioxide equivalent over the systems' lifetime.

The LEAF programme was developed in collaboration with the Green Climate Fund, which approved USD 170.9 million in concessional financing for it in July 2021. The framework forms part of the Bank's broader off-grid strategy under the New Deal on Energy for Africa, which aims to increase the Bank's financial commitment to energy and climate finance on the continent and complements existing initiatives such as the Sustainable Energy Fund for Africa.

Source: (AfDB, 2022).

High shares of public financing support for the off-grid renewable energy sector in Africa are not surprising given the specific contexts in which companies must operate. Off-grid renewable energy investments typically involve companies selling energy products or services to low-income households and to small businesses with little or no credit history – circumstances that often make such companies too risky for local commercial banks and other traditional investors. In these contexts, targeted policy and regulatory support, technological innovation, capacity building, and the application of tailored delivery and financing models can lower the cost of capital for both entrepreneurs and energy users.

Private investments came mainly in the form of private equity or venture capital, with some infrastructure funds. Over 2010-2021, these investors committed USD 612 million, or 49% of the total private investments in off-grid renewable energy; shares slightly increased over time.

In recent years, private corporations and business associations, individuals (mainly through crowdfunding platforms) and commercial financial institutions have also demonstrated increased participation; the sector has a greater diversity of active private investors in turn. Most public commitments came from DFIs, which invested USD 671 million over 2010-2020 (or 91% of the total public commitments during this period). Publicly owned equity, venture capital and infrastructure funds also began investing in off-grid renewables in 2017, while the contribution of government agencies and inter-governmental institutions declined considerably over time.

The varied experiences and levels of development of each region's off-grid renewables sector attracted different types of investors. In more advanced markets, such as those of the West and East, at least half of the commitments came from a combination of private equity, venture capital and infrastructure funds, and institutional investors. In addition, funding from commercial financial institutions and private corporations focused almost exclusively on these two regions, demonstrating the growing commercial viability of off-grid renewables in these markets. Conversely, off-grid renewable energy companies and projects in Central and Southern Africa have relied more heavily on DFIs and government agencies and their funded programmes and partners, besides relying on financing from individuals attracted through crowdfunding campaigns.

In 2020-21, amid the COVID-19 crisis, substantial financing was raised through crowdfunding platforms (*e.g.* Energise Africa, Trine and Lendahand) to refinance existing debt raised in earlier campaigns on the same platforms. This allowed companies to ease short-term cashflows and improve their ability to face the impacts of COVID-19 (IRENA and AfDB, 2022). Financing models such as crowdfunding are allowing African entrepreneurs and off-grid companies to bypass the hurdles of conventional financing. In addition, many COVID-19–related relief funds were announced, including the Electricity Access Relief Fund, which is managed by Social Investment Management and Advisors. In 2020, the United States Agency for International Development (through its Power Africa Programme) provided USD 2.6 million in grant money to power nearly 300 healthcare facilities in Sub-Saharan Africa; this was one of the agency's many recent initiatives.

The lion's share of funding for off-grid renewables in Africa came from investors based in Europe, North America and Oceania. European investors accounted for almost half of the total funding; they invested USD 1.1 billion million in 2010-2021. An additional USD 550 million came from investors based in North America and Oceania (25% of the total). Starting in 2016, investors from the African continent have played an expanding role; they invested USD 55 million on average in 2016-2021, up from just USD 1.7 million in 2010-2015.

Commitments by financing instrument

Over time, as the off-grid sector matured, instruments, along with the projects they financed, have become increasingly varied. Prior to 2014, financing was mainly done through grants and loans. Since 2014, equity and debt have become more prominent as the sector becomes more mature. Transactions classified as blended finance, where public and philanthropic capital leverage private investment, remained low throughout 2010-2019 but have started to mobilise large-sized investments in recent years; for example, in 2020, Greenlight Planet (now known as Sun King) received a USD 90 million blended finance commitment to expand its operations. That single commitment is expected to help deliver over 1.3 million PAYG solar products in Kenya, the United Republic of Tanzania, Uganda and Nigeria (Business wire, 2020).

In addition, relatively established markets such as Kenya and Nigeria are seeing more local currency debt financing. In 2020-2021, about 28% of debt was denominated in local currencies (primarily the Kenyan shilling, followed by the Nigerian naira), compared with just 11% during the pre-pandemic years. This included a USD 75 million equivalent Sustainable Finance Facility for Greenlight Planet Kenya (now known as Sun King) and the USD 127 million equivalent financing vehicle called Brighter Life Kenya 1 Limited. Although the volumes of local currency financing were lower before 2020, a more diverse mix of countries were receiving this financing, including some relatively underdeveloped markets, such as Côte d'Ivoire, Mozambique, Rwanda and Uganda, among others. In 2018, for example, Zola Electric received an equivalent of USD 9 million to provide approximately 100 000 rural households in Côte d'Ivoire with access via SHSs (IRENA and CPI, 2023).

Going forward, low-cost local currency financing will be preferred for the next phase of the off-grid renewable energy sector's development. Established companies are looking to finance the next phase of their development, while younger companies would benefit from the low cost of capital to build profitable businesses and attract equity investors. In the absence of low-cost financing, the burden may fall disproportionately on low-income households as companies seek to increase profitability, and maintain healthy cash flows, to service their debt obligations or satisfy the expectations of equity investors (IRENA and CPI, 2023).

03
POLITICAL COMMITMENTS TO RENEWABLE ENERGY DEPLOYMENT

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Harnessing Sub-Saharan Africa's largely untapped renewable potential could help the continent bridge the energy deficit and create a more inclusive and sustainable energy system. This chapter identifies renewable energy commitments in Sub-Saharan Africa. First, it looks at regional plans and targets (section 3.1); then it looks at national commitments (section 2.2) and city-level strategies (section 2.3).

3.1. REGIONAL COMMITMENTS AND INSTITUTIONS

Sub-Saharan Africa has received significant regional renewable energy commitments both as part of historical long-term planning and, in more recent years, in response to falling technology costs, which have rendered renewable energy technologies increasingly cost competitive with conventional energy sources – in the on-grid as well as off-grid segments (ESMAP, 2022). Regional leaders have also committed to a variety of wider-reaching development plans, for example, inclusive and sustainable economic growth and development in Agenda 2063: The Africa We Want (IRENA, KFW and GIZ, 2021). The strategic framework highlights social and economic development, continental and regional integration, democratic governance, and peace and security among other issues (African Union, 2021).

At the regional level, the twin goals of renewable energy and energy efficiency are supported through the formation of dedicated centres mandated to support the transition, in co-ordination with member countries, donor agencies and other international institutions. Regional centres have co-ordinated the development of energy plans and roadmaps (Table 3). Renewable energy targets for West and Southern Africa prioritise the power sector. West Africa had targeted an increase in renewables' share of the electricity mix to 35% by 2020; for 2030, it is targeting an increase to 48%. In Southern Africa, the share was set at 33% for 2020, and 39% for 2030. A key challenge remains the non-binding nature of these targets; their swift translation into effective national policies will thus be a pre-requisite for credibility and the materialisation of the benefits promised in these regional plans and strategies.

Table 3 Renewable energy regional plans and centres

North Africa	
	**North African** countries have set targets at the national level and together with the other members of the League of Arab States, they have formed the Regional Center for Renewable Energy and Energy Efficiency (RCREEE) to support renewable energy and energy efficiency across the Arab region. The Pan-Arab Strategy for the Development of Renewable Energy 2010-2030 was expanded in 2018 to become the Pan-Arab Sustainable Energy Strategy – 2030 and include energy efficiency and energy access. The strategy aims at reaching a 12.4% share of renewables in the electricity mix, and it is presented with an implementation plan with 17 programmes (6 at the regional level and 11 at the national level) that rest on national efforts, in addition to regional and international co-operation. The strategy suggests shifting Arab electricity markets towards higher shares of renewables, ensuring the needed public and private investments, mitigating most of the risks and challenges related to grid planning, expansion and operation, and integrating smart services and quality assurance schemes. The implementation tool for renewables is the Arab Renewable Energy Framework, which offers guidelines for Arab states to develop their National Renewable Energy Action Plans based on a customised template, serves as baseline for annual progress reports (IRENA, League of Arab States and RCREEE, 2014).
West Africa	
	In **West Africa**, the Economic Community of West African States (ECOWAS) Renewable Energy Policy (EREP), adopted in July 2013 by ECOWAS heads of state and governments, aims to increase the share of renewable energy in the region's electricity mix to 35% in 2020 and 48% in 2030 (excluding large hydropower, this would be 10% and 19%, respectively). Complementing the EREP is the ECOWAS Energy Efficiency Policy, which aims to make available 2 000 megawatts of power generation capacity through efficiency gains and ultimately double the rate of improvements in energy efficiency (IRENA, n.d.a). Following the adoption of the regional policies, all ECOWAS member states developed National Renewable Energy Action Plans, National Energy Efficiency Action Plans and SEforALL Action Agendas between 2014 and 2015. As such, the aggregated targets of ECOWAS members as expressed in their Sustainable Energy Country Action Plans align with the regional targets declared in the EREP (ECREEE, 2018). The ECOWAS Centre for Renewable Energy and Energy Efficiency (ECREEE) was established in 2010 to create favourable conditions for regional renewable energy and energy efficiency markets.
East Africa	
	In **East Africa**, the East African Community established the East African Centre of Excellence for Renewable Energy and Energy Efficiency (EACREEE) in 2016 to facilitate the creation of an enabling environment for renewable energy and energy efficiency markets and investments (EACREEE, 2020). Although all countries have set their targets at the national level, by 2021 there was no regional plan or target set.
Central Africa	
	In **Central Africa**, the 11 ministers of energy of the Economic Community of Central African States (ECCAS) approved a Renewable Energy Roadmap and the creation of the Centre for Renewable Energy and Energy Efficiency for Central Africa (CEREEAC) as a specialised institution. The Renewable Energy Roadmap for Central Africa, developed by IRENA and ECCAS, demonstrates that 77% of the electricity mix could be provided by renewable energy sources (around 25% if large hydropower is excluded) by 2030 (CEREEAC, 2021).
Southern Africa	
	In **Southern Africa**, the Southern African Development Community adopted the Renewable Energy and Energy Efficiency Strategy and Action Plan in July 2017. The regional targets are to increase the share of renewable energy in the region's electricity mix to 33% in 2020 and 39% in 2030. It also mentions increasing the off-grid share of renewable energy as per total grid electricity capacity to 5% in 2020 and 7.5% in 2030 (SACREEE, 2017). The Southern African Development Community Centre for Renewable Energy and Energy Efficiency (SACREEE) was established in 2015 to boost access to modern energy services and energy security by promoting market-based uptake of renewable energy, energy efficiency and energy services.

Disclaimer: These maps are provided for illustration purposes only. Boundaries shown on these maps do not imply any endorsement or acceptance by IRENA.

3.2. NATIONAL PLANS AND TARGETS

Most Sub-Saharan African countries' have by now made some form of commitment to modern renewable energy, for example, through their Nationally Determined Contributions (NDCs), and national energy plans and set targets. By mid-December 2022, 48 Sub-Saharan African countries had submitted NDCs; 43 had sent updated NDCs in 2020-2022. Of the countries submitting NDCs, about 46 included renewable energy targets, of which 45 focused on the power sector, and about 12 included targets on end uses such as heating, cooling and transport (see Annex). Many of these targets remain conditional on international financial and technical assistance, highlighting the need for mobilising more international public finance to these countries.

Attracting public and private investment in Sub-Saharan Africa's energy sector necessitate long-term energy plans that integrate energy needs with sectoral policies and long-term development priorities. These plans must be based on specific needs; macro-economic conditions; resource availability; the established infrastructure; and the level of development, accessibility and cost of technologies. Such plans are necessary to co-ordinate the deployment of renewables-based solutions with measures to develop infrastructure, while sidestepping any collisions on different energy pathways that render assets obsolete.

West Africa is notable on the continent for having integrated renewable energy targets into its national energy plans, which mostly prioritise the power sector (see Annex). Renewable power targets are formulated mostly in terms of installed capacity (megawatts) and renewables' share in the electricity mix. Plans vary in ambition and target dates – for example, in 2021, Cabo Verde set a target share of 100% renewable electricity by 2040 in its national plan. Also in 2021, Togo set a share target of 50% renewable electricity by 2025 in its national plan. Meanwhile, Côte d'Ivoire set a target share of 42% renewable electricity by 2030 in its national plan in 2022. Nigeria released its Energy Transition Plan in 2022; while this plan was aimed as a pathway towards achieving the 2060 net-zero target, it keeps emphasising fossil gas as a "transition fuel" (Federal Republic of Nigeria, 2022). The plan aims to eliminate diesel and petrol generators through the expansion of generation capacity, primarily from solar photovoltaic (PV), by 2050. Nigeria's target by mid-century is nearly 200 GW of solar PV, 11 GW of hydro and 6 GW of biomass (Federal Republic of Nigeria, 2022).

Given the importance of rural access to electricity as part of many Sub-Saharan African countries' development agendas, renewable energy for rural access has become a distinct part of many African countries' planning agendas. As of December 2022, 25 Sub-Saharan African countries had renewable energy targets for rural electrification in their NDCs and national plans; these targets mostly prioritised off-grid solar PV. Almost half of these countries are in West Africa, while Central Africa has the fewest countries with renewables-based rural electrification plans. Clean cooking targets were included in the NDCs and national plans of more than a third of Sub-Saharan African countries (19 countries); these targets include access to cleaner cooking fuels as well as to improved cooking stoves. By 2021, about half of the African countries had also included energy efficiency targets in their NDCs and national energy plans (see Annex).

National development plans also reflect this priority. Nigeria's Economic Sustainability Plan of 2020, for instance, outlines plans for a solar home systems project, which is aimed to cover up to 5 million households and serve about 25 million individual Nigerians who are currently not connected to the national grid. The plan requires solar equipment manufacturers to set up production facilities in Nigeria, in turn offering additional job opportunities to Nigerians (Economic Sustainability Committee, 2020).

When it comes to translating targets into concrete action, specifically in the power sector, most Sub-Saharan African countries benefit from the fact that their power systems are fully or partially state owned, which means that planning for additional capacity is part of central procurement processes, which could help to reach targets. Few African countries, however, have well-functioning procurement planning processes – where the expansion of least-cost power generation is translated into competitive procurement rounds on a timely basis. This results in either underinvestment (most frequently) or expensive overcapacity (in a few recent cases). Some examples are outlined in Box 2.

Box 2 Procurement planning for renewable power plants

The South African government introduced the Renewable Energy Independent Power Producer Procurement Programme (REIPPPP) in 2011 as part of its commitment to implement the objectives of the Integrated Resource Plan (IRP 2010-2030), which aims to diversify the country's energy mix away from fossil-fuel-fired power generation such as coal and crude oil, and add 30 GW to the grid before 2030 (Ministry of Energy, 2011). The programme since then allowed the government to purchase power from lower-emitting energy plants in 2011, besides allowing it to purchase power from renewable sources, funded by independent power producers (IPPs). The country's capacity target from IPP procurement is 29 GW by 2025; it also has ambitious diversification targets for the electricity sector: the government calls for some 37.7 GW of new capacity to be added over 2019-2030 from a diverse mix of energy sources and technologies as ageing coal plants are decommissioned and the country transitions to a larger share of renewable energy (Agrawal *et al.*, 2023; Department of Energy, 2019). South Africa's IRP remains an indicative plan. The IRP sits astride a fraught contest over the country's energy future, delaying procurement and worsening South Africa's protracted power supply crisis (Mukherjee, 2023). While these public procurement plans face delays, South Africa's rolling blackouts have led to an increasing number of private sector companies, and higher-income households, to investment in decentralised renewable energy solutions, mainly based on solar PV (Ferris, 2023).

Kenya's approach exemplifies this model for procurement planning, whereby an integrated national energy plan is reviewed every three years while a least-cost power development plan is updated every two years (RES4Africa Foundation, 2019). This capability, however, has been eroded in recent years, mainly due to unrealistic power demand projections and a reversion to directly negotiated procurement processes (including as part of the feed-in tariff process) (Eberhard *et al.*, 2018). The result has been expensive overcapacity in the system. A similar situation is unfolding in Ghana, where several power purchase agreements were signed with mostly gas-based IPPs outside of any formal planning framework. This is triggering renegotiations for these agreements in both countries, undermining investor confidence and highlighting a procurement planning node for project sustainability.

Namibia has ambitious plans for renewable energy. By 2030, a total of 510 MW of grid-connected renewable energy capacity is expected to be installed, through competitive tenders with IPPs leading to power purchase agreements with Namibia's state-owned utility, the Namibia Power Corporation (NamPower), or regional electricity distributors. The government also plans to accelerate rural electrification with mini-grids using photovoltaics or biomass, again through the use of IPPs, and also boost self-generation by commercial and industrial customers (GIZ, 2022). After opening up its electricity sector to private investment in 2015, the country had 20 operating IPPs by 2018, making it the fourth Sub-Saharan African country in terms of number of IPPs, surpassed only by South Africa, Uganda and Kenya (Kruger, 2022). Solar plants are price competitive in Namibia without subsidies; this means the country's recent years' auctions have achieved some of the lowest prices for solar in all of Africa, well below typical grid electricity prices (Jaeger, 2023).

3.3. THE ROLE OF CITIES

Cities will be critical to the transition of Africa's energy system to one based on renewables and energy efficiency. More than 40% of Sub-Saharan Africa's 1.1 billion population lived in urban areas in 2021, and urbanisation rates are high: the region's urban population increased more than eight-fold between the 1970s and 2020; from 59 million in 1972, it had reached nearly 495 million by 2021 (World Bank, 2023). Higher living standards in cities, higher incomes than in rural areas, and varied housing and transportation needs all translate into a high concentration of energy consumption in urban areas. City-level policies are thus key to achieving renewable energy and energy efficiency targets.

Cities also offer many opportunities for renewable energy in Sub-Saharan Africa. For example, consumers in cities have greater access to technologies and information – a factor important for self-generation; besides, there is potential for renewable energy to contribute to electricity access and service stability. Cities in the region have also seen renewables as an opportunity to reduce air pollution (and thus improve public health), mitigate climate change, create more liveable urban areas and foster a better quality of life through greater access to basic services (IRENA, 2021c).

City governments can help shape Sub-Saharan Africa's energy landscape. Cities have supported local renewable energy deployment in a variety of ways: Increasingly, cities in the region set renewable energy targets and support policies, including Cape Town and Durban (in South Africa) and Kampala (Uganda). They have also supported collaborative projects led by national governments, development finance institutions and/or private actors. Some Sub-Saharan local governments, especially in cities where transport is responsible for a large share of energy consumption, also have entered public-private partnerships to advance e-mobility (sometimes linked to renewable electricity) at the city level (IRENA, 2021c).

Many regional governments and cities in Sub-Saharan Africa have developed their own plans and strategies for renewable energy deployment. This includes signatories to the Covenant of Mayors that have voluntarily committed to implementing climate and energy actions in their communities. Eleven large cities in Sub-Saharan Africa, Accra (Ghana) and Nairobi (Kenya) have pledged to become net-zero emitters by 2050 under the Climate Action Planning Africa Programme by C40 Cities (REN21, 2021a).

To build internal capacity and knowledge, and support the implementation of renewable energy, municipalities in Sub-Saharan Africa have formed partnerships with external organisations and established or joined city networks such as the Covenant of Mayors in Sub-Saharan Africa. Examples of how cities in African countries have supported national renewable energy targets are discussed in in Box 3.

Box 3 Renewable energy in Sub-Saharan African cties

Cities in the region differ widely, including in terms of their national context, population size, level of urbanisation and socio-economic development, and access to energy. These factors influence their sector-wise total energy demand and energy use. The following case studies outline renewable energy trends in five cities.

Cape Town, South Africa

With a dedicated energy and climate change unit, Cape Town is a pioneer in providing affordable and secure energy access while tackling rapid urbanisation and associated energy poverty. The city installed solar photovoltaic (PV) on municipal buildings (alongside energy efficiency efforts), besides developing tariffs and guidelines for the safe installation of distributed renewables on commercial and residential buildings. By 2020, the city had approved about 42 MW of rooftop solar PV. Similar processes, guidelines and tariffs have since been adopted in 40 other South African municipalities. In addition, the city started a roll-out of solar water heaters to low-income communities and is replacing its municipal diesel bus fleet with electric buses. The city is also preparing its power grid for high electric vehicle penetration, with electricity either to be generated by local solar PV or procured.

In a country where most electricity generated is from coal, the city entered into a court challenge with the national government to expand its renewable electricity supply and purchase electricity from independent power producers. In late 2020, a landmark decision amended the national regulations so municipal governments can develop their own generation projects. As a result, Cape Town has begun laying the foundations for supplying renewables at scale.

Dakar, Senegal

The Senegalese capital aims to achieve 15% local electricity production from renewables by 2035, and it is looking to reduce the reliance on diesel power generation, which was 90% in 2013, to 5% in 2035. This climate plan is being developed as part of Senegal's pledge under the C40 Cities Leadership Programme to achieve net zero carbon by 2050.

As in cities elsewhere, transport dominates Dakar's energy demands (accounting for 55% of the total energy consumption). This dominance is reflected in Dakar's deteriorating roads, inefficient public transport and ageing vehicle fleet. The city has launched an ambitious mobility and urban planning strategy to address these issues and reduce air pollution. This plan includes increasing electrification and reducing the reliance on fossil fuels in the transport sector, as well as equipping half of the municipal buildings with distributed rooftop solar PV by 2030.

Kampala, Uganda

In Kampala, the transport sector is responsible for the largest share of energy demand, and it predominantly consists of inefficient motorcycles and private cars running on fossil fuels. In response to these challenges, the city developed its first energy and climate change action plan, which seeks to accelerate renewables' deployment, support a green economy and promote more environmentally friendly public transport. As part of this plan, the city is promoting electric mobility to reduce noise and air pollution, and petrol demand and traffic jams, and has formed public-private partnerships with start-ups. As a result, by 2020, more than 200 new and retrofitted electric motorcycles were introduced in the city (charged mostly from the hydropower-dominant grid).

Tsévié, Togo

This town north of the capital, Lomé, is growing at a rate of 2.8% a year and has minimal industrial activity, with its economy largely built on agricultural activities. Due to low levels of industrialisation and electricity access, traditional biomass (wood and charcoal) is the most important fuel to meet household cooking and water heating needs.

To boost local energy access and development, Tsévié introduced a three-year municipal energy programme, which aims at developing sustainable biomass use, deploying distributed rooftop solar PV, increasing the adoption of electric motorcycles and a gradual shift to public transport. In addition, the municipality has improved access to clean cooking facilities and has distributed 8 200 efficient stoves to reduce the use of biomass for cooking and heating water in households.

Yaoundé IV, Cameroon

Yaoundé IV is one of seven communes of the Cameroonian capital. Yaoundé IV's transport and residential sector accounts for the majority of the city's energy demand. As part of its energy and climate action plan, the city aims to reduce greenhouse gas emissions and increase energy access by 2030; it seeks to do so by boosting renewable energy (*e.g.* fitting 3 000 solar streetlights, installing distributed rooftop solar PV on municipal buildings and distributing 3 600 solar kits to disadvantaged households). Also, the municipality has rolled out a demonstration project to build nine biogas plants.

Source: (REN21, 2021a).

Urban areas are highly suitable to implement and promote self-generation using renewable-energy-based systems, especially based on rooftop solar PV. Several African countries have begun incentivising self-generation through net-metering regulations applied nationally and regionally, with the support of urban centres; these include Botswana, Mauritius, Namibia, Rwanda, Senegal, Uganda and the United Republic of Tanzania. Box 4 offers a case study from Uganda.

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Box 4 The role of cities in renewable energy deployment in Kasese (Uganda)

Kasese's district government has focused on renewable energy deployment as a means to improve health and education, and reduce poverty (KDLG, 2013):

- Ambitious targets are being set under a Kasese District Renewable Energy Strategy, as part of which, the number of institutions using renewable energy and the number of renewable energy enterprises are increasing by 20%; households and local industries using renewable energy will each commit to increase their use of renewables by 10%.
- Kasese is also undertaking a pilot project supported by IRENA – the SolarCity Simulator – which optimises photovoltaic installations homeownerbased on homeowners' assessments of these installations' viability and affordability; commercial entities and municipal authorities can also conduct these assessments.
- The municipality is supporting an initiative inspired by the Supporting African Municipalities in Sustainable Energy Transition project. It helped Kasese fill data gaps in the energy sector, built capacity through courses in professional development, and broadened Kasese's network locally and internationally with funding from the United Kingdom.
- The municipality also took part in the Solar Loan Programme run by a government agency, which facilitates investments and credit support for renewable projects in Uganda. The municipality helped to train workers in installing, maintaining and distributing renewable energy technologies, and fostered partnerships between local businesses and non-governmental organisations (NGOs). Kasese's Conservation and Development Agency, a local NGO, arranged financing schemes for solar photovoltaic and improved cookstoves and trained local producers of briquettes and local arborists and their tree nurseries. Finally, national research institutions provided data and analysis.

Source: (IRENA, 2021c).

While city governments have influenced the shape of the region's energy landscape, including advancing efforts to meet national renewable energy targets, legislative, financial and technological constraints persist in many cities (IRENA, 2021c). These constraints include:

- Limited municipal control over energy supply, grids and infrastructure, which are controlled by national governments and utilities, with an emphasis on centralised, large-scale generation.
- Weak fiscal decentralisation, few funds to invest in infrastructure grids and a lack of access to financial markets.
- Low reported data on renewables, in part due to limited capacity, funding and non-existent internet access; lack of technical equipment; and the absence of systematic and robust data collection. This is also a barrier for private investors.
- Human capacity constraints to taking a more proactive role in renewable energy deployment.

04

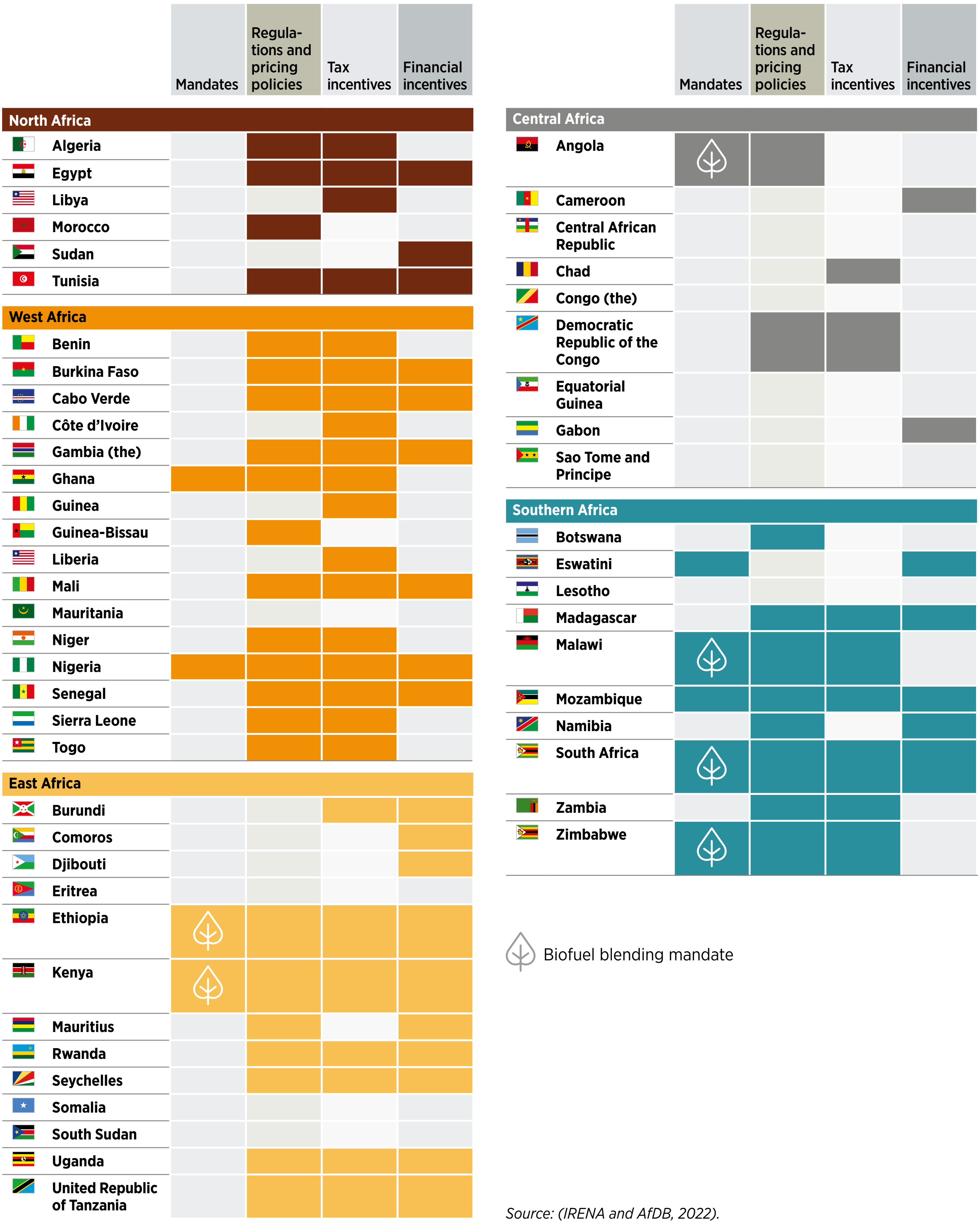
RENEWABLE ENERGY POLICY FRAMEWORKS

A range of policies that cut across all sectors and end uses help create enabling conditions for the accelerated deployment of Africa's energy transition. This chapter reviews the existing policy framework in Sub-Saharan Africa. First, it looks at specific renewable energy deployment policies (section 4.1); then it looks at how enabling policies support the deployment of renewable energy at a larger scale (section 4.2). Sections 4.3 and 4.4 examine in greater detail two separate elements in Sub-Saharan Africa's policy landscape for renewables: green hydrogen and the development of regional electricity markets.

4.1. RENEWABLE ENERGY DEPLOYMENT POLICIES

In the past decade, Sub-Saharan Africa has had an increasing number of direct deployment policies targeting renewable energy technologies; the policies include regulatory measures that create a market for renewable energy solutions and fiscal and financial incentives that make them more affordable. Such policies' variety has been the greatest in East, West and Southern Africa, while few policies have been implemented in Central Africa to date (Table 4).

Figure 17 Overview of deployment policies by region



Source: (IRENA and AfDB, 2022).

So far, most deployment policies in Sub-Saharan Africa have prioritised the power sector, while transport and heating and cooling have received less attention, even as gaps in access to cooling continue to widen, especially for the rural and urban poor. In 2020, 36 Sub-Saharan African countries had regulatory and pricing policies for renewables in the power sector, compared with only seven countries with renewable transport fuel obligations or mandates, and two countries with renewable heat obligations – reflecting global trends (REN21, 2021b). While the power sector is also globally at the centre of renewable energy policies, Sub-Saharan Africa could benefit from exploring the use of renewables in other sectors as well; this includes modern renewable energy for heating and cooling, for use in off-grid areas, agriculture and food processing, for use in other small-scale industries, and for use in clean cooking and in public transport, through electrification (see section 4.1.3).

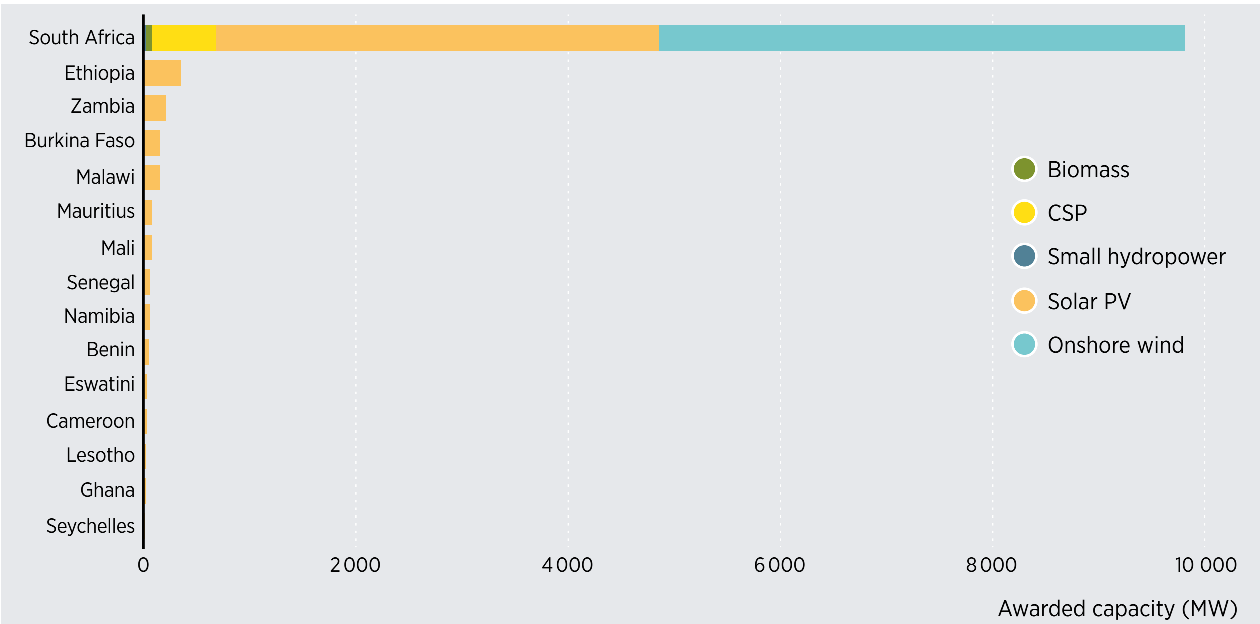
4.1.1. Structured procurement mechanisms

Auctions

Auctions are now widely used in all regions in Sub-Saharan Africa; over half of the countries in each region (except Central Africa) have hosted or at least announced an auction. Since 2010, auctions have been announced in at least 25 African countries; this represents more than 22 GW of auctioned capacity, of which more than 15 GW have been awarded (Figure 17) – with more capacity scheduled to be announced in the short to medium term. This is considerable given that Africa currently has less than 250 GW of installed capacity and about half of the countries have power systems smaller than 500 MW.

Most of the procured capacity is concentrated in Southern Africa, due to South Africa's large power system and economy, its proactive approach towards implementing utility-scale renewable energy projects as a matter of urgency and the success of its Renewable Energy Independent Power Producer Procurement Programme (REI4P). Developments in South Africa hence dominate auctions' success, as well as many other renewable-energy-related indicators in Sub-Saharan Africa. Most of the awarded capacity pertains to solar photovoltaic (PV) projects, although on-shore wind, geothermal, concentrated solar, landfill gas, biomass and small hydro projects have also been awarded. Figure 17 illustrates the volumes awarded in Sub-Saharan Africa between 2010 and 2022.

Figure 18 Renewable capacity awarded through auctions in Sub-Saharan Africa (MW), 2010-2022



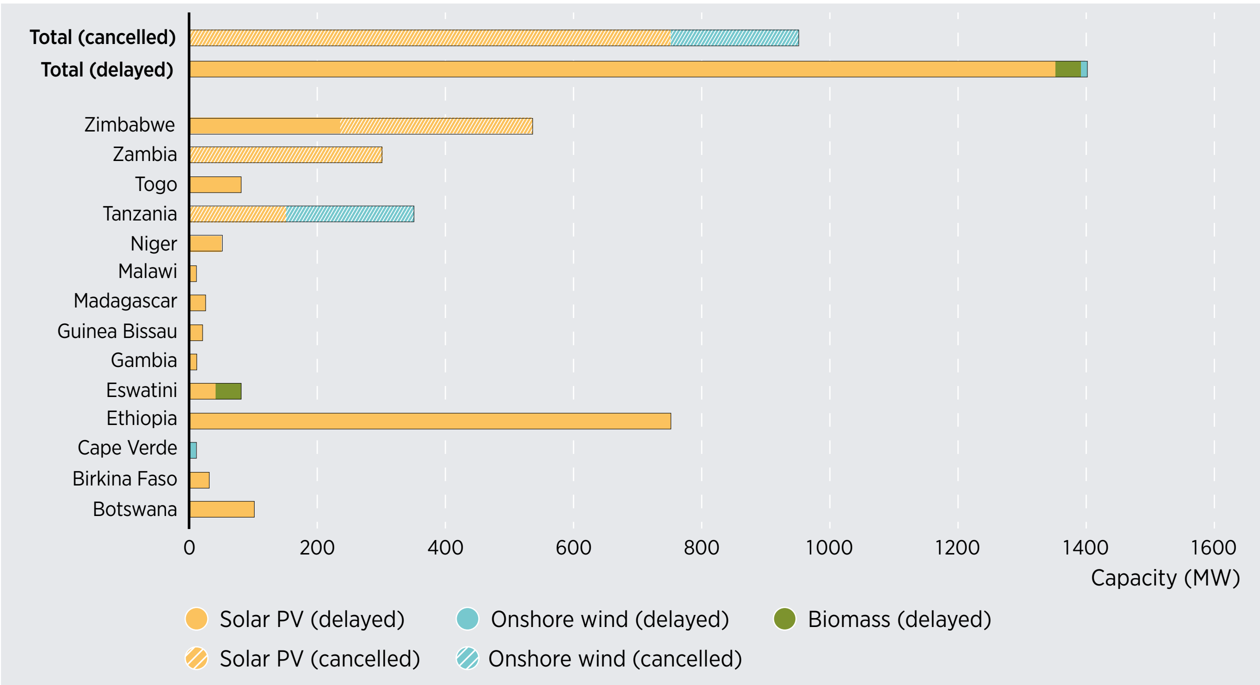
Source: (IRENA, n.d.[b]; Power Futures Lab, 2022).
Note: CSP = concentrated solar power; MW = megawatt; PV = photovoltaic.

Solar auctions have realised prices that have repeatedly broken the continent's solar PV price record. Wind power auctions have yet to gain as much attention as solar PV. Among the strengths of auctions, and an important one in Africa, is their ability to achieve objectives beyond price. Paramount are socio-economic development goals, with extensively reported experience from South Africa. Another objective of growing importance for the region is system integration as the share of variable renewable energy increases. Design elements include hybrid renewable auctions for dispatchable capacity. These produced the Malawi-based Golomoti project, which links PV and a lithium-ion battery, and zone-specific auctions as seen in South Africa (IRENA, 2019b).

Auctions have another objective that is crucial for Africa as many of its countries struggle with undercapacity: ensuring timely project completion. IRENA identifies key stages where auctions can underperform – starting from the auctions' announcement and extending through bidding, award, contracting, construction and operation of the assets specified in the power purchase agreement (PPA). Design elements to ensure performance at each stage are detailed in IRENA, (2019b).

Many auctions have been delayed or cancelled in the bidding and awarding stage – equivalent to almost 2.35 GW, of which 950 MW have been cancelled (Figure 18). There are also examples where awarded projects have failed or are struggling to reach financial close in the contracting stage, undermining investor confidence, affecting competition levels and the cost of capital, and ultimately resulting in higher power prices. Of the volume awarded, as of 2020, projects representing over 7 GW of capacity have reached financial close and moved to construction and commercial operation; this is equivalent to over 60% of the volume awarded.

Figure 19 Cancelled or delayed auctions in Sub-Saharan Africa, 2010-2022



Source: (IRENA, n.d.[b]).
Note: MW = megawatt; PV = photovoltaic.

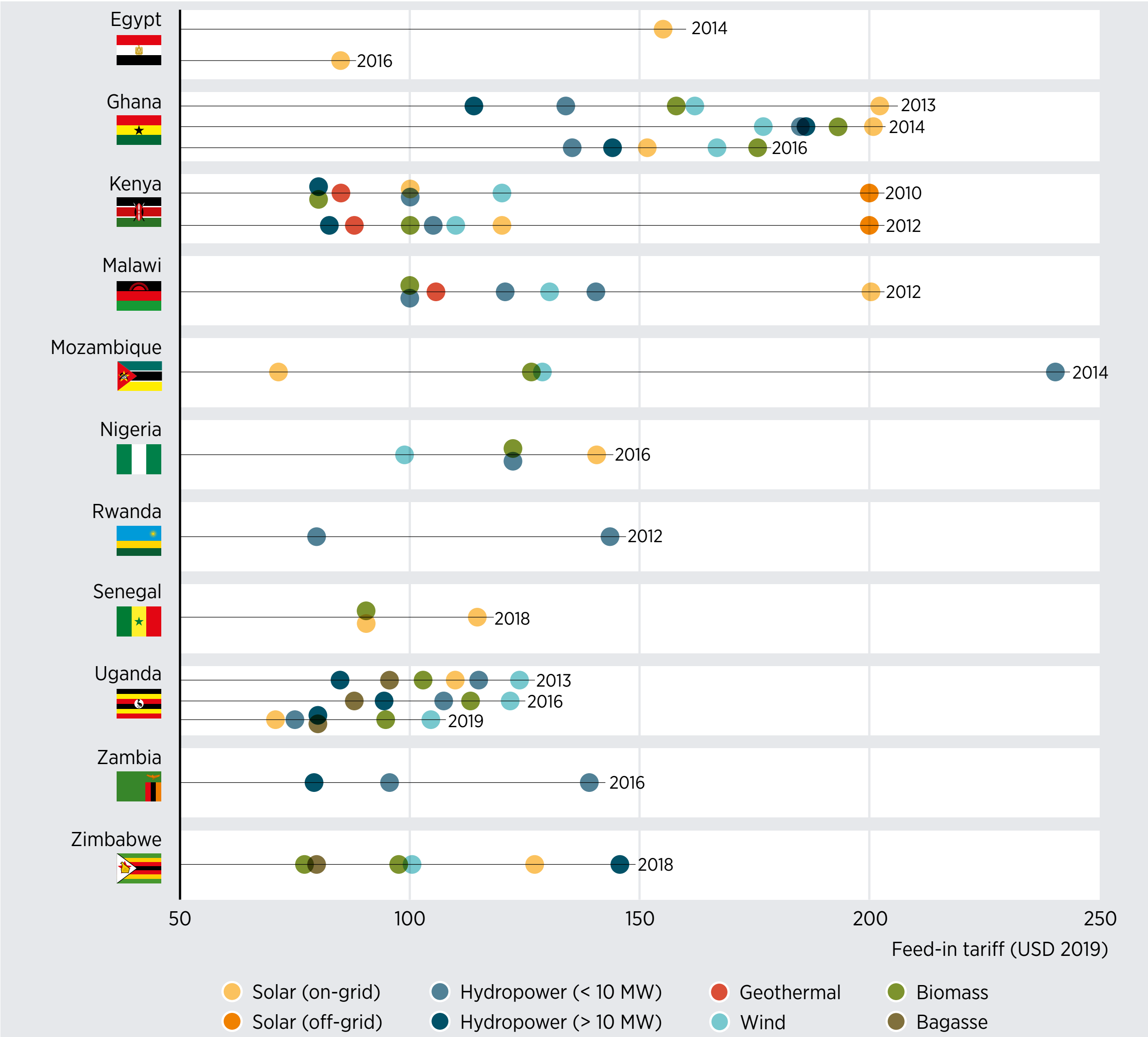
A key feature of several successful auctions in Africa has been the notable presence and support of international and multilateral development partners. The impact of this support was also seen in feed-in tariffs (FiTs).

Feed-in tariffs

FiTs are not widely implemented in Africa. They have been adopted in only about 14 countries and have resulted in meaningful utility-scale investments in only three Sub-Saharan African countries (Kenya, Namibia and Uganda), and were implemented for a total of about 2 GW[9] from solar PV, on-shore wind, biomass and small hydro. All three countries have transitioned or will be transitioning to competitive procurement methods for future projects, aiming for lower tariffs.

Figure 19 shows the tariffs offered in Africa over 2010-2020 for various technologies. In general, FiTs have failed to deliver much investment as they are often not supported by the necessary regulatory and policy reforms or backed by bankable contractual frameworks. Countries such as Angola, Malawi, Mozambique,[10] Ghana and Zimbabwe have had FiT policies on their books for close to a decade but have no operating FiT projects to show for it. Box. 5 illustrates the experiences of Ghana, Kenya and Namibia with FiTs.

Figure 20 Renewable energy feed-in tariff prices in Sub-Saharan African countries



Source: (IRENA, n.d.[b]).
Note: MW = megawatt; PV = photovoltaic.

9 This excludes the Kenya-based 60 MW Kinangop project, which, despite reaching financial close in 2013, failed to be constructed due to conflicts with the local community.

10 A scheme was adopted in Mozambique in 2014, but its implementation was hindered, because the country still lacks the regulatory framework to allow power to be injected into the grid.

Box 5 Experience with feed-in tariffs in Namibia, Uganda, Kenya and Ghana

Ghana initially implemented a feed-in tariff (FiT) strategy in 2011. The strategy did not attract investors, partly because FiT contracts had a ten-year limit and project capacity was capped to maintain grid stability. In 2016, Ghana made efforts to improve its strategy; the contract limit was increased to 20 years and capacity constraints were relaxed. However, unsolicited and negotiated power purchase agreements (PPAs) were preferred to FiTs, and they have resulted in a high-cost system. Therefore, as of 2020, Ghana placed a moratorium on new PPAs until a more sustainable contracting system is developed. Moreover, FiTs increased nominally over 2013-2016 (although they still fell when adjusted for inflation and purchasing power parity), reaching between GHS 529.4/megawatt hour (MWh) and GHS 691.2/MWh (USD_{2019} 607.6/MWh and USD_{2019} 793.3/MWh, respectively). These FiTs are significantly higher than the FiTs found in many other countries. Going forward, Ghana must focus on financially sustainable renewables deployment – for example, through auctions, which, when designed for that purpose, have the ability to discover real prices (IRENA and GIZ, 2021).

Kenya's experience with FiTs has been mixed. The policy was first promulgated in 2008, and revised in 2010 and 2012. The FiT policy differs in that the published tariff levels act as tariff ceilings or caps rather than being guaranteed for approved projects. Final project tariff levels therefore still have to be negotiated and approved – which to a large extent negates many of the advantages (predictability and transparency) associated with FiT policies. By 2018, investors had expressed interest in developing more than 4 000 MW under the policy, including 104 small hydro projects (578 MW total capacity), 19 wind projects (898 MW total capacity), 6 biomass/biogas projects (496 MW total capacity), 2 519 MW of solar projects and 15 MW of geothermal projects (Republic of Kenya Ministry of Energy, 2018). However, only eight projects (representing 361 MW – biomass, solar photovoltaic, on-shore wind and small hydro) have managed to reach financial close.[11] Most projects are stuck at the feasibility study stage,[12] while existing projects (or projects with signed PPAs) face the threat of tariff and dispatchability renegotiations based on overcapacity in the system. In 2022, the government announced that "mature" clean energy sources would be excluded from the national FiT programme; instead "fixed incentives" were offered to biomass, small hydropower and some other renewable energy projects (MWIRIGI, 2022).

Namibia announced an interim FiT programme in September 2015. The programme sought to increase investment from non-hydro sources. Prior to 2015, the country had no private power generation investment; it imported close to 50% of its annual power demand from neighbouring South Africa. FiT levels were based – in part – on prices achieved in South Africa's Renewable Energy Independent Power Producer Procurement Programme (REI4P), although they were still considered attractive[13] and managed to attract substantial local and international interest. Prior to the launch of the FiT programme, Namibia's energy regulator (Electricity Control Board) had granted 27 provisional licenses to renewable energy projects, all of which had failed to secure financing in the absence of a structured procurement process. These projects were invited to participate in the Renewable Energy Feed-in Tariff programme and given six months to submit all documentation to NamPower, the country's state-owned electricity utility. Fourteen projects rated at 5 MW (13 solar PV and 1 on-shore wind) were awarded on a "first come, first to meet the requirements" basis. All facilities reached commercial operation within 12-24 months from award, fundamentally changing the structure and composition of the country's power sector. Namibia's experience with auctions (2016) ultimately ended the FiT programme as it became clear that the project prices achieved through competition were much more attractive.

11 One of these being the aborted 60 MW Kinangop wind project.
12 Many are also held up by a lack of clear guidelines for PPA negotiations.
13 Tariffs were in local currency and indexed to local inflation levels for a period of 20 years.

Grid access, priority dispatch and other forms of generation/consumption

To support renewable energy deployment, open and non-discriminatory access can promote the injection of renewable electricity into the grid. This is often required by law (often referred to as "obligation to take") in many countries. Initially, this provision was included in regulations to support renewables and eliminate relevant risks. However, since renewables' costs have declined and grid operators are less concerned about integrating renewables into the grid, there is wide recognition that renewables must be dispatched first as they have near-zero variable costs. Technical standards for grid connection must be communicated clearly and transparently to generators, and system operators must enforce these standards to avoid synchronisation and system balancing issues in the future.

Ethiopia drafted a transmission grid code in 2018; the right to non-discriminatory access to the national transmission network was established. Similarly, Ghana adopted a national grid code for transmission services in 2009, besides dedicated transmission and distribution (T&D) grid subcodes for renewables. The codes include technical and performance requirements, as well as grid connection procedures and cost allocation. However, there remains room for improvement as regulations regarding priority dispatch and curtailment compensation were not included as of 2020 (RES4Africa Foundation, 2019).

Providing priority dispatch or preferential grid access can support renewable energy development. Although the implementation of this measure is not yet common in Africa, a few countries do have regulations supporting grid access. For example, in 2020, Niger implemented new measures that made renewable energy sources "self-dispatching" – this meant that renewable energy projects are connected to the distribution network and are automatically synchronised, if the appropriate grid voltage is available. This guarantees grid access and priority dispatch for renewables. The Madagascar Electricity Code, established in 2017, provides a framework for priority grid connection and dispatch of renewables.

South Africa's grid code also includes provisions for priority dispatch of renewables, curtailment compensation and coverage for imbalance risk (RES4Africa Foundation, 2019). However, it should be noted that in 2020, the state utility, Eskom, curtailed power from wind generators since COVID-19 lockdowns depressed the demand in the system. In 2021, South Africa announced that projects up to 100 MW will be exempt from the requirement to secure a generation license from the regulator – a process that needed a lot of time (Kuhudzai, 2021) and in late 2023, the government waived the threshold altogether (Kuhudzai, 2023). Since then, South Africa has seen a marked increase in the number of registrations and the size of generation plants; over 2 400 MW of projects were registered in the first three months of 2023 by private firms seeking to generate their own power. Generation projects would still need to obtain a grid connection permit to ensure they meet all the requirements for grid compliance (Kuhudzai, 2023).

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4.1.2. Fiscal and financial incentives to support renewables

The fiscal policies that render renewable energy more affordable include, for example, tax incentives (*e.g.* value added tax), customs and import-duty exemptions, and capital depreciation/capital allowances. African countries have adopted some form of fiscal policy to support renewable energy, mainly in East Africa and West Africa (see Table 4). For example, in 2019, the Ethiopian Revenues and Customs Authority approved import tax exemptions for solar products. While the authority typically charges a 35% duty tax and up to 100% excise tax on imported products, solar products under 15 watts-peak power and quality-certified solar home systems are tax exempt.

Financial incentives are also employed in some cases. Djibouti, for example, provides subsidies for household renewable energy applications. In Namibia, the Solar Revolving Fund provides low-interest loans for the purchase of solar energy technologies including solar home systems, solar water heaters (SWHs) and solar pumps.

4.1.3. Policies for the direct use of renewables: Heating, cooling and transport

A few Sub-Saharan African countries have begun to implement policies targeting the direct use of renewable energy in end-use sectors. This, however, is not yet the policy focus in Africa, where, except clean cooking, the potential for renewable-energy-based heating and cooling solutions on the one hand and transport on the other is significant. To take full advantage of its vast potential in solar, geothermal and bioenergy resources, Sub-Saharan Africa will need to do much more so that it can fuel productive uses such as agriculture and industrial processes.

Heating and cooling

The heating and cooling sector has received little attention when it comes to renewable-energy-based applications, even though it could bring substantial benefits in Sub-Saharan Africa in the future. Besides its direct use in heating water, renewable energy can also make a valuable contribution to space heating and cooling, and in particular, to the agro-food chain. Sub-Saharan Africa faces up to 50% post-harvest losses, with large consequences on food security and the wider economy (CSC, n.d.). Renewable energy, including through flexible off-grid solutions, could help provide better cooling along the agri-food chain. Similarly, renewables-based refrigeration could increase access to vital medicines and vaccines and reduce vaccine waste (Everitt 2022; see also Box 6).

The potential for sustainable cooling solutions for Africa has been increasingly recognised, including through the creation of a dedicated research centre, the Africa Centre of Excellence for Sustainable Cooling and Cold Chain (ACES), which is based in the University of Rwanda (University of Rwanda, 2020). Ghana and Kenya are partner countries of the Green Cooling Initiative (part of the GIZ programme Proklima), which seeks to raise international awareness of the mitigation potential associated with environmentally and climate-friendly cooling technologies and supports countries' efforts in mitigating greenhouse gas emissions from cooling equipment (Green Cooling Initiative, 2022).

Kenya has begun to tap geothermal energy for commercial agriculture. Being an African front-runner in developing geothermal resources of its Rift Valley, in 2023, it had two geothermal power plants, with total installed capacity of over 828 MW (EPRA, 2023). The plant in Oserian, near Lake Naivasha, uses geothermal steam to warm greenhouses and generate electricity (Yee, 2018). Kenya's success in leveraging its rich geothermal resources for direct heating and productive use is attributed to:

- integrated geothermal energy and rural development plans;
- active engagement with local actors and promotion of partnerships;
- assessment of specific productive-use activities in the early stage; and
- a strong focus on capacity building for end users.

District heating and cooling (DHC) networks also have great but untapped potential in Africa. Although capital-intensive, well-designed DHC networks can present the most cost-efficient and technically feasible solutions for Africa's growing heating and cooling needs, especially in cities. Small-scale DHC networks are being deployed globally to service larger buildings or groups of buildings, for example, university campuses or hospitals. All these institutions will require more cooling as climate change and global warming progress; thus, these technologies will potentially be much more important in coming decades.

In **industry**, bioenergy has been used in co-generation. In the city of Lugazi (Uganda), where many households make a living from agriculture, crop residues and farm waste play a huge role in energy generation (BDLG, 2016; Drake *et al.*, 2017). Lugazi's largest industry, the Sugar Corporation of Uganda, established a bagasse-fired co-generation plant with a capacity of 9.5 MW (MEMD, 2015). Eco-Fuel Africa has converted farm and municipal waste into briquettes and biochar fertiliser with simple, low-cost technologies that draw on local fuel usage (Gebrezgabher and Niwagaba, 2018).

Gas grids could expand to biogas and biomethane, provided waste is better managed, with the positive side effect of also lowering methane emissions. Biogas could have substantial potential for Africa's agricultural producers, as well as for waste-to-energy. National strategies and roadmaps will need to define the role of renewable gases more clearly, if the potential of the existing gas network infrastructure is to be harnessed, renewable gases are to be accommodated and demonstration projects are to scaled up (IRENA, REN21 and IEA, 2020).

While renewable energy can have multiple uses in the heating and cooling sector in Sub-Saharan Africa, most policies to date prioritise clean cooking and water heating. Policies to promote solar water heating are common in **East Africa** (Kenya, Mauritius and Rwanda), and in **Southern Africa** (Zimbabwe, South Africa and Eswatini). Typically, these policies offer subsidies to support SWHs. **South Africa**'s state-owned utility, Eskom, implemented a SWH rebate programme in two phases, 2008-2013 and 2010-2015. In 2011, Rwanda rolled out its flagship programme, SolaRwanda, which provided grants and loans for residential SWHs. By 2018, 3 400 units had been installed (Oirere, 2018).

In **Kenya**, a building regulation mandated the use of solar thermal systems to heat at least 60% of the hot water supplied to new, expanded or renovated commercial and residential buildings whose daily hot water usage exceeds 100 litres (REN21, 2019). A privately owned equity bank collaborated with companies to provide preferential loans with longer tenures to small-scale residential SWH users (Hakeenah, 2018).

In **Zimbabwe**, incentives for SWHs are considered alongside regulations restricting the installation of electric heaters. In 2019, a regulation banned the installation of new electric heaters (geysers), subject to certain exemptions (for example, if the premises use renewables-based electricity and divert excess electricity to heat water). SWH systems are to be used instead of electric heaters. The regulations also govern the licensing, operation, repair, maintenance, retrofit and upgrade of these SWH systems. In **Mauritius**, a Deep Ocean Water Applications project proposes to air condition buildings in Port Louise with seawater captured at the coldest depths of the Indian Ocean.

Box 6 Cooling access gaps for the rural and urban poor at highest risk in Africa

An analysis of 31 African countries with rising temperatures has found that close to 390 million of the rural and urban poor are the most vulnerable due to lack of financial capacity to adapt and invest in the necessary technology. In rural areas, approximately 174 million people are at high risk due to lack of access to cooling. These individuals represent 39% of Africa's rural population and 21% of its total population. The number increased by 11.4 million over 2020 in 2021 - a larger increase than in previous years. This was partly due to the poverty caused by the COVID-19 pandemic, although it continues a trend that began in early 2020.

In cities, lack of cooling access exposes 215 million of the urban poor to the highest risk – an increase of 8 million over 2020. More than 70% of the urban populations in the 16 countries of Angola, Benin, Burkina Faso, Chad, Congo, Guinea-Bissau, Liberia, Malawi, Mali, Mozambique, Niger, Nigeria, South Sudan, Sudan, Togo and Uganda are at high risk. Those in the lower-middle-income group will soon be able to purchase the most affordable air conditioner or refrigerator on the market – a growing trend in Africa, increasing by 43 million people since 2018. Among these three groups, approximately 776 million people across the 31 high-impact countries in Africa, or 93% of their total population, face cooling access challenges.

Source: (SEforAll, 2020).

Clean cooking

Renewable energy can also play a crucial role in accelerating progress towards universal clean cooking access in Sub-Saharan Africa – a target that has seen insufficient progress and investment to date. Several renewables-based cooking options exist, involving both cleaner bioenergy solutions (including biogas and bioethanol) and renewables-based electric cooking. Biogas is one of the cleanest cooking options; it produces very low indoor emissions and brings multiple environmental and social benefits (IRENA, 2017). Most rural households without access to clean cooking fuels engage in smallholder farming, and many keep livestock. The manure and other agricultural waste can be used as feedstock for biogas production; digestate, a by-product of the process, can be used as fertiliser. There is also scope for village- or institutional-scale biogas production with adequate feedstock availability.

Several African countries have implemented market-oriented biogas programmes, which have helped boost deployment over the past decade (Box. 7). Senegal set up a new National Domestic Biogas Programme in 2019; in 2021, the Swiss government announced its support for the programme's aim to develop 60 000 biodigesters, which will utilise cattle dung and faecal sludge (Magoum, 2021). Senegal is also one of eight founding nations in the Biodigester Alliance of West and Central Africa, which seeks to accelerate the use of biogas in the region (AB-AOC, 2021). A major development in recent years has been the entry of pre-fabricated modular systems in East African markets, particularly in Kenya. One of them, the Mexican social enterprise Sistema.bio, has sold over 4 000 biodigesters; it also offers finance, after-sales service and training. These developments indicate the potential for biogas in Sub-Saharan Africa. The number of Africans cooking with biogas was estimated to be 410 000 by 2019 (IRENA, 2021b), which is, however, less than 0.5% of Africa's biogas potential. There may be scope for deploying digesters in 18.5 million households (World Bank, 2019).

Scaling up biogas across more countries will require supportive policy and regulatory frameworks that link agricultural policy with energy policy. Affordability remains a major challenge, as with other clean cooking solutions. In the short to medium term, some financial support will be needed to improve viability for end users, strengthen biogas companies and build markets. A lack of awareness of the existence and benefits of biodigesters is also a major barrier (World Bank, 2019).

Electric cooking gained a foothold in only a few African countries. It did so in South Africa, whose national grid is, however, mainly coal based, with only 10% of electricity generated from renewables (Malinga, 2021). Electric cooking on alternating current grids is already cheaper than cooking with charcoal in some African urban centres (ESMAP, 2020; Sánchez-Jacob *et al.*, 2021; Scott and Leach, 2023). The widespread lack of electricity access in Sub-Saharan Africa, combined with the inefficiency of available appliances (such as hot plates), prevents electric cooking from being seen as a viable solution (Scott and Leach, 2023). With the decline of solar PV and battery costs, renewables-based electric cooking has become more affordable in certain settings. Between 2016 and 2019, the cost of solar modules and lithium-ion batteries declined 30-50%, and electric cooking appliances became more efficient (Couture and Jacobs, 2019; Efficiency for Access, 2019). The expansion of mini-grids in several Sub-Saharan African countries also offers opportunities to expand electric cooking. Solar mini-grids are often underused; using solar power for cooking offers an opportunity, with electricity tariffs and effective demand-side management being the key enablers (Onjala, 2020; Kweka *et al.*, 2021).

Box 7 The Africa Biogas Partnership Programme, 2009-2019

The African Biogas Partnership Programme (ABPP), which was launched in 2009, sought to develop a viable biodigester market in Sub-Saharan Africa. The development organisations, Hivos and SNV, implemented the programme in two phases. Phase I, 2009-2013, covered Burkina Faso, Ethiopia, Kenya, Senegal, the United Republic of Tanzania and Uganda. Phase II (2014-2019) excluded Senegal. Phase I prioritised technical and institutional capacity building. While deployment targets were largely not met due to challenging conditions, adoption grew. In Burkina Faso, a lack of local skills, a weak private sector and difficult climate conditions resulted in only 44% of the target being met (Fair & Sustainable Consulting, 2019).

ABPP shifted its focus in Phase II; incentives targeting producers and other upstream actors instead of consumers were added (Clemens *et al.*, 2018). Over 38 000 biogas digesters were installed in Phase II, which ended in 2019 (REN21, 2021b). While installations remained well below the target of 100 000, the programme did make some progress towards commercially viable biogas markets, especially in Kenya.

A follow-up programme, the African Biodigester Component, has received funding for 2021-2025. It is being implemented in Burkina Faso, Kenya, Mali, Niger and Uganda by the Netherlands Enterprise Agency in partnership with EnDev. The goal is to deliver 50 000 small digesters by 2025, partly by improving access to finance and strengthening biogas enterprises.

Sources: (Clemens et al., 2018; Fair & Sustainable Consulting, 2019; REN21, 2021b; RVO (Netherlands Enterprise Agency), 2021; SNV, n.d).

Transport

Renewable energy use in Africa's transportation sector lags behind that of electricity, with scant progress in recent years. Policies prioritise biofuel blending; currently, 6 out of 36 Sub-Saharan African countries have some form of biofuel blending mandate (Table 4). The gap between regulation and implementation means many mandates go unenforced, mostly because of insufficient local supply. **Senegal** and **Uganda** have biofuel laws regulating blending, but nothing with mandates.

Few African countries have implemented policies or projects for electric mobility. This is hardly surprising since most still have an electricity deficit and electric vehicles (EVs) remain largely unaffordable. Although the extent to which electric mobility counts as a decarbonisation solution depends on the electricity mix, investing in EVs as most countries start expanding their fleets could align well with a future renewables-based electricity mix.

The potential for electrified transport in Africa is considerable especially for public transport such as trains and buses, and will likely grow also for private EVs as urbanisation and income levels grow, especially in cities. Sustainable, quality public transport within and between cities is critical not only for improving safety and quality of life of Africa's rapidly expanding urban population, but also for progressing many other socio-economic development goals. Such goals include greater access to economic opportunities for rural and urban residents, less traffic congestion and less air pollution. The gradual electrification of public transport could in particular also help reduce the need to subsidise transport fuels, which continue to receive hefty public spending across Africa, in response to the perceived need to keep transport affordable for people (IMF 2023).

As in other parts of the world, promoting transport electrification in Sub-Saharan Africa relies on upfront investment in infrastructure, especially charging stations, the majority of which will have to be borne by governments. Promoting electrified (public) transport in Sub-Saharan Africa will thus require significantly more commitment by national and regional governments, and municipalities, as well as much greater international financial support for such policies in Africa. The United Nations Development Programme has initiated an electric mobility project across Africa. Over USD 70 million have been mobilised for the project's implementation, and the Global Environmental Facility, the European Union, the German Climate Initiative, the Climate and Clean Air Coalition, the FIA Foundation, and other foundations and bilateral donors have provided financial support (UNEP, n.d.). This is a model case, which might be one way of promoting more necessary investment in electrified-transport-related infrastructure.

Promoting transport electrification in Africa must also be seen in the context of increased demand for the critical minerals needed for EV production, including lithium, cobalt and graphite, the demand for which will grow as EVs' use increases. Africa is a potential producer of many raw materials associated with EV technology. Transport electrification will thus also have to go hand in hand with the promotion of better environmental and social safeguards and regulatory instruments in Africa's mining industry.

Ghana launched an EV initiative, making several charging stations available for use by POBAD International and Ghana's electricity company (Box 8). In 2020, the Seychelles Ministry of Environment, Energy and Climate Change launched an electric mobility project with the Department of Land Transport. Its pilot phase involves the introduction of two electric public transport buses and is to start in 2021. Cabo Verde adopted an electric mobility policy charter whose goal is to replace internal combustion engine vehicles with EVs – a 100% EV fleet for public administration by 2030 and 100% electrification by 2050.

Box 8 The deployment of electric vehicles in Ghana

Ghana's Energy Commission launched the Drive Electric Initiative in 2019. Ghana has excess electricity generation capacity; of this, some can be taken up by electric vehicles (EVs). At the end of 2019, Ghana had about 5 000 MW of installed generation capacity, whereas peak load was 2 612 MW. The country moved from a deficit to excess generation capacity in just a short period after a rush of independent power producers moved in to address the deficit. "Take or pay" clauses in the producers' contracts mean that excess electricity must be paid for. This means Ghana is paying over USD 500 million annually for unused power generation capacity.

Ghana's EV market is growing through start-ups such as SolarTaxi and Accraine Ghana, which are leasing EVs, EV accessories and used EVs imported from Europe. POBAD International has partnered with the national power utility to install EV charging stations across the country. In the project's first phase, POBAD will install 200 chargers across southern Ghana.

In 2023, Ghana launched its Ghana Automotive Development Policy, which seeks for the development of an EV industry in the country to substitute imports and generate a new export industry. The policy offers incentives to producers, including a five-year corporate tax holiday for enhanced semi knocked down (SKD) registered assemblers and a ten-year corporate tax holiday for registered completely knocked down (CKD) assemblers and component manufacturers; also included in the policy are exemptions from import duties and related charges on plant machinery, equipment for SKD, enhanced SKD and CKD auto assembly. This creates an lucrative investment environment.

Sources: (Kuhudzai, 2020; Shaibu, 2023).

South Africa has ambitious targets for EVs. The country's Green Transport Strategy 2018-2050 proposes a modest 5% transport emission reduction goal by 2050. The strategy also highlights investments in biogas filling stations and electric car charging points (DoT, 2018). South Africa's Nationally Determined Contribution includes transport-related commitments such as a target of 20% of hybrid EVs by 2030 and more than 2.9 million electric cars on the road by 2050. Achieving these targets will require approximately ZAR 6.5 trillion (USD 440 billion) of new investment in the EV industry over the next four decades (Grabosch, 2018). Nearby **Namibia** aims to have 10 000 EVs by 2030 (SLOCAT, 2021). In 2016, South African Airways became the first airline on the continent to power commercial flights with biofuel produced locally and certified by the Roundtable on Sustainable Biomaterials (Biofuels International, 2019).

Some countries and cities have adopted fiscal incentives and demonstrations. The Government of **Mauritius** has halved excise duties, road taxes and registration fees for electric cars and hybrid vehicles since 2009 to promote the development of low-carbon transport (GFPN, 2017). The Government of **Rwanda** approved new incentives to catalyse EV adoption. The incentives include a preferential corporate income tax rate of 15% for e-mobility investors – half of the 30% standard tax rate (MININFRA, 2021). Other policies include reduced electricity tariffs at the industrial level and rent-free land for the installation of charging infrastructure in some cases (GGGI, 2021).

City-level demonstration projects are underway in **Cape Town** (South Africa), where two electric buses were deployed for daily public transport operations after a 12-month testing period (ESI Africa, 2021). **Addis Ababa** (Ethiopia) has a pilot project for electric buses (Endale, 2020). Renewable energy deployment and supporting policies for other forms of transport, such as railway, maritime and aviation, however, remain very limited.

The potential for transport electrification is large once vehicle costs reduce, given the promise of cost-effective, solar-based charging stations that could help many private users reduce their reliance on public petrol stations. So far, investment in EV infrastructure has prioritised a few cities and demonstration projects in Sub-Saharan Africa (UNEP, n.d.). In December 2020, the city of Cape Town (South Africa) launched the first of two solar-powered EV charging stations that will be offered free of charge to the public for the first two years (Pombo-Van Zyl, 2020). In 2021, Nigeria commissioned its first solar-powered EV charging station at the University of Lagos (Tena, 2021).

Electric two- and three-wheelers provide a cost-competitive alternative to decarbonise road transport in Sub-Saharan Africa. In 2022, Africa had 27 million registered two- and three-wheelers; 80% of these are used as passenger taxis and for delivery services. Nigeria, Burkina Faso, Kenya, the United Republic of Tanzania and Uganda are major two-wheeler markets, with 1 million to 5 million motorcycles. South Africa and Namibia have fewer motorcycles, about 600 000 and 65 000, respectively (FIA Foundation, 2022). Almost all these two- and three-wheelers are powered by fossil fuels, which represent a significant share of transport fuel consumption and air and noise pollution.

Two- and three-wheeler electrification offers great potential to improve local air quality, reduce noise pollution, mitigate greenhouse gases and save costs for riders. Some examples emerge in a few countries. A Kenya-based start-up Zembo, which operates electric two-wheelers and provides a battery swap service, has planned three solar-powered charging stations to provide charging services. The company also promotes a "rent-to-own" business model, which allows motorcycle taxi drivers to own their electric two-wheelers after two years. Electric motorcycles can enable motorcycle taxi drivers to help their riders save 60% on costs as compared with petrol motorcycles (PREO, 2022). Today, over 20 start-ups and companies are promoting and developing electric two- and three-wheelers in East Africa (IKI, 2021).

However, the uptake of electricity-powered alternatives remains low due to different challenges, including low awareness of the viability and benefits of electric motorcycles, the potential risk of fire due to overcharging, and lack of supply of renewable electricity and charging networks. Additional policy support is needed to accelerate the deployment of motorcycle and charging infrastructure and strengthen technical and financial assistance. International stakeholders can also play a role. In East Africa, the United Nations Environment Programme is working closely with governments in Kenya, Uganda, Rwanda, Ethiopia, Burundi, Madagascar and Seychelles to spearhead the region's electric mobility transition (UNEP, 2018).

4.2. ENABLING POLICIES

Governments play a central role in creating market conditions for renewable energy technologies to succeed. This includes the elimination of market distortions that favour fossil fuels, in particular, fossil fuel subsidies; investment in infrastructure such as power grids, heating and cooling networks, and, in markets with prospects for transport electrification, EV infrastructure; and investment in domestic research and development (R&D) capacity, and information and consumer protection, including through new regulations. This section explores these wider market policies and reforms in more detail.

4.2.1. Power sector organisational structures

The organisation of national utility markets, including decisions over who can invest in, produce and feed electricity into the grid, are critical to the levels of investment and the choice of the fuels and technologies used in any country. A number of Sub-Saharan African countries have over the past decades engaged in progressive sectoral reform to boost private sector investment, and eventually boost generation and grid capacity in line with their growing populations and economies. This includes vertically unbundling national monopolies into separate generation, transmission and distribution companies; horizontally unbundling generation and retail; allowing private sector participation and introducing market competition through large-scale power contracting.

Many of these sectoral reforms have been implemented only partially, to address specific issues across varying contexts: **Nigeria** and **Uganda**, for instance, have instituted structural reforms to improve operational efficiency and boost electricity access. **South Africa** permitted private investment in independent power producers (IPPs) to boost generation capacity in light of recurrent blackouts, although enormous challenges in reaching sufficient electricity generation capacity remain. At the time of writing, most Sub-Saharan African utilities remain vertically integrated monopolies. By 2019, national utilities had a partially or fully unbundled structure in only 10 of 42 African countries surveyed by the African Development Bank (AfDB, 2019a), implying limited scope for electricity generation through private enterprise. The off-grid sector often constitutes the most important exception, often with specific rules, but by and large, the policy environment for renewable energy in many countries remains challenging.

One increasingly used structural market reform in Sub-Saharan Africa has been regulatory changes to allow for private investment in new electricity generation through IPPs, many of which, though, opt for fossil-fuel-based electricity generation, often in combination with fiscal incentives including subsidies on the fossil fuels used. Regional IPP investment trends show that power investments track resource potential. For instance, West Africa has the greatest proven gas reserves and the most gas-fired IPPs by installed capacity in Sub-Saharan Africa. Similarly, IPPs could in the future follow the sizeable potential for solar energy, and in parts of Africa, wind power, if political direction and fiscal incentives shift away from fossil fuels to renewables.

East and Southern Africa have attracted more investment into their solar PV and wind resources than any other parts of Africa. Kenya and Ethiopia have invested into their geothermal resources, besides wind, solar and hydropower. In Central Africa, private investment has predominantly gone into hydropower, for example, Cameroon's 420 MW Nachtigal hydropower plant, the largest privately owned project on the continent. But aside from a few large projects, the Central African power sector has seen less private investment compared with other regions in Africa. Lack of institutional capacity, off-takers' poor financial condition and countries' risk profiles contribute to comparably limited investments in renewable energy (IRENA and AfDB, 2022; UNECA, 2021). Hydropower in such markets is often seen as the least-risky technology, given it has already been established, and thus it attracts public investment first; however, environmental, climatic and socio-political concerns all mean that such projects can carry substantially more environmental, social as well as legal risks than wind and solar projects (see Box 9).

Box 9 Large-scale hydropower: Environmental and human rights implications

Large-scale hydropower projects often exert severe impacts on the environment and on communities and people. Environmental impacts include far-reaching changes to rivers' ecosystems, pollution through waste and hazardous materials, noise, dust, air quality, erosion and sediments, and, in many cases, losses to the natural architecture of riverbeds and the surrounding environment. Local communities and peoples can be deeply affected by these environmental impacts, including through loss of livelihoods due to declining fish populations and loss of access to safe drinking and irrigation water; physical and/or economic displacement of communities and peoples without fair and adequate compensation, often leading to subsequent loss of culture and traditions, community cohesion and identity for indigenous peoples; threats, intimidation and violence against human rights defenders via actions of security personnel; and other infringements on the rights to freedom of expression, association and peaceful assembly, among others.[14] These impacts are in addition to impacts on labour rights impacts linked to poor working conditions, health and safety hazards on construction sites, or the lack of a living wage.

But such projects also involve significant risks to various other stakeholders. These risks could include, for instance, delayed or foregone realisation of investment benefits due to conflict with aggrieved project-affected communities; legal risks stemming from action taken against host states in domestic and international courts; and reputational harm for the governments and foreign companies investing in large-scale hydropower, as well as development finance institutions financing and facilitating projects that adversely affect human rights in developing countries. Foreign companies investing in these projects also carry significant financial and legal risk, as failure to address investments' adverse human rights impacts may cause project delays or cancellations. This is in addition to cross-border conflicts potentially arising as a result of new, large dam constructions on rivers passing through multiple countries. Climate change already complicates this situation, and will likely affect the effective capacity of many hydropower stations over the coming decades.

New, large-scale hydropower projects will thus need to carefully consider all risks involved, as well as the necessary safeguards to protect the environment and human rights. Key to this is the implementation of well-designed and implemented strategic environmental assessments at the policy level, and environmental, social and human rights impact assessments that are based on effective collaboration with local communities and offer them protection against land acquisition without free, prior and informed consent. Rights protection must be given careful attention. Attention must also be paid to assessing the full implications of any investment incentives in the renewable energy sector for land availability and public revenues.

Sources: (Agrawal et al., 2023; IRENA, 2023; Waters-Bayer and Wario, 2022; World Commission On Dams, 2001).

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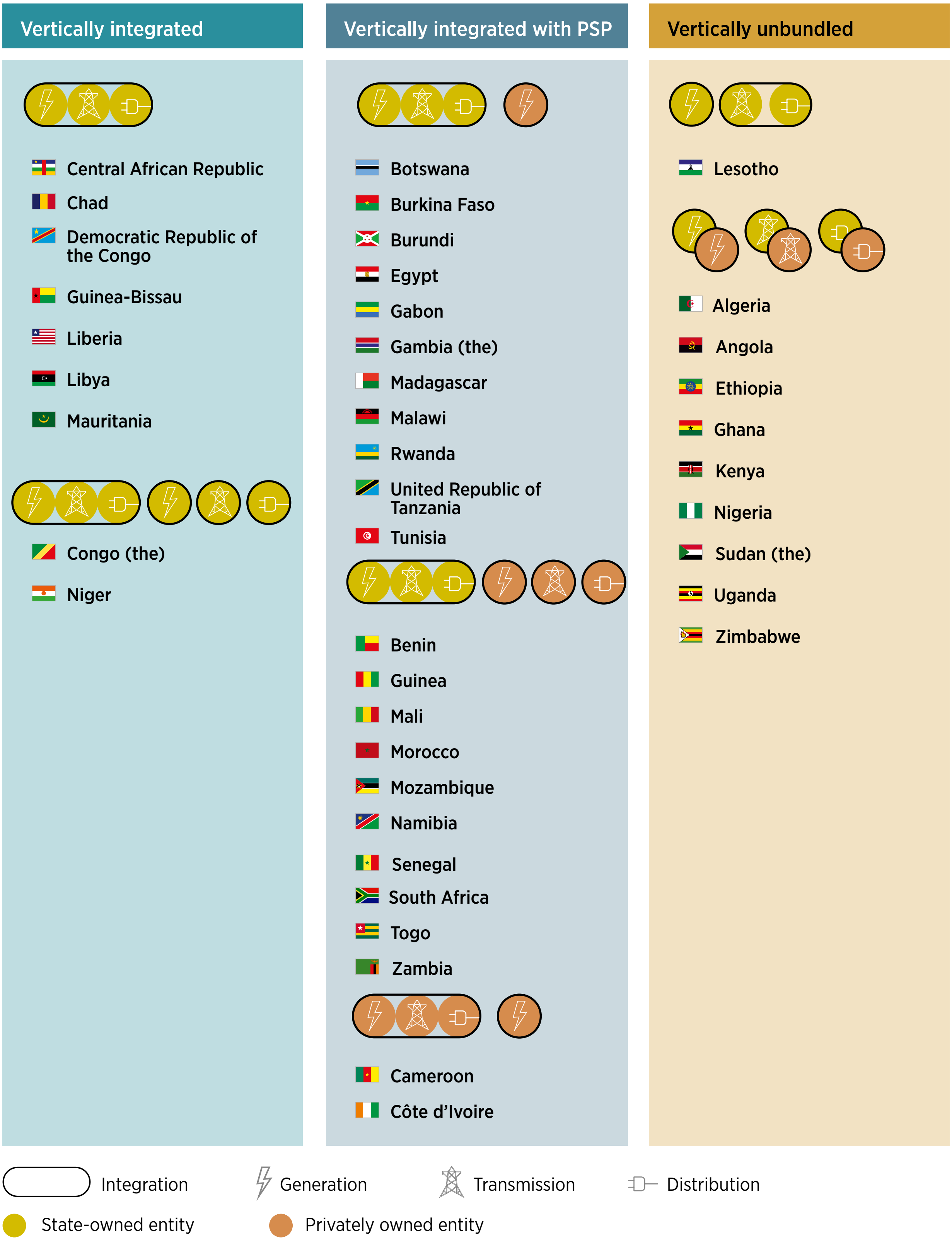
14 For examples of the legal basis of the rights to freedom of expression, association, and peaceful assembly in Southeast Asia, see Business & Human Rights Resource Centre (2020).

Since 2010, around 70% of IPPs that have reached financial close in Africa have been based on renewable energy, including solar PV and wind (Power Futures Lab, 2022). sector participation in T&D remains scarce, however (Figure 20), highlighting large differences in investment opportunities across these different market segments. Lacking T&D infrastructure, and maintenance thereof, hence remains an important obstacle to the scale of renewable energy projects in Sub-Saharan Africa, as does overall grid capacity. In the off-grid segment, lack of technology access, affordability, financing, poor technology quality standards, and lack of local capacity for routine installation and maintenance further complicate more widespread renewable energy deployment, despite its vast potential (IRENA and AfDB, 2022).

Figure 21 Electricity market structure in Africa



Source: (IRENA and AfDB, 2022).
Note: PSP = private sector participation.

The top IPP investment destinations in Sub-Saharan Africa, Uganda, Kenya, Namibia, Ghana and Nigeria, all have vertically integrated utilities now; this has been achieved with private sector participation or through the vertical unbundling of utilities. South Africa is on the way to establishing an independent, state-owned transmission and system operator; the aim is to eliminate the conflicts of interest currently in the system that have hampered the roll-out of renewable energy IPPs over the past five years.[15]

Planning, procurement and contracting frameworks, together with the sector's financial stability, are central considerations for IPP development in Africa; over 12 African countries have developed model PPAs for renewable energy, including five countries with technology-specific contracts (AfDB, 2020). To ease this process and streamline project development, IRENA and the Terrawatt Initiative launched Open Solar Contracts, an initiative that provides simple, universally applicable legal agreements to reduce the time and cost associated with the contracting process (IRENA and TWI, n.d.).

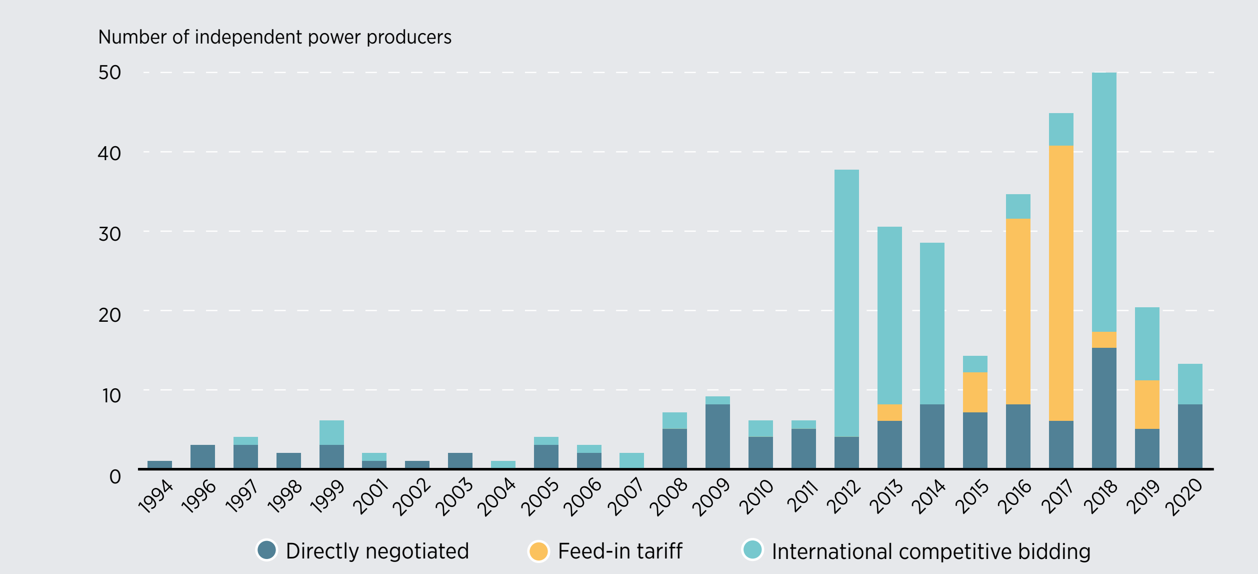
Standardised contracts and PPAs must be accompanied by financial stability of the sector, and particularly the financial stability of the project off-taker. By 2016, only three Sub-Saharan African electricity utilities had an investment-grade credit rating, in Namibia, Uganda and Seychelles. Otherwise, African utilities are not able to charge cost-reflective tariffs. This is often compounded by low tariff collection rates, which further fall if tariffs increase; high technical and non-technical losses due to aging and poorly maintained T&D infrastructure; and poor financial and technical management. As a result, many African utilities rely on subsidies from the state, representing considerable fiscal liabilities (Trimble *et al.*, 2016).

Because most jurisdictions allow projects to sell power only to these utilities, projects often need sovereign guarantees. In many cases, these guarantees are also backstopped by further multilateral cover because of the host states' difficult fiscal positions. These guarantees present further contingent liabilities to treasuries in host countries, constraining their ability to raise finance at competitive rates. International development banks are hence a major player determining the financial viability of many utility-sector projects, including renewable energy.

Historically, most utility-scale (5 MW+) IPPs in Sub-Saharan Africa have been procured using direct negotiation. These projects were often initiated in emergency power supply contexts through unsolicited proposals, with limited transparency and lengthy negotiation processes. Recent years have seen a shift towards structured procurement programmes – both auctions and, to a lesser extent, FiTs (Figure 21). This procurement shift coincided with increased investment in renewables, largely because these instruments set out a clear, more transparent and predictable route to market. Also, they require that the procuring government thinks through its power needs, and the necessary steps before going to market (Kruger, Alao and Eberhard., 2019; Power Futures Lab, 2022).

15 Recent developments include the plans to unbundle Eskom, the national power utility, and increase the threshold for distributed generation capacity from 1 MW to 100 MW without the need for a generation licence (simplified procedures).

Figure 22 Number of IPPs in Africa by procurement method and year of financial close



Source: (Power Futures Lab, 2022).
Note: DN = direct negotiation; FiT = feed-in tariff; ICB = international competitive bidding; IPP = independent power producer.

These amounts include generation capacity from mini-grids and off-grid solutions, and a considerable amount will be directed towards T&D. So far, most governments have relied on public investments, mostly from development finance institutions to develop power grids. Other countries have privatised their T&D.

Governments can also invest in technology-driven innovation or provide finance and incentives to the private sector to do so. To address the issue of space limitation, **Seychelles**, for instance, is planning the development of the first floating solar PV plant in Africa. The plant will cover 40 000 square metres of water, will consist of approximately 13 500 PV modules and will represent 2% of Seychelles' national production (5.8 MW) (Qair, 2020). In early 2023, an independent producer was confirmed to begin the project's construction by year end (Kemp, 2023).

Countries with existing hydropower generation, or unutilised further potential for hydropower, such as Guinea, Ghana and Nigeria, can integrate variable renewables and reduce the cost of the power system by leveraging innovations in modernising hydropower facilities and operating pumped hydro storage. South Africa is currently the only Sub-Saharan African country with operational pumped hydro. Electrifying the transport sector, especially public transport, could help African cities effectively address pollution in densely populated African cities and save municipalities fuel costs in the long run.

Attracting public and private investments in smart technologies such as digitalisation, smart grids, blockchain and cryptocurrency, and the Internet of Things has been identified as a priority for African utilities. These technologies would be crucial for demand-side management as the share of VRE increases in the electricity mix. They would help reduce commercial and technical losses and improve service quality (IRENA, 2019d).

Africa needs innovative and inclusive solutions to harness its potential to leapfrog towards an energy system based on renewable energy and energy efficiency, besides ensuring continued progress in energy access. Innovative policies and financing and business models (*e.g.* results-based financing, crowdfunding and pay-as-you-go [PAYG]) are driving the adoption off-grid technologies, aided by digitalisation. The PAYG business model, which was supported by mobile money's growing popularity in East Africa, has supported the deployment of solar technologies, and helped make such solutions increasingly affordable and accessible. In 2020, PAYG was used to purchase over 1.6 million solar systems (GOGLA, 2020). In the future, such schemes could also help make decentralised renewable energy solutions such as solar home systems more affordable.

4.2.3. Fossil fuel subsidy reform

Electricity tariffs differ vastly across Sub-Saharan Africa, but they mostly share certain common features, including tariffs set by governments rather than utilities, which vary to different degrees with consumption rates. Many African countries continue to subsidise fossil fuels, in addition to the electricity generated from them. In 2019, fossil fuel subsidies on the African continent, including North Africa, were an estimated USD 36.5 billion, of a global total exceeding USD 312 billion (IEA, 2021b). Most of these subsidies were directed at the consumption and production of petroleum, including liquefied petroleum gas, for cooking, coal and electricity.[16] Angola and Nigeria are the two Sub-Saharan African countries providing the largest energy subsidies; they provided subsidies of approximately USD 1.5 billion and USD 414 million, respectively, in 2020, almost all of which for oil (IEA, 2022). Angola's subsidisation rate stood at 54% of energy consumption in 2020, equivalent to USD 46 per person, and worth 2.4% of the gross domestic product (GDP) in 2020 (IEA, 2021b).

As elsewhere in the world, the effectiveness of fossil fuel and electricity subsidies can often be low. The International Energy Agency finds that in 2021, almost 390 million people, or over three-quarters of the Sub-Saharan African population with an electricity connection, are unable to pay for an extended bundle of electricity services, and over 150 million, or 30%, cannot afford even an essential bundle at national household grid tariffs (IEA, 2022).

Fossil fuel subsidies also reinforce reliance on fossil fuels; they do so by reducing their cost vis-à-vis alternative energy technologies, especially renewable energy, which often does not receive the same level of fiscal support. This is in addition to socio-political challenges associated with fossil fuel reforms, with proponents arguing that removing fossil fuel subsidies would make the poorest even worse off, even though these subsidies are inefficient (Worrall *et al.*, 2018). Not all subsidies are direct, transparent, financial transfers; they could also be indirect, through tax exemptions (including where carbon tax exists, for example, in South Africa), free or subsidised infrastructure, and subsidy-enhanced demand, for example, in the case of South Africa's coal industry.

By the end of 2020, several countries, including Ethiopia, Ghana, Rwanda and Togo, had committed to fossil fuel subsidy reform in their Nationally Determined Contributions. South Africa took a different route to curtail the use of fossil fuels; instead of reforming energy tariffs, it introduced carbon pricing. In 2021, carbon prices in South Africa consisted of carbon taxes, which covered over 41% of carbon dioxide (CO_2) emissions from energy use, up from 14.3% in 2018, although large emitters have since received standard 60% exemption from the 2019 carbon tax (Pant, Mostafa and Bridle, 2020). Moreover, since 2018, carbon prices have decreased in South Africa, reflecting industry pressure. Explicit carbon prices have risen to an average of EUR 1.04/tonne of CO_2, up by EUR 1.04 since 2018 (in real 2021 euros). In 2021, fuel excise taxes amounted to EUR 16.57 on average, down by EUR 2.32 relative to that in 2018 (in real 2021 Euros) (OECD, 2021).

The applicability of the South African model to other African countries warrants caution, however, given the substantial differences among Sub-Saharan African countries, high poverty levels and the limited carbon footprint of most Sub-Saharan countries, which limits the justification for a carbon tax when weighing off carbon reductions with energy access. Ultimately, a reform of fossil fuel prices will however be inevitable for many Sub-Saharan African countries to create incentives for new, cost-competitive energy technologies.

16 When accounting for externalities such as impacts on climate change and pollution, the estimated costs of fossil fuel subsidies was almost USD 75 billion in 2015 (Worrall, Whitley and Scott, 2018).

4.2.4. Research and development

At the core of innovation are also public investments, local and foreign, in R&D, which, as a percentage of GDP, is relatively low in Africa. Many countries do not spend – or report on spending – on R&D, and those that do, spend below 1% of their GDP. R&D spending is the highest in South Africa (at 0.83%), but even this is far below the average in the countries of the Organisation for Economic Co-operation and Development (3-5%) (World Bank, n.d.).

Nevertheless, some research institutions have been established, and have been addressing issues related to renewable energy development. For instance, the Swiss-African Research Cooperation collaborates with numerous African higher education institutions on R&D. One example is the International Institute for Water and Environmental Engineering (2iE), an international non-profit association of public utilities that is headquartered in Burkina Faso (SARECO (Swiss-African Research Cooperation), n.d.).

Moreover, the Regional Research Alliance is a collaborative partnership made up of three national research organisations – the Botswana Institute for Technology Research and Innovation (BITRI, n.d.), the Council of Scientific and Industrial Research of South Africa Research (CSIR, n.d.), and the Scientific and Industrial Research and Development Council (SIRDC, n.d.) of Zimbabwe. Each institution has a department conducting research in energy including renewables, and the Regional Research Alliance collaborates on several areas, including renewable energy.

Table 5 outlines the Africa-based research centres that are publicly funded and focused on renewable energy technology and policy solutions.

Table 4 Examples of centres for research and innovation that are promoting renewable energy deployment in Africa

Region	Centre	Focus
East Africa	Centre for Research in Energy and Energy Conservation at Makerere University, Uganda	Conducts largely applied research on energy management, solar photovoltaic (PV), pico-hydropower and biomass; its focus is on the transfer of clean energy technology to the business community and general public. Studies include one on small hydropower in rural Uganda and another on solar energy kiosks.
Southern Africa	Centre for Renewable and Sustainable Energy Studies at Stellenbosch University, South Africa	Conducts research on renewable-energy-related technologies and their applications, and laboratory testing of renewable energy equipment to evaluate their performance characteristics. Studies include one on the development of a testing facility for biofuel-powered engines and another on the design and development of a novel wave energy converter.
	Power Futures Lab (PFL) at the University of Cape Town, South Africa	Focuses on infrastructure investment, and power sector reform and regulation in Africa. Since 2013, PFL has released at least eight studies on renewable energy auctions in Africa. The latest was titled “Counteracting Market Concentration in Renewable Energy Auctions: Lessons Learned from South Africa”.
West Africa	Center of Studies and Research on Renewable Energies (CERER) at the University Cheikh Anta Diop DE Dakar, Senegal	Promotes technological innovation in the field of renewable energy. Through its Solar PV Components Quality Control Laboratory (LCQS), CERER ensures follow-up monitoring for PV components installed nationwide.
	Kwame Nkrumah University of Science and Technology (KNUST), Ghana	Focuses on PV panels, concentrated solar power and bioenergy (biogas, biodiesel and bioethanol); provides consultancy services to policy makers. Studies include one on biogas production from kitchen waste generated on the KNUST campus and another on the technical challenges and impact of integrating high-penetration PV systems into Ghana’s transmission grid.
	International Institute for Water and Environmental Engineering (2iE), Burkina Faso	Develops academic research programmes and courses focused on strategic sectors for the social and economic development of Africa, including renewable energy, water and waste treatment, mining and the production of eco-materials.

4.2.5. Awareness raising and standards

Consumer confidence is critical to building markets for renewable energy. This includes transparency and information about the costs – including long-term costs – of currently used energy technologies and the benefits of new energy technologies. Many African countries have acquired substantial on-the-ground experience with this aspect in the context of clean cooking solutions. Equally important are campaigns on the purchase and use of equipment and, more importantly, the implementation of quality standards to ensure product reliability and high confidence among consumers, including industries, private businesses and individual households.

There has been plenty of experience in awareness-raising campaigns to support the deployment of decentralised technologies, for instance, SWHs and distributed solar PV. An example is the Lighting Africa programme, implemented by the World Bank, which initiated efforts in 2007 to educate consumers on the benefits and proper use of solar lighting and energy products and how to identify quality lanterns in Ghana and Kenya. Since then, consumer education has anchored every country programme implemented by Lighting Africa; a strong correlation can be seen between off-grid solar markets (and their sharp growth trajectories) and locales targeted by consumer education campaigns (BNEF and Lighting Global, 2016).

Most off-grid consumers live in remote areas, which are hard to reach for traditional advertisement campaigns. Direct communication with “last-mile” consumers is made possible by travelling roadshows, which allow them to see and test products first hand. Lighting Africa has also developed a series of posters, radio spots and TV advertisements, which can be adapted to local audiences. Most recently, Lighting Africa developed a comic book series called “Spotlight” for young readers; it teaches them about the many uses and benefits of solar lighting products (Lighting Global, 2021). Financial incentives, capacity building for institutions, training of local technicians and entrepreneurs (including women), and monitoring of results would further strengthen awareness-raising campaigns and voluntary initiatives.

Such campaigns must be matched by more robust technology standards and safeguards through national governments. This is especially important for renewables, since investment in the corresponding technologies is heavily front-loaded, often requiring more upfront financing than for conventional fuel technologies. Zambia and Zimbabwe, for instance, have established cross-sectoral policies relating to product quality. As of 2017, solar equipment importers were required to present the Zambia Bureau of Standards with a certification of product quality. In 2015, the Standards Association of Zimbabwe and the Zimbabwe Regulatory Authority established a solar equipment testing laboratory. These are unique cases, and quality standards are not yet widely adopted; faster market adoption of many prospective renewable energy technologies is so far hampered, thus.

4.3. IN FOCUS: GREEN HYDROGEN

Africa has abundant renewable resources and demonstrated potential for production at globally competitive costs. Several European countries are looking into investing in Africa’s green hydrogen production and transport infrastructure (mostly ships). While the prospect of low-cost, green hydrogen from African countries is an important strategic consideration for many European partners to reduce reliance on fossil fuels and decarbonise their economies, it is difficult to endorse the idea of generating renewable electricity at a large scale for export using green hydrogen when most Sub-Saharan African countries cannot even provide universal electricity access to their own populations. Any green hydrogen producer should therefore adhere to the principle of additionality. If any electricity from renewable sources has other productive uses, then converting it into green hydrogen for export may not be its most effective use. As it stands, European regulation already prohibits green hydrogen that does not have additionality attributes (European Commission, 2023).

Conversely, green hydrogen could absorb excess renewable electricity and the overcapacities that exist in some Sub-Saharan African power systems, albeit accounting for the potential for increase in demand with industrialisation and economic development. Moreover, unlike Europe and other parts of the developed world, many African economies are not confined to already established industries. As such, green hydrogen could support a leapfrogging strategy, whereby green industry and sustainable long-distance exports are not constrained by the risks associated with large-scale devaluations or stranded assets. Other benefits of green hydrogen include greater energy security and socio-economic gains, besides job creation potential (UNIDO *et al.*, 2024) given many of the currently proposed hydrogen projects involve building utility-scale renewable energy plants, including wind and solar.

In recent years, a number of regional initiatives have emerged to support African countries in their hydrogen strategies:

- The African Hydrogen Partnership is a continent-wide trade association dedicated to the deployment of green hydrogen and fuel-cell technologies. Its vision is to construct renewable energy hubs, large-scale power-to-gas plants, which will be located in metropolitan areas, ports and mining centres along trans-African highways (Clifford Chance, 2021).
- Egypt, Kenya, Morocco, Mauritania, Namibia and South Africa launched the Africa Green Hydrogen Alliance in May 2022 with the intention to foster collaboration and ensure the continent is able to lead in green hydrogen development for an energy transition (Green Hydrogen Organisation, 2022).
- H2 Power-Africa is a green hydrogen initiative sponsored by the German Federal Ministry of Education and Research (BMBF) and the countries of the Southern African Development Community and the Economic Community of West African States (ECOWAS). The purpose of the initiative is to explore renewable energy potential in Southern and West Africa (BMBF (Federal Ministry of Education and Research), 2021; Clifford Chance, 2021).
- The Global PtX Atlas also covers the regional potential for green hydrogen (PtX-Atlas, n.d.).
- The ECOWAS Centre for Renewable Energy and Energy Efficiency partnered with the West African Science Service Centre on Climate Change and Adapted Land Use (WASCAL) to develop the ECOWAS Green Hydrogen Policy and Strategy Framework, and the action plan, to unlock green hydrogen's full potential in the region (ECOWAS, 2023).

The past years have seen the launch of many national plans and ambitions for hydrogen projects to transform Sub-Saharan African countries' economies; an increasing number of memoranda of understanding (MoUs) and country partnerships, as well as projects, have been announced. These include the ones listed below.

The Government of **Djibouti** signed a Framework Agreement with Australian Fortescue Future Industries in July 2022, for the installation of two hydrogen and ammonia production units using green energy (FMGL, 2022). This was followed by an MoU in December 2022 with US-based Power to X developer CWP Global for the development of a 10 GW renewable energy and green hydrogen project to produce renewable energy for domestic consumption, and green ammonia for export; the development includes cable networks, pipelines, port loading facilities and drinking water for local communities (Collins, 2022).

Kenya is also in the process of developing a hydrogen development programme. With renewable energy already representing 90% of the country's electricity mix, the Ministry of Energy is planning to produce green hydrogen using extra capacity in its grids, especially at night during periods of low electricity demand in the short to medium term. The hydrogen generated could be used in the transport sector, or it could be used as a means to transmit energy off-grid, for green steel production, and for the production of fertilisers' nitrogen sources for existing and new regional industrial processes, including in the form of methanol and ammonia (Green Hydrogen Organisation, n.d.a). To help finance the plans, the country signed an agreement with the German government in December 2022 and with the European Investment Bank in March 2023 to develop and unlock investments to produce green hydrogen using renewable energy as part of the Kenya Energy Roadmap 2040 (APNews, 2022; EIB (European Investment Bank), 2023).

The Government of Mauritania has signed several MoUs to drive the country's hydrogen development: with Chariot in September 2021; with BP in November 2022 and with a consortium consisting of the German project developer Conjuncta, Egypt's energy provider Infinity and the United Arab Emirates' Masdar in March 2023. Chariot will partner with the Mauritanian government for Project Nour, which will develop 10 GW of green hydrogen based on wind and solar power generated from an on-shore and off-shore area of approximately 14 400 square kilometres (Power engineering international, 2021).

Under the terms agreed with BP, the company will initially study the feasibility of building the on-shore wind and solar farms required for producing green hydrogen. The studies will cover the availability and quality of wind and solar resources in large areas in the northwest of the country. The development involving BP targets a production capacity of up to 30 GW of green hydrogen, for 2 million tonnes of annual production of the gas. Later phases would focus on building electrolysis and then hydrogen export infrastructure (Reuters, 2022a). Mauritania's 2023 MoU with a consortium including Infinity and Masdar are for a USD 34 billion green hydrogen project with the capacity to produce up to 8 million tonnes of green hydrogen or other hydrogen-based end products annually and up to 10 GW of electrolyser capacity. The first phase of the Mauritania project, to be located northeast of the coastal capital of Nouakchott, should be completed in 2028 with planned capacity of 400 MW (Reuters, 2023a).

European Commission President Ursula von der Leyen's February 2024 visit to Mauritania could be seen as a turning point in the strategy for this country. She urged Mauritania to leverage its renewable hydrogen for producing and exporting not hydrogen but green iron and steel to Europe. Von der Leyen highlighted the added value and job creation potential for Mauritania in processing its own green steel, with EU funding support via the Global Gateway Fund, aiming for a win-win situation for both Mauritania and the European Union. It is a turning point since Europe is not looking to import hydrogen, as stated earlier, but semi-finished green products, which the region cannot produce with its relatively limited renewable energy potential (Collins, 2024).

Namibia has ambitious plans to turn into a green hydrogen producer within the coming years. Its Green Hydrogen and Derivatives Strategy aims at delivering up to 12 million tonnes of green hydrogen annually by 2050. The initiative is expected to create an additional 600 000 jobs by 2040, in a country with an approximately 2.5 million population (Rust and Ossenbrink, 2022). Namibia has secured up to EUR 40 million in funding from Germany's Economic Stimulus and Future Package for co-operation as part of its Hydrogen Agreement with Germany in 2021 (Hydrogen Central, 2021). Namibia's first hydrogen plant, Swakopmund, which has the capacity to generate approximately 85 MW of electricity using solar PV–powered electrolysers, is expected to begin production as early as 2024 (Reuters, 2022b). Moreover, the country contracted Hyphen Hydrogen Energy to develop the USD 9.4 billion Southern Corridor Development Initiative Green Hydrogen project in the Tsau Khaeb national park, which in its first phase is planned to start, in 2025, green hydrogen production based on 2 GW of renewable electricity generation capacity, converting hydrogen into green ammonia (Reuters, 2023b). Further development later in the decade is planned to increase the combined renewable generation capacity to 5 GW and electrolyser capacity to 3 GW, with a 300 kilotonnes (kt) per year hydrogen production target (Collins, 2021; Green Hydrogen Organisation, n.d.b).

South Africa is one of only a few African countries with a clear hydrogen strategy, its Hydrogen Society Roadmap, which was published in 2021 and sets out to turn South Africa into "an inclusive, sustainable and competitive hydrogen economy by 2050". The strategy prioritises domestic manufacturing for hydrogen products and components; the creation of new, high-quality green jobs; the decarbonisation of the transport sector, energy-intensive industries and exports; and a concrete target of 10 GW electrolysis capacity, reflected in the production of at least 500 kt of hydrogen annually by 2030 and 15 GW of hydrogen-based power generation by 2040. The plan also includes a 1 MW small-scale electrolysis facility, which is to be piloted by 2025, and the deployment of 10 GW of electrolysers in the Northern Cape and 1.7 GW of electrolysers in the Hydrogen Valley by 2030 (Department of Science and Innovation, 2021). South Africa's hydrogen strategy is expected to create 20 000 jobs annually by 2030 and 30 000 by 2040 (Department of Science and Innovation, 2021). In mid-2023, South Africa signed agreements with several European governments to co-operate on hydrogen projects, including Denmark, Germany and the Netherlands (Reuters, 2023c).

South Africa is developing several flagship projects. These include the Platinum Valley Initiative, which was launched to develop green hydrogen hubs and establish a "Hydrogen Corridor" (Hydrogen Central, 2022); the Mpumalanga-based COALCO2-X project (Fraunhofer, n.d.); and the Northern Cape–based Boegoebaai Green Hydrogen Development Project, under which a deep-water port; 30 GW of wind and solar electricity generation capacity; and a battery park to power 10 GW of electrolysers are to be developed by 2030, for producing green ammonia linked to green hydrogen for export and for use as maritime fuel and feedstock (Hydrogen Central, 2022).

Other countries that have expressed interest in hydrogen include **Angola**, whose state-owned energy company, Sonangol, signed a letter of intent with two German companies in June 2022 to build a green ammonia plant; the plant, to be ramped up later, is so that Angola can begin exporting some 280 kt of ammonia from 2024 (Reuters, 2022c). **Nigeria**, too, has expressed interest. Its 2018 National Energy Policy details short-, medium- and long-term strategies on incorporating hydrogen energy. Uganda's Rural Electrification Agency partnered with Tiger Power, a Belgian company, to supply solar power to three villages in the Kyenjojo District. Using hydrogen batteries, the project stores excess solar energy from the day to power villages through the night.

Box 10 shows the pillars of green hydrogen policy making as per the IRENA framework. Although green hydrogen helps decarbonise energy sectors, it is not a priority in Africa. Renewable energy projects will address power shortages for some time to come.

Box 10 Key pillars of green hydrogen policy making

Set policy priorities. Green hydrogen can support a wide range of end uses. Policy makers should identify and focus on applications that provide the highest value.

Establish a national hydrogen strategy. Each country needs to define its level of ambition for hydrogen, outline the amount of support required, and provide a reference on hydrogen development for private investment and finance.

Introduce guarantees of origin. Carbon emissions should be reflected over the entire life cycle of hydrogen. Origin schemes should include clear labels for hydrogen and hydrogen products to boost consumer awareness and facilitate claims of incentives.

Adopt a governance system and enabling policies. As green hydrogen becomes mainstream, policies should cover its integration into the broader energy system. Civil society and industry must be involved to maximise benefits.

Source: (IRENA, 2020a).

4.4. IN FOCUS: INTRA-AFRICAN ELECTRICITY TRADE

Renewable energy sources and their integration are central in the global energy transition. Secure supply by power grids requires balancing supply and demand continuously. This constant supply–demand balancing requires VRE such as solar and wind power. Yet, VRE feed-in depends on meteorological conditions such as solar irradiation and wind speed. The challenge, therefore, is to integrate variable renewables into existing systems. Given the relatively low base of installed capacity in Sub-Saharan Africa and the continent's steep demand growth, many countries face a dual challenge: growing renewables while growing the system itself. The region has a unique opportunity to design power systems that are able to accommodate high shares of variable renewables (Sterl, 2021). Power pools provide a framework for regional and cross-national planning.

Sub-Saharan Africa is inter-connected through four power pools,[17] which could help integrate renewables into the energy system. As of 2017, all but three member states of the Southern African Development Community – Angola, Malawi and Tanzania – were connected through the Southern African Power Pool (SAPP), which is able to trade electricity with member states and to bolster energy security in the region (AfDB, 2019a).

Markets operating at the power pool level support VRE by harnessing a region's "spatiotemporal synergies", which are complementary dynamics between renewable energy sources and demand profiles (IRENA, 2018c, 2021d). Hydropower in the rainy mountains and solar/wind power in low-lying deserts is one type of synergy (*e.g.* Ethiopia and Sudan, and Guinea and Senegal), which creates pronounced temporal synergies on seasonal timescales, especially in regions with strong monsoons. An adequate power pool could invest in VRE projects to lower the costs of grid integration. The substantial power grid created by regional markets generates a larger balancing area, which, if well designed, can moderate VRE curtailments and reserve requirements.

17 The Southern African Power Pool, Eastern Africa Power Pool, Central African Power Pool and the West African Power Pool.

Power pools require technology that can adapt operations across different types of power plants. Hydropower plants may have to ramp up (or down) more often to accommodate VRE infeed from solar and wind power generated elsewhere in the pool. Older hydropower plants may require refurbishing to achieve the required ramp rates. For other types of power plants, for example, those that integrate concentrated solar power with thermal storage and biomass, flexibility provisions may be required. Gas-fired power plants will have an important role until they are phased out in compliance with the Paris Agreement.

After flexibility provisions, storage-based technologies could also accommodate variable renewables in Sub-Saharan Africa's power pools. Currently, South Africa is the only country using pumped-storage hydropower. But this mature technology also holds promise for hydro-rich countries like Ethiopia (Hunt *et al*., 2020). Over the next decades, large-scale battery storage could accommodate the integration of renewables to decarbonise electricity systems across Sub-Saharan Africa – particularly to balance the diurnal nature of solar PV (Barasa *et al*., 2018). For seasonal storage, power-to-gas technologies (*e.g*. green hydrogen) could play important roles (IRENA and GIZ, 2021) but this mature technology also holds promise for hydro-rich countries such as Ethiopia (Hunt *et al*., 2020). Over the next decades, large-scale battery storage could accommodate renewables' integration to decarbonise electricity systems across Sub-Saharan Africa – especially to balance solar PV's diurnal nature (Barasa *et al.*, 2018). For seasonal storage, power-to-gas technologies (*e.g*. green hydrogen) could play important roles.

On the policy side, integrating renewables into the energy system requires that the power system have a conducive organisational structure, and there are sector coupling policies to support end use electrification. Those policies include enabling electricity tariff structures such as time-of-use tariffs and other innovative solutions to support demand-side management. Forward-looking plans are also needed, to integrate the additional renewable electricity and address the load imposed by end use electrification through grid expansion and strengthening (IRENA, 2020b).

On the economic side, regional markets rely on appropriate transmission infrastructure, co-ordination rules and consistent regulatory frameworks. Unfortunately, in practice, cross-border collaboration within African power pools has been hindered by a lack of aligned national policies and regulations, and inadequate funding and investment in infrastructure. Apart from the SAPP, most power pools are relatively young. These power pools, therefore, have limited ability to achieve targets (AfDB, 2019c; IRENA, 2019b). Innovative practices may have to be scaled up over the coming years. For instance, the SAPP makes it possible for initiatives to set up investment-grade intermediary off-taker agreements, which can then trade on the pool to improve the bankability of renewable energy projects that would normally have been able to sell only to low-rated state-owned utilities. Africa GreenCo is an example of such an initiative.

Previous analyses have emphasised the importance of the procurement planning nexus for accelerating power investment in Africa, including renewables (Eberhard *et al*., 2016). Dynamic, frequently updated power system expansion plans need to ensure that projected electricity demand will be met by a least-cost mix of technologies. In the African context, this least-cost mix is most often dominated by renewable energy resources in the long term (IRENA, KFW and GIZ, 2021), but this is likely to require near-term policy support to drive renewables' deployment and cancel fossil fuel projects in the pipeline, without which the energy transition may fail (Alova *et al*., 2021). A recent IRENA analysis, for instance, showed that unless generation capabilities in East and Southern Africa are reviewed and reconsidered, the region is on track to construct more than 100 GW of new coal-fired power until 2040, leading to a substantial increase in CO_2 emission levels (IRENA, 2021b). Dynamic, frequently updated power system expansion plans must ensure that projected electricity demands will be met with a least-cost mix of technologies. In the African context, this least-cost mix is most often dominated by renewable energy resources in the long term (IRENA, KfW and GIZ, 2021), although this is likely to require near-term policy support to drive renewables' deployment and cancel fossil fuel projects in the pipeline, without which the energy transition may fail (Alova, Trotter and Money *et al.*, 2021). A recent IRENA analysis, for instance, showed that unless generation capabilities in East and Southern Africa are reviewed and reconsidered, the region is on the way to constructing over 100 GW of new coal-fired power plants until 2040, leading to a substantial increase in CO_2 emission levels.

Such plans should ideally also stipulate – based on clear criteria – which projects will be built by the public sector utility and which by the private sector. For these plans to lead to sustainable, increasing investments, they must be translated into internationally competitive bidding rounds regularly and in a manner that is predictable. This predictability stimulates project pipeline development, which boosts investment volumes, improves project quality and results to greater competition in bidding programmes (resulting in lower project prices). It also makes better alignment with grid infrastructure plans possible.

For plans to function as guides for investment decision making, it is paramount that institutional capacity be established to effectively govern the planning process. Critical aspects of an effective planning process include ownership of the process, the ability to update plans as needed, transparency of the process and stakeholder participation (CCG (Climate Compatible Growth), 2021; IRENA, 2018b). To support this effort, IRENA has undertaken a range of capacity-building initiatives to inform energy/capacity expansion planning, on the country and the power pool level. Examples include country-level support to Eswatini, Sierra Leone and Cameroon, and power pool-level analyses for the Central African Power Pool and the Eastern and Southern African Power Pools, together known as the African Clean Energy Corridor.

05 CONCLUSIONS AND RECOMMENDATIONS

Sub-Saharan Africa is an exceptionally diverse region; it presents unique development challenges, but also significant opportunities related to the renewable energy deployment and development. Sub-Saharan Africa has contributed very little to global carbon emissions, yet it is among the regions most vulnerable to climate change. This vulnerability is due to the region's geography and the structure of its economies, as well as many countries' lack of financial capacity to fund their energy transitions while adapting to climate change. The energy transitions in Sub-Saharan Africa will therefore rely on international partnerships, including reliable climate finance to boost regional use of sustainable and modern renewable energy.

Sub-Saharan Africa can draw on its tremendous wind, solar, hydropower and geothermal resource potential. Unlike fossil fuels, these resources cannot be depleted, offering countries sustainable and increasingly cost-effective sources of energy to support their socio-economic development plans. Falling technology costs are bringing renewables increasingly within reach, whether as utility-scale solutions or decentralised solutions, including mini-grids or standalone applications. This evolution is being reflected in the renewable targets being set in regional and national energy plans, together with policy instruments that make these technologies more affordable and the related investments more attractive.

However, the region's share of global renewable energy investments and capacity installations remained relatively small over the past decade. Sub-Saharan Africa received less than 1.5% of the USD 2.8 trillion invested in renewable energy projects globally over 2000-2020 (IRENA and AfDB, 2022) and its share reduced further in 2021 and 2022, to less than 1% of the global investment. Moreover, investments have been distributed unevenly across the region, with most concentrated in Southern Africa, followed by West and East Africa, and, finally, Central Africa.

For Sub-Saharan Africa to achieve its vast energy potential and meet energy needs, and realise the associated socio-economic benefits, it will require significant investments distributed evenly. Yet attracting renewables investments has been a consistent challenge in the region, given the high real and perceived risks in investing. Even amid public financing and risk-mitigation support from governments, development partners and multilateral development banks, financing conditions have not been favourable to many governments. For example, governments are increasingly unable to provide sovereign guarantees (a one-size-fits-all solution often used to mitigate credit risks) as they face high inflation and currency fluctuations or devaluations.

Overcoming these issues will require a new paradigm for financing renewables, supported by a fundamental shift in lending, redirecting it from developed to developing nations, especially for countries afflicted by economic and climate crises. This will require the international community to step up and provide more public financing in the form of concessional financing, grants and tailored risk-mitigation support. Such support should encompass a broader definition of risks, which considers the environmental, economic and social implications of not deploying renewables, and the risk of leaving a large part of the population out of the energy transition and locked in underdevelopment. As such, it will require moving away from the narrow investor-centric focus on the risk of energy asset investments not paying off.

Backstopped by donor governments, and multilateral development banks, these catalytic efforts of the international community – in the form of increased concessional public financing and innovative risk-mitigation instruments – can help mobilise more private financing to help reach the required investment scale. International development partners, including governments, private businesses and philanthropies, and international development finance institutions, will need to strategically partner with the region's countries in building the necessary infrastructure, promoting technology innovation and research, and facilitating investment into the sector. Future development initiatives in Africa could and should also focus on sustainable value chain and human resource development, all of which will help the countries do more with less resources. This will be especially crucial as Sub-Saharan Africa has 33 of the world's 46 least-developed countries.

The wide-ranging challenges outlined here call for comprehensive policy making across the region. While there is significant potential for intra-regional co-operation – be it through increased power trade, or regulatory approaches such as harmonised technology quality and efficiency standards – this potential is yet to be fully realised. Countries across the continent would benefit from co-operating transition-related activities, not least for creating new value and supply chains that could relieve the continent of its heavy reliance on foreign-imported technology and expertise. If more Sub-Saharan policy makers embrace these opportunities now, the coming years should be the best possible time to invest in renewables in Africa.

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ANNEX OVERVIEW OF NATIONAL COMMITMENTS TO RENEWABLE ENERGY AND ENERGY EFFICIENCY

Region	Country	Paris Agreement	Latest date of NDC submission	Renewable energy target in NDCs/ INDCs	Renewable energy target in the national energy plan	Renewable energy target in the rural electrification plan	National renewable energy target	Clean cooking target
West Africa	Benin	Ratified the Paris Agreement on 31 October 2016	12-Oct-21	Yes, focus on power	Yes, focus on power	Yes	The NDC sets renewable electricity targets: **Unconditional:** Hydro and solar 87 MW (DEFISSOL, MCA II and others) + biomass 4 MW **Conditional:** 25 MW of hydro and solar and 11 MW of biomass The NDC aims for 8.4% (unconditional) and 3.75% (conditional) GHG emission reductions in the energy sector by 2030 compared with the BAU scenario.	Yes
	Burkina Faso	Ratified the Paris Agreement on 11 November 2016	09-Oct-21	Yes, focus on power	Yes, focus on power	Yes	The NDC sets renewable electricity targets: **Unconditional:** 128.62 MW of solar plants **Conditional:** 402 MW of solar plants and 10 MW of biomass The NDC aims for 19.60% (unconditional) and 9.82% (conditional) GHG emission reductions by 2030 compared with the BAU scenario.	Yes
	Cabo Verde	Ratified the Paris Agreement on 21 September 2017	02-Apr-21	Yes, focus on power	Yes, power and heating	No	The NDC sets a target to boost the share of renewable energy in the electricity supply by 30% by 2025 and up to 50% in 2030. The NDC states that by 2030, Cabo Verde commits to an economy-wide 18% GHG emission reduction compared with the BAU scenario. Conditional on adequate international support, this reduction target may go up to 24% compared with the BAU scenario.	No
	Côte d'Ivoire	Ratified the Paris Agreement on 25 October 2016	09-May-22	Yes, focus on power	Yes, focus on power	Yes	The NDC aims for 10.5% (unconditional) and 19.6% (conditional) reductions of national GHG emissions by 2030 compared with the reference scenario. The NDC sets a target of 42% of renewable electricity by 2030.	No
	Gambia, The	Ratified the Paris Agreement on 7 November 2016	12-Sep-21	Yes, power and heating	Yes, focus on power	Yes	The NDC sets renewable electricity targets: **Unconditional:** Solar home systems to supply off-grid consumption **Conditional:** 89 MW of utility-scale solar PV capacity; 3.6 MW of utility-scale wind capacity; solar water heating facilities to supply 10% of the demand by 2030; 6 MW of solar PV rooftop systems by 2024. The NDC aims for a 49.7% GHG emission reduction by 2030 compared with the baseline scenario.	No
	Ghana	Ratified the Paris Agreement on 21 September 2016	04-Nov-21	Yes, focus on power	Yes, focus on power	Yes	The NDC aims for GHG emission reduction by 64 $MtCO_2eq$ by 2030 compared with the baseline scenario. The NDC sets a target to scale up renewable energy penetration by 10% by 2030.	No
	Guinea	Ratified the Paris Agreement on 21 September 2016	28-Jul-21	Yes, focus on power	Yes, focus on power	No	The NDC aims for 20% (unconditional) to 49% (conditional) GHG emission reductions by 2030 compared with a trend scenario. The NDC sets a target of 80% renewable sources in electricity generation and supply by 2030.	Yes
	Guinea-Bissau	Ratified the Paris Agreement on 22 October 2018	12-Oct-21	Yes, focus on power	Yes, power and heating	Yes	The NDC aims for 10% (unconditional) and 20% (conditional) GHG emission reductions compared with the reference scenario. The NDC sets a target to build installed renewable energy capacity of about 90 MW by 2030.	No

Region	Country	Paris Agreement	Latest date of NDC submission	Renewable energy target in NDCs/ INDCs	Renewable energy target in the national energy plan	Renewable energy target in the rural electrification plan	National renewable energy target	Clean cooking target
	Liberia	Ratified the Paris Agreement on 27 August 2018	04-Aug-21	Yes, power and transport	Yes, power, heating and transport	Yes	The NDC aims for a 10% (unconditional) to 54% (conditional) reduction of economy-wide GHG emissions compared with the BAU scenario. The NDC also aims for a 40.6% reduction of energy sector GHG emissions compared with the BAU levels by 2030 through the installation of 100 MW of renewable energy plants, which will produce 300 gigawatt hours annually.	Yes
	Mali	Ratified the Paris Agreement on 23 September 2016	11-Oct-21	Yes, focus on power	Yes, focus on power	Yes	The NDC plans a 39.9% GHG emission reduction by 2030 compared with the base scenario. The NDC sets a target of increasing the installed capacity of renewable energy to 58.3%.	Yes
	Mauritania	Ratified the Paris Agreement on 27 February 2017	12-Oct-21	Yes, power and heating	No	No	The NDC aims for an 11% (unconditional) to 92% (conditional) GHG emission reduction by 2030 compared with the BAU scenario. The NDC sets a target to boost the share of renewable sources in the electricity supply by 50.34% by 2030.	No
	Niger	Ratified the Paris Agreement on 21 September 2016	13-Dec-21	Yes, focus on power	Yes, power and heating	Yes	The NDC sets a target of 402 MW of electricity generation from renewable energies by 2030. The NDC sets a target for a 10.60% (unconditional) to 45% (conditional) reduction of energy sector GHG emissions by 2030 compared with the BAU scenario.	No
	Nigeria	Ratified the Paris Agreement on 16 May 2017	30-Jul-21	Yes, focus on power	Yes, power, heating and transport	Yes	The NDC aims for a 20% (unconditional) to 47% (conditional) GHG emission reduction compared with the BAU scenario. The NDC sets a target of 30% of on-grid electricity from renewables and 13 gigawatts of off-grid renewable energy by 2030.	Yes
	Senegal	Ratified the Paris Agreement on 21 September 2016	29-Dec-20	Yes, power and heating	Yes, power and heating	Yes	The NDC aims for a 7% (unconditional) to 29% (conditional) GHG emission reduction by 2030 compared with the BAU scenario. The NDC sets a target of 699 MW of renewables-based installed capacity by 2030.	No
	Sierra Leone	Ratified the Paris Agreement on 1 November 2016	31-Jul-21	Yes, focus on power	Yes, power and heating	Yes	The NDC sets a target of 42% greater energy efficiency and access to grid connections in 2025, and 27% and 10% increases for off-grid mini-grid and solar standalone systems in 2030, respectively. The NDC aims for a 10% GHG emission reduction by 2030 compared with a no-policy scenario of 2015-2030.	Yes
	Togo	Ratified the Paris Agreement on 28 June 2017	12-Oct-21	Yes, focus on power	Yes, focus on power	Yes	The NDC aims for a 20.51% (unconditional) to 30.06% (conditional) GHG emission reduction by 2030. The NDC sets a target to boost renewables' share in the electricity generation by 50% by 2025.	No
East Africa	Burundi	Ratified the Paris Agreement on 17 January 2018	05-Oct-21	Yes, focus on power	No	No	The NDC aims for a 3.04% (unconditional) to 12.61% (conditional) GHG emission reduction by 2030 compared with the BAU scenario.	No
	Comoros	Ratified the Paris Agreement on 23 November 2016	05-Nov-21	Yes, focus on power	No	No	The NDC aims for a 23% GHG emission reduction by 2030 compared with the BAU scenario.	No
	Djibouti	Ratified the Paris Agreement on 11 November 2016	11-Nov-16	Yes, focus on power	Yes, focus on power	No	The NDC aims for a 40% GHG emission reduction by 2030 compared with the BAU scenario. The NDC sets targets: **Unconditional:** 1 200 MW of geothermal by 2030; 250 MW of solar by 2025; 60 MW of wind by 2025 **Conditional:** 30 MW of wind; 10 MW of biomass; 5 MW of tidal turbines (conditional).	Yes

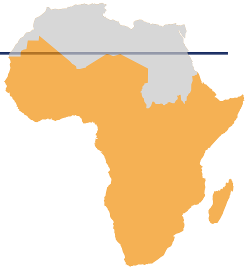
Region	Country	Paris Agreement	Latest date of NDC submission	Renewable energy target in NDCs/ INDCs	Renewable energy target in the national energy plan	Renewable energy target in the rural electrification plan	National renewable energy target	Clean cooking target
	Eritrea	Not yet ratified	19-Jun-18	Yes, focus on power	Yes, focus on power	No	The NDC aims for a 12.6% (unconditional) to 38.5% (conditional) GHG emission reduction by 2030 compared with the BAU scenario. The NDC sets a target of 70% of renewables in the electricity supply by 2030.	Yes
	Ethiopia	Ratified the Paris Agreement on 9 March 2017	23-Jul-21	Yes, focus on power (no quantified target)	Yes, focus on power	Yes	The NDC aims for a 68.8% GHG emission reduction by 2030 compared with the BAU scenario.	Yes
	Kenya	Ratified the Paris Agreement on 28 December 2016	28-Dec-20	Yes, focus on power (no quantified target)	Yes, focus on power and heating	Yes	The NDC aims for a 32% GHG emission reduction by 2030 compared with the BAU scenario.	Yes
	Mauritius	Ratified the Paris Agreement on 22 April 2016	05-Oct-21	Yes, focus on power	Yes, focus on power	No	The NDC aims for a 40% GHG emission reduction by 2030 compared with the BAU scenario. The NDC sets a target of boosting renewables' share by 60% in the energy supply by 2030.	No
	Rwanda	Ratified the Paris Agreement on 6 October 2016	20-May-20	Yes, power and transport	No	Yes	The NDC aims for a 16% (unconditional) to 22% (conditional) GHG emission reduction by 2030 compared with the BAU scenario. The NDC sets targets: **Unconditional:** To develop 56.75 MW of large hydro capacity; 24.5 MW of small and mini hydro projects; 75 MW of regional projects by 2030 **Conditional:** 68 megawatts peak of solar mini-grids	Yes
	Seychelles	Ratified the Paris Agreement on 29 April 2016	30-Jul-21	Yes, power and transport	Yes, focus on power	No	The NDC aims for a 26.4% reduction of economy-wide GHG emissions compared with the BAU scenario. The NDC sets a target of 15% of renewables in the generation of electricity by 2030.	No
	Somalia	Ratified the Paris Agreement on 22 April 2016	31-Jul-21	Yes, focus on power	Yes, focus on energy access	No	The NDC aims for a 30% GHG emission reduction by 2030 compared with the BAU scenario.	No
	South Sudan	Ratified the Paris Agreement on 23 February 2021	21-Sep-21	Yes, focus on power	No	Yes	The NDC aims for an emission reduction of 109.87 $MtCO_2eq$ by 2030. The NDC sets a target of installing 2 729.5 MW of renewables-based power plants by 2030.	No
	United Republic of Tanzania	Ratified the Paris Agreement on 18 May 2018	30-Jul-21	Yes (no quantified target)	Yes, focus on power	Yes	The NDC aims for a 30% to 35% reduction of economy-wide GHG emissions compared with the BAU scenario by 2030.	Yes
	Uganda	Ratified the Paris Agreement on 21 September 2016	12-Sep-22	Yes, focus on power	Yes, power and heating	Yes	The NDC aims for a 24.7% GHG emission reduction compared with BAU scenario by 2030. The NDC sets targets to implement 756.8 MW of hydropower, 25 MW of bagasse-based power, 20 MW of solar power and 20 MW of wind power.	Yes

Region	Country	Paris Agreement	Latest date of NDC submission	Renewable energy target in NDCs/ INDCs	Renewable energy target in the national energy plan	Renewable energy target in the rural electrification plan	National renewable energy target	Clean cooking target
Central Africa	Angola	Ratified the Paris Agreement on 16 November 2020	31-May-21	Yes, focus on power	Yes, power and heating	Yes	The NDC aims for a 14% (unconditional) GHG emission reduction by 2025 compared with the base year. The NDC sets renewable energy targets by 2025: **Unconditional:** To install 500 MW of biomass plants; 100 MW of mini-hydro; 700 MW of hydroelectric power stations; 104 MW of large-scale solar power plants (PV); 100 MW of wind farms **Conditional:** To install 500 MW of biomass plants; 150 MW of mini-hydro; 2 050 MW of hydroelectric power stations; 104 MW large-scale solar power plants (PV)	Yes
	Cameroon	Ratified the Paris Agreement on 29 July 2016	11-Oct-21	Yes, focus on power	Yes, focus on power	Yes	The NDC aims for a 12% (unconditional) to 23% (conditional) GHG emission reduction by 2030. The NDC sets a target to boost renewables' share (other than hydro's) by 25% in the electricity mix by 2035.	No
	Central African Republic	Ratified the Paris Agreement on 11 October 2016	24-Jan-22	Yes, focus on power	No	No	The NDC aims for a 11.82% (unconditional) to 24.28% (conditional) GHG emission reduction by 2030 compared with the BAU scenario. The NDC sets a target to build 110 MW of renewable energy plants by 2030 (unconditional).	No
	Chad	Ratified the Paris Agreement on 12 January 2017	19-Oct-21	Yes, focus on power	No	No	The NDC aims for a by 19.3% GHG emission reduction by 2030 based on the reference scenario.	No
	Democratic Republic of the Congo	Ratified the Paris Agreement on 13 December 2017	28-Dec-21	Yes, focus on power	No	No	The NDC aims for a 2% (unconditional) to 19% (conditional) GHG emission reduction by 2030 compared with the BAU scenario. The NDC sets a target of 4 GW of hydroelectricity and 42.7 MW of solar, geothermal and wind by 2030.	No
	Congo	Ratified the Paris Agreement on 21 April 2017	02-Aug-21	Yes, power, heating and transport	No	Yes	The NDC aims for a 21.46% (unconditional) to 32.19% (conditional) GHG emission reduction by 2030 based on the BAU scenario.	Yes
	Equatorial Guinea	Ratified the Paris Agreement on 30 October 2018	24-Oct-22	Yes, focus on power	No	No	The NDC aims for a 35% GHG emission reduction by 2030 taking 2019 as the base year.	No
	Gabon	Ratified the Paris Agreement on 2 November 2016	06-Jul-22	Yes, focus on power	No	No	The NDC aims for a 50% GHG emission reduction by 2030 compared with the BAU scenario. The NDC sets a target of 260 MW of installed hydropower capacity by 2030 and 630 MW by 2050; and of developing 115 MW of grid-connected solar power plants by 2030.	No
	São Tomé and Príncipe	Ratified the Paris Agreement on 2 November 2016	30-Jul-21	Yes, focus on power	Yes, focus on power	No	The NDC aims for a 27% GHG emission reduction by 2030 compared with the BAU scenario. The NDC sets a target of 49 MW of renewables in the electricity supply by 2030.	No

Region	Country	Paris Agreement	Latest date of NDC submission	Renewable energy target in NDCs/ INDCs	Renewable energy target in the national energy plan	Renewable energy target in the rural electrification plan	National renewable energy target	Clean cooking target
Southern Africa	Botswana	Ratified the Paris Agreement on 11 November 2016	11-Nov-16	No	Yes, focus on power	No	The NDC aims for a 15% GHG emission reduction by 2030 taking 2010 as the base year.	No
	Eswatini	Ratified the Paris Agreement on 21 September 2016	12-Oct-21	Yes, power and transport	No	No	The NDC aims for a 5% reduction of economy-wide GHG emissions by 2030 compared with the baseline scenario. The NDC sets a target of boosting renewables' share by 50% in the electricity mix by 2030.	No
	Lesotho	Ratified the Paris Agreement on 20 January 2017	22-Jun-18	Yes, power and heating	No	No	The NDC aims for a 10% (unconditional) to 25% (conditional) GHG emission reduction by 2030 compared with the BAU scenario. The NDC sets a target to boost access to clean energy by 50% by 2030.	Yes
	Madagascar	Ratified the Paris Agreement on 21 September 2016	21-Sep-16	Yes, focus on power	Yes, focus on power	Yes	The NDC aims for a 14% GHG emission reduction by 2030 compared with the BAU scenario. The NDC sets a target to boost renewables' share by 79% in the electricity supply by 2030.	Yes
	Malawi	Ratified the Paris Agreement on 29 June 2017	30-Jul-21	Yes, power, heating and transport	No	Yes	The NDC aims for a by 6% (unconditional) to 45% (conditional) GHG emission reduction by 2040 compared with the BAU scenario.	Yes
	Mozambique	Ratified the Paris Agreement on 4 June 2018	27-Dec-21	No	Yes, power and transport	Yes	The NDC aims for GHG emission reduction by about 40 $MtCO_2eq$ over 2020-2025. The NDC sets a target to prioritise the production of 5 645 MW from hydropower sources; 600 MW from solar; 1 146 MW from wind; 128 MW from biomass; 20 MW from geothermal energy.	No
	Namibia	Ratified the Paris Agreement on 21 September 2016	30-Jul-21	Yes, power, heating and transport	Yes, power	Yes	The NDC aims for a 91% GHG emission reduction by 2030 compared with the BAU scenario. The NDC sets a target to develop 70 MW of renewable energy feed-in tariffs; 45 MW of solar rooftop systems; 20 MW of solar power; 40 MW of wind power.	No
	South Africa	Ratified the Paris Agreement on 1 November 2016	27-Sep-21	Yes, focus on power	Yes, focus on power	No	South Africa's Renewable Energy Independent Power Producer Procurement Programme (REI4P) has, as of March 2020, approved 112 renewable energy independent power producer projects; 6 422 MW have been procured in four large-scale and three small-scale bid windows.	No
	Zambia	Ratified the Paris Agreement on 9 December 2016	30-Jul-21	Yes (no quantified target), focus on power and transport	No	No	The NDC aims to reduce GHG emissions by 25% (with the BAU level of international support prevailing in 2015) to 47% (with substantial international support) compared with the 2010 levels.	No
	Zimbabwe	Ratified the Paris Agreement on 7 August 2017	24-Sep-21	Yes, power and heating	Yes, power, heating and transport	No	The NDC aims for the a 40% (conditional) GHG emission reduction by 2030 compared with the BAU scenario. The NDC sets a target of developing 300 MW of solar in 2025; 2 098 MW of capacity added through micro-grids by 2028; 4.1 MW of biogas capacity added in 2024.	No

Source: Adapted from (IRENA et al., 2022); (UNFCCC, n.d.)

Note: BAU = business-as-usual; GHG = greenhouse gas; INDC = Intended Nationally Determined Contribution; NDC = Nationally Determined Contribution; $MtCO_2eq$ = million tonnes of carbon dioxide equivalent; MW = megawatt; PV = photovoltaic.



SUB-SAHARAN AFRICA

POLICIES AND FINANCE FOR RENEWABLE ENERGY DEPLOYMENT

IRENA
International Renewable Energy Agency