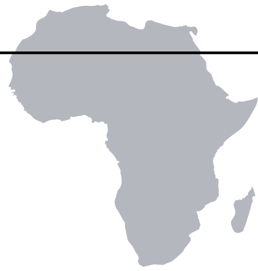
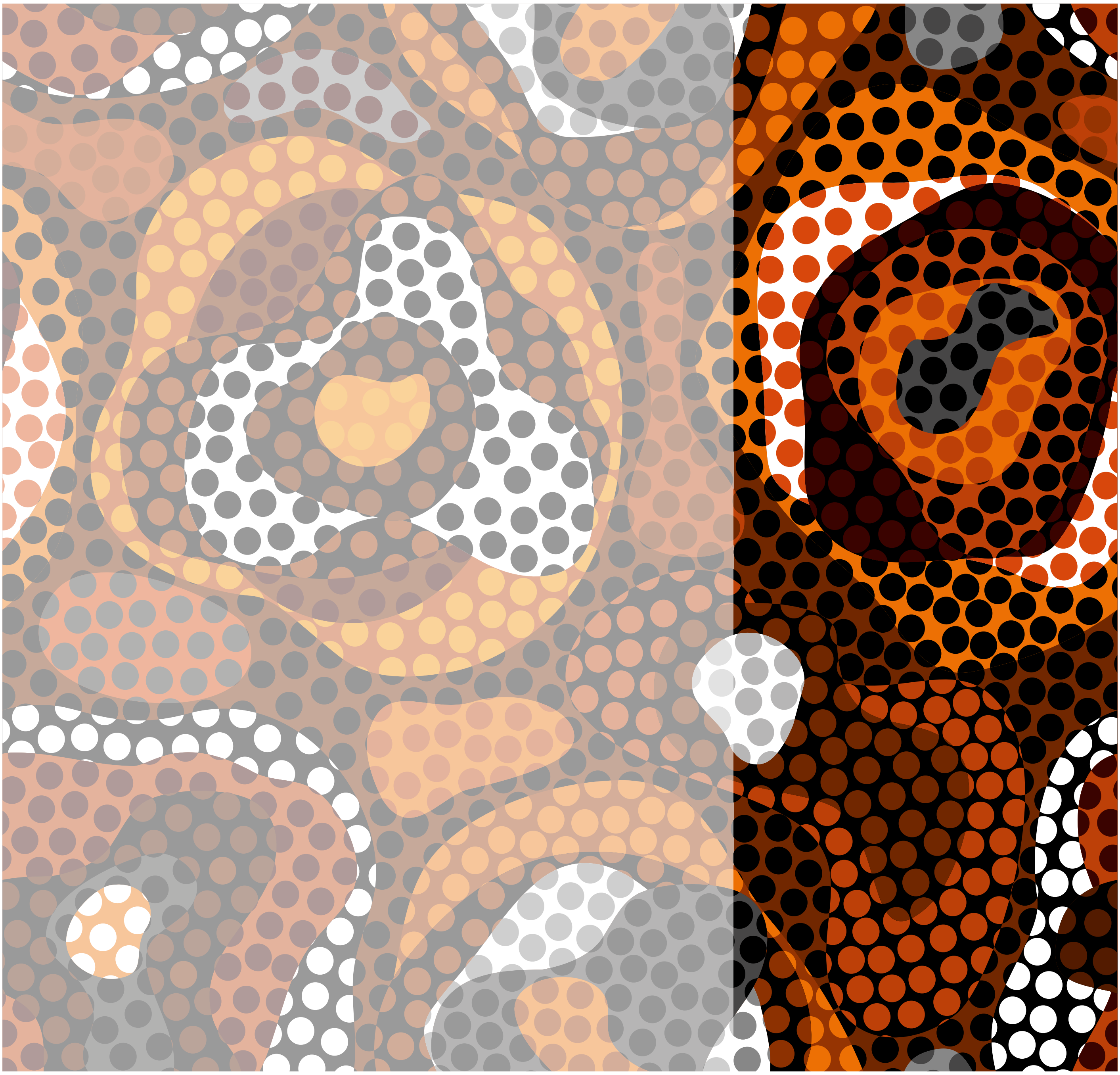
IRENA
International Renewable Energy Agency

SUMMARY FOR POLICY MAKERS

RENEWABLE ENERGY MARKET ANALYSIS



AFRICA AND ITS REGIONS



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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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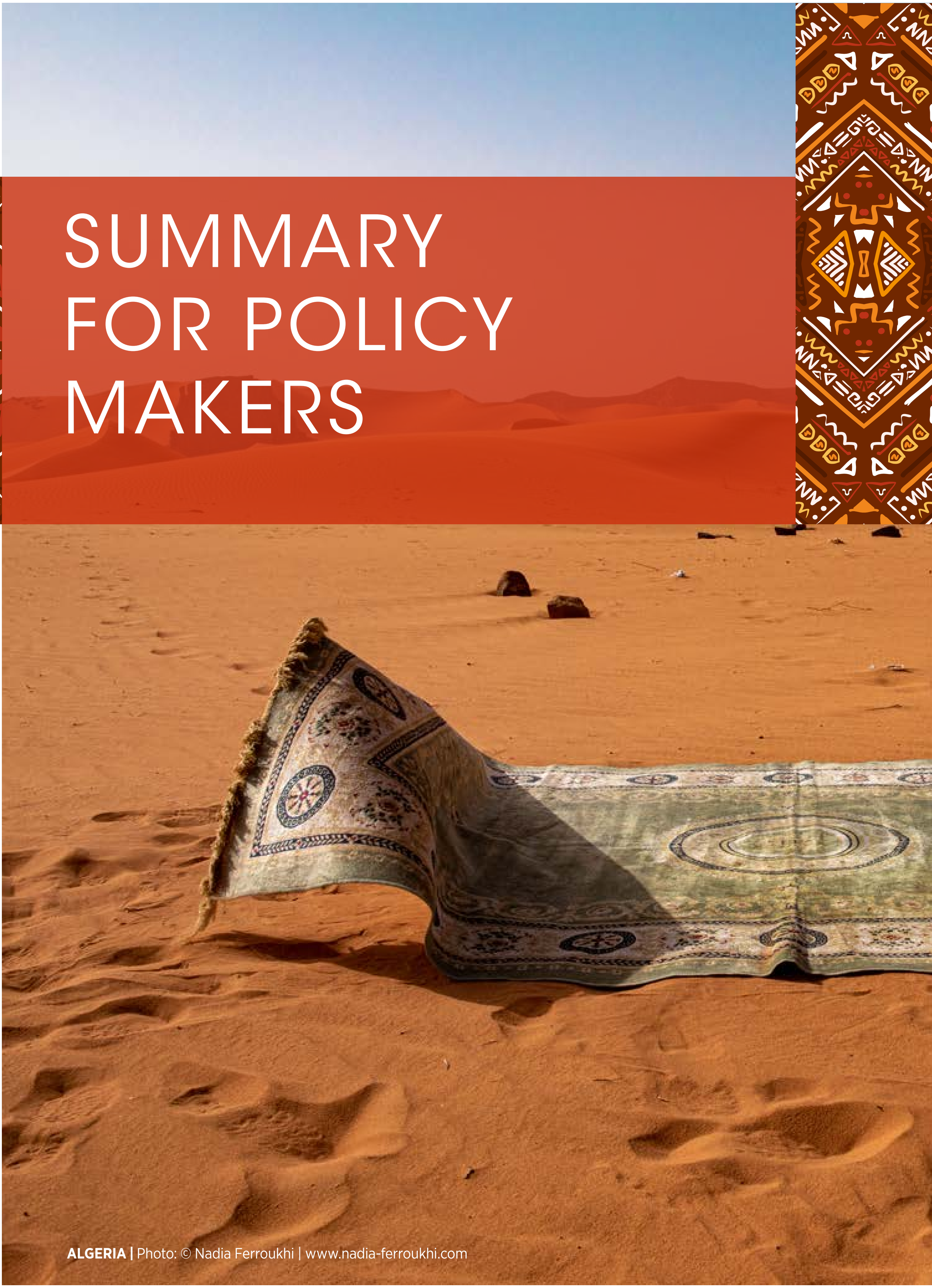
SUMMARY FOR POLICY MAKERS



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AFRICA'S ENERGY CHALLENGE AND OPPORTUNITY

Sustainable, renewable energy is fundamental to Africa's future. Renewable energy can play a critical enabling role in Africa's socio-economic development and industrialisation. By 2050, the continent will be the home of 2 billion people, and two in every five of the world's children will be born there. Meeting their needs with sustainable sources of modern energy – for consumption and production – will be essential to social welfare and economic development.

This report offers a transition framework for a diverse continent. Africa is extraordinarily diverse, and no single approach will advance its energy future. But efforts must be made to build modern, resilient and sustainable energy systems across the continent to avoid trapping economies and societies in increasingly obsolete energy systems that burden them with stranded assets and limited economic prospects (IRENA, 2020a). This report proposes a calibrated energy transition framework for the African continent and its five regions to help policy makers identify, prepare and foster the virtuous relationship between the energy transition and overall development.

The magnitude of the task is most apparent in Sub-Saharan Africa, which had an electrification rate of 46% in 2019 and where 906 million people still lack access to clean cooking fuels and technologies (World Bank, 2021a; WHO, 2021). Lack of reliable and affordable access to sustainable, modern energy hinders agricultural productivity, food security and industrial development. Furthermore, it impedes the delivery of critical public services (*e.g.* health care, education), damages health and the environment, and reinforces rural and gender inequality.

Many African countries remain highly dependent on commodity exports, including fossil fuels. In the context of a low-carbon future, fossil fuel–dependent countries are increasingly exposed to the risks of stranded assets, with nascent manufacturing capabilities caught between changing approaches to energy. Because fossil fuels remain among Africa's largest exports, many hydrocarbon-exporting African economies may face difficult socio-economic challenges if they miss the opportunity to diversify their economies today.

Renewable energy options can power the economy of the future while helping to restore environmental quality. Poor energy services and reliance on polluting sources of energy further hinder progress in Africa's fight against environmental degradation and climate change, with the continent having contributed little to the global carbon footprint. Transitioning their economies to renewable energy, while building up high-quality energy infrastructure will thus be a critical enabler of sustainable development in Africa. Sustainable energy development will also have a critical influence on Africa's recovery from the COVID-19 crisis and deserves much more policy focus in this context than it has received in the past.

While the energy transition holds challenges for Africa's economies, it also promises vast opportunities, notably in employment. For many African energy importers, renewable energy holds great potential to reduce vulnerability to the external shocks caused by movements in the price of fossil fuels. Renewables can also play a central role in creating jobs, because investing in energy transition technologies creates up to three times as many jobs as fossil fuels per million of dollars spent (Garrett-Peltier 2017).

Jobs created in the renewable energy transition will outweigh those lost by moving away from traditional energy. Under IRENA's 1.5°C Scenario for the period 2020-2050, every million U.S. dollars invested in renewables would create at least 26 job-years; for every million invested in energy efficiency at least 22 would be created annually; for energy flexibility, the figure is 18. The gains would far outweigh the loss of fossil fuel sectors jobs during the transition.

The energy future must by aligned with the overall economy. Although the development of renewable energy has been incorporated into more and more national and regional structural transformation programmes, more attention must be paid to the feedback loops and synergies between energy, industrialisation and development.

Regional supply chains are vital to Africa's resilient long-term development. The importance of diversifying and regionalising renewable energy supply chains was highlighted by the COVID-19 crisis, which severely disrupted cross-border supply chains. But more robust supply chains closer to home are also essential to boost long-term resilience against exogeneous shocks and support economic diversification. Building regional supply chains in the renewable energy sector in Africa is essential to support the energy transition, boost development and create jobs on a continent with high rates of unemployment. The sector today employs more than 12 million people worldwide, but only around 323 000 in Africa (less than 3% of renewables employment worldwide) (IRENA and ILO, 2021).[1]

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1 *Because of limitations in jobs data across Africa, energy-related employment figures are very likely underestimated. Significant additional employment is also found in providing access to energy, but these jobs are not accounted for in the cited references.*

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Regionally based renewable energy enterprises can help Africa advance using its own natural resources locally. The benefit Africa derives from the energy transition will depend in part on the extent to which producers of raw materials invest in and develop processing capacity further up the value chain. Only when economic activity moves from the mere export of raw materials to higher-value products can countries maximise the potential for local job creation and improved livelihoods. Renewable energy could also help boost intra-African trade in clean energy technologies, services and electricity, benefiting from the African continental free trade area and the recent launch of the African Single Electricity Market. Securing such benefits hinges on leveraging and enhancing local industrial capacities, putting in place adequate education and training programmes, and adopting far-sighted industrial and labour market policies. In this way, the energy transition could play a pivotal role in the much wider diversification and transformation of African economies. Anchored by renewable energy deployment, the development of green industries with strong local value chains would be a major departure from current economic structures in which Africa principally exports commodities while the value-added is captured elsewhere in the world.

Modern renewable energy has a vital role to play in advancing socio-economic and human development. Africa has made uneven progress in socio-economic development over the past decade. The continent's score on the Human Development Index rose from 0.45 in 2000 to 0.57 in 2019 (see Figure S.1), implying overall positive progress, including on Sustainable Development Goals (SDGs) such as education and poverty alleviation (IEA, IRENA *et al.*, 2021). Still, the fight against poverty and hunger and for improving access to education, health care and economic opportunity remains a fundamental challenge in many parts of Africa. Access to affordable, reliable and sufficient energy is a crucial enabler of livelihoods, public services and the capacity of communities and enterprises to adapt to shocks. With Africa containing 33 of the world's 47 least-developed countries (in the UN classification) and more than half of those earning less than USD 1.90 per day (in purchasing power parity terms), the scope of the challenge is clear.

Figure S.1 Evolution of key socio-economic indicators by African region

Source: UNECA, 2017; UNDP, n.d.

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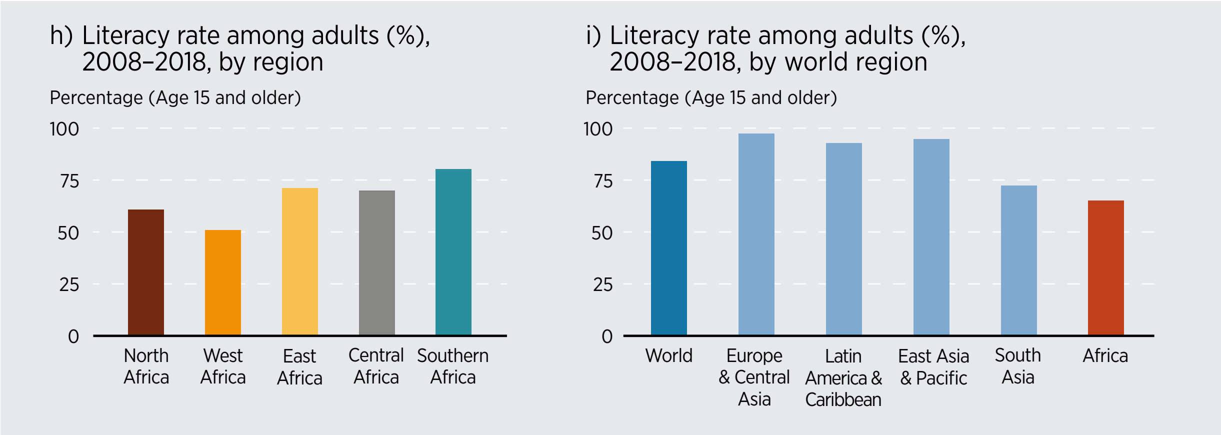
Figure S.1 Evolution of key socio-economic indicators by African region (continued)



Source: UNECA, 2017; UNDP, n.d.

Transitions from traditional energy sources require inclusive planning and consensus building. Modern renewable energy has a vital role to play 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 cooking and heating. Because some renewable energy projects, in particular large-scale hydropower dams, can interfere with local ecosystems and communities' traditional forms of managing their land and may themselves have unfavourable effects on the climate, increased deployments of these technologies will require transparent, inclusive decision-making to maximise benefits and minimise harm to the environment and to local communities.

Sustainable, clean energy development is the catalyst for broad-based social and economic development. Endowed with significant energy resources – including vast renewable energy potential as described below – African countries could push ahead with sustainable energy deployment at a scale commensurate with the needs of their people. Energy development is intrinsically related to core socio-economic issues in Africa, and the deployment of renewables can help countries across the continent achieve their objectives.

ENERGY ON THE CONTINENT: A PANORAMA

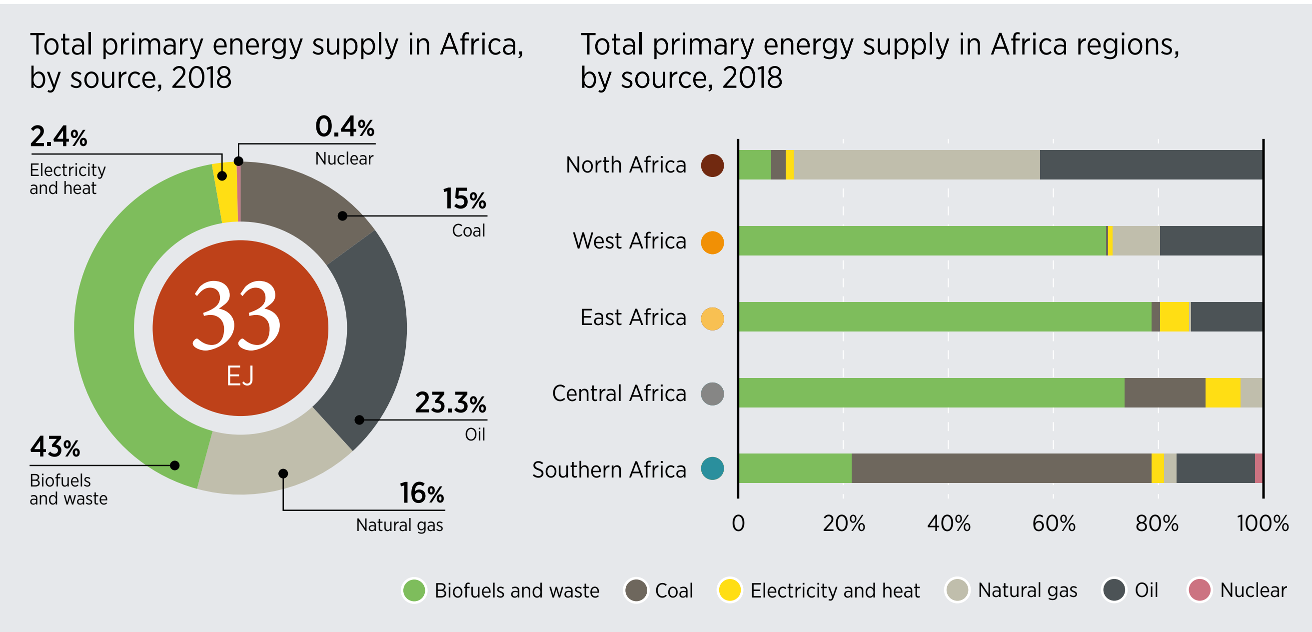
Africa's regions display both the ample availability of energy resources and limitations in access to them. Africa's energy landscape features a range of energy resources, from hydrocarbons and traditional biomass fuels to a variety of renewable energy technologies. But even though the continent is home to a fifth of the world's population, it accounts for just 6 percent of global energy demand and 3 percent of electricity demand (IEA, IRENA *et al.*, 2021). Significant gaps remain in access to modern energy, particularly in Sub-Saharan Africa, while industrialisation and agricultural productivity lag in many parts of the continent. This part of the summary provides a panoramic view of the status of the energy sector on the African continent, with particular focus on renewable energy. The pressing topic of expanding access to modern forms of energy is the subject of a separate section.

PRIMARY ENERGY AND ELECTRICITY SUPPLY

Bioenergy remains the most widely used energy source on the continent. Africa's primary energy supply has grown at a Compound Annual Growth Rate (CAGR) of around 2% per year over the past decade (2008-2018) on the back of increased production of oil, natural gas and biomass (UNSD, 2018). Biofuels and waste remain the most widely used source of energy on the African continent, accounting for over 40% of energy supply (Figure S.2). Ranging from traditional biomass to improved traditional biomass technologies and modern bioenergy,[2] bioenergy is a critical source of energy, particularly for household cooking. Some 927 million people on the African continent continue to rely on traditional biomass for cooking and heating (WHO, 2021).

Besides bioenergy, fossil fuels (oil, gas and coal) supply most of Africa's energy. Oil is the second-largest source of primary energy, particularly in transport, industry and power generation. Natural gas, too, has long been used for power generation and industrial processes in gas-producing countries. Southern Africa, by contrast, which lacks its own gas reserves, has historically relied on coal for power generation; the region accounts for a large share of the continent's coal consumption. Coal, natural gas and oil together account for almost 80% of Africa's total electricity generation during 2019 (IRENA, 2021a). Africa's largest electricity-consuming economies – South Africa, Egypt, Algeria and Nigeria – drive these trends.

Figure S.2 Total primary energy supply in Africa and its regions, by source, 2018



Source: UNSD, 2018.
Note: EJ = Exajoule

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

There is great potential for regional energy trade using existing networks. While electricity trading within Africa remains limited, the potential for expansion is great given the existence of several large cross-border grids, as well as interconnection projects that enable neighbouring countries, in theory, to share backup power and to engage in electricity trading. The maturity and effectiveness of these interconnected networks varies widely, however, with the most significant regional trading taking place in the Southern African Power Pool. A large share of existing trade is bilateral, using existing infrastructure rather than a multilateral trading platform.

RENEWABLE ENERGY

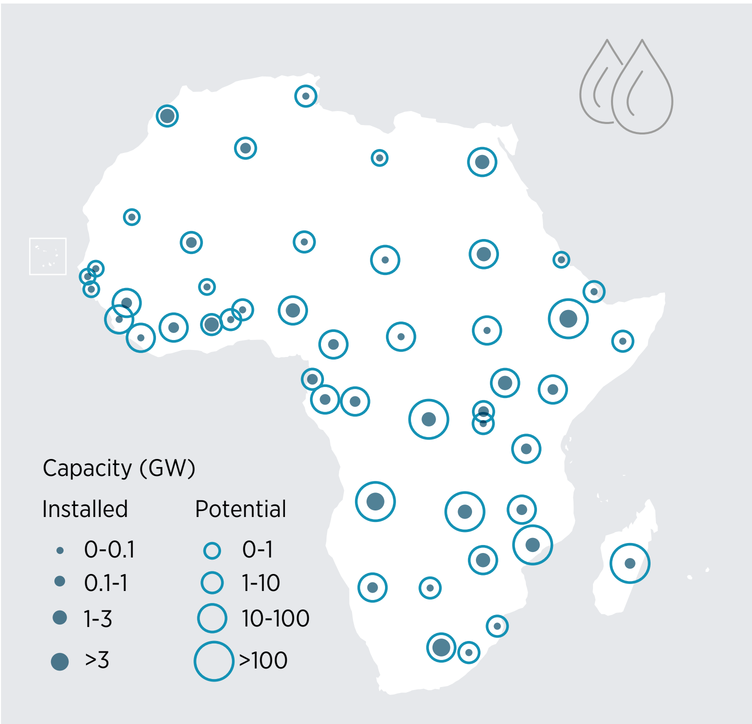
New energy technologies are poised to expand. With the exception of hydropower, modern renewable energy – solar, wind, geothermal and modern bioenergy – still contributes only marginally to Africa's energy mix, despite its vast potential. Africa accounts for almost 3% of the world's installed renewables-based electricity generation capacity in spite of large resource potential (IRENA, 2021a).

More recently, renewable energy deployment has grown, with renewables-based generation capacity on the continent rising 7% in the last decade (2010-2020). The largest additions were in solar energy. Much of the growth has been driven by large-scale projects in individual countries, particularly new utility-scale hydropower and solar PV projects. Regionally, Southern Africa led total renewable generation capacity in 2020 with 17 GW, or around a third of Africa's total, followed by North Africa with 12.6 GW, a fourth of the continental total (IRENA, 2021a).

Hydropower

Hydropower has been used in Africa for many decades owing to the presence of major rivers. At almost 34 GW capacity by the end of 2020, large-scale hydropower is the largest source of renewable-based electricity in Africa, with sizeable unexploited potential – estimated some years ago at 1753 GW (Figure S.3). In several African countries with major rivers crossing through their territory, hydropower accounts for half or more of electricity generation. Africa's largest hydropower producers are Ethiopia, Angola, South Africa, Egypt, the Democratic Republic of Congo, Zambia, Mozambique, Nigeria, Sudan, Morocco and Ghana.

Figure S.3 Hydropower potential and installed capacity, Africa



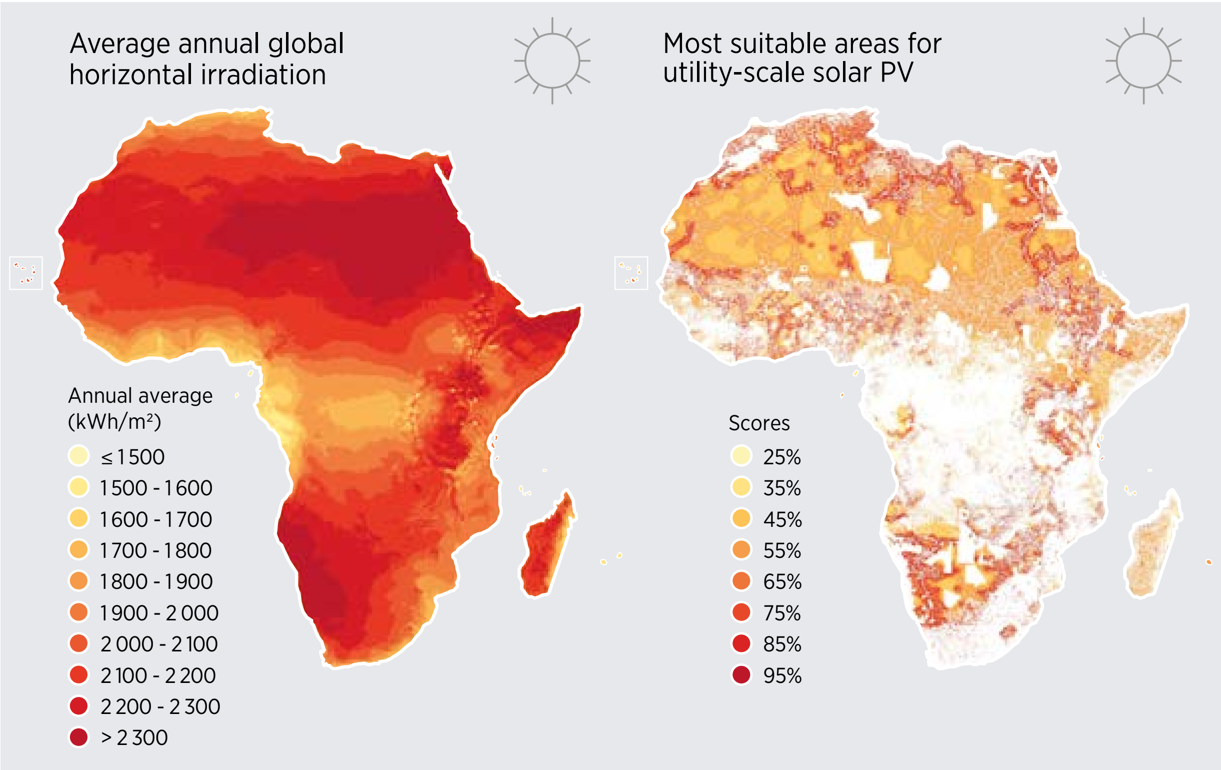
Source: Hydropower potential, Africa: Hoes, 2014 (Delft University of Technology); Installed hydropower capacity, Africa: IRENA, 2021a; Base map: UN boundaries.

Note: Includes pumped storage. GW = gigawatt; km = kilometre.

Disclaimer: This map is provided for illustration purposes only. Boundaries shown on this map do not imply any endorsement or acceptance by IRENA.

3 Assuming a 1% land-utilisation factor.

Figure S.4 Africa: (a) average annual global horizontal irradiation; (b) most suitable areas for utility-scale solar PV



Source: (a) Global Solar Atlas (ESMAP, 2019); (b) IRENA Global Atlas for Renewable Energy (IRENA, 2021e).

Note: kWh/m² = kilowatt hours per square metre; PV = photovoltaic.

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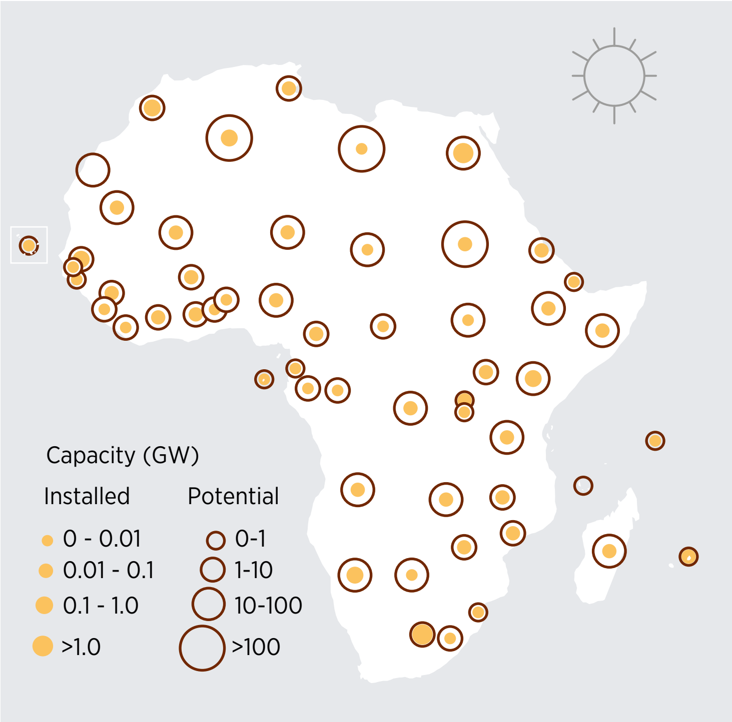
Solar energy

Africa possesses some of the globe's greatest potential for solar power generation. The continent receives annual average solar irradiation of 2 119 kilowatt hours per square metre (kWh/m²), with most countries across North, West and Southern Africa receiving an average in excess of 2 100 kWh/m² annually. IRENA estimates the continent's solar photovoltaic (PV) technical potential at 7 900 GW,[3] indicating vast potential for the generation of solar power (Figures S.4 and S.5). Despite the potential, utility-scale solar power has been deployed in just a few countries.

Solar energy is now the fastest-growing renewable energy source in Africa. Between 2011 and 2020, solar capacity in Africa grew at an average compound annual growth rate (CAGR) of 54%, two and a half times that of wind (22.5%), almost four times that of geothermal (14.7%) and almost 17 times that of hydropower (3.2%). Total solar additions over the past decade (2010-2020) amounted to 10.4 GW (9.4 GW solar PV; 1 GW concentrated solar power) with the most additions made in 2018 (2.9 GW). Most of these new additions occurred in a handful of countries in Southern and North Africa (Figure S.6).

Figure S.5 Solar PV potential and installed capacity, Africa



Source: Solar potential, Africa: IRENA; Installed solar capacity, Africa: IRENA, 2021a; Base map: UN boundaries

Note: GW = gigawatt; km = kilometre.

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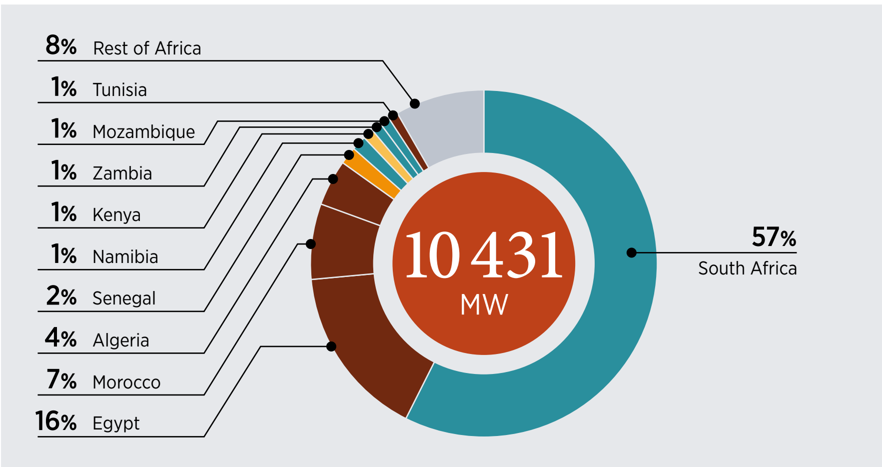
Figure S.6 Africa's installed solar generation capacity, 2020

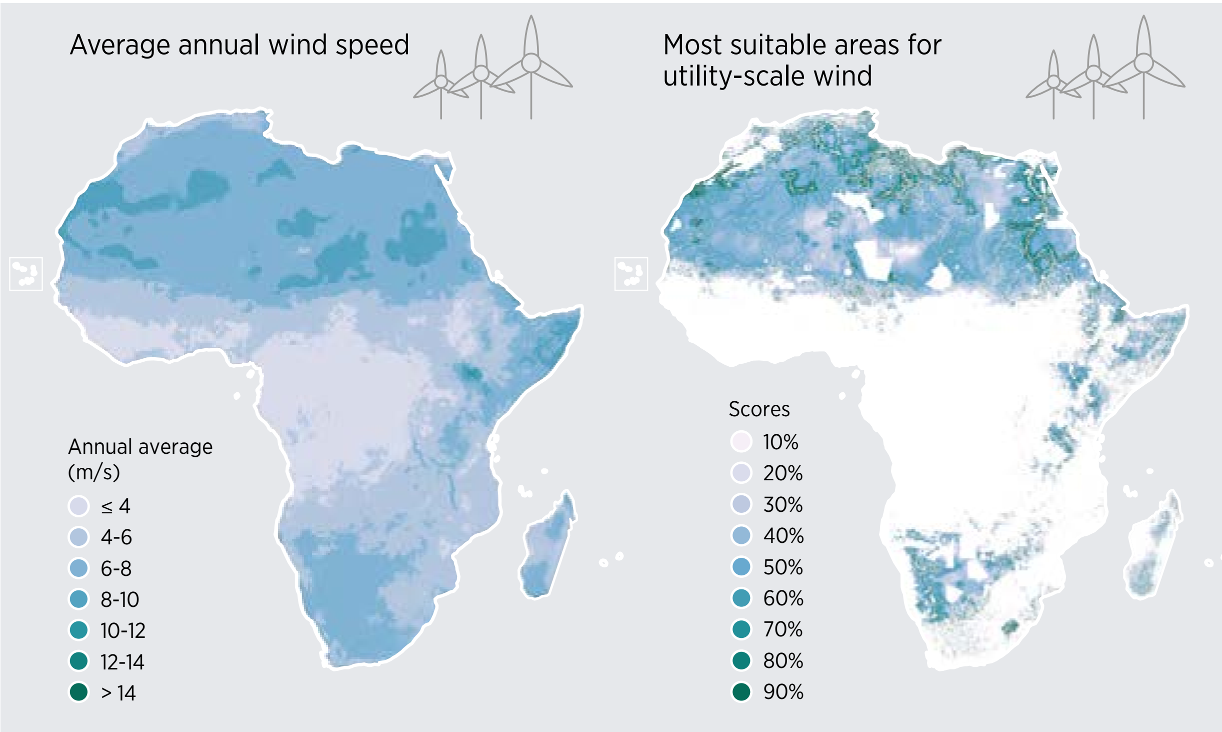


Source: IRENA, 2021a.
Note: MW = megawatt.

Wind power

North Africa, East Africa and Southern Africa are the regions best suited for the development of wind energy. IRENA estimates the technical potential of wind power generation at 461 GW[4] with Algeria, Ethiopia, Namibia and Mauritania possessing the greatest potential. Annual average wind speeds in North Africa and Southern Africa are high, reaching 7 metres per second (m/s) (Figure S.7a). Figure S.7b shows the areas suitable for utility-scale project development. Overall, however, wind resources remain underexploited in Africa, in particular in parts of North Africa and the Sahel area (Figure S.8).

Figure S.7 Africa: (a) average annual wind speed; (b) most suitable areas for utility-scale wind



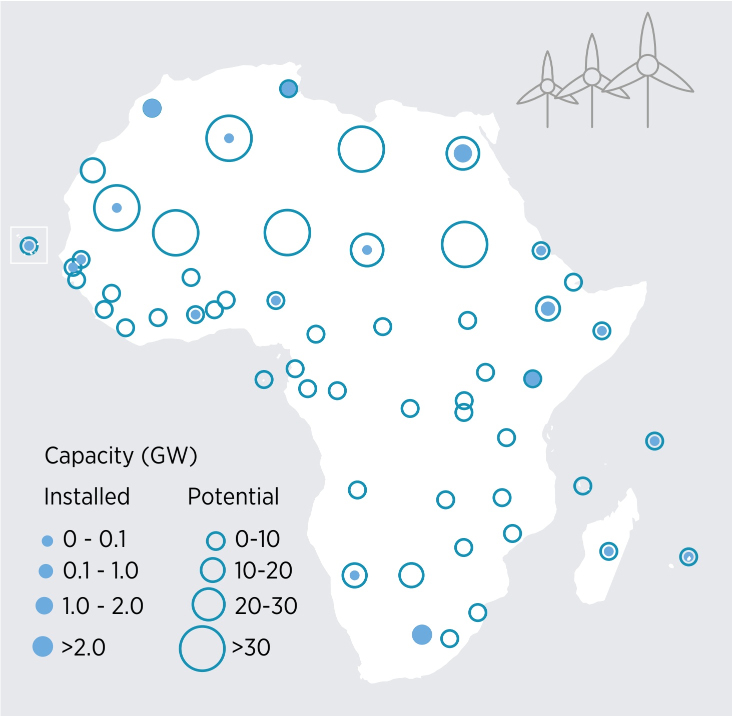
Source: (a) Global Wind Atlas (DTU, 2015); (b) IRENA Global Atlas for Renewable Energy (IRENA, 2021e); Base map: UN boundaries.

Note: m/s = metre per second; m = metre; s: second.

Disclaimer: This map is provided for illustration purposes only. Boundaries shown on this map do not imply any endorsement or acceptance by IRENA.

4 Assuming a 1% land-utilisation factor.

Figure S.8 Wind potential and installed capacity, Africa



Source: Wind potential, Africa: IRENA; Installed solar capacity, Africa: IRENA, 2021a; Base map: UN boundaries.

Note: GW = gigawatt; km = kilometre.

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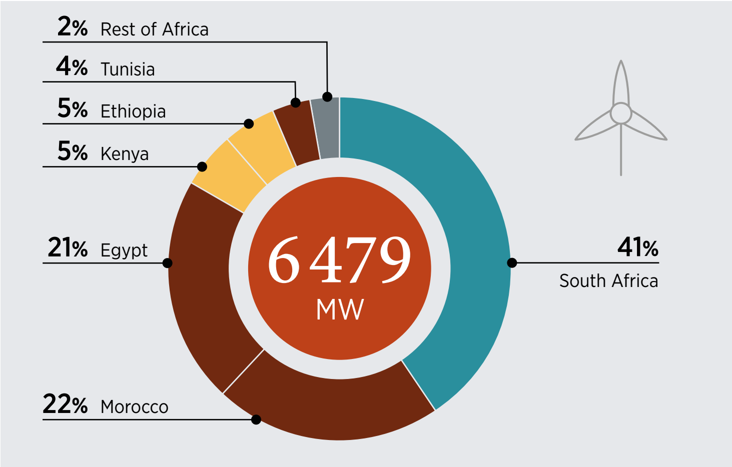
Wind power facilities are unequally distributed across the continent, being tied to the geographic distribution of wind resources and policy interest in developing them. At the end of 2020, wind generation capacity in Africa amounted to 6.5 GW, of which some 0.7 GW was added in 2020. Countries with significant generation capacity are South Africa, Morocco and Egypt, as well as Kenya, Ethiopia and Tunisia, which together account for over 95% of Africa's total wind generation capacity (Figure S.9).

Geothermal energy

The continent's geothermal resources are found in the East Africa Rift System, where an estimated 15 GW of potential remains untapped (BGR, 2016). At the end of 2020, Kenya was the continent's only substantial producer of electricity from geothermal power, with a generation capacity of 823.8 MW. Ethiopia, the only other African country currently producing geothermal energy, operates a small pilot plant. At the end of 2019, new geothermal capacity was being planned in Uganda, Djibouti, Tanzania and Eritrea (IEA, 2019).

Figure S.9 Installed wind generation capacity, Africa, 2020



Source: IRENA, 2021a.

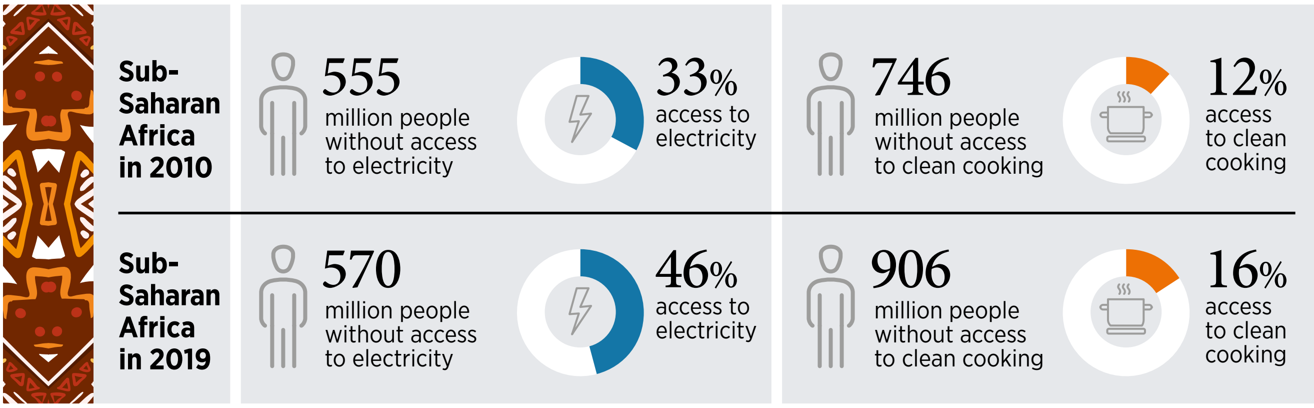
Bioenergy

Bioenergy ranges from rudimentary and inefficient to modern engineered fuels. Although biomass is the most widely used energy source on the continent, most of it is consumed for cooking, using inefficient traditional practices. Modern uses of bioenergy for electricity generation represented around 1% of all renewable electricity generation in 2019, and it is not clear how much of the fuel was sustainably sourced. Modern heat uses include bagasse-fired co-generation plants for sugar-cane processing in East Africa. There are also prospects for using advanced biofuels in the transport sector in several African countries. West Africa alone may have the potential to produce over 100 megatonnes per year of agricultural residues that could be converted into biofuels like ethanol and biobutanol, or into electricity (UNSD, 2018; EIA, 2019).

THE PRESSING NEED TO EXPAND ACCESS TO MODERN FORMS OF ENERGY

Despite advances, universal energy access goals are in jeopardy. Africa has made progress over the past decade in expanding access to energy. However, population growth has outpaced the rate of expansion in many parts of the continent. While the rate of access to electricity in Sub-Saharan Africa as a whole rose from 33% in 2010 to 46% by 2019, 570 million people still lacked access to electricity in 2019 (see Figure S.10), an increase of about 20 million people over 2010, many of them in rural areas (World Bank, 2021a). Even worse, there were 160 million more people without access to clean cooking over the same time period (WHO, 2021). On the current trajectory, the continent is set to miss, by a large margin, the target of universal access to modern forms of energy by 2030 spelled out in SDG 7.1. By 2030, around 560 million people in Sub-Saharan Africa are expected to remain without electricity; more than a billion people will still lack access to clean cooking fuel (IEA, 2020; IEA, IRENA *et al.*, 2021).

Figure S.10 Access to electricity and clean cooking in Sub-Saharan Africa, 2010 and 2019



Source: World Bank, 2021a; WHO, 2021.

Achieving universal access to modern forms of energy is central to meeting several of the other SDGs and achieving a sustainable, just and inclusive recovery. The COVID-19 crisis has been a sobering reminder of the critical role energy plays in health care, sanitation, telecommunications and resilient livelihoods, highlighting the way Africa's energy access deficit remains a major constraint on sustainable socio-economic development.

Access to energy is characterised by a deep urban/rural divide. Electricity access is typically higher in urban centres, where great progress has been made in recent decades all across Africa, though the quality of service often remains low (United Nations, 2021). Rural electrification, by contrast, has not increased in many parts of Sub-Saharan Africa, reinforcing a persistent urban-rural divide: an 84% electrification rate in urban areas compared with 29% in rural areas. Much rural access is limited to basic electricity for lighting and mobile charging, with insufficient power for the income-generating activities needed to drive wider economic development. At the same time, across much of rural Sub-Saharan Africa access to clean cooking is very limited.

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Countries in North Africa have the continent's highest rates of electrification and access to clean cooking, whereas the deficit is greatest in West Africa. Nigeria, the Democratic Republic of Congo and Ethiopia have the largest populations living without access – about 218 million for electricity and 362 million for clean cooking. In terms of population shares, South Sudan, Chad, Malawi and Burkina Faso had the lowest rates of electricity access in 2019, at 7%, 8%, 11% and 18%, respectively. For clean cooking, rates are even lower, with six African countries (Burundi, Liberia, the Central African Republic, Sierra Leone, South Sudan and Uganda) having rates below 1% (IEA, IRENA *et al.*, 2021).

DIMENSIONS OF THE DEFICIT: AFFORDABILITY, RELIABILITY, ACCESSIBILITY

Gathering thorough country-level data will strengthen evidence-based planning. A multi-dimensional understanding of energy access can fully capture the quantitative and qualitative aspects of access for households, public buildings and enterprises. The Energy Sector Management Assistance Program's (ESMAP's) Multi-Tier Framework for Energy Access has introduced additional attributes of energy access: availability, reliability, quality and affordability for electricity access; cookstove efficiency, convenience, affordability and fuel availability for clean cooking (ESMAP, 2015). Gathering country-level data across these different attributes provides greater insights into the landscape of energy access and makes it possible to set targets and track progress towards *meaningful* access for all. This section discusses selected attributes of energy access, drawing on available data and information.

Affordability of energy is a fundamental challenge. The affordability of access to energy has several aspects, including the cost of subsistence consumption as a proportion of gross household incomes, the affordability of connection fees and clean cookstoves, and the existence of lifeline tariffs. While consumer affordability in Africa has improved in recent years, the pandemic-related economic shock is likely to widen the affordability gap (IEA, IRENA *et al.*, 2021). The number of people without electricity actually *increased* in 2020 as basic electricity services became unaffordable for millions of people who had previously gained access (UNSD, 2021). Tackling the affordability challenge requires a range of measures, including demand-side subsidies, fiscal incentives (*e.g.* reduction in value-added tax and import duties) and tailored consumer financing.

Reliability of electricity supply is a major constraint in Africa. It inhibits households, public institutions and enterprises from fully exploiting the opportunities afforded by electricity access for both consumptive and productive uses. In Ethiopia, for instance, almost 60% of grid-connected households face 4-14 disruptions a week, and 3% face more than 14 (World Bank, 2018a). The proportion of firms experiencing outages is higher than in any other world region, forcing enterprises to use generators and pushing up their operating costs. In 25 of 29 countries surveyed in Africa, fewer than one-third of firms had reliable access to electricity (Blimpo and Cosgrove-Davies, 2019).

Variability of energy supply and quality limits progress throughout society. The lack of reliable supply makes it difficult for households, enterprises and public infrastructure (*e.g.* schools and clinics) to fully exploit the opportunities offered by modern energy, holding back socio-economic development. Closely linked to reliability is availability, *i.e.* the ability to draw energy or fuels when needed for use.

Energy access plans must account for accessibility-related obstacles. Solutions that open access to energy in principle are not always truly accessible for various social and consumer groups because of the absence of requisite infrastructure or poor opportunities to take advantage of that infrastructure. In Rwanda, for example, high connection fees keep many households from accessing the grid (World Bank, 2018b). The lack of roads in remote areas and inadequate distribution channels for products and fuels can also hinder access.

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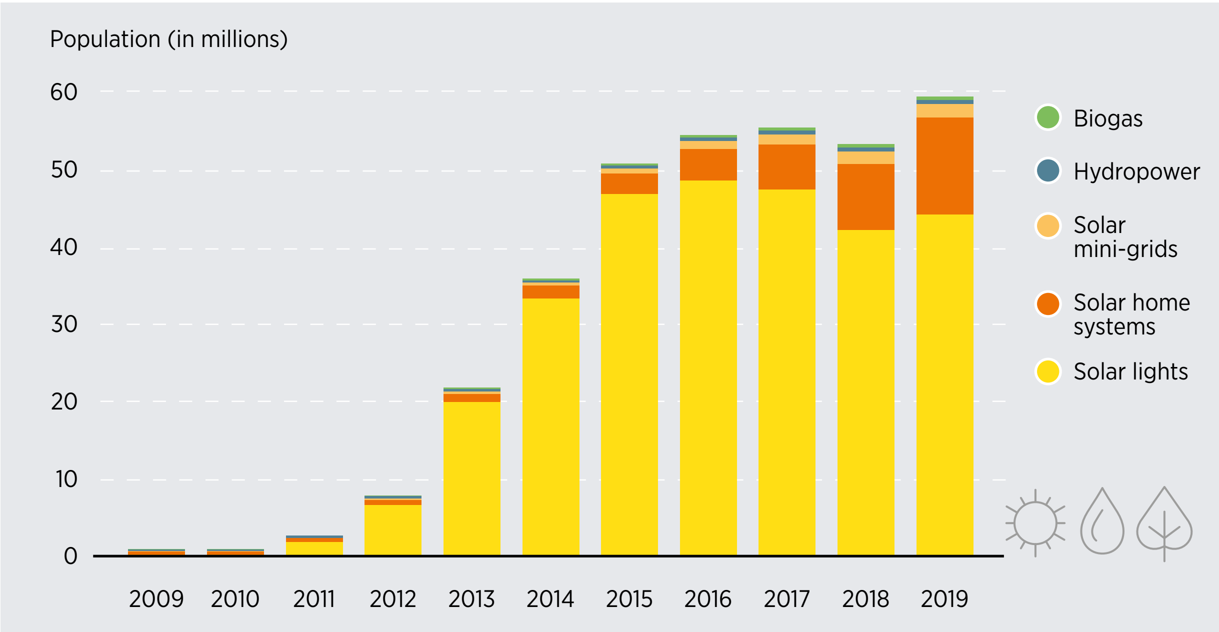
EXPANDING ACCESS USING DISTRIBUTED RENEWABLE ENERGY

Distributed renewable energy solutions, including stand-alone systems and mini-grids, play a steadily growing role in expanding electricity access in off-grid areas and strengthening supply in already connected areas. In the off-grid context, renewables-based stand-alone systems (*e.g.* solar lights, home systems) and mini-grids have spread in recent years, driven by improving technology, falling costs and favourable policy and regulatory environments (Figure S.11). With the active participation of the private sector and facilitated by context-specific local conditions (*e.g.* mobile payments in East Africa), these solutions have quickly come to complement electrification through grid extension. According to IRENA data, nearly 60 million people in Africa had access to electricity services through off-grid solutions in 2019, the majority in East Africa (IRENA, 2021b). Over 700 000 people in Africa were connected to solar mini-grids between 2016 and 2019 (IRENA, 2021b).

Grid-interactive distributed renewables can also raise the quality and reliability of supply in connected areas, particularly for commercial and industrial consumers. Distributed renewables are increasingly deployed to support the delivery of public services such as health care and education. Linking electricity supply with income-generating activities and public services is crucial to maximising socio-economic benefits and making progress on multiple SDGs.

Access to clean cooking solutions is a central pillar of the just energy transition in Africa. Most households have little choice but to burn biomass fuels (mostly firewood and charcoal) on open fires or in inefficient stoves. Scaling-up renewables-based clean cooking solutions can help accelerate progress towards SDG 7.1 and mitigate the significant social, economic and environmental cost of traditional fuels. This will involve both cleaner bioenergy solutions (including biogas and bioethanol) and renewables-based electric cooking. At the end of 2019, nearly 412 000 Africans were using biogas for residential cooking (IRENA, 2021b).

Figure S.11 African population served by off-grid renewable power, 2009-2019



Source: IRENA, 2021b.

The way forward includes co-ordinated efforts across many priority areas. Distributed energy systems are now recognised by national governments and other public and private actors as a key to expanding access to electricity and clean cooking in a timely and environmentally sustainable manner. Building on progress to date, distributed renewable electricity and clean cooking must be scaled up significantly if the continent is to have a shot at reaching the 2030 target of universal access. Necessary actions include making energy access a national and regional priority; greater ambition and investments in renewables-based clean cooking; stronger policy and regulatory frameworks; ramped-up financing for energy access; stronger links with livelihoods and public services; and inclusive approaches for active involvement of women, youth and marginalised communities.

Universal access to modern energy must be a cornerstone of Africa's energy transition. Without reliable, affordable and sustainable modern energy for every household, farm, enterprise, school and clinic, the continent's socio-economic development objectives will be difficult to attain. In addition to being a dedicated target of SDG 7, modern energy access in Africa is a matter of energy justice. A just and inclusive energy transition – an increasingly prominent goal in international discourse – will not be possible without addressing the problem of access on the continent with the lowest per capita energy consumption of all world regions and the largest energy deficit.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FINANCE FOR RENEWABLE ENERGY

Investment in renewable energy in Africa is lagging. Of the USD 2.8 trillion invested in renewable energy globally between 2000 and 2020, only 2% went to Africa, despite the continent's enormous potential to generate energy from renewable sources and its huge need to bring modern energy services to the hundreds of millions of people still lacking them. Between 2000 and 2020, Africa attracted almost USD 60 billion in investment in renewables (excluding large hydropower). Over 90% of that – some USD 55 billion – was committed between 2010 and 2020 and concentrated in a handful of countries. In the 2000-2009 period, renewable energy investments in Africa averaged less than USD 0.5 billion annually. In 2010-2020, the average increased ten-fold to reach USD 5 billion (Figure S.12).


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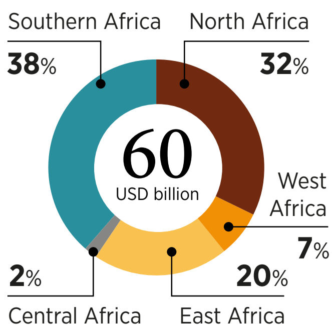
Figure S.12 Summary of renewable energy investments in Africa, 2000-2009 and 2010-2020

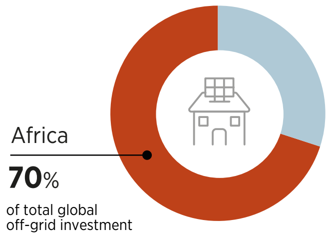
Overall renewable energy investment in Africa and globally, 2000-2020 (USD Billions, current 2020)

	2000-2009	2010-2020	Cumulative 2000-20
Global	587 USD billion	2 254 USD billion	2 841 USD billion
Africa	4.8 USD billion; 0.8% of global investment	55 USD billion; 2.4% of global investment	60 USD billion; 2% of global investment
North Africa	1.9 USD billion	17.5 USD billion	
West Africa	0.5 USD billion	3.9 USD billion	
East Africa	2.0 USD billion	9.7 USD billion	
Central Africa	0	1.3 USD billion	
Southern Africa	0.3 USD billion	22.4 USD billion	



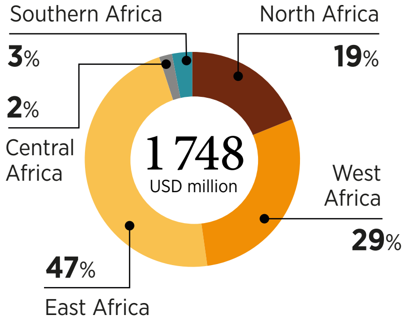
Off-grid renewable energy investment in Africa, 2010-2020
(USD Millions, constant 2019)

Global	2 485 USD million
Africa	1 748 USD million



	2010-2020
North Africa	330 USD million
West Africa	509 USD million
East Africa	822 USD million
Central Africa	36 USD million
Southern Africa	52 USD million

Share in regions (percentage)



Notes: Data on overall renewable energy investments in Africa (private and public) come from Bloomberg New Energy Finance (BNEF 2021), focus on investments in projects and exclude investments in large hydropower (>50 megawatts). Investments in off-grid renewable energy are based on data from Wood Mackenzie (2021). Owing to the different methodologies and methods of the data providers, trends are examined without making comparisons between the various data sources.

Figure S.12 Summary of renewable energy investments in Africa, 2000-2009 and 2010-2020 (continued)

Public commitments of financing for energy, including renewable energy, in Africa, 2010-2019 (USD Billions, constant 2019

	Overall energy	Renewable energy	Renewable energy share (percentage)
Africa	83 USD billion	55[a, b] USD billion	61%
North Africa	18.9 USD billion	10.2 USD billion	54%
West Africa	21.2 USD billion	15.9 USD billion	75%
East Africa	11.2 USD billion	10.7 USD billion	95%
Central Africa	14.7 USD billion	3.9 USD billion	26%
Southern Africa	17.3 USD billion	7.6 USD billion	44%

a. Includes large hydropower and non-technological investments in capacity building, technical assistance, etc. This explains why some of the values may exceed those from the BNEF database. b. About USD 2.8 billion was classified under "Other Africa".

IPP investments in energy, including renewable energy, in Africa, 2010-2020 (USD Billions, current 2020)

	Overall energy	Renewable energy	Renewable energy share (percentage)
Africa	54* USD billion	35.1 USD billion	65%
North Africa	13.3 USD billion	8.9 USD billion	67%
West Africa	10.0 USD billion	1.5 USD billion	15%
East Africa	3.9 USD billion	3.2 USD billion	82%
Central Africa	1.9 USD billion	0.2 USD billion	11%
Southern Africa	24.9 USD billion	21.3 USD billion	86%

Source: Power Futures Lab (2021); World Bank (2021b).

** This corresponds to 12% of the overall IPP investments in energy globally over the 2010-2020 period.*

Note: Data on public investments come from IRENA and OECD (2021). Unlike the BNEF data, these include large hydropower, as well as capacity building, technical assistance and other non-technological investments. Investments in independent power producers through private sources and from development finance institutions are based on data from the Power Futures Lab (2021). Owing to the different methodologies and methods of the data providers, trends are examined without making comparisons between the various data sources.

SOURCES OF FINANCE AND TYPES OF SUPPORT

In Africa, most energy investment comes in the form of public financing. Globally, renewable energy has been financed largely by the private sector, with public finance accounting for just 14% of direct investments in renewable energy assets, mostly via development finance institutions (DFIs) (IRENA, 2021c). But public financing plays a more dominant role in Africa, where, except in a few countries, projects are not able to attract private capital owing to real or perceived political, legal and economic risks.

Between 2000 and 2019, Africa received a total of USD 109 billion in public commitments in the energy sector. Almost USD 64 billion of that was committed to the renewable energy sector, (including large hydropower), of which USD 50 billion (78%) came in the last ten years (2010-2019) (IRENA and OECD, 2021). Most of the capital was provided by bilateral donors and DFIs using debt and grants, although the use of equity, guarantees and mezzanine financing has increased in recent years.

The ranks of active donors increased from 27 in 2010 to 45 during the peak year (2017). Out of the 54 donors active at some point during 2010-2019, 10 provided 85% of the public funding in Africa, equivalent to USD 43 billion. These include bilateral donors (such as China, France, Germany and the United Kingdom); multi-lateral development banks (MDBs), including the World Bank and the African Development Bank (AfDB); and DFIs such as FMO, KfW and Proparco) (IEA, IRENA *et al.*, 2021; IRENA and OECD, 2021).

Support for independent power producers (IPPs) from DFIs and MDBs takes many forms, including direct investment (equity and debt), technical assistance, risk mitigation and structured procurement programmes combining all those instruments. Prominent examples are the U.S. Trade and Development Agency and the Sustainable Energy Fund for Africa (managed by AfDB) which was converted at the end of 2019 into a fully-fledged blended finance facility, raising over USD 300 million in new donor contributions since then. 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 paid for by development funds have been critical in developing an initial IPP pipeline to accelerate sustainable market growth. DFIs also provide a basket of instruments to support IPPs participating in structured procurement processes, including technical assistance, financing and de-risking instruments. Technical assistance may take the form of prefeasibility studies for IPPs (including site studies and resource analyses), support for the procurement process, or advice on proposal evaluation and contract negotiations. Structured financing and risk mitigation packages increase the bankability of contracts in these programmes and the competitiveness of the bidding process.

Public funding plays an important role in supporting the off-grid renewables sector. Over 60% of the financing directed to off-grid renewables in Africa during 2010-2020 came from the private sector, while the public sector accounted for about 34%. In 2020, 41% of commitments came from the public sector, up from 33% in 2019, signalling the need for greater support to the industry during the COVID-19 pandemic. In East and West Africa, where investments have been concentrated so far, public sector support will continue to 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 plays an important role in catalysing the sector's growth by supporting enabling policies and regulations, as well as through other measures to de-risk investments and encourage market development. Public support accounted for 68% of total commitments in Central Africa in 2010-2020, and 49% in Southern Africa.

THE FINANCING ENVIRONMENT

While conventional power still attracts far more funding than renewables in Africa, new investment in renewable energy has been taking off. The pace of investment in renewable energy accelerated 20-fold between 2010 and 2020, reaching USD 55 billion. The renewables financing environment was marked by an unequal distribution of investments and technology across the continent, changing capital dynamics, and advances in risk mitigation. While solar PV and wind technologies have accounted for 64% of all investments, the pace of investment slowed dramatically with the arrival of the pandemic, allowing the gap in access to electricity to continue to grow.

An unequal distribution of investments and technology across Africa

Investments in renewables have not been distributed evenly across the African continent. Concentrations have emerged, with Southern and North Africa as the favoured destinations. East Africa and West Africa rank somewhat lower; Central Africa has received the least amount of financing.

The distribution within regions is also unequal: in the period 2010-2020, 90% of all investments in renewables went to 14 of the 55 countries. South Africa, Morocco, Egypt and Kenya have attracted 75% of the investments. In the off-grid sector, East Africa (Kenya and Tanzania) attracted 50% of all investments over the 2010-2020 period, while West Africa (including Nigeria and Senegal) has started to receive more investment in recent years. Investment in the rest of Sub-Saharan Africa remains low and concentrated in a handful of countries.

Investments flow to where returns are more predictable. These trends show that investments flow to countries which offer higher returns and lower risks owing to their policy and institutional environment, regulations, access to finance and market characteristics (*e.g.* size, prospects and stability). In less-advanced economies, these enabling factors may not be as strongly present, giving rise to (real or perceived) political, financial, legal, operational and credit risks. As a result of the lack of well-structured projects with attractive risk-return profiles, insufficient capital is flowing to countries that need it the most.

Changing capital dynamics

There is a regional divide between private and public financing. While West, East and North Africa have drawn the most public funding, Southern and North Africa have been the largest recipients of private capital. These inter-regional differences reflect differences in the level of development of the electricity industry: more mature markets attract more private funding.

Loans have been the most common instrument for funding renewable energy projects in Africa, accounting for 78% of capital infusions. Equity has accounted for 20%. The data imply an average debt/equity ratio of 4, indicating acceptable levels of risk by lenders and equity investors. Guarantee instruments have played a role in this achievement. Ten investors accounted for 85% of all public commitments over the 2010-2019 period. China was the largest lender, followed by MDBs (AfDB, the World Bank Group and GCF) and DFIs. Debt remains the dominant instrument in public commitments.

New finance sources and instruments are changing the landscape for energy projects. The emergence of privately managed funds played a crucial role in accelerating investments, changing funding sources from public to private. More recently (and still incipient), capital-market debt instruments have begun to replace loans after several years of operation, freeing capital for redeployment.

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Evolutions in risk mitigation

Africa's general project default rates are lower than in the rest of the world, displaying the continent as attractive and relatively safe for investment. Fiscal discipline, MDB support and guarantees have contributed to this achievement. For example, the AfDB supports improvement in the financial and operational capacity of public power utilities as part of its Desert to Power Initiative (AfDB, 2021). However, policy and transaction risks remain in project development; public authorities can mitigate those risks and mobilise private capital through regulatory instruments, fiscal incentives, guarantees and market development. MDBs, DFIs (including the export credit agencies), guarantee funds and private reinsurance firms have provided a plethora of risk-mitigation structures. Technological innovation and new applications of mitigation tools have increased the use of guarantees to mobilise capital towards renewable energy investments. The continent has been the stage for financial creativity – from partial risk guarantees to liquidity facilities and breach-of-contract provisions.

MOBILISING FUTURE INVESTMENTS AT SCALE

Reliable and adequate funding is necessary to meet the energy goals of the SDGs. Large-scale investment will be required in coming years and decades to support an African energy transition pathway in line with the SDGs, both in terms of expanding renewable energy capacities and in creating the economic structures needed to support the energy transition and secure associated development benefits.

Trade constraints require debt adjustments and risk management. Africa's constrained tariff context could jeopardise the bankability of projects; consequently, international financial institutions have taken the first steps towards lowering risks and the cost of debt to enable access to pools of capital. Blended finance and green bonds have led this response, though their use remains small in scale.

With access to climate finance a key obstacle for African countries, green financing programmes can provide a solution. One way to boost spending in Africa is to ensure that public sector investment decisions clearly prioritise renewables over fossil fuel projects. Green financing programmes under the auspices of national development banks could be expanded to widen access to the credit needed to undertake industrial activities that feed into renewable energy value chains. To date, several examples of green financing programmes exist in Europe, North America, and South America, but very few can be found in Africa. Continued support from DFIs, including export credit agencies, MDBs, and guarantee funds, is needed to mobilise additional amounts of capital. All relevant actors need to make good on their promises and pledges, whether offered in pursuit of COVID-19 recovery packages, in context of COP26 commitments, or other frameworks.

Money must flow not only to the power sector, but also to end uses such as transport, cooking, heating and cooling. It is critical that African communities large and small derive tangible benefits from the energy transition. This is not only a matter of extending a more renewables-based grid to serve currently underserved communities or to install mini-grids and other decentralised forms of renewables. Equally important is that community voices be heard in the decision-making and that slogans such as 'an inclusive and just transition' be turned into lived reality.

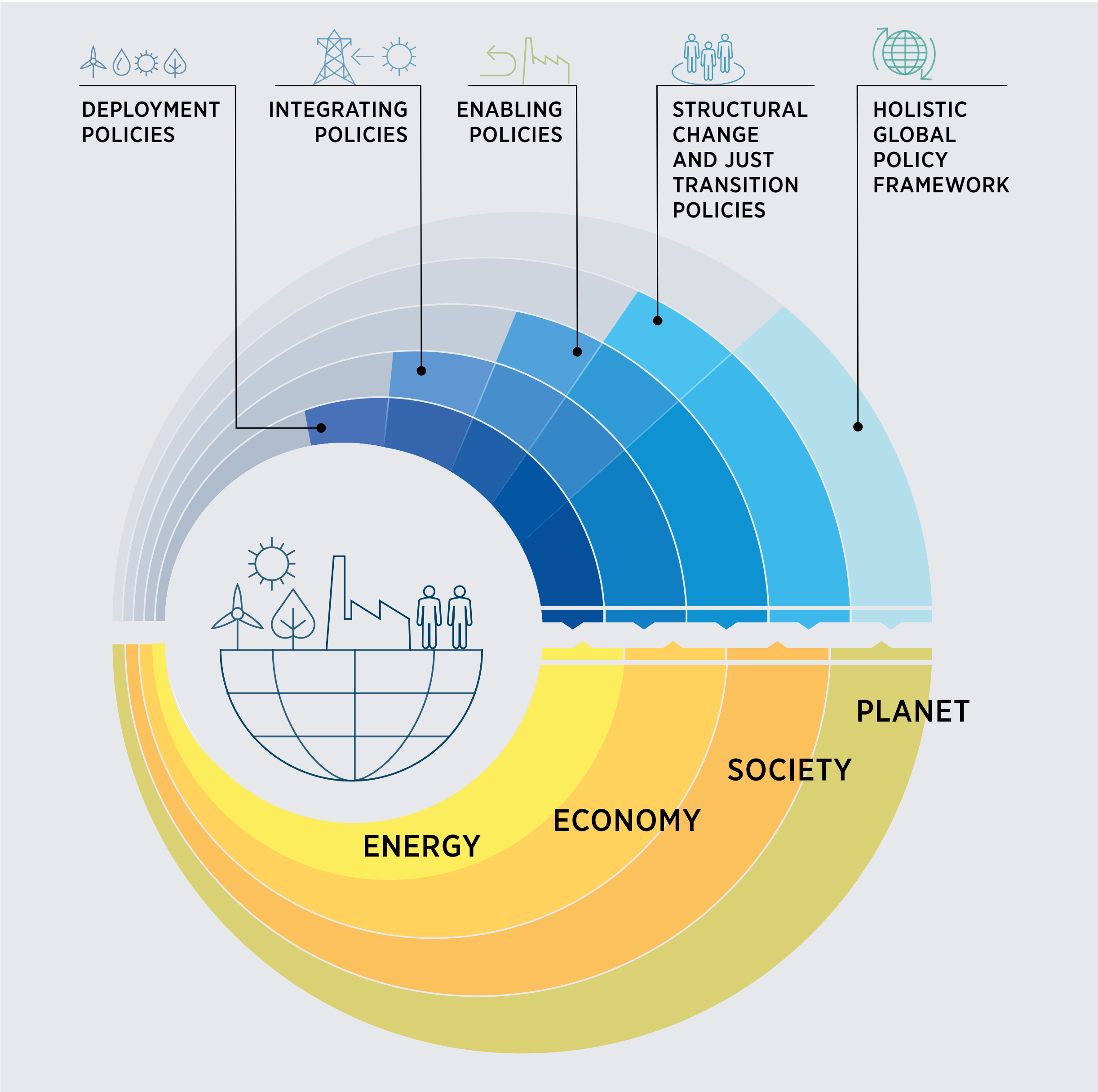
REALISING THE FULL POTENTIAL OF THE ENERGY TRANSITION

In the absence of effective mitigation and adaptation, climate change will pose a growing threat to socio-economic progress. Changes in rainfall patterns and droughts threaten rain-fed agricultural production, reservoirs and hydropower generation. Extreme weather events such as flooding and storms are hitting vulnerable populations. Temperatures on the continent are expected to rise faster than the global average, leading to a land temperature increase in Africa of between 3°C and 6°C by the end of the century (IPCC, 2014). The damage threatened by climate change is already affecting economic activity and will continue to do so. The COVID-19 pandemic has added social, economic and financial stress, especially in light of Africa's limited access to vaccines and its inadequate health care infrastructure. The need to enhance the resilience of people and communities has become impossible to ignore.

A comprehensive policy framework is the key to a just and inclusive transition

IRENA has developed a comprehensive policy framework for transitioning (Figure S.13) to an energy system centred on renewable energy and energy efficiency. The framework's components cut across multiple technological solutions, with specific deployment strategies to integrate those solutions into the continent's energy system. While policies must be tailored to particular national and regional contexts, the holistic approach can help achieve a wide range of social, economic and environmental goals.

Figure S.13 Comprehensive policy framework for a just and inclusive energy transition



Source: IRENA (2021c).

A range of policies to set enabling conditions for the energy transition in Africa

Under the framework, policies applying to all sectors and end uses build enabling conditions for the accelerated deployment of transition solutions. These include more ambitious national and regional commitments (such as specific renewable energy targets embedded in long-term plans) and measures that eliminate market distortions, disincentivise investments in fossil fuel technologies, facilitate access to finance, increase energy efficiency and conservation, develop needed infrastructure, foster innovation, and raise awareness among consumers and citizens to support the uptake of transition-related technologies.

Regional and national commitments to renewable energy anchor sustainable development and industrialisation for the continent. Leaders committed to inclusive, sustainable economic growth and development in *Agenda 2063: The Africa We Want*, a strategic framework that highlights social and economic development, continental and regional integration, democratic governance, and peace and security (African Union, 2021). Collateral assistance for technology transfer, financing and policy support would be sought from the international community, including bilateral and multilateral development institutions, such as the African Development Bank and its New Deal on Energy for Africa.

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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. Notable among the regional centres are the Regional Center for Renewable Energy and Energy Efficiency [RCREEE] for countries in North Africa, the ECOWAS Centre for Renewable Energy and Energy Efficiency [ECREEE] for West Africa, the East African Centre of Excellence for Renewable Energy and Energy Efficiency [EACREEE], the Southern African Development Community Centre for Renewable Energy and Energy Efficiency [SACREEE] as well as the Centre for Renewable Energy and Energy Efficiency for Central Africa [CEREEAC] which is being operationalised.

At the national level, commitments to renewable energy and energy efficiency are indicated in Nationally Determined Contributions, national energy plans and set targets. By mid-November 2021, 53 African countries had submitted Nationally Determined Contributions under the Paris Agreement on Climate Change. Of the countries submitting them, around 40 have included renewable energy targets, 37 of which focused on the power sector. Thirteen included targets on end uses such as heating, cooling and transport.

Necessary measures to eliminate market distortions that favour fossil fuels (including a fiscal system that curbs their use) must be implemented carefully so as not to impede access to basic energy needs. In addition, commitments by countries such as Egypt and South Africa to move away from coal, and from the international community to halt funding for coal power plants in Africa, are paving the way for a clean and sustainable energy system where renewables are already cost-competitive.

Investments will be guided by sound planning. The deployment of renewable energy in Africa will require investments in new infrastructure and in upgrading existing networks. Major investments are ideally guided by long-term national energy planning to ensure that they do not result in stranded assets or lock-ins to fossil fuels.

Energy efficiency, one of the main technology solutions for the energy transition, goes hand in hand with energy access, affordability and reliability goals. The deployment of efficient appliances will be crucial in the buildings sector, where energy demand is expected to rise with population growth and cultural changes – that is, as comfort standards evolve with development. In industry, efficient industrial processes will be key in building competitiveness. Support to date for energy efficiency and conservation has come in the form of policy and regulatory measures (*e.g.* minimum efficiency performance standards in North African countries), subsidies, energy audits (as in Kenya), and voluntary initiatives that rely on end consumers with financial or moral motivations (as in South Africa).

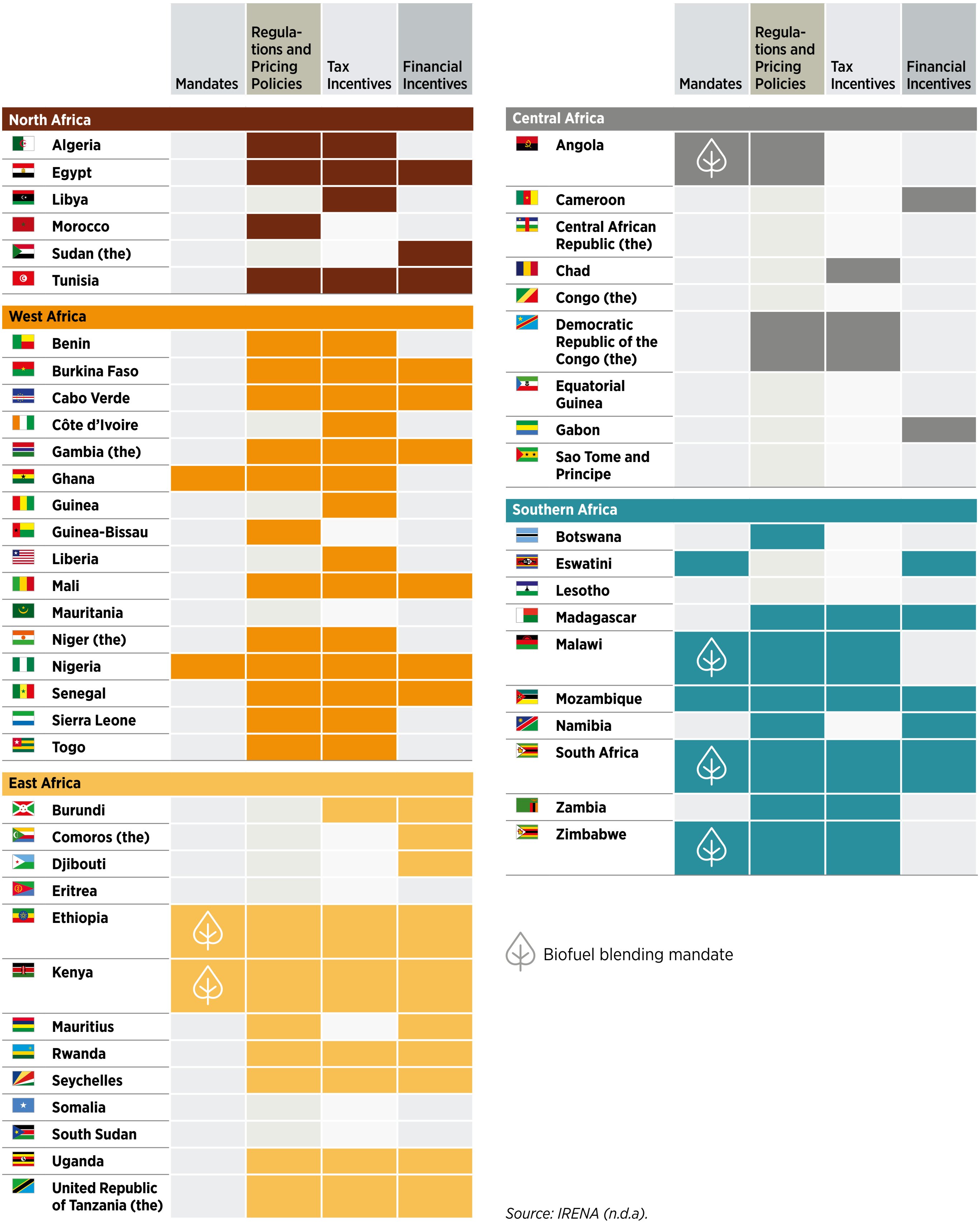
Raising awareness about the negative effects of fossil fuel plans has had positive outcomes. Local communities have led successful campaigns to cancel coal power plants in Kenya and Ghana. Continued awareness-raising regarding the potential for renewable energy and energy efficiency solutions and their benefits will play a major role in increasing the uptake of renewable energy in Africa. Equally important are campaigns for the purchase and use of energy-efficient equipment and the implementation of quality standards to ensure product reliability and high confidence among consumers.

Innovative solutions will have to integrate planning, best practices and standards, financing, reforms, and public buy-in. For Africa to fulfil its potential to leapfrog towards an energy system based on renewable energy and energy efficiency, innovative solutions extending far beyond technology supply and infrastructure are needed. Some key measures to improve the uptake of renewable electricity generating technologies are improved national planning, country-wide industry standardisation and certification measures, and incentives to attract long-term investments and encourage people to adopt new technologies. These would be combined with new financing and business models, new ways of designing and operating the power system, and finely tuned regulatory frameworks. At the core of innovation are continued public investments – local and foreign – in research and development.

Deployment policies to promote the uptake of renewables, the electrification of end uses, and the direct use of renewables for heating, cooling and transport

Direct deployment policies include regulatory measures that create a market for renewable energy solutions, as well as fiscal and financial incentives that make them more affordable. Such measures are widespread in Africa, but they have been more effective in some regions than others (Figure S.14). Fiscal policies that help make renewable energy technologies more affordable and financial incentives such as subsidies and grants have been mostly adopted in East and West Africa. Successful regional models of fiscal reforms and incentives can be adapted across Africa.

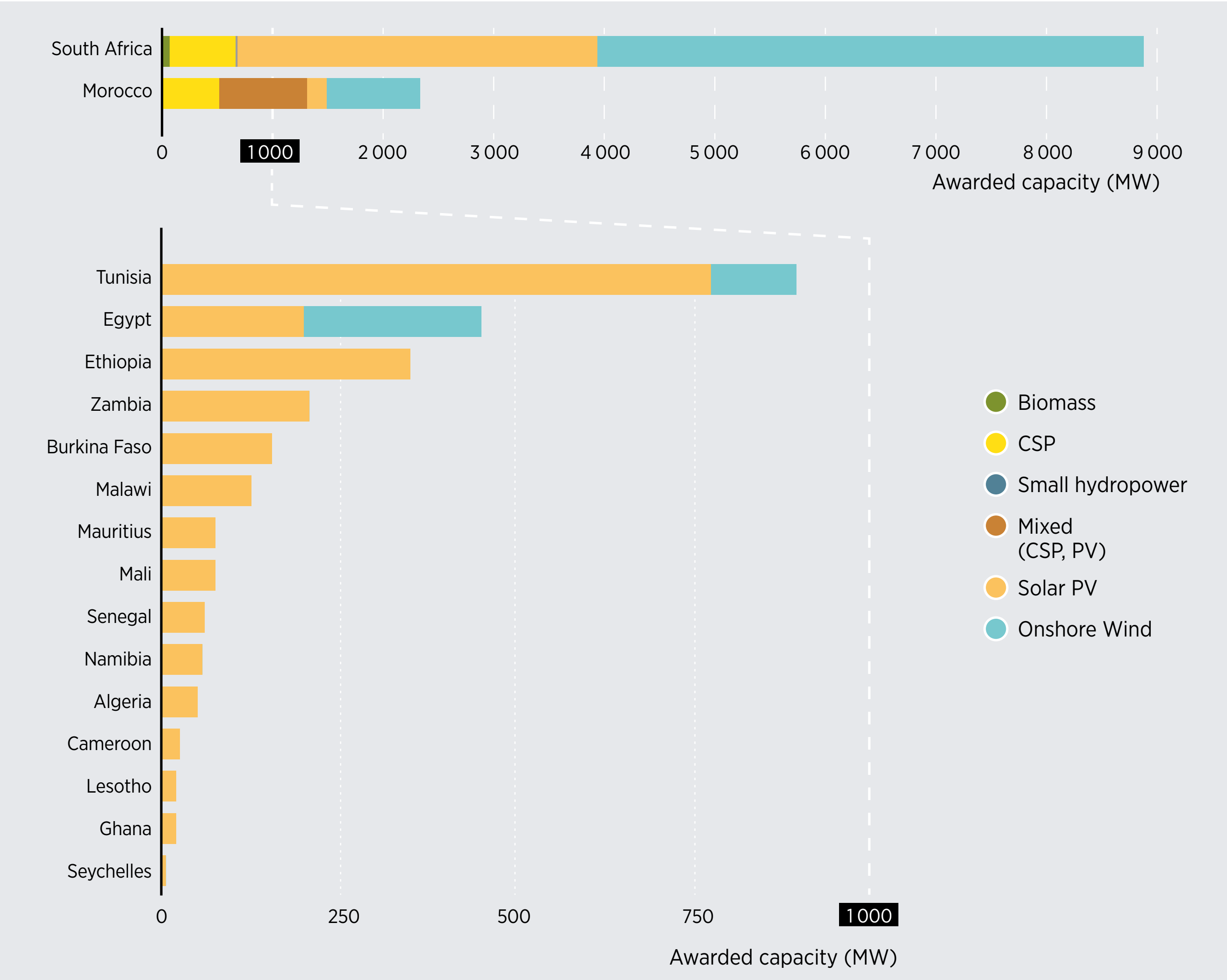
Figure S.14 Overview of deployment policies by region



Source: IRENA (n.d.a).

Structured procurement mechanisms such as feed-in tariffs and auctions have been instrumental in attracting private investments in renewable power. They are often implemented as part of a basket of instruments together with financing, risk mitigation and technical assistance. Since 2010, auctions have been announced in at least 25 African countries, representing more than 22 GW of auctioned capacity, out of which more than 13 GW have been awarded (Figure S.15). Increasingly, auctions are designed to achieve objectives beyond price discovery. Morocco and South Africa were pioneers in auction design to achieve socio-economic development, while in Ethiopia, Senegal and Zambia auctions were primarily innovative in their ability to mitigate risks.

Figure S.15 Renewable capacity awarded through auctions in Africa, 2010-2020



Source: IRENA (n.d.b); Power Futures Lab (2021).
Note: CSP = concentrated solar power; MW = megawatt; PV = photovoltaic.

Similar to global trends, policies in Africa have focused on the power sector, while renewable energy policies for heating and cooling and transport have lagged. Policies to support renewable energy for the heating and cooling sector in Africa have so far focused on clean cooking and water heating. More will be needed for the continent to take full advantage of its vast renewables potential. In transport, at least 7 countries have introduced some form of biofuel blending mandate, and a handful of countries have implemented policies or projects for electric mobility.

Green hydrogen can be an important option in the transition to renewables. For hard-to-electrify sectors, some countries in Africa – including Egypt, Mauritania, Morocco, Namibia, Nigeria and South Africa – have developed strategies to tap into abundant renewable hydrogen resources and their demonstrated potential for production at globally competitive costs. Because many African economies are not trapped into established industries built on fossil fuels, they can leapfrog into an economy based on sustainable energy. Green hydrogen could help make that a reality while absorbing excess renewable electricity and overcapacity. Other benefits of green hydrogen include greater energy security and socio-economic gains, with the accompanying potential for job creation. But green hydrogen production should adhere to the principle of additionality, implying that if any electricity from renewable sources has other uses (such as providing access to electricity), it should not be converted into green hydrogen (IRENA, 2020a).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Integrating policies to bring transition-related technologies into the energy system and harness the potential of the African power pools

Africa presents a relatively clean slate for a green energy future. Given its relatively low base of installed capacity and steep growth in demand, the continent has a unique opportunity to design power systems able to accommodate high shares of variable renewables (Sterl, 2021).

An existing power-pool infrastructure is a significant draw for investment. As mentioned above, power pools – of which Africa has five – play an important role. Regional markets at the power-pool level make it possible to exploit synergies among multiple renewable energy sources and demand profiles across the region – for example, spatial synergies between hydropower and solar/wind power in Ethiopia and Sudan, and between Guinea and Senegal. Temporal synergies on seasonal timescales between those same resources are often pronounced, especially in regions with strong monsoon influences (IRENA, 2021d; IRENA, 2018a). The presence of adequate power pool infrastructure may make investments in variable renewable projects more attractive, since it may lower the costs of grid integration. The larger underlying power grid created by regional markets also generates a larger balancing area, which can reduce curtailments of variable renewable energy and permit lower reserve requirements. The construction of large-scale transmission interconnectors hast started most recently in West Africa, adding to the expanding infrastructure in other parts of Africa.

Storage-based technologies offer additional flexibility, accommodating variable renewables in Africa's power pools. Currently, South Africa and Morocco are the only countries using pumped-storage hydropower. But this mature technology also holds promise for hydro-rich countries like Egypt and Ethiopia (Hunt, *et al.*, 2020). Over the next decades, large-scale battery storage could accommodate the integration of renewables to decarbonise electricity systems across Africa – and particularly to balance the diurnal nature of solar PV (Barasa, *et al.*, 2018). For seasonal storage, system integration through power-to-gas technologies could play important roles, for example, in the case of green hydrogen (IRENA and GIZ, 2021).

Integrating renewables into the energy system requires a conducive organisation of the power system, together with sector-coupling policies to support the electrification of end uses. These policies and arrangements include appropriate 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 the electrification of end uses through grid expansion and strengthening (IRENA, 2021a).

Pan-African power pools and crossborder interconnections will require a broad range of co-operation and investment to evolve successfully. 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, as well as inadequate funding and investment in infrastructure. Therefore, their ability to achieve targets remains limited so far (AfDB, 2019; IRENA, 2019a). Efforts are on-going to address this including through the launch of the African Single Electricity Market as well as the COP26 Green Grids Initiative – One Sun One World One Grid.

Structural policies to improve domestic skills, leverage local resources and develop home-grown industries – all to allow the energy transition to yield maximum socio-economic benefits

The energy transition must be fairly distributed across society. To expand the economic value of the transition to renewable energy, policies should emphasise local value and labour, regional trade opportunities, shared research and development, and good support for energy transition technologies. Communities and businesses must be part of the process (Figure S.16).

Figure S.16 Overview of structural change policies

Source: IRENA

Local and regional integration in planning and policies should be built in. The energy transition in Africa will change the way citizens consume, produce and travel. Local and regional economies will shift (IRENA, 2021a). Policies that promote structural change must consider how regions depend on resources, commodity trade and other economic characteristics.

On the labour side, there are opportunities to build a skilled and diverse workforce. Building that workforce will require vocational training, employment and wage improvements, recruitment of women into the energy sector, and better communications and transparency about opportunities. Policies targeting transition-related sectors in Africa can advance entrepreneurship in climate-smart sectors. They must also address potential misalignments that may emerge as old fossil fuel industries and jobs fall by the wayside and new ones in renewables and related industries appear during the energy transition. The misalignments can occur in *time* (if new jobs are not created as quickly as old ones disappear); *space* (new jobs may be created in locations different from old ones); *education* (the energy transition may require different skill sets); and *economic structure* (the transition may feature different sectors and supply chains than those prominent under the old energy economy).

For African nations to maximise the socio-economic benefits of the global energy transition, far-sighted industrial policies will be necessary. Africa's narrow industrial base means that industrialisation is still an essential pillar of development supported by sustainable agriculture and services. In view of the need to combine industrialisation (and related services, as well as sustainable agricultural inputs) with sustainable environmental management, Africa's structural transformation will need to align with the precepts of the energy transition. A circular economy will be an important aspect of this. For example, there is significant potential for using organic wastes as energy resources (*e.g.*, biogas), both in urban and rural areas. With the growing penetration of off-grid solar PV and battery systems, issues around repairability and recycling need to be addressed. This also creates new business and employment opportunities in collecting used systems and feeding them into upgrading and recycling mechanisms (IRENA and NREL, forthcoming).

Industrial policies are central to an economy that combines sustainability and socio-economic development. They include a set of incentives and rules, business incubation initiatives, supplier-development programmes, support measures for small and medium enterprises, and promotion of industrial clusters. They create the structural underpinnings for viable local supply chains through infrastructure spending (providing basic public goods such as electricity, roads and telecommunications); programmes to bolster local firms' access to finance and information and boost their capacities along the value chain; as well as a set of well-designed local content incentives and requirements. The latter are needed to create and facilitate spill-over effects (learning by doing and incremental innovation), overcome high barriers to entry and support local value creation. For example, Morocco has taken advantage of its existing aircraft and automobile industries, to promote wind energy.

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Regional resources and commodities must become value-added parts of the renewable energy transition. Central and Southern Africa have abundant mineral resources essential to the production of electric batteries, wind turbines, and other low-carbon technologies. Yet minerals critical to the clean energy industry are bound to be affected by commodity price cycles. To avoid commodity dependencies, critical mineral producers need to leverage the energy transition to move into higher value-added segments of the renewable energy supply chains such as processing rather than merely exporting its valuable raw materials. The mining industry could share its experience with maximising local value.

Local content requirements (LCRs) and incentives can leverage the energy transition for industrial development and job creation by ensuring demand for domestic products and services. To overcome the high barriers to entry presented by consolidated global supply chains, such measures need to help local firms learn (and innovate) by doing in the face of consolidated supply chains that present high barriers to entry. In the past, some LCRs have been judged to violate World Trade Organization rules (WTO, 2018), but the paradigms seem to have shifted in context of the "just transition" debate and given the urgency of climate change. The post-COVID-19 recovery provides an opportunity to rethink world trade rules and perhaps carve out policy space for LCRs – granting special status, for example, for renewable energy technologies. Egypt had already adopted a 30% local content target, rising to 70%, for wind farm inputs, and a 50% goal for concentrated solar power plants. South Africa included requirements in its auctions to develop a local industry for solar PV, ratcheting them up over time. Local content requirements spur efforts to source inputs locally, helping to leverage and develop existing local industrial capacities (IRENA 2017a, 2017b, 2018b, 2021f), though progress in the manufacturing segment is more challenging than in project development or installation.

Regional trade co-ordination among African countries could help fill the basket of policy solutions to create more localised industries. Market integration and cross-border collaboration are relevant given the limited markets that hinder productivity gains in most African countries. Larger market access, regional clustering and the consequent ability to localise more of Africa's industrial value chains could drive down costs and boost productivity (Lebdioui and Morales, 2021). For local firms to gain productivity and avoid duplication of effort, regional synergies around the supply of renewables will be vital. Regional co-operation will also improve quality standards and technology impact. The African Continental Free Trade Area is one such device able to boost intra-regional trade and local production of renewables.

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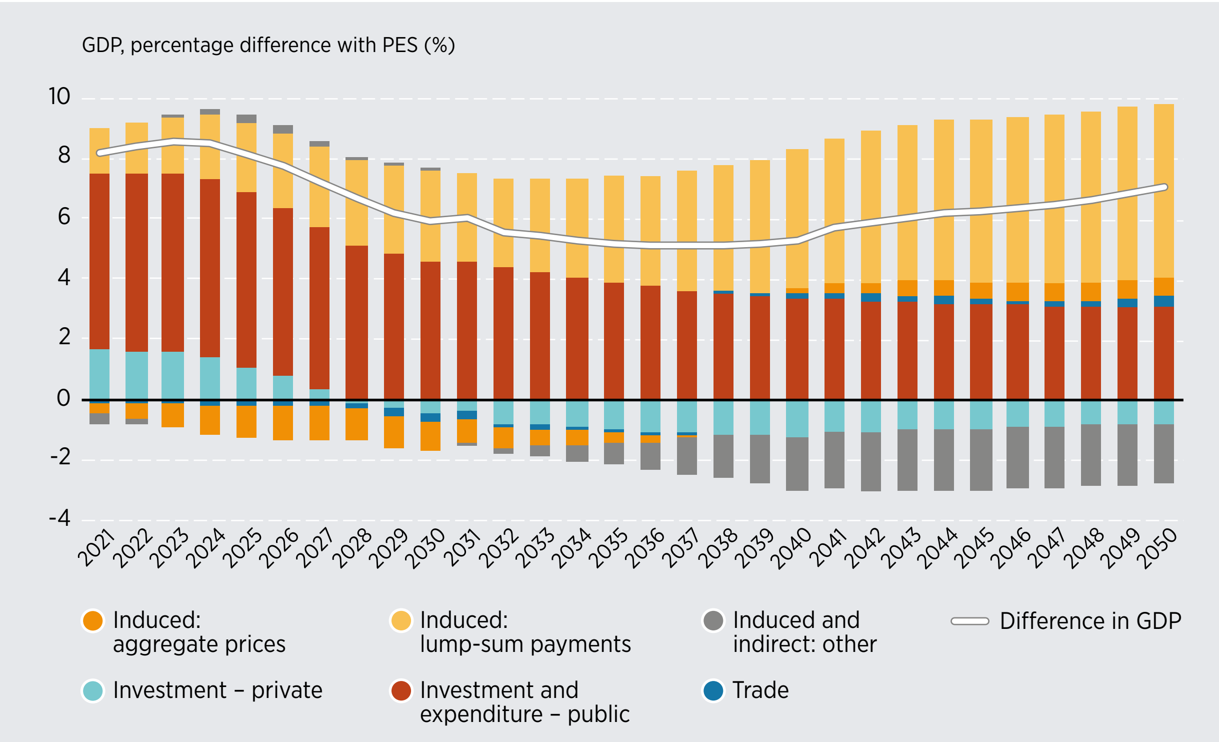
THE SOCIO-ECONOMIC FOOTPRINT OF THE TRANSITION

The energy transition is about both the global 1.5°C goal and the overall socio-economic progress of Africa. IRENA evaluates the socio-economic footprint of energy transition roadmaps using integrated modelling in which GDP, jobs and welfare impacts are quantified up to 2050 (IRENA, 2016, 2018c, 2019b, 2020a, 2021c; IRENA and IEA, 2017). IRENA's latest modelling compares two scenarios: 1) an ambitious energy transition scenario (called 1.5-S) that aims to reach the global 1.5°C goal; and 2) the Planned Energy Scenario (PES) based on the status quo. 1.5-S not only assumes that the provisions of the Paris Agreement are being met, but also that the transition is accompanied by a proactive set of policies designed to maximise the socio-economic benefits of transitioning energy systems. The modelling reveals that despite the difficult shift away from carbon-intensive energy sources, the energy transition – when accompanied by an appropriate policy basket – holds huge promise for Africa. 1.5-S predicts 6.4% higher GDP, 3.5% higher economy-wide jobs and a 25.4% higher welfare index across Africa than that realized under current plans, on average throughout the outlook period. Throughout the outlook period. IRENA's analysis also shows Africa prospering from a diversified economy, industrial development and innovation, energy access, and profound benefits for the environment, all of which are critical to more equitable socio-economic development across the continent.

A rise in GDP

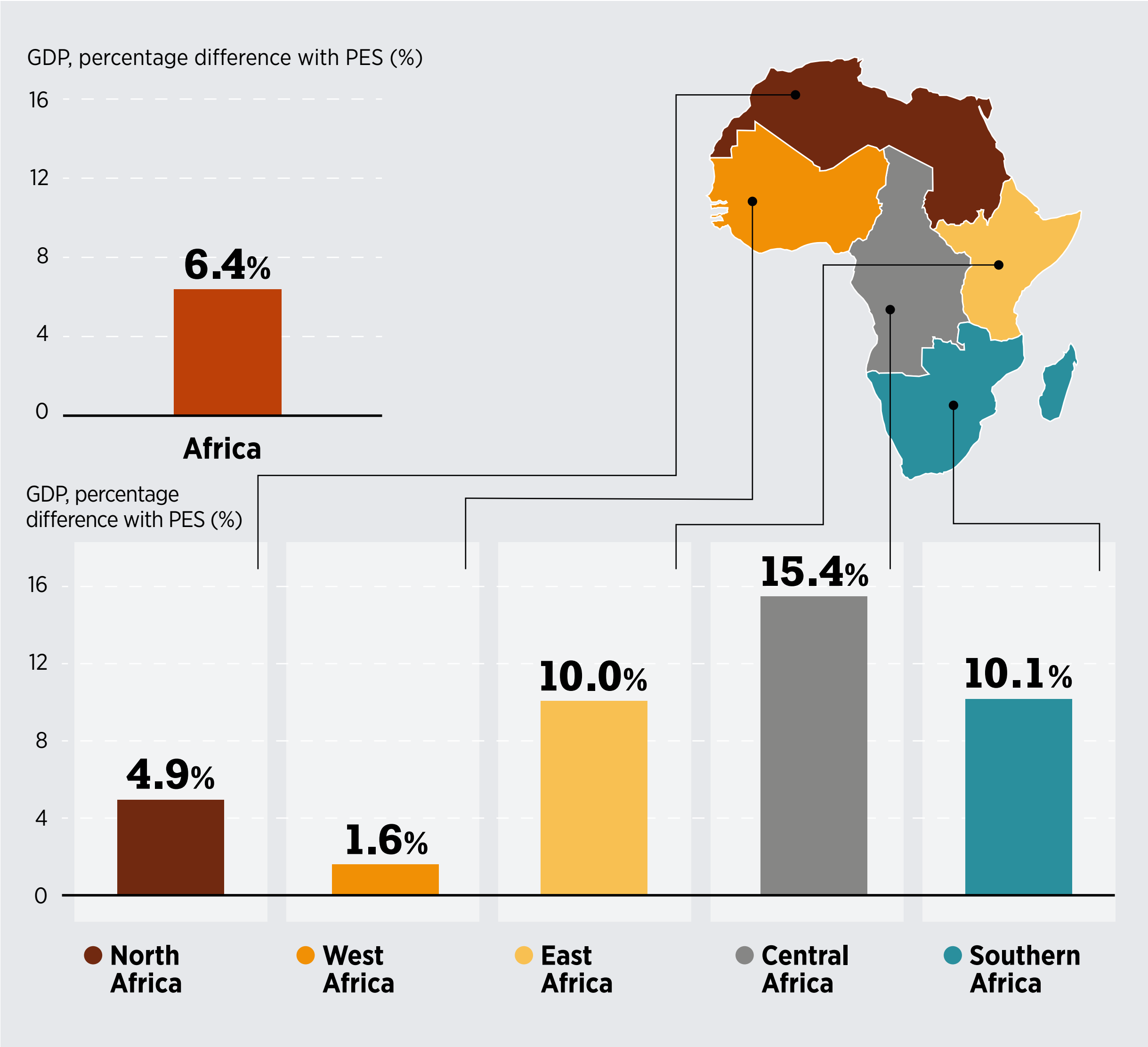
The energy transition under IRENA's 1.5-S pathway boosts Africa's GDP through to 2050, compared with PES. For Africa, on average, GDP is 7.5% higher in the first decade and 6.4% over the nearly three decades until 2050. Although with significant differences across regions, all African regions experience positive GDP impacts. Figure S.17 presents GDP differences between the scenarios and its main drivers, in percentages, for Africa and Figure S.18 shows average GDP percentage differences over the outlook period, for Africa and its five regions.

Figure S.17 Difference in GDP between 1.5S and PES, with its drivers. Africa, 2021-2050



Source: IRENA

Figure S.18 GDP percentage difference between 1.5-S and PES for Africa and its regions (2021-2050 average)



Source: IRENA.
Disclaimer: This map is provided for illustration purposes only. Boundaries shown on this map do not imply any endorsement or acceptance by IRENA.

A spur to job-creation

The transition's economic promise must deliver jobs and opportunities. Africa is a young continent, with around 420 million people between the ages of 15 and 35. The AfDB estimates that each year more than 10 million young people enter the workforce, but only 3 million new jobs are created, leaving vast numbers unemployed or in unstable and informal employment. The energy transition can become one of the drivers of jobs for Africa's young population over the coming decades, across different sectors and value chains, supporting goals to promote more diversified economies. IRENA's analysis shows that the number of jobs created by investment in renewables and other energy transition-related technologies can grow substantially from today's roughly 300 000 jobs in renewables.

Employment gains will surpass losses in the fossil fuel sector. The energy transition pathway sketched by IRENA holds the potential to create more than 12 million transition-related new jobs between 2019 and 2030 across Africa, and an additional 3 million by 2050, mostly in renewables, energy efficiency, electricity grids and flexibility. These would more than offset the loss of in fossil fuels (around 2.2 million jobs between 2019 and 2050), leading to significant net employment gains for the energy sector as a whole.

Renewables, collectively, can provide a significant base of employment. The solar sector alone could employ 3.3 million Africans by 2050. With more than 2.2 million jobs, sustainable bioenergy is another main contributor to employment creation under IRENA's ambitious transition scenario. This large figure is explained by the comparably labour-intensive nature of feedstock operations in support of bio-fuels production. Wind energy is projected to employ more than 1.8 million people by 2050. Most jobs are in manufacturing of hardware components and in labour-intensive construction and installation. Figure S.19 shows the resulting positive differences in economy-wide jobs between 1.5-S and PES, on average, during the outlook period (2021-2050) for Africa and its regions. By 2050, economy wide, the African continent would have 25.7 million jobs more under 1.5-S than under PES.

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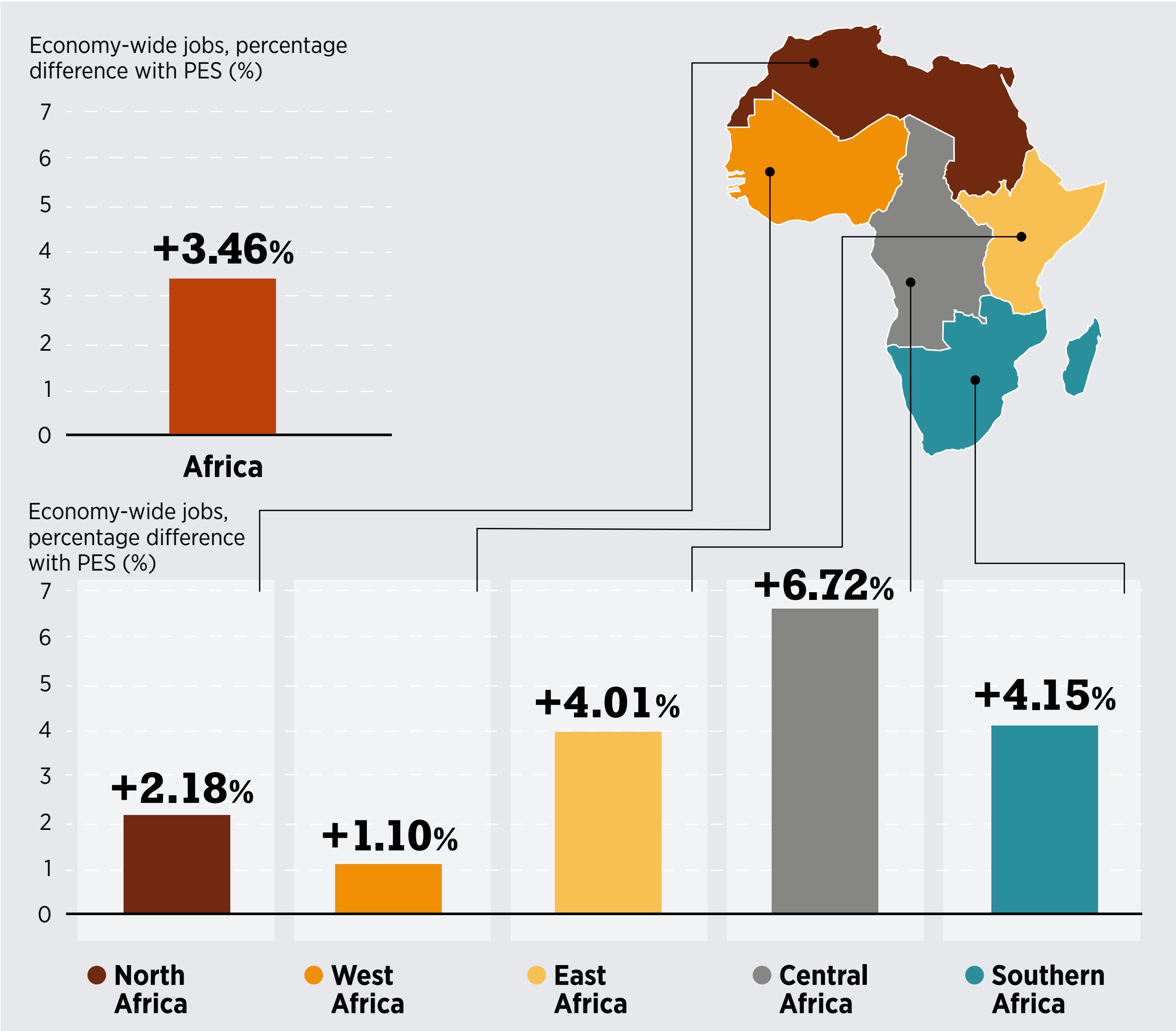
A boost in welfare

The benefits extend across socio-economic dimensions. The energy transition also has a large potential to produce significant welfare benefits in Africa. IRENA quantifies the welfare impact of the energy transition through its Welfare Index, a compound index aimed to assess the multidimensional nature of welfare (IRENA 2016, 2018c, 2019b, 2020a, 2021c; IRENA and IEA, 2017). IRENA's Welfare Index has five dimensions: economic, social, environmental, distributional and energy access.

Welfare advances across the regions. The welfare improvement for the African continent under 1.5-S over PES reaches 24.3% by 2050, ranging between 14.6% in North Africa to 39.6% in Southern Africa (Figure S.20). While the relative contribution of the different dimensions differs across regions, it is very clear that all African regions benefit. These high welfare improvements are even larger than those for GDP and economy-wide employment, highlighting the value of the transition for Africa over and above purely economic benefits. Welfare improvements, like other socio-economic benefits, depend on proactive government policy and available fiscal space. This is why, under 1.5-S, the climate policy basket includes elements that support governments' ability to invest in people and the wider economy.

Figure S.19 Economy wide jobs percentage difference between 1.5-S and PES for Africa and its regions (2021-2050 average)



Source: IRENA.
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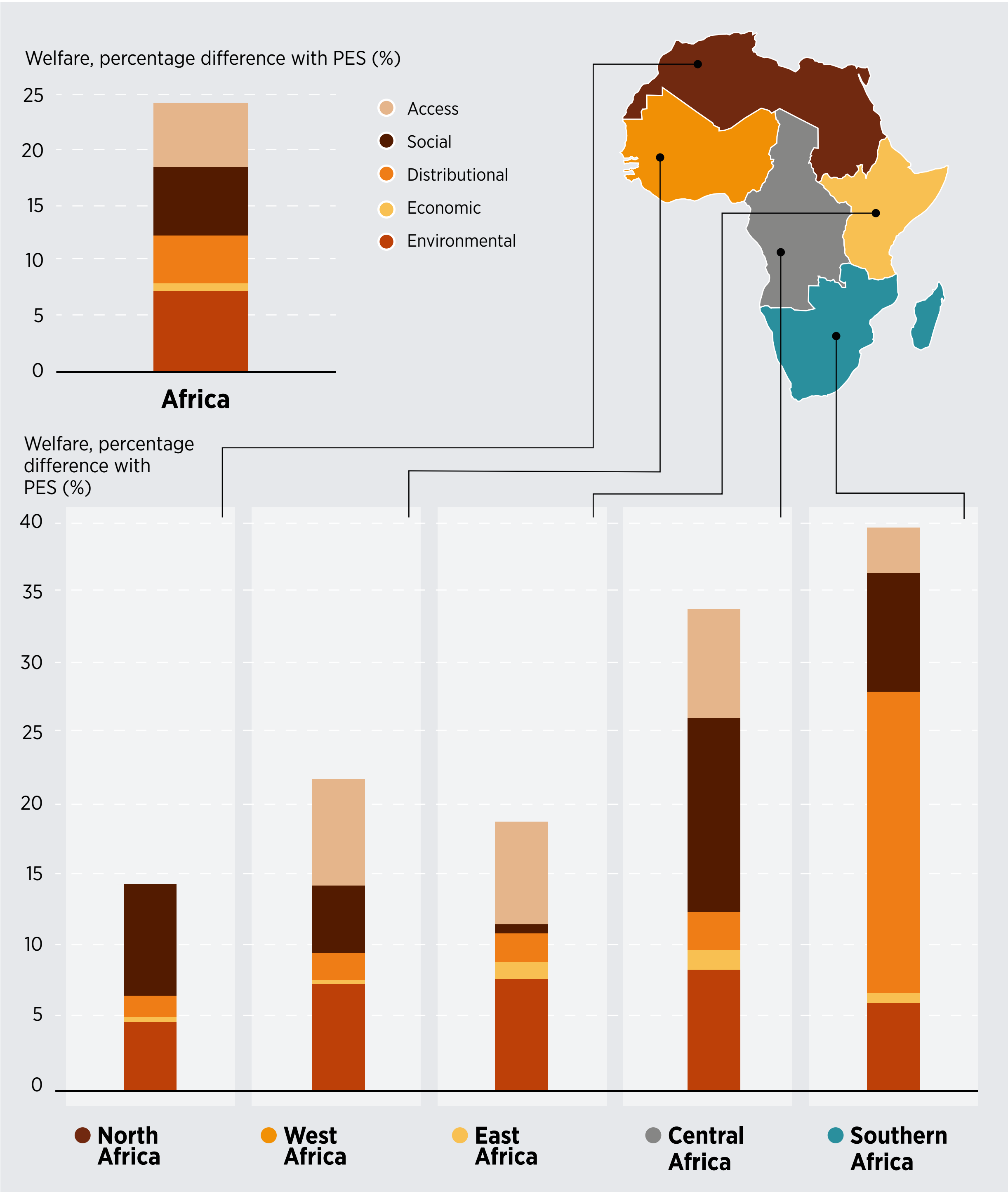
Figure S.20 Welfare Index percentage difference by 2050 between 1.5-S and PES for Africa and its regions, by welfare dimension



Source: IRENA
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THE WAY FORWARD

As governments and other actors in Africa contemplate the challenges and opportunities of the energy transition, this vast continent finds itself at a crossroads. Interlinked with a wide range of socio-economic and sustainable development challenges is the imperative of improved access to affordable, reliable, sustainable and modern energy. A just and inclusive energy transition will be incomplete without tackling widespread energy poverty on the continent and redressing the injustice inherent in Africa having the lowest per capita energy consumption of all world regions. While the goal is not to replicate unsustainable energy use in other parts of the world, raising Africa's low levels is essential for meeting the SDGs and improving the continent's resilience.

The energy transition is also the path of inclusive development. The energy system is intrinsically linked to the smooth functioning of the economy, the well-being of people and the sustainability of the ecosystems that support life on earth. A successful energy transition offers new opportunities for inclusive development. Yet much depends on putting in place adequate structural and institutional underpinnings to strengthen supply chains, shore up the skills base and allow greater local value creation that benefits the local population broadly.

The comprehensive policy framework sketched here provides broad principles. It also recognises that countries embark on the energy transition from their own starting point and that decisions must be adapted to specific national and subnational contexts, including resource potential, development experiences, socio-demographic patterns and institutional capacities. Well-designed industrial and labour market policies will be particularly important for industrialisation, economic diversification and local value creation.

The climate policy basket includes necessary financial resources and international co-operation. Advancing energy transition policies that power development requires adequate financial means. Beyond mobilising domestic funds in African countries, the climate policy basket proposed in this report's socio-economic analysis envisions a strong element of international co-operation to that end.

TOWARDS AN AFRICAN GREEN DEAL

A broad institutional and programmatic framework is needed to mobilise resources and co-ordinate policy action at the appropriate scale and speed. Such a framework could be provided by an African Green Deal – a comprehensive policy package that combines the pursuit of climate and environmental goals; economic development and jobs creation; and social equity and welfare for society as a whole. The systemic character of a Green Deal has led to renewed attention in various countries and regions, including the European Union and the United States. Development of such a framework in Africa could be inspired by ongoing discussions elsewhere but would need to be tailored to fit the continent's own needs and challenges. African leaders must clearly articulate, map and assert their unique development and climate agendas.

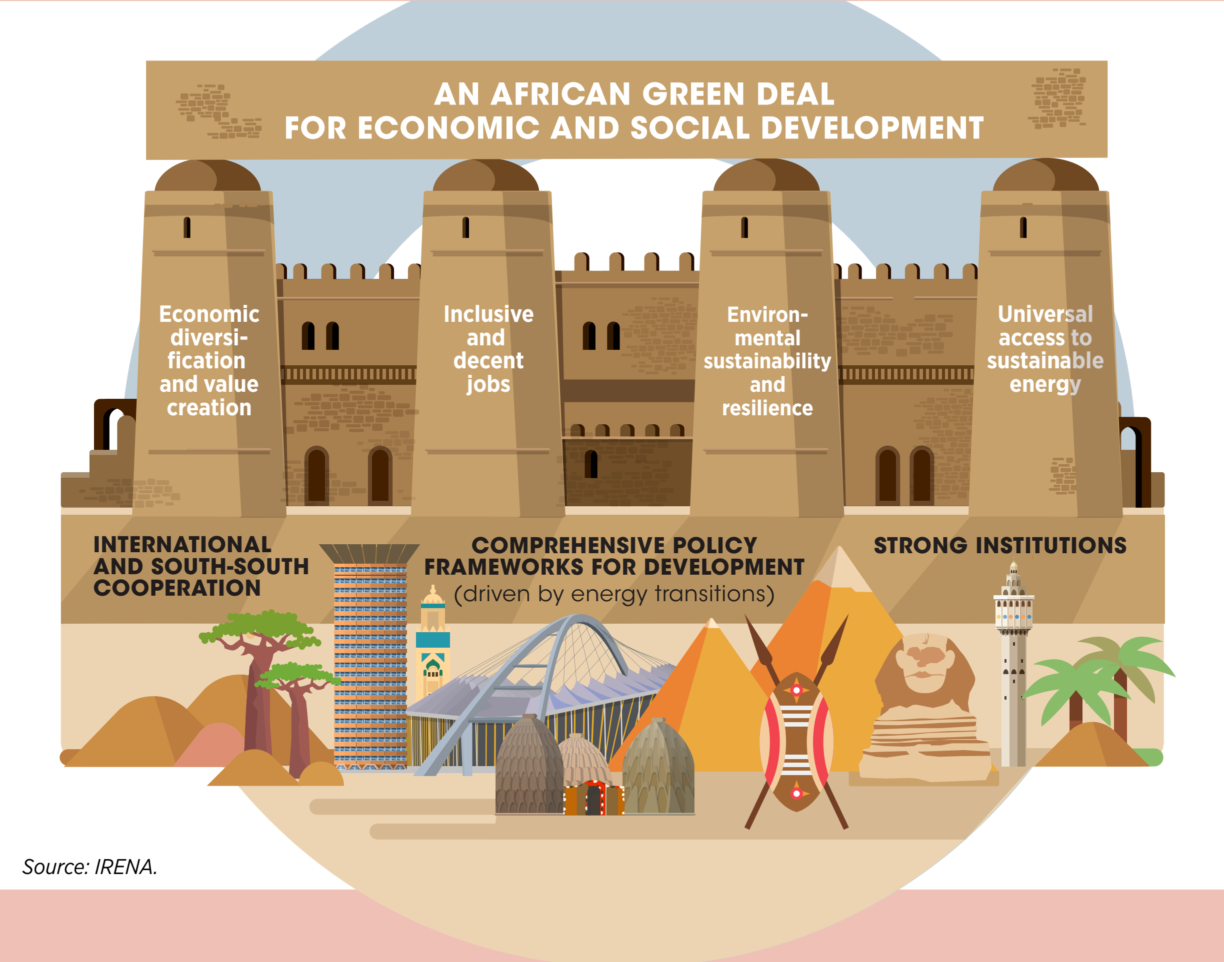
A carefully designed African Green Deal, driven by a comprehensive policy package, strong institutions and international co-operation (including South-South co-operation), has the potential to generate positive effects in a wide array of social, economic and sustainability areas (see Figure S.21). These include universal access to affordable, reliable, sustainable and modern energy; economic diversification and value creation; inclusive and decent jobs; and environmental stewardship and climate resilience.

Beyond the necessary overarching political vision, an African Green Deal would require considerable co-ordination at the regional level. Fortunately, such a policy programme can capitalise on existing institutions and initiatives at both the continental and regional levels. African leaders have made clear their commitment to inclusive and sustainable economic growth and development in the African Union's *Agenda 2063: the Africa We Want* (African Union, 2021). This blueprint and master plan for transforming the continent into a global powerhouse establishes the links between the energy transition and industrialisation (IRENA, KFW and GIZ, 2021). In addition to the AfDB's New Deal on Energy for Africa, several initiatives are under way to promote renewable energy deployment. These include the Africa Renewable Energy Initiative, the Africa Power Vision, the African Clean Energy Corridor, the Desert to Power initiative for the 11 countries of the Sahel and the recently launched African Single Electricity Market).

Under the umbrella of a green deal, regional alliances can be created to co-ordinate the research, production and deployment of specific renewable energy technologies. Suitable co-operation mechanisms related to clean energy and industrial development exist both at the continental and regional levels, which a Green Deal could integrate into an ambitious regional policy package. A platform bringing together key regional actors (such as the African Union), governments, multilateral institutions, the private sector and other development partners could facilitate dialogue and consensus-building; identify credible continent-wide and regional targets; and identify and exploit synergies between different national and regional energy transition strategies, thus advancing the design and implementation of an African Green Deal.

Resolving the greater climate crisis will require international co-operation as well. Beyond intra-African co-operation and South-South co-operation, Africa can benefit from a vigorous multilateral approach that draws on the experiences of countries around the world; provides promised climate mitigation and adaptation funding; and ensures that lessons and solutions are shared to benefit every region, country and community.

Figure S.21 An African Green Deal for economic and social development



Source: IRENA.

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SUMMARY FOR POLICY MAKERS

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AFRICA AND ITS REGIONS

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