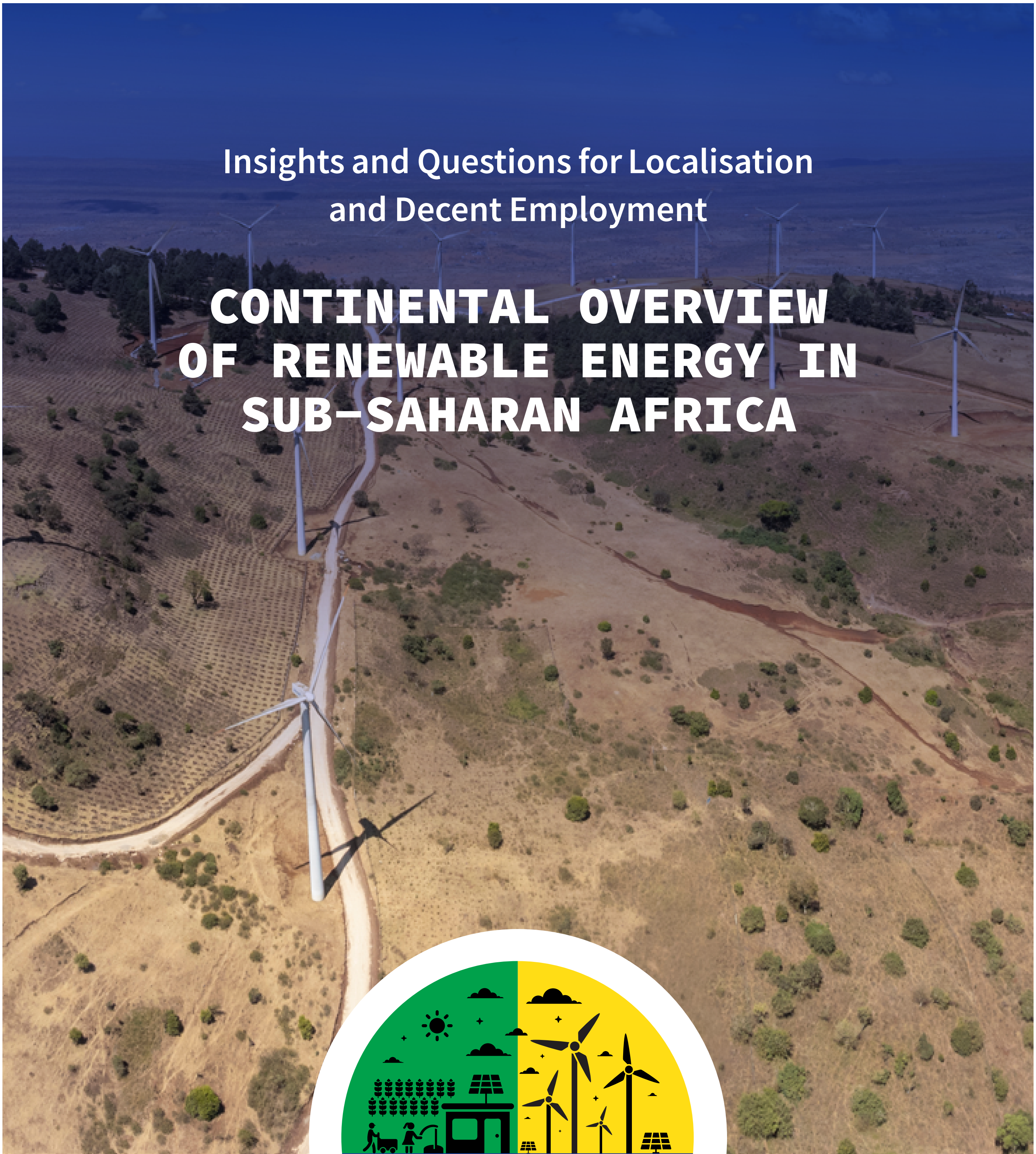
Insights and Questions for Localisation and Decent Employment

CONTINENTAL OVERVIEW OF RENEWABLE ENERGY IN SUB-SAHARAN AFRICA



Just Energy Transition:
Localisations, Decent Work, SMMEs, and Sustainable Livelihoods

Institute for Economic Justice · COSATU · Africa Centre for Energy Policy · ACTS · IDRC · CRDI

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The current global energy transition has been positioned as an opportunity for Africa to meet its current and future energy needs. Alongside this direct opportunity to increase generation, access and productive use, the transition is framed as an opportunity to deliver green industrialisation while supporting climate action. This paper is part of a wider project that aims to understand how renewable energy fits into this landscape of opportunity as the continent and its national governments navigate the energy transition.

This broader project, 'A Just Energy Transition: Localisation, Decent Work, SMMEs and Sustainable Livelihoods', is concerned with the industrial and labour implications of an increasing penetration of renewable energy technologies within the broad transition of Africa's electricity sectors. To support this investigation and contextualise forthcoming research, this paper collates available continent-wide energy data, focusing on electricity, to map the status quo and pertinent patterns and trends.

In line with global policy trends, Africa's governments have adopted, to varying degrees, 'sustainable energy' and 'just energy transitions' policy agendas. A 'sustainable energy transition' entails a shift to low-carbon energy sources, notably the renewable energy, wind and solar projects currently being advanced across the continent (Bawakyillenuo *et al*., 2018; Borchers et al., 2018; Sareen and Haarstad, 2018; UNDP and University of Bergen, 2018; IEA *et al*., 2021). Under this banner, African governments and international development agencies have also advocated increasing energy access and energy poverty alleviation (The United Republic of Tanzania Ministry of Energy and Minerals, 2015; Republic of Kenya Ministry of Energy and Petroleum, 2016; UNDP and University of Bergen, 2018). This policy framing is aligned with the Paris Agreement and the Sustainable Development Goals, with the former also introducing "the principle of equity and common but differentiated responsibilities (CBDR) and respective capabilities, in the light of different national circumstances" (United Nations, 2018). The implication of CBDR is an increased burden of transition investment on the wealthy countries that are predominantly responsible for and have benefited most from the global carbon economy. Building on this equity concern, the Paris Agreement also foregrounds the need for a 'just transition', responding to decades of advocacy significantly driven by labour movements. The 'just transition' or 'just energy transition' is now commonly used to centre issues of inequality and concern for vulnerable groups in the context of transition (McCauley and Heffron, 2018; The African Development Bank, 2022a; Sokona *et al*., 2023). While there is not one accepted universal definition of 'just transition', there are clear points of congruence in approaches in multilateral processes such as those under the United Nations Framework Convention on Climate Change (UNFCCC) or the International Labour Organisation (ILO) guideline development (ILO, 2015; G77 and China, 2023a). Both these forums have centred the concerns, rights and interests of workers within domestic transitions within declining carbon-intensive industries and, more recently, within 'green jobs', such as renewable energy jobs (Hauff *et al*., 2014; IRENA, 2018; Sareen and Haarstad, 2018; van der Ree, 2019; International Energy Agency, 2021).

Calls for a just energy transition, as part of a broader just transition of the global economy, are gaining momentum under the UNFCCC (also driven by the African Group of Negotiators), in African domestic policy and in the African Union (Haddaoui and Gulati, 2021; Kumar,

[1] The wider research project which investigates the role that economic development around renewable energy technologies can play in creating a more sustainable and just economy in three African countries (South Africa, Ghana and Kenya). We centre this investigation around the potential of renewable energy technologies to a) establish local manufacturing and assembly, b) increase local ownership, c) support local employment, and d) use domestic resources and supply local markets.

Höffken and Pols, 2021; Sokona *et al*., 2023). The just transition policy agenda has provided a critical lens through which to consider and interrogate the goals, mechanisms, processes and outcomes of the global 'sustainable' energy transition for African countries' domestic transitions. As well as a way of considering the interests of workers in fossil fuel industries, the 'just energy transition' is also used as the overarching framework under which energy-related issues and socio-economic development are considered together, as is the case with the African Union's (AU's) African Common Position on Energy Access and Just Energy Transition. Within this framework, renewable energy is positioned as a tool to increase electrification, expand energy access, increase productive energy use, create green jobs and support green industrialisation (Hartley et al., 2019; IEA *et al*., 2021; IRENA and ILO, 2023).

Beyond this paper, the broader project considers the extent of and conditions for maximised socio-economic benefits in relation to increasing renewable energy technologies, particularly considering the potential for green industrial opportunities, green business development and green jobs. This paper sets the parameters for this exercise by characterising Africa's current electricity systems in terms of their structure, capacity, needs and resource flows, decarbonisation goals and obligations under the Paris Agreement (nationally determined contributions (NDCs)). By 2022, Africa had contributed an estimated 51.7 billion tonnes of CO_2 emissions (less than 3%) out of 1.73 trillion tonnes globally. Very few African countries have significant fossil fuel industries and correlated emissions reduction obligations. Egypt and South Africa are notable exceptions, with the latter contributing just under 43% of the continent's total emissions in 2022 (Global Carbon Project, 2023). According to the World Bank, Africa's total electrical energy consumption in 2021 stood at 892 terawatt hours (TWh). Most African countries' energy systems fall far short of their basic needs, falling behind other regions in various aspects, including electricity generation capacity, electricity access, the state and extent of network infrastructure, and investment levels.

As clearly evident in data, energy poverty is more pronounced than on any other continent, with over 600 million, out of the estimated 800 million people globally without access to energy, living in Africa (World Bank, 2024). Energy constraints are a barrier to industrialisation and economic development plans. Thus, low generation and access levels have led to questioning of the idea of a transition for much of the continent to emphasise the need for growth and development. Some stakeholders have asserted that the challenge for most of Africa is more usefully understood as building an energy system that works for people and the economy (Sokona *et al*., 2023). While the need is well-articulated, plans to address it are encumbered with several constraints. Among these, unsustainable sovereign debt limits African governments' capacity to invest in energy infrastructure and create industrial incentives and progressive subsidies to support just transition goals.

This paper aims to delineate the main current features and trends shaping the sustainable energy transition across the African continent. It characterises current continental energy policy and planning; energy demand and the state of generation, transmission, distribution and supply of electricity; the potential for micro-, small and medium enterprises; and localisation of value chains[2]. Noting the limitations of this kind of high-level view, it acknowledges salient differences between Africa's 54 countries[3], foregrounding issues of broad relevance across contexts. This paper constructs an empirical foundation that underpins the broader project's endeavour, laying the groundwork for subsequent analysis. Serving as an initial navigational guide, the paper deliberately limits theoretical analysis. Ghana, Kenya and South Africa, being key cases for 'A Just Energy Transition: Localisation, Decent Work, SMMEs and Sustainable Livelihoods', are given limited, focused attention. The paper begins by outlining guiding questions and the methodological approach. In relation to this, it comments on the constrained availability and quality of data related to energy. It then moves to an overview of issues contextualising the just energy transitions in Africa, with an overview of infrastructure, including energy generation, transmission, distribution and consumption. It briefly characterises renewable energy investment levels, and then moves on to characterising the production, marketing and provision of wind and solar, commonly characterised as the 'value chain'. This latter content is considered from a 'Global Production Networks' (GPN) approach, as outlined in section 6, in line with the broader project's conceptual framing.

[2] The electricity sector is a focal point of the energy transition for several reasons. It is a major contributor to greenhouse gas emissions, primarily through the burning of fossil fuels for power generation. Transitioning to cleaner and renewable sources in this sector has a significant impact on overall efforts to reduce carbon emissions.

[3] As recognised by the United Nations (UN).

SECTION TWO:
GUIDING QUESTIONS AND METHODOLOGICAL APPROACH

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2.1 THE NEED FOR THIS MAPPING WITHIN THE OVERALL RESEARCH PROJECT

The larger project, 'A Just Energy Transition: Localisation, Decent Work, SMMEs and Sustainable Livelihoods', investigates the role that economic development around renewable energy technologies can play in creating a more sustainable and just economy in three African countries (Ghana, Kenya, and South Africa).

"Localisation" is understood as a) establishing local manufacturing and assembly, b) increasing local ownership, c) increasing local employment and d) using domestic resources to supply local markets. Additional key issues considered are decent work, gender dynamics, sustainable livelihoods and outcomes for medium, small and micro enterprises (MSMEs). To adequately engage with the potential for renewable localisation, it is necessary to identify, scope and characterise the current material realities of electricity systems in which renewable energy technology integration and related industrial processes are unfolding. For this reason, this paper aims to provide a broad characterisation of the continent-wide state of electricity systems and the trends around them. It seeks to provide a high-level characterisation of Africa's diverse power systems regarding policy and governance, market structure, electricity demand, generation, transmission and distribution infrastructure, finance and investment. This is done to contextualise and ground considerations around the current and potential localisation of renewable energy technologies.

This project uses a GPN approach to understanding the complex set of actors and relationships involved in production processes, which are vertically disaggregated and geographically dispersed (Henderson, 2002). We draw on this framework to analyse the potential for social upgrading, through localisation, of various productive processes in the renewable energy economy. The GPN framework offers a view which links the actions of firms, states, labour and civil society, and shows the importance of national and international factors in localising new technologies. This makes the framework broader than the global value chains framework, which focuses more narrowly on only the productive and distributive firms, overlooking the role of other actors (Henderson, 2002).

2.2 APPROACH

The research encompasses a review of available African energy statistics and data, a desktop review of international and selected national policies (energy, climate change and industrial policy), as well as several secondary materials, such as reports, notably from international energy policy think tanks, development agencies and financial institutions, as these are influential in global energy policy. The investigation has also been informed by limited stakeholder interviews, mostly reflecting the policymaking and research community, with some attention to engaging industry market trends. From a methodological perspective, it must be noted that the interviews are not representative or used to draw any analytical conclusions. Rather, they were used to test the framing of issues that were surfaced in the desktop review. The insights gained from the research are contextualised by the authors' experience over the past decade in researching and engaging in policy and institutional work on the energy sector, climate change and transitions, governance, and distributed infrastructures.

2.3 DATA AND KNOWLEDGE GAPS FOR AFRICA'S ENERGY SYSTEMS

Although there is a plethora of research and policy work on Africa's electricity system(s), challenges and solutions, the data on which these rest are often incomplete and involve methods and assumptions that result in incomparability between different sources. Significant data gaps were observed during this desktop review, in both quantitative and qualitative data sources. For example, an open-source dataset, the Global Power Plant Database, released in June 2021 by the World Resources Institute (World Resources Institute, 2021), maps 35 000 power plants across 167 countries – but there are gaps, particularly on the African continent. Again, the African Development Bank report on the state of power-sector reforms only covers 42 of 54 countries. Because this paper aims to provide continent-wide information, the latest available figures covering all countries are often from 2021.

There are significant gaps around energy employment data, a central project focus, as well as renewable energy employment. Where data is available, it is also highly aggregated. Significant disparities exist between regions and technologies regarding the availability and quality of more granular employment data. Discrepancies between employment figures are significantly impacted by the variable use of distinct metrics such as headcounts, full-time equivalents (FTEs), and job years, each providing an incommensurate measure of work (Hermanus, 2022). Methodological differences, including variations in assumed workday hours and data-collection methods, further complicate the comparison of employment data across studies. Accurate disaggregated data allowing for gender or age-related employment characterisations are not available, as noted in the body of this report.

SECTION THREE: **OVERVIEW OF ISSUES CONTEXTUALISING THE JUST ENERGY TRANSITIONS IN AFRICA**

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Although they are anchored in technology changes, sustainable energy transitions are not merely technological nor merely techno-economic[4].

There are multiple intersecting issues that shape the energy transition and renewable energy uptake, both globally, on the continent, and at the domestic level. Below, we highlight the domestic electricity market structure, climate and transition risk, regional policy integration, and international power dynamics. These are key elements to consider when conceptualising the transition and its green business and employment potential.

3.1 ELECTRICITY MARKET STRUCTURE ACROSS THE CONTINENT

The energy market structure determines who can drive and participate in the transition. While a degree of unbundling in utility services has taken place in Africa over the past few decades, most nations still maintain vertically integrated public utilities, with minimal or no involvement of private entities. Liberalisation of Africa's power sectors has been on the international development agenda since the 1990s when the World Bank and other development finance institutions (DFIs) began to introduce sector reforms, alongside other economy-wide structural adjustments. The result was a 'standard model', entailing the restructuring and independent regulation of energy monopolies, seen as an antidote to the various real and perceived failures of national power utilities (Association of Power Utilities of Africa (APUA) and The African Development Bank, 2019; Godinho and Eberhard, 2019). The drive for liberalisation follows from the rationale that monopolistic, vertically integrated utilities are associated with particular challenges, resulting from transparency and other governance issues, as well as finance practices. These challenges include constrained capital access, accumulating debt, and slow response to technology innovation. As noted by the African Development Bank, "Reform programs are often explained as strategies to improve utility performance, attract investment, and stem financial crisis" (Association of Power Utilities of Africa (APUA) and The African Development Bank, 2019). As an example, national investigations into corruption at the vertically integrated South African public utility, Eskom, have been a strong motivator for its reform.

Based on an International Energy Agency (IEA) survey published in 2020, among the 54 countries in Africa, ten countries have implemented unbundling of utilities into separate generation, transmission and distribution functions, featuring either an independent transmission system operator or a legally separated transmission system (International Energy Agency, 2020). These countries are Algeria, Angola, Ethiopia, Ghana, Kenya, Lesotho, Nigeria, Sudan, Uganda and Zimbabwe. Uganda, in particular, has been a World Bank case study in successful reforms, and associated performance improvements, largely because of significant increases in generation capacity (Godinho and Eberhard, 2019). Along with distribution utilities in the Seychelles, Eswatini, and Namibia, Uganda's Umeme has been among the best performers in terms of revenue-collection rates and finance stability (including debt-to-asset ratios) (Balabanyan et al., 2021). However, since 2022, Uganda's liberalised power sector has been politically contested, with private-sector concessions to South Africa's Eskom, for the operations and maintenance of the Kiira and Nalubaale hydroelectric power stations, ended and handed over to the state-owned Uganda Electricity Generation Company Limited (UEGCL) (Eskom, 2023). Additionally, Uganda's increased generation and improved financial performance has not been able

[4] Power et al., 2016; Ockwell et al., 2018a; Sareen and Haarstad, 2018; Sareen, 2020a; Kumar, Höffken, and Pols, 2021.

to meet the country's energy needs or help address pervasive energy poverty (19% grid connectivity and 35% off-grid electricity connectivity), which remains significant. According to a 2021 study, 48 of 60 African electricity utilities reviewed did not generate enough revenue to cover debt obligations (Balabanyan et al., 2021).

The continent's power sectors are generally highly centralised in terms of planning, concentrated within national executive and administrative systems, and regulated mainly by an independent regulator – 33 of 42 countries, according to a 2020 African Development Bank study (Association of Power Utilities of Africa (APUA) and The African Development Bank, 2019). Countries with recently established regulators include Botswana, Liberia, Morocco and Mozambique. Despite the varying implementation of structural reforms, most of these countries (29 of 54) permit varying levels of private sector participation (International Energy Agency, 2020). The main mode of private sector participation is through independent power producers (IPPs) contracted to utilities. It is important to note that the liberalisation of African generation markets is dominated by IPPs developed by foreign companies, some of which have significant ownership by Global North governments, such as Globeleq (United Kingdom), Électricité de France SA (EDF) (France) and Enel (Italy). While IPPs mainly sell to public utilities, this utility-driven, single-buyer market is being challenged by business-to-business power-purchasing modalities, as, for example, in South Africa.

The centralised structure of electricity sectors has several implications for domestic transitions. First, the central role of the state and sectoral planning means that the state is the leading actor driving the transition. Relatedly, given that investment in public utilities relies heavily on public funds sourced from governments, DFIs, and export credit agencies, finance for the transition relies on the public mobilisation of resources. The centralised governance of African electricity sectors is also at odds with the decentralised model that several theorists and policy actors, mainly in the in the Global North, see as essential to the sustainable energy transition (Beermann and Tews, 2016; Brisbois, 2019; De Pascali and Bagaini, 2019; Hermanus and Cirolia, 2024). These actors see the integration of grid-tied or off-grid renewable energy technologies at different scales, from households to community or commercial, to utility-scale, as broadening the range of actors influencing the energy mix through distributed infrastructure decision-making. This imagined decentralisation also encompasses expanded mandates for city governments. Distributed renewables can be driven by a broader diversity of actors, including subnational governments, different kinds of communities, and the private sector. However, the reality of how this unfolds is context-specific. Off-grid solutions to energy access across the continent are mostly driven by foreign development agencies, DFIs, non-profits, and commercial energy companies. Most African cities (even large capitals) have limited electricity mandates, if any, as well as limited political and economic power and resources to drive localised electricity planning and investment (Hermanus and Cirolia, 2024). South Africa and parts of North Africa are notable exceptions but even these local governments face constraints. Considering the case of South Africa, despite having strong electricity mandates, it is only recently that local governments have been seriously integrated into national electricity planning. Additionally, local government action is limited by constrained funding and capacity (Hermanus, Scholtz and Kritzinger, 2022).

3.2 THE DOUBLE BURDEN OF CLIMATE AND TRANSITION RISK

The capacity of African states, utilities, private sector actors and civil society to drive domestically appropriate transition action is limited and complicated by the disproportionately high risk exposure of these actors. In particular,

African countries are disproportionately exposed to climate and transition risk, while making a limited contribution to the climate crisis (AGN, 2023). The transition itself will also create specific risks driven by market shifts, technology changes, and legal and policy changes, impacting economic sectors, businesses, workers, communities, households, and states and public entities (ClimateWise, 2019). Transition risks include cross-border carbon-pricing exposure, reputational impacts, changing market preferences decreasing demand for locally produced goods and services, lack of access to new technology, job losses, loss of economic activities, stranded assets, and more. The few African countries with coal, oil and gas (as noted above) are often highly dependent on these fuels and related economic activities and thus vulnerable to these transition dynamics (Global Carbon Project, 2023). Additionally, despite having fossil fuel resources, most African countries have been stuck in cycles of underdevelopment, unsustainable development, and unmanageable debt.

The sustainable energy transition (particularly a growing share of renewable energy) is also positioned as "Africa's best opportunity to achieve the Sustainable Development Goals" (African Development Bank Group, 2023). However, this opportunity is not seen by all stakeholders as being robust or realistic, and it must be contextualised and interrogated within global political, economic and other dynamics at a continental and national level. African governments' risk burdens are relevant to this discussion because they impact those governments' capacities to invest in the development and transition of electricity systems. Advancing the just energy transition across the continent will require significant resources, capacity and new capabilities to manage new infrastructure configurations while managing shifting connected economies. This demand for transition implementation exists in the context of serious sustainable development needs and deficits, compounded by climate change, resulting in a 'double burden' on government capacity (The African Development Bank, 2022b; Sokona *et al*., 2023). The finance to address climate change risks and to transition away from fossil fuels while pursuing sustainable development has not been forthcoming despite international commitments under the Paris Agreement. Given a lack of industrial capacity and limited fiscal space, African countries may not be in a position to harness or shape potential green industrialisation opportunities and create limited green jobs, especially high-quality jobs (G77 and China, 2023b). Concerns have been raised that Africa, as a continent, will lose out in a decarbonised global economy, supplying unprocessed resources for global supply chains, leading to "green extractivism" or similar modes of unequal economic exchange (Kalt *et al*., 2023).

3.3 INTEGRATION INTO REGIONAL POLICY

The sustainable energy transition is incorporated into regional policy through the African Union's (AU's) Green Recovery Action Plan – "Promoting renewable energy, energy efficiency and access, and supporting the 'Just Transition' to clean energy" (African Union Commission, 2015; African Union, 2021) – and into the policy of member states. The AU has an African Energy Transition Programme, which is aligned with Agenda 2063 (the overarching development vision for the continent). Domestically, sustainable energy transitions comprise different combinations of fossil fuel phase-outs, reduced reliance on biomass for energy, as well as an increase in renewable energy and other low-carbon energy, encompassing wind and solar power, hydroelectricity, geothermal energy, and nuclear power (Aklin and Urpelainen, 2013b; Sareen and Haarstad, 2018; Frantzeskaki et al., 2019). Individual countries have their specific policy packages to advance the transition, which respond to local contexts. As noted by the African Group of Negotiators (AGN) at COP28, expanding energy infrastructure and access is an important priority in the region: "Whilst noting the importance of differentiated pathways towards net zero and phasing down of fossil fuels, and the required support for African countries to effect the transitions, [the] pursuit of low-carbon development pathways should also take into account the balance with universal access to modern clean energy, energy security to drive industrial development in Africa, based on needs, and priorities of developing countries" (AGN, 2023).

Nationally determined contributions (NDCs) serve as the core national policy mechanisms to translate the Paris Agreement into national actions, crucial for realising its overarching objectives. These contributions represent the endeavours of individual nations to reduce their domestic emissions (mitigation) and address the challenges posed by climate change (adaptation). According to the Paris Agreement (Article 4, paragraph 2), each participating Party must formulate, communicate and consistently update successive NDCs outlining their intended goals and targets. Given the significance of energy sectors in current and projected national emissions, it is unsurprising that their transformation features prominently in these national plans. This is also true for the three country case studies considered in this project: Ghana (MESTI, 2021), Kenya (Government of Kenya, 2020) and South Africa (South Africa, 2021; Tyler and Steyn, 2021). In addition, 36 African countries have renewable energy targets in place. To achieve the NDCs for all sub-Saharan African countries, an estimated $377 billion is required for climate mitigation investments (effecting a low-carbon transition) and $222 billion for climate resilience (UNU-INRA, 2021). It is important to emphasise that it remains unclear how these investments will be made, by whom, and under what conditions.

As noted above, the 'just' energy transition (JET) promises to improve energy access, eradicate energy poverty, and serve as a catalyst for green industrialisation and greater energy democracy (Carrasco-Miró, 2017; Burke and Stephens, 2018; Hughes and Hoffmann, 2020; Kumar, Höffken and Pols, 2021; Sokona et al., 2023). The usefulness of a JET policy frame is not universally accepted by stakeholders, especially because the historical focus on fossil fuel phase-outs has limited applicability in many African countries (Sokona et al., 2023). While just transition policy has historically focused on the additional risks (such as job losses) brought about by the climate transition (AGN, 2023), it is increasingly being advanced at a supranational level as a banner under which structural economic issues that shape future risks, opportunities and inequality within and between countries, can be addressed (G77 and China, 2023b). This includes upstream manufacturing, construction and installation activities, and shortening the distance between energy production and consumption, which this project considers under 'localisation'. This is not a homogenous, coherent or universally prioritised policy priority for African countries. However, it is informed by a range of international actors, who are defining renewable energy-related socio-economic opportunities as related to, inter alia, employment creation and skills development (ILO, 2012; Hartley et al., 2019; IRENA and ILO, 2023), political and governance processes (Burke and Stephens, 2017; Becker, Angel and Naumann, 2019), attracting investment in public infrastructure (Traini and Guzzo, 2023), and increasing energy access (BloombergNEF, 2020; Energy Sector Management Assistance Program (ESMAP), 2022; IEA, 2022a).

A significant JET policy development on the continent is the introduction of Just Energy Transition Partnerships (JETPs), finance agreements structuring joint efforts from the International Partners Group (IPG) to allocate different kinds of funding in line with a national JET plan. South Africa was the first country to launch a plan in November 2022 (South Africa's Just Energy Transition Investment Plan) at COP27 (The Presidency, 2022). At COP26, a total of $8.5 billion[4] was pledged by the IPG, comprising France, Germany, the United Kingdom, the United States and the European Union, as the first round of financing to support energy transition projects, as part of the JETP. The money falls far short of the country's conservative estimates for the cost of a JET, and most of the money allocated is in the form of public (concessional) and private debt. South Africa has been followed by Senegal, with $2.5 billion in financing. No other JETPs for African countries have been announced.

3.4 ACTORS, RELATIONSHIPS AND POWER DYNAMICS

The particular local dynamics of this transition also depend on external or global systemic dynamics, such as access to, and cost of, capital, shifts in official development , and international trade and tax regimes; and it is shaped by bottom-up dynamics, such as industrial needs and ambitions, energy access needs and ambitions, local policy and fiscal space, and climate change commitments. Locally relevant factors, including foreign government- and business-driven commercial interests and international geopolitics, are also critical drivers of transition dynamics. The pervasiveness of external actors and interests in the shaping of local energy agendas can lead to risks related to the compromise of local goals, the bypassing of local institutions, and the inability to attract funding for local priorities. The global energy sector is structured by contested political and economic relationships, unequal power dynamics, knowledge asymmetries, and patterns of exploitation and "extractivism" (noted above) identified in different studies (Ockwell et al., 2018b; Sareen, 2020b; Kumar, Höffken and Pols, 2021; Kalt et al., 2023). It is not the purpose of this paper to unpack the theoretical or practical assertions of any of these bodies of work. However, it is useful to outline some of the important actors and observable dynamics:

01 Africa's energy transitions are profoundly political and contested by different stakeholders, with a strong presence of different public, private and civil society actors from the Global North. They are commonly structured to align with the economic and geopolitical interests of international partners (Perry, 2021).

02 Bilateral and multilateral international cooperation, including finance as under the JETP structure, often lacks transparency in aspects of negotiation, as well as the actual financial instruments and terms. This means that contestation regarding these kinds of interventions within countries is shaped by knowledge asymmetries, undermining agreement between stakeholders.

03 The state of the African energy transition is tracked by a number of policy actors originating and operating outside of the continent (World Bank, 2017; Balabanyan et al., 2021; IRENA, 2021; IEA, 2022a, 2023). Knowledge production for the sustainable energy transition, and related policy development, are significantly concentrated in the Global North, among institutions like the World Bank, the IEA, Global North universities, development agencies, and DFIs. The IEA is an intergovernmental agency with

[4] Initial pledges included $2.6 billion through the Climate Investment Funds Accelerating Coal Transition Investment Plan (CIF ACT); $1 billion from France; $1 billion from Germany; $1.8 billion from the UK; $1 billion from the US; and $1 billion from the EU.

predominantly Global North membership, and the following African associate countries: Egypt, Kenya, Morocco, Senegal and South Africa. The Internal Renewable Energy Agency (IRENA) is a global intergovernmental agency for energy transformation, with several African member states, including Ghana, Kenya and South Africa. Countries do engage bilaterally and multilaterally with IRENA. For example, Kenya, Ethiopia, Namibia, Rwanda, Sierra Leone and Zimbabwe, supported by Denmark, Germany, the United Arab Emirates (UAE) and IRENA, established the Accelerated Partnership for Renewables in Africa (APRA) at the African Climate Summit in September 2023.

04 Initiatives focused on energy access, industrial development, climate mitigation and climate adaptation feature prominently within the portfolios of DFIs and multilateral development agencies involved in international cooperation. However, these programmes, much like the broader global development agenda, are often shaped by the knowledge, assumptions and interests of Global North actors in their framing and goals. They commonly fail to be sufficiently adapted to directly address the unique needs and risks present in African contexts.

05 African utilities play a critical role in energy transitions, whether they act as monopolies or private participation is allowed. As such, their governance and performance are of critical importance in matters of energy investment. While there are several valid critiques of state-run utilities, it should also be noted again that foreign governments (France, United Kingdom and Italy) hold significant ownership in companies that operate as independent power producers in Africa.

06 Private energy companies, including Engineering Procurement Construction companies (EPCs), Original Equipment Manufacturers (OEMs) and IPPs, are increasingly important, sharing different relationships with state actors, depending on regulatory and procurement arrangements. National governments are challenged to facilitate legal and policy environments for private-sector actors that incentivise investments aligned to development goals.

07 Large energy users and other commercial energy users are critical, especially if energy planning and industrial planning are to be integrated by national policymakers. Integrating the energy needs of these users in plans to expand energy access is a significant policy challenge.

SECTION FOUR: **ENERGY CONSUMPTION, GENERATION, TRANSMISSION AND DISTRIBUTION**

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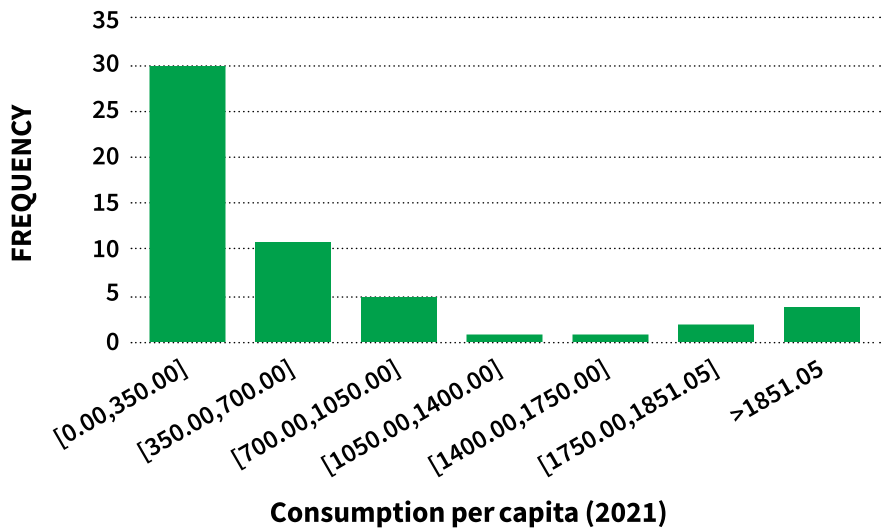
This section provides data related to energy consumption, as well as levels of generation from different sources. It also considers network infrastructure, transmission, and distribution, which are critical to the transition to renewable energy-dominated electricity systems.

4.1 ENERGY CONSUMPTION

According to the World Bank, Africa's total electrical energy consumption in 2021 stood at 892TWh (see Figure 1), with South Africa (25%), Egypt (21%) and Algeria (8.66%) accounting for over half of the total consumption, and local generation capacity dominated by coal- and gas-based generation systems. More recent data is incomplete; however, given the decline in demand in Africa's largest electrical energy consumer, South Africa, due to loadshedding, and the rising costs of global fuel prices (gas and diesel), it is unlikely that there has been a significant increase in demand. In sub-Saharan Africa, average electricity consumption per capita is the lowest of all global regions, with demand constrained by low levels of electricity access.

Due to low levels of industrial manufacturing in most African states, demand for electricity is largely driven by urban residential and commercial loads. National electrification schemes aligned to Sustainable Development Goal 7, which aims to "ensure access to affordable, reliable, sustainable and modern energy for all" by 2030, prioritise expanding rural electrification projects, which displace the use of potentially harmful fuels for basic cooking and lighting. To achieve this goal, an estimated 90 million people will need to be connected, and a further 130 million per year shifted to clean cooking fuels (IEA et al., 2021). Estimates included in the IEA's Africa Outlook 2022 report (IEA, 2022a) indicate that energy poverty increased by 4% from 2019 to 2021, primarily because of the harsh economic consequences of the global COVID-19 pandemic. Energy investment featured significantly in the AU and several African countries' 'green recovery' packages in response to the pandemic (African Union, 2021; Power Shift Africa, Positive Agenda Advisory, and Society for Planet & Prosperity, 2021).

Figure 1: Electricity Consumption (kWh/year) per capita for African states (2021) grouped by frequency



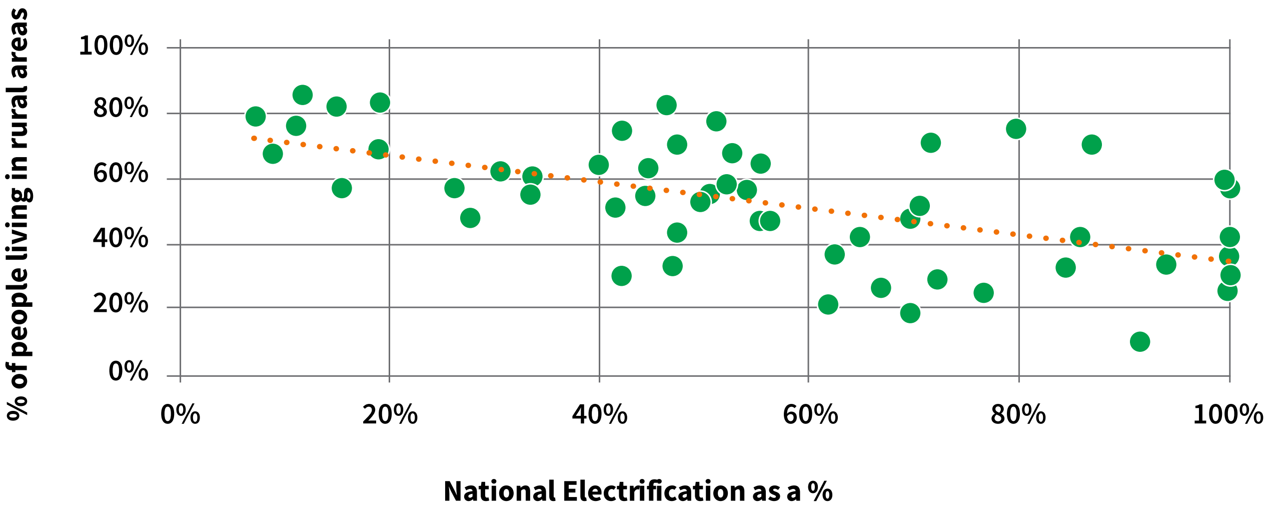
Source: World Bank

Inequality between and within states across the African continent is important to consider when assessing the state of electricity access in the region. Nigeria, whose population of 220 million (2022) accounts for 16% of the total African population, only consumes an estimated 3% of the electrical energy. Nigeria's per capita electricity consumption in 2021 was less than 150 kWh per capita, 25 times less than South Africa's. Ethiopia has extended electricity access from 16% in 2006 to 57% in 2018, as part of its national electrification strategy, marking the continent's largest connection boom over the past two decades. A survey report in Ethiopia (Padam, 2018) found that, of the 57% of Ethiopian households connected to electricity, 33.1% received access from grid connections, and 23.9% through a variety of off-grid solutions. Of the electrified households, about half were found to have access for only eight hours per day, with a further 20% having access for 23 hours per day. These comparisons make clear that access to electricity must also be appreciated qualitatively. Utilities typically categorise electrical energy demand from different customers by distinguishing between user classes (i.e. residential, commercial, industrial, state services) as well as by location of connection (urban or rural). The different uses and locations of electrical loads in a network carry important behaviour information, which helps utilities plan the necessary generation mix and grid-infrastructure buildout required to meet the social and economic requirements of users in a network, under the prevailing environmental constraints. There are also implications for cost and cost recovery through various tariffs.

Beyond the direct social benefits of electrification, access to reliable supply has the potential to multiply productivity levels, which can improve economic performance in industrial manufacturing and agriculture sectors. Early electrification in Africa focused on commercial lighting, railways, telecommunication, pumped water irrigation, and the beginnings of mining mechanisation. Today, while electrification levels have increased, access to electricity is only one factor in a more complex industrial policy puzzle, which determines whether the productivity gains made possible by modern technology can be achieved and scaled in local economic activity, in an affordable manner. A frequently cited study, 'Out of the Darkness and Into the Light? Development Effects of Rural Electrification' (Burlig, 2016), assessed the impact of rural electrification schemes in India, to reflect on a potential causal relationship between access to electricity and an increase in GDP. The study reflected on mixed academic evidence on the benefits of rural electrification, with some experimental data observing only moderate local welfare gains, despite the high costs associated with electrification (grid expansion) for villages with low populations. In contrast, for high population villages with sufficient density, the paper concluded "we find that electrification creates sizeable welfare gains in larger villages, likely due in part to structural transformation". Industrial incentives at village level, including subsidies and support programmes for adoption, or complementary technology like (solar) water pumps and agri-processing machinery, among others, help increase energy demand and improve the financial viability of micro-/ mini-grid solutions and grid-extension schemes (Booth et al., 2018).

This valuable analysis provides context for understanding the relationship between continental electrification trends and their local economic linkages. The data presented in Figures 2, 3 and 4, using the World Bank Open Data portal, highlights several key issues. Figure 2 shows a majority of countries with extremely low rural electrification rates.

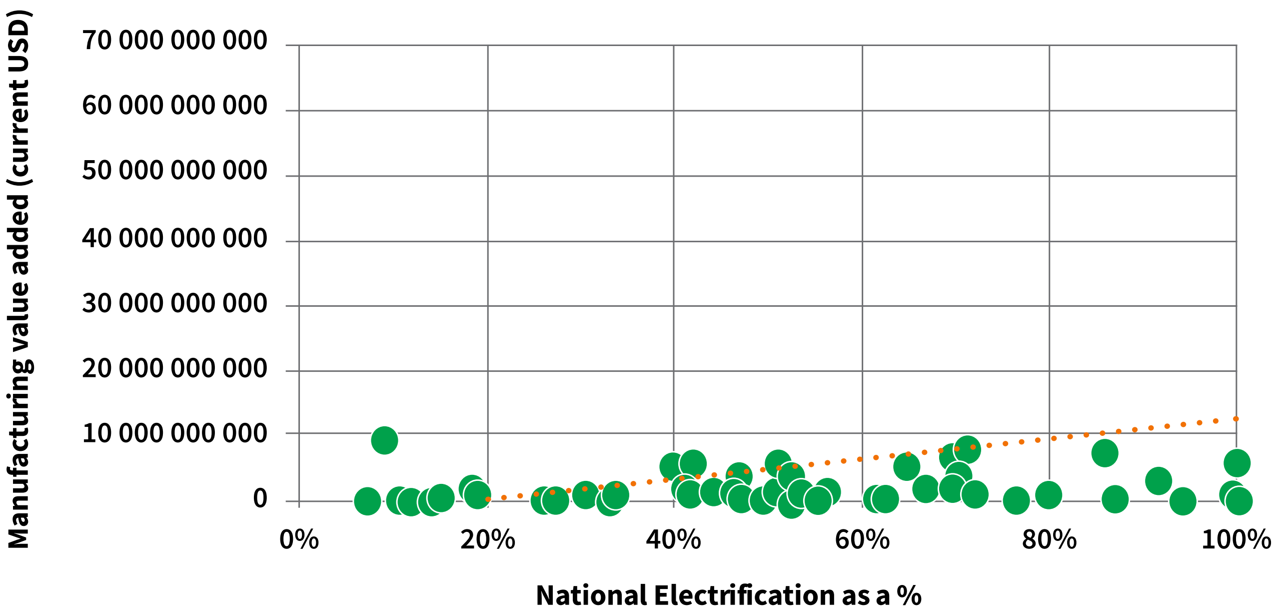
Figure 2: National Electrification rate for African states by percentage of population in rural areas (2021)



Source: World Bank

Additionally, as shown in Figure 3, a positive correlation exists between higher levels of electrification and increased manufacturing value added to the economy. Relatedly, industrial machinery has the potential to enhance production and create opportunities for local resource beneficiation.

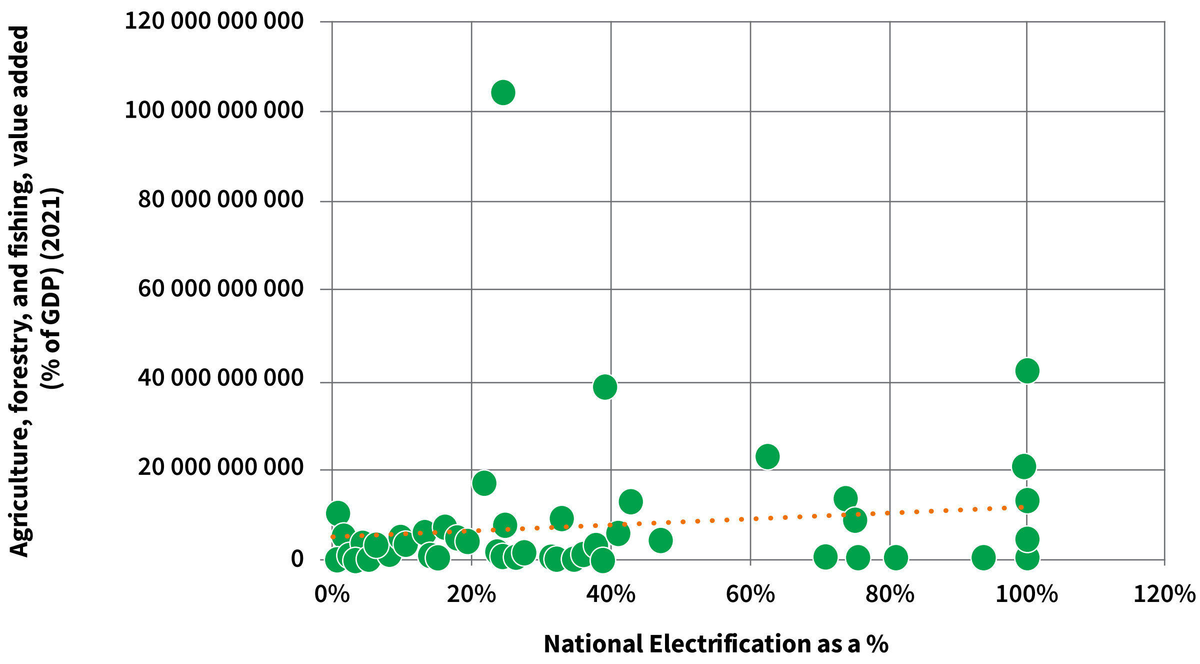
Figure 3: Manufacturing value added (current USD) across African states by national electrification rate (2021)



Source: World Bank

As shown in Figure 4, rural electrification does not necessarily translate into significantly increased agricultural productivity in rural areas. However, it is important to recognise that the relationship between energy inputs and the economic value of products varies significantly by context. Rural electrification statistics do not reflect the qualitative differences between the types of infrastructure which have been rolled out to provide access. In some instances, electricity access may be provided for basic home lighting, cell phone charging and other consumer electronic applications. In other cases, rural electrification schemes may be related to expanding the extension of water pumping systems for commercial and civil applications.

Figure 4: Agriculture, forestry, and fishing value add (as a % of GDP) by Rural Electrification rate across African states in 2021



Source: World Bank

Setting the ambition for rural electrification projects is critically important. Providing basic access solely for individual lighting and cooking needs has substantively different technical and economic implications from creating infrastructure capable of supporting agri-industrial activities, electrification of hospitals and schools, and reticulation of water for productive and household use. Integrating these ambitions is a challenge in the context of international development assistance finance, which is often disconnected in this regard.

4.2 ENERGY GENERATION

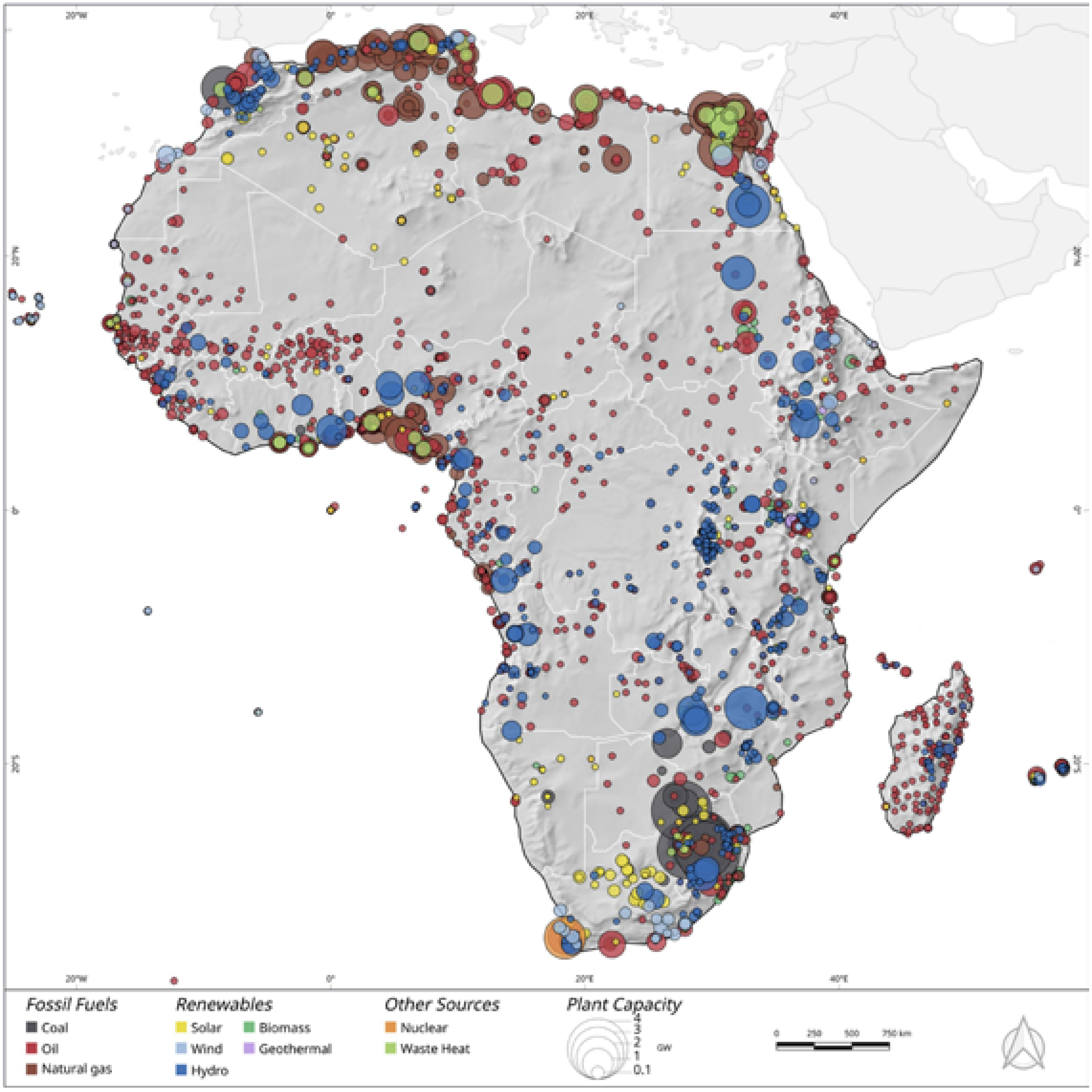
4.2.1 Continental view

As mentioned under the project approach, an accurate and useful understanding of Africa's energy systems and the JET is frustrated by the quality and availability of, and access to, data. According to the African Development Bank, total electricity generation capacity on the African continent stands at 245GW in 2023, up by 50% from 2015 (African Development Bank, 2023). No source is cited for these figures. According to the WRI Global Power Plant Database[5], however, Africa was estimated to have 157GW of installed generation capacity by 2021, with 38 of the 54 states listed in the region reported to have a total capacity of less than 1GW. It is important to note that these capacity figures appear to exclude mini-grid and other forms of small-scale embedded generation. Of this capacity, wind and solar contributed an estimated 2.4% of African generation in 2018. Capacity

[5] As noted, this is a limited database.

largely consists of LNG gas (39.52%), coal (29.55%), hydropower (large-scale and micro-hydro) (15%), oil (8.82%), nuclear (1.6%) geothermal (0.69%),and other renewable energy sources (2.52%). Figure 5, presents a map of the geographical spread and relative plant size for the different technology types using data from the WRI Global Power Plant Database, IRENA Renewable Energy Statistics 2018, and the S&P Global Platts World Electric Power Database (2016 (Gonzalez Sanchez et al., 2020)

Figure 5: Mapping power plants in Africa by location



Source: Image sourced directly from Gonzalez Sanchez et al., 2020

While wind energy, geothermal and nuclear generation capacities exist, they are not widely adopted technologies on a continental scale. There are several notable cases where high-capacity plants across differing technology types (coal and hydro) are performing well below their technical capability. Most explanations cite lack of maintenance (and consistent resources committed to this) and skills shortages (Gonzalez Sanchez et al., 2020).

There is still a heavy reliance on traditional biomass, with variations among countries influenced significantly by urbanisation and the availability of forest resources (Sokona et al., 2023). According to the African Union, 80% of the cooking fuel in sub-Saharan Africa is from traditional solid biomass – the highest rate among developing regions (North Africa, East and South Asia, Latin America and the Caribbean) (African Union, 2021).

The diversity and inequality between countries, in terms of rates of generation and energy mix, are pronounced. As an indication of this diversity:

01 North African states like Algeria, Tunisia and Egypt, which are reported to have achieved universal basic access, are dependent on gas-fired power stations.

02 Ethiopia, with a population roughly double that of South Africa, is home to Africa's second-largest installed capacity, which stands at more than 4.5GW, largely based on its recently commissioned Grand Ethiopian Renaissance Dam (GERD) project (hydropower). Grid-connected electricity is highly concentrated in urban areas, and electrical demand levels remain relatively low (122kWh/per capita, 30 times less than South Africa). This has resulted in a short- to medium-term capacity excess which has been sold to neighbouring states, through the regional interconnected network (Eastern Africa Power Pool).

03 Nigeria, which is routinely among Africa's three largest economies by GDP, has historically poor levels of grid access to electricity, coupled with low levels of electricity consumption per capita (147kWh/per capita), despite having over 12GW of installed generation capacity. Over 75% of Nigeria's electrical capacity is derived from fossil fuels, with the balance largely covered by hydroelectric power, and a modest contribution from solar power plants. The poor performance of Nigeria's generation infrastructure is emblematic of a common issue across the continent, with low levels of plant capacity utilisation reported in 2021 – as low as 28% for fossil fuel-based plants, and only 50% for hydropower in 2021 (IRENA, 2023b) – as a by-product of low levels of sector investment, and poor levels of infrastructure maintenance.

04 Nigeria, Algeria and Egypt are currently the leading African producers of liquified natural gas (LNG). Unlike its North African counterparts, Nigeria has not managed to leverage gas resource availability and local extraction capabilities to achieve extensive electricity access. Producers in Nigeria have prioritised exports to Europe, with less than 35% of LNG extracted being utilised domestically.

05 The Democratic Republic of the Congo (DRC), home to almost 100 million people, is uniquely positioned on the continent and perhaps globally. Its abundant natural resource endowment (copper, coltan, cobalt, uranium, and lithium, among others) has made mining and extraction central to the supply chains of everything from high-end consumer electronics to emergent industries like electric vehicles, as well as solar and wind GPNs. The DRC's estimated electrical generation capacity stood at 2.8GW, which is largely met by the Grand Inga Dam project, additional small hydroelectric capacity, and limited solar capacity in rural areas. Despite ambitious capacity projections, the Grand Inga Dam project has been plagued with cost overruns, high debt levels, severe negative environmental consequences for rural river-adjacent communities, and the plant has been victim to poor levels of operational maintenance (IRENA, 2023a).

In terms of resource potential, Africa is well endowed with renewable energy resources. High-capacity potential is estimated for solar (10TW), hydro (35TW), wind (110GW) and geothermal (15GW) resources (IEA, 2022a). Modelling completed by the IEA, through the development of the Africa Energy Outlook, developed by an international multistakeholder process in collaboration with the African Union Commission and the United Nations Economic Commission for Africa, illustrated the trajectories for key scenarios, including the 'Sustainable Africa Scenario' (SAS) and the 'Stated Policies Scenario' (STEPS) (IEA, 2022a). The SAS assumes that African states meet the targets articulated in SDG 7 – providing universal access to all – and are consistent with all the required state-sanctioned climate pledges. The STEPS model reflects assumptions aligned with sector-by-sector assessments of country-specific energy policies announced by governments. Under the SAS, Africa's emissions levels are expected to rise in conjunction with increased levels of industrialisation, because of the expansion of physical infrastructure and the anticipated expansion of cities through urbanisation. Renewable energy uptake and energy efficiency measures are cited as key measures to curtail emissions increases. The upgrading of grid infrastructure, and adequate resourcing and staffing of African public utilities, are highlighted, with the report stating: "Expanding and modernising Africa's electricity infrastructure requires a radical improvement in the financial health of public utilities" (IEA, 2022a).

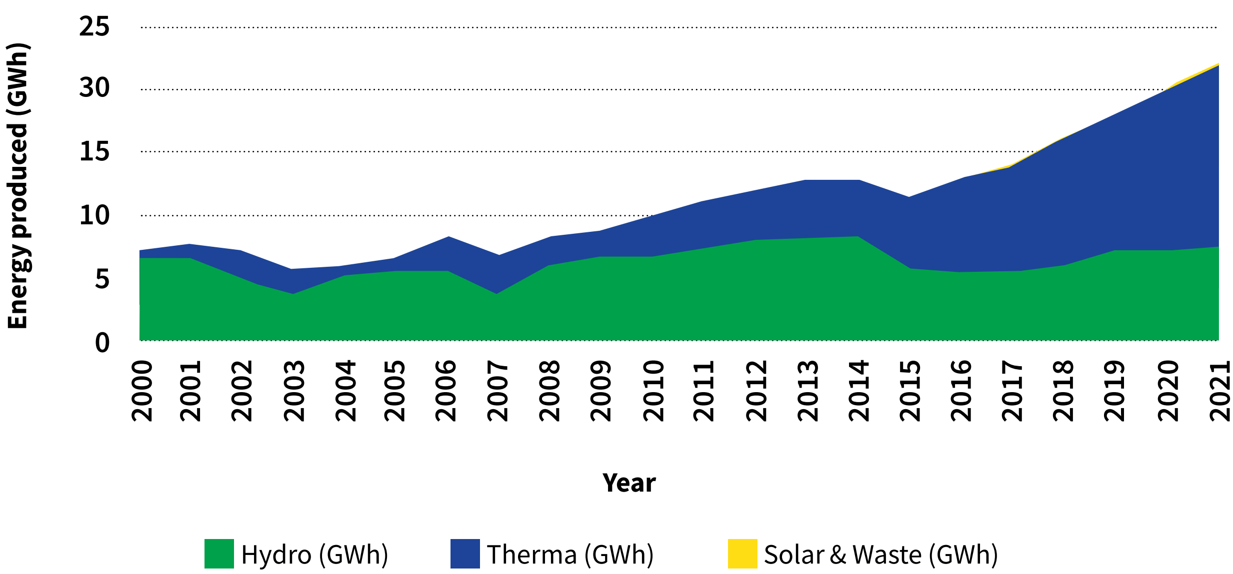
Additionally, predominantly in rural areas, there is an emphasis on using distributed and modular small-scale renewable energy options, such as mini-grids and solar home systems, which are proposed as key elements of solutions to improve access rates, again offering a range of additional indirect benefits, such as employment (Ahmadian et al., 2019; Mahomed et al., 2020; Hermanus and Cirolia, 2022, 2024; IEA, 2022a). There are a number of related programmes on the continent, including the Africa Minigrids Program, led by the United Nations Development Programme (UNDP), which aims to use mini-grids to respond to what it estimates to be 567 million people without energy access in sub-Saharan Africa. The World Bank has published research under its Energy Sector Management Assistance Program (ESMAP) asserting that mini-grids will be the lowest-cost option to meet energy access in unserved communities across the continent (Energy Sector Management Assistance Program (ESMAP), 2022). It reports 3 000 mini-grids installed by 2022, up from 500 in 2010, and estimates that electricity provided by mini-grids could be extended to 380 million additional people at a cost of $91 billion (R1.6 trillion) for 160 000 mini-grids.

Additional high-level, country-specific data for Ghana, Kenya and South Africa follows below.

4.2.2 Ghana

Data sourced from the Ghana Energy Commission's National Energy Statistics Report 2022 provides official information on historical high-level capacity and demand (see Figure 7). Ghana's installed generation capacity is reported to have grown from 1.65GW (hydro 1 072MW, thermal 580MW) in 2000, to 5.48GW (hydro 1 584MW, thermal 3 753MW, solar and waste 1.44MW) in 2022. Over this period, demand for electricity tripled, reaching 21TWh, while access roughly doubled, rising to 86.3%.

Figure 7: Ghana electricity generation by plant type 2000-2021



Source: GEC National Statistics

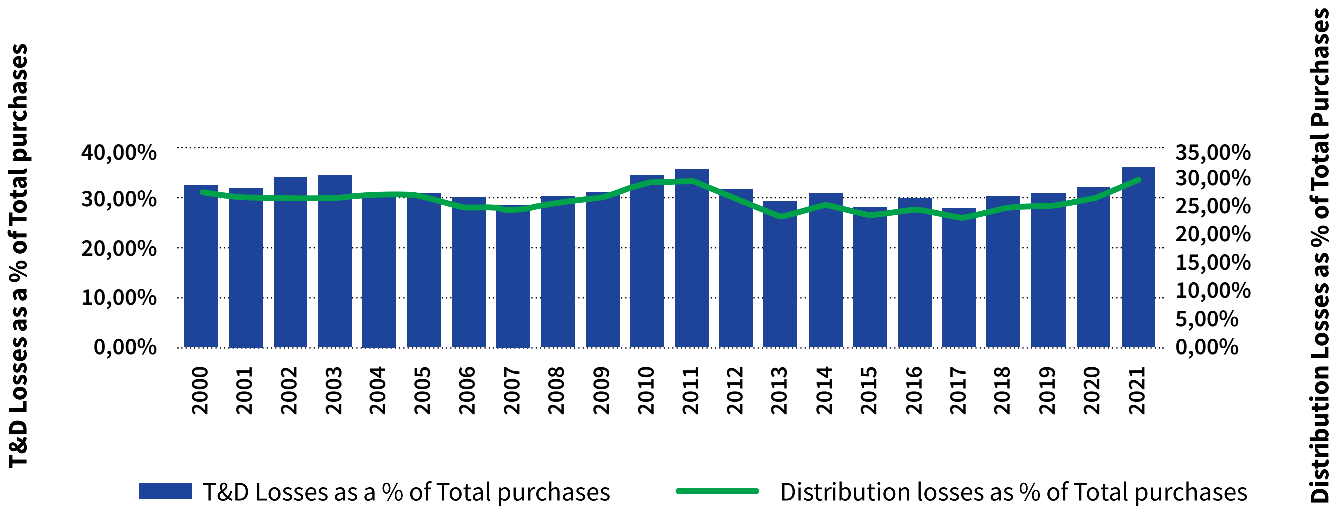
Ghana is connected to a regional network, the West African Power Pool, through cross-border transmission interconnectors which facilitate the import and export of power purchases between utilities across state lines. By 2018, increased investments in Ghana's generation capacity shifted the nation from being a net energy importer to a net exporter, selling over 1.5TWh annually from 2019 to 2021. The combined impact of the power exports and additional demand from the Volta Aluminium Company (the largest industrial-load customer) contributed an additional 11.8% to the domestic peak load, resulting in a total peak demand of 3.5GW by 2021.

Policies and legislation aimed at encouraging investment in low-carbon generation technologies include the Renewable Energy Act (2011), feed-in tariff policies, publication of a net metering code, the Renewable

Energy Services Programme (RESPRO), and the national electrification scheme. Utility-scale solar projects began to contribute to meeting national demand by 2013, and solar photovoltaic (PV) systems have been adopted for use in embedded generation projects in urban centres, and have played a prominent role in decentralised off-grid energy solutions for rural electrification schemes. By 2021, on-grid solar PV capacity was reported to stand at 144MW, with a further 7.2MW off-grid, and 0.2MW wind capacity. Mini-grids add a further 0.31MW of solar PV, and small-scale wind turbines add 0.11MW.

Transmission and distribution losses in Ghana's electricity grid network have been historically high, owing to poor levels of investment in maintaining and upgrading physical grid infrastructure. By 2020, over 36% of all electricity energy purchases across Ghanaian distribution companies were lost due to the poor performance of the transmission and distribution infrastructure (see Figure 8). Distribution losses account for most of the technical and commercial losses.

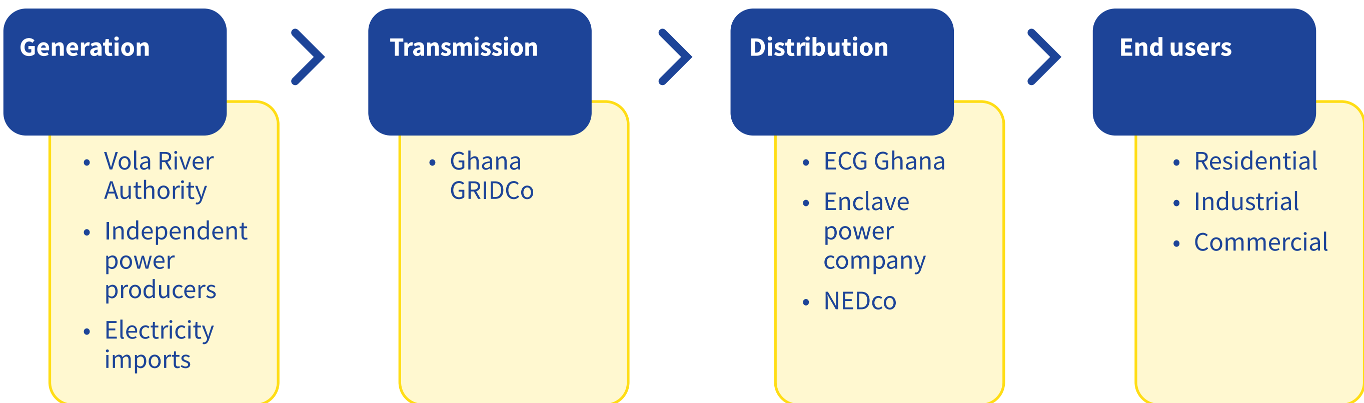
Figure 8: Transmission and distribution losses in Ghana's electricity network from 2000 to 2021



Source: World Bank Data

The power sector in Ghana transitioned from a traditional vertically integrated monopoly of generation, transmission and distribution to a vertically 'unbundled' structure, in the late 1990s, to encourage private participation in the generation sub-sector only (see Figure 9). Both state-owned and private generators (IPPs) operate and sell power to the central system operator, the state-owned Ghana Grid Company (GRIDCo), which operates and maintains the high- and medium-voltage grid networks. Distribution services are offered by three distribution companies (DISCOs): ECG Ghana, Enclave Power Company, and NEDco.

Figure 9: Ghanaian power-sector structure

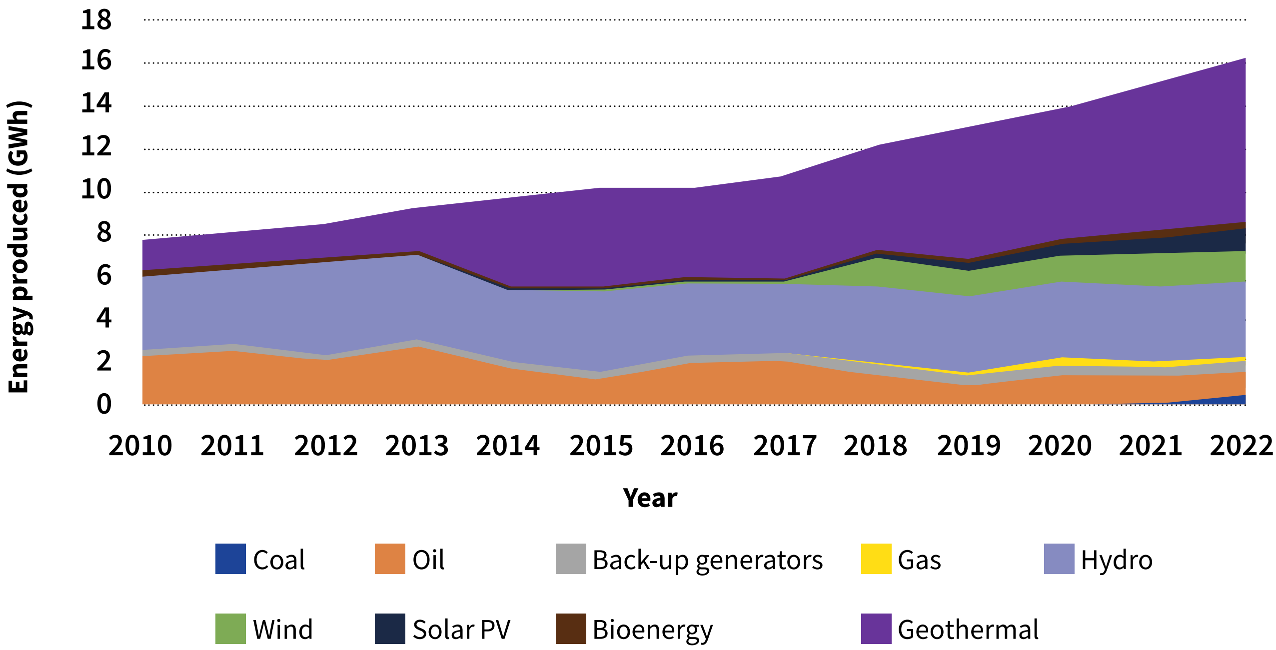


Source: Gyamfi, Modjinou and Djordjevic, 2015

4.2.3 Kenya

Data sourced from the Kenyan government's Energy and Petroleum Statistics 2021 report provides the official historical high-level data on electricity sales, and transmission and distribution losses, as well as the current capacity levels. Kenya's installed generation capacity is reported to have grown from 2.4GW in 2015 to 2.98GW (hydro 838MW, thermal 720W, solar 92MW, wind 436MW, biomass 2MW) in 2021 (see Figure 10). Over this period, electrical demand increased by 156%, reaching 15TWh, while access to electricity increased from 41.6% in 2015 to 76.5% in 2021.

Figure 10: Kenya's electrical generation mix by source from 2010-2022



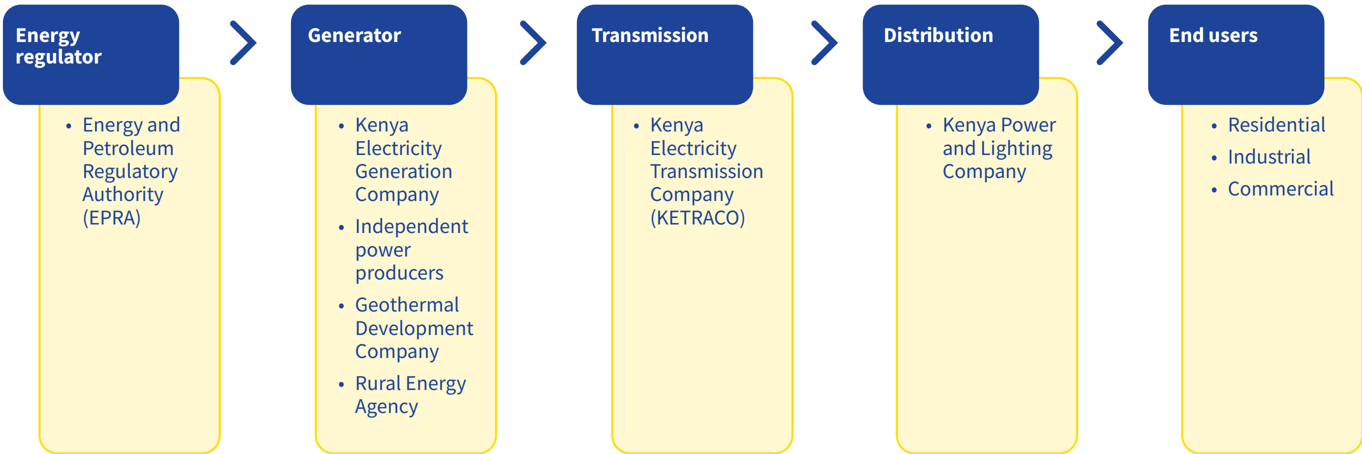
Source: IEA Data Portal

Policies and legislation aimed at encouraging investment in low-carbon generation technologies include the Energy Act (2019), the establishment of the Rural Electrification and Renewable Energy Corporation (REREC), the Kenya Off-grid Solar Access Project, feed-in tariff policies, publication of a net metering code, and the publication of the National Energy Policy (2018), which established the targets for universal access (Wako and Ngumo, 2020). Utility-scale solar projects began to exceed 1MW of capacity after 2018, and solar PV systems have been adopted for use in embedded generation projects in urban centres and have played a prominent role in decentralised off-grid energy solutions for rural electrification schemes. By 2021, the on-grid solar PV capacity was reported to stand at 90.25MW, with wind capacity at 435.5MW. A further 2.26MW of solar PV and 0.55MW of wind capacity have been installed and connected to mini-grid systems.

Kenya's transmission and distribution networks grew by over 400% from 2014 to 2020. By 2024, Kenya's transmission network stands at an estimated 6 295km, split between Kenya Power and Lighting Company (3 930km) and Kenya Electricity Transmission Company (2 365km) (ESI Africa, 2024). Public digital records on transmission and distribution losses proved challenging to access, technical and commercial losses were reported to stand at 23.46% in 2020 and 24.08% in 2021. The financial implications for consumers of the high loss levels were buffered by the energy regulator (EPRA), which only permits loss levels of 14.9% to be passed through to tariff increases. Reports estimate that the total value of the recoverable losses came to Sh15.99 billion ($99.2 million).

The power sector in Kenya went through a market reform process initiated in 1996, which vertically unbundled the electricity sector, allowing private participation in the generation and transmission sectors. This resulted in the establishment of the Kenya Electricity Generating Company (KenGen) and the Kenya Power and Lighting Company (KPLC). This process allowed for the introduction of IPPs, which introduced new capacity levels through public-private power-purchase agreements. By 2008, the power sector was further restructured through the breaking up of the KPLC into a newly established Kenya Electricity Transmission Company (KETRACO) with the KPLC retaining distribution as its sole mandate, accompanied by the establishment of the Rural Energy Agency (Godinho, 2019) (see Figure 11).

Figure 11: Kenyan power-sector structure



4.2.4 South Africa

Official historical high-level electricity sales data, and transmission and distribution losses, as well as the current capacity levels was sourced from IRENA and South Africa's state-owned enterprise Eskom's 2021 report (Eskom Holdings SOC Ltd, 2021; IRENA, 2022). South Africa's installed generation capacity, excluding private generation projects, is reported to have grown from 48GW in 2015 to an estimated capacity of between 58 and 62GW in 2022 (hydro 602MW, coal 39GW, nuclear 1.8GW, diesel OCGT 2.4GW, pumped storage 2.7GW, solar 2.3GW, wind 3.4GW) through contributions provided cumulatively by Eskom, IPPs, and small-scale embedded-generation projects by commercial and industrial users. Over this period, demand for electricity decreased by 1.3%, reaching 226TWh, while access to electricity increased from 85.3% in 2015 to 89% in 2021. Demand levels were negatively impacted by the declining performance of South Africa's coal-fired generation fleet, which precipitated high levels of loadshedding.

South Africa is home to Africa's most extensive transmission and distribution network, consisting of over 400 000 km of cabling. Technical energy losses increased by 4 907GWh from 2015 to 2022, rising to 11% system-wide. High levels of loadshedding increasingly resulted in outages at the distribution level, due to equipment stress failures.

South Africa's power sector largely developed under the mandate of the state-owned, vertically integrated, monopoly utility, Eskom, and local municipalities that operate a significant share of distribution customers. Market reforms imposed in 1998, through the Cabinet-approved White Paper on Energy Policy, aimed to enable private participation in the generation sector. South African private renewable energy procurement was initiated through the Renewable Energy Feed-In Tariff scheme (REFIT), which offered power-purchase agreements (PPAs) with generous tariffs and guaranteed rates of return on investment, pegged to inflation. REFIT was succeeded by the Renewable Energy Independent Power Producers Procurement Programme (REI4P), which commissioned over 5.7GW of combined wind and solar capacity by 2023. In 2021, Eskom initiated the legal process to advance the unbundling of the utility, first through transfer of its transmission division to a wholly owned subsidiary named the National Transmission Company of South Africa.

4.3 TRANSMISSION AND DISTRIBUTION

Networked infrastructure plays a pivotal role in facilitating electricity access for households, as well as for commercial and industrial users. Nevertheless, investments in reinforcing and expanding electricity networks, particularly in transmission and distribution infrastructure, have been limited. Consequently, transmission and distribution networks often fall short, inadequately supporting the economic development objectives of governments. Electrification patterns across Africa are marked by several key factors: notably, limited rural electricity access, subdued industrial electricity demand – primarily driven by urban residential consumption – and a corresponding lack of substantial investment in the electricity sector. These challenges are compounded by historical issues such as underperforming installed generation infrastructure and significant technical losses within distribution networks (Arcia-Garibaldi, Cruz-Romero and Gómez-Expósito, 2018; Juma, Munda and Kabiri, 2020).

Transmission networks in Africa are grouped between five regional networks: the Southern African, Eastern African, Central African, West African, and North African[6] Power Pools. Digital access to public data is poor and uneven between the regional bodies. Annual reports for West and North Africa were not obtainable, and there is little standardisation between the reporting on physical characteristics and performance indices between the Southern African Power Pool (SAPP) and its East African counterparts. The largest interconnected area, covered by the SAPP, demonstrates the importance of investments in regional interconnectors. Beyond the anchor provided by South Africa's coal and nuclear generation fleet, large hydroelectric dam projects in Angola, the Democratic Republic of the Congo, Mozambique and Zambia collectively play a significant role in improving grid stability across the region. In East Africa, the development of the Grand Ethiopian Renaissance Dam has provided reliability and capacity benefits to the Eastern African Power Pool. In 2019, a major regional transmission project, the 1 000km, 500kV Ethiopia-Kenya high voltage direct current (HVDC) line, created a pathway for up to 2GW of capacity to be evacuated between the national grids.

At a continental level, in June 2021, the African Union unveiled a proposed African Single Market (AfSEM) alongside the African Continental Power Systems Masterplan. This initiative introduces a high-level strategy to orchestrate the expansion of regional network interconnections, with the overarching goal of paving the way for continent-wide integration among regional grids. The AU then commissioned the African Union Electricity Sector Outlook (AUESO), which maps different demand-scenario trajectories up to 2040. Several AUESO scenarios consider significant increases in solar- and wind-generation technologies up to 2040, with small nations anticipated to achieve variable renewable penetration levels of up to 40%. The impact of this technology path has profound effects on transmission and distribution planning on the continent. This pathway heightens the significance of local capital investments in reducing losses, implementing grid modernisation, and expanding grid access to high-energy resource yield areas. Regional interconnections will remain crucial, particularly to enable deep levels of grid decarbonisation, by allowing benefit-sharing between countries with access to large hydropower capacity.

In African nations, constrained distribution networks – some unable to keep pace with urban expansion, and excluding peri-urban and informal settlements – impede households, businesses and large industrial consumers from benefiting from expanded electricity generation. Even in areas with network connections, the age and condition of networks may give rise to challenges, such as outages and poor power quality (e.g. power surges, voltage flickers), which can cause damage to customers' electrical equipment. The use of mini-grids is being deployed as a response to the limitations of distribution grids, operating in their absence, or supplementing where there are capacity or performance issues (Mahomed et al., 2020; Hermanus and Cirolia, 2022). Additionally, the Utilities 2.0 project in Uganda has been experimenting with applications that aid in the expansion of distribution network infrastructure, by taking on financial risk and preparing energy users (Mahomed et al., 2020).

Grid network expansion in Africa includes challenges in these key areas:

High capital costs: transmission and distribution (T&D) projects are typically capital-intensive, making the high costs of capital a significant barrier to implementation.

Political implications of cost recovery: the necessity of raising electricity prices to cover expenses can have severe political ramifications, impacting affordability and public perception.

Long connection distances: many areas require long connection distances, which not only add to expenses but also involve costly land concessions and permitting processes, often complicated by environmental impact concerns.

[6] Also known as the Maghreb Electricity Committee.

Geographically complex terrain: the diverse geography of the continent adds complexity to infrastructure design and construction, increasing both the length and intricacy of T&D networks.

Historical lack of regional coordination: poor levels of regional coordination have historically hindered efforts to address these challenges collectively, exacerbating the complexity of T&D expansion efforts across Africa.

Addressing these obstacles requires strategic planning, innovative financing mechanisms, and improved regional cooperation to ensure sustainable and effective T&D infrastructure development across the continent. Proposed enhancements to T&D networks in Africa encompass various measures, notably the replacement of aging infrastructure such as cables, transformers and protection devices, alongside substantial investments in upskilling and expanding the workforce. These improvements hold the promise of economy-wide advantages, including the creation of quality employment opportunities within public distribution companies, and the localisation of industries involved in transformer design, manufacturing, copper armature winding, and cabling. Additionally, such initiatives aim to bolster the efficacy of existing infrastructure, thereby fostering a more resilient and efficient electricity distribution system across the continent.

SECTION FIVE: **ENERGY INVESTMENT**

SECTION FIVE: ENERGY INVESTMENT

Energy investment data is also inconsistent. However, it is clear across reports that Africa receives a minor share both of global energy investment and of renewable energy investment. Bloomberg reports that, despite several public and private actors advocating for a strong role for renewables in Africa's JET, the continent is starting from a meagre 0.6% ($2.6 billion) share in 2021 of global renewable energy investment of $434 billion (BloombergNEF, 2022).

More than half renewable energy investment in Africa is private sector investment (IEA, 2022a). This share is set to increase, with the IEA pointing to the critical role of concessional finance to unlock more private equity. The majority of investment on the continent is from international sources and is unevenly geographically distributed across countries, with Egypt, Kenya, Morocco, Nigeria and South Africa receiving a significant majority of total investment.

The World Bank Group's 'Private Participation in Infrastructure' database shows that, from 2010 to 2020, only 7.5% of combined public and private investment in electricity infrastructure was in sub-Saharan Africa (often separated regarding energy statistics from North Africa, which is grouped with Middle East countries) (Attia, 2022). In line with the above observations on the state of transmission and generation infrastructure, this investment is dramatically skewed towards generation (98.2%). IPPs constitute the primary avenue for private-sector investment in power in sub-Saharan Africa. More than 2028 utility-scale projects exceeding 5MW constructed, owned and managed by private entities have successfully secured financial closure since 1990 (Kruger and Eberhard, 2023). Notably, a significant portion of these projects over the past decade have been renewable energy projects. The World Bank and other DFIs and foreign development agencies have been a driver of expanding IPP procurement in several countries under programmes like GET FiT (GET Fit Uganda, 2017; GET FiT Zambia, 2018).

Only 0.3% of the investments identified by the World Bank went into transmission networks. This reality is at odds with the continent's ambitions (both AU and regional) for greater cross-border integration of transmission networks. Critical components like distribution grids and last-mile connections are limited and demand substantial investment, often lacking viable financing options. This applies to conventional distribution grid extension-driven electrification projects as well as new mini-grid projects. Limited network infrastructure has significant implications for the feasibility of large-scale generation investments, and for industrial investments such as green hydrogen development, as planned in Namibia. For medium- and small-scale generation, mini-grids are a viable solution where grid extension is not financially feasible, but these remain a challenge to fund sustainably. In several countries the increasing, but still limited, uptake of mini-grids is often funded through some combination of public, donor and philanthropic money. This raises questions as to the long-term sustainability of investments.

Securing funding for infrastructure projects in Africa remains significantly challenging. African nations are frequently labelled as high-risk, a characterisation often tied to a lack of data, or understanding of pertinent realities and patterns, as well as the inadequacy of frameworks and concepts transplanted from different contexts. In this setting, acquiring capital for essential services like electricity entails substantial – and often punitive – costs. Furthermore, operational budgets required to sustain continuous investment in utilities must grapple with challenges related to both poverty and inequality, impacting revenue collection and the population's ability to pay, while fiscal constraints are often cited as a limit on the extent of utility or direct consumer subsidies. However, it is worth noting that, in 2022, Moody's Investors Service published a now widely quoted report showing that African infrastructure projects have lower default rates than other low- and middle-income regions (Latin America and Asia), and lower default rates on average when compared to North America and Western Europe.

There are multiple estimates of the investment needed to address infrastructure and access deficiencies. These estimates depend on the assumptions embedded in the future scenarios that underpin them. These assumptions concern the future of demand, the energy mix, the plan for off-grid versus grid-tied energy access, and the prioritisation afforded to network (transmission and distribution) maintenance, upgrading and extension. Different estimates also need to be understood in relation to their underpinning goals for energy sector development and framing (for example, combatting energy poverty versus green industrialisation). So, the answer to the question of how much investment is enough is not straightforward. The parameters for different estimates are also not always understood or agreed. These are some of these estimates:

01 The IEA suggests an annual requirement of $190 billion from 2026 to 2030 for all climate finance, with two-thirds allocated to sustainable energy (IEA, 2022a, 2023). This represents an increase to 5% of global renewable energy investment during this time.

02 To achieve the NDCs for all sub-Saharan African countries, an estimated $377 billion has been identified for climate mitigation (effecting a low-carbon transition) investments, and $222 billion for climate resilience (UNU-INRA, 2021).

03 As noted above, the World Bank reports that the reach of mini-grids providing electricity access could be extended to 380 million additional people, at a cost of $91 billion for 160,000 mini-grids.

Whatever the estimate, more detailed national and regional plans will need to be integrated with industrialisation planning to identify realistic estimates, as well as effective instruments to meet these needs.

SECTION SIX: **OVERVIEW GLOBAL PRODUCTION NETWORKS FOR WIND AND SOLAR ENERGY**

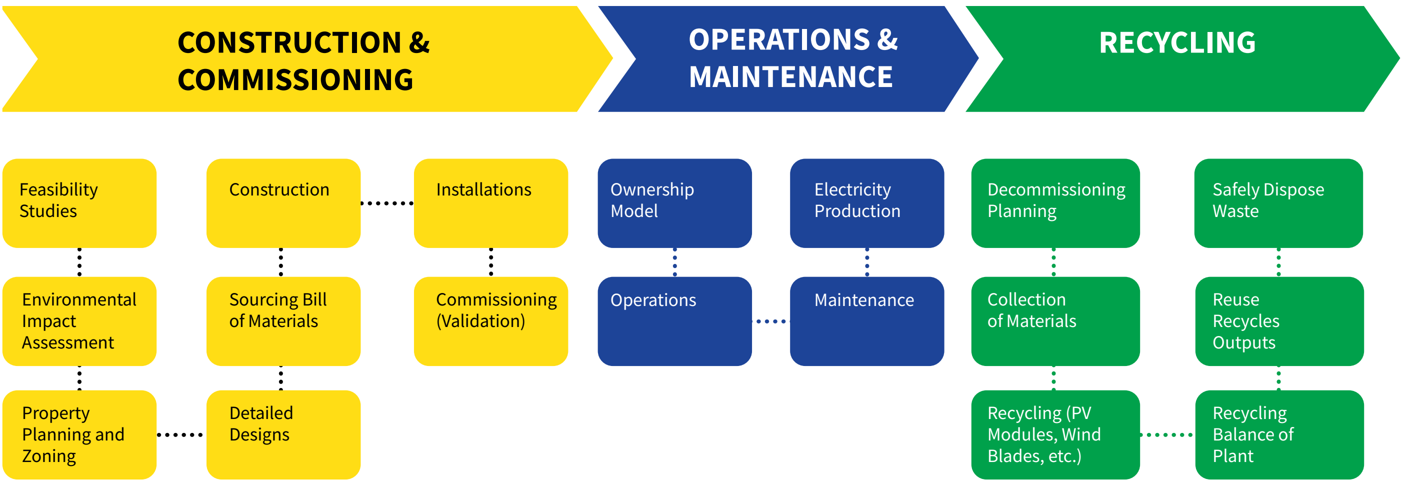
SECTION SIX: OVERVIEW GLOBAL PRODUCTION NETWORKS FOR WIND AND SOLAR ENERGY

The Global Production Networks (GPN) framework has been identified in the International Development Research Centre (IDRC) conceptual framework document as a key tool for understanding the dynamics of global wind and solar value chains in the African context. This report focuses on the firms involved in the solar and wind GPNs, with an emphasis on large utility-scale projects. It leaves a more detailed analysis of non-firm activities by states, labour, and civil society to forthcoming research.

The global solar PV GPN is highly concentrated and geographically located in China. By 2023, the top 10 firms were estimated to account for 85% of global market share (VeraWang, 2023). Lead firms in the wind turbine industry are more geographically dispersed, with original equipment manufacturers based in Denmark (Vestas), China (Dongfang, Goldwind, Envision, Mingyang, among others), Spain (Siemens Gamesa), Germany (Enercon, Nordex Acciona, Guodian United Power) and the United States of America (General Electric) (Lucía Fernández, 2023). African states are linked into wind and solar global production networks, but remain dependent on imported technology and trade in intermediate goods and services (particularly in the solar PV industry). Developing industrial policy to improve the value-capture trajectories for wind and solar GPN localisation in Africa has largely depended on country-by-country measures, including tax exemptions on investments, feed-in tariff schemes, and public procurement programmes (Development Reimagined, 2023). Component demand levels, existing infrastructure presence, and access to local manufacturing capital vary significantly across the continent. There could be important strategic benefits from supporting multilateral negotiations, aligned with regional development outcomes, to support onshoring renewable energy manufacturing capacity on the continent.

Developing effective industrial policy measures is crucial, necessitating targeted approaches to ensure alignment between trade and investment incentives, local industrial goals, and societal expectations regarding benefit distribution, amid the anticipated surge in green industrialisation. Figure 13 maps the standard, high-level life cycle of utility-scale wind and solar power plants, offering insight into their operational stages.

Figure 12: The life cycles of wind and solar plants



'Sustainable Energy for All' (SE4ALL), an international multistakeholder platform established under the auspices of the United Nations to facilitate advancements aligned with Sustainable Development Goal 7, issued a report in 2023 focusing on critical renewable energy manufacturing opportunities and trends (Sustainable Energy for All, 2023). The report underscored substantial prospects for the localisation of battery storage and solar PV GPNs. However, it identified constraints affecting the solar PV sector – notably, uncertainties regarding local market potential, barriers related to supply chain imports, and constraints imposed by limited local manufacturing capabilities. An SE4ALL report included reflections drawn from interviews with 15 suppliers, and highlighted the following recommendation to enhance local manufacturing on the continent: "Africa should consider incentives for local manufacturing, labour force improvements, infrastructure support, a secured supply of low-cost green electricity, and preferential financing packages". The report analysed several key minerals used as inputs into the solar PV value chain, and found that only the Democratic Republic of the Congo and South Africa, with copper and chromium respectively, feature on the lists of top three global producers. The study identified opportunities for mineral beneficiation of critical materials for solar, wind, electric vehicle and battery storage technologies in Africa, but only found significant short-term demand in South Africa.

Recognising the complex interplay between local and international supply chains underscores the significance of trade in shaping the global division of labour within renewable energy (RE) GPNs. Contractors, for instance, leveraging imported products like power inverters, often operate locally under licensing agreements that regulate the usage of the supplier's intellectual property. To facilitate technology transfer alongside technology adoption, substantial efforts in research and development (R&D), and supportive innovation systems, are typically implemented, especially in instances of significant imported technology diffusion (Institute for Economic Justice, 2021).

6.1 SOLAR GPNS IN AFRICA

Solar PV systems already enjoy wide application on the continent, from household-level systems through to large, utility-scale plants. The 2022 IEA Special Report on Solar PV Global Supply Chains (IEA, 2022b) emphasised the degree of supply chain concentration, pointing out that just four countries accounted for up to 85% of all PV manufacturing jobs. The most job-intensive segments along the PV supply chain are module production and cell manufacturing, due to the high number of steps in the assembly processes, and quality-control testing requirements. The cost-competitiveness of module assembly is driven by the cost of capital, labour and input electricity prices. Significant value chain activities include raw materials extraction, polysilicon production, ingot production, wafer production, solar cell production and solar PV module assembly.

The 2024 Solar Outlook report by the continental solar industry body, the Africa Solar Industry Association (AFSIA) (AFSIA, 2024), estimated potential module competitive rates in Ghana ($0.182/kW), South Africa ($0.180/kW) and Nigeria ($0.184/kW) compared to China ($0.160). The AFSIA report estimates that South Africa installed a continental record of 2 965MWp in 2023, largely derived from small-scale embedded generation (SSEG) projects, in response to enabling reforms in local electricity sector regulation. From 2010 to 2021, solar PV module demand in South Africa was largely driven by the REI4P public procurement programme. Due to a degree of uncertainty and inconsistency with the REI4P, demand levels fluctuated during this period, leading to periods of 'boom and bust'. Local industrial policy measures did not compel utility-scale plans to source from local module assembly manufacturers, resulting in a reliance on cheap imported panels. Over this period, exports for South African-assembled solar PV products fell from $500 million to $300 million by 2021 (Rivett-Carnac, 2022).

There are limited examples of solar assembly plants across the continent's five regions:

01 Chinese-led firms such as Jiangsu Seraphim Solar System Co. Ltd. and Talesun have invested in two module-assembly factories in South Africa. Talesun, in a joint partnership with a domestic manufacturer, ARTSolar, launched a 325MW per year tier 1 manufacturing plant aimed at meeting the project localisation requirements for the public procurement programme named the Risk Mitigation IPP Procurement Programme (RMIPPPP). Despite comparatively high levels of domestic demand for solar PV products in South Africa, factory utilisation levels have proven erratic and sub-optimal because of porous local content requirements for public procurement programmes, and a lack of alignment between industrial investment incentives and trade protections (Institute for Economic Justice, 2021).

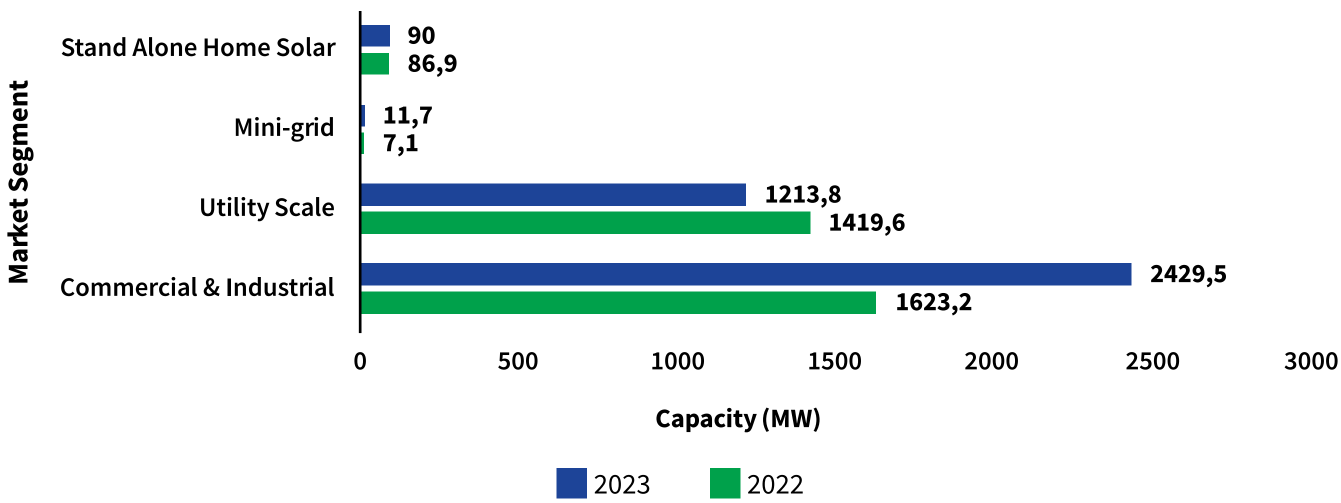
02 In West Africa, Burkina Faso has a module assembly factory, with a capacity of 80-120MW per annum (Renewables Now, 2020), launched in early 2024 in partnership with China's Yingli Solar and with equipment from the Spanish firm Mondragon Assembly (Faso Energy, 2022). In Ghana, a local firm, Strategic Power Solutions, built a 30MW per annum solar module manufacturing firm in 2016, with the support of equipment from Bootsolar (China), NPC (Japan), and Panamac (Italy) (Kenning, 2016). Both plants are advertised as focusing on rural applications and commercial and industrial (C&I) SSEG projects.

03 In East Africa, Solinc (formerly known as Ubbink East Africa) launched a small solar module assembly factory in Kenya in 2011 (Mulupi, 2016). There is little publicly available data to describe the plant's capacity; however, the company states that it has sold 69MW worth of plants to neighbouring Uganda, Tanzania, Rwanda, Burundi and Democratic Republic of the Congo. This capacity includes wholly imported panels (up to tier 1 quality level) from partners Huawei, Trina Solar and Jinko Solar. The market for the panels is reported to largely derive from commercial and industrial projects, as well as small solar home kits sold for rural applications.

04 In North Africa, two solar module manufacturing facilities have been built since 2020, in Algeria (Milltech, 200MW) and Egypt (Teriak Industrial Group,100MW), with equipment supplied by Spanish firm Mondragon Assembly (Milltech, 2020). Algeria's Milltech is the largest module manufacturer in Africa outside of South Africa, and lists a technology partnership with China's tier 1 manufacturer, Huawei, with a commitment to supporting technology transfer. An industry review article, 'Top Solar Panel Manufacturers in MENA 2022', names additional module facilities in the region, including in Egypt (A.R.E Group, Egyptian German Co. Trading and Supply), Tunisia (Aurasol) and Algeria (SARL Algerian PV Company, Aures Solaire) (Solar Feeds, 2023).

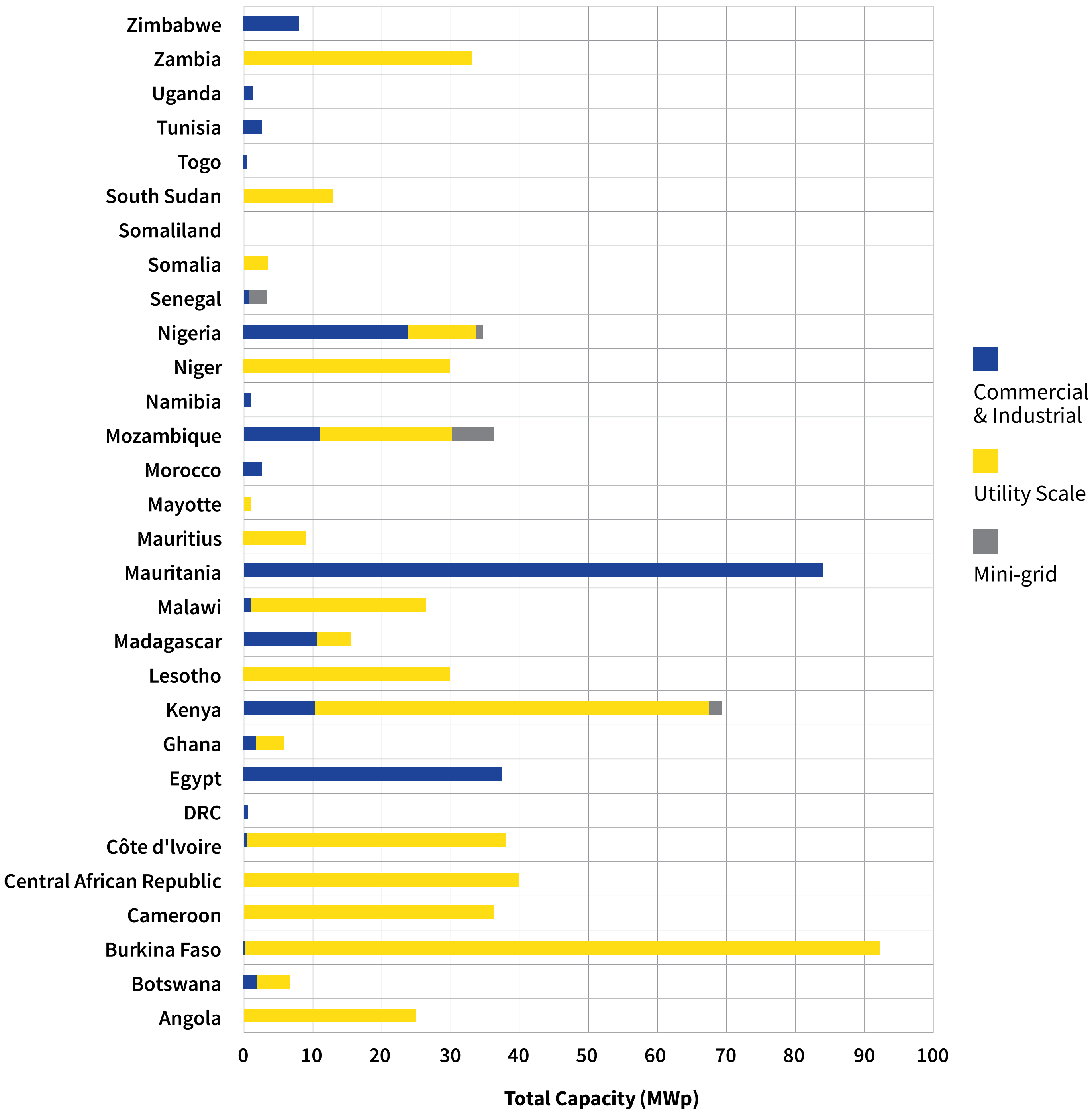
The market for solar PV products in Africa is segmented by applications, for utility-scale and small-scale embedded generation (SSEG) projects. Utility-scale projects are dependent on state incentive programmes, which are currently driven by IPP programmes, commercial and industrial projects, and SSEG-enabling policies and incentives. Mini-grid systems vary significantly in scale, and are typically tied to subsidies, grants and donor funds earmarked for rural electrification schemes.

Figure 13: Annual Solar PV capacity installations by market segment from 2022-2023



Source: AFSIA Solar Outlook 2024

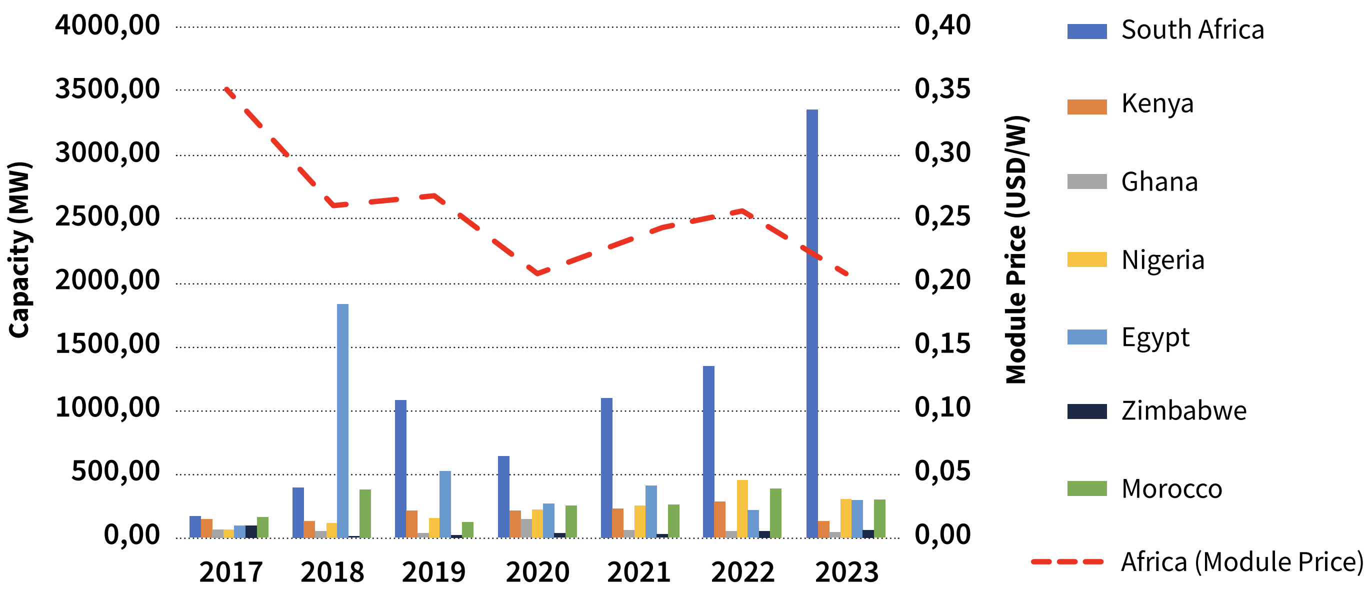
Figure 14: Solar PV Capacity installations in Africa by Country in 2023, excluding South Africa



Source: AFSIA Solar Outlook 2024

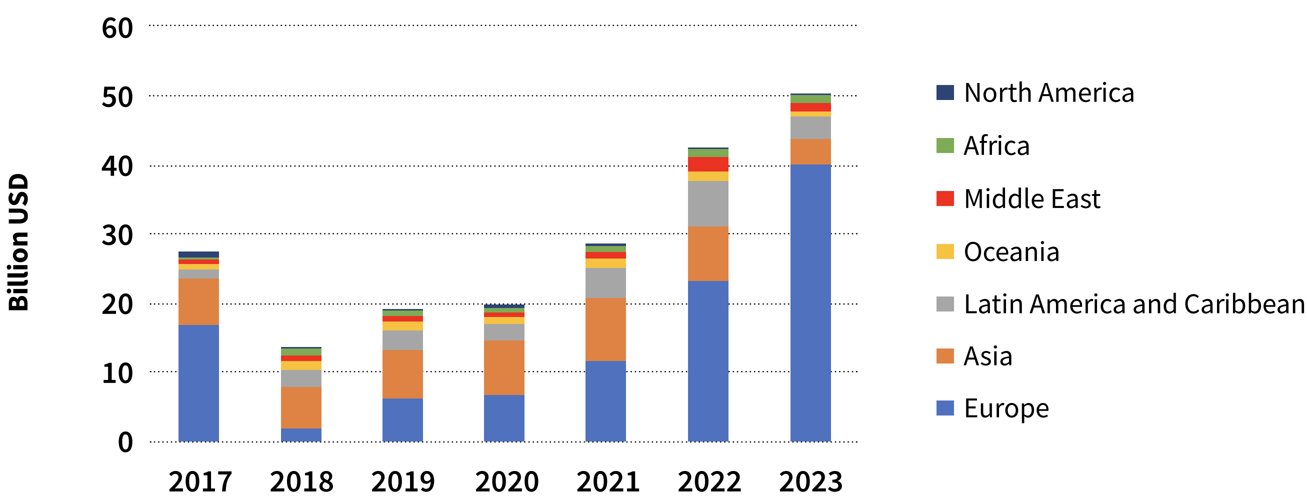
Over the past year, utility-scale plants have driven the key base demand for solar components on the continent in most states, with the notable exception of Mauritania, Egypt, Nigeria, Zimbabwe and South Africa, which saw a significant uptake in private-private solar projects for commercial and industrial applications. Out of the list of solar module assembly facilities identified in this study, only factories in South Africa and Algeria expressly list supplying to independent power plants as a key target market for their products. IPPs, under the influence of private creditors, tend to favour the use of imported, high-efficiency tier 1 panels from China, which are viewed as low-risk. Between 2017 and 2022, imports of solar PV modules from China to the top 30 African states (excluding South Africa) deploying solar PV systems showed a steady increase, surging from an estimated 891MW to 2.5GW in 2022. During this time frame, module costs plummeted to 60% of the 2017 price, rendering solar PV investments increasingly attractive for private-private projects, while utility-scale plants continued to benefit from publicly-backed incentive schemes. With substantial trade volumes involving Chinese-based Original Equipment Manufacturers (OEMs), and a growing list of technology partners for domestic African solar module manufacturers collaborating with leading firms in China, it is imperative to consider the formulation of regional industrial strategies aimed at advancing the solar value chain. This includes proposing trade, investment and technology transfer agreements during China-Africa multilateral economic negotiations.

Figure 15: Import trends for Solar PV modules from China to several African states from 2017-2023



Source: Ember Data

Figure 16: Solar PV cell and module export value (billion USD) from China to the rest of the world



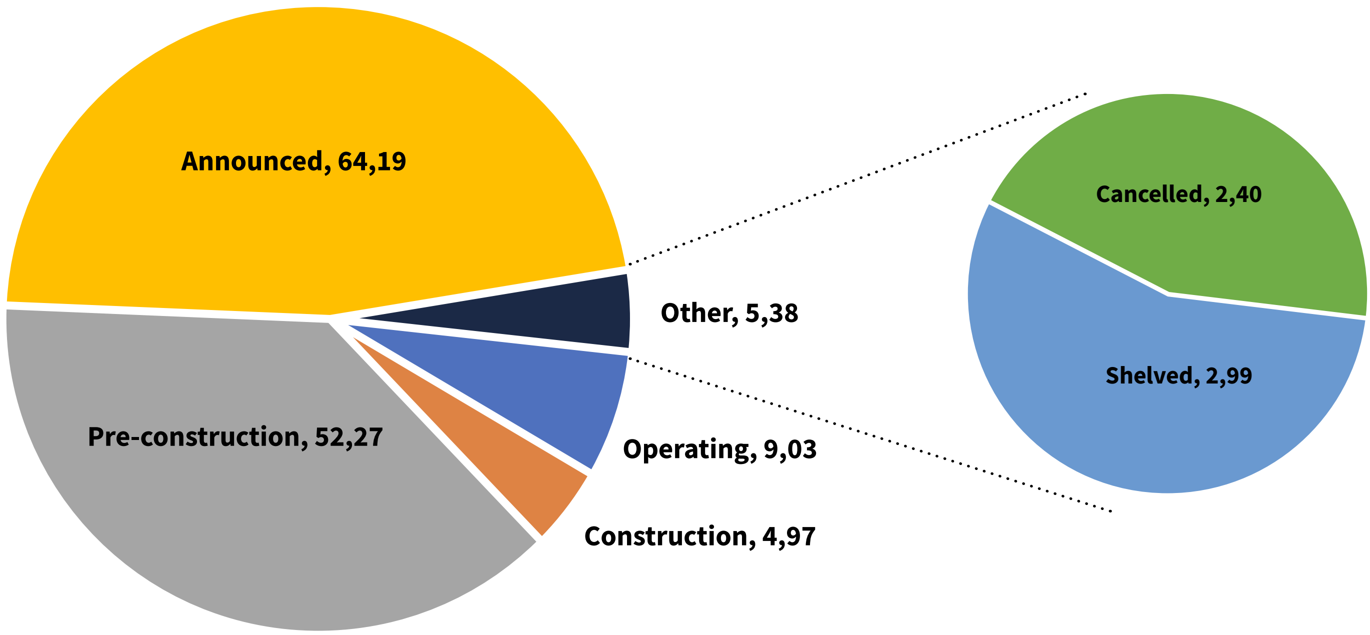
Source: Ember Data

6.2 WIND GPNS IN AFRICA

Localising the wind value chain in Africa presents unique challenges due to the inherently more site-specific nature of wind power plants compared to solar irradiance. Wind energy potential, particularly at economically advantageous levels, may be found in areas distant from existing grid infrastructure, necessitating additional investments in supporting infrastructure, to facilitate increased demand for wind turbine components. Unlike small commercial solar PV plants, which undergo a relatively straightforward installation process, wind turbines are sizable structures requiring substantial amounts of concrete and steel in their foundations, as well as road infrastructure of a certain quality, capable of carrying the weight of the specialised vehicles which carry massive components. Although there are a few innovative micro-wind turbine designs with limited commercial utility, many wind turbines are large-scale installations, further complicating the localisation process. Significant components of wind GPNs include raw material extraction and processing, blade and blade bearing manufacturing, gearbox production, nacelle manufacture and assembly, tower structure manufacturing, and balance of system (inverter, transformer, cabling, substation).

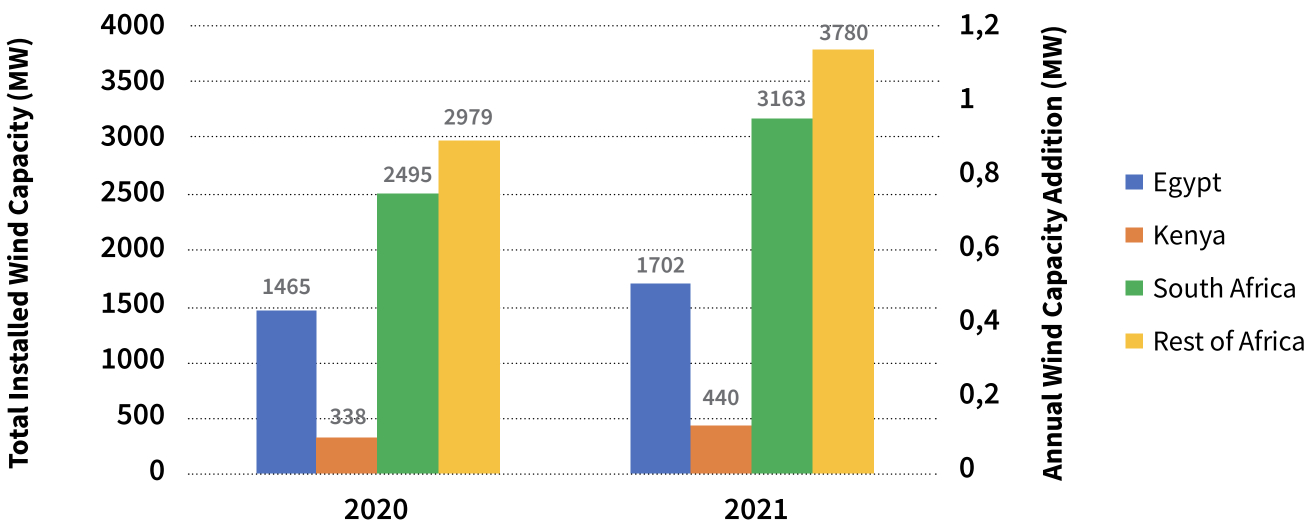
Several African states have acknowledged the significant wind resource potential and have included this technology's in national energy mix projections over the coming decades. Figures 18 to 21 illustrate the capacity levels across different phases in the wind plant project pipeline, in the African market.

Figure 17: Wind power plant project pipeline in Africa by 2023 (GW)



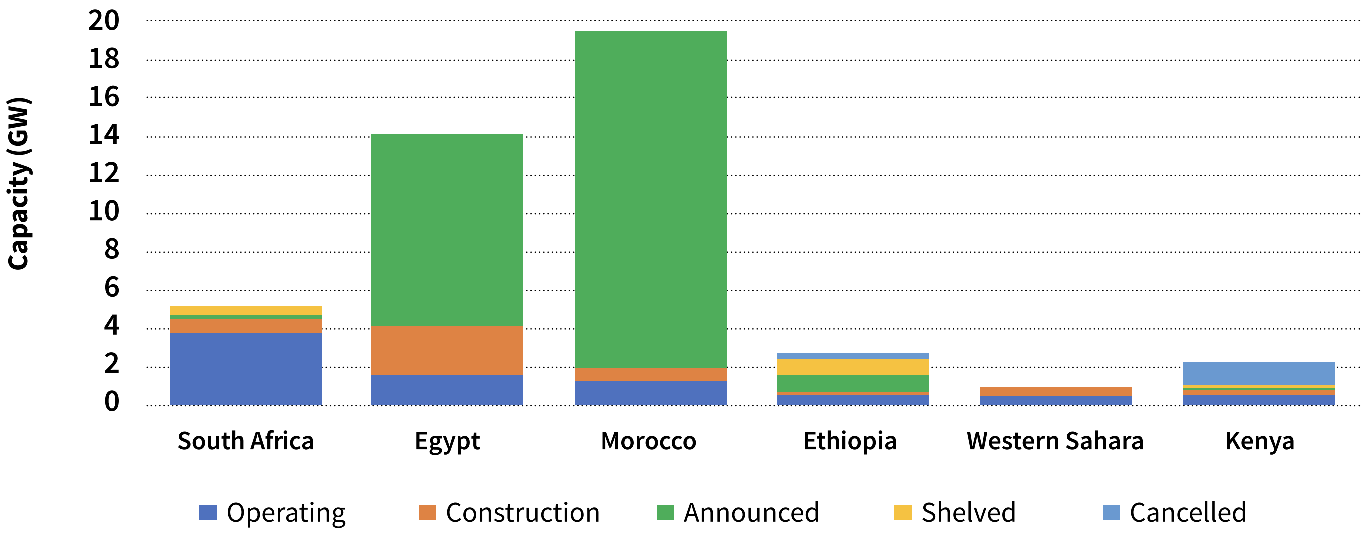
Source: Global Energy Monitor

Figure 18: African wind sector deployment trends



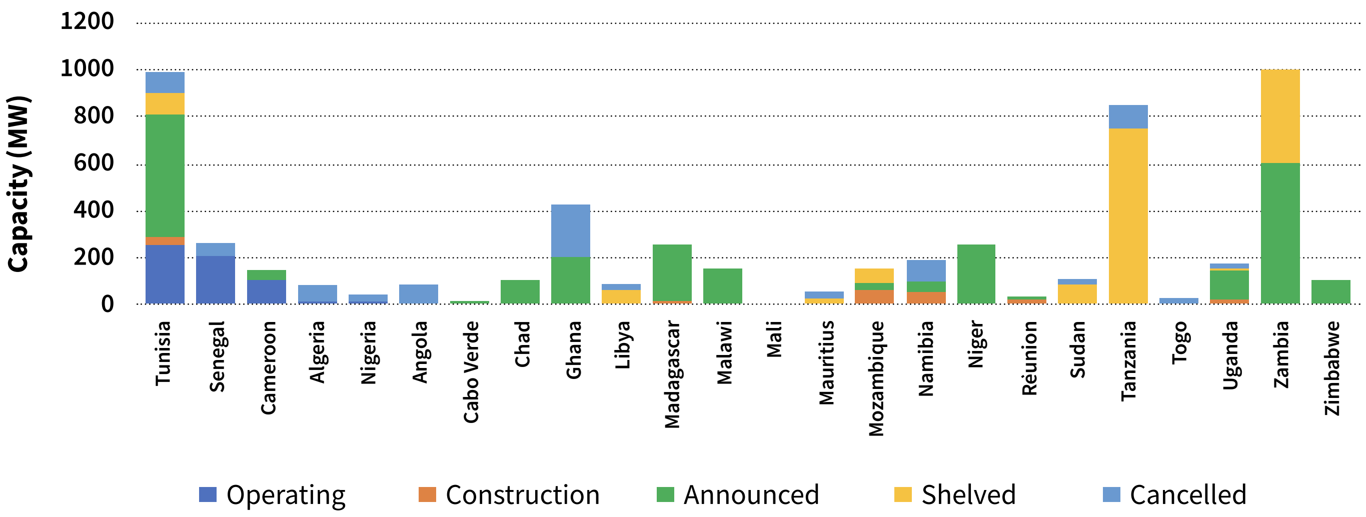
Source: GWEC Annual Wind Report

Figure 19: Status of wind power project pipelines in Africa (Installed Capacity > 500MW)



Source: Global Energy Monitor

Figure 20: Status of wind power project pipelines in Africa (Installed Capacity < 500MW, excluding Mauritania and Djibouti)



In 2020, the Global Wind Energy Council (GWEC), a prominent global wind industry organisation, released an Africa Wind Energy Handbook (GWEC, 2020), which included an insightful discussion on the establishment of the continent's inaugural rotor blade manufacturing plant in Morocco. This significant milestone was achieved when the Spanish-German Wind OEM giant, Siemens Gamesa, inaugurated the facility in 2017. Strategically situated just 35km from the Tangier-Med port, the plant aimed to mitigate logistics costs by capitalising on Morocco's advantageous location between Europe and continental Africa. The plant was estimated to have created as many as 700 direct jobs and 500 auxiliary jobs in Morocco. Five years later, media outlet Reuters reported that Siemens Gamesa aimed to sell the facility ahead of a planned plant shutdown in early 2023 (Eljechtimi, 2022). The reason was declining profitability in the company, caused by rising input costs and wind value chain and supply chain issues in the aftermath of the COVID-19 pandemic. While input costs and transport costs have escalated, wind and solar power plants have faced pressure to offer low power tariffs in major electricity markets, leading to several high-profile project cancellations, notably including projects in the offshore wind markets in the United Kingdom and USA. Siemens Gamesa recorded losses of over €884 million in Q1 of 2023, which more than doubled its recorded losses from Q1 of 2022 (Steitz and Landauro, 2023). In 2021, another Spanish firm, the InCom Group, established a facility outside of Tangier, Morocco, to engineer, design and manufacture composite kits for wind blades. Its purpose was to meet the demand for export to Europe. While Siemens Gamesa's fortunes have declined recently, Aeolon continued to expand its global reach with new projects committed in Germany in 2023 (North Africa Post, 2021). Aeolon moved to establish its own rotor blade manufacturing plant in Morocco, with an estimated annual production capacity of 600 sets, and is expected to employ 3 332 people at an anticipated annual revenue of €626 million.

In South Africa, localisation requirements in the REI4P public procurement process have helped to develop local capacity for wind tower manufacturing. In April 2024, German wind turbine OEM, Nordex, declared the intention to invest in a tower manufacturing facility creating 300 new jobs in the Eastern Cape (Nordex Energy, 2024). A similar initiative was launched in 2014 by a Spanish tower manufacturer, GRI Industries, which launched a facility in Cape Town, South Africa, capable of producing 150 towers per year. It reported creating up to 150 jobs at its peak (Windtech International, 2014). However, domestic demand uncertainty around the programme in the early phases resulted in the collapse of a burgeoning domestic wind blade manufacturing firm (Baker, 2016). In 2019, following years of political and policy uncertainty undermining the implementation of the REI4P, DCD Wind Towers, a wind turbine manufacturer based in Nelson Mandela Bay, closed its factory in the Coega Industrial Development Zone (IDZ), citing a lack of demand because no wind farms were anticipated to be built between 2022 and 2025.

SECTION SEVEN: **EMPLOYMENT IN RENEWABLE ENERGY**

SECTION SEVEN: EMPLOYMENT IN RENEWABLE ENERGY

7.1 UNDERSTANDING RENEWABLE ENERGY EMPLOYMENT FIGURES

Numerous evaluations of existing and anticipated employment levels in the electricity sector on the continent have provided data and insights, with a range (sometimes divergent) of policy implications. Discrepancies in the figures arise from distinct metrics, methodologies and assumptions employed, and differences in data sources. These variations in study design and outcomes have resulted in significant confusion, with stakeholders expressing conflicting views on job losses and job creation in the JET.

It is crucial to transparently delineate these differences to foster a foundational level of consensus regarding the factual basis and rational assumptions for employment policies among various stakeholders and interest groups. One of the most obvious methodological differences is between the use of headcounts, full-time equivalents (FTE) and job years (Hermanus and Montmasson-Clair, 2021).

These various measures obfuscate and elucidate different information about employment. Only a headcount reveals how many people depend on a particular economic activity for any income, although it may not indicate full employment per person. FTEs and job years are measures of an amount (hours, days) of employment not associated with a particular individual. This means that these measures also say nothing about the underemployment of individuals. For each of these measures, there may be further differences in the particular methodological assumptions (e.g. how many hours in a workday) and data collection (e.g. self-reporting by renewable energy companies) applied within a particular study. There are significant concerns from a range of different stakeholders about the integrity of data used in employment studies. Across quantitative studies, as suggested above, there is little connection to qualitative data for issues of employment quality or decent labour.

7.2 CURRENT EMPLOYMENT FIGURES, PATTERNS AND PROJECTIONS[7]

There are noteworthy trends that emerge regarding employment:

- The IRENA Renewable Energy and Jobs Annual Review 2023[8] reports that solar photovoltaic systems dominate the employment landscape, accounting for nearly 91% of renewable energy jobs across 17 African countries (see Figure 22).
- There is a stark contrast between small-scale embedded generation projects in countries like Nigeria, Kenya and Ghana, and large-scale utility projects in Egypt and South Africa. Wind energy employment is largely driven by utility-scale power plants, with Morocco and South Africa leading in total employment across wind GPNs. Morocco's higher job ratio per gigawatt of installed capacity is attributed to its rotor blade manufacturing facilities, which support both domestic and export markets. Despite varying estimates and projections, the potential for significant job creation in Africa's renewable energy sector is evident, with studies indicating substantial growth in employment as the continent transitions towards cleaner energy sources.

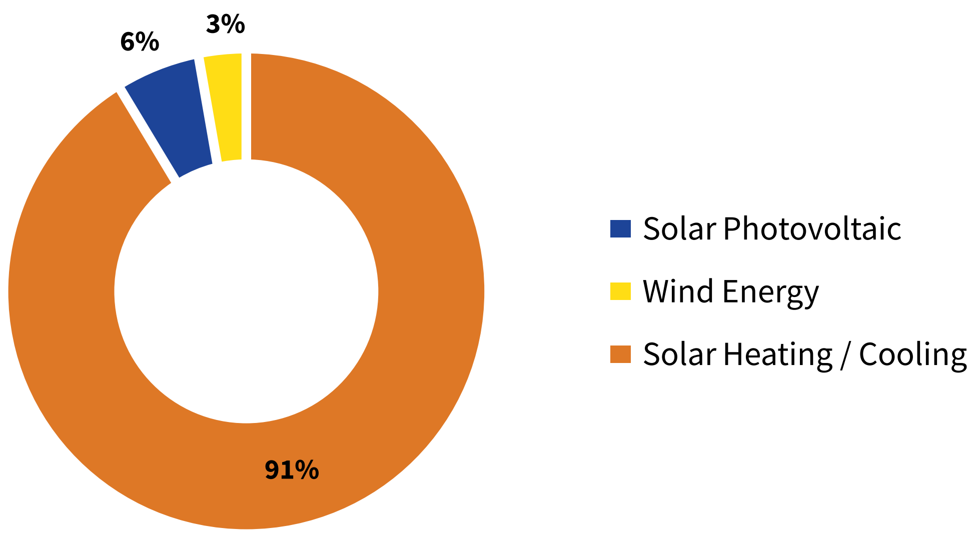
[7] An overview of concerns and efforts from organised labour will be included in version 2.0 of this document.

[8] The IRENA Renewable Energy Jobs Annual Review 2023 sourced its global data from national statistics, utility reports and various United Nations publications.

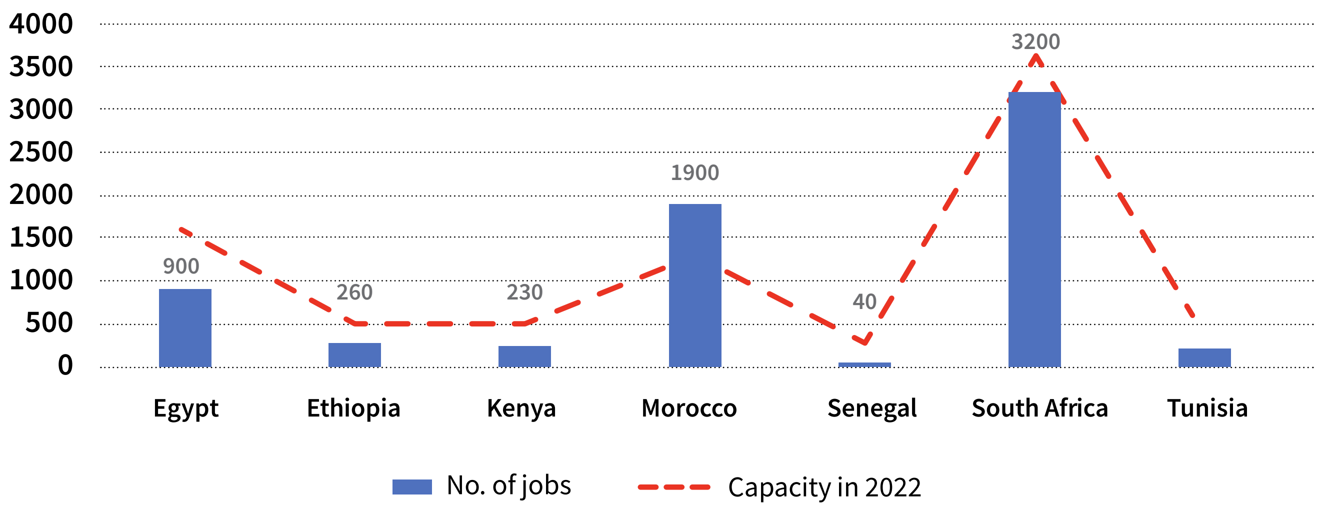
- In terms of headcount, the employment associated with solar photovoltaic systems constituted nearly 106 600 jobs across 17 African countries, representing a staggering 91% of the total employment in renewable energy (excluding biogas).
- The wind energy sector in Africa is predominantly steered by demand from utility-scale power plants. Consequently, employment figures closely mirror installed capacity. Morocco and South Africa emerge as leaders in total employment across wind GPNs.

However, Morocco achieves a higher ratio of jobs per GW of domestic capacity installed than South Africa. This can be attributed to the existence of Africa's sole rotor blade manufacturing facilities in Morocco, which bolster the export market. South Africa's localisation policies have fostered a domestic industry primarily geared towards fulfilling local demand, with notable success seen in tower construction and power transformers.

Figure 21: Wind and solar employment share in Africa in 2023



Source: IRENA and ILO, 2023c



Source: IRENA Annual Jobs Review 2023

Figure 21: Total estimated employment in wind energy sector across top 7 African states by domestic capacity

There is little consensus on the status quo regarding the extent of job opportunities in the renewable energy sector in Africa, and therefore it is difficult to compare the subsequent projections which accompany forecasts for net-zero pathways for various African states. Table 1 below summarises key studies and reports from reputable organisations, which attempt to estimate employment statistics for renewable energy technologies in Africa.

Table 1: Key literature estimating renewable energy sector employment statistics in Africa.

Source:	Description:	Key employment statistics:
Renewable Energy Market Analysis – Africa and its regions (IRENA and AfDB, 2022)	A report prepared by IRENA and AfDB which aims to provide modelling data and policy recommendations for Africa's energy transition.	Transition to renewable energy (RE) has the potential to create 9 million jobs from 2019 to 2030, and an additional 3 million up to 2050. Fossil fuel industry expected to employ 2.1 million less by 2030. Energy efficiency programmes could create up to 5.2 million jobs by 2030. Modelling projects increases in RE sector employment from 350 000 jobs in 2020 to 4 million by 2030, including 800 000 jobs in solar and 500 000 in wind.
Renewable Energy and Jobs Annual Review 2023 (IRENA and ILO, 2023)	A pioneering study developed, using field research collected from Kenya and Nigeria, Africa's largest distributed renewable energy (DRE) markets. The study evaluates the employment opportunities for small-scale renewable energy systems.	Pico-solar and standalone home solar jobs: Direct formal: 7 500 in Kenya, 11 000 in Nigeria. Direct informal: 15 000 in Kenya, 8 400 in Nigeria. Standalone solar and grid-tied commercial and industrial: Direct formal: 1 800 in Kenya, 2 700 in Nigeria. Direct informal: 200 in Kenya, 390 in Nigeria. Mini-grid: Direct formal: 260 in Kenya, 120 in Nigeria. Direct informal: 290 in Kenya, 9 in Nigeria. Women's participation in DRE workforce: 23% in Kenya, 27% in Nigeria
Power Jobs Census 2022 – The Energy Access Workforce (Power for All, 2022)	An annual report prepared by Power for All, which acts as a census for employment created by decentralised energy resources across Ethiopia, India, Kenya, Nigeria and Uganda. Pico-solar systems, solar home systems (SHS), mini-grids and standalone commercial and industrial (C&I) solar systems were surveyed.	DRE direct jobs: 49 572 in Nigeria, 48 280 in Kenya, 29 736 in Uganda, 14 335 in Ethiopia. Kenya direct jobs in DRE significantly outnumber utility workers (8 000) in Kenya Power and Lighting Company, by headcount. Women's participation in DRE: 35% in Nigeria, 41% in Kenya, 28% in Uganda, 37% in Ethiopia. Levels of informal jobs: 17% in Ethiopia, 19% in Uganda.

Source:	Description:	Key employment statistics:
World Energy Employment 2023 (International Energy Agency, 2023)	An annual report prepared by the International Energy Association, providing a comprehensive stock-take of energy employment, with estimates of the size and distribution of the labour force across regions, sectors and technologies (2023 Edition).	Under the STEPS scenario, Africa has 3% of global solar PV employment by 2030. Employment in Africa by 2019: 500 000 in grids, 400 000 in generation, 400 000 in energy efficiency.

Regarding gender, various studies have projected and promoted increased employment opportunities for women in wind and solar, as compared to other energy value chains (IRENA, 2019). Consecutive reports by talent recruitment agency, Shortlist, funded by the Global Energy Alliance for People and Planet (GEAPP), note that existing employment in renewable energy jobs is still male-dominated (Zollmann and Remerscheid, 2023; Remerscheid and Kotecha, 2024). According to these reports, women hold only 32% of full-time jobs in the clean energy sector globally, with significant underrepresentation in technical and engineering roles. In renewable energy companies across sub-Saharan Africa, women hold only 25% of leadership positions and 26% of middle and lower management roles (Remerscheid and Kotecha, 2024).

Industry surveys and research reports, compiled by entities such as GEAPP, Global Women's Network for the Energy Transition (GWNET), and Women in Renewable Energy (WiRE), identify key issues of underrepresentation in women’s employment and presence in leadership roles in the sector. In order to help bring gender parity in the workplace, a growing list of professional associations and non-governmental organisation (NGO) initiatives are attempting to provide workforce development support, mentorship, and to amplify job opportunities to networks of women in the renewable energy sector. Gender studies include a mixture of qualitative data obtained from industry surveys and national and international statistics. The patterns of poor transparency found in reports to governments of sector employment clearly negatively impact these organisations’ ability to hold the existing industry accountable for the perpetuation of the gender gap in workplaces, to challenge existing social norms, and to address ingrained biases relating to gender, and existing structural inequalities between employees.

SECTION EIGHT: FINDINGS AND QUESTIONS FOR FURTHER INVESTIGATION

SECTION EIGHT: FINDINGS AND QUESTIONS FOR FURTHER INVESTIGATION

To understand the potential role of renewable energy in creating localisation opportunities in Africa, it is necessary to contextualise this potential within the current reality of electricity systems. This report has sought to do this by delineating the main current features and trends shaping the sustainable energy transition across the African continent.

In so doing, it establishes an empirical foundation that supports the broader project, 'A Just Energy Transition: Localisation, Decent Work, SMMEs and Sustainable Livelihoods', and sets the stage for further exploration into opportunities for localisation, work, SMME opportunities and gender inclusivity. To this end, it is useful to end by surfacing several salient implications of the issues covered:

Just energy transitions are prioritised in high-level policy, but knowledge, policy and implementation gaps persist.

01 Data gaps are a hindrance to policymaking that is appropriate to country-specific, regional and continental policy and cooperation for the just transition. While it is known that energy access and energy poverty are significant issues, and energy is a constraint on industrialisation, without more and better quality data, it is not possible to properly plan for a just energy transition. Additionally, given the proliferation of external knowledge generation for the continent's transition, the extent to which this knowledge adequately addresses the knowledge gaps related to locally determined goals has to be questioned. As this research progresses, it aims to address specific gaps in qualitative information on workers and labour, as well as localisation.

02 A just energy transition for Africa is integrated into African Union policy for the continent, as well as national-level policy. However, there is, expectedly, considerable diversity in what the just energy transition means, as well as the extent of prioritisation of energy access issues versus green industrialisation. Nonetheless, several countries have significant policy gaps and implementation gaps that require more detailed country-level analysis.

03 In terms of market structure, regardless of whether private generation is allowed, utilities are still important actors to consider in transition planning. The degree of allowed and actual private participation in country-level electricity systems is also important for finance planning.

Energy consumption is limited and uneven across countries, constrained by limited generation as well as transmission and distribution networks in most African countries.

04 In terms of consumption levels, with a few notable exceptions (including one of the project cases, South Africa), there is limited electricity consumption, hampered by issues of access, generation levels, affordability, and more. The emphasis in most countries, therefore, is on building electricity systems that meet the development needs of those countries and are aligned with national policy, international climate change commitments, and several different dimensions of sustainable development. The latter includes electricity for household use, as well as public infrastructure and business consumption.

05 There is significant potential for increasing renewable energy generation. According to the African Development Bank, the continent's total electricity generation capacity is 245GW, reflecting a 50% increase since 2015. However, the WRI Global Power Plant Database estimated Africa's installed capacity in 2021 to be 157GW, with 38 of 54 countries having less than 1GW capacity each. This data often excludes mini-grid and small-scale embedded generation, which are increasingly important for meeting electrification goals. While wind, geothermal, and nuclear energy projects exist, they are not widely adopted. High-capacity plants often underperform due to a lack of maintenance and skills shortages. Traditional biomass remains heavily relied upon, especially in sub-Saharan Africa, where 80% of cooking fuel comes from solid biomass. The diversity in energy generation and mix among African countries is pronounced, and so, therefore, is the implicit transition pathway available and appropriate for each country.

06 Transmission and distribution infrastructure is crucial for providing electricity to household, commercial and industrial users. However, there has been insufficient investment in enhancing and expanding these electricity networks, particularly in transmission and distribution. As a result, they often fail to adequately support the energy and economic development goals of governments.

Energy investment is far lower than in any other region, and most of the current investment is in generation

07 Whatever the estimate for required investment for just energy transitions, more detailed national and regional plans will need to be integrated with industrialisation planning, to identify realistic estimates, as well as effective instruments, to meet these needs. In 2021, Africa accounted for only 0.6% ($2.6 billion) of the $434 billion global investment in renewable energy. More than half of renewable energy investment is from the private sector, with the potential for increased private equity through concessional finance. The investment is predominantly from international sources and is unevenly distributed, with Egypt, Kenya, Morocco, Nigeria and South Africa receiving the majority.

08 Risk perceptions are a significant barrier to investment; they are related to knowledge-generation gaps but not entirely explained by these gaps.

In terms of energy GPNs, this paper highlighted both solar and wind GPNs, noting their differences as well as the need for public-private cooperation to harness opportunities in both.

- The solar PV sector has made significant advances, finding applications in diverse settings, from household installations to large-scale utility plants. However, the concentration of PV manufacturing jobs in a few select countries underscores the importance of strategic supply chain management and domestic industrial policies. Notably, analysing competitive module rates among various African nations highlights the potential for localised manufacturing to improve cost competitiveness and drive job growth. In contrast, localising the wind energy value chain poses unique challenges, due to the specific requirements of wind power plants, and the complexities of their construction and operation.

- Despite recognising the abundant wind resources in several African states, realising wind energy projects requires substantial investment in infrastructure and supply chain development. The example of Morocco's rotor blade manufacturing plant illustrates both the opportunities for, and obstacles to, localising wind energy manufacturing capabilities, especially given shifting market dynamics and global economic uncertainties.

- As nations transition towards cleaner energy sources, strategic collaborations between governments, industry stakeholders, and international partners will be essential for maximising the potential of renewable energy, driving sustainable economic growth and fostering job creation.

The extent to which opportunities in solar or wind GPNs can be harnessed and sustained varies significantly between countries.

- Ambitions should be contextualised, with reference to China's notable dominance. This is not to say that there are no opportunities. However, they are limited and severely constrained. Nonetheless, where they exist, they should be interrogated for alignment to all sustainable development ambitions within countries, and just transition considerations at all scales.

- Additionally, where there are cases of localisation, these tend to be in partnership with Chinese OEMs. Therefore, consideration of options for collaboration through bilateral and regional multilateral efforts is essential for navigating the current landscape of opportunity.

In summary, Africa has the potential for the localisation of renewable energy, but this potential varies greatly across different countries and is influenced by systemic challenges. The continent has abundant renewable resources, such as solar, wind and hydro, which can be harnessed to meet local energy needs and support economic development. However, the realisation of this potential is uneven, due to disparities in infrastructure, investment, and technical capacity. Countries like South Africa, Kenya and Morocco have made strides in renewable energy deployment, benefiting from relatively better-developed infrastructure, favourable policies, and international investment. In contrast, other nations face obstacles, such as limited access to finance, inadequate grid infrastructure, and policy uncertainty, which hinder their ability to fully exploit their renewable energy resources. Additionally, integrating renewable energy into existing energy systems requires overcoming challenges related to grid stability and energy storage. Addressing these systemic issues is crucial for enabling a just and sustainable energy transition that can leverage the continent's renewable energy potential equitably across all regions.

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