DISCUSSION PAPER

Powering Progress?
China's Role in Shaping Africa's Energy Infrastructure

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Introduction

Africa faces the lowest energy access rates globally, presenting a unique challenge: building its energy infrastructure during a worldwide climate crisis for which it holds minimal responsibility. Addressing this energy shortfall requires tapping into a variety of resources, notably the continent's rich renewable sources and natural gas, deemed the least damaging fossil fuel to the environment (Chandler, 2022).

Despite Africa's considerable energy potential, its electricity demand remains largely unmet. The continent only utilizes a small portion of its available hydropower, wind, and solar resources. By 2050, significant growth is anticipated in the gas market. However, Africa needs an estimated $35 billion to $50 billion in energy financing to meet the United Nations' seventh Sustainable Development Goal, which aims for affordable and clean energy access. While African governments and global financiers have made some energy investments, the continent receives less than 5% of worldwide energy investment (Moses, 2023).

China is notably influential in the rapid transformation of Africa's energy sector. As Chinese President Xi Jinping has observed, "Inadequate infrastructure is the biggest bottleneck to Africa's development." From this perspective, Africa's urgent need is infrastructure development, an area where China possesses considerable expertise. Africa, seeking infrastructure-led economic growth similar to China's experience, is increasingly looking to China for guidance and assistance in this field (Shepard, 2019).

Beyond its involvement in oil and gas, China is also tapping into Africa's clean energy potential, which could significantly increase electrification rates while promoting resource conservation and climate sustainability. However, the expansion of renewable energy is impeded by technological and financial challenges, often restricted by limited funds and technological know-how.

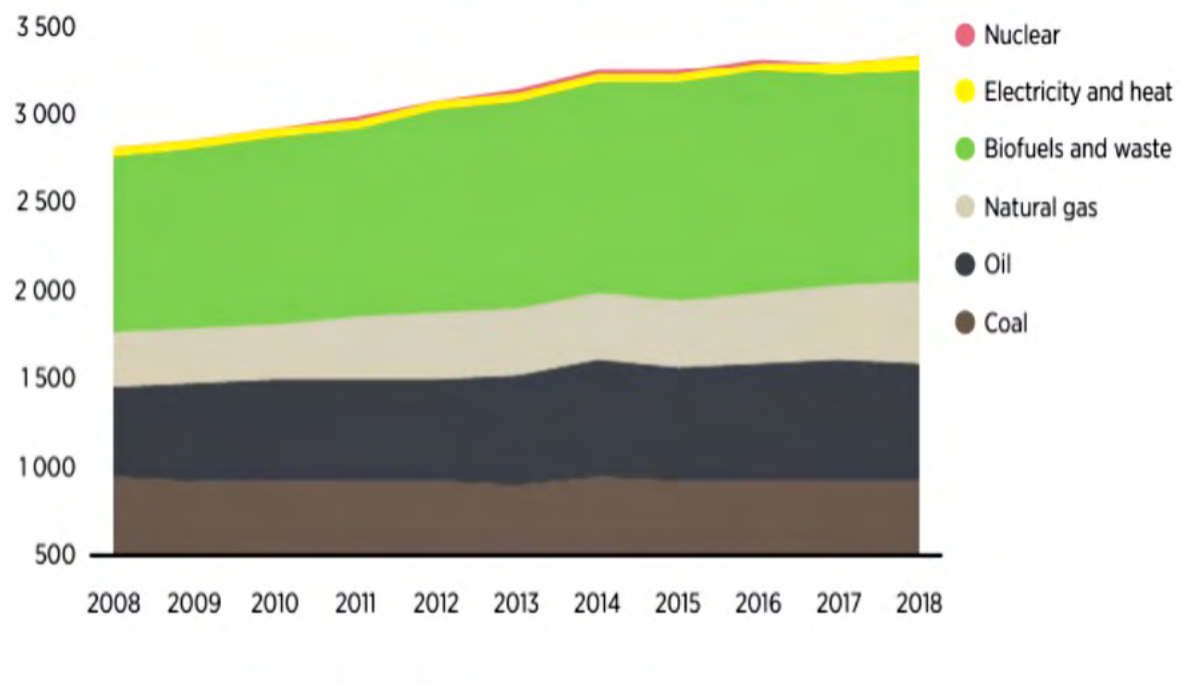
China could play a pivotal role in bridging this gap, potentially spurring the development of renewable energy in Africa (Conrad et al., 2011). Despite this, renewables alone cannot yet provide large-scale, consistent energy supply due to their intermittent nature. Therefore, significant technological advancements and investments are necessary until this goal is achieved, with natural gas acting as an interim solution in Africa (Deloitte, 2022). Consequently, the sporadic nature of energy in Africa highlights the challenges of accessibility, affordability, and sustainability in achieving energy security. The extent of China's current and potential contributions to resolving these issues remains a topic for further discussion.

Africa's Energy Landscape

Primary energy supply in Africa has increased at a compound annual rate of around 2% over the past decade, covering the years 2008 to 2018, thanks to the increased oil and natural gas production alongside bioenergy. Bioenergy and waste constitute the most commonly used sources of energy supply, whereby bioenergy has become a critical source, particularly for household cooking. Yet, wood is still a primary source of bioenergy in most of Sub-Saharan Africa, where its use for household energy corresponds to 90% of Africa's wood consumption. Sub-Saharan Africa's large dependence on wood poses a great environmental issue, and it contributes to deforestation and forest degradation in Africa on top of health problems resulting from incomplete combustion in traditional stoves, especially affecting women and children in the forefront (IRENA & AfDB, 2022).

Wood-based fuels are the primary source of household energy for valid reasons: wood and charcoal are relatively affordable, and traditional stoves are nearly without cost. In addition, they remain reliable sources as they are available throughout the year and can be stored conveniently. Traditional energy sources are preferred due to cooking habits, available kitchen utensils, neglect of health concerns, and other behavioural factors. Even with subsidies, alternative energy sources like liquefied petroleum gas (LPG) face challenges competing with wood-based energy. Its concentration remains on high- and middle-income households, which often use wood-based energy (Hoffman et al., 2016).

Figure 1: **Total Primary Energy Supply (PJ)**



Note: PJ = petajoule.

Source: UNSD, 2018

Oil comes second as the most widely used source of primary energy, particularly in the transport, industry and power sectors, alongside natural gas, owing to countries possessing domestic gas, such as Algeria, Libya and Nigeria. On the other hand, Southern Africa is deficient in sufficient gas resources and, therefore, traditionally relies on coal for power generation as it has its own coal-mining industries.

In this regard, coal, natural gas and oil comprised 77% of Africa's total electricity generation in 2019. South Africa, Egypt, Algeria and Nigeria are key players in this regard, while the continent's coal supply predominantly goes to South Africa. Among African nations, only South Africa presently generates nuclear power. Over the last decade, electricity production on the continent has grown by approximately 25%. This growth is primarily attributed to new natural gas-based power generation and significant growth in renewable energy, albeit in modest numbers when it comes to solar, wind, geothermal and modern bioenergy, except for hydropower. This low rate comes against the backdrop of Africa's vast renewable energy potential (IRENA & AfDB, 2022).

As a result, coal, oil, and natural gas are employed to fulfil the surging energy requirements on the continent. Despite relying heavily on these conventional sources for generating electricity, most countries still lack energy resources (Mukhtar et al., 2023). Indeed, it is paradoxical that, despite the abundant potential in annual solar radiation and wind power compared to other developing nations, the continent's overall energy generation from these sources remains inadequate. While various challenges and risks may contribute to this situation, it is essential to unlock the maximum potential of renewable sources to power the continent (Ogunniyi & Pienaar, 2019) due to its feasibility for energy security encompassing the elements of accessibility, affordability and sustainability necessary for Africa's energy future.

On the other hand, it is argued that given this nexus, while the widely acknowledged ultimate objective is to completely replace fossil fuels, there is a compelling argument for initiating the transition by substituting coal with natural gas, particularly when it comes to baseload-generating capacity. Compared to coal, it is still a viable alternative in the transition phase as a bridge between coal and renewable energy because African nations need to grow their generation capacity, and burning gas creates fewer local pollutants than coal – nearly half as much of CO2 per unit of energy. However, gas-fired generation still emits greenhouse gases and may draw away investments from renewable energy projects (Hodder & Richards, 2022). However, it is imperative to recognise that Africa's energy composition includes a mere 5% contribution from natural gas, yet nearly half of its 55 nations possess confirmed reserves of this resource. Africa needs a fresh perspective that envisions an extensive network of natural gas pipelines crisscrossing the continent to deliver energy to every corner. On top of Africa's modest contribution to global greenhouse gas emissions, leveraging the region's natural gas reserves could only lead to a slight increase.

Moreover, a significant opportunity exists to transition impoverished Africans from biomass fuel usage and safeguard the region's forests by introducing compact, liquefied petroleum gas (LPG) stoves. While climate change poses a concern in Africa, addressing poverty is an even more pressing issue, as it remains the primary cause of mortality on the continent today (African Energy Chamber, 2023). Therefore, when it comes especially to energy, the burden should not be borne by Africa, but rather, there should be a fair and equitable assessment in addressing Africa's energy needs, which is inextricably linked with the continent's development.

In this respect, accessibility, affordability and sustainability are Africa's energy objectives as entrenched in the seventh goal of the United Nations Sustainable Development Goals (SDG 7) to be achieved by 2030. In Africa, SDG 7 necessitates linking 90 million people annually to electricity by 2030 and moving 130 million people annually into using clean cooking fuels (Marais & Spangenberg, 2023), excluding broader factors. This indicates the sheer scale of responsibility to be undertaken. Regarding accessibility, the main challenge remains the availability of national power grids – whose rollout has stalled. Although programmes such as Power Africa[1] and Sustainable Energy for All[2]

[1] "A U.S. Government-led partnership, Power Africa convenes the collective resources of the private sector, international development organisations, and governments from around the world to increase energy access and to end energy poverty in sub-Saharan Africa" (USAID, n.d.).
[2] The UN Secretary General's Sustainable Energy for All (SE4All) initiative was launched in September 2011, indicating three main goals to be reached by 2030: ensuring universal access to modern energy services, doubling the global rate of improvement in energy efficiency, and doubling the share of renewable energy in the global energy mix (SE4All Africa Hub, 2015).

have aimed to address what the African Development Bank also tried to achieve – speeding up the supply of electricity – along with the New Deal on Energy for Africa[3], the reality on the ground points to a grim observation.

According to a survey, it was discovered that, on average, approximately two-thirds (65%) of citizens resided in areas covered by an electric grid. This figure closely mirrored the results of a survey conducted three years prior. The accessibility to an electric grid exhibited significant variations among countries. While almost all Cabo Verdeans, Mauritians, and Tunisians lived in areas served by a grid, less than one-third of citizens in Burkina Faso (28%), Madagascar (29%), Mali (30%), Guinea (32%), and Liberia (33%) had similar access. Stark regional disparities were also identified: approximately nine out of 10 North and Central Africans lived in areas served by an electric grid (91% and 86%, respectively), while only about half (55%) of East Africans did.

Regarding progress tracking, East Africa stood out as the sole region where significant advancements were observed. However, being connected did not ensure a consistent power supply, as power cuts persisted in certain countries. All in all, factoring in households with no access to a grid, no connection to an existing grid, or an unreliable supply, only 43% of Africans had access to a dependable electricity supply (Logan, 2020).

Regardless of this breakdown, Sub-Saharan Africa is particularly strained with substantially lower electricity access than it could be. The picture is bleaker considering the income levels, electric grid footprint, and the growing population outpacing the growth of electrification. Contradictory to the common understanding, the root causes lie in demand-side problems as much as those on the supply side. To render the expansion of electricity financially viable and attract investment, there is a need for higher uptake and utilisation. For instance, connecting all households within reach of the electrical grid could substantially increase access rates, exceeding 60 per cent on average in Africa and nearly doubling the current rate in many countries.

The question that arises is why these households are not connected and what incentives would prompt their connection. This scenario underlines the need for a more profound understanding of the demand-side constraints affecting uptake. The reluctance to connect is undoubtedly influenced by the maximum amount people are keen to pay. For instance, in Rwanda, when households were presented with three price and payment options, 88 per cent declined all of them. Analysing the results based on various social and economic factors revealed consistently low uptake across all the groups.

Similarly, in Liberia, willingness to pay dropped from 90 per cent to 60 per cent when connection charges went from zero to $10, and it plummeted to about 10 per cent when proposed connection charges exceeded $50 (Blimpo & Cosgrove-Davies, 2019). Therefore, poverty and energy access feed into each other, whereby the energy access problem cannot be solved without mitigating poverty or vice versa. The demand constraints are a symptom of more deep-rooted structural problems to low access, the solution to which relies on affordability and sustainability as well. These challenges encompass standardised and insufficiently adaptable connection requirements and processes that fail to alleviate the constraints faced by the economically disadvantaged; the application process involves prolonged waiting periods, frequently surpassing ten weeks; and despite the perception of a fixed connection cost, notable discrepancies exist among households within the same country, especially when factoring in wiring and transaction expenses.

For households with irregular income streams, the consistent payment of even a modest amount can pose a significant challenge. Also, electricity connection through conventional alternating current supply necessitates minimum building standards. Most houses do not abide by these standards, making coordination for building permits even more vital (Blimpo & Cosgrove-Davies, 2019). Access is interlinked not only with the presence of electricity grids but also with the connection and reliability of those grids on the part of households. Africa faces the highest electricity costs globally, yet regulated tariffs frequently fall below the levels necessary for cost recovery, exacerbating challenges in ensuring reliability.

The limitations on maintenance and required investments further impede the provision of dependable services. Reliable electricity can contribute to higher uptake, and countries with high

[3] In 2016, the African Development Bank launched the New Deal on Energy for Africa (NDEA), a partnership-driven effort to achieve universal access to electricity in Africa by 2025. A key element of the New Deal is mobilising private and public sector engagement in the African energy sector (Africa Energy Portal, n.d.)

uptake are prone to offer more reliability. Therefore, prioritising investment in reliability is crucial, as poor service quality significantly hinders economic impact. Perceived service quality may be worse than anticipated, with variations reflecting income inequality. Inadequate quality constrains the economic impact of electricity even with other complementary factors in place – the effect on firms' revenue is by no means non-trivial since a percentage point increase in outage frequency results in a 2.7 per cent loss in firm revenue (Blimpo & Cosgrove-Davies, 2019).

Thus, affordability comes into the picture, through which the uptake could be effectively improved by solving demand and supply-side constraints. Achieving energy efficiency is one of the ways to ensure this. Renewable energy sources might contribute to building resilience to volatile prices and lower energy costs, particularly against the backdrop of the war in Ukraine, which is debilitating low-income energy-importing countries.

Historically, fossil fuels were cost-effective, making it challenging for both countries and individuals to invest upfront in new clean energy infrastructure. In developing countries, the absence of access to finance under reasonable terms renders the expensive initial investments in renewable energy financially unattainable. To attract essential private financing, developing countries must initiate large-scale renewable infrastructure projects that guarantee a return on investment while maintaining affordability for consumers, including the most economically disadvantaged (Papathanasiou, 2022).

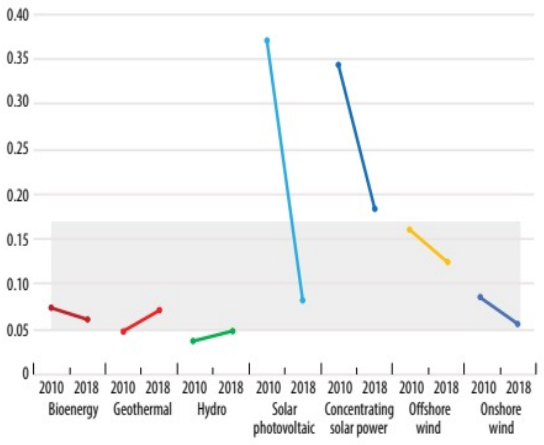
Energy efficiency alleviates strain on national grid systems by liberating limited public resources and energy production capacity. It also diminishes countries' dependence on fossil fuel imports, providing energy to underserved sectors and populations (IEA, 2022). There are already positive developments observed on this front: Morocco has implemented renewable energy projects, currently constituting nearly 40 per cent of its installed energy capacity, to surpass 50 per cent by 2030. Morocco boasts the world's largest concentrated solar power plant, the Noor Ouarzazate Solar Complex, spanning 3,000 hectares in the desert and boasting an overall capacity of 580 MW (Papathanasiou, 2022).

Improved efficiency could enhance the security of supply as electrification rates increase and minimise exposure to the volatile energy process of imported fuels, thereby optimising power production and consumption as well as alleviating the pressure of peak demand. This could happen through regulations, information and incentives, such as Minimum Energy Performance Standards (MEPS) for appliances and buildings, and grants, rebates, auctions, tax incentives, low-interest loans, on-bill finance, floor-space incentives or recognition programmes – all of which can lead to a 'pull factor' to incentivise consumers to draw on these products and services. Kenya has taken robust steps to become the EV hub in the greater Horn of Africa. In recent years, Kenya has implemented measures to transition to cleaner transport systems, including enforcing an 8-year maximum age limit for used car imports. Similarly, Ethiopia raised excise taxes on used car imports in 2020 and plans to phase out such imports by 2026, favouring local car assembly manufacturers (IEA, 2022).

Figure 2: Getting Cheaper

The cost of generating electricity using renewable sources declined sharply from 2010 to 2018 and is now in the same range ($0.05 to $0.17 a kilowatt hour) as fossil-fuel-fired power generation.

(2018 US dollars a kilowatt hour)



Note: The fossil-fuel-fired power generation cost range for Group of Twenty countries between 2010 and 2017 was estimated to be between $0.05 and $0.17 a kilowatt hour, according to IRENA. We assume the same fossil-fuel-fired power generation cost range in 2018.

Source: International Renewable Energy Agency (IRENA), Renewable Cost Database (2019).

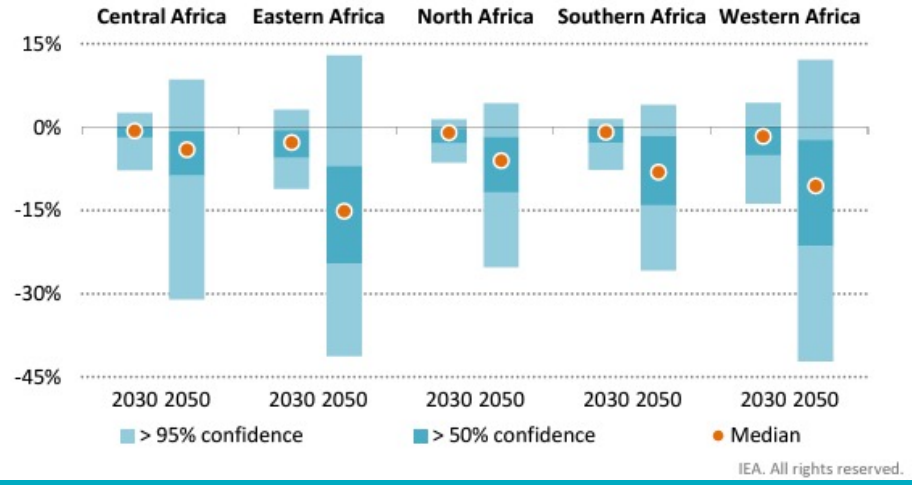
However, realistically speaking, not all countries can secure such a transition financially in the short term for guaranteed efficiency. There is insufficient infrastructure, and many African countries cannot access finance because of perceptions of high risk and low creditworthiness (Ntoubia, 2023). Whether Africa can leapfrog to electricity depends on the government's ability to coordinate and extend reliable grid access to meet energy needs.

Although in the past decade, the increased availability and affordability of small-scale renewables, particularly solar panels, have led advocates to highlight their potential in enabling ordinary Africans to leapfrog towards improved energy access and potentially drive post-COVID-19 economic recovery, critics argue that expanding individualised micro-system connections is an imperfect solution for meeting Africa's energy needs. Unlike mobile phones, solar panels remain too expensive for the poorest households, and achieving economies of scale is more challenging than centralised power grids. Also, factoring in schools, hospitals, and businesses, localised micro-power sources are not sufficient (Logan & Han, 2022). This type of leap without following the Western experience has occurred in information and communication technology in Africa, where individuals bypassed network-based telephone technology and directly adopted mobile technology.

Consequently, unique mobile phone-based services have emerged in Africa that were not present elsewhere (Koskimäki, 2012). Yet, it is argued that "the supposed analogy between cell phones and distributed solar is misplaced" due to cost, benefits of centralised networks, actual development goals, and quality in comparing distributed solar with cell phones. Catherine Wolfram argues that the notion of energy leapfrogging may divert attention from the challenging trade-offs between development and the environment when extending electricity and improved energy services to those without access. She suggests that modern energy can be transformative, and it is unfair to require households without electricity to adopt high-cost, zero-carbon alternatives. Instead of discussing energy leapfrogging, the focus should remain on achieving cost-effective, low-carbon solutions (Moss, 2014).

Interlinked with this is the sustainability issue, which again brings up a shift to more efficient and cleaner technologies. "Climate change could undo even the little progress most African countries have achieved so far in terms of development," and the rise in climate change has brought about a surge in health issues like malaria, meningitis, and dengue fever, requiring these poor countries to allocate their limited resources to address successive health crises. Consequently, funds that could have been directed towards crucial projects for economic development must now be redirected to emergency healthcare (Fields, 2005), intensifying the energy supply problem, which cannot be considered separately from economic development.

Figure 3: Climate-related impacts on GDP per capita by region in Africa, 2030 and 2050



A temperature rise of 2 ˚C in 2050 would reduce median GDP per capita by 4-15%, but there is a higher than one-in-four chance of a 20% reduction in East Africa and West Africa

Notes: Impacts based on representative concentration pathway 8.5 which has a median temperature rise of around 2 ˚C in 2050, in line with that in the STEP. Impacts are relative to a baseline without climate change.

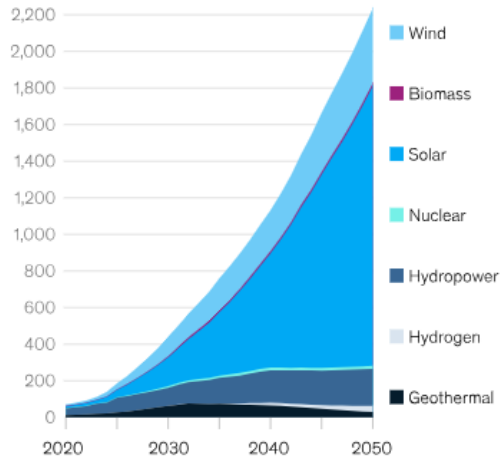
Source: Baarsch et al.(2020); UNECA and African Development Bank, (2019)

(Minasse Wondimu Hailu - Anadolu Agency)

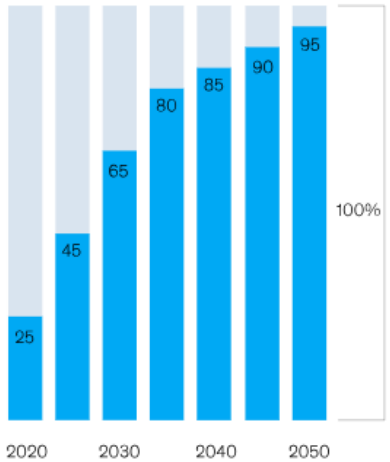
Renewables will assume a more significant role in a progressive manner – to reach 65 per cent of installed capacity by 2030 and almost 95 per cent by 2050, as expected. However, around $2.9 trillion of cumulative capital spending would be necessary between 2022 and 2050, mostly going to green resources to enable dramatic shifts. While the surge in renewables is anticipated to accelerate in 2030, financial institutions have a chance to position themselves early. By investing in the African green-energy transition at an early stage, these institutions can secure a lasting presence and foster the required competencies. Some investors are already taking steps in this direction, and funding is starting to catalyse substantial green-energy projects on the continent. In this regard, however, as mentioned, gas could act as a catalyst to forge a bridge until 2030 and is expected to fall afterwards in use as renewables are scaled up and battery storage becomes more cost-effective (Augier et al., 2023).

Figure 4

Projected installed renewable power capacity,[1] gigawatts



Projected installed renewable power,[2] % share of renewables



[1] In Africa in Achieved Commitments scenario.
[2] Includes solar, wind, hydropwer, biomass, nuclear, geotermal and hydrogen-fired gas turbines.

Source: Experts interviews; Global Energy Perspective 2022, McKinsey Energy Insights; McKinsey Power Solutions

Nations with access to affordable domestic or imported natural gas are likely to opt for gas-to-power solutions for baseload electricity, and the IEA notes that Africa is the world's fastest-growing natural gas producer, with average output growth of five to six per cent annually. By 2025, Africa's natural gas supply is projected to rise by 15 per cent, reaching an estimated 295 billion cubic meters per year (Deloitte, 2022). It can also contribute to circumventing the supply fluctuation in renewables.

However, technological advances such as using hydropower as a buffer during periods of peak demand, pooling electricity production from different geographic regions through a well-connected electricity grid, adjusting electricity demand to supply, and storing energy with flow batteries and hydrogen electrolysis are available. They can be adopted when there is an increased share of renewables in total production (Sy & Schweroff, 2020).

In addition, detecting the most efficient use of natural gas can promote an increased amount of renewable energy penetration in electricity systems, whereby enabling the integration of utility-scale solar into flexible grids as happened in Thailand, Brunei, and Singapore, in which natural gas for electricity generation has paved the way for investments in solar and offshore wind generation. A spinning reserve system enabled by natural gas provides a nearly instantaneous basis in times of unbalanced supply and demand (Deloitte, 2022). Therefore, it further reinforces the necessity of this two-pronged approach.

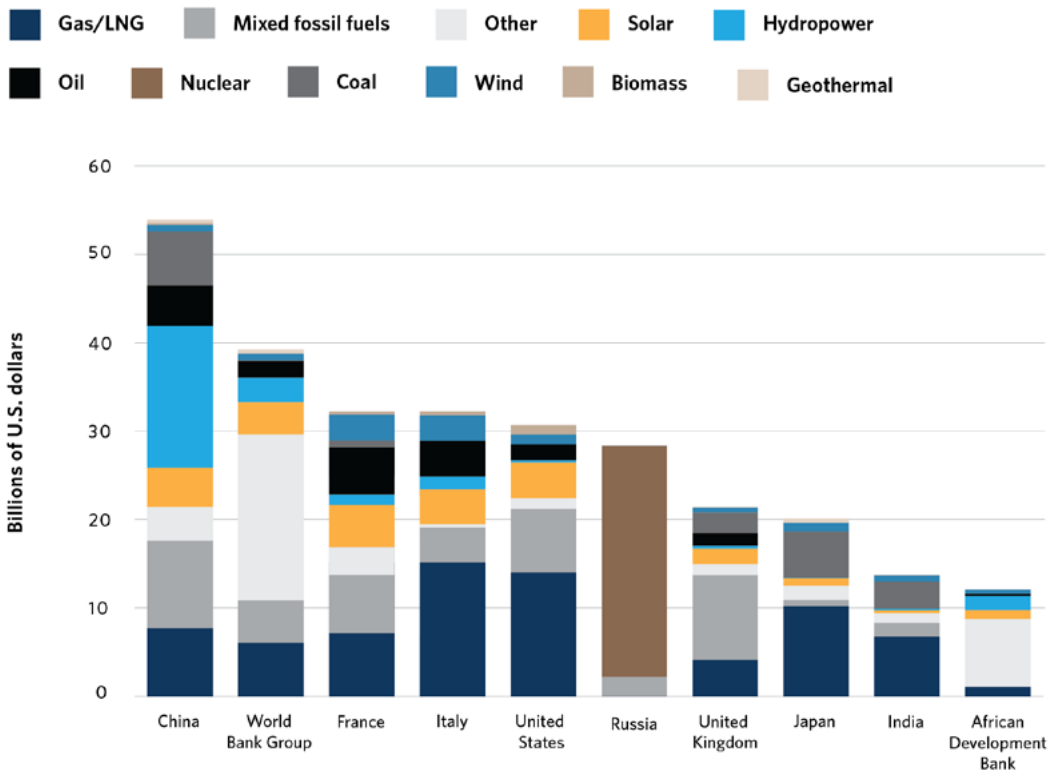
China's Role in Africa's Energy Transition

African leaders and policymakers aspire to capitalise on the continent's energy resource potential, driving a substantial demand for energy finance. While African governments and international financiers have contributed to energy investments, the continent still attracts less than 5 per cent of global energy investment. Energy finance to Africa exhibited uneven distribution among recipient countries, with the top ten receiving the majority ($267.40 billion, or 77 per cent).

In descending order, these countries are Egypt, Mozambique, Nigeria, South Africa, Angola, Morocco, Ghana, Uganda, Kenya, and Ethiopia. The financing was predominantly provided by ten major bilateral and multilateral financiers ($283.84 billion, or 82 per cent). In decreasing order, these financiers are China, the World Bank Group, Italy, France, the United States, Russia, the United Kingdom, Japan, India, and the African Development Bank (AfDB).

These countries not only feature active public finance institutions but also benefit from substantial contributions from major corporations in their fossil fuel sectors, amplifying the total finance committed to the continent. Most of the top ten financiers supported a diverse range of sectors, though there were a few exceptions. China encouraged all energy sources except nuclear, while Russia primarily supported mixed fossil fuel sectors and allocated significant public finance for a nuclear project in Egypt. All examined countries, excluding Russia, extended support for solar projects. Energy finance reached its peak in 2015, two years after China announced the Belt and Road Initiative (Moses, 2023), which can be indicative of China's ambitions in the region, even though there were other contributing factors, including the Paris Agreement.

Figure 5: Top Ten Providers of Energy Finance to Africa by Energy Source



Note: Data are for the 2012-2021 period.

Source: Carnegie Endowment for International Peace, 2023.

As evident from the data, China has been increasingly prominent in Africa's highly needed energy transition, principally through implementing energy infrastructure projects in the past two decades, leading it to be in the first position. Various drivers affect Chinese investments in diverse energy sectors, mainly revolving around the development of finance institutions and state-owned enterprises (SOEs) against the backdrop of the retreat of state ministries in sectoral planning and project-level approval.

One of the main findings is that a substantial portion of Chinese development finance does not strictly adhere to OECD foreign aid criteria; instead, these loans function more like commercial finance. While financial viability is not the sole determinant of lending decisions, the evaluation criteria of Chinese policy banks, as highlighted in public speeches by former CHEXIM bank presidents, differs from traditional Western financial institutions. Chinese policy banks prioritise the overall and long-term contributions of infrastructure projects to the development of recipient countries rather than immediate financial returns.

Additionally, an often-overlooked aspect is that SINOSURE's export credit insurance services cover a significant portion of CHEXIM and CDB loan portfolios for high-risk countries and sectors, amplifying Chinese banks' risk appetite for such projects. (Shen, 2020). Given the scale of Chinese investments and loans, one of the main dilemmas for African countries that aspire to improve their infrastructure is how to pay back.

China has long faced accusations of debt trap diplomacy and vote buying. Detractors have often considered Beijing's intentions dubious, claiming that the latter

intends to exploit Africa as much as possible. Analysts have argued that key energy investment recipients have consistently aligned with China at the UN. Notably, Nigeria aligns with China 76% of the time, Egypt 75%, and Algeria 79%. In a recent instance, the UN Human Rights Council rejected a motion led by Western nations to discuss China's alleged human rights abuses. Several emerging oil-producing nations supported Beijing, including Cameroon, Cote d'Ivoire, Gabon, Namibia, Mauritania, Senegal, and Sudan. Beyond diplomacy, Chinese oil and gas investments are suggested to be driven by current needs and strategies for securing future energy supplies (Mitchell, 2023).

Although China leveraged existing relations with politicians of other states to its advantage, a move typical of any country in a similar position, the claims of debt trap diplomacy to burden borrowing countries with debt to acquire strategic assets are largely unbacked. This is evident from various Chinese actions that contradicted potential strategic gains. For instance, amidst the COVID-19 pandemic, China delayed Kenyan debt payments by six months, slightly reduced Maldivian debt for the same reason, and decreased Malaysian debt by a third. In each case, China could demand debt repayment in exchange for strategic assets but chose not to. Additionally, there is no evidence of acquiring non-material assets, such as increased influence in the internal affairs of borrowing states, as per one study (Himmer & Rod, 2022).

Chinese activities in Africa may be part of a broader strategic engagement rather than a mere aspiration to establish a currency of relations as the West is doing, according to Deborah Bräutigam. China is following in the footsteps of Japan in that, coming out of the turbulent Cultural Revolution, Chinese leaders recognised the imperative for modern technologies. They understood the necessity of boosting natural resource exports to finance these technological imports. Japan initially offered a model of projects financed through a line of credit with deferred repayment in resources, which was crucial in advancing China's modernisation programme. The current system of using commodities as collateral for a commercial line of credit allows a country to fund a specific investment immediately and defer payment until later to use future earnings. Securing the investment with a flow of resources mitigates risk, resulting in a lower interest rate and more affordable loan (Bräutigam, 2011).

On the other hand, as China's economy faces challenges from increasing debt and the impact of the coronavirus pandemic, its previous generosity has waned. Energy companies have now stepped in, with the three major Chinese players – CNPC, CNOOC, and Sinopec – collectively ranking as the fourth-largest energy investors in the continent. They trail behind BP, Shell, and Italy's Eni regarding investment. It is significant because China has historically made large amounts of credit available yet has been reluctant to take direct ownership. This trend could still benefit producers facing divestments from mature basins to frontier plays like Namibia and Guyana and need significant new drilling to maintain current production levels (Mitchell, 2023).

A policy instrument mostly adopted by Beijing has been the "projects-for-oil" approach. Chinese state-owned development banks, specifically the China Export and Import Bank and the China Development Bank, fund diverse projects in Africa, spanning social and industrial infrastructure and agricultural research and development. In return, oil-rich nations grant Chinese national oil and gas corporations' access to their oil resources, repaying loans with future oil production. This approach is often called the "Angola model," as seen in Angola, where Beijing has supported the construction of low-cost residential housing projects (Powanga & Giner-Reichl, 2019). Also, the type of energy investments has relied to a great extent on local conditions, where Chinese energy funding in Africa tends to be in line with local resources – coal in the south, hydropower in the east, and gas in the West.

On the other hand, China has become fonder of low-carbon cooperation, and it is reflected in the announcement of the end of financing for overseas coal-powered plants in 2021, as well as the release of "Guidelines for Ecological Environmental Protection of Foreign Investment Cooperation and Construction Projects", albeit not legally binding. The lack of legal consequences leads to mixed reactions, as it remains unclear whether commercial lenders, as well as Chinese contractors, would adopt this policy position abroad, especially in the context of increased domestic use of coal in the last couple of years. The hope lies in Chinese companies voluntarily adhering to these guidelines. In the absence of compliance, internal political pressure may be applied, but currently, there are no legal consequences. In their Five-Year Plan, the Chinese government intended to create legislation overseeing overseas investments. This proposed legislation could potentially empower

the Ministry of Environment and Ecology to regulate and manage Chinese investments abroad, particularly focusing on their climate impact, which could be a positive development (Feffer, 2022).

On the other hand, Chinese SOEs are primarily contractors in energy infrastructure projects, showcasing significant expertise in the hydropower sector. Chinese energy utilities or project developers have a comparatively lesser role in overseas projects, contributing to the prevalence of hydropower and Overseas Concession Contracts (OCC) in the current project pipeline in the Sub-Saharan Africa region. Chinese contractors prefer bilateral negotiations and are generally less enthusiastic about engaging in open procurement or tendering programs. This inclination helps elucidate the prevalence of Chinese contractors in large hydro and coal-fired power plants.

Conversely, in the non-hydro renewable energy sector, where open tendering is more prevalent, Chinese contractors are less dominant because of the increasing popularity of open tendering arrangements, particularly in developing wind and solar energy projects. While ministries like MOFCOM, MOFA, and MOF play crucial roles in developing the overall strategy and planning by establishing policies, rules, guidelines, and decisions at the project level are increasingly delegated to policy banks and the export credit insurance company – the autonomy of which is significantly constrained by the influence of large SOE contractors (Shen, 2020). In this respect, their preferences translate into project selection and development, and this could be particularly challenging to navigate for this new policy focus while underscoring the need for a strengthened role of ministries.

China's role in African economies has risen since the early 2000s, eventually becoming the continent's largest trade partner in 2009 (International Energy Agency, 2023). While having implications for Africa's development, specifically on the key issue of energy security, between 2010 and 2020, approximately 120 million people gained access to electricity through grid development and increased power generation capacity. Chinese contractors significantly achieved this milestone, contributing to 30% of the overall effort. Additionally, households already connected to the grid experienced improved and more reliable electricity supply. China can be said to be exporting its own experience with electrification, where approximately half a billion people gained access to electricity between 1980 and 2000, resulting in China achieving an electrification rate of over 99%. This can be attributed to the effective management and execution capabilities of the central government. Key factors include clear government policies, implementing off-grid solutions, numerous hydropower projects, and mobilising local governments. Increased autonomy and additional funding for construction projects provided to local governments further contributed to the rapid electrification pace. In sub-Saharan Africa, for example, the Chinese government has donated solar energy kits for rural areas such as Rwanda and Comoros. For instance, in Rwanda, these solar kits provided electricity access to 2.000 villagers in 2014, offering off-grid electricity to remote communities. Chinese companies, like Sinohydro, have undertaken distribution projects, supporting networks and connections. In the small town of Cuito Canavale in Angola, Sinohydro facilitated access for 5.000 people by installing lines and substations.

While decentralised solar projects are progressing in Africa, they can only provide limited electricity per capita. As electricity demand extends beyond lighting, there remains a need for centralised electricity systems, especially with the rising middle class in the region. (OECD/IEA, 2016). RReliability is vital in the power sector; fewer than 20% of Chinese generation projects are designed to supply a specific industry exclusively, such as a mine, cement plant, or sugar mill, but mostly mining. Many other Chinese-built power plants are connected to the grid without a specific purpose, contributing to the economy.

An illustrative instance is the Gishoma peat power project in Rwanda, the first of its kind in sub-Saharan Africa. If more projects like this are developed, peat could become Rwanda's second-largest energy source. As a result, the nearby cement factory is planning to significantly increase its production capacity from 100.000 tonnes to 600.000 tonnes of cement. Chinese projects also help promote economic growth by establishing refinery plants, such as the 20-MW Djarmaya refinery in Chad, which has an oil-fired generation capacity.

Also, investments aimed at modernising the agricultural sector are crucial for development, given that it remains the largest employment sector in Africa but faces significant inefficiencies. Biomass projects in Ethiopia, such as the Welkait biomass plant, can contribute to the modernisation of agriculture by providing elec-

tricity to sugar cane factories (OECD/IEA, 2016). While infrastructure is a crucial factor in economic growth and development, many African countries face challenges due to inadequate and unreliable infrastructure, hindering their potential (Chiyemura, 2021), and with these initiatives, Beijing can alleviate that problem.

There have been certain advantages of the Chinese engagement in Africa – one important one being the involvement with Corporate Social Responsibility (CSR) practices. A notable instance is Sinopec's acquisition of the Canadian oil and gas multinational Addax Petroleum in 2009, which is operating in Nigeria. After this acquisition, the company established the Sinopec-Addax Petroleum Foundation in order to administer the company's social investments aimed at achieving the Sustainable Development Goals. Moreover, Sinopec's foundation initiated "technical acquisition programs" in its operations in Nigeria with the dual purpose of enhancing the skills of nationals in the workforce to benefit the Nigerian economy and foster entrepreneurship to uplift the young population from poverty.

Another example is Sinohydro, which is involved in a diverse range of activities, having invested $900 million in over 30 projects in Angola. These projects extend beyond hydropower and encompass hospitals, schools, and transportation infrastructure. Sinohydro has also provided training for over 8.000 local workers as part of its engagement in these projects as part of technology transfer. Therefore, Chinese SOEs can rely on a strong national network to mitigate the risks (Grimoux, 2019), which could foster the population's development to ensure sustainable energy access.

For instance, in the Adama Wind Project, the inflow of hardware from China included the provision of design blueprints and project management frameworks. University consultants mediated interactions between project owners and EPC contractors, allowing for exchanging experience and knowledge. This engagement helped project owners gain valuable insights for future collaborations with foreign EPC contractors. The EPC contractors actively transferred skills related to operations and maintenance, while personnel from the executing entity and university consultants received training in China as part of this comprehensive knowledge exchange.

Similarly, in the Garissa Solar PV Project, the important involvement of local engineering and consulting firms was ensured, granting them project-level experience during feasibility and construction, alongside utilising locally sourced inputs (Lema et al., 2021). Indeed, FDI is positively correlated with economic growth, and the positive effects of FDI come greatly from technology transfer, knowledge, and other intangible assets, leading to increased productivity and improvements in efficiency in resource allocation. According to a study conducted for Kenya, FDI in the energy sector has facilitated the development of efficient procurement networks for the international production and sale of local goods. It has contributed to technology transfer, established markets for domestic production, increased domestic savings, and improved investment policies.

Additionally, FDI has attracted new capital on favourable terms, reducing net debt flows. This investment has influenced the establishment of finance-related and trading networks, upgraded telecommunications services in Kenya, and led to industrial upgrading. Major investments in the energy sector have enabled local firms to leverage new technologies, enhancing productivity and contributing to overall economic growth. However, the potential costs and benefits of foreign capital are often more indirect, stemming from the transfer of skills and technologies (Osano & Koine, 2016), particularly with Chinese investments.

Moreover, State Grid, along with others, prospect the possibility of a green belt of connectivity of renewable energy installations globally through an advanced intelligent grid, which, if achieved, would spur demand from the 1 billion African and South Asian people lacking access to electricity. State Grid has already been involved in national power grid projects that are part of its broader foreign investment strategy, making up a total value of $40bn, with ten cross-border power transmission lines completed (Todd, 2019). Power system connectivity is a key strategy for enabling power systems' secure, affordable, and sustainable development. Connectivity in this regard improves power system resilience through resource complementarity by allowing for the aggregation of resources, the availability of which is less correlated and allows the sharing of reserve generation capacity at times of unanticipated outages or spikes in demand while meeting reliability at a lower cost due to less reserve capacity required. This, in turn, could reduce the dependency on imported energy (Economic and Social Commission for Asia and the Pacific, 2023).

On the other hand, Africa can harness Chinese expertise in leveraging emerging technologies to advance initiatives for reliable and resilient electricity services. The continent begins with a relatively undeveloped infrastructure, offering a clean slate to build smart power systems. This presents an opportunity to establish a shining example of sustainable energy development with the support of Chinese expertise. In energy efficiency, the success stories of Ghana and South Africa serve as blueprints that could be followed across the African continent. What could add to this is that China possesses valuable experience in establishing energy policies, incentives, and prescriptive measures, providing a framework against which progress can be assessed and adapted.

Regarding efficient cookstoves, energy efficiency is even more vital in rural areas. China executed a government initiative that effectively introduced over 100 million cookstoves into households. African governments could benefit from understanding the implementation of this programme, especially its financial components and the related public discourse. By adapting the programme to the African context, more lives could potentially be saved. In addition, many power-generating systems in Africa are remnants of the colonial era, exceeding their economic lifespans. These systems, lacking provisions for cyber-attacks, are vulnerable to such threats. Given China's notable advancements in information and computer technologies, there is an opportunity for knowledge sharing with African partners to enhance defences against cyber-attacks (Powanga & Giner-Reichl, 2019).

However, human capacity development and energy policy components are the most indispensable to ascertain access — every investment should include a training program designed to enable local participation at all levels of the projects. Also, China's effective energy policies could serve as a model for African countries to adapt to their specific environments. A critical aspect of Africa's energy policy involves addressing the security risk arising from the food, energy, and water nexus. This nexus has the potential to significantly slow down Africa's economic growth and trigger political instability — a security concern China also faces. Addressing this common issue could strengthen China-Africa relations as both regions seek collaborative solutions (Powanga & Giner-Reichl, 2019).

Indeed, successful electrification rollout, as observed in other regions, often hinges on the development and execution of a national electrification strategy. This strategy should systematically and cohesively address institutional, technical, and financial aspects related to electrification. However, a study by the World Bank in 2017 revealed that only half of the 35 countries in Africa have officially approved electrification plans. Establishing an adequate regulatory framework becomes crucial to attract investment, especially where funding falls short. Notably, many African countries rank poorly in an index measuring electricity regulation, indicating the need for institutional reform and assistance in human and financial capacity. African electrification efforts must consider key megatrends such as urbanisation, technological change, regional integration, and climate change (Blimpo & Cosgrove-Davies, 2019)

Conclusion

In conclusion, African nations, grappling with increasing energy demands, have garnered significant investments, though these fall markedly short of the actual need. Within this scenario, China has emerged as a key influencer. Mirroring Japan's historical approach, China strategically focuses on infrastructure development and resource exports to secure its investments. Beyond mere financial input, China's role encompasses progress in electrification and technological transfer in infrastructure, especially notable given its own economic challenges in recent times. Infrastructure development is vital, as it underpins reliable energy access and efficiency. Projects aimed at infrastructure improvement promise not only broader energy access but also economic growth, potentially enhancing energy infrastructure and reliability by boosting household purchasing power and demand. The success stories of electrification and efficiency in countries like Ghana and South Africa offer models for the wider African continent. China's proficiency in energy efficiency could significantly benefit Africa's evolving energy landscape.

Additionally, Chinese engagement in Corporate Social Responsibility (CSR) initiatives, such as Sinopec's foundation and Sinohydro's projects in Angola, highlight the positive impact of its involvement. State-owned Chinese enterprises are instrumental in transferring skills and technology, thus contributing to sustainable energy access and growth. However, it's crucial to acknowledge the need for more proactive strategies. Despite high tariffs, operational costs often remain uncovered, emphasizing the necessity for a comprehensive approach that addresses efficiency and reliability, areas where China can expand its role.

Improving the regulatory environment to address existing challenges and capitalizing on ongoing projects through effective energy policies is essential. Emphasizing local capacity building, institutional reforms, and regulatory frameworks is key to maximizing the benefits from Chinese investments. As Africa aims for comprehensive electrification, addressing interconnected challenges like the food, energy, and water nexus is vital for sustainable economic growth and political stability, presenting an opportunity for China's cooperation.

A sustainable acceleration in energy sector development is needed, with renewables poised to play a larger role. Significant capital investment is required, even as the cost of electricity generation through renewable means decreases. Natural gas, as a transitional solution, complements renewables by stabilizing supply fluctuations, especially in areas with access to affordable gas. Although China invests significantly in hydropower in Africa, it also maintains substantial investments in fossil fuels and varies its resource strategies regionally. Given China's reliance on coal and its pledge to promote green investments post-2021, its future role as a responsible actor in the face of escalating energy needs remains to be seen.

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