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Research Article

China's Contribution to the African Power Sector: Policy Implications for African Countries

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China has over the past thirty years experienced unprecedented economic growth averaging over 10% per year ("China GDP Annual Growth Rate | 1989-2018 | Data | Chart | Calendar" n.d.). For this reason, the relationship between China and Africa is often characterized as a case of China colonizing Africa to own natural resources and their associated infrastructure to feed its industrialization. Despite this postulation, Africa sees the cooperation as based on mutual interests in areas such as energy. The two regions could leverage their cooperation with the help of the international community to significantly advance access to electricity in Africa by improving energy efficiency, deploying cookstove programs to reduce health hazards and deaths from smoke inhalation, diversifying energy portfolio, and creating power pools that countries experiencing hiccups in their systems could tap into to meet their electricity needs. The two regions could also formulate energy policies to support these programs. Additionally, the energy infrastructure in Africa is still in infancy presenting an excellent opportunity to utilize emerging technologies and new power systems that are more efficient, resilient, and clean.

1. Introduction

Relations between the People's Republic of China (China) and the African continent have a long history, starting in 1956 when China established diplomatic relations with Egypt. This was soon followed by cooperation agreements with various African Heads of State, Ben Bella of Algeria, Kwame Nkruma of Ghana, Sékou Touré of Guinea, to cite but a few. African support was crucial for China securing membership in the United Nations (where the Chinese seat had been occupied by Taiwan).

In the last 20 to 15 years, however, the international community witnessed an intensification of the relationship which was institutionalized in 2000 with the creation of FOCAC (Forum on China Africa Cooperation) [1]. According to a State Council Information from 2014, more than 53% of Chinese foreign assistance funds were directed towards 51 countries in Africa and the African Union [2]. China became Africa's biggest trading partner in 2009. The relationship encompassing political, economic, scientific, and cultural dimensions is of critical importance for the development of the African continent and has significant geostrategic implications (Sautman and Yan 2007 [3]). An assessment of the Chinese involvement in the African energy sector where access to modern energy services is still elusive for hundreds of millions of people is the focus of this paper. China's contribution to the energy sector in Africa is crucial to meet the ever-increasing demand for energy. Getting energy right on the continent is not only important to overcome energy poverty and open avenues for development, but also

relevant to global attempts to mitigate climate change and to steer towards sustainable energy systems worldwide.

2. Literature Review and Methodology

China's economy has over the past decades grown at an unprecedent 10% per year until 2010 and thereafter more than 6% to grow from US$100 Billion to US$11.2 Trillion in gross domestic product [4]. During that period, energy use per capita per kilogram of oil equivalent increased from 465 to 2,237 in 2014 [5] and life expectancy increased from 60.3 to 76.1 years [5]. The population grew from 841 million to 1.3379 billion [4]. In ten years, from 2005 to 2015, the true steel use per capita, a measure of steel demand, increased from 198.8 kilograms to 437.9 kilograms of finished steel products [5].

Between 2000 and 2012, the middle class earning between US$16,000 and US$34,000 a year rose from 1% of the urban population to 6% to 14% of the 730 million urban population and increased dramatically to 51% by 2020 (Wike 2017). The upper middle class was expected to grow from 14% of urban population (730 million) in 2012 to 54% in 2015 (Wike 2017). By 2020, urban consumption is expected to buoy to US$5.6 trillion [6]. All these factors in combination have fueled China's need to secure minerals and other resources to support the growth [7].

For this reason, the relationship between China and Africa is often portrayed as a case of China colonizing Africa to own oil, gas, minerals, and other natural resources and their associated infrastructure to create a secure source of supply to sustain its industrialization rather than compete in the open market [8]. This view is also supported by Butts and Bankus (2009), who stated that "the major reason for China's renewed involvement in Africa is the need for access to Africa's natural resources, primarily energy and minerals".

The New York Times [9] detailed some of China's projects citing the US$4.6 billion investment in the Husab Uranium Mine in Namibia, a country of 2.5 million people [10], and the US$8 billion high-speed railway through Nigeria among others [9] to illustrate China's burgeoning influence in Africa. Alden and Davies (2006) gave a very detailed account of the rise of Chinese multinational corporations in Africa and the linkages to the Chinese national strategy and the impact of these companies on Africa. Pigato and Tang (2015) discussed the main drivers of China's expansion to Sub-Saharan Africa and how that expansion led to large scale investments in the region.

Esposito and Tse (2009) characterized China's increasing footprint in Africa as "detrimental to Africa's overall competitiveness" because of the opaqueness in identifying projects and participants. Complaints about Chinese companies are cited as another disadvantage to the China-Africa cooperation. Chinese companies employ few locals because they (Chinese companies) choose to employ workers from China ranging from unskilled to skilled workers leaving no room for skill transfer [11]. Even the few locals that are employed are forced to operate under extreme adverse conditions. In Zambia, for example, miners working for Chinese owned mines are given hard hats after working for two years [11].

Several well-known international figures support the colonization hypothesis as the motivation for China's cooperation with Africa (Fioramonti and Kimunguyi 2011). Jack Straw, then British Foreign Secretary, stated that "what China was doing in Africa was much the same as what Britain had done 150 years ago" [12]. Hillary Clinton, then United States Secretary of State, warned that "China's presence in Africa was a new colonialism" (Reuters 2011). In 2014, the Japanese Prime Minister, Shinzo Abe, said "China's aid to Africa was motivated by a desire to secure access to African natural resources [13].

It must be observed however that China is not doing anything different from what other countries do. The essence of foreign policy is pursuing the country's own best interest. The above assessment of China is largely precipitated by traditional Western partners—European countries as well as the United States—out of the fear of the diminishment of their own influence on the continent and claims that China undermines the West's environmental and labor standards and disregards human rights and rules of good governance.

A paper commissioned by the United States Military (Butts and Bankus 2009) points to predominantly positive opinion polls regarding the Chinese presence in Africa and concludes that Africans tend to give better marks to Chinese activities and presence than to American activities and presence on the continent.

African countries view the relationship with China as based on mutual interest (Fioramonti et al. 2011) to advance economic development [14] through access to sustainable energy, improved infrastructure, better international trade, developing natural resources, establishing better financing, and enhancing agricultural performance and environmental solutions. The issue of a win-win situation between China and Africa is often overlooked in the colonization hypothesis. Consequently, literature on mutual benefits from the China-Africa relationship is at best fragmentary. This paper seeks to help fill this void by discussing China's contribution to the energy sector in Africa and identifying areas where further cooperation with China and the international community could occur. The information is particularly important to government officials to inform energy policies on a continent where such policies are nonexistent in most countries. The paper is organized as follows. In Section 3, the history of the relationship between China and Africa is presented to give the reader the historic background in which the paper is framed. Sections 4 and 5 detail China's engagement in the oil and gas industry and the power generation sectors. Section 6 covers the opportunities for cooperation where China and the international community could play a leading role. The conclusions are presented in Section 7.

3. China and Africa: Political and Economic Partners

China is not new to the African continent. As far back as 1949, after the proclamation of the People's Republic of China, Africa was the centerpiece of China's strategy to extend the socialist influence to counter the capitalist system [1]. However, the relationship started formally in

1956 when China and Egypt established diplomatic relations. Cooperation agreements with several African Heads of State followed swiftly with Ben Bella (Algeria), Kwame Nkrumah (Ghana), or Sékou Touré (Guinea) as examples. Though their intention may have been more ideological than economic, they presented "a third way" (besides the cold war policies of Washington DC and Moscow) and enlarged the group of countries which recognized the People's Republic as the legitimate Chinese State [15]. This support was later crucial for China's 1971 acceptance into the United Nations.

In 1963, Zhou Enlai, the first Premier of the People's Republic of China, visited several African countries culminating in the one of the most important projects in Africa—the construction of the rail road between Tanzania's port of Dare-Es-Salaam and Zambia's Kapiri Mposhi commonly known as TAZARA [1].

Over the past fifteen years, China has considerably deepened its relations to Africa and widened its fields of action. According to a State Council Information, 52% of China's foreign assistance funds "flowed into 51 African nations and the African Union" (the AU's modern headquarters in Addis Ababa is Chinese-built)[16].

In the context of a 2000 conference—under the auspices of Chinese President Jiang Zemin, with the attendance of the presidents of Togo, Algeria, Zambia, Tanzania, and the Secretary General of the Organization for African Unity, Salim Ahmed Salim, China created the Forum on China-Africa Cooperation (FOCAC) [17], providing the institutional framework for China's relations with Africa. 52 African States—which means all those states that have diplomatic relations with China, excluding Burkina Faso and Swaziland which continue to recognize Taiwan—and the African Union are currently members of FOCAC. FOCAC has so far organized six conferences at the ministerial level and two summits (in Beijing 2009 and in Johannesburg 2015) which adopted extensive action plans [16].

A second official Chinese policy paper on relations with Africa [18] was published prior to the Johannesburg Summit. Chinese President XI Jinping traveled to Johannesburg and proposed that relations between Africa and China be elevated to a comprehensive partnership and strategic cooperation, with emphasis on industrialization, agricultural modernization, infrastructure, financial services, green development, trade and investment facilitation, and people-to-people-contacts, as well as peace and security.

The Belt and Road Initiative, China's current grand design to revive the old silk roads and create new ways of connectivity, trade, and exchange between Asia and Europe, does not exclude Africa. To the contrary, Heilemariam Dessalegn, then Ethiopia's Prime Minister, was one of the opening speakers at the Belt and Road Forum in Beijing on 14 May 2017 [19]. On his visit to four West-African countries—Mauritania, Cape Verde, Mali, and Ivory Coast—in 2017, Chinese Foreign Minister Wang YI confirmed that the Belt and Road Initiative would be open to all interested African countries (notwithstanding their geographical location) and reconfirmed the commitment at the Belt and Road Forum for International Cooperation in May 2017 [20].

To further illustrate the strong ties between China and Africa, the Chinese Foreign Minister Wang YI has with only two months into 2018, already visited Rwanda (where later in the year the third FOCAC Summit will take place), Angola (for which China has become the largest trading partner, largest oil export market, and the biggest source of financing), Gabon and Sao Tomé, as examples. Additionally, over one million Chinese citizens currently live and work in Africa, and 200 000 Africans live in China [21].

4. China in Africa's Energy: Oil and Gas

China imports two-thirds of the oil it consumes, with Africa accounting for 22% (1.4 million barrels per day), the second most important provider, after the Middle East [22]. Oil imports from Angola constitute 47% of the African import market share in China [22], surpassing Saudi Arabia as China's largest source of crude oil imports in 2006.

Africa is home to five of the top 30 oil producing countries; Africa's proven oil reserves are listed at 130 billion barrels (at the end of 2012). More than 57% of Africa's export earnings come from hydrocarbons [23]. Given Africa's richness in oil and gas, it is not surprising that all the international oil companies are strongly present in Africa (see Figure 1).

China's footprint in the oil and gas sector in Africa has increased substantially according to the Institute of Developing Economies-Japan External Trade Organization, IDE-JETRO, as depicted in Figures 2 and 3. In 2000, China was involved in two projects in Sudan and by 2009, the footprint had spread to over 30 projects. China's power of the purse seemed particularly relevant during the prolonged global recession of 2008 and the subsequent years when Western countries were reeling under the impact of the economic crisis which left Beijing largely unaffected.

IDE-JETRO [24] points out that the shock of 9/11 terrorist attacks on the US in 2001 compelled the Chinese leadership to curtail its reliance on the Middle Eastern oil suppliers, and turning to Latin America, Central Asia, Russia, and Africa. China entered the offshore oil industry in countries such as Angola and Nigeria, ventured into conflict-ridden countries such as Chad, Sudan, Mauritania, Niger, and Equatorial Guinea, and looked for new exploration opportunities in Ethiopia, Kenya, Madagascar, and Uganda largely through joint ventures with national oil companies. At times, the Chinese investments were accompanied by anti-terrorist treaties. The concern for safe navigation of their tankers led China to conclude bilateral agreements covering the use of strategic ports in Algeria, Egypt, and Tunisia by the Chinese navy. Naval cooperation agreements have also been concluded with Sierra-Leone, Nigeria, Cameroon, Equatorial Guinea, and Angola.

Africa Oil and Power [25] summarizes the Chinese presence in the African oil and gas sector as follows: "By 2014, Sinopec alone was active in 16 countries – Algeria, Angola, Cameroon, Central African Republic, Chad, Egypt, Gabon, Ghana, Kenya, Libya, Mauritania, Niger, Nigeria, Sudan, South Sudan and Tunisia". China National Petroleum Corporation (CNPC) is currently active in Tunisia, Algeria,

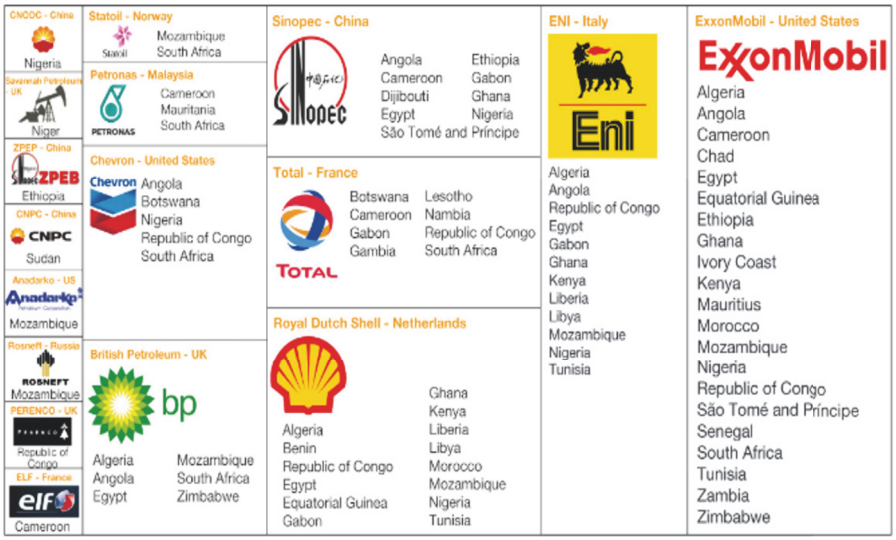

Figure 1: **International oil companies operating in Africa.** Source: http://atlantablackstar.com/2016/10/25/international-oil-companies-competing-operate-investment-africa/.

Figure 2: **China's footprint in Africa's energy sector 2000.** Source: http://www.ide.go.jp/English/Data/Africa_file/Manualreport/cia_07.

Libya, Niger, Chad, Nigeria, Sudan, and South Sudan; and China Offshore Oil Corporation (CNOOC) has interests in Gabon, Uganda, Nigeria, Algeria, and Republic of Congo. According to the same source, in 2016, Nigeria, a key provider of Chinese oil, signed $80 billion in provisional contracts with Chinese companies to upgrade its oil and gas infrastructure, with Sinopec as one of the 38 Chinese companies. This figure clearly dwarfs the $24 billion ExxonMobil has committed over the last years to energy exploration and development [23]. Chinese oil companies are reported to have total capital expenditure in Africa of more than $ 35 billion with an annual production capacity of 50 million tons of oil and gas [26].

A policy instrument often used by Beijing is the "projects-for-oil" approach. In an article published by China Daily, Sikhumbuzo Zondi [27] describes the approach as follows: "Chinese State-owned development banks, namely the China Export and Import Bank and the China Development Bank, are financing a range of projects on the continent, from social or industrial infrastructure development projects to agricultural research development. In exchange, these oil-rich countries give Chinese national oil and gas corporations access to their oil resources and repay their loans with their future oil production. The model has been dubbed the "Angola model" because in Angola, Beijing has assisted in building that country's low-cost residential housing projects" [25].

African countries will continue to seek Chinese investments. Industry observers recommend that China should tailor its approach to the pertinent particularities which vary greatly from one of the great African regions to the next. Lu Ruquan in an article originally published in Chinese by Caixinmedia (English version: (Zondi 2017)), for example,

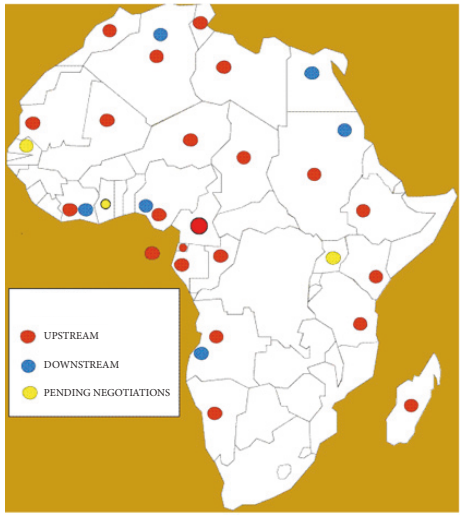

Figure 3: **China's footprint in Africa's energy sector 2009.** Source: http://www.ide.go.jp/English/Data/Africa_file/Manualreport/cia_07.html.

advises China to adopt a package solution's approach to North and West Africa where the industrial base is weak and the market poorly developed; in Nigeria and Angola, where China has already made significant inroads, cooperation should be enhanced in downstream refining and natural gas [26]. For East Africa, e.g., Kenya and Mozambique, where the oil and gas market is relatively high-end, China should actively explore the engineering services market.

5. China and Africa's Power Sector

Africa still faces tremendous electricity access challenges [28]. Access to modern energy services is one of the most severe impediments to development not only in Africa, but also in other developing countries. It is therefore pertinent that the new development paradigm adopted by the UN in 2015 under Agenda 2030 [29] identifies universal access to energy, improved energy efficiency, and doubling electricity from renewable energy sources as one of the 17 sustainable development goals.

According to the International Energy Agency (IEA) [30], the number of people in the world without access to electricity is around 1.1 billion (see Figure 4), significantly down from the 1.7 billion in 2000. However, the IEA points out that the electrification penetration rate in Sub-Saharan Africa is still significantly low. The IEA [30] estimates that, by 2030, roughly 600 million of the 674 million people still without access will be in Sub-Saharan Africa, mostly in rural areas.

As illustrated in Figure 5 only 15% of the world's population has no access to electricity. Out of that figure, 55% reside in Africa mostly in rural areas. Even those with access to the grid face frequent disruptions in electricity supply due to archaic power generation, transmission and distribution systems, and poor maintenance. For example, the study by Research Network Afrobarometer [31] found that Nigeria with a connection rate of 96% is plagued with low quality connections with only 18% of those connections having electricity available most or all the time necessitating widespread use of the costly diesel or gasoline generators as backup systems.

Compounding the situation is the increasing demand for electricity. Estimated at 423 Terawatt hours in 2010, the demand is expected to increase at 4% per year until 2040 according to the International Energy Agency [30]. The report concluded that providing electricity for all by 2030 would require doubling current levels of annual investments and 95% of these investments will need to go to Sub-Saharan Africa underscoring the significant investment needed to increase energy access to underserved populations in the region.

The case for modern energy services in pursuit of sustainable development hardly needs repeating: without access to electricity, critical education and health goals cannot be achieved; agricultural productivity is curtailed; entrepreneurial endeavors are hampered; industries—which have been proven to lead up to wealth generation—cannot develop and the benefits of connectivity and the Internet cannot be reaped.

Recently, renewable energies and distributed power systems have become competitive with fossil-fuel generation opening the possibility of increasing access without adding to the overall carbon footprint. Africa's abundant renewable sources especially solar, wind, geothermal, and hydropower, make an excellent business case for investments in renewable power generation.

China is heavily engaged in the African power sector. Between 2010 and 2015, China injected US$13 billion in the African power sector accounting for at least 30 percent of the new productive capacity [30]. In another partner report, the International Energy Agency [32] examines this involvement closely. Here are a few statements gleaned from this publication: Power generation in Sub-Saharan Africa rose from 95 Gigawatts (GW) in 2010 to 115 GW in 2015; 30% of these additions were brought about by Chinese contractors alone. Chinese projects added 4.2 GW in West Africa, 5.5

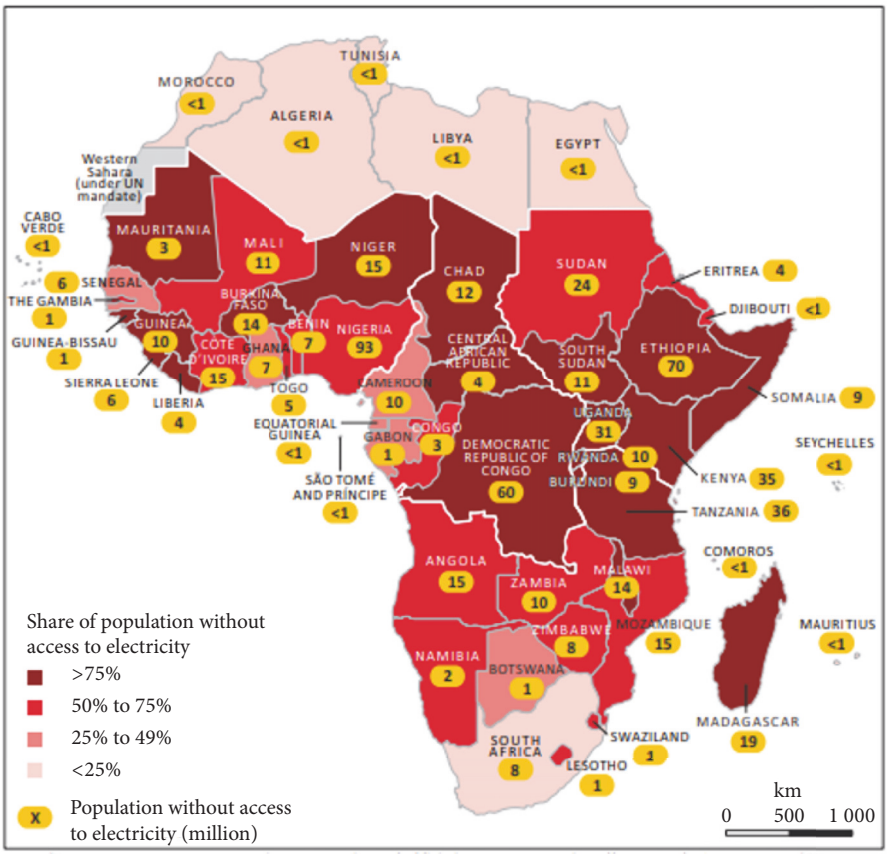

Figure 4: **Population without access to electricity in Africa.** Source: IEA Africa Energy Outlook 2014 and the World Bank, 2018.

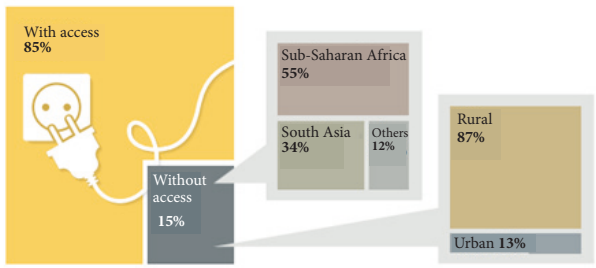

Figure 5: **World electricity access and lack of access 2012.** Source: REN 21 Global Status Report, 2015.

GW in East Africa, 1.3 GW in Central Africa, and 5.5 GW in Southern Africa. Some 25% of all greenfield power plants were contracted to Chinese companies between 2010 and 2015, with hydro being by far the preferred area of investment.

China seems involved in the whole value chain. Chinese State-Owned Enterprises (SOEs) account for 90% of all Chinese-held contracts. Almost 80% of Chinese-built power projects are supported by (mostly sovereign debt) financing from China (World Crunch 2016). As documented by the last several REN 21 Global Status Reports (2017), China has taken the global lead in national additions to installed capacity in most areas of renewables, particularly hydroelectric, solar photovoltaic, wind power, and solar water heating. China is also ready to invest in renewables in Africa in a more concerted fashion. In August 2017, the China-Africa Renewable Energy Cooperation and Innovation Alliance was launched to cooperate with the Africa Renewable Energy Initiative AREI [33].

In line with the unfolding Belt and Road Initiative, Chinese institutions (notably the powerful State Grid) ruminate about the possibility of a green belt of connectivity which would link renewable energy installations globally through an advanced intelligent grid (cf, Financial Times, "China plans super-grid for clean power in Asia", 5 December 2017 [34]). Xinhuanet [11] quotes State Grid Chairman Shun Yinbiao, speaking at the B20 China Business Council meeting in

December 2017, as saying that power investment demand would reach US$1.5 trillion in Belt and Road countries in the next five years. The demand would come from the 1 billion people without access to electricity in Africa and South Asia, an upgrade of power facilities in Central and Eastern Europe, as well as energy system transitions in Western Asia.

According to the article, the State Grid has worked on several national power grid projects in Belt and Road countries, with a contract value of nearly US$40 billion dollars, helping export Chinese power equipment to more than 80 countries and regions. The company has built 10 cross-border power transmission lines to improve power grid connectivity and invested in power grids in countries such as the Philippines, Brazil, and Italy [35]. By extrapolation, Chinese investment in the African power sector is expected to continue because that is where most of the demand for power generation will come from.

6. Further Areas of Cooperation in the Energy Sector

Africa has tremendous sources of clean energy such as geothermal, wind, solar, hydroelectric, and biomass, all grossly underdeveloped. Case in point, only 1% of geothermal and 10% of hydroelectric potential have been tapped. Africa could generate 10,000 GW from solar, 350 GW from hydroelectric power, and 400 GW of natural gas, totaling more than 11,000 GW [36] in power generating potential. In addition to the energy challenge (Matinga, et al. 2014), Africa is faced with two important threats: cyber-attacks and susceptibility to harsh natural disasters, and variations in weather conditions due to climate change. Africa could leverage China's expertise and that of other countries to use the emerging technologies to advance a variety of initiatives designed to provide reliable and resilient electricity services. The case to be made is that Africa is beginning with a clean slate because the infrastructure is not fully developed thereby providing an opportunity to build smart power systems that would serve as a shining example of sustainable energy development.

6.1. Energy Efficiency. In most African countries, despite the demand for electricity outstripping the supply, energy efficiency policies are not in place due to either lack of awareness or understanding the value inherent in this approach. Consequently, electricity consumption is much higher than it should be because there is little incentive to save electricity. To help close the gap between supply and consumption, energy efficiency policies should be at the fore front to free up power generation capacity without the expense of building new power plants.

In 2000, Ghana rolled out an appliance labelling program and associated regulations precipitated by prolonged periods of power outages and rolling blackouts. The program sought to implement labels that would show consumers the energy consumption and efficiency of the different products. The effort paid off immediately yielding estimated savings of more than 120 megawatts (MW) during peak times, reducing the need for US$105 million in power generation investment while at the same time avoiding emitting into the air over 110,000 tons of carbon dioxide annually [37].

In South Africa, where the government has pushed for energy efficiency [38], a total of 3 GW was saved over ten years through the energy efficiency and incentive program, equivalent to the electricity output of five 600 MW generators. The success of Ghana and South Africa provides a blue print that could be replicated across the continent. Even more significant is the fact that China has experience in setting up energy policies, incentives, and prescriptive measures against which to gauge the progress. For that reason, this is another area where the two regions could cement their relationship. This is also an opportunity for national governments and international firms to be part of the solution.

6.2. Efficient Cookstoves. Energy efficiency is even more crucial in the rural areas where traditional fuels such as wood, charcoal, and agricultural waste are the main sources of fuel for heating, lighting, and cooking. The high levels of fine particulate matter of 443 μg m−3 (micrograms per cubic meter of air for a 24-hourly average is much higher than the stipulated World Health Organizations guidelines stipulated range of 150 μg m−3 to 230 μg m−3 for 24-hourly average) from the household pollution cause more than 50% of the premature deaths among children under 5 years [39], more than 4 million people from lung cancer and heart diseases, and up to 4.3 million deaths every year [40]. The traditional cooking is inefficient; it uses only 10-12% of the heat generated with plenty of toxins released to the air compared with a liquefied petroleum gas stove whose efficiency is more than 70% [41] with significantly lower toxin levels in the emissions [42]. Traditional cooking methods also cause fires which in some cases result in death. In South Africa, it is estimated that 45,000 house fires and 3000 deaths annually are caused by kerosene as a fuel source [31]. With the emerging technologies, biomass cooking could be used safely, efficiently, and sustainably to mitigate many problems associated with biomass cooking. Though cookstoves that use biomass are not completely clean, they produce significantly fewer emissions than open fires or traditional stoves saving millions of lives [43].

Other benefits accrue to cookstoves. In rural areas, women spend hours looking for fuel wood, with improved usage fewer hours would be used to have more time for other activities. Another benefit is the reduction in deforestation contributing to the climate change solution [42]. The major obstacles to adopting cookstoves despite the awareness of the health risks associated with traditional stoves are the reluctance to part with traditions and the lack of income to purchase cookstoves ([44] and Taliotis et al. 2014) with one exception; China implemented a government program that successfully deployed more than 100 million cookstoves into people's homes (Smith et al. 1993). The African governments could learn how the program was implemented, particularly the financial aspects and the associated public discussions, and adopt the program to the African environment to save even more lives.

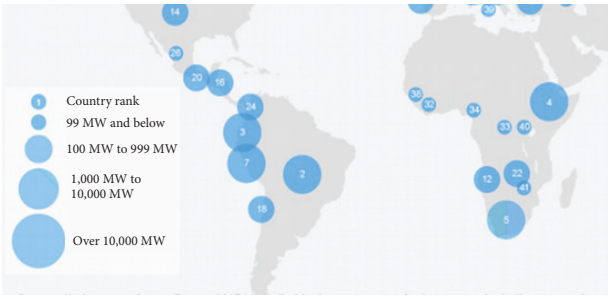

Figure 6: Hydropower capacity installed in 2016. Source: Hydropower Status Report 2017.

6.3. Prevention of Cyber-Attacks. Most of the power generating systems in Africa are left over from the colonial era or were built just after independence and are way past their economic lives. These systems did not cater for cyber-attacks and are therefore susceptible to such attacks [45]. China has improved tremendously in information and computer technologies and could share some of its knowledge with the African partners to fend off such attacks.

6.4. Diversifying the Energy Portfolio. Most countries in Africa tend to depend on a single source for power generation, largely hydroelectric power. Hydropower constitutes 98% of Malawi's electricity supply and Zambia gets 95% of its electricity from hydroelectric power. And more hydroelectric power capacity came on stream in Africa as shown in Figure 6 [46]. However, hydropower is vulnerable to changes in climatic conditions. In 2016, for example, Zambia experienced a 13% decline [47] in water levels due to erratic rainfall and prolonged periods of drought and the country's power generation was significantly curtailed resulting in load shading with key infrastructure such as hospitals and mining operations hit hard constraining the quality of life and limiting economic growth to about 3% from the about 5% the previous year [48].

Hydropower is the cheapest source costing about US 7cents per kilowatt hour (KWH) in Zambia and US3c/KWH in Ethiopia (Energy Africa Conference 2017). However, it should be complimented with other renewable sources such as wind, geothermal, biomass, and solar to increase the resilience and continuity of electricity supply. The national grids should also be tied together to create a ready power pool that countries struggling with power supply can siphon from to offset the shortfalls in their system.

China has played a major role in expanding the renewable energy productive capacity in Africa [49]. However, the bulk of the investment flow has been in fossil fuels. Between 2014 and 2016, an annual average of US$11.7 billion of the public funds deployed went to fossil fuel energy accounting for 60% of the total energy budget. China provided an average of US$5.1 billion per year of all the total public finance [50]. There is an urgent need to diversify the energy portfolio presenting an opportunity for the international community in concert with China and Africa to invest in the effort needed to create a stable energy system for Africa that can withstand variations in weather conditions [51]. This is very important particularly that projections of the weather patterns indicate that climatic conditions will continue to affect Africa adversely.

6.5. Human Capacity Development. A key component to advancing energy access is human capacity development. Though China has been engaged in training in Africa (Changsong 2013), this sector provides a great opportunity for China to erase the image of being seen to be reluctant to engage locals in Chinese sponsored projects on the continent. Each investment should come with a training program to allow the locals to participate at all levels of the projects.

6.6. Energy Policy. The programs described above can be accomplished by effective energy policies that will allow for the design, implementation, monitoring, and evaluation of the program to make them successful. Currently, very few African countries have energy policies with specific targets [52]. China (has good energy policies which African countries could adopt to their environment), and the rest of the world could help eliminate some of the limiting factors in harnessing the power generation potential by providing technical support, financing, and advising on policy implementation to support developing the resources as part doing business with Africa.

A crucial component of the energy policy in Africa is the security risk posed by the food, energy, and water nexus, which could considerably decelerate Africa's economic growth and create political instability, a security threat that exists in China. China cannot resolve this issue without reaching out beyond its borders for access and management of water, food, and energy resources. This issue could deepen the China and Africa relations as both regions seek [14].

Additionally, Africa is in infancy in terms of the existing infrastructure and well positioned to develop better and cleaner power systems and become a shining example of how low-carbon sustainable power systems could be developed. China could be instrumental in advising on urban and rural solutions. The policy would include how to share electricity across the continent through power pools. Though power pools already exist, only 7% of the electricity is traded across the continent. Such a coordination could save more than $50 billion in capital expenditures which could augment the current US$ 8 billion spent on electrical systems every year [37].

7. Conclusions

Several observations emerge from this paper. First, Africa has significant potential for generating electricity from renewable energy sources, which has not been harnessed leaving over 600 million people without access to electricity. Since the energy infrastructure is still in development stages, Africa could institute energy efficiency policies and deploy a low carbon power system to increase energy access and help mitigate the effects of climate change. Second, the relationship between China and Africa is a win-win situation as both regions pursue their common interest. Third, this relationship

is not new; it has been in place for a long time and has broadened over time resulting in increased trade and investments. Fourth, China has poured a substantial amount of money into Africa to help develop its energy infrastructure. Finally, China and the rest of the world could do more business with Africa and assist region to develop a sustainable, resilient, and cost-effective infrastructure through establishing energy efficiency programs, installing new capacity, deploying newer technologies, developing local human capacity, and formulating energy policies that have shared objectives across the continent.

Data Availability

The data used to support the findings of this study are available from the corresponding author upon request.

Conflicts of Interest

The authors declare no conflicts of interest.

Authors' Contributions

Irene Giner-Reichl and Luka Powanga contributed to the paper equally.

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