Contemporary Chinese Political Economy and Strategic Relations: An International Journal Vol. 4, No. 3, Dec. 2018, pp. 1061-1103

Promoting Production Capacity Cooperation and Industrialization through Energy Infrastructure Development: The Case of China-Ghana Partnership

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Abstract

Although a number of studies have analyzed China-Ghana economic relations, an in-depth exploration of the role of the China-Ghana energy infrastructure development partnership in promoting production capacity and industrialization cooperation between the two countries is still lacking. In light of the Forum on China-Africa Cooperation (FOCAC) Action Plan (2016)'s commitment between China and African countries towards production capacity and industrialization cooperation, this paper examines the extent to which production capacity and industrialization cooperation between China and Ghana can be facilitated and promoted through energy infrastructure development in Ghana. Methodologically, secondary data sources are utilized. The paper argues that whilst China

and Ghana already have a number of projects under implementation in the energy sector, there is scope for China and Ghana to increase and intensify the current levels of investment cooperation in energy infrastructure development to spur industrialization and economic development in Ghana. The paper therefore recommends strategic prioritization of investments in the energy sector, a shift towards more emphasis on renewable energy, improvement of investment climate through policy and regulatory framework review, and complementing Chinese investments through exploring alternative sources of local and international funds for energy infrastructure development.

Keywords: *energy infrastructure development, industrialization, production capacity, China, Ghana*

1. Introduction

The economic relations between China and Africa span back to the 14th century during China's Ming Dynasty with the voyages of Admiral Zheng He in East Africa (Vhumbunu, 2016: 272). Whilst the economic relations intensified over time with increasing trade, aid and investments which has seen China becoming the largest trading partner and investor in Africa, it is the formalization of the production capacity and industrial capacity cooperation between China and Africa through the Forum on China-Africa Cooperation (FOCAC) Summit of 2018 which presented an opportunity to transform Africa's industrialization agenda. To facilitate the production capacity and industrial capacity cooperation, China and Africa committed to cross-sector infrastructure development, which included, among others, the development of energy infrastructure. Just as other countries, Ghana was presented with an opportunity for energy production which is key in industrialization. Whilst a number of

studies have been conducted on China-Ghana economic relations, there has not been any exploration of the role of the China-Ghana energy infrastructure development partnership in promoting production capacity and industrialization cooperation between the two countries. This paper therefore sought to examine the extent to which production capacity and industrialization cooperation between China and Ghana can be facilitated and promoted through energy infrastructure development in Ghana. In terms of organization, the paper will present a background and context of the China-Africa production capacity and industrialization cooperation. A review of literature on energy infrastructure and industrialization will then be presented, followed by an overview of energy production trends and patterns in Ghana. The impact and implications of China-Ghana cooperation in energy infrastructure development on Ghana's industrialization will be discussed, before outlining the recommendations of the study in the form of policy review and strategies.

2. China-Africa Production Capacity and Industrialization Cooperation: Background and Context

One of the key outcomes of the FOCAC Summit of 2018 was the joint commitment made by China and African countries to promote production capacity and industrial capacity cooperation between the continent and China. Africa has had a long history of industrialization attempts, dating back to the colonial era, and the economic Structural Adjustment Programmes (SAPs). The understanding has been that accelerated industrialization will modernize the continent, facilitate job creation and poverty reduction, and promote inclusive growth (African Development Bank, 2018).

However, all the attempts appear to be failing to industrialize the continent at the desired pace and expected quality as evidenced by the state of industrialization in almost all of the African countries. The manufacturing trends on the continent depict de-industrialization in some countries whilst reflecting very minimum growth in manufacturing value added (MVA) component. For instance, the United Nations Industrial Development Organization (UNIDO)'s *Industrial Development Report* of 2018 states that whilst global MVA has more than doubled between 1990 and 2016, Africa's MVA remains very low by global comparison. Even in all manufacturing and industrialization indexes, African countries continue to rank low. The UNIDO (2017)'s *Competitive Industrial Index Report* of 2017 which benchmarks the ability of countries to produce and export manufactured goods competitively ranks the majority of African countries low in terms of the MVA per capita and in Gross Domestic Product (GDP) Index, Industrialization Intensity Index, Manufacturing Export per Capita Index, Share of Manufacturing Exports in Total Exports, Manufacturing Export Indexes, Share in World Manufacturing Export Index, Share of Medium and High-Tech Activities in Total Manufacturing Export, and Index Industrial Export Quality Index (*see* UNIDO's *Competitive Industrial Performance Report*, 2016: 6-295).

Table 1 presents a comparison of Africa's MVA to other regions for the period between 1990 and 2016. As depicted in the table, it can be noted that industrialization in Africa has generally been low as compared to other regions. On the other hand, China has fast industrialized, having joined the Asian Tigers (Hong Kong, Singapore, South Korea and Taiwan) in Asia and Pacific region. China remains the world's largest manufacturing producer and exporter with manufactured exports representing almost 97 percent of its total exports (UNIDO, 2018).

The country accounts for 18.4 percent of world's trade in manufactured goods and 23.5 percent of global MVA, thereby accounting for the world's largest share of MVA (UNIDO, 2018: 86).

Table 1 Manufacturing Value Added (MVA) in Developing and Emerging Industrial Economies (1990, 2000 and 2016)

REGION	MVA PERCENT		
	1990	*2000*	*2016*
Africa	**9,2**	**6,5**	**4,4**
Asia and Pacific	**38,6**	**54,3**	**76,0**
Europe	**16,0**	**9,9**	**6,6**
Latin America	**36,2**	**29,3**	**13,0**

Source: Author's construction using data from UNIDO's *Industrial Development Report* (2018: 158).

With such a manufacturing and industrialization base and performance, China is well-positioned to partner with African countries for industrial capacity cooperation and production capacity promotion. Therefore a smart partnership is essential and indispensable if industrialization is to be realized in its full potential. The joint commitment made by China and Africa to promote production capacity and industrial capacity cooperation thus presents a pivotal and fundamental opportunity to facilitate accelerated industrialization.

Under *Industry Partnering and Industrial Capacity Cooperation* in the FOCAC Action Plan (2016-2018:8), China and African countries expressed their readiness to "combine China's competitive industries and high quality industrial capacity with Africa's industrialization and economy diversification" for industrialization. The Action Plan stated:

> "The Chinese side is willing to give priority to Africa in industrial partnering and industrial capacity cooperation. The African side welcomes the transfer of labour-intensive competitive industrial capacities of China to Africa in an orderly way, assisting Africa to increase employment, taxation and foreign exchange, and achieving technology transfer and common development."

Further, there was a commitment to develop infrastructure through Public-Private Partnership (PPP) and Build-Operate-Transfer (BOT) across all sectors given its role in facilitating industrialization. Among other sectors targeted is the energy infrastructure development.

Ghana, like most Africa countries, is faced with the energy deficiency challenge which is impeding industrial growth and other economic activities. Access to electricity and other forms of energy remains a key component in achieving sound economic development and economic production since all these depend on a reliable and sustainable energy supply as aspired in the 2015 United Nations Sustainable Development Goal (SDG) Number 7 which seeks to achieve affordable and clean energy so as to ensure access to affordable, reliable, sustainable and modern energy for all people. The African Union (UN) Agenda 2063 also commits to "harness all African energy resources to ensure modern, efficient, reliable, cost-effective, renewable and environmentally friendly energy to all African households, businesses, industries and institutions" (African Union, 2015: 16).

However, adequate, efficient and sustainable energy production has been sluggish in Ghana for many years despite the existence of vast potential energy in hydro-electric energy, solar energy, marine power, geo-thermal energy, wind energy, and bio-energy, as well as crude oil and natural gas deposits (*see for instance* Andrews and Nwapi, 2018;

Asumadu-Sarkodie and Owusu, 2016; Rupp, 2013; Odoom, 2017; Prasad, 2008). It will be prudent, therefore, for Ghana to fully utilize the China-Ghana partnership with a view to promote production capacity and industrialization cooperation through energy infrastructure development.

3. A Review of Literature on Energy Infrastructure and Industrialization

Energy infrastructure development has for long been acknowledged as salient in any society given its socio-economic utility in economic production, economic growth, industrialization, modernization and sustaining improved living standards of citizens. Several empirical studies have confirmed that the expansion, upgrading and maintenance of a country's energy infrastructure immensely contributes towards economic growth and development (*see for instance* Alper and Oguz, 2016; Bhattacharya *et al.*, 2016; Alshehry and Belloumi, 2015; Bilgili and Ozturk, 2015; Bloch *et al.*, 2015; Inglesi-Lotz, 2016; Iyke, 2015; Shahbaz *et al.*, 2015). The authors stress the importance of energy access to health service delivery, education, reducing the cost of doing business, and job creation. As the African Development Bank (2018) notes, energy access is a key driver of inclusive growth as it opens up opportunities for all citizens including traditionally marginalized groups in the society such as women, youths and children in both rural and urban areas.

Countries that have emerged and succeeded in industrialization have largely invested heavily in energy production infrastructure. Jiang and Lin (2012) argued that energy demand has characterized industrialization and urbanization in China. As established by the authors based on a comparison of China to developed countries, higher economic growth fuels high energy demand, which then underscores the

need for a sufficient energy infrastructure base as a sine qua non for accelerated industrialization and economic development. This is critical if one considers the losses that are incurred by industries due to lack of reliable access to energy. The African Development Bank (2018: 2) hinted that firms in Ghana and Tanzania are losing 15 percent of the value of their sales due to incessant power cuts. The same debilitating effects on African industries and industrialization which are affected by load shedding, power faults, power cuts, and power technical constraints such as overbilling was confirmed by several other studies (*see for instance* Mandina and Kurwiravamwe, 2016; Mensah, 2018).

Of importance to note, however, is that debate on energy consumption-economic growth and energy production-industrialization nexus has lost much traction. Instead, the discourse has now shifted to energy renewability, energy production and distribution methodologies, as well as energy consumption formulas. Such has characterized global and regional trends in energy infrastructure development. Being the second largest consumer in the world after the United States (US), China has also shifted towards renewable energy production.

Alper and Oguz (2016) examined the role of renewable energy in economic growth using the asymmetric causality test approach and auto-regressive distributed lag (ARDL) model based on Eurostat data. The study focused on selected European Union (EU) countries for the period between 1990 and 2009. The authors' overall finding was that there is a causal relationship between economic growth and renewable energy consumption. Similarly, Bhattacharya *et al.* (2016)'s study on the effect of renewable energy consumption on economic growth established that renewable energy sources are a significant driver of economic growth. The authors' study focused on 38 top renewable energy consuming countries and applied heterogeneous panel estimation techniques. What has to be noted, however, is that the full potential of energy production,

upgrading and distribution may be hamstrung by barriers such as financial inadequacy, politics, climate change, human technical limitations, geographical factors, tariff regimes, as well as limited investment flows.

A study by Chang *et al.* (2003) reviewed the production and consumption of traditional and renewable energy in China since the 1970s. The findings were that China had committed a lot of investments towards research, development and exploitation of renewable energy. It is not surprising that today, studies are confirming that China has made strides in the development of renewable energy supplies. Csefalvay and Horvath (2018)'s assessment of the sustainability of renewable energy in the US, Canada, EU, China and Russia revealed that China, among other countries under review, was making significant progress in replacing non-renewable energy such as natural gas, crude oil and coal with a wide array of renewable energy sources like bioethanol, solar energy, *et cetera* for the purposes of sustainability. As Jiang (2008: 257) recommended, China should now focus on "energy-saving, high efficiency, diversified development, environment protection, technology guidance and international co-operation".

It is the international cooperation dimension in energy production infrastructure that stands to be a fundamental feature in promoting production capacity and industrialization cooperation through energy infrastructure development in Africa in general, and in Ghana particularly. This is because Africa generally, and Ghana particularly suffers from energy deficit as well as constrained energy production, maintenance and upgrading capacity. The African Development Bank (2018) has stated that over 640 million people in Africa have no access to energy, with most African countries having an electricity access rate of just over 40 percent which is the lowest in the world. Per capita energy consumption in Sub-Saharan Africa (excluding South Africa) is

180kWh which is far below the 13,000 kWh per capita in the US, and 6,500 kWh in Europe (African Development Bank, 2018). This is despite having vast energy potential; for instance, studies have revealed that Africa is currently utilizing less than a tenth of its hydropower potential whilst failing to harness the immeasurable and boundless solar and wind energy potential on the continent (Cuesta-Fernandez, 2015; Tshombe *et al.*, 2017; Mukasa *et al.*, 2017; African Development Bank, 2018).

With specific reference to Ghana, Asumadu-Sarkodie and Owusu (2016)'s study on the potential and economic viability of solar photovoltaic (PV) power in Ghana established that at least 5 MW can be harnessed in 20 regional areas at a cost of US$17,752,179. To facilitate investments into the sector, the authors submitted that incentivization from the Government of Ghana via subsidies and creation of a conducive environment for investments was essential. As of 2015, Ghana was ranked 18 out of 45 African countries in terms of electricity consumption per capita, recording just over 400 kWh, with Libya, South Africa, and Seychelles constituting the top three with over 4,000 kWh of electricity consumption per capita (African Development Bank, 2017: 20).

Whilst the energy sector is vital for Ghana's industrialization and socio-economic development, the energy infrastructure that facilitates the generation, transmission and distribution of electricity for both industrial and commercial purposes as well as domestic use remains inadequate. All in all, indications are that the electricity sector in Ghana is confronted with multifarious and multitudinous challenges. In "Energy demand in Ghana: A disaggregated analysis", Mensah *et al.* (2016) avers that the existing power plants in Ghana are operating below full capacity due to constraints in power supply, climate challenges, limited water inflows in hydropower plants resulting in peak power

shortages. In the study, which sought to estimate the energy demands in Ghana through disaggregated analysis, the author recommended subsidization policies, encouragement of independent power producers as well as energy conservation programmes to enhance energy service delivery. Likewise, Appiah (2018) also recommended massive investments into the energy sector with more emphasis on renewable energy with the objective of boosting energy efficiency.

Whilst the recommendations are plausible and prudent, the need for high capital investments would require cooperation with international investors given the limits of domestic capital. This has been acknowledged by the various public institutions that administer the power system in Ghana, namely the Ministry of Power, the Energy Commission (EC), the Ghana Grid Company (GridCo), Volta River Authority (VRA), Public Utility Regulatory Commission (PURC), as well as the Electricity Company of Ghana Limited (ECG) (see Ghana Investment Promotion Centre, 2018). Therein lies the importance of promoting production capacity and industrialization cooperation with China through energy infrastructure development. This would also assist the country to achieve its renewable energy targets as set out by the Government to achieve 10 percent contribution of modern renewables in the electricity generation mix by the year 2020, and reduce wood fuels demand from 72 percent to 50 percent by the year 2020 (*see* Ghana Investment Promotion Centre, 2018: n.p.). Moreover, by 2030, Ghana will have a projected population of 40 million, which would translate to an energy demand of 18,000 to 25,000 MW, and per capita output of about 3,000 kWh. A smart partnership with China in energy infrastructure development will be necessary and needful.

Indeed, China has been involved in several energy infrastructure development projects in Africa through what has been widely termed "hydro-diplomacy" or "energy diplomacy" (*see for instance* Vhumbunu,

2016; Du Plessis, 2016; Arewa, 2016; International Energy Agency, 2017; Sy and Copley, 2017; Shen and Power, 2017). The projects mainly funded by Chinese State-owned banks though concessional loans and grants, mainly been implemented by Chinese State-Owned Enterprises (SOEs), may be a giant step towards the realization of Africa's energy dream. A study by Castellano *et al.* (2015), *Brighter Africa: The growth potential of the sub-Saharan electricity sector*, states that Africa's power sector alone requires US$450 billion up to the year 2030 to close the energy deficit whilst the oil and gas industry requires an estimated excess of US$2 trillion in investment between the years 2013 and 2035.

Several energy generation projects have been implemented by African countries in partnership with China. For instance, hydro-power projects alone include projects such as the Merowe Hydro-Electric Dam in Sudan, Song'oro Hydro-Electric Plant in Kenya, Zongo II Hydro-Electric Power Plant Project in the Democratic Republic of Congo (DRC), Kariba South Power Station Expansion Project in Zimbabwe, Dikgatlhong Hydro-Electric Dam Project in Botswana, Tekeze Dam in Ethiopia, Caculo Cabaca Hydro-Electric Power Project in Angola, Batoka Gorge Hydro-Electric Power Station Project in Zambia, Mamve'ele Hydro-Electric Dam Project in Cameroon, Soubre Hydro-Electric Power Station Project in Côte d'Ivoire, Imboulou Hydro-Electric Power Station Project in Congo Brazaville, Poubara Hydro-Electric Dam Project in Gabon, Mambila Hydro-Electric Dam Project in Nigeria, Isimba Power Plant Project in Uganda, and Grand Renaissance Dam in Ethiopia, among other several projects across Africa. Whilst studies by various scholars such as the International Energy Agency (2017), Vhumbunu (2016), Du Plessis (2016), Arewa (2016), Sy and Copley (2017) and Shen and Power (2017) have all stressed the fundamental role played by Chinese-partnered projects in terms of contributing to energy access, impacting on economic development, and

transferring of modern technologies in the energy sector via cheap loans or grants from China, there has been criticism of the funding mechanism that involves a conditionality for contracting Chinese companies in project implementation (Davies *et al.*, 2008; Jansson, 2009) whilst other studies have identified long-term debt over-hang as a possible challenge in the long run (International Energy Agency, 2017; Jansson, 2009; Davies *et al.*, 2008). Perhaps as Davis *et al.* (2008) recommended, African countries need to have an adequate understanding of Chinese aid architecture as well as improve the reporting capacity of government agencies for accountability purposes whilst debt reporting will also enhance transparency in debt accumulation.

Sustainability also remains vital in the China-Africa partnership in energy infrastructure development. Tan-Mullins *et al.* (2017) study "Evaluating the behavior of Chinese stakeholders engaged in hydropower projects in Asia and Africa" explores the interests of different Chinese stakeholders and accompanying implications in the Chinese hydropower projects using fieldwork data from four hydropower projects in Cambodia, Ghana, Nigeria and Malaysia. To the authors, the implementation of energy infrastructure projects in general, and hydropower projects in particular, requires sustainable planning, building and mitigation strategies that consider the national development priorities, local communities and the environment (Tan-Mullins *et al.*, 2017: 464). Certainly, such an approach allows for sustainability even in industrialization and economic development.

The China-Africa partnership in energy infrastructure development can also be viewed within the context of the Belt and Road Initiative (BRI). The BRI is a long-term strategic development initiative of the Silk Road Economic Belt (SREB) and 21st Century Maritime Silk Road meant to foster trans-continental economic cooperation and connectivity through logistical and transport networks in the form of roads, pipelines,

airports, seaports, railways, energy and ICT infrastructure between China and over 65 countries of Europe, Middle East, Asia, and Africa. Although the BRI initially mentioned Egypt and Kenya as the main African players, other African countries may link the Africa BRI route and derive economic benefits of investments and trade. As Mathews and Huang (2018) argue, the BRI presents another dimension as a "conduit for clean power project". Thus the BRI opens an opportunity for African countries to benefit from Chinese energy infrastructure development investments.

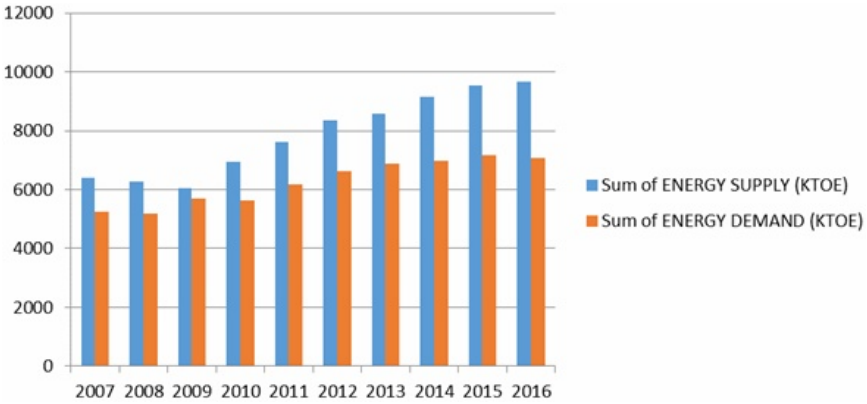
4. Energy Production Trends and Patterns in Ghana

The need for Ghana to embark on the massive industrialization and building of social amenities such as roads, schools, hospitals, and factories called for a reliable supply of power after attaining independence in 1957. This heightened need for infrastructural development initiated the building of a dam to provide the country with hydropower. The government therefore sourced for funding in terms of loans from the World Bank and the USA (VALCO specifically) to execute the project. Due to this factor, the Volta River Authority (VRA) was established in 1961 and charged with the duties of electricity generation via the hydropower of the Volta River, the construction of the Akosombo Dam and a power station near Akosombo, and the resettlement of residents. Formal construction of the dam begun in 1962 and was completed in 1965 at an estimated cost of US$200 million (Eshun and Amoako-Tuffour, 2016).

Rapid import substitution industrialization followed the construction of the dam in Ghana's major cities, thus increasing the demand for power. By 1980, electricity demand matched electricity produced. Total generating capacity of the Akosombo Dam by 1972 had reached

3,321.23 GWh with the installation of two additional generating units. Domestic power consumption increased nearly sixfold from 540 GWh in 1968 to 3,917 GWh by 1976 with about a 10 percent annual growth rate. Domestic power consumption, however, fell from 3,917 GWh in 1976 to 3,429 GWh in 1978 and declined further to about 1,151 GWh in 1984 (VRA Annual report 2016) as a result of the deteriorating economy in the late 1970s and early 1980s especially in 1983.

Figure 1 Trend of Energy Supply and Demand in Ghana, 2007-2016



Source: Energy Commission, Ghana (2017).

By the end of the year 2016, the total primary energy supply was 9,660 (KTOE). This was mainly generations from oil, natural gas, biomass, hydro and solar plants. Total energy demand on the other hand by the year 2016 was 7,085.5 (KTOE), also comprising mainly demand for electricity, petroleum products and biomass consumptions. Up until 1991, Ghana solely depended on hydropower for energy. Thereafter, other power generating alternatives were enacted to expand electricity

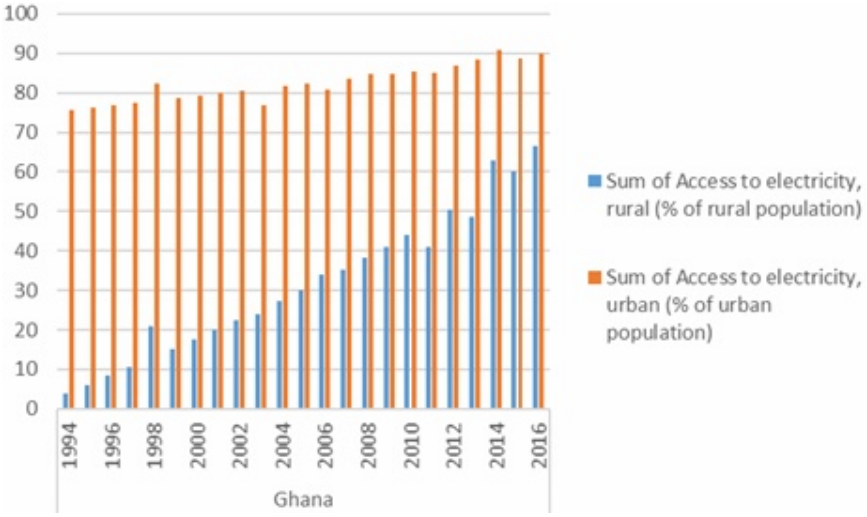
networks in Ghana especially in the northwest areas of Accra. This brought about the introduction of other sources of power such as thermal energy, solar energy, wind energy, bioenergy and renewable energy. In 1994 the construction of the first thermal energy plant was anticipated, enacted and it was completed by the year 1997. Upon completion, the plant contributed about 300 MW of electricity to the Ghana national grid.

Over the last decade, Ghana has experienced an increase of 49.8 percent in peak load from 1,274 MW in 2007, 1,506 in 2010 and 2,087 MW in 2016 respectively (Energy Commission, Ghana, 2018). Energy supply or generation capacity has also more than doubled over the period between 2007 and 2016, from 6,406 KTOE to 9,660 KTOE, recording an average annual increase of 8.60 percent. In spite of this, the country is still struck with energy instability, which has been the case over the last decade. This major challenge has affected many industries in their various operations and hence attracted huge losses to several others. With Ghana yet to be an industrialized economy, this power instability is going to greatly impact the economy becoming an industrialized nation since potential investors are becoming more rational with their business venture choices.

Figure 2 shows the share of distribution regarding access to electricity. This captures the total population's access to electricity, access to electricity in the urban sectors of Ghana as well as access to electricity in the rural sectors. The trend indicates an annual increase in electricity access rate in both the rural and urban sectors of the economy. Given Ghana's commitment to achieving universal access to electricity in a bid to become an energy economy by the year 2020, the National Electrification Scheme was established (Ministry of Energy, 2010). The National Electrification Scheme (NES), which is one of Ghana's flagship projects, serves as the principal instrument leading the efforts to extend

electricity to all parts of the country within a period of thirty years from 1990 to 2020. As confirmed by the Ministry of Energy (2010), as at the time the scheme set off to assume service only about 15-20 percent of Ghana's population had access to electricity (Energy Commission, Ghana, 2018). However, access to electricity reviews indicate a high access rates of 66.7 percent in 2009, 80.51 percent in 2015 and 82.5 percent in 2016 (Ministry of Power, 2016). The trend shows an annual increase in electricity access rate of 2.60 percent. However, Ghana's situation is not that hopeless. There is hope for a sky-high revival if the right measures and policies are enacted.

Figure 2 Access to Electricity – Urban and Rural Sectors, 1994-2016



Source: World Bank data, 2018.

Table 2 Installed Grid Energy Generation Capacity Operational as of May 2018

GENERATION PLANT	Installed Capacity (MW)	Dependable Capacity (MW)	Fuel Type
Hydro Generation			
Akosombo	1,020	900	Water
Kpong	160	140	Water
Sub-Total	1,180	1,040	
Thermal Generation			
TAPCO- T1	330	300	LCO/Gas
Takoradi International Company(TICO 2)	80	320	LCO/Gas
Mines Reserve Plant (MRP)	110	70	Gas
Tema Thermal 1 Plant	49.5	100	LCO/Gas
Tema Thermal 2 Plant	38	45	Gas
Tema Thermal 2 Plant (Expansion TT2PP-X)	38	32	Gas/DFO
Kpone Thermal Power Plant (KTPP)	220	200	Gas/DFO
VRA Navrongo Solar Plant	2.5	-	Sunlight
Sub-Total	2,340	2,107	
IPP			
Sunon Asogli Phase 1	200	180	Gas
Sunon Asogli Phase 2 Stage 1	180	160	LCO/Gas
Sunon Asogli Phase 2 Stage 2	180	160	Gas/LCO
CENIT Power Plant	110	100	LCO
Kar Power Barge 1	235	225	HFO
Ameri Power Plant	250	230	Gas
BXC Solar	20	-	Sunlight
AKSA	360	340	HFO
Kar Power Barge 1	235	225	HFO
Ameri Power Plant	250	230	Gas
BXC Solar	20	-	Sunlight
AKSA	360	340	HFO
Sub-Total	1,935	1,735	
TOTAL	4,275	4,882	

Source: VRA *Annual Report*, 2018.

Table 2 shows Ghana's installed electricity generation capacity. Ghana's power supply sources are mainly from hydroelectricity, thermal fueled by crude oil, natural gas and diesel, solar and some imports and exports to and from Côte d'Ivoire, Togo, Benin and Burkina Faso respectively. With the current activities on grid expansions, there is high anticipation that Ghana will be unable to export energy to other neighboring countries in the sub-region (Energy Commission, Ghana, 2018). Ghana has a vibrant power generation terrain with players from both the public and private sectors. Reforms in the power sector in the 1980s gradually removed barriers and created a level playing field for the participation of independent power producers in an area which hitherto had only public sector participants.

As of May 2018, Ghana's total installed capacity for existing energy plants was 4,132 MW consisting of hydro 38 percent, thermal 61 percent and solar less than 1 percent respectively. By the year 2020, Ghana aims to become an energy economy with reliable supply of high-quality energy services for the Ghanaian economy, with a budget of power distribution amounting 70,421,555 Ghana cedis. Prior to making Ghana an energy economy by the year 2020, a number of projects and activities (some completed with others yet to be completed) at various levels have been affected within the recent past years. For instance in 2017 a total of 445 MW of power capacity was added to the country's installed generation capacity to bring the installed capacity from 4,132 MW in 2016 to 4,577MW in 2017. Significant among these projects are Kpando-Kadjebi 161 kV Transmission Line which was completed, the Aboadze-Prestea 330 kV Transmission Line which is about 70 percent complete, the Prestea-Kumasi 330 kV Transmission Line which is about 70 percent complete, and the Kumasi-Bolgatanga 330 kV Transmission Line which is about 50 percent complete. The current 225 MW

Karpowership was replaced by a 450 MW Karpowership resulting in an addition of 225 MW capacity. Counting on, the Unit 2 of Kpong Generation Station Retrofit Project and Phase 1 of the 220 MW out of the 370 MW AKSA Power Project were also completed. As of May 2018, the 340 MW CenPower Power Project is 85 percent complete. Works has also commenced on the 400 MW Early Power project and 240 MW Amandi Power Project (Energy Commission, Ghana, 2018).

Until the late 1990s, Ghana's power sector had the Volta River Authority playing a monopolistic role in terms of generating and transmitting electricity to all regional sectors of the economy amidst balanced distribution to the Northern Sector through its subsidiary the Northern Electricity Department (NED). After the enacting of the power sector reform in the late 1990s, it came to light the need for Volta River Authority (VRA) to split into a separate generation and transmission system operations. This came as an opportunity for the private sector domain which also made it possible for other Independent Power Producers (IPP) to penetrate the market. According to Edjekumhene, Amadu and Brew-Hammond (2001), power supply constraints amidst growing energy demand coupled with the challenge associated with securing financial aid from the traditional financiers of the sector, including the World Bank, propelled the initiation of the power sector reform in Ghana. Overall, the inclusion of generating activities of the energy sector has in one way or the other increased access to energy.

5. China-Ghana Cooperation in Developing Ghana's Energy Sector

The Republic of Ghana, with a population of just over 24 million, is one of the best performing economies of West Africa. Ghana is classified as a low-middle income country with a per capita GDP (PPP) of US$2,500. China's relationship with Ghana dates back to the Pharaonic times in the

early 1960s even though modern Africa-China relations only began to blossom upon the continent's decolonization in the 1950s and 1960s (Zeleza, 2014). Since 2000, after the first FOCAC, China has substantially scaled up its financial assistance to Ghana focusing largely on infrastructural projects (including water supply projects), making up for approximately two thirds of investments since 2007. The intention has been to support Ghana's effort towards addressing the huge infrastructural deficits that impedes the country's economic development.

According to the Ghana Investment Promotion Center, China continues to remain on top of foreign direct investment in Ghana, with a cumulative total of 23 new projects registered in just the first quarter of 2011 (Sarpong, 2015). With the aim of rising to a middle-income status nation, Ghana sets to implement all efforts needed to stimulate productivity in agriculture, expand the industrial base and encourage learning and innovation in information and communications technology (ICT) to place the country in good stead to benefit from the global information technology (IT) industry (Keith, 2014). Given the fact that Ghana depends mostly on hydropower plants, it has become necessary to investigate China's engagement with Ghana in the energy sector. In the project analysis of China-Ghana South-South Cooperation on Renewable Energy Technology Transfer (Energy Commission, Ghana (n.d.)), in order to sustain its current economic performance, Ghana's energy sector vision is to develop an "Energy Economy" to secure a reliable supply of high-quality energy services for all sectors of the Ghanaian economy and also to become a major exporter of oil and power.

6. Highlight on China-Africa Partnership on Energy Development Projects

The Bui Dam stands as one of the hydropower projects developed in recent years in Africa financed by China Exim Bank (CEB) and constructed by Sinohydro. Built on the Black Volta River in western Ghana, the Bui Dam is a multi-purpose dam with the key aims of electricity generation and water supply. Bui Dam's history began in 1925 when its location was first deemed to be promising for a dam. In 1978, negotiations on the construction of the dam had evolved to the planning stage, with the involvement of the World Bank and Australia. Nevertheless, as elaborated by Hensengerth (2011: 9) a couple of coups d'état made accomplishment of this initiative an impossible one.

As highlighted by International Rivers (2015), there is no doubt that "China's low-interest loans got the [Bui Dam] project into becoming a reality". This is evident in Anane's (2015) report indicating that the World Bank refrained from the decision to fund the project in the early 2000s particularly due to "the amount of campaign against the dam" on the environmental impacts of the project. The World Bank also generally abstained from hydropower projects at that time (*The Guardian*, 2013).Apparently, the Ghanaian government had to fall back on the Chinese counterpart for needed support again. After this period, Sinohydro finally submitted a proposition for the dam in the year 2005. The Bui Dam's initial total project costs amounted to stand at US$622 million. Of this amount, US$562 million was provided by CEB, while the remaining US$60 million was accessed via an investment of the Ghanaian government (Hensengerth, 2011; International Rivers, 2015). Further funding of US$168 million accounting for about 27 per cent was needed to ensure the project was successfully completed. The CEB provided this additional funding (*The Ghanaian Chronicle*, 2011).

The Bui Dam with an envisaged capacity of 400 MW is currently ranked the second largest hydroelectric plant in Ghana next to the Akosombo Dam with a capacity of 1,020 MW (Volta River Authority, 2015). Together with the Kpong Dam with a capacity of 160 MW, the Bui Dam and the Akosombo Dam are Ghana's only hydroelectric power stations. According to Water Technology (2015) and Stocks (2014), the Bui Dam also comprises an irrigation scheme that is likely to supply water for approximately 30,000 hectares of land, 32 km north-east of the dam (Kirchherr *et al.*, 2016). This area would be comparable to 7.3 per cent of Ghana's Tain District where the project is located (*Ghana Districts*, 2015).

Aside from the construction of the Bui Dam, several other engagements and partnerships have also evolved. Significant among these include the signing of a US$3 billion deal with China Development Bank (CDB) in 2010 to develop Ghana's oil and gas infrastructure as well as a US$10 billion deal with CEB to develop the country's roads, railways, schools, and hospitals (Verma, 2011).

In the context of deepening Africa-China and Ghana-China ties, Shaanxi Regional Electric Power Group (SPG) has also partnered with BXC Ghana as a strategic partner. This partnership has seen the Electricity Company of Ghana (ECG) receiving over US$200 million in investment to boost its infrastructure to ultimately revive the local power distributor and make it more efficient. SPG is a large-scale electric power company which supplies power to more than 1,000 townships in 70 counties and districts in 9 municipalities of China's Shaanxi province. With 6.38 million power customers, SPG proudly covers 76 percent of the provincial territory, or an area of 142,500 square kilometers, and provides electric power service to more than 20 million people in its catchment area. According to *Business & Financial Times* (2018), SPG

stands ready to forge ahead with IPP partners such as BXC Ghana to make investments and contributions to the development of power distribution network in Ghana by jointly building a new type of modern power distribution network in West Africa.

Again, as of June 2018, construction plans are underway to birth another huge energy project prior to the signing of a partnership agreement between the two countries in March 2015. Armech Africa Limited, a subsidiary of the Armech Group, in a partnership agreement with Electricity Company of Ghana will construct a US$300 million waste-to-energy (W2E) power plant in Tema to generate 60 megawatts of clean energy (*Construction Review*, 2018). The project will be pre-financed by the Armech Group via Industrial and Commercial Bank of China, a Chinese multinational bank, without any sovereign guarantee from the government and is intended to create over 1,500 direct and indirect jobs and will also increase access to green and renewable electricity and lower environmental hazards as well as exposure to harmful pollution. Here again, the construction will be done by Energy China, one of the largest comprehensive solutions providers for the power sector and infrastructural project in China and the world. This project is intended to significantly enhance environmental sustainability, improve public health and limit the need for landfill sites, whilst producing the scarce base load renewable energy and will represent the first waste-to-energy project in the Economic Community of West African States (*ibid.*).

With a project budget of US$2,720,000, Denmark financed the China-Ghana South-South Cooperation on Renewable Energy Technology Transfer Project (RETT). RETT is a four-year (2015-2018) tripartite initiative designed to facilitate the transfer of knowledge and technology between China and Ghana, by building on China's unique experience in renewable energy development via south-south

cooperation with funding support from Government of Denmark. The project forms an integral part of the Government of Denmark's commitment to enabling coherent cooperation between China and countries in Africa, in the promotion of the UN's Sustainable Energy for All (SE4ALL) initiative (United Nations Development Programme, 2018). This is in relation to the reality that even though the national-level electricity access in Ghana has increased to 76 percent, rural areas lag with only 40 percent access, which has a negative impact on rural development in Ghana.

This project is a partnership of the Energy Commission in Ghana, the Ministry of Science and Technology in China together with the UNDP Country Offices in Accra and in Beijing. The project operates both at the upstream level (supporting the creation of an enabling environment for technology transfer) and downstream level (actual transfer and demonstration of technologies with potential upscaling by the private sector). By June 2017, pre-feasibility studies have been conducted and potential sites identified. Match-making between Chinese and Ghanaian companies is ongoing with the hope that this project will be completed and finally see the light of the day. If this becomes a shining reality, Ghana can have a sigh of eventual relief from severe energy technology deficiency (United Nations Development Programme, 2018).

The above projects indicate that there is firm foundation for greater cooperation in terms of energy production which is vital in ensuring productive capacity cooperation between China and Ghana whilst triggering Ghana's industrialization. The two countries have greater scope to partner in energy production across the various energy sources, especially relating to renewable energy production.

7. Possible Challenges and Threats to the China-Ghana Partnership in Energy Infrastructure Development

Whilst the China-Ghana partnership in energy infrastructure presents very valuable opportunities to facilitate the promotion of production capacity and industrialization cooperation, one cannot ignore the potential challenges that may threaten the process. The main challenges affecting the effective implementation of China-Africa partnership projects may also perturb the China-Ghana energy infrastructure development projects. In the report *Dance of the lions and dragons: How are Africa and China engaging, and how will the partnership evolve?*, Sun *et al.* (2017) state that while job creation and skills development, knowledge and technology transfer, and access to infrastructure financing are accrued as benefits from Chinese investments, there are challenges that local outsourcing is limited, local managers in China-Africa investment projects are few, and challenges such as corruption, labour law violations and insufficient adherence to environmental regulations are still common. A very prominent case is the massive deportation of Chinese nationals from Ghana in 2013 after they were accused of being involved in illegal gold mining activities ("*galamsey*") which was also causing extensive damage on the environment (see Aidoo *et al.*, 2017).

With respect to skills transfer, Tang (2018: 940)'s study on the impact of Chinese investments on Africa's manufacturing sector focusing on Ghana observed that Chinese investors were unwilling to teach local workers and companies skills because of communication problems, prejudice against Ghanaians or competition concerns, whilst also revealing that most of the machinery/technology brought to Ghana were out-of-date or already "mature" which obviously retards industrialization and modernization. The China-Ghana partnership in

energy infrastructure development may fail to promote production capacity and industrialization cooperation due to these factors.

The real benefits of production capacity cooperation and industrialization has a possibility of being affected by corruption amongst political leadership and within the bureaucracy. Idun-Arkhurst (2008) also observed that despite Ghana's impressive policy performance on investment governance issues compared to most African countries, there is prevalent corruption in political circles which is often worsened by bureaucratic delays in handling and approving investment deals. If checks and balances are not instituted, perhaps through enhancing the oversight role of parliament as well as promoting the watchdog role of civil society organizations and media, corruption will affect the end objectives of the China-Ghana partnership in energy infrastructure development.

With the heightened fear of debt accumulation, the China-Ghana partnership in energy infrastructure development faces a possible threat. Through what has now been termed the "debt-trap diplomacy" (*see The Australian*, 2018), there are legitimate fears that some African countries may mortgage their strategic assets and resources. More prudent financing mechanisms are encouraged which will also preserve the international reputation and image of China as a viable investor on the continent. The real threat may be shortcomings with respect to negotiation abilities and skills amongst the political elite and bureaucrats within African governments. Coupled with this, limited capacity of African governments to undertake comprehensive investment project planning, project design, project risk management and analysis may also threaten the optimum delivery and socio-economic impact of the energy infrastructure development projects in Ghana since this is also a challenge. This has been the case with other Chinese projects elsewhere on the continent; for example, the US$4 billion Addis Ababa-Djibouti

freight railway officially inaugurated in 2018 was reportedly costing China almost US$1 billion in losses due to debt restructuring whilst Sierra Leone scrapped the US$318 million Mamamah International Airport Project which had been commissioned by the previous president of the country in March 2018 and was scheduled to be completed by 2022, on the basis that the project was economically unviable and had been embarked on without due diligence (*The Straits Times*, 2018). Proper and detailed project feasibility analysis as well as wide consultations and stakeholder engagements are critical as Ghana engages China on energy infrastructure development projects.

8. Recommendations and Conclusion

From the discussions, it can be noted the China-Ghana partnership in energy infrastructure development has significant potential to facilitate more effective production capacity and industrialization cooperation between the two countries. This is because as discussed, energy infrastructure development ensure more reliable distribution and access to energy which propels industrialization and economic production in Ghana.

It is therefore recommended that Ghana fully utilizes the opportunities presented by Chinese production capacity and industrialization cooperation through identifying priority energy infrastructure development projects for investments from China. These may cut across different sources such as hydro-electric energy, solar energy, marine power, geo-thermal energy, wind energy, and bio-energy, as well as crude oil and natural gas deposits. Developing an energy sector investment catalogue will facilitate strategic engagement with China and allow for Ghana to be able to pursue its interests in the sector when negotiating with investors from China.

It is also recommended that Ghana focuses more on prioritizing renewable energy infrastructure development. Such an approach will require the key public institutions in Ghana, namely the Ministry of Power, the Energy Commission (EC), the Ghana Grid Company (GridCo), Public Utility Regulatory Commission (PURC), and Electricity Company of Ghana Limited (ECG) to prioritize renewable energy projects in light of the threats posed by climate change on the country's heavy reliance on hydropower energy. Given China's advanced and sophisticated technology in the energy sector as well as its drive for renewable energy, Ghana may take advantage to negotiate more investments into harnessing abundant solar energy, wind power, geothermal energy, biofuel, biomass, tidal power, and biogas. For instance, China is one of the leading producers and developers of photovoltaic power stations across Africa (*see for instance* Wang, 2010; Zhang and Yang, 2006; Zhao *et al.*, 2013; Zhao *et al.*, 2011). It will be strategic to incentivize Chinese investments in solar energy production given Ghana's advantageous geographical location along the equatorial region.

With the establishment of the US$10 billion China-Africa Industrial Capacity Cooperation Fund, jointly established by the China Foreign Exchange Reserves and Export-Import (Exim) Bank of China, engaging China to secure infrastructure financing is critical. However, developing bankable and sustainable projects remains a pre-requisite. Thus the Government of Ghana should invest in diligent project preparation capacity building, effective project planning and management, as well as sound practices in monitoring and evaluation especially in the private and public sector. This will also reduce the possibility of lopsided and asymmetric investment deals on the part of Ghana.

It is also prudent for Ghana to complement its partnership with China in energy infrastructure development through Private-Public

Partnerships (PPPs) as well as other local sources of funds for infrastructure development such as further capacitating its already existing Sovereign Wealth Fund (SWF), tapping into pension funds, incentivizing local investment initiatives, and cooperating with other international economic partners or investors. This will assist to avoid a debt trap and accumulation of unsustainable debts through China's lending.

Lastly, the development of conducive policy, legislative and regulatory frameworks within the energy sector in Ghana will assist to promote production capacity and industrialization cooperation between the country and China. Crucial to this is the reduction of cost of doing business as well as other barriers to investment. Currently, Ghana is ranked 111 out of 137 countries on the *Global Competitiveness Report* of 2017-2018 (World Economic Forum, 2018). However, with specific reference to the performance of public institutions, which encompasses, among other indicators, the burden of government regulation and efficiency of legal frameworks, the country is ranked 46 out of 137 (*ibid.*). This is not so bad by African standards and peer comparison although there is scope to improve on all the indicators. Investment governance has to be strengthened to prevent corruption and facilitate quicker turnaround time with regard to investment approvals.

Similarly, the World Bank's *Doing Business Report* for 2018 ranks Ghana on position 120 out of 190 countries (World Bank, 2018). The World Bank rankings are a product of consideration of 10 indicators, namely revolving around procedures, time and cost of starting a business, dealing with construction permits, getting electricity, registering property, getting credit, protecting minority investors, paying taxes, trading across borders, enforcing contracts, and resolving insolvency (World Bank, 2018: 2). Therefore, as committed in the study of Jonker and Robinson (2018: 8) on the FOCAC Action Plan (2016-

2018), Ghana must continue to "improve laws, regulations [in terms of improving the functioning of market-regulating institutions] and introduce preferential policies [in a bid to pursue macroeconomic stability, and strengthen procedures for contract enforcement and dispute settlement. To this effect the Ghanaian government can also improve the coherence of policies in areas such as trade, tax, competition and investment promotion which will in turn affect the volume of investment and its development impact] to create an enabling conditions and environment to attract investments by Chinese companies and support industries and industrial capacity from China."

On the basis of the study's findings, it can be concluded that the China-Ghana partnership presents massive opportunities for the two countries to promote production capacity and industrialization cooperation through energy infrastructure development. There is scope for China and Ghana to increase and intensify the current levels of investment cooperation in energy infrastructure development to spur industrialization and economic development in Ghana. Strategic prioritization on the part of Ghana as well as further improving the investment climate in the country will bear desirable fruits in energy infrastructure development.

Notes

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