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An assessment of Ghana's electricity sector, challenges, and remedies

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Abstract
Ghana has traveled quite a journey in developing its power sector from the days of 1914 where only a few cities had electricity to about 83% electricity coverage across the entire country in recent days. The country has succeeded in improving its generation mix; it has nineteen (19) power plants and not relying so much on the Akosombo dam. The days of Power rationing; "Dumsor" are seemly over. There is limited data on Ghana's power sector, therefore, this research delves into the current issues of the sector including the power sources that make up the national grid as well as consumption trends of the economy. The study also reveals some hindrances facing the sector and adds to the available literature on Ghana's power sector. This research used data from the official pages of key players in Ghana's power sector including the Energy Commission (EC), the World Bank and others.
The paper reveals that over-involvement of the government in the affair of the utilities, indebtedness, poor performance of some utilities and disregard for energy efficiency policies by citizens pose a deleterious challenge to the sector. The paper suggests the development of mini-grids, adoption of measures to reduce transmission losses as a way to improve the current state of the country's power sector.

Keywords: electricity, generation capacity, consumption trend, Ghana

1. Introduction
Attempts by various governments to grow their economies include; a journey to providing individuals and industries with stable electric power at reasonable rates. The gross domestic product (GDP) of every country is affected by electric power stability. However, this does not come easily since every stage of power production (generation, transmission, and distribution) comes with its associated costs and challenges.
In the colonial days, electricity in Ghana (formerly Gold Coast) was produced by diesel-powered generator plants scattered across the country. Industries and institutions used different generators for their operations. The Gold Coast Railway Administration established the first public electricity generation system to supply electric power for railway operations in Sekondi in 1914, which extended to Takoradi in 1928 (ECG, 2019) [7]. Between 1922 and 1938, electricity gradually extended to other major cities such as; Tema, Accra, Kumasi, Tamale and Cape Coast by the Electricity Department of the Public Works Department (PWD).
The Akosombo Hydroelectric Project (HEP) commonly referred to as the Akosombo dam constructed in 1965 provided 912 megawatts (MW) of power for the country and by 1972 reached 3,321.23 Gigawatt hours (GWh) (Eshun & Amoako-Tuffour, 2016) [8]. The country's power situation improved upon the establishment of the Volta River Authority (VRA) in 1961, which's mandate was to generate, transmit and distribute electricity under the Volta River Development Act, Act 46. With the aim of strengthening the country's power sector, Electricity Corporation of Ghana was established in 1967 to take over from the Electricity Department of PWD and was charged with the bulk purchase of electricity from VRA for distribution to customers in the entire country. The Act was later modified to permit VRA to engage in the distribution of electricity. VRA distributed electricity to the northern part of the country and that led to the establishment of the Northern Electricity Department (NED) in 1987. This in effect limited the operation of Electricity Company of Ghana (ECG) as NED took over the Brong, Northern, Upper East and West regions of the country.
Today, Ghana's energy sector is made of two main sectors, comprising petroleum and power. The petroleum sector comprises the upstream activities which include; the production, procurement, and refining of crude oil. The downstream involves the production, distribution, and marketing of petroleum products and the premixing of petroleum products for industrial uses, including fisheries (GIPC, 2019) [9]. The power sector encompasses the generation, transmission, and distribution of electric power for domestic, commercial and industrial use. Generation is carried out by VRA, Bui Power Authority (BPA) established by the BPA Act 740, 2007 and five (5) Independent Power producers (IPPs). Transmission is also carried out by Ghana Grid Company (GRIDco) established in 2006 by the Energy Commission Act (541), to facilitate electricity transmission via delivery at power distribution centers and subsequently to all market participants whiles, VRA continues with its generation business (Eshun & Amoako-Tuffour, 2016) [8]. Distribution is done by Power Distribution Services (PDS) former ECG, NEDCo, and Enclave Power Company, a privately-owned Ghanaian company incorporated in 2009.
Ghana currently has nineteen (19) power sources (plants), made up of three (3) Hydro, fourteen (14) Thermal and two (2) Renewable Energy Plants. These sources together produce a total installed capacity of 4,420 MW and a dependable capacity of 3,877 MW (VRA, 2019) [19]. As part of its efforts to attain nationwide access to electricity, the

government launched an agenda that will ensure that the entire country has access by the end of 2020. Despite the efforts to increase power production and in ensuring that the power crisis seen in 1984 and 1998 do not reoccur, rapid economic development with its demand for power has exceeded the supply of power causing power crises in recent years. From 2007, the country has been struggling to supply enough power to its citizens, which earned a local term "Dumsor" which translates to on-and-off; the description of electric power stability. Reasons attributed to this include low water levels of the Akosombo dam, cut off of natural gas supply by the West Africa Gas Pipeline from Nigeria, inadequate alternative power sources. The country's power sector is challenged by obsolete machinery and equipment thereby affecting efficiency (Kumi, 2017) [12]. Transmission losses, the insufficiency of tariffs to power companies, inadequate diversity in the electricity generation mix and the difficulty of entry into the sector are also a challenge to the sector.

This paper seeks to discuss the current state of Ghana's power sector in terms of access to electricity, generation mix, current demand and supply, plans of the government for the sector and also to address some of the challenges confronting the sector and to provide some suggestions.

2. Methodology

This study adopts the qualitative data approach. The approach aims at turning the unstructured data found in texts and other artifacts into a detailed description of an important aspect of a problem, even though, analysis and interpretation of data at times pose challenges compared to quantitative data usage (Lazar, Feng, & Hochheiser, 2017) [13]. There is only a few published literature on this study. This study gathered data from key documents and reports of the VRA, ECG, and other utility companies, official web pages of government and key stakeholders, World Bank database as well as published literature.

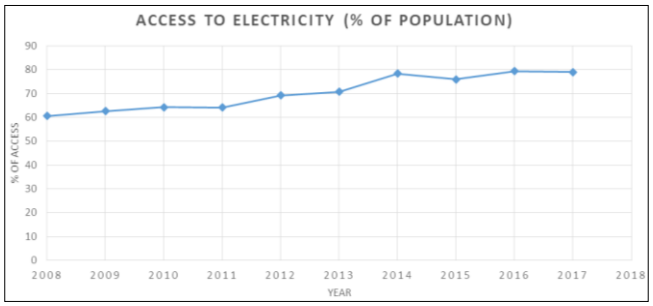
3. Current situation

3.1 Access to electricity

Energy access means a household having reliable and affordable access to clean cooking facilities, the first connection to electricity and an increasing level of electricity consumption to reach the regional average (IEA, 2013) [10]. Access to electricity is measured by how the supply meets the demand for electricity and also factors such as the affordability and consistency of electric power supply.

Ghana's strive to achieve universal access to electric power begun long ago. In 1989, the National Electrification Scheme (NES) was established in line with the aim of the country to attain 100% electrification by 2020. The Self-Help Electrification Program (SHEP) was also introduced to encourage the participation of various communities in achieving the goals of the government.

Ghana, South Africa, Sudan, Ethiopia, and Angola are the five countries in Sub-Sahara Africa to have added more MWs to their grid since 2000, (Eberhard, 2015) [3]. In 2010, Ghana, Nigeria and Ivory Coast's power production accounted for more than 90% of the about 10 gigawatts (GWs) produced in West Africa (IRENA, 2015). Although the country has not achieved its target, it has gone a long way to produce power for its local market and even export to neighboring Togo, Burkina Faso, and Ivory Coast.



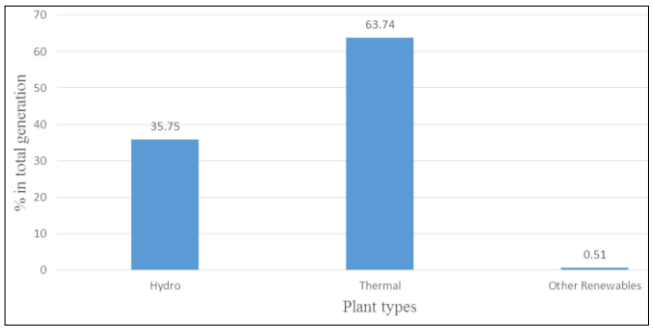
Source: World Bank database

Fig 1: % Trend of electricity access in Ghana

Ghana moved from nationwide electricity coverage of about 30.6% in 1993 to 42.6% in 1998 and further to 60.5% in 2008. Even though there is not much information, data from the United States Agency for International Development (USAID), a key stakeholder estimates the accessibility rate to be at 83% whilst the rural-urban rate is about 50% and 91% respectively as of 2018 (USAID, 2018).

Current generation mix

The generation of power is carried out by VRA which operates the Akosombo dam and a number of thermal plants and a renewable energy source, BPA as well as five (5) IPPs. These IPPs are Kar Powership, Sunon Asogli, Cenit power plant, BXC Ghana and AKSA Generators. The nineteen (19) power plants are made up of 15.8% hydro, 73.7% thermal and 10.5% solar plants which are an improvement over the previous years and reduces the country's over-reliance on hydropower. Out of an installed capacity of 4,420 MWs, 35.75% is hydro, 63.74% are thermal whiles 0.51% are other renewable (solar) plants.



Source: VRA, 2019

Fig 2: Installed capacity by plant type

The current generation mix tells the effort of the country to migrate from its overdependence on Akosombo hydro dam to thermal plants for reasons including the uncertainty in predicting rainfalls which is the main ingredient for the hydro dam. The country has only two renewable sources of energy (solar) on the national grid despite the abundance of sunshine the country enjoys.

Table 1: VRA generation plants

Plant	Installed Capacity (MW)	Dependable Capacity (MW)	Type of Plant
Akosombo	1,020	900	Hydro
Kpong	160	140	Hydro
TAPCO - T1	330	300	Thermal
TICO - T2	340	320	Thermal
Mines Reserve Plant - MRP (Decommissioned)	80	0	Thermal
Tema Thermal 1 Plant - TT1PP	110	100	Thermal
Tema Thermal 2 Plant - TT2PP	49.5	45	Thermal
Tema Thermal 2 Plant Expansion - TT2PP-X	38	32	Thermal
Kpone Thermal Power Plant – KTPP	220	200	Thermal
Ameri Power Plant	250	230	Thermal
VRA Navrongo Solar Plant	2.5	-	Solar
Total capacity	2,600	2,267	

Source: VRA 2019

Table 2: Generation plants by other IPP's

Plant	Installed Capacity (MW)	Dependable Capacity (MW)	Type of Plant
Bui	400	340	Hydro
Kar Power Barge 2	470	450	Thermal
Sunon Asogli Phase 1	200	180	Thermal
Sunon Asogli Phase 2 Stage 1	180	160	Thermal
Sunon Asogli Phase 2 Stage 2	180	160	Thermal
Cenit Power Plant	110	100	Thermal
BXC Solar	20	-	Solar
AKSA	260	220	Thermal
Total Capacity	1,820	1,610	

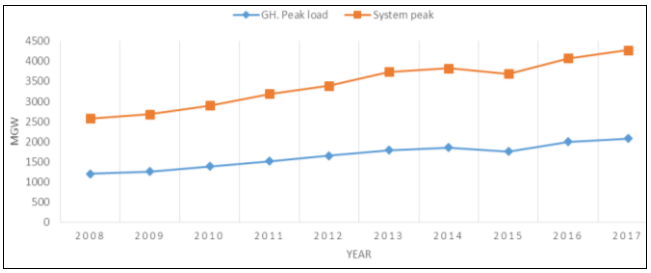
Source: VRA 2019

The country has to some extent succeeded in improving its generation mix. From the details above, the country is resorting to thermal plants currently to complement the Akosombo dam. It rather has few renewable power plants, despite the ease of access to them, especially sunlight and wind and biomass. For instance, the sunshine duration of the country is estimated to be about 1800 to 3000 hours per annum (Park, 2018) [17], which could have increased renewable power plants use.

The installed capacity of a plant refers to the amount (measured in MWs and KWs) a plant or generator can produce at its full capacity. The United States' Energy Information Administration refers to capacity as the maximum output of electricity that a generator can produce under ideal conditions (Daron, 2017) [2]. Dependable capacity, on the other hand, refers to the amount of power that a plant is expected to produce under adverse or unfavorable systemic conditions.

3.2 Peak load and system peak load

The highest power demand of a power grid over a period of time is referred to as its peak load or peak demand. In the case of Ghana, it is the total of all power (produced by local plants and imports) consumed by the country and the mines except for that of Volta Aluminum Company (VALCo). The system peak load refers to the highest power demand of a grid over a time period including its exports. For the case of Ghana, it includes household, commercial and industrial power used plus that of VALCo as well as exported power (EC, 2018b) [5]. Data from the EC's national energy statistics for 2008 to 2017 tells that except for 2016 the country has been achieving a positive balance of trade (surplus) in its power trading. From figure 3 below, the country's system peak is far above its local consumption (Ghana peak load). This reflects the increase in the availability of power to the various classes of customers as well as export obligations.

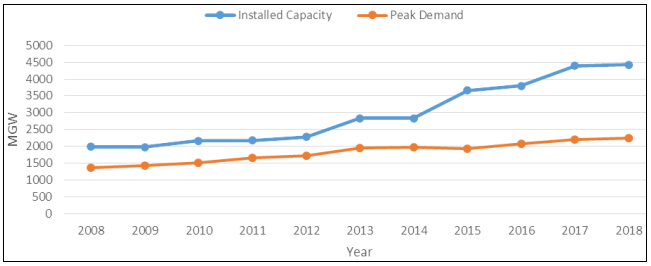


Source: EC, 2018b

Fig 3: Peak load vs. system peak load

3.3 Electricity demand and supply

Ghana, being a developing economy has always seen a rise in the demand for electric power. By the 1980s, the demand for electric power had exceeded the capacity of the Akosombo and Kpong hydro plants which caused the need for the West African Gas Pipeline (WAGP) (Asante & Attuquaye, 2007) [1]. The country's journey to industrialization and economic growth has come with more households (individuals) and industries demanding more supply of power. The country is also currently seeing an increase in a category of power consumers known as the bulk customers. According to (EC, 2018c) [6] a consumer with a demand of at 500KVA (about 0.5MW) for about three (3) months continuously or a minimum annual consumption of one (1) million Kwh) is considered a bulk customer. The total electricity generation of the country for the year 2017 was 14,069 GWh, an increase of 8.4 % over the previous year, whilst system peak load (maximum utilized) including export of 115 MW for 2017 was 2,192 MW (EC, 2018a) [4]. The peak demand for the year 2018 was between 2,150 MW and 2,600 MW.



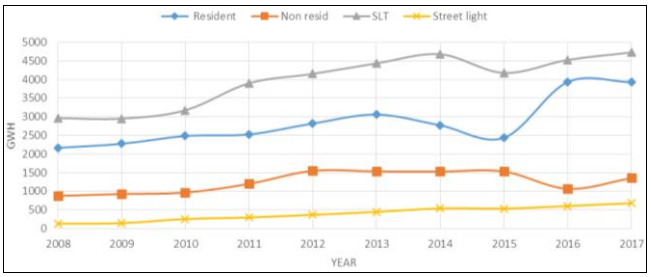
Source: EC, 2018b

Fig 4: Installed capacity and peak demand

The figure for 2008 and the prediction of the EC for 2018 shows a good level of improvement in the installed capacity which far exceeds the peak demand. The issue has been with the inability to generate much from these plants due to reasons such as the periodic unavailability of fuel for the plants as well the poor performance of the utilities leading to actual demand overshadowing supply.

3.4 Consumption trend by consumer classes

The country's journey to economic development has also influenced the demand for electrical power by the various class of consumers. Even though the supply in some years has been affected by various constraints, demand has always increased. After a fall in the 2007 value of 1,997 GWh from 2022 GWh in 2006, the consumption rose until 2013 (3060 GWh). There have been fluctuations in consumption due to generation challenges. Figure 5 gives an account of the trend of power consumption by the various class of consumers from 2008 to 2017.



Source: EC, 2018b

Fig 5: Consumption trend by consumer class

The country's growth trend reflects its increase in demand for electricity by all consumer classes. Special Load Tariff customers (SLT) class which comprises of the class whose energy demand is for industrial purpose and with a consumption of more than 100 KVA. The country is likely to see a rise in SLT customers as the government plans to establish more companies and attract investment into the industrial sector of the economy.

3.5 Government's plans for the sector

The government of Ghana in its quest to eliminate all setbacks of the sector has for the past decade made various initiatives and effected some plans. The energy sector reforms, agenda 2020, rural electrification project, the introduction of prepaid meters, the Energy Sector Levy Act (ESLA), plans to improve the generation mix and add more renewable sources and others have been plans executed.

The government as part of its initiatives to clear the debts sinking the power sector issued the ESLA which has generated some funds to pay WAGP project amongst others.

The government with support from the World Bank and the Swiss government is constructing a number of mini-grids on the Volta Lake as well as Ada to provide electricity to citizens of five island communities along the lake.

The country's parliament passed the electricity regulations, Legislative Instrument; L.I 1937, 2008 in an attempt to streamline the sector's activities. This L.I provides for the establishment of a Wholesale Electricity Market (WEM) to facilitate the wholesale of electricity trading as well as an electricity market oversight panel to supervise the administration and operation of the WEM.

3.6 Privatization of ECG

The government, in order to streamline the activities of the country's biggest power distributor, has for the past years made various attempts to have private involvement. The governments of Ghana and the USA through the Millennium Challenge Cooperation (MCC's) project dubbed ECG's Financial and Operational Turnaround facilitated a 20-year concession agreement with a consortium led by Manila Energy Company popularly known as Meralco. The consortium which started to operate in February 2019 under the name Power Distribution Service Ghana (PDS) includes Meralco (30%) AEnergia SA, an Angolan company (19%) and three local companies, TG Energy Solution Ghana limited, Santa Power limited and GTS Power limited (51%). The country's power sector is expected to benefit from the $580 million to be injected by the consortium. The MCC is also to add some $498 million into the sector (MCC, 2018) [14]. Per the terms of the agreement, ECG's assets will become those of PDS; thus, ECG becomes a holding company and will reclaim the assets at the expiration of the contract.

4. Hindrance facing the sector

Just like the power sector of developing and even some developed economies, transmission and distribution losses, inadequate investment to improve existing infrastructure, utilities not being able to cover costs and be financially sound, difficulties in entering the industry amongst others are challenges faced by Ghana's power sector.

The country's power sector is financially unfit due to a number of reasons. Almost all utilities have accrued substantial sums of money in debts which according to (Mohammed, M., & Yusheng, K. 2019 [15], badly affect the financial performance of a firm. Also, ECG has huge sums stuck with government and private institutions, and individuals in utility bills. This affects the ability of utilities to acquire better equipment to improve their services and achieve their various investment plans. There is also over-involvement of the government in deals and operation of the utilities which sometimes do not go well for these utilities. The government has sought to provide funds in subsidies that prevent the utilities from charging the appropriate tariffs. Meanwhile, the said subsidies accrued for years into a pileup and are paid in bits which do not help the operation of these utilities. Even though many disregard this; exchange rates affect every aspect of a developing economy. It plays a key role in every sector of an economy. Utility companies require foreign exchange to import fuel for generating plants, buy equipment and carry out other investments. Hence, a continuous depreciation of the local currency means a continuous appreciation in cost to the utilities.

The country also suffers from the energy policies of the Nigerian government related to the supply of natural gas as Ghana relies on the WAGP to complement local production for the generation of power.

Despite the sector currently having a number of IPP's, the sector does not look so much attractive to investors despite the opportunities it presents. A major reason for this is the monopolistic nature of the sector, the over-involvement of the government and bureaucracy.

The unprofessional and unethical way of operation of some utilities set as a drawback for the sector. The sector seems to be characterized by customer agitations of delay in response to inquiry and disregard for customer satisfaction due to the monopoly the distribution companies enjoy. The distribution companies also blame the inability of the generations and transmission companies to effectively perform their duties as the main cause of electric power instability.

5. Suggestions and conclusion

The government has already made several efforts to improve electric power stability by putting in place measures to increase generation and pay off the debt entangling the sector. A common problem that has almost turn to be a national weakness is the inability to ensure that implemented measures are adhered to and a maintenance culture of rules and assets. The country seems to have weakly implemented the ban on second-hand fridges as these fridges and second-hand air conditioners are still on the market despite the education by the government on the power consumption and the environmental unfriendliness of these products. It is highly important that the EC continues its energy-efficiency campaign. The country is just recovering from a power crisis and should learn to conserve the power produced. Countries such as Nepal and Sri Lanka have succeeded in using mini-grids to improve its power generation making the achieve a worldwide recognition (Waldorf, D, 2015) [20] with Sri Lanka attaining over 99.7% whilst rural electrification in Vietnam was over 98% in 2018. Mini-grids could be provided in the rural communities where the national grid has not yet reached. This will provide power for the citizens and help in the universal electrification agenda.

Transmission losses are a challenge in most power sectors across the globe. The question in place becomes the magnitude of the loss. Considering the relationship between efficiency and firm's performance as researched by (Mohammed, M., Yusheng, K., & Isaac, A. M. 2019) [16], it is of importance that measures are put in place to reduce transmission losses. In 2017, Ghana lost about 4.1% of its total transmission. Various countries have adopted strategies to reduce such losses and so must Ghana. The government should maintain a professional level of oversight over all other companies in the sector and provide the necessary structures to enable them function. This will boost investor confidence and allow for a fruitful operation of the sector. The interim sources of fuel for the power sector; WAGP especially should be given attention to ensure a continuous flow of gas until Ghana can produce enough to feed the sector.

The country should take advantage of the sunshine especially in the Northern part of the country to develop more solar plants there as the country will also enjoy some cost-benefit compared to powering such places with a hydro or thermal plant.

Being one of the fastest-growing economies in the world, Ghana's economy is very promising and certainly requires some good electrical power backing to reach its aims. With an annual electrification rate of about 4.38 as at 2017 (Kumi, 2017) [12] and a national electrification rate of about 83%, the electricity growth rate will need some boosting. The country will not be able to reach agenda 2020 but could reach goal 7 of the United Nation's (UN) sustainable development goal which's targets include a universal access to affordable, reliable and modern energy services by 2030.

The new distribution company with its intended investment is expected to collaborate with stakeholders to improve the flow of power to customers. The paper's suggestion that the country considers having more mini-grids whilst putting in place measures to ensure a continuous flow of natural gas for the power plants. It is most important that African governments come to realize that a stable electric power supply is paramount to attracting investors.

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