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Research Article

Review and Analysis of Ghana's Power Sector Policies, Programmes and Reforms

Essandoh E. O.[1*], Akolgo G. A.[1], Kumi E. N.[1], Atta-Darkwa, T[1]

Abstract
Ghana has so far consumed about 60% (1580 MW) of its hydropower potential with the remaining untapped potential being just 820 MW. The country currently lacks adequate financial sources for harnessing renewable energy resources to generate electricity at the levels generated by developed countries. Thermal power which happens to be the best option to the country for firm power generation is relatively expensive. Nuclear power generation has not yet been implemented in Ghana primarily because of its safety requirements and the level of technical knowledge and commitment it requires. It is therefore incumbent on the country to carefully draw and strictly execute coherent energy policies to ensure the supply of affordable, reliable and sustainable power. This research reviews policy formulations, reforms and programmes of Ghana's power sector from 1966 to 2019 with the aim of having a fair idea of the power landscape and proposing measures and workable solutions for better understanding of the country's electricity situation in the future. Among the workable solutions identified and proposed in this paper is the call on government, not to sell out the state-owned power generating utilities and the need for it to have oversight responsibilities over the utilities in a manner that would not be adjudged as interference but rather help them to grow. The challenges faced by Ghana in its energy sector are attributed to factors such as inadequate power supply for both internal and external consumption, disconnection between policy directions and implementation (i.e., gap between policy and implementation), politicization of energy policies, reforms and programmes, excessive government influence and inadequate investment in the power sector of the economy. Inadequate investment in the power sector appears to be the major cause of the rampant power crises in Ghana.

Keywords
Energy, Ghana, Power, Reforms, Sector

[1*]Department of Mechanical and Manufacturing Engineering, UENR, P. O. Box 214, Sunyani-Ghana
***Corresponding author**: eric.essandoh@uenr.edu.gh

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1. Introduction

Energy demand of the world has increased tremendously with time as a result of civilization and essentiality of energy. Energy as a developmental tool, is an agent of socio-economic change whose proper, continuous and sustainable utilization results in total development of countries.

The usefulness and versality of electricity in modern life call for careful planning, organizing, directing and controlling of the power sector of countries to ensure the generation of reliable and affordable power. This makes it imperative for countries to formulate policies and programmes that would from time to time ensure sustainable development and utilization of energy for all of its citizenries.

People enjoy improved quality of life when energy is adequately made available to them. Energy policy instruments containing energy access and security issues if religiously followed and implemented ensure a vibrant energy sector and prevent the occurrence of energy crises. The objective of this research is to investigate the na-

tional policies, reforms and programmes undertaken in the power sector of the country to provide relevant information about the sector to citizenries and interested parties to help them make informed decisions about the "overall health" of this important sector of the Ghanaian economy. This may be done by juxtaposing the past against current programmes to establish whether there is continuity and linkage between past and present programmes to ensure consistency or there is total departure from past programmes due to modernity. Such a research should offer the future generation the opportunity to learn from our past and assess the challenges, achievements, benefits and the sustainability of past policies, reforms and programmes.

2. Review of Energy Issues

2.1 Energy Resource Potential of Ghana

Ghana's energy resource endowments are carbon-containing fuels (crude oil and natural gas), large and medium-hydropower and renewable or non-traditional energy sources such as solar (photovoltaic), wind (onshore and offshore), biomass and tidal waves (no public study has yet been done on tidal wave power generation). However, in 2018, TC Energy Limited, a local energy company contracted Seabed Wave Energy Company of Sweden to construct a tidal wave power plant of 100 MW, a fraction of the total tidal power generation capacity (1000 MW) which TC Energy Limited intends to install in the Greater Accra Region (precisely at Ada Foah) in the future. Tradable quantities of fossil fuel were first discovered in 2007 in the Western Region of the country with new discoveries made later in the same region. In 2017, Ghana's proven oil reserve was estimated as 840 million barrels [1]. Both crude oil-based and non-crude oil-based natural gas deposits have also been found in Western Region. The total natural gas deposit of Ghana has been estimated to be over 2.0 trillion cubic feet (tcf) [1]. The country does not have plans to use biomass for utility power generation however, it has plans to use biomass for cooking using improved cookstoves or biogas plants. Nuclear and clean coal power plants are other types of relatively cheaper power technologies that Ghana can deploy by importing radioactive materials and coal to fuel them respectively. One of the operating power plants in Ghana can run on both coal and LPG but coal is currently not being used for its operation. Thus, Ghana's current energy mix does not include nuclear energy and thermal generation from coal.

Ghana's Hydropower potential used to be the largest source of commercial energy until the discovery and introduction of oil into the economy of Ghana. About 60% of the country's hydropower potential of approximately 2400 MW has been exploited as of December, 2013 [1]. Ghana currently has three hydropower plants exploiting 60% of its hydropower potential. Ghana's first hydropower plant (the Akosombo Hydropower Plant) built in the Eastern Region on the Volta River has a generation capacity of 1020 MW while its second hydropower plant (the Kpong Hydropower Station) has a generation capacity of 160 MW and is also located in the Eastern Region. A third hydropower plant of generation capacity, 400 MW was built at Bui on the Black Volta in the Bono East Region of Ghana in 2013 [1]. The remaining hydropower resources are of medium sizes between 10 and 100 MW, with the total potential being about 820 MW.

Wind resource assessment carried out in Ghana in 1999 by Energy Commission of Ghana indicates that there exist wind sites with wind speeds ranging from about 5.5 m/s to about 6.2 m/s along the coast. The exploitable wind power potential of the country is pegged between 300 and 400 MW. Solar irradiation varies from place to place thus, the average annual solar irradiation of Ghana lies between 4.4 kWh/m^2/day and 5.6 kWh/m^2/day. In order to promote the deployment of renewable energy technologies mainly for electricity generation, the Parliament of Ghana enacted a Renewable Energy Law, ACT 811 in 2011. The first feed-in tariff scheme was also developed, to promote investment in renewable energy technologies in 2013 [1].

2.2 Energy Sector Reform in the World

A standard energy reform model tagged as 'standard energy model' was developed and first applied successfully in Chile in 1982. The standard energy model contains very relevant primary criteria and employs key events during the reform process to yield positive results and as well identify limitations of the reforms. It was also successfully applied in United Kingdom (UK) and Norway in 1990 and 1991 respectively thus encouraging many developed and developing countries to adopt similar energy models in their energy sectors. The standard energy model was developed for easy analysis, solutions and predictions of energy sector issues. It brought in its wake, a fundamental radical change in terms of energy sector management, market structures, role of the state and the regulation of the energy sector of the countries where it was implemented [2]. A very important and highly expected deliverable of the standard energy reform model was the privatization of state-owned utilities or energy assets. However, this belief became less acceptable when Norway successfully applied the standard energy reform model in its power sector without relinquishing the control of its state-owned, municipality and national utilities demonstrating that privatisation is not a pre-requisite for energy sector reforms [2]. However, the issues have been ineffective market structure, competition and network regulation. Most of the electricity reforms carried out by countries across the globe happened as a result of reactivity and not "proactivity". In addition, there are examples of situations across the globe where electricity reforms were initiated but could not be carried through

[2].

An extensive electricity reform for example, was initiated in 1993 by Ghana in response to an electricity supply shortage as a result of rising electricity demand in the face of drought. In 1997 Ghana's cabinet formulated an inclusive reorganized plan to reform the electricity sector in conformity with the standard electricity reform model. However, the reforms were not carried out due to an objection raised by the Volta River Authority (VRA), a state-owned enterprise, arguing at the time that the segmentation or unbundling of Ghana's power sector would weaken its competitive advantage in the West Africa Power Pool [2]. Though the Parliament of Thailand authorized its preliminary steps of electricity reforms in 1992, the 'Privatization Master Plan' which was finalized in 1997 could not receive any parliamentary approval because of financial crisis. The liberalization of the Thai electricity industry was halted as a result of the California crisis coupled with the change in the USA government in 2001 [2]. These are indications of situations where the implementation of energy reforms is ignored or delayed. Table 1 provides the circumstances that brought about the implementation of electricity sector reforms in some selected countries and the outcomes of the projects.

2.3 Electricity Sector Reforms Drivers

Global power sector reform was greatly strengthened as part of the energy sector reform programme during the 1990s. The involvement of countries across the globe in planning and controlling their energy sectors increased after the Second World War as governments decided to encourage socio-economic development and increase the accessibility of its citizenries to energy. Energy sector and external drivers are the two main categorization of the drivers of energy sector reforms. These drivers of the energy sector reforms depend on a country's developmental status mostly in terms of economic and infrastructural development [2]. Two basic classifications of countries are developed and developing countries. A developed country is basically a wealthy and an industrialized country with a well-developed economy and an advanced technological infrastructure while a developing country is a country with less industrial base and low human development index (below 0.8) seeking to be more developed economically, socially and technologically. Electricity sector reform drivers of both developed and developing countries are shown in Table 2.

2.3.1 Political Economy of Power Sectors

It is very easy to conclude that political economy of power sectors of developing countries has not received adequate attention considering the myriad of challenges faced by this sector in most developing countries. Political economy is about the study of how government policies influence the economy of a country so this research's intention to review and analyse the policies, reforms and programmes implemented by the Government of Ghana over the years is definitely not out of place. Once, the power sectors of countries across the globe are expected to be effective and efficient, it is therefore natural to expect that policies, reforms and programmes implemented by the power sector of countries yield positive and productive results. As a result, the political economy of the power sector of countries with notable challenges (developing countries) has been part of a World Bank knowledge program that aims to update the frame of reference for institutional pathways and market models for the power sector to improve the end results of the sector in developing countries, with special attention to goals of universal access and clean energy. The departure point is the model of market-oriented power sector reforms that became an international norm in the 1990s. These reforms were meant to improve economic efficiency and attract private investment, among other objectives. To understand the 1990s model reforms in a political economy context, it is very important to examine their history and theory in the context of broader energy sector and development issues [2].

2.4 Reforms, Programmes, Policies and Projects in Ghana's Power Sector

This section of the research is prepared to recount the reforms, programmes and policies that have been formulated or/and implemented in Ghana. It is also intended to provide a basis for assessing whether the reforms, programmes and policies instituted by the country have been potent enough in yielding positive results with respect to availability, accessibility, affordability and the quality of power enjoyed by electrified communities.

Power sector reforms in Ghana are not recent developments since after the formulation of the first legal framework in 1920 (The Electricity Supply Ordinance) for the then Gold Coast (now Ghana after independence in 1957), numerous reforms have taken place. Several of the reforms carried out in the country and presented in this section have gotten to do with the establishment of energy institutions and transfer of institutional mandates with none of the policy directives being legally binding on both policy makers and implementers as far as the execution of policies is concerned.

A minor reform was initiated through the enactment of Act 47 by the Legislative Council of Gold Coast in 1947 to give the Electricity Department of Gold Coast the mandate to generate and distribute power in the country thus, permanently relieving the Public Works Department (PWD), established in 1922 [3,4] of this responsibility. This reform was carried out to take and give the then PWD's function of generating and distributing power in the country to a dedicated company so as to ensure industrial efficiency. The next reform led to the establishment of Volta River Authority (VRA), a publicly owned utility company in Ghana on 26 April, 1961 to

generate electric power for the operation of an aluminium company (Volta Aluminium Company Limited-VALCO) and for general industrial and domestic uses by employing power technologies that the Authority may deem fit. Though per Act 46 of the Parliament of Ghana which established VRA, it could employ hydro and other energy resources to generate power for the country however, much has not been done in utilizing the country's renewable energy resources for electricity generation.

The inability of VRA to harness the country's renewable energy resources to the fullest is mainly attributed to lack of finance. In 2005, the responsibility of VRA for power transmission was given to Ghana Grid Company (GRIDCo), a company carved out of VRA with the aim of introducing efficiency and productivity in the power sector. It can be deduced from the above arrangement that apart from creating a management board for GRIDCo, no substantial changes might have occurred at the time as far as the work force of the transmission service operator of Ghana was concerned. All this while, the northern sector of the country was seriously under electrified so an offshoot of VRA, Northern Electricity Department was developed as a very important component of a larger scheme dubbed as Northern Electrification and System Reinforcement Project (NESRP) to transmit and distribute grid-electricity in the northern sector of the country thus relieving the Electricity Company of Ghana (ECG) from the responsibility of distributing power in the northern sector [6, 7]. A section of VRA's Northern Electricity Department was restructured into a subsidiary company and named as Northern Electricity Distribution Company (NEDCO) in May, 2012 to distribute power in the northern sector of the country [8].

A rural electrification programme was rolled out in 1970 but was discontinued after less than two years due to a change in government (Coup detat). On 23rd December, 1972 Ghana began to export electric power to both Republic of Benin and Togo through Communaute Electrique du Benin (CEB)- [9] to support these neighbouring countries to provide its people and productive sectors with relatively cheaper electricity and to foster healthy neighbourliness.

Following a drought and its concomitant power crisis in 1982/1983, a National Energy Board (NEB) was established in 1983 to formulate a plan to ensure the complete conversion and utilization of energy resources particularly to promote the use of unconventional and cleaner forms of energy, assess energy related public agreements and advise governments on energy issues however, it became operational in 1985. Again, the country was advised after this drought by some experts in the power industry to restructure the power sector in order to prevent future catastrophe. Notwithstanding this advice, the country has witnessed five other power crises which occurred in the following periods: 1993-94; 1997-98; 2002-03; 2006-07 and 2008-2015. Ghana was a net exporter of power to Cote d'Ivoire till Cote d'Ivoire increased its power generation capacity to absorb the quantity of power it used to constantly import from Ghana.

This necessitated the synchronization of the Ghana-Cote d'Ivoire Electrical Network in June, 1984 however, power and energy exchanges between VRA of Ghana and Energie Electrique of La Cote d'Ivoire (EECI now CIE) began on 24th February, 1984 [11]. In 1989, a National Electrification Scheme (NES) was instituted as the main instrument of the government of Ghana to achieve its policy of extending electricity to every part of the country over a thirty-year period as a result of the successful implementation of the National Electrification and System Reinforcement Programme (NESRP) in 1986 by the Government of Ghana (GOG). The NESRP was however terminated in 1990 without any reasons offered to the country [12]. The country has not yet been able to realize the feat of achieving universal electricity coverage and access even though the 30-year period earmarked for its attainment has elapsed for four years now in spite of the prominence of the programme as a policy directive. The aim of the NES programme was to electrify the whole country by the year, 2020 however, this objective is a failure since the time for its attainment is almost up and it is practically impossible currently to extend electricity to all the parts of the country [13, 14]. The NES programme comprised the District Capital Electrification Programme (DCEP) and the Self-Help Electrification Programme (SHEP). The purpose of the DCEP was to connect all the district capitals at the time to the national grid [13] and the SHEP was instituted to connect communities within 20 km of an existing 33 kV or 11 kV sub-transmission line to the national grid [14]. Residential demand for electricity increased steadily about 11% per year between 1985 and 1993 and 15% between 1993 and 1995. As a result of this, a Power Sector Reform committee (PSRC) was formed in September, 1994 to look into the energy situation of the country at the time and make recommendations for addressing the problem in the long-term. Reactively, the government took an initiative that sought to reduce the increasing pressure on the government in securing timely and adequate funding for investment in the power sector, which had started experiencing delays in the implementation of expansion plans in the very year PSRC was formed [15]. This initiative of government is deemed very prudent since the PSRC submitted its report to government in April, 1997 [13].

The objective of this policy shift was to:

1. "create an environment which can attract private investment for the expansion of electricity generation and refinery capacity

2. to deploy technical innovation

Table 1. Power Sector Reform Matrix for Selected Countries [2]

Country	Main factors for reform	Key event of the reform process	Main Output	Limitations/setbacks
India	Ease to direct foreign investment; unsatisfactory performance of national electric utilities	Advent of IPP (1991); Enforcement of independent regulation (2003); Enactment of Electricity Reform Act (2003)	Functional unbundling by eleven states; adoption of partial unbundling by five states; 12 states produced independent regulators without any paradigm shift in restructuring; Orissa and Delhi states were provided with regulators; complete unbundling and privatization of distribution utility	Outcome of reform not successful nor encouraging; outcomes, questionable and based on competition and privatization; 35% of India's power generation capacity is lost through technical faults; unabated power theft; pervasive corruption; subsidized tariffs
Thailand	Inadequate power supply; massive government debt; Asian financial crisis	Enactment and operationalization of Electricity Law in 1992; enactment of IPP Law in 1996; approval of the establishment of Independent regulator in 1999; nullification of price-based power pool in 2003; delay of privatization in 2004, creation of energy regulatory board in 2008	Electricity market reforms remain inactive; unprofitable tariff structure which is as well inimical to consumers; application of regulation and incentive schemes that do not promote efficiency but favour state enterprises	Political turmoil affecting reform implementation; weak and dependent regulatory institutions; favoured state enterprises; market competition difficult to promote
Ghana	Inadequate power supply; promotion of external lending policy; financial crisis; inadequate power sector investment; underperforming public distribution utility	Reform used as a condition for granting of loan to Ghana by the World Bank in 1994; Formulation of a restructuring and privatization plan in 1997; creation of public utilities regulator; introduction of IPPs in 1998; reforms suspended by parliament in 2001	Delay of reforms; virtually stagnant structure of the power sector; VRA mostly operating under financial losses; high distribution losses; tariff setting uneconomic and contributes to the erosion of the economic viability of the utilities in the long-term	Regulator not independent from political influence or interference; PPA in the power market has no standard form; competing and concentrated pressures to keep consumer tariffs low thus, hampering the fixing of cost-reflective tariffs
Fiji	Financial problems; Promotion of donors lending policy	Enactment of Public Enterprise Act in 1998; recommencement of internal power sector reform in 2002; increase in tariff approved by independent regulator in 2005	Increase in productivity; reduction in system losses (from 18% to 10%); increase in tariff collection; more authority and discretionary powers were delegated to independent regulators	Regulator's true independence and effectiveness remains questionable; low private sector involvement due to political instability
Brazil	Underperforming government-regulated utilities; spillover of effects of demonstrations staged in Chile and Argentina	Radical electricity sector reforms launched in 1996; Introduction of power sector privatization in 1995; establishment of independent power regulators in 1998; creation of short-term wholesale electricity market from 1995 to 2003; between 2004 and 2005, a previous wholesale electricity market was replaced with a long-term contracts model	Reverting to central planning; improved competition in the electricity sector; incentives for investors and market competition in the transmission sector created by auction process; transmission service operator sells power to distribution companies at competitive price	Over reliance on hydropower could lead to power crisis in the face of rising demand as in 2001-2002; the dominance of the power sector by hydropower generation makes decarbonization, a challenge; securing private investments is a necessary condition for growing the power sector
China	Reforms in power sector pursued as part of a broader liberal economic reforms	Corporatization and commercialization of power sector in 1998; bidding for contracts by power generators; vertical unbundling of the power sector in 2002; formation of national electricity regulatory commission in 2002; introduction of power price reform scheme in 2003	Postponement of overall reforms; restructuring of power industry not accompanied by the creation of competitive markets; obstruction of further reform due to deep-rooted interest; doubling power generating capacity between 2002 and 2007	Future of power sector reform uncertain; political will- important in moving forward with stalled reforms; less-developed and ineffective legal system and capital markets cannot promote competitive markets
Russia	Reforms in power sector pursued after the collapse of the Soviet-Union as part of a broader liberal economic reforms	Joint stock company for production of electricity was established in 1992; Adoption of reform principles began in 2001; A regulatory framework for electricity sector Reform was formulated in 2003; gradual transition from state-controlled to free market pricing occurred in 2003	delaying of reforms; inadequate investments for modernization of power systems; low carbon pollution levels; state-controlled pricing of electricity to address social equity concerns	Incidence of blackouts in 2002 demonstrated the fragility of the power system; prioritization of system modernization after decommissioning of hydropower plant in 2008; inoperative market pricing as government actively monitored electricity prices
South Africa	Introduction of major democratic changes in 1994; underperforming state-owned utilities, innovative international concepts and principles	Creation of an independent regulator in 1995; issuance of White Paper on energy policy in 1998; declaration of no unbundling of the power sector in 2004; Publication of White Paper in 2003 on renewable energy	Total reluctance to power sector reform; power sector performance improved in quality and security of supply after 1990, extension of electricity access was rapidly implemented; low electricity tariff by international standards and below cost-recovery levels	Capacity expansion urgently required as generation capacity is tight; pricing principles of efficiency and cost-reflectivity necessary; transparency in subsidy schemes required

Table 2. Energy Sector Reforms Drivers [2]

Developed countries energy sector reform drivers	Developing countries energy sector reform drivers	External Drivers
Power supply exceeds demand;	Problems of energy subsidies;	Social norms, political and economic ideology: belief in or allegiance to the forces of market, competition, privatization and institutional framework
Adoption of expensive power generation technologies;	Low quality service;	Technological creativity, adaptability and innovation such as the development of modern power plants whose fuels are readily available including combined cycle gas turbines
inefficient use of financial resources;	unacceptable energy losses;	"Macroeconomic events such as the post-Soviet economic transition (1989), Latin American debt crisis (1980s), Asian financial crisis (1997-1998)"
Growing demand of consumers for cheap energy	service coverage woefully inadequate;	Capitalization options: the most preferred option is the privatization of state-owned assets
	shortage in generation capacity and limitations of energy sector investment schemes	Energy deregulation: creation of new energy multinationals looking for new investment opportunities as recommended by OECD
		Lending regimes such as those of the World Bank and IMF with conditionalities
		Macroeconomic reform: these reforms are carried out in the context of national economy as a result of economic crisis and structural adjustment programmes

3. ensure realistic energy pricing policy and competition and

4. incorporate use of renewable energy resources into the country's energy mix" [13].

The 1994 energy policy directive sought to phase out the government's involvement as owner and manager of energy businesses and re-focus its role on policy making and market regulation. The intent of this policy was to take the government out of the energy business so that public funds can be saved to improve social infrastructure. Several minor reforms have been carried out after this policy shift [16,1]. This policy brought into existence two key energy sector institutions namely, Public Utilities Regulatory Commission (PURC) - established by Act 538 and Energy Commission (EC) - established by Act 541 in 1997 respectively. PURC is responsible for tariff setting and pricing, service quality standards, and standards enforcement while the Energy commission is expected to do the following:

- "recommend national policies for the development and utilization of indigenous energy resources
- advise the Minister of Energy on national energy policy for the efficient, economical and safe supply of electricity, natural gas and petroleum products having due regard for the national economy
- prepare, review and secure comprehensive database for national decision making. A tax and duty exemption policy were introduced in the power sector of the economy of Ghana in 1998" [16].

A Renewable Energy Services Programme (RESPRO) was instituted in 1999 as an economic instrument to facilitate direct and infrastructural investments [17]. The first Independent Power Producer to enter into Ghana's energy market is Takoradi International Power Company Limited (TICO). The Ministry of Energy formulated an energy policy dubbed "Energy for Poverty Alleviation and Economic Growth, Policy Framework, Programmes and Projects" in 2001 to introduce some shine into the lives of the masses engaged in the informal economic sector [18]. In 2003, Ghana, Nigeria, Togo and Benin signed an international agreement for the development of a sub-regional gas pipe line (The West African Gas Pipeline). This treaty received the ratification of Ghana's Parliament in August, 2004 and the pipeline bill was passed in October, 2004 paving the way for the construction of the West African Gas Pipeline to haul gas from one country to the other [19]. The construction of the West African Gas Pipeline offshore and onshore began in 2005 and 2006 respectively and was completed in 2008 [20].

A strategic national energy plan which contained power sub-sector policies was formulated by the Energy Commission in 2006 to ensure efficient and productive uses of Ghana's energy resources. A Ghana Energy Development and Access Programme (GEDAP) was started in 2007 to provide Electricity Company of Ghana with some financial and technical support to increase the electricity access rate in the country. Since 2010, the objective of the government of Ghana for the power sector is to achieve a target of 5000 MW of installed power generation capacity [21, 22]. This generation capacity target was obtained in 2019 amidst key challenges in the power sector. This feat has been obtained under very intense pressure on government to curb the periodic power crisis Ghana has

been facing over a period of about thirty years. The first officially published National Energy Policy was launched in 2010 and a renewable energy act enacted in December, 2011 all with the aim of providing guidelines to relevant stakeholders in the power sector. A Feed-in tariff for electricity generated from renewable energy resources was set in September, 2013 to provide incentives to renewable power producers. A net metering code to encourage exchange of power between auto producers of electricity from renewable energy sources and power distributors was planned in 2015 and implemented in October, 2016.

A reform was recently taken in the power sector of the Ghanaian economy but failed due to non-standard industrial practice or ethics. This reform sought to regulate the partial takeover of ECG by Power Distribution Services, a company that was established just after the government of Ghana had declared its intention to relieve the ECG from distributing power in the Southern sector of the country due to its heavy losses in revenue collection. This reform was initiated to help stabilize the power distribution in the southern sector of the country (the largest consumer of Ghana's power). PDS was licensed by the Energy Commission to distribute power in the southern power distribution zone for twenty years effective 1st March, 2019 and ending 28th February, 2038. The main aim of the PDS was to invest and block leakages in the power distribution sector. The PDS was established after Ghana had signed a power compact with the United State of America acting through the Millennium Challenge Corporation (MCC), an independent United State government agency, on the outcome of the US Africa Leaders' Summit in Washington DC on August 5, 2014. The PDS were accused on 31 July, 2019 barely six months in existence by the Minister of Energy in a press conference for issuing an invalid demand guarantee for the concession agreement. Basically, PDS failed to provide a 'precedent condition', among other requirements, a documented lease payment security and bulk supply agreement payment security in the form of valid letters of credit. This initially resulted in the suspension of PDS and all its functions were temporarily returned to ECG immediately after the detection of the anomaly. As of now, ECG is playing its original role in the power sector of Ghana following the abrogation of the contract between PDS and the government. This development provides solid grounds for the argument that critical issues in the power sector of any economy should not be left to chance.

A news item attributed to modernghana.com (2019) disclosed that under the Ghana-USA power compact, the following projects are supposed to be carried out to address the root causes of the unavailability and unreliability of power in Ghana.

- "ECG financial and operational turnaround project
- NEDCo financial and operational turnaround
- Regulatory strengthening and capacity building project
- Electricity access project
- Power generation sector improvement
- Energy efficiency and demand side management project"

Before this compact, Ghana had undertaken several energy-efficiency programmes in its energy sector. Notably among them are the following legal and regulatory frameworks which were instituted in the past but are still in force:

1. "Energy Efficiency Standards and Labelling (Nonducted Air-conditioners and Self Ballasted Fluorescent Lamps) Regulations 2005, LI1815
2. The Energy Efficiency Standards and Labelling (Household Refrigerating Appliances) Regulations, 2009, LI 1958 and amendment 2010, LI 1970 [23]
3. Energy Efficiency (Prohibition of Manufacture, Sale or Importation of Incandescent Filament Lamp, Used Freezer and Used Air-conditioner) Regulations, 2008, LI 1932" [23].

In fact, this and other sections of this paper makes it evidently clear that Ghana has performed creditably in terms of policies, reforms and programmes formulation however all these efforts have not yielded the desire results in terms of energy security. With the current power supply situation in Ghana, it can be concluded that the plan formulated by the defunct NEB and the numerous interventions taken in the power sector of Ghana over the years have not been followed and monitored religiously by energy policy implementers and policy makers respectively and that the weaknesses of the country's power sector can partially be attributed to policy abandonment. It can also be concluded that, Ghana does well in formulating policies but resolving all the identified problems of its power sector is a very big challenge.

2.5 Ghana's National Energy Policy

The main energy policy that guides Ghana's energy sector currently is the National Energy Policy, 2010, which outlines the Government of Ghana's policy direction regarding the current challenges facing the energy sector. "The National Energy Policy document provides a concise outline of the Government's policy direction in order to contribute to a better understanding of Ghana's Energy Policy framework. It is hoped that the policy document will facilitate the effective management and development of the energy sector as well as provide the public with information about the Government's policy goals" (Ministry Energy, 2010). According to Ministry of Energy, Ghana (2010), the policy document intends to serve as:

1. "a decision-making platform for the effective management and development of Ghana's Energy Sector;

2. a guide to key stakeholders and institutions in the energy sector highlighting the definition and implementation of key activities in respect of their mandates;

3. a guide for coordinating the implementation and monitoring of energy sector policies; and

4. a platform for dialogue on investment opportunities with Ghana's development partners and the private sector."

2.6 Ghana's National Energy Policy

The goals of the power sub-sector are to increase installed power generation capacity quickly from about 2,000 MW in 2010 to 5,000 megawatts (MW) by 2015, and increase electricity access from the current level of 66% (2010 access rate) to universal access (100%) by 2020. According to the Ministry of Energy Ghana, "the challenge is how to attract investments to build the necessary infrastructure for the generation, transmission and distribution of electricity throughout the country. This is key to ensuring the sustainable development of the sector. Apart from financing, the policy focuses on institutional and human resource capacity strengthening as well as regulatory reforms required to create a competitive electricity market. Creating the right environment for private-public partnerships in the development of new power plants is essential to the growth of the power sector. In the view of Ghana's Ministry of Energy, the biggest obstacle to achieving this condition is the issue of cost-recovery, a challenge that this policy tries to directly address."

The medium-term policy objectives (deemed to cover a period of 5 years from 2010) of the power sector of Ghana are presented as follows:

- "Increase the generating capacity of power
- Provide adequate reliable safe affordable and sustainable power
- Promote the production & distribution of electricity from all sources
- Development of Renewable Energy law to incentivize investments in renewable technologies
- Formulate policies to reduce greenhouse gases emission
- Harmonize energy policies ensure better collaboration & coordination
- Reduce accident cases from energy usage" [24]

Based on the numerous programmes and reforms carried out in the country's power sector as evidenced by the elaborate review of this subject matter in this paper, it can easily be inferred that Ghana has extensively carried out power sector reforms. This fact is corroborated by Figure 1 which illustrates the power sector reform index of Ghana among that of forty-two (42) African countries. However, in spite of all these reforms Ghana still faces fundamental problems in the power sector. It is therefore incumbent for the power sector regulatory bodies to effectively and efficiently play their roles to ensure the sound management of the sector. This can be done if the power regulatory bodies in Ghana (i.e., Energy Commission and Public Utilities Regulatory Commission) perform their established functions holistically to achieve their set goals if these functions are still worth pursuing or make the necessary reforms to ensure the sound management of the power sector of the country. It will be interesting to end this discussion with a summary of recent development in Ghana's power sector.

Ghana was grappled with inadequate power generation issues from 2012 to 2016 but can now be described as a country with surplus electricity generation capacity. However, the guarantee of its electricity supply is dependent on the country's ability to adequately finance the power sector. A number of new power projects are currently ongoing and are expected to increase both generation and transmission capacities of the country. Should the much-touted industrialization policy of the government i.e., One District, One Factory (1 D, 1 F) become successful then it will be necessary for present and future governments of Ghana to put in place measures that would ensure adequate use of electricity (produced from both conventional and renewable sources) domestically. A renewable energy Master Plan which aims to increase the penetration of renewables in the countries power generation mix was formulated and made public in February, 2019.

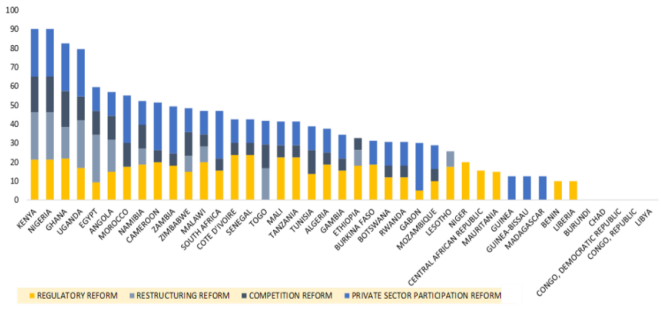

Figure 1. Power Sector Reform Index by Country in Africa [24]

2.7 Identified Challenges of the Power Sector

[25] did extensive work with regard to identifying and explaining the major challenges faced in the power sector of Ghana. This study totally agrees with the section of the work of [25] which identified the following as the key challenges faced by the power sector of the country.

- Power crisis/shortages
- Generation capacity shortages
- Need of large investments to meet expanding demand
- Need to remove barriers to attracting productive Independent Power Producers (IPPs)
- Commercial performance of Ghana's power distributors needs improvement
- Financial constraints of VRA in recent times
- The need to separate VRA'S hydro and thermal power operations
- The need to implement energy efficiency aggressively
- The need for renewable energy to play a growing role in the future
- The need to assign GRIDCo with the overall responsibility for electricity sector Planning
- PURC Performance (not good enough)

These problems can only be surmounted if all the active players (in this case, government, suppliers, contractors, non-managerial and managerial work force of the utility companies) of the power sector marshal the needed entrepreneurial, managerial, technical and personal maturity skills and direct their concerted efforts towards the successful and smooth running of the sector. The power sector and other equally important sectors of the Ghanaian economy require competent people to manage it. These people should be insulated from undue influence of government that might be injurious to the company. So, this warrants the creation of an independent national energy board that would appoint these officers based on competence and loyalty and devoid of favouritism. These appointed officers should be people who are willing to face the consequences should their companies fail under their authority through negligence and mismanagement. They should also be well resourced and remunerated according to the financial success of their companies during their tenure. The composition of the national energy board is suggested in section 4.4 of this paper.

2.8 Ghana'S Power Sector Performance Towards the Achievement of Sustainable Development Goal (SDG) 7

The Sustainable Development Goals (SDG) otherwise referred to as Agenda 2030 are a collection of seventeen global goals introduced by the United Nations in 2015 with the aim to end poverty, protect the planet and to ensure prosperity for all by the year, 2030. Though these global goals are not binding, a lot of countries especially less developed ones including Ghana have bought into the idea because of the positive socio-economic effects of these global goals. The main objective of power sectors of global economies is to efficiently and sustainably harness available energy sources to produce clean power for safe use. It therefore implies that the power sectors of global economies are set to end poverty, protect the environment and to ensure prosperity (i.e., the aim of the SDGs). This is because, the usual end product of the power sector, electricity, is used to power industry which is the most widely known source of income. Other income generating activities are also carried out with the use of electricity. Thus, the use of electricity allows activities that deal with poverty and ensure prosperity to be carried out easily. In contrast, in the wake of alarming climatic change, the core activities of the power sectors of global economies are expected to be carried out to avoid the disturbance of the average temperature of the earth's atmosphere (14℃ or 15℃ at the earth surface depending on the reference-Goddard Institute for Space Studies) and environmental pollution. The power sector of Ghana can be considered to be doing its best to protect the planet with its relatively low carbon emissions as of 2018 (0.53 tCO_2/MWh)-[26], thus, it is perceived to be partially meeting the SDG 7. The power sector of Ghana is providing clean energy but fails to satisfy the affordability component of the SDG 7 since current end-user electricity tariffs in Ghana are perceived to be higher as compared to that of the developed countries which are mostly the benchmarks or standards in the global energy market. The irony is that electricity tariffs in most African countries are below cost-recovery rates [27] and yet they are not generally accepted as affordable by most of the people in Africa including Ghana due to the relatively low-income levels of average workers in the continent who usually own almost the same types but a smaller number of electrical appliances as owned by the rich. Notwithstanding, the perceived unaffordability of Ghana's electricity, the country is making some strides in achieving the SDG 7.

3. Research Methodology

The methodology for this study makes use of survey, working papers, national energy issues, and academic journals to acquire data for its analysis. This study intends to perform a review of the current status of the electricity

sector of Ghana, identify working energy policies and challenges in the power sector and as well make suggestions or recommendations for the power sector of the Ghanaian economy to mitigate the energy challenges of the country. This study investigated the electricity situation of Ghana from 1966 to present and reviewed the country's energy policies, reforms and programmes. It made significant use of general survey, existing information, observation, experience and evaluation in its development. The data analysis strategies adopted for this study are documentary analysis and narration. As a result, the tools of observations, investigations, analyses, deductions and inferences were employed to draw conclusions from the facts adduced by this paper. It is also the intent of this paper to use recent and past events in the power sector as well as opinions of the general public to draw conclusions using basic principles and concepts in the power industry. The electricity infrastructure of the country and their generation capacities from 1966 till now have been captured in this work to depict the growth rate of the country's generation capacity. The information gathered by this paper was subjected to critical analysis and synthesis to yield its analysis and conclusions.

4. Results and Discussion

4.1 Historical and Current Perspective of Demand and Supply of Power

The situation of demand and supply of power in Ghana since 1966 to 1997 is presented in Figure 2a and that of the period spanning 1998 to 2017 is shown in Figure 2b. Figures 2a and 2b show the generation and consumption capacities of Ghana for the periods, 1966 – 1990 and 1991 – 2018 respectively. It is evidently made clear in Figure 2a that Ghana had shortfall in power supply from 1992 to 1997 since it was unable to export power at the time to its neighbouring countries that depend on it for electricity supply. However, from 1998 to 2018 as illustrated by Figure 2b, the country has been able to sustain its drive to export energy to its neighbouring countries.

A very fundamental step taken by most power utility generators is to determine the load profiles of its known and prospective consumers. This enables them to know the appropriate amount of power they have to supply. The knowledge of this situation should also assist them to roll out the right strategies to provide the needed investments to ensure that supply is always adequate to meet demand, ceteris paribus. The energy demand of countries is highly dependent on the population of the country and for this reason, a country's rate of population increase is usually considered when determining its electricity supply.

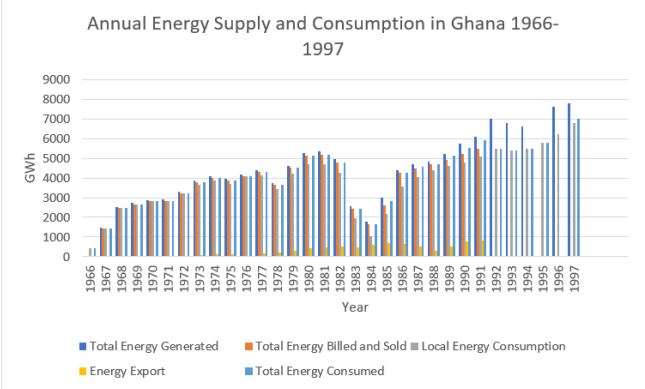

Figure 2. Annual Energy Supply and Consumption in Ghana 1966-1997 (Compiled by Authors from various publications of VRA)

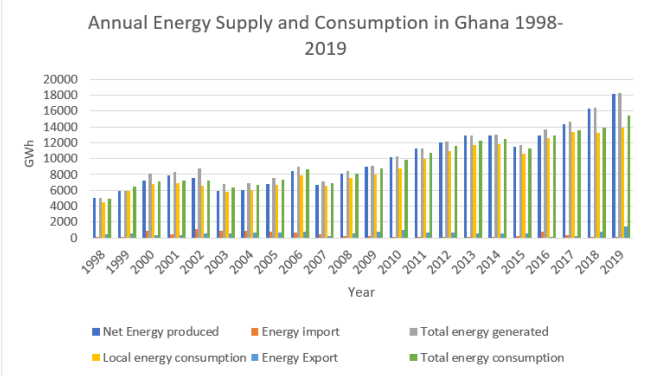

Figure 3. Annual Energy Supply and Consumption in Ghana 1998-2017 (Compiled by Authors from various publications of VRA & GRIDCo)

4.2 Electricity Generation Capacity

The electricity generation of Ghana in a particular year is represented by the total generation capacity of all the existing power plants in service in that year. The generation capacity of the country since the installation of its first hydropower plant in 1966 to date has been presented in Tables 3a and 3b. The tables reveal the frequency at which the country has been adding new generations to its generation capacity since the inception of its national grid. It can be deduced from Tables 3a and 3b that Ghana was not increasing its generation capacity in line with its demand in the late 1990s and beyond and had to take emergency steps in 2013 and beyond to ensure that the country has adequate supply of electricity for its populace.

Table 3a. Electricity Generation Capacity of Ghana from 1966 – 1990

Year	Generation Capacity
1966	588 MW
1967	588 MW
1968	588 MW
1969	588 MW
1970	588 MW
1971	588 MW
1972	912 MW
1973	912 MW
1974	912 MW
1975	912 MW
1976	912 MW
1977	912 MW
1978	912 MW
1979	912 MW
1980	912 MW
1981	912 MW
1982	1072 MW
1983	1072 MW
1984	'1072 MW
1985	1072 MW
1986	1072 MW
1987	1072 MW
1988	1072MW
1989	1072 MW
1990	1072 MW

Source: Compiled by Authors from various publications of VRA and GRIDCo

Table 3b. Electricity Generation Capacity of Ghana from 1991 – 2018

Year	Installed Generation Capacity
1991	1072 MW
1992	1072 MW
1993	1072 MW
1994	1072 MW
1995	1072 MW
1996	1072 MW
1997	1072 MW
1998	1072 MW
1999	1402 MW
2000	1622 MW
2001	1622 MW
2002	1622 MW
2003	1622 MW
2004	1622 MW
2005	1730 MW
2006	1730 MW
2007	1730 MW
2008	1981 MW
2009	1981 MW
2010	2165 MW
2011	2170 MW
2012	2280 MW
2013	2831 MW
2014	2831 MW
2015	3656 MW
2016	3795 MW
2017	4398 MW
2018	4758.82 MW
2019	5082.82 MW
2020	5082.82 MW

Source: Compiled by Authors from various publications of VRA & GRIDCo

4.3 Power Generation Facilities

The power plants that are currently licensed and are in operation in Ghana to ensure adequate supply of electricity are presented in Tables 4 (a and b). The country can now boast of about twenty-two (22) operational power plants being run by both state-owned power companies and Independent Power Producers (IPPs) who are mainly not indigenous business men. Based on Tables 4a and 4b, Ghana's total power generation capacity can be calculated as 5082.82 MW with 1584 MW which translates into about 31.2% coming from hydropower generation, 68% (3456 MW) comes from thermal generation and about 0.8% (42.5 MW) comes from solar power generation while that of bioenergy (0.32 MW) may be considered as negligible. Out of this generation capacity, the government of Ghana through its power generating utility companies produces about 2570.5 MW (50.6%) while 2512.32 MW (44.4%) is produced by IPPs. The introduction of thermal generation into Ghana's energy mix meant increase in its cost of power production since it is a common knowledge that it costs lower to generate hydropower than to generate thermal power.

4.4 Survey Analysis

The end results of the activities of utility companies are experienced by consumers and this phenomenon normally makes consumers to express their views about the quality of service they enjoy from utility companies especially when they are not satisfied with the services of the utilities. Likewise, the utilities also expect good energy use practices from consumers. As a result of this and the host of challenges Ghana faces in the power sector, this study deemed it fit to have a lot of discussions done with a host of people with diverse backgrounds to suggest how the country's energy situation and the performance of the country's problem-battling utility companies can be improved. Some people including energy students, academics, utility workers, workers of manufacturing and service sectors and workers of other walks of life were directly interviewed to solicit their candid opinions on how to address the problems of the electric power sector of the country. These people were contacted to seek their views because they were all end-users of electricity in Ghana and were victims of the various energy crises the country has faced. This paper therefore gathered some of the concerns of these groups of people and evaluated them to make the following informed suggestions for consideration by energy policy makers in order to mitigate the electric power problems in Ghana going forward.

1. Government should not sell out the state-owned power generating utilities and should have oversight responsibilities over the utilities in a manner that would not be adjudged as interference but rather help them to grow.

Table 4a. Operational Power Plants in Ghana

Name of Power Plant	Type of Licence	Plant Type	Installed Capacity	Commissioning Date	Location
Akosombo Hydroelectric Power Plant	Hydro generation	Reservoir	1020 MW	January, 1966	Ajena
Amandi	Thermal generation	Combined cycle	190 MW	April, 2019	Aboadze
AKSA Power Limited	Thermal generation	HFO generator	370 MW	March, 2017	Tema
Bui Hydroelectric Power Station	Hydro generation	Reservoir	404 MW	April, 2013	Bui
Cenit Energy Limited	Thermal generation	Combined cycle	110 MW	October, 2012	Kpone, Tema
CEN Power	Thermal generation	Combined cycle	360 MW	June, 2019	Tema
Genser Power Ghana Limited	Embedded power generation	Simple cycle	22 MW	April, 2013	Tema
Karpower Ghana Limited	Thermal generation	Combined cycle	470 MW	December, 2015	Takoradi
Kpone Thermal Power Plant (KTTP)	Thermal generation	Simple cycle	220 MW	April, 2016	Kpone, Tema
Kpong Hydro	Hydro generation	Run-of -river	160 MW	July, 1982	Akuse
Meinergy	Solar	Solar PV	20 MW	September,2018	Gomoa Onyaadze
Safisana	Thermal generation	Biogas plant	0.32 MW	2018	Ashaiman, Tema
Sunon Asogli Power Ghana Limited, Phase 1	Thermal generation	Combined cycle	200 MW	August, 2010	Kpone, Tema
Sunon Asogli Power Ghana Limited, Phase 2 Stage 1	Thermal generation	Combined cycle	180 MW	April, 2016	Kpone, Tema
Sunon Asogli Power Ghana Limited, Phase 2 Stage 2	Thermal generation	Combined cycle	180 MW	January, 2017	Kpone Tema

Source: Compiled by Authors from various publications of VRA and Energy Commission

Table 4b. Operational Power Plants in Ghana (continued)

Name of Power Plant	Type of Licence	Plant Type	Installed Capacity	Commissioning Date	Location
Takoradi Thermal Power Plant (TAPCO)-T1	Thermal generation	Combined cycle	330 MW	April, 1999	Aboadze, Takoradi
Takoradi International Power company (TICO)-T2	Thermal generation	Single cycle	220 MW	December, 2000	Aboadze, Takoradi
Takoradi 3 (T3) Plant	Thermal generation	Combined cycle	120 MW	March, 2013	Aboadze, Takoradi
Tema Thermal Plant 1 (TT1)	Thermal generation	Single cycle	110 MW	July, 2008	Tema
Tema Thermal Plant 2 (TT2)	Thermal generation	Simple cycle	80 MW	February, 2010	Tema
Trojan	Thermal generation	V-power engine	44 MW	2016	Tema
Volta-River Authority (VRA)/AMERI	Thermal generation	Combined cycle	250 MW	December, 2015	Aboadze, Takoradi
VRA/Beijing Xiaoclay Company (BXC) Solar Plant	Solar power generation	Solar PV array	20 MW	December, 2015	Gomoa Onyaandze
VRA Solar Power Plant	Solar PV power generation	Solar modules	2.5 MW	November, 2013	Navrongo

Source: Compiled by Authors from various publications of VRA and Energy Commission, Ghana

2. Government should take steps to pay all the debts it owes the utilities and to ensure that herself and none of its agencies owe the utilities for more than three months.

3. Consumers should inculcate the habit of energy conservation irrespective of the energy situation of the country and should be prepared to pay realistic tariffs (tariffs not set as a result of inefficiencies of the utilities).

4. A reliable and sustainable source of funding for the electricity sector of the economy should be established through taxation in addition to retained earnings and should be used solely for the intended purpose by government to ensure adequate and sustainable supply of power in the country.

5. Unelectrified communities, future real estate development in the country should be accurately determined from time to time and appropriate measures taken to get them electrified as and when it becomes necessary using the most appropriate and available energy resource and technology to avoid load shedding or power rationing.

6. It is highly recommended that a national electricity development body or board made up of relevant and key stakeholders in the power sector of the country should be constituted by the national legislative body (Parliament of Ghana) using a bi-partisan approach that would involve broader consultations.

7. The Parliament of Ghana should place the responsibility of good performance on the mother institutions i.e., the relevant utility companies. The national electricity board should be tasked to initiate timely workable energy planning policy reforms to mitigate future energy crisis. It should also be charged with the full responsibility of overseeing the effective and efficient management of the power sector of the country, deploying appropriate power technologies and ensuring that existing and new energy infrastructure are improved and built respectively when necessary. They should as well be mandated to do this job transparently and professionally.

This will ensure that national power projects are devoid of praise singing politics but rather such projects would be made nationalistic and transparent enough in character to avoid the unnecessary partisan politics that take place in government institutions. The composition of the national electricity board suggested above, should be made up of a standing committee and a co-optative committee constituted by representatives from relevant institutions. The exact makeup in terms of the people who would constitute the national electricity board of Ghana should be left to the discretion of Parliament. It is proposed that the standing committee of the national electricity board should be made up of the following institutions.

- Ministry of Energy of Ghana
- Ministry of Environment Science and Technology (MEST)
- Ministry of Finance and Economic Planning
- The Parliamentary Select Committee on Energy
- Energy Commission of Ghana
- The Volta River Authority (VRA)
- Ghana Grid Company (GRIDCo) Limited
- Ghana Electricity Company (ECG)
- Public Utilities and Regulatory Commission (PURC)
- Development partners in the Energy Sector

The kinds and number of co-optative members to be placed on the electricity board will include the following agencies. The inclusion of these agencies on the energy board should be decided by Parliament depending on the type of power technology project to be developed at a particular time, the kind of inputs required to make sacrosanct decisions and the relevance of the co-optative institution.

- Ministry of Trade
- Ministry of Justice and Attorney General
- The Independent Power Producers of Ghana
- Bulk and Residential Consumers Associations (if available)
- Ghana National Petroleum Commission (GNPC)
- Ghana Gas Company
- National security
- Universities that offer energy programmes
- Internationally recognized local think tanks

Finally, an energy market of best and proven international practice favourable to Ghana should be introduced to encourage the right kind of capital injections into the power sector of the country to increase energy access and ensure energy security in the future.

5. Conclusion

Ghana has a good power sector reform index in Africa but it is still burdened with energy insecurity issues as evidenced by its periodic power crises. Its energy demand has been growing steadily against decline in energy supply since the late 1990s leading to varied degrees of periodic power crises over two decades, etc.). The country has not focussed on the strict implementation of its coherent energy policies as well as the achievement and evaluation of its policy goals over the years even after unbundling its power sector in 2005 since the country is faced with problems that can be considered as teething problems in the power sector. Since the inception of the Public Private Partnership (PPP) concept, energy sector investments made by indigenous Ghanaians have not been significant. Considering the challenges faced by the country in the energy sector, it can be concluded that acquiring adequate long-term domestic and foreign investments to develop the energy resources of the country for electricity generation has been a very big problem to the government. The actions of the key players of the power sector should be guided by formulated energy policies and realized through strict implementation of formulated energy policies.

6. Acknowledgements

We wish to express our profound gratitude to the utility companies and their stakeholders in the energy sector of Ghana especially, the Volta River Authority (VRA) and the Energy Commission of Ghana for making available substantial information for use by researchers for the evaluation of the power sector of the country to influence policy-making in the future. We are also very grateful to the authors of the other works we consulted in the preparation of this paper. Finally, we are very thankful to the majority of Ghanaians who motivated us to do this paper by openly registering their displeasure for the occurrence of avoidable power crises in the country over the years.

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