Energy Security In West Africa: An Assessment Of Ghana's Implementation Of The West African Power Pool (WAPP) And The ECOWAS Renewable Energy Policy (EREP)

By Samuel Asante

10174028.

THIS DISSERTATION IS SUBMITTED TO THE UNIVERSITY OF GHANA, LEGON, IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE AWARD OF THE MASTER OF ARTS DEGREE IN INTERNATIONAL AFFAIRS.

LEGON **JULY, 2018**

DECLARATION

I, Samuel Asante, hereby declare that with the exception of dully acknowledged citations and references**,** this dissertation**"Energy security in West Africa: An assessment of Ghana's implementation of the West African Power Pool (WAPP) and the ECOWAS Renewable Energy Policy (EREP)"**is the results of an original research conducted by me under the erudite supervision of Dr.Juliana Appiah and that no part of it has been submitted elsewhere for any other degree in this University or elsewhere.

..... **.....**

Samuel Asante **Dr. Juliana Appiah**

Student **Supervisor**

DEDICATION

This work is dedicated to my entire family, especially to the newly born baby, Samuel Kwasi Asante-Gyebi. Kwasi, welcome to the family of the Asante-Gyebi's. I'm eternally grateful to you all for your love, support, encouragement and above all your fervent prayers without which this work wouldn't have been possible.

ACKNOWLEDGEMENTS

I would like to first and foremost express my heartfelt gratitude to the almighty God for his grace which has always been my source of strength and sufficiency. To my supervisor, Dr. Juliana Appiah, I say kudos for your guidance and encouragement. I'm equally grateful to all experts at the Energy Commission, the Volta River Authority, Ghana Grid Company Limited (GRIDCo), The ECOWAS Regional Electricity Regulatory Authority *(ERERA) and the African Centre for Energy Polices (*ACEP)for their time and knowledge shared. I'm particularly grateful to Mr Prosper Adams and Dr. Nii Darko, both of the Energy Commission. Finally, I wish to thank the entire members of the Legon Centre for International Affairs and Diplomacy (LECIAD), for their invaluable and diverse supports during the period of my study.

LIST OF ABBREVIATIONS

ACEP	-	African Centre for Energy Policy
AfDB	-	African Development Bank
AGI	-	Association of Ghana Industries
APL	-	Adaptable Programme Loan
AU	-	African Union
BPA	-	Bui Power Authority
CAPP	-	Central African Power Pool
CEB	-	CommunautéElectrique du Benin
CIE	-	CompagnieIvoirienned'Electricité
CTB	-	Coastal Transmission Backbone
DFO	-	Distillate Fuel Oil
EAPP	-	East African Power Pool
EC	-	Energy Commission
ECA	-	Economic Commission of Africa
ECCAS	-	Economic Community of Central African States
ECG	-	Electricity Company of Ghana
ECOWAS	-	Economic Community of West African States
ECREEE	-	ECOWAS Centre for Renewable Energy and Energy Efficiency
ECSC	-	European Coal and Steel Company
EREF	-	ECOWAS Renewable Energy Facility
EJ	-	Exajoule
EREP	-	ECOWAS Regional Renewable Energy Policy
ERERA	-	ECOWAS Regional Electricity Regulatory Authority
FDI	-	Foreign Direct Investment
GDP	-	Gross Domestic Product
GEDAP	-	Ghana Energy Development and Access Project
GOG	-	Government of Ghana
GRIDCo	-	Ghana Grid Company Limited

GSGDA	-	Ghana Shared Growth and Development Agenda
GWh	-	Gigawatt Hour
HFO	-	Heavy Fuel Oil
ICA	-	Infrastructure Consortium for Africa
IEA	-	The International Energy Agency
IPP	-	Independent Power Producers
ISSER	-	Institute of Statistical, Social and Economic Research
kV	-	Kilovolt
kWh	-	Kilowatt Hour
LCO	-	Light Crude Oil
LPG	-	Lignified Petroleum Gas
MMscf/d	-	Million Standard Cubic Feet per Day
MoU	-	Memorandum of Understanding
MW	-	Megawatt
Mwh	-	Megawatt Hour
NEDCo	-	Northern Electricity Distribution Company
NEPAD	-	New Partnership for Africa's Development
NES	-	National Electrification Scheme
NITS	-	National Inter-connected Transmission System
NREP	-	National Renewable Energy Policies
OECD	-	Organisation for Economic Co-operation and Development
OMVG	-	Organisation pour la mise en Valeur du fleuveGambie
OMVS	-	Organisation pour la mise en Valeur du fleuve Senegal
PIDA	-	Programme for Infrastructure Development in Africa
PURC	-	Public Utilities Regulatory Commission
PV	-	Photovoltaic
RE	-	Renewable Energy
RECs	-	Regional Economic Commissions
REMP	-	Renewable Energy Master Plan

RES	-	Renewable Energy Sources RET
SAA	-	South Saharan Africa
SADC	-	Southern African Development Community
SAPP	-	Southern African Power Pool
SDG	-	Sustainable Development Goals
SE4ALL	-	Sustainable Energy for All
SREP	-	Scaling-up Renewable Energy Programme
TEN	-	Tweneboa, Enyenra andNtomme
TOR	-	Tema Oil Refinery
UN	-	United Nations
VRA	-	Volta River Authority
WAGP	-	The West African Gas Pipeline
WAPCo	-	West African Gas Pipeline Company (
WAPP	-	West African Power Pool
Wp	-	Watt Peak Capacity.

TABLE OF CONTENT

CHAPTER TWO: OVERVIEW OF ENERGY SECURITY, REGIONAL POWER POOLING SCHEMES, THE WAPP AND THE EREP

CHAPTER FOUR: SUMMARY OF FINDINGS, CONCLUSION AND RECOMMENDATIONS

LIST OF TABLES

ABSTRACT

Energy security became critical in the past few decades when governments and inter-governmental organisations saw it prudent to ensure constant supply of energy for domestic and industrial consumption. This became pertinent after the devastating effect of global wars on energy supplies. With increased awareness of the significance of energy to the socio-economic development of nations, the Economic Community of West African States (ECOWAS) formed the West African Power Pool (WAPP) to integrate the electricity market of Member States. The ECOWAS Renewable Energy Policy (EREP) was also introduced to facilitate the exploration of the renewable energy potentials of the sub-region. Under the WAPP and the EREP policy, Member States are required to harmonize their energy policies with regional energy frameworks. The study employed qualitative methods, using interviews and secondary data, to examine the extent to which Ghana's national energy policies reflect that of the WAPP and the EREP, and evaluate their implementation, attendant challenges and implications for energy security. The study reveals that Ghana's energy policies are consistent with regional energy frameworks. However, the implementation process is hindered by some challenges, chiefly financial and technical, affecting its ability to generate and export power at a competitive cost. As a result, the EREP's target of increasing renewable energy in the overall energy mix, excluding large hydro, to 10% by 2020 will be missed. In addition, the target to increase LPG for cooking to 36% by 2020 will be missed in rural communities but attainable in urban communities, where factors facilitating its usage are high. The study, therefore, recommends that Ghanaian authorities should adopt cost recovery and cost reduction measures, among others, to deal with the financial challenges of the power sector, explore alternative sources of funding for renewable energy projects due its high upfront cost and subsidise the cost of LPG for rural communities.

CHAPTER ONE

INTRODUCTION

1.0 Background to the Study

The International Energy Agency (IEA) defines Energy Security as "the uninterrupted availability of energy sources at an affordable price"[1]. Energy, especially electrical energy, is central to nearly every major challenge and opportunity the world faces today, including job creation, security and food production. The Global Energy Security Conference of 2015 estimated that nearly 1.1 billion people worldwide lacked access to electricity[2]. A country cannot be considered developed if it lacks access to affordable, reliable and sufficient energy which is critical to the attainment of basic human needs. This is stressed in the United Nations Sustainable Development Goal(SDG)on energy, goal number seven, which calls for clean, affordable and sustainable energy for all[3].

Africa is confronted with inadequate energy supply, particularly electricity, with an average 10-15% electricity demand growth against declining supply[4].Cognisant of Africa's challenges in the energy sector, the African Union, in collaboration with the New Partnership for Africa's Development (NEPAD) Secretariat and the African Development Bank (AfDB) Group, launched an infrastructural initiativedubbed "Programme for Infrastructure Development in Africa (PIDA)" in 2010 [5], with energy high on the agenda.

The energy situation in the West African sub-region is nothing to write home about as it remains one of the most energy-poor regions of the world with per capita electricity consumption estimatedat 88kWh against continental and global rates of 563 and 2596 kWh respectively[6]. Also, electricity access rate varies from below 20 % in countries like Liberia, Sierra Leone, and Niger to more than 50 % in countries like Senegal, Ghana and Cape Verde.

Householdaccess rate for LPG/Kerosene is estimated at of 5%[7].Mindful of the indispensable role of electricity in the socio-economic development of every country, leaders of the Economic Community of West Africa States (ECOWAS) developed an ambitious regional energy agenda, the West African Power Pool (WAPP) in 1999,to integrate the operations of the national electricity networks of Member States into a unified regional market to ensure affordable and reliable supply of electricity[8]. In 2003, the ECOWAS Energy Protocol was promulgated to increase complementarity and attract investments to promote regional energy trade.

The agenda was further extended to cover the establishment of the West African Gas Pipeline (WAGP) in 2005 and the ECOWAS Centre for Renewable Energy and Energy Efficiency (ECREEE), in 2010, to deepen energy sector integration. In addition to ECREEE, the ECOWAS Regional Electricity Regulatory Authority (ERERA) was also institutionalised in 2008, to regulate cross-border electricity trading in the sub-region. Similarly, the ECOWAS Renewable Energy Policy (EREP) was established in 2014, in line with the objectives of the UN sustainable Energy for All (SE4ALL) programme, to increase the share of renewable energy sources in the overall generation mix[9].

Whilst significant investments have been made to boost energy production through these regional energy initiatives, almost all ECOWAS Member States have experienced major challenges in the form of repeated nationwide power outages and load shedding of which Ghana is not an exception.The phenomenon of rural-urban migration is on the ascendancy and projected that by 2050, 63% of the population will reside in urban areas, boosting demand for electricity and other energy resources in the process[10].

The challenges underpinning the low access to electricity are linked to interplay of factors such as financial,regulatory, social, economic, and technical constraints. In Ghana, there is a cyclic

powercrisis that hasbecome a perennial development challenge, with cumulative severity that threatens the country's socio-economic growth and transformation. The power crisis mainly manifests itself in the form of a power rationing system, which slows downindustrial activities, leading to job and income losses and social disruptions[11]. The Institute of Statistical, Social and Economic Research (ISSER) in 2014 estimated that Ghana lost between $320 million and $924 million per annum in productivity and economic growth due to the power crises of 2012-2014[12].

1.1 Statement of The Research Problem

The West African Power Pool (WAPP) policy's overarching objective is an inter-connected electricity network in the sub-region through the promotion and development of energy infrastructure for electricity generation and transmission. Also, it is to guarantee the coordination of electric power exchanges between ECOWAS Member States. On the other hand, the purpose of the ECOWAS Regional Renewable Energy Policy (EREP) is to "ensure the increasing use of renewable energy sources such as solar, wind, small-scale hydro and bio-energy for grid electricity supply and for the provision of access to energy services in rural areas"[13].

The relevance of the WAPP and the EREP polices are unquestionable because they serve as an overall regional framework to address the precarious state of energy security in West Africa. Although there have been a lot of studies carried out on energy security in West Africa, not enough academic work has focused on studying how Ghana is integrating its national power system into the WAPP, including how much of its generation mix reflects the targets of the EREP and the challenges thereof. This study, therefore, seeks to assess Ghana's

implementation of the WAPP and the EREP to determine whether the policies have improved energy security in the country against the backdrop of recurring power outages.

1.2 Research Questions

- To what extent does Ghana's national energy policies reflect the WAPP and the EREP?
- What have been the implications of the implementation of the WAPPand the EREP in Ghana towards ensuring energy security?
- What are the challenges/prospects to implementing the WAPP and the EREP in Ghana?

1.3 Objectives of the Study

The study seeks:

- To determine the extent to which Ghana's national energy policies reflect the WAPP and the EREP;
- To evaluate the implementation of the WAPP and the EREP in Ghana and their implications to ensure energy security;
- To ascertain the challenges militating against the implementation the WAPP and the EREP in Ghana.

1.4 Hypothesis

Though Ghana's energy policies are consistent with the WAPP and the EREP, their implementation is fraught with challenges.

1.5 Scope of Study

The West African Power Pool Policy has eight specific objectives. This study focuses on objective number two which seeks to "improve the reliability of power system and quality of

power supply in the region as a whole" by ascertaining how Ghana's production and transmission of electricity is integrated into the WAPP.

The ECOWAS Renewable Energy Policy sets three clear targets to be achieved by Member States by 2020. This study places emphasis on targets number one and three, which mandate Member States to:"increase the share of renewable energy in their overall electricity mix, including large hydro, to 35% by 2020 and 48% by 2030;increase the share of renewable energy in the overall energy mix, excluding large hydro to 10% by 2020 and 19% by 2030; increase the share of the population served with modern fuel alternatives, including LPG for cooking, to 36% by 2020 and ensure 100% universal access to improved cook-stoves by 2020"[14].

1.6 Rationale of the Study

Power outages cost West African countries an estimated 1-2% of their GDP annually[15]. Energy security is therefore, critical to the socio-economic development of West African states, given the fact that the economies of some countries in the sub-region are amongthe fastest growing on the continenet[16]. Furthermore, the West African sub-region is currently experiencing rapid urbanisation and high population growth.In 2013, the region surpassed North Africa in Foreign Direct Investment (FDI) inflows, becoming the second most attractive sub-region on the continenet[17]. This trend has continued and in 2017, FDI inflows to Ghana increased significantly during the first three (3) quarters of the year, amounting to US$ 4.37 billion[18]. These modest economic gains, risk been derailed by unreliable and expensive power supply.

This research looks at a very significant but undiscussed aspect of Ghana's energy architecture with the hope that the findings of this study will be useful to policy makers and stakeholders. The anticipation of this work is to bring to the appreciation of all stakeholders the importance

of Ghana's participation in the implementation of regional power projects; and its bearings on her social-economic development. This study adds to the growing body of literature on energy security, which has become a critical subject in energy studies. It is also expected that other Member States would learn from Ghana through the findings of the study.

1.7 Theoretical Framework

The underlying theoretical concept of this work is Neo-functionalism, which posits that no state has the capabilities to fulfil the economic needs of its people, without cooperation with neighbouring states. Neo-functionalists envisage that the significance of nationalism and nation-states will dwindle as supranational institutions emerge due to regional integration. The Theory of neo-functionalism surfaced in 1950s following the search for European integration[19].

Key proponents of the theory are Leon Lindberg,Ernst Haas, Robert KeohaneandJoseph Nye. Ernst Haas introduced the central concept of spill-over and was applied by Lindberg. According to Lindberg, spill-over refers to "a situation in which a given action, related to a specific goal, creates a situation in which the original goal can be assured only by taking further actions, which in turn create a further condition and a need for more action, and so forth"[20].Haas also identified three mechanisms that propel integration forwardas "positive spill-over, the transfer of domestic allegiances and technocratic automaticity"[21].

Positive Spill-over

It entails a spill-over in an economic context and occurswhen a sectorgoverned by central institutions, such as coal and steel, creates pressure so that the neighbouring areas of policy such as taxation and wages are influenced by the process of integration. For example, this might

entailincorporatinga coal and steel industry with a transport system to facilitate the movement of coal and steel[22].

Transfer of Domestic Allegiance

According to the neo-functionalism theory, the process of integrating diverse national interest groups, associations and elites has the tendency of shiftingloyalties away from national institutions in favour of supra-territorial institutions. The reason being that,national groups will consider supra-territorialinstitutions aswellplaced instruments through which they could accomplish an improved outcome in their interests rather than through national institutions. Here, political actors shift their loyalty to a new centre, for example from the national parliaments to sub-regional Parliaments.

Technocratic Automaticity

It describes the process when integration is accelerated, supra-territorial institutions will themselves be able to lead and support further integration process because they will be more influential than Member States. For instance, the European Commission's growingindependence.

Nye identified seven integrative process mechanisms that are largely to follow the creation of an integrative scheme as Functional Linkage of Tasks, Ideological-Identitive Appeal, Involvement of External Actors in the Process, Deliberate Linkages and Coalition Formation, Rising Transactions, Elite Socialization and Regional Group Formation[23].

Haas further talked about "the expansive logic of sector integration" and predicted that the process of trade liberalization, within the customs union, would lead to "harmonization of general economic policies and eventually spill-over into political areas and lead to the creation of some kind of political community". Whilst Lindberg also acknowledged that, some

conditions are indispensable for the success of the neo-functionalist hypothesis, such as the creation of central organizations and rules to facilitate the creation of social and economic processes to enable them take their remit beyond normal mandate of an international organization[4].

Neo-functionalism, however, is heavily criticised despite its early success, by several theories and approaches. The most outstanding critique of neo-functionalism, however, originated from a group of international relations scholars from the realists perspective that places emphasis on the interaction between governments. Known as inter-governmentalists, they have advanced three arguments in their critique of neo-functionalism. Firstly, inter-governmentalists dismiss the concentrationon non-state actors in neo-functionalism due to the continuous dominance of states in the international system and the perpetual pursuit of their national interests. Inter-governmentalistsregard states as the primary actors of international relations, who, through their foreign policies, remain the final authorities on integration and are able to oppose integration when they wanted to[25].

They argue, further, that any increase in the power of a supranational institution, results directly from decisions taken by governments. Secondly, they argue that Member States have coherent unified negotiating positions and posses the ability to resist efforts from organised interests both at the domestic and regional levels. Thirdly, inter-governmentalists criticise the concept of spill-over for "assuming a degree of automaticity in integration processes and failing to account for increasing protectionism and limitations to integration put up by states at times"[26].

Tranholm-Mikkelsen opines that "the external environment would increase diverse responses from states which eventually create division and disintegration". He adds that neo-functionalists failed to realise the distinction between low and high politics, hence their

inability to distinguish the differences between economic sectors, defence and foreign policy sectors[27].

Despite these criticisms, the theory remains a useful framework for analysing contemporary integration processes, including ECOWAS sub-regional integration efforts. The theory is relevant to this study because the whole idea of sub-regional integration, under the ECOWAS framework, suggests collaboration among a Community consisting of fifteen (15) states, with the intent of economic development, promotion of trade and investment among others. As indicated through the concept of spill-over effect, programmes and policies actions that are jointlyimplemented by different governments within a sub-region, in a given sector, will lead to cooperation in other spheres of inter-state activities. We may find the application of the spill-over effect in the operations of ECOWAS.

For instance, ECOWAS was originally formed to promote economic integration among Member States, but now it also focuses on political integration,through the creation of the ECOWAS Parliament and physical integration, through sub-regional infrastructural projects in key areas such as Transport, Telecommunication and Energy. The quest to collaborate beyond the original agenda of ECOWAS, led to the adoption of the WAPP protocol in 1999, aimed at integratingthe national power systems into a unified regional electricity market to ensure the supply of stable and reliable electricity, at competitive costs.

1.8 Literature Review

1.8.0 Overview of Energy Security

There exist extensive scholarlywork addressing the issue of energy security, power pooling schemes and renewable energy sources. Studies in the field range from conventional security analysis, grid engineering to aspects covering availability, accessibility, environmental

acceptability and affordability of energy. The focus of my review, however, is on the role of regional power pooling schemes and renewable energy in ensuring energy security.

The most outstanding contribution to the field of energy security is the work of Daniel Yergin, the acclaimed father of modern energy security studies. According to Yergin, traditionally, the concept of energy security began in the first half of the 20th Century as anxiety over secured sources of supply of fuels (coal and oil) for military operations arose.Leaders adopted a number of measures to ensure the security of supply of fuel through diversifying suppliers, replacing foreign imports with domestic production, seeking military control over energy resources and infrastructure [28].

In the mid-20th century, oil became indispensable in sustaining industrial growth in the areas of transport, mechanised farming and electricity generation besides military purposes, increasing the West's dependent on imported oil, mainly from the Middle East, prompting the use of oil as a weapon in the implementation of foreign policy objectives[29]. For instance, the Arab Oil embargo of 1974 intended to penalize the United States of America for its support for the State of Israel during the Yom Kippur war. This development brought the concept of energy security to the fore of political attention in the industrialized countries[30].

The oil embargo culminated in the formation of the International Energy Agency (IEA) and the adoption of several measures to reduce the impact of disruptions in oil supply and ensure energy security. Notable among the measures were the replacement of oil with natural gas and nuclear energy in electricity generation, the building of energy -efficient vehicles, the establishment of emergency fuel stocks and joint response mechanisms in Organisation for Economic Co-operation and Development (OECD) and huge investments in oil reserves in regions outside the Organization of the Petroleum Exporting Countries (OPEC) [31].

Whilst developed nations equate energy security to abundance and competitive pricing, other countries define the concept differently. For Energy-exporting nations, it connotes “security of demand" for their exports, since oil accounts for a greater proportion of their Gross Domestic Products (GDP). In order to ensure energy security for oil-dependent economics, Yergin outlines three principles that nations should abide by.

They are diversification of supply sources to reduce the outcome of potential disruptions in supply from single source; ensuring that a security margin is setup in the energy system to provide buffer against potential shocks to aid rapid recovery through resilience; and recognition of the role of regional integration in ensuring energy security. Statements such as “diversification is the first principle of energy security”, or Winston Churchill's adage "safety and certainty in oil lie in variety and variety alone", have become catchphrases in energy security debates[32].

Yergin’s work stresses the crucial role of diversification of energy sources in promoting energy security. This study is very much interested in this work, because the EREP, as feeder to the WAPP, calls on Member States to reduce their over-reliance on fossil fuels for electricity generation by diversifying energy sources, by paying particular attention to renewable sources.

Examination of contemporary literature reveals that the concept of Energy security has evolved from the constricted definition of reductions in oil consumption and import to encompassing an extensive scope of issues and an approach towards human security, bringing on board different dimensions encircling risks associated with natural causes such as resource scarcity, technical factors such as infrastructure and accidents; political factors such as restrictions on supplies, sabotage, terrorism and economic factors relating to pricing[33].

Although contemporary definitions of energy security expands the scope beyond the security of oil supply and demand, to securing enough supply of energy resources (gas, oil, hydro, bio-

fuel, solar, wind) locally and internationally, the security of oil supply is crucial for this study because oil remains a vital component of energy security in West Africa due to the region's dependency on imported fossil fuel for electricity generation. For instances, in some parts of the sub-region, nearly 90% of electricity is generated through fossil fuels, rendering the sector susceptible to global petroleum price volatility and supply disruptions.

Cherp and Jewel provides a synthetic overview of the concept by considering energy security as "a politically constructed concept, rooted in the properties of energy systems of nations and governing institutions"[34]. They have identified three perspectives of energy security as Sovereignty, Robustness and Resilience. The "Sovereignty" perspective places emphasis on disruptions emanating from forces outside the control and jurisdiction of nations such as sabotage and terrorist attacks, political embargos and malevolent exercise of market power. Strategies to deal with issues of sovereignty are protection of energy infrastructure, political and economic control of energy systems, trusted supply sources and relying on domestic sources under the wider concept of energy independence[35].

The "Robustness" perspective focuses on protection of energy systems from potential disruptions emanating from technical, natural and economic sources such as resource insufficiency and exhaustion, malfunction of infrastructure, severe natural events and demand outpacing supply. Strategies to ensure a robust energy system are regular renewal and upgrade of infrastructure, adoption of safer technologies and rely on resources that are more abundant[36]. The "Resilience" perspective deals with unpredictable factors that have the potential to undermine energy security such as technological changes, climate change, market volatility and regulatory changes[37].

Cherp and Jewel's overview of the concept of energy security borders on the role of national policies in ensuring energy security. This study is relevant to this work vis-à-vis how Ghana is

implementing sub-regional policies geared towards ensuring energy security. Robust national energy policies ensure energy security.

According to Scott Valentine, irrespective of a country's source of energy, energy security is anchored on three main pillars: affordability, resilience and availability. In terms of affordability, energy security entails the ability for a state to maintain realistic prices irrespective of the increase in the cost or major global price variations of fossil fuel as seen in the last decade.Resiliencemeans energy security can be achieved not only by safeguarding the current energy reserves but also fortifying the current energy mix against any supply disruptions. Availability implies that energy security is only possible if sufficient energy is available and accessible to all by increasing the sources of energy in the overall energy mix[38].

ECOWAS participation in the regional power pool arrangement, through the implementation of the objectives of the WAPP and its Feeder projects, such as the EREP, has the potential of guaranteeing electricity availability, accessibility and resilience of power systems within and for the sub-region.

1.8.1 Ensuring Energy Security through Renewable Energy

GregorCzisch contends that a key to ensuring energy security in the European Union is the development of strong regional inter-connections with members of the Union and neighbouring countries, including North Africa and the Middle Eastern countries, with greater emphasis on the increasing use renewable energy sources in electricity generation mix. He posits that such regional inter-connections will spread the geographic area of variable electricity sources and assist in ensuring variability[39].

Renewable Energy (RE) sources are replenished naturally almost as quickly as they are utilized. They are obtained from varied sources, including the "sun - in form of thermal, photo-chemical and photo-electric energy, the wind, hydropower and photosynthetic energy stored in biomass"[40]. RE in recent years has become a major part of the global energy agenda as nations continue to diversify their energy mixestowards attainingtheobjective of energy security.

According to the Institute of Energy Security (IES), renewable energy sources tend to be cheaper, because they are typically indigenous and widely but unevenly distributed. It further opines that the use of renewable sources to generate electricity equally has the potential of minimising cost and transmission loses, especially when located close to demand load of end users. It adds that, the zero fuel cost of renewable energy sources over a period of time offsets the relatively high capital costs per unit of installed capacity of Renewable Energy Transmissions (RETs) [41].

Against the backdrop of increasing demand of energy globally, countries around the world are seeking modern energy technologies to increase energy supply and reduce interruptions in supply through diversification of their energy mix to encompass alternative clean renewable energy sources. For instance, China's hopes to ensure that by 2030 renewable energy sources account for 20% of its primary energy supply, whilst Denmark projects having renewable energy account for all of its energy by 2030[42].

The West African sub-region has abundant renewable energy resources, with the application of renewable technologies fast approaching grid parity in some Member States [43].Some countries in the sub-region, such as Senegal, Cape Verde, The Gambia, Mali,Niger and Ghana posses' high potentials for wind energy generation. Huge solar potentials have been identified in Burkina Faso, Niger, Mali and the Northern regions of Nigeria and Ghana[44].

The effective implementation of the EREP in the sub-region, therefore, depends on ability to

promulgate national renewable energy policies and fashion out programmes, to facilitate the exploitation of the region's abundant renewable energy resources towards ensuring increased power accessibility and affordability, especially in rural areas.

Writing under the topic: "Improving Electricity Supply Security in Ghana – the Potential of Renewable Energy" Gyamfi, Mawufemo and Djordjevic indicate that, although Ghana has a number of renewable energy sources, such as solar PV, mini hydro but their utilizationfor electricity generation is very low. As a result, RE accountsfor less than 0.13% of the country's total electricity generation mix as at 2014. They, however, conclude that, given the commitment shown by the Government of Ghana (GOG), the country is expected to see a substantial increase over the next decade[45].

Lamenting on the poor attention being given to the renewable energy sector in the sub-region, David Vilar, reports that of the sum of €1.92 billion investments by ECOWAS in the energy sector, barely 5% goes into renewable energy. Also, apart from Ghana, Cape Verde and Nigeria, other Member States of ECOWAS have not established regulatory authorities to deal with renewable energy. He concludes that "the achievement of energy security is not only in increased efficiency in the use of energy but increasing use of renewable energy"[46].

Notwithstanding the above-mentioned advantages, renewable energy sources have their own limitations. According to Ölz& Kirchner, hydropower can experience seasonal variability due to changing rainfall pattern, hence making it difficult to have "predictable power supply"[47]. Likewise, solar photovoltaics could experience regular daylight variations due to fluctuating clouds. Regarding wind energy, they opine that insufficient wind speed or too much wind - could destroy turbines- resulting in low output variability[48]. Analysing affordability of renewable energy sources, Flavin and Aeck, states that "upfront cost of equipment and

installation and maintenance cost are not affordable to many rural residents without long-term financing options"[49].

1.8.2 Regional Integration and Energy Security through Power pooling

The importance of regional integration as a mechanism to address issues of energy insecurity in Africa has been recognised by the African Union, as captured in the Agenda 2063 document, "harnessing all African energy resources to ensure modern, efficient, reliable, cost-effective, renewable and environmentally friendly energy to all African households, businesses, industries and institutions, through building the national and regional energy pools and grids, and PIDA energy projects"[50].

The Energy Sector Management Assistance Programme (ESMAP) adds that, for developing nations, energy security is contingent upon thedrafting of regional energy strategies to complement national strategies. It opines further that as an alternativeto high capital costs of building additional power generating units, countries may depend on regional power pools to access electricity[51].ArvydasGalinis at the Lithuanian Energy Institute, writing under the topic "Regional integration and energy security in the Model for Energy Supply Strategy Alternatives and their General Environmental Impact (MESSAGE), postulates that depending on regional integration to guarantee energy security offers a number of advantages such as increased diversification of primary energy sources and technologies. It also gives an opportunity for a more efficient use of technologies, reduces cost for the development of power infrastructure, reduces environmental impact of new projects and lessens vulnerability of the entire power system[52].

In a report entitled: "Assessment of Power Pooling Arrangements in Africa", published by the Economic Commission of Africa (ECA), it indicates that African abounds in energy resources in commercial quantities, albeit unevenly distributed. As such, it calls for the facilitation of

regional cooperation and integration via power pooling schemes, to assist in lessening the cost of supply, by taking advantage of the economy of scale[53].

The energy landscape in Africa has evolved with the creation of many bilateral and multilateral regional power arrangements. In West Africa, regional cooperation in the energy sector began in the late 1960s, following the commissioning of the Kainji project in Nigeria in 1968, which supplies power to Niger. Ghana-Togo-Benin grid inter-connection project, relying on the Akosombo Dam, also began in 1970. Ghana and Côte d'Ivoire inter-connection project took place in 1983, whilst Côte d'Ivoire - Burkina Faso and Nigeria- Benin inter-connections began in 2000 and between in 2003 respectively[54].

The IEA opines that cross-border regional collaboration in the power sector could bring down the costs of electricity in Africa by US $2 billion per year. In view of the strategic importance of power to the socio-economic development of every country, it urged African governments to "build high levels of trust in order to share in the cost of developing power infrastructure for long-term benefits of their respective economies"[55].

The role of cross-border collaboration in the electricity sector in ensuring energy security is relevant to this study, which, among other things, is interested in examining the role of the WAPP in ensuring energy security and how Ghana, as member of the WAPP, has integrated its national transmission network into regional networks to enhance cross border exchange of power in the sub-region.

The literature reviewed focused on the linkage between geo-politics and energy security as well as the role of regional power pooling schemes and renewable energy in guaranteeing energy security in Member States. The literature reviewed has given the researcher further impetus to explore this subjected further.

1.9 Sources of Data and Research Methodology

Both primary and secondary sources of data were used for the study. Secondary data was sourced from books, articles, reports and official publications of the institutions concerned. The study adopted non-probability sampling methods- purposive and snowball sampling. Purposive sampling is usually employed during exploratory research and involves purposive selection of a sample unit relevant to the goal of the research and to answer the research questions towards fulfilling the goals of this research.

The sample population relevant to this study was, therefore, selected from three categories of institutions. The first category encompassed five experts from five separate institutions involved in the implementation of the WAPP and the EREP polices in Ghana. They include the Ministry of Energy, the Ghana Grid Company Limited (GRIDCo), the ECOWAS Regional Electricity Regulatory Authority (ERERA), the Volta River Authority (VRA) and the Energy Commission. The second category consisted of Civil Society Organisations (CSO) involved in monitoring and evaluation of energy-related policies implemented in Ghana, such as, the African Centre for Energy Policy (ACEP). The third category covers two Interdependent Power Producers (IPPs), BXC Solar and SunnonAsogli, to ascertain the challenges confronting their operations.

Hence personalities such as Prosper A. Amuquandoh (Inspector of Renewable Energy of the Ghana Energy Commission), Mr. Rasheed Baisee, (Senior Engineer at GRIDCO), Mr. Nii Darko K. Asante (Director of the technical regulation of the Energy commission), Mr. Emmanuel Antwi (Principal Engineer (RE &ID) of VRA) were interviewed.

Data was collected from the above-mentioned respondents through unstructured interviews using open-ended questionnaires. The interviews were recorded, transcribed and analysed using a qualitative method. Conclusion was drawn and recommendations made, based on the stated objectives of the study and available literature.

1.10 Arrangement of Chapters

The study was arranged in four chapters.

- Chapter one is the Introduction;
- Chapter two gives a historical overview of the concepts of Energy Security, Regional Power Pooling Schemes , the WAPP and the EREP policy;
- Chapter three examines the state of Ghana's implementation of the WAPP / the EREP and the challenges/prospects thereof;
- Chapter four is summary of findings, conclusion and recommendations.

``

Endnotes

1. Energy Information Administration (US), and Government Publications Office, eds. *International Energy Outlook 2016: With Projections to 2040*. Government Printing Office, 2016.
2. www.gdforum.org/global_energy_security_conf. 2015
3. https://au.int/en/ie/pida.
4. ibid
5. Mbekeani, Kennedy K. "Making Regional Integration Supportive of Economic Development." *IMMIGRATION CRISIS*: 40.

6. Quansah, A. D., and E. W. Ramdé. "Potentials, Opportunities and Barriers for the Deployment and Usage of Solar Energy Technologies and Services in West Africa." (2010)
7. www. ecowapp.org
8. www.ecreee.org
9. www.ecowapp.org
10. Eshun, MaameEsi, and Joe Amoako-Tuffour. "A review of the trends in Ghana's power sector." *Energy, Sustainability and Society* 6.1 (2016): 9.
11. ISSER. Electricity insecurity and its Impact on Micro and Small Businesses in Ghana. Electricity Insecurity and Its Impact on the Economy of Ghana. Accra. (2015).
12. ECREEE. ECOWAS Renewable Energy and Energy Efficiency Status Report. Paris: REN21 Secretariat (2014).
13. Ibid.
14. www.cdcgroup.com/documents/evaluation/economic
15. www.webforum.org/agenda/2016/africa's-fastest-growing-economics
16. Anyanwu, John C., and Nadege D. Yameogo. "What drives foreign direct investments into West Africa? An empirical investigation." *African Development Review* 27.3 (2015): 199-215..
17. www.gipcghana.com/quarterly-investmnet-report 2017.
18. Evans, Graham, and Jeffrey Newnham. *The Penguin dictionary of international relations*. London: Penguin Books, 1998
19. Lindberg, Leon N. "The European Community as a political system: notes toward the construction of a model." *JCMS: Journal of Common Market Studies* 5.4 (1967): 344-387. .
20. Haas, Ernst B., and Desmond Dinan. *The uniting of Europe: Political, social, and economic forces, 1950-1957*. Vol. 311. Stanford: Stanford University Press, 1958.
21. Pollack, Mark A. *Policy-making in the European Union*. Oxford University Press, USA, 2015.
22. Keohane, Robert O., and Joseph S. Nye Jr. "Power and interdependence in the information age." *Foreign Aff.* 77 (1998): 81.
23. Sangiovanni, Mette, ed. *Debates on European integration: A reader*. palgrave, 2006.
24. Haas, Ernst B., and Desmond Dinan. *The uniting of Europe: Political, social, and economic forces, 1950-1957*. Vol. 311. Stanford: Stanford University Press, 1958.
25. Sangiovanni, Mette, ed. *Debates on European integration: A reader*. palgrave, 2006.
26. Tranholm-Mikkelsen, Jeppe. "Neo-functionalism: Obstinate or Obsolete? A Reappraisal in the Light of the New Dynamism of the EC." *Millennium* Journal of International Studies. 20.1 (1991): 1-22.
27. Yergin, Daniel. "Ensuring energy security." *Foreign affairs*(2006): 69-82.
28. ibid
29. ibid
30. ibid
31. ibid
32. Sovacool, Benjamin K., and Marilyn A. Brown. "Competing dimensions of energy security: an international perspective." *Annual Review of Environment and Resources* 35 (2010): 77-108.
33. Cherp, Aleh, and Jessica Jewell. "The concept of energy security: Beyond the four As." *Energy Policy* 75 (2014): 415-421.
34. Ibid
35. ibid
36. ibid
37. ibid
38. Valentine, Scott Victor. "Emerging symbiosis: Renewable energy and energy security." *Renewable and Sustainable Energy Reviews* 15.9 (2011): 4572-4578..
39. Czisch, Gregor, and GregorGiebel. *Realisable scenarios for a future electricity supply based 100% on renewable energies*. No. RISO-R--1608 (EN). 2007.
40. Ellabban, Omar, Haitham Abu-Rub, and FredeBlaabjerg. "Renewable energy resources: Current status, future prospects and their enabling technology." *Renewable and Sustainable Energy Reviews* 39 (2014): 748-764.
41. Birol, Fatih. "World energy outlook 2010." *International Energy Agency* 1.3 (2010).
42. IRENA. Second Ministerial Roundtable: 'The Role of Renewable Energy in Energy Security. (2015).
43. Adeyemo, Babatunde. "West African power pool." *Being a Presentation Made at the South Asia Regional Workshop on Competitive Electricity Markets, Colombo, Sri Lanka*. 2014.
44. ibid
45. Gyamfi, Samuel, MawufemoModjinou, and SinisaDjordjevic. "Improving electricity supply security in Ghana—The potential of renewable energy." *Renewable and sustainable energy reviews* 43 (2015): 1035-1045.

46. Vilar (ed) 'Renewable Energy in Western Africa: Situation, Experiences and Trends', ECREEE and Casa Africa.(2012)
47. Ölz, Samantha, Ralph Sims, and Nicolai Kirchner. "Contribution of renewables to energy security." (2007).
48. ibid
49. Flavin, Christopher, and Molly Hull Aeck. *Energy for development: the potential role of renewable energy in meeting the millennium development goals*. Prepared for the Renewable Energy Policy Network by the Worldwatch Institute, 2005.
50. https://au.int/en/agenda2063
51. https://esmap.org/node/374
52. www.iaea.org/INPRO/activities
53. United Nations Economic Commission for Africa (UNECA), "Assessment of Power-Pooling Arrangements in Africa", UNECA, Addis Ababa, October 2004, p. 21
54. Thiam, Nogoye. "Towards a Sustainable Energy System for Africa: An African Perspective on Energy Security." *Facing Global Environmental Change*. Springer, Berlin, Heidelberg, 2009. 445-456..
55. IEA .*World Energy Outlook-2017,* OECD/IEA, Paris. (2017

CHAPTER TWO

OVERVIEW OF ENERGY SECURITY AND REGIONAL POWER POOLING SCHEMES, THE WAPP AND THE EREP

2.0 Introduction

This chapter discusses the components of Energy Security and provides a historical overview of Regional Power Pooling Schemes in Africa. It also examines the background and objectives of the West African Power Pool and its feeder projects, encompassing the West African Gas Pipeline (WAGP), and the ECOWAS Renewable Energy Policy (EREP). It further assesses the objectives of complementary institutions of the WAPP, such as the ECOWAS Regional Centre for Renewable Energy and Energy Efficiency (ECREEE) and the ECOWAS Regional Electricity Regulatory Authority (ERERA). Finally, it provides an overview of the prevailing power situation in West Africa.

2.1 Energy Security Defined

The International Energy Agency (IEA) defines energy security as "the uninterrupted availability of energy sources at an affordable price"[1]. It identifies two dimensions of energy security as short-term and long-term. Essentially, the long-term dimension covers timely investments in the energy sector to guarantee the supply of energy in line with socio-economic developments and sustainable environmental needs, whilst the short-term dimension stresses on the capacity of an energy system to react to sudden changes within the supply-demand chain[2]. The IEA further outlines three components of energy security as accessibility, affordability and availability.

It defines energy access as "a household having reliable and affordable access to both clean cooking facilities and to electricity, which is enough to supply a basic bundle of energy services initially, and then an increasing level of electricity over time to reach the regional average"[3]. A basic bundle of energy services means, “at a minimum, several light bulbs, task lighting, such as a flashlight, phone charging and a radio”, whilst access to clean cooking facilities means:

> Access to, and primary use of, modern fuels and technologies, including natural gas, Liquefied Petroleum Gas (LPG), electricity and biogas, or Improved biomass Cook Stoves (ICS), as opposed to the basic biomass cook stoves and three-stone fires used in developing countries[4].

TheIEA further equates energy access to “the golden thread that weaves together economic growth, human development and environmental sustainability”[5]. Energy has long been acknowledged as essential for human development and progress. The political recognition of this led to the adoption of the United Nations Sustainable Development Goals (SDGs) in 2015. Nonetheless, the UN estimates that globally, "nearly 1.06 billion people lack access to electricity, including the ECOWAS sub-region, whereaverage electricity access rate is about 38% and being among theleast in the world"[6].

The World Bank defines affordable electricity “as 30 kWh of electricity that costs not more than 5% of a household’s income”[7]. With regards to electricity, affordability has two dimensions, that is affordability of access relating to the costs of connection and the affordability of use, relating to the share of household income expended on electricity usage, which tend to be recurrent in nature. Although sub-Saharan Africa has low electrification access rates, electricity tariffs are higher compared to the global average. For instance, industrial electricity tariffs vary between $20-50 cents/kWh as against global average of $10 cents/kWh[8].

Overall, most ECOWAS Member States continue to encounter major developmental challenges, with 13 out of 15 countries being classified as having “Low Human Development” by the United Nations[9].The urban and rural poor in the sub-region expend proportionately more of their incomes “for poor quality energy services than the better-off for better quality services”[10]. This has been attributed to limited access and poor quality services in rural areas. Similarly, "poor households are unable to afford high electricity connection charges and tend to thus, rely on kerosene for lighting and on wood fuel, charcoal and LPG for cooking”[11]. Even if the grid reaches a rural area, the families may be hard pressed to afford it.

Availability implies running an energy system that aims at reducing reliance on imported fuels and providing sufficient and uninterrupted supply of energy. To guarantee consistent availability, there has to be comparative independence and diversification of sources of energy and services. Diversification encompasses both source and spatial diversification, where source diversification implies integrating various sources of energy into the energy mix, whilst spatial diversification entails ensuring dispersion of location for energy facilities[12].

2.2 What Is a Power Pool?

The Economic Commission of Africa (ECA) defines power pool as "an arrangement between two or more inter-connected electric systems that are planned and operated to supply power in the most reliable and economical manner for their combined load requirements"[13]. Power utilities can be deemed as forming a power pool if their generation and transmission infrastructures are brought together, as if they were a single system, through coordination[14]. Sivanagaraju and Sreenivasan also define power pool as "an association of two or more inter-connected electric systems having an agreement to coordinate operations and planning for improved reliability and efficiencies of their generating or transmission facilities, or both"[15].

According to Anne Ku, power pooling is "an arrangement where output from different power plants are pooled together, scheduled according to increasing marginal cost, technical and contractual characteristics and dispatched according to the merit order to meet demand"[16].

2.2.0 Objectives of Power Pools

Regional Economic Commissions (RECs) have inter-connected their power systems to enable them benefit from cost reduction, economies of scale and reduction in total reserve requirement of individual states[17]. Reduction in operating costs could be gained from power pools through the use of the most economical energy resources and operational benefits, including merit order loading and the balancing of non-coincidental peak loads. Inter-connected power systems allow the sharing of operational reserves and installed capacity to avoid additional investment in generation infrastructure[18].

Power pooling, therefore, permits cost savings; especially operating costs and enhances reliability of power systems. This is because the operation of isolated systems comes with the requirement to provide operational reserves that commensurate with expected system contingencies, with increased maintenance costs[19]. Italso benefitsfrom economies of scale through:

> Investments in larger projects with low unit cost being, being considered from a regional instead of a national perspective; the Sharing of the responsibility for providing a collective reserve margin for an entire region instead of each individual utility having to provide its own reserve margin; and the Introduction of bigger generation facilities to permit better power quality, lower costs and optimize investment in infrastructure[20].

Supply security is also enhanced through increased diversity of sources of energy. Also, large systems, created due to the pooling of power resources, tend to be more robust against contingencies[21]. In general, power pooling constitutes an integral part of a wider regional integration effort[22].

Regional power pool arrangement, moreover, is way of pooling risks by participating countries andby so doing making capital intensive power projectsmore attractive to investors, who often consider indicators such as project and country risks, when taking investment decisions[23]. Power pools, if operated well, has the potential of reducing the riskslinked to prospective investments by fashioning out wider regional markets so that a Member State's economic, financial and political challenges could be moderated[24].

According IvarWangensteen, the benefits that could arise from balancing power production mixes, chiefly from integration and coordination of hydropower and thermal systems comprise reduction in operating costs achieved through:

> Increased hydropower generation in off-peak periods at almost zero cost, replacing thermal generation and thereby saving fuel in the thermal system; Reduced operation costs in the thermal system due to import in peak (high cost) periods and export in off peak (low cost) periods; Reduction or postponement of investments in new peak power capacity in the thermal generating capacity; and Reduced investment in the hydro system due to the possibility of importing in a dry year[25]

Nonetheless, the operation of power systems are saddled with some challenges such as lack of trust among Member States in the pool, poorly developed transmission infrastructure and tie lines, insufficient generation capacities and reserve margins and problems associated with mobilizing investments for power pool projects. Others challenges include the absence of legal regimes to regulate cross border electricity trading, dearth of rules for access to the transmission grid, such as the setting of wheeling charges, and lack of mechanisms for conflict resolution and mamagement[26].

2.2.1 Power pooling in Africa

Cooperation in establishing sub-regional cross-border electricity inter-connections in Africa began in the 1950s, when Tunisia and its neighbour Algeria, linked their electricity networks to facilitate the exchange of power in case of emergencies[27]. However, in Sub-Saharan Africa (SSA), cross-border electricity exchange began in 1958 following the construction of the Owen Falls Dam that linked Kenya and Uganda via a 132 kV transmission line. Zambia and Zimbabwe were also inter-connected following the construction of the Kariba South hydropower project in the mid-60s whilst the building of the Akosombo Dam in 1960 linked Ghana's power system to Togo and Benin through the CommunautéElectrique du Benin (CEB) in 1972 and to Côte d'Ivoire 1984[28].

The above power exchanges were mainly bilateral agreements and involved national utilities that were vertically integrated and concurrently performed the functions of generation, transmission and distribution. However, the first ever power pooling arrangement in Africa began in 1995 following the establishment of the Southern Africa Power Pool (SAPP) by the Southern Africa Development Community (SADC)[29]. Other power pools, such as the West African Power Pool (WAPP) for ECOWAS and the Central African Power Pool (CAPP) for the Economic Community of Central African States (ECCAS)were subsequently established by the various RECs. Presently, there are four power pools established in Sub-Saharan Africa, namely; the Southern African Power Pool (SAPP), the West African Power Pool (WAPP), the Central African Power Pool (CAPP) and the East African Power Pool (EAPP)[30].

2.3 Towards Energy Security in West Africa

The quest to ensure energy security has featured prominently on the Agenda of the Authority of Heads of State and Government of ECOWAS. For instance, Articles 3, 26 and 55 of the ECOWAS Treaty spelt out the essential principles relating to promotion, cooperation, integration and development of the energy sector of the sub-region[31]. Also, in 1982, through the adoption of decision number A/DEC. 3/5/82, the Authority of Heads of State and Government of ECOWAS adopted the ECOWAS Energy Protocol which laid the legal framework for long term cooperation, among Member States, on energy related matters[32].

The provisions of the Protocol, among other things, seek to guarantee free exchange of energy and related equipment and products between Member States. The implementation of this protocol led to the setting up of the West African Gas Pipeline in 2005, the West African Power Pool in 1999, the ECOWAS Regional Electricity Regulatory Authority (ERERA) in 2008, the ECOWAS Centre for Renewable Energy and Energy Efficiency (ECREEE) in 2010 and the promulgation of the ECOWAS Renewable Energy Policy (EREP) in 2014[33].

2.3.0 The West African Power Pool

ECOWAS Ministers of Energy adopted an indicative master plan for the development of energy production facilities and the promotion of inter-connected electricity grids of Member States, including the establishment of the WAPP in November, 1999as an institutional framework for integrating the national power systems of Member States into a regional electricity market to guarantee the provision of steady and sustainable electricity supply for economic development, with the vision to:

> Integrate the national power systems into a unified regional electricity market with the expectation that such mechanisms would over the medium to long term ensure citizens of ECOWAS with a stable and reliable electricity supply at competitive cost[34].

The WAPP has a core mission of: "Promoting and developing infrastructure for power generation and transmission, as well as to assure the coordination of electric power exchanges between ECOWAS"[35]. To fulfil its core mission, some key legal frameworks were enacted to govern its operations such as the ECOWAS Energy Protocol, the Inter-governmental Memorandum of Understanding (MoU) of October 2000; the Inter-utility MoU and the MoU between the transmission system operators of March 2001; and the ECOWAS Energy Information Observatory launched of 2003[36].

The following have been identified as the obligations of Member States under the WAPP MoU: a.)The provision of support to the implementation of priority inter-connection projects, including rights of way and security; b.) Granting of permit to transmission system operators to enable them develop and implement schemes and programmes that promote regional electricity trading; and c.) Facilitating the formation and operation of the West Africa Power Pool by undertaking ,among other things, to adopt appropriate tariff policies and regulations, synchronize their respective regulatory frameworks, facilitate cooperation among operators to administer settlements and establish a regulatory framework to govern private investment within the West Africa Power Pool[37].

At the operational level, the Inter-governmental MoU provided for the splitting of the WAPP operational areas into two distinct zones for the effective implementation its projects due to different levels of development among Member States. Zone A comprises Côte d'Ivoire Benin, Ghana, Nigeria,Burkina Faso, Niger and Togo; whilst Zone B encompasses CapeVerde, Guinea Bissau, Guinea, Sierra Leone, Mali, Liberia, Senegal, Mauritania and The Gambia[38].

2.3.1 Objectives of the WAPP

The WAPP objectives are to:

> Formalize an official collaboration among Member States in order to develop power generation and transmission facilities, in order to enhance power supply and strengthen power security in the sub-region; Improve the reliability of power system and quality of power supply in the sub-region; Minimize operating cost of networks and increase investments needed for power grid expansion in the region, with greater emphasis on the implementation of cross-border projects; Create a conducive environment to attract investments to fund capital intensive generation and transmission facilities; Create a common operating standards and rules for power exchanges and a transparent and reliable mechanism for the settlement of disputes associated with power trade transactions and finally to; Increase the level of power generation and transmission in the sub-region, through the implementation of identified priority projects[39].

The WAPP is promoting new investments in transmission and generation in the sub-region and has been involved in the development of a number of regional transmission projects, under its priority projects initiative, such as the Soubré, Bumbuna and Kaléta hydroelectric projects in Cote d'Ivoire, Sierra Leone and Guinea respectively; the Sendou Coal power plant in Senegal, the inter-connection project of Ghana-Burkina Faso-Mali via a 225kV line. Others include the 225 kV transmission loop between Senegal, The Gambia, Guinea and Guinea-Bissau and the Coastal Backbone Inter-connection project from Cote d'Ivoire to Nigeria passing through Ghana, Benin and Togo[40.]

2.3.2 The ECOWAS Regional Regulatory Authority (ERERA)

The ECOWAS Regional Electricity Regulatory Authority (ERERA) was established in 2008 as a legal and institutional framework for the development of the power sector in the sub-region. ERERA's main objective is to regulate cross-border electricity inter-connections and support national regulatory bodies[41].The support to national regulatory bodies is provided, among other things, through:

> Regulation of interconnected line and electricity market/exchanges; Establishment of transparent methodologies for regional power market and related prices/tariff; Facilitation of regulatory and economic framework for the development of the regional electricity market; Regulation of technical issues

for sub-regional electricity trade and monitoring of the market; Resolution of disputes among market participants[42].

ERERA is the regulator of regional cross-border trade in electricity and sets up the requisite legal and institutional frameworks for the development of the electricity sector in West Africa. The entity, after boarder consultation among stakeholders, is due to launch the regional electricity market this year, 2018, as enshrined in the Directive C/DIR/1/06/13 on the organisation of the regional market, adopted on 21st June 2013 in Abidjan, by the ECOWAS Council of Ministers. The market will, among, other things, harmonise the contractual provisions concerning cross-border electricity trading between a seller and a buyer in Member States of ECOWAS, including access, inter-connection and use of regional transmission networks[43].

2.3.3 ECOWAS Regional Centre for Renewable Energy and Energy Efficiency (ECREEE).

ECREEE is a specialised agency of ECOWAS, dealing primarily with the promotion of Renewable Energy Sources (RES) and Energy Efficiency (EE). Following the creation of ECREEE in 2010, the ECOWAS Renewable Energy Facility (EREF) was launched to target small-to-medium-scale renewable energy and energy efficiency projects, mostly in rural and peri-urban areas[44]. In 2010, the ECOWAS Renewable Energy Policy (EREP) and the ECOWAS Energy Efficiency Policy (EEEP)were adopted.

ECREEE also provides technical support to Member States so that the EREP and the EEEP can be mainstreamed into National Renewable Energy Policies (NREPs) and Action Plans (NREAPs). This collaboration with Member States is a significant step forward in harnessing renewable energy resources, mainstreaming policy development and scaling up investment in

sustainable energy solutions towards increasing energy access and improving energy security[45].

Institutional, legal, regulatory,tariff structures and frameworks for renewable energy are, "largely non-existent or weakly implemented in the region"[46]. With the exception of Nigeria and Cape Verde, there are no regulatory authorities dealing with renewable energy. Similarly,Mali, Senegal, Guinea Liberia and Nigeria have developed national renewable energy polices, with Senegal passinga renewable energy law[47]. Furthermore, Mali, Liberia, and Senegal have adopted renewable energy targets of 30%, 25%and 15% by 2021respectively. Countries such as Burkina Faso, Guinea Bissau, Togo, Sierra Leone and The Gambia have notset renewable energy targets yet; nonetheless, they have diversified their generation mix with considerable investments in renewable energy[48].

2.3.4 The ECOWAS Renewable Energy Policy

The ECOWAS Renewable Energy Policy was adopted by the ECOWAS Authority of Heads of State and Government in 2013 as a feeder project of the WAPP power supply strategy and conventional national supply systems, serving as an important contributor to bulk power generation and universal energy access. The policy aims at:

> Ensuring increased use of renewable energy sources such as solar, wind, small-scale hydro and bio-energy for grid electricity supply and for the provision of access to energy services in rural areas, promote access to energy services in rural and urban areas, reduce dependence on imported fossil fuels and its attendant negative environmental externalities[49].

Article 2 of the supplementary Act of the EREP requires ECOWAS Member Statesto dovetail the EREP objectives into their national developmental agenda and see to its implementation with the objective of contributing to the achievement of universal access to sustainable energy

services in the region by 2030[50]. Hence, specific targets ought to be achieved by Member States. The policy require Member States to: Augment the share of RE in their overall electricity generation mix, including large hydro, to 35% by 2020 and 48% by 2030; and augment the share of RE in the overall energy mix, excluding large hydro, to 10% by 2020 and 19% by 2030. This is expected to lead to the installation of 2,424MW of RE generation capacity from solar, wind, bio-energy and small scale hydro power by 2020 and 7,606 MW by 2030; and increase the share of the populace served with modern fuel alternative, encompassing LPG, for cooking to 36% by 2020 and to 41% by2030[51].

The EREP policy has a six-step implementation plan aimed at achieving the set targets. They include:

> Securing a regional legal, institutional, and regulatory framework to develop consistency between the regional and the national renewable energy policies; Ensuring each Member state has a National Renewable Energy Policy (NREP) with an associated implementation strategy and a five year rolling action plan; Incentivizing the private sector to participate in renewable energy power and hardware production; Training national officials and required technicians to design, implement, and operate renewable energy technology; Calculating the viability gap for renewable energy technologies and identifying funding to close the viability gap; Advocacy, awareness, and knowledge management through the Regional Observatory of the ECOWAS Centre for Renewable Energy and Energy Efficiency (ECREEE)[52]
>
> .

The policy's timeline requires Member States to come up with a completed NREP in 2013 and roll out a five year implementation plan, beginning 2014. So far, RE technologies account for merely 28.8% of the regions'overall grid-connected installed capacity, of which nearly 99% originates from hydropower, a situation that has persisted for decades. Non-hydro renewable installed capacity of grid-connected, such as solar, wind, and modern biomass, is just 39 MW and is largely concentrated in Ghana and Cape Verde.[53.]

2.3.5 The West African Gas Pipeline (WAGP)

The West African Gas Pipeline (WAGP), a sub-regional backbone for gas distribution, was established in 1995, and mandated to supply natural gas from Nigeria to neighbouring Benin, Togo and Ghana at competitive prices[54].It is owned and managed by the West African Gas Pipeline Company (WAPCo), a public- private joint venture headquarters in Accra, Ghana. The first natural gas supply from the pipeline arrived in Ghana in 2009[55]. The project has, however, suffered a number of obstacles, notably insufficient gas supply to buyer countries, non-payment of bills by major off-takers and pipeline security. For instance, gas supply to Ghana has persistently been less than 50% of the contractual volumes. Given Ghana's increasing reliance on thermal sources of generation, the inconsistent supply compelled the Volta River Authority (VRA), which supplies power to four WAPP members, to procure expensive crude oil to run its thermal plants[56].

2.4 The power situation in West Africa

With a growing population in excess of 334.6 million as at 2014, ECOWAS represents about one third of Sub- Saharan Africa’s total population. The sub-region has long witnessed huge shortfalls in the supply and distribution of energy resources, culminating in an annual per capita consumption of electricity of less than 88 kWh, being among the least in the world[55]. Accessibility to electricity is a major problem in the sub-region, with access rates varyingfrom below 20 % in countries like Niger, Liberia, Burkina Faso and Sierra Leone and to more than 50% in Senegal and above 70% in Cape Verde and Ghana. In addition, there are huge discrepancies between urban and rural access rates, with the latter being underserved. The share

of rural populations with access to electricity ranges from 1% in Sierra Leone and Guinea and up to 70% in Cape Verde[57].

In areas with high electricity access, frequent blackouts and unreliable power, especially during high peak periods or during the arid seasons in countries that depend extensively on hydro, limit electricity usage and its associated benefits[58]. The lack of access to electricity impacts negatively on the socio-economic development of Member States, since frequent power shortages reduce overall productivity and drive up operating costs, compelling many economic operators to rely on expensive energy from generators, which are three to five times more costly than power from electricity grid[59].

The availability of electrical energy, in terms of generation capacity is also a challenge in the region. Nigeria, Côte d'Ivoire and Ghana account for over 90% and 82.5% of installed and available capacities in the region, whilst generation is dominated by thermal and hydroelectric plants, which account for about two thirds and one third of the electricity generated in the sub-region[60]. Besides over-reliance on thermal plants, the issue of inadequate generation is also a problem in the electricity sector;which is occasioned by over reliance on obsolete power plants, mainly constructed during colonial era or shortly after independence, undiversified energy mix, frail national transmission networks and limited inter-connection for cross-border electricity[61].

The affordability of electricity is also a key issue within the power sector in the region. The installed capacity in many Member States rely on fossil fuels, albeit expensive, for emergency energy solutions at an estimated cost US $0.2 to US $0.3 per kWh compared to conventional generation[62]. Hence, the cost of electricity in the region is among the highest globally, leading to the introduction of subsidies in the power sector. State-owned electricity companies also tend to run at fiscal deficits, estimated to represent "1.8% of Gross Domestic Product (GDP) in 2009–10, due to the difference between the revenue collected and that required to fully

recover the capital and operating costs"[63].Subsidies, once introduced, impose great fiscal costs on governments, weaken the finances of power producers and discourage investors[64].

Other major characteristics of the power market in the sub-region are that the sector remains vertically integrated, under majority state-ownership and lacks a strong dominant player, both in the areas of demand and supply[65]. Côte d'Ivoire and Cape Verdeare the only two countries where majority of the power sector is owned by private companies, whilst Ghana, Burkina Faso, Nigeria, Côte d'Ivoire and Senegal have independent power producers[66].

Notwithstanding the above-mentioned challenges, the region is endowed with enormous energy production potentials, ranging from non-renewable sources such as oil, gas and uranium and renewable energy sources such as hydroelectric power, wind and solar energy[67]. The bulk of the region's energy generation potential resides in Nigeria, which owns about 98% of proved crude oil and natural gas reserves. Similarly, about 91% of West Africa's exploitable hydropower potential is concentrated in five countries, namely; "Nigeria (37.6%), Guinea (25.8%), Ghana (11.4%), Côte d'Ivoire (10.9%) and Sierra Leone (5.2%)"[68].

The imbalance between supply and demand is at the cause of power problems in the region, occasioned mainly by a number of constraints such as financial, technical, socio-economic and regulatory. Financial constraints deal with electricity supply side issues such as high costs of power and lack of adequate funds for infrastructural projects. High costs of electricity in Africa are a major challenge of the power sector[69]. According to a report on Regional Power Status in African Power Pools prepared by the Infrastructure Consortium for Africa (ICA), "electricity is generated and distributed at higher costs, a cost often transferred to consumers in the form of high electricity tariffs"[70].

Generation and transmission projects in most countries in the region are capital intensive and exceeds the financial capacities of Member States, hence their reliance on external support.

Furthermore, since these projects are principally funded by donor agencies and development partners, sub-regional governments feel less involved, "They simply feel being like agents with diffuse responsibilities"[71].

Technical limitations arelinked to inadequate capacities for generation, transmission and distribution - a recurrent constraint that affects electricity access in the sub-region. Performance deficiencies in the power sector are linked to insufficient and obsolete generation and transmission infrastructures. Transmission constraints, among others, are related to voltage fluctuations, cable overloads, high losses and long feeders. The rates of transmission and distribution losses remain high in the sub-region and estimated to be about 35.7%. It is thehighest in Africa and three times higher than the internationally accepted rate of 10%[72].

Countries affected by conflict tend to performpoorer in terms of infrastructure development than those at peace. In the sub-region, some generation capacities and related infrastructures have been ruined during periods of armed conflicts in Liberia and Sierra Leone. Generation and transmission facilities were completely shattered in the process. In 2012, a decade after the civil war in Sierra Leone, reliable installed capacity was just under 53 MW against total demand of 125 MW[73].

Environmental and climate variability constraints also impact onelectricity supply interruptions in the region. Periodically, due to drought, the Akosombo Dam operates below capacity leading to cyclicpower crisis in Ghana, affecting Benin and Togo, who import electricity from Ghana[74]. In addition, countries such as Senegal, Nigeria, Guineaand Mali have all suffered from frequent disruptions in the supply of electricity due to droughts[75]. Environmental constraints undermine ECOWAS traction in the energy field as Member States think of solutions in furtherance of their national interest.

Given the above prevailing power situation in the sub-region, and against the backdrop of the implementation of the WAPP and the EREP, the next chapter examines the power situation in Ghana - a member of the WAPP under the WAPP and how regional polices have been mainstreamed into national polices, challenges of implementation and the implications for its national energy security.

Endnotes

1. Energy Information Administration (US), and Government Publications Office, eds. *International Energy Outlook 2016: With Projections to 2040*. Government Printing Office, 2016.
2. ibid
3. ibid
4. ibid
5. The World Bank Group. ECOWAS -Regional Electricity Access Project Information Document/ Integrated Safeguards Data Sheet (PID/ISDS) Report No: PIDISDSC22358, 2018
6. ibid

7. Kojima, Masami, and Chris Trimble. *Making Power Affordable for Africa and Viable for Its Utilities*. World Bank, 2016.
8. The World Bank Group. (2016b) *Getting electricity*. Retrievedfromhttp://www.doingbusiness.org/data/exploretopics/getting-electricity (2016).
9. Bowd, Richard, and Annie Barbara Chikwanha. "Understanding Africa's contemporary conflicts: origins, challenges and peacebuilding." *Institute for Security Studies Monographs* 2010.173 (2010): 281.
10. ibid
11. Eberhard, Anton, et al. *Africa's power infrastructure: investment, integration, efficiency*. The World Bank, 2011.
12. Sovacool, Benjamin K., ed. *The Routledge handbook of energy security*. Routledge, 2010..
13. United Nations Economic Commission for Africa (UNECA), "Assessment of Power-Pooling Arrangements in Africa", UNECA, Addis Ababa, 2004, pp. 21-27
14. Ibid
15. Sivanagaraju, S. *Power system operation and control*. Pearson Education India, 2009.
16. Ku, Anne. "Forecasting to understand uncertainty in electricity prices." *Platts Energy Business and Technology* (2002): 59-64.
17. United Nations Economic Commission for Africa (UNECA), "Assessment of Power-Pooling Arrangements in Africa", UNECA, Addis Ababa,2004, p. 21
18. Ibid
19. Ibid
20. Ibid
21. Ibid
22. Ibid
23. Ibid
24. Ibid
25. Ibid
26. United Nations Economic Commission for Africa (UNECA), "Assessment of Power-Pooling Arrangements in Africa", UNECA, Addis Ababa. 2004, p. 21
27. Niyimbona, P. "The challenges of operationalizing power pools in Africa." *United Nations Commission for Africa, UNDESA Seminar on Electricity Inter-connection*. 2005.
28. United Nations Economic Commission for Africa (UNECA), "Assessment of Power-Pooling Arrangements in Africa", UNECA, Addis Ababa.2004, p. 21
29. Ibid
30. ibid
31. WAPP *WAPP Business Plan 2016-2019 West African Power Pool*. (2015).
32. Ibid
33. Ibid
34. Ibid
35. United Nations Economic Commission for Africa (UNECA), "Assessment of Power-Pooling Arrangements in Africa", UNECA, Addis Ababa. 2004, pp. 51-52
36. Ibid
37. WAPP *WAPP Business Plan 2016-2019 West African Power Pool*. (2015).
38. Ibid.
39. WAPP *WAPP Business Plan 2016-2019 West African Power Pool*. (2015).
40. ibid
41. ERERA (n.d). Welcome to Erera. Retrieved from www.erera.arrec.org.
42. Ibid
43. Prof. Honoré Note on the Official Launch of the ECOWAS Electricity Market.pp.5 (2018).
44. Policy, Energy Efficiency. "ECREEE." *Cape Verde*: 56. .
45. Auth, Katie, et al. "ECOWAS renewable energy and energy efficiency status report-2014." (2014).
46. Vilar (ed) . Renewable Energy in Western Africa: Situation, Experiences and Trends, ECREEE and Casa Africa. (2012)
47. Ibid
48. Ibid
49. Policy, Energy Efficiency. "ECREEE." *Cape Verde*: 56.
50. Ibid
51. Ibid
52. Ibid

53. KarimKaraki Understanding ECOWAS Energy Policy - *From national interests to regional markets and wider energy access.* (2017).
54. www.ecowas.int/wp-content/uploads/2015/01/7-West-African-gas-Pipeline.pd
55. ibid
56. ECREEE. ECOWAS Renewable Energy and Energy Efficiency Status Report. Paris: REN21 Secretariat. 2014.
57. ibid
58. Mbekeani, K. K. "Understanding the barriers to regional trade integration in Africa." *African Development Bank Group*(2013).
59. ibid
60. IAEA Sustainable Electricity Supply Scenarios for West Africa. 2016.
61. Adeyemo, Babatunde. "West African power pool." *Being a Presentation Made at the South Asia Regional Workshop on Competitive Electricity Markets, Colombo, Sri Lanka*. 2014.
62. Bhattacharyya, Subhes C. "Financing energy access and off-grid electrification: A review of status, options and challenges." *Renewable and Sustainable Energy Reviews* 20 (2013): 462-472./.
63. Alleyne, Mr Trevor Serge Coleridge, and Mr MumtazHussain. *Energy subsidy reform in Sub-Saharan Africa: Experiences and lessons*. International Monetary Fund, 2013.
64. Kojima, Masami, Robert Bacon, and Chris Trimble. "Political economy of power sector subsidies: a review with reference to Sub-Saharan Africa." (2014).
65. Besant-Jones, John E. *Reforming power markets in developing countries: what have we learned?*. Washington, DC: World Bank, 2006.
66. ibid
67. IAEA Sustainable Electricity Supply Scenarios for West Africa. 2016.
68. ibid
69. Manz, D. Smart Grid Opportunities A Global Perspective. Irvine, California, USA. (2011).
70. Infrastructure Consortium for Africa (ICA). Regional Power Status in African Power Pools. Tunis (2011).
71. Pineau, Pierre-Olivier. "Electricity sector integration in West Africa." *Energy Policy* 36.1 (2008): 210-223..
72. Manz, D. Smart Grid Opportunities A Global Perspective. Irvine, California, USA. (2011).
73. Kirubi, Charles, et al. "Community-based electric micro-grids can contribute to rural development: evidence from Kenya." *World development* 37.7 (2009): 1208-1221.
74. PPPIRC. Theft / Non-Technical Losses (Water and Electricity (2014).
75. Gnansounou, Edgard, et al. "Strategies for regional integration of electricity supply in West Africa." *Energy policy* 35.8 (2007): 4142-4153.

CHAPTER THREE

GHANA'S IMPLEMENTATION OF THE WAPP AND THE EREP: IMPLICATIONS, PROSPECTS ANDCHALLENGES

3.0 Introduction

This chapter seeks to provide an assessment of the electricity sector in Ghana; examine whether its energy policies are in consonance with that of the sub-region with reference to the WAPP and the EREP. The chapter also examinesthe policy implicationsvis-à-vis implementation, as well as the prospects and challenges.

The quest to provide reliable and affordable electricity to the citizens of the Economic Community of West Africa informed the decision of the Twenty-second Summit of the ECOWAS Authority of Heads of State and Government to create the West African Power Pool in 1999 and the ECOWAS Renewable Energy Policy in 2013. The WAPP Articles of Association necessitate Member States to commit to the "full and effective implementation of WAPP priority projects towards the attainment of its objectives"[1]. To this end, Member States are required to develop short, medium-to-long term policiesthat reflect regionalenergy polices and dovetail them into their national development agenda[2].

Ghana as a signatory to both the WAPP and the EREP is, therefore, obliged to commit to the objectives spelt out in these policies to help achieve energy security, at both local and sub-regional levels.

3.1 Overview of the Power Situation in Ghana

Electricity isthe most dominant form of modern energy used in Ghana. It accounts for about 65% and 36% of energy used in the industrial and the residential sectors respectively[3]. As at

2016, Ghana had an estimated electricity access rate of 82.5%, being the second highest rate in the sub-region, after Cape Verde[4]. The relatively high access rate is due to the combined efforts of the Ghana Energy Development and Access Project (GEDAP) and the National Electrification Scheme (NES). Under the NES, a National Electrification Master Plan was developed, with the aim of achieving nationwide access to electricity by 2020[5].

Ghana has suffered severe power rationing in the years 1983–1984; 1997–1998; 2003; 2006–2007; and 2011–2016. Generally, the power rationing was attributed to fuel supply challenges to thermal generating plants and dwindling water level in the Akosombo Dam due to cyclic drought[6]. The beleaguered power supply challenges have occasionedextensive impact on the socio-economic situation of the country. For instance, during the power crisis of 2007, the country lost about 1.8% of its GDP, leading to the electricity sector been ranked as"the second most important constraint to business operations in Ghana"[7].

3.1.0 Demand and Supply Dichotomy

In 2016, the power sector recorded atotal peak load of 2,087 MW against a figure of 1,933 MW in 2015, representing an increase of 154 MW that is 8%. Totalenergy supplied, encompassing imports from Cote d'Ivoire, over the period, was 13,707 GWh, comprising 5,561 GWh from hydro generations, 7,381 GWh from thermal generations and 765 GWh from imports[8]. Meanwhile, total energy consumption is on the increase in the country. For instance, in 2016, total energy consumed, including losses, was 13,700 GWhcompared to 11,692 GWh in 2015, representing a 17.2% growth in energy consumption[9].The main drivers of the increasing electricity consumption in Ghana are attributed to the fast growingindustrial sector, especially in the petroleum and mineral exploration sub-sector; Service sector, especially in the communication,banking and hospitality industries; increased urbanization due to a growing middle class and overall national population growth, estimated at about 2.3 % per annum and

projected to reach 40 million by 2030; and fast expansion of the four major cities, Accra, Kumasi, Tema and Takoradi[10].

3.1.1 Electricity Generation Mix

Concerning power generation, the country's capacity has increased over the years from a figure of 1,730 MW in 2006 to4,420 MW in June 2018. In 2016, total energy generated was 13,693 GWh - with a generation mix of 40.6% hydro, 53.9% thermal and 5.4% imports[11]. Presently, the installed generation mix comprise of 1,580MW of hydro, 2,817MW of thermal and 22.5MW of solar as indicated in the Table 1 below. In percentage terms, it amounts to 35% of hydro. 63.8% of thermal and 0.5% of solar[12].

Facts and Figures of Power Generation in Ghana

PLANT	**INSTALLED CAPACITY (MW)**	**TYPE OF PLANT**
AKOSOMBO	1,020	HYDRO
KPONG	160	HYDRO
Bui	400	HYDRO
TAPCO T1	330	THERMAL
TICO T2	340	THERMAL
MRP	80	THERMAL
TT1PP	110	THERMAL
TT2PP	49.5	THERMAL
TEMA THERMAL 2	38	THERMAL
KTPP	220	THERMAL
AMERI PLANT	250	THERMAL
VRA NAVRONGO SOLAR	2.5	SOLAR
KAR POWER	470	THERMAL
ASOGLI PHASE 1	200	THERMAL
ASOGLI PHASE 2 STAGE 1	180	THERMAL
ASOGLI PHASE 2 STAGE 2	180	THERMAL
CENINT POWER	110	THERMAL
BXC	20	SOLAR
AKSA	260	THERMAL
TOTAL	**4,420**	

Source: VRA, June 2018.

3.1.2 Actors in the Power Sector

The Ministry of Energy is charged with the oversight responsibility of formulating, monitoring and evaluating policies, programmes and projects in the sector. The Public Utilities Regulatory Commission (PURC) and the Energy Commission (EC) are also charged with the responsibility of regulating the activities of the power sector. Technical regulatory activities in the power sector, such as the licensing of operators, fall within the remit of the EC. It also plays an advisory role by counselling the Minister of Energy on matters relating to planning and energy policy formulation.Regarding power generation, the sector is managed by three institutions; the Volta River Authority (VRA) - using thermal, hydroand renewable sources, Bui Power Authority (BPA) - using mainly hydro and Independent Power Producers (IPP)-using both thermal and renewable sources[13].

The transmission of electricity from generation to distribution companies is the responsibility of the National Inter-connected Transmission System (NITS), owned and operated by a state-owned company, the Ghana Grid Company Ltd (GRIDCo). Electricity is distributed by two public companies, the Electricity Company of Ghana (ECG) - operating mainly in the Southern part of Ghana and the Northern Electricity Distribution Company (NEDCo) - operating in the Northern regions[14].

3.2 Polices of the Power Sector and Level of Harmonisation with the WAPP and the EREP

One of the requirements of the WAPP and the EREP is that ECOWAS must endeavour to align their national energy policies with its objectives. This section, therefore, seeks determine the

extent to which Ghana's energy policies reflect the WAPP and the EREP by outlining the various components of the country's energy polices.

Generally, Ghana's energy sector has a vision to " attain a developed energy economy with reliable high quality energy services"[15]. In order to accomplish this vision, the national energy policy goals seek to achieve universal access to electricity by 2020; a generation capacity of 5,000 MW by 2020; RE, excluding large hydro, contributing 10% to the overall power generation mix by 2020 and increase national LPG penetration to 50% by 2020[16].

Presently, the mainpolicies and strategies of the energy sector are incorporated into the Ghana Shared Growth and Development Agenda number two (GSGDA-II) for 2014-2017.

It is an overarching national medium-term policy framework that seeks to put "Ghana's economy on the path to achieve a per capita income of at least US$ 3000 by 2020 and attain the Sustainable Development goals (SDGs) by 2030"[17]. According to Mr. Ahmed Prosper of the EC, concerning energy polices in Ghana:

> The GSGDA-II serves as a collective document, bringing all previous energy polices of Ghana, such as the National Energy Policy (2010), the Energy Sector Strategy and Development Plan (2010), the Renewable Energy Act (2011) and the Sustainable Energy for All (SE4ALL) Action Agenda of 2012 under one umbrella. It also mainstreams Ghana's energy polices into its overall national development strategy[18].

Under the sub-heading, "Energy Supply to Support Industries and Households" as akey focus area, the GSGDA II for 2014-2017's main objective for the electricity sector is to "provide adequate, reliable and affordable energy to meet the national needs and for export"[19]. It outlines the different strategies towards the attainment of this objective, especially for electricity and thermal energy, where the policy seeks, among other things, to "expand power generation capacity, accelerate and sustain the implementation of the power sector reforms and facilitate

the participation of independent power producers(IPPs) and other private sector institutions in the generation and distribution sectors"[20].

Regarding the WAPP and EREP, the GSGDA II for 2014-2017strategy is to "Support and intensify sub-regional power inter-connectivity under West African Power Pool (WAPP) involving Burkina-Faso, Mali, Niger, Togo, Benin, and Cote D'Ivoire"[21]. Also, on the subject of the regulatory environment in the electricity sector, Ghana's strategy seeks to "harmonise its legal, regulatory and institutional regimes in conformity with ECOWAS Energy Protocols, strengthen and streamline regulations and institutional arrangements to ensure the independence of the national regulatory agencies"[22].

Under RE, the policy seeks to "increase the proportion of renewable energy (solar, bio-mass, wind, small and mini-hydro and waste-to energy) in the national energy supply mix[k]". It further seeks to "accelerate implementation of the provisions in the Renewable Energy Act, 2011 and the Ghana Energy Sector Strategy and Development Plan"[23]. Themainaspiration of the plan is to set renewable energy goals and produce 10% of the national energy generation by 2020 from non-hydro renewable sources. Strategies to attain this goal include the "promotion of Public Private Partnerships for integrated mini-hydro projects, support for resource assessment for solar, wind, hydro and biomass, promotion of the use of alternative fuels such as LPG, biogas and energy efficient end use devices such as improved wood fuel stoves)"[24].

Specific measures to boost the use of renewable energy in Ghana include the "establishment of a licensing criterion for commercial activities in the renewable energy industry, feed-in tariff structure for renewable energy, a renewable energy purchase obligation and establishment of a special fund to provide financial resources for the promotion, development and utilization of renewable energy resources"[25].Others measures aim at "improving the cost-effectiveness of solar and wind technologies, supporting the use of decentralised off-grid alternative

technologies, such as solar, PV and wind, promoting Public Private Partnerships for integrated mini-hydro projects and promoting the use of alternative fuels"[26].

Concerning the United Nations SustainableEnergy for All (SE4ALL), which aims at: "Ensuring universal access to modern energy services; doubling the rate of improvements in energy efficiency; and doubling the share of renewable energy in the global energy mix[27]", Ghana in June 2016, developedits SE4ALL Action Agenda and Investment Prospectus (SE4ALL AA-IP) to expedite the mobilization of financial resources from government, private sector and donors to fund projects and other interventions[28].

Since the inception of the WAPP and the EREP, Ghana has shown tremendous commitment to theirobjectives. Ghana has set the pace by harmonising its energy polices with regional frameworks andhosted various meetings of the WAPP, which culminated in major decisions that currentlygoverntheoperations of the institution.Most recently, Ghana hosted the 12thWAPP General Assembly on 13th November, 2017 in Accra,under the theme: "Regional Electricity Market: Ensuring African Integration"[29]. The meeting was addressed by His Excellency, Nana AddoDankwaAkufo-Addo, President of the Republic of Ghana. He used the occasion to reiterate Ghana's confidence in the WAPP's ability to ensure energy security in the sub-region by stating that:

> WAPP has what it takes in terms of capacity and capability to create the regional electricity market. This is the surest way to harness the abundant energy resources of the region to accelerate the social economic development of the region and improve the living standards of our people. We must travel all down on this road[30].

Similarly, Ghana hosted the 3rd Meeting of the Steering Committee of the West African Power Pool in 2002, that adopted Resolution No. 1 concerning to the objectives of the sub-regional power pool. As noted by the ECA:

> After the meeting held in Accra, Ghana, on April 5, 2002 a report was presented on the progress made in view of mobilizing the necessary funds for financing the following projects: Inter-connection of CEB-NEPA electricity grids; Inter-connection of Ghana and Burkina Faso; Reinforcement of the inter-connection Benin-Togo-Ghana; Inter-connection of Côte d'Ivoire and Mali; Feasibility studies of Sambagalou and detailed studies of Fomi (Guinea); The creation and launching of an Information Centre for WAPP; and Stability study of the interconnected ECOWAS networks". Also at the Accra meeting, the WAPP Steering Committee adopted Resolution No. 3, relating to the "Development of appropriate legal and regulatory framework necessary for the development of the West African Power Pool". 'In this Resolution, the Committee resolved that all the necessary steps should be taken to create the institution of a regional regulatory body to become operational within three years of this resolution[31].

So, Ghana's energy policies have a regional outlook since its overall aim is to emerge as a leading net exporter of power in the West African sub-region, whilst meeting domestic requirements.Its energy policies havetargets that are in consonance with regional targets. The next sub-section provides a comprehensive examination on how Ghana has integrated regional polices through their implementation.

3.2.0 Implementation of the WAPP

This sub-section seeks to evaluate the implementation of the WAPP in Ghana and its implications to ensure energy security in the country. The WAPP's implementation strategy is anchored on realizing projects identified under its priority projects such as the Coastal Transmission Backbone project involving Côted'Ivoire, Ghana, Benin, Togo and Nigeria; the Inter-zonal Transmission Hub programme connecting Burkina Faso, Senegal via Mali and Côte d'Ivoire; the North-core Transmission programme linking Nigeria, Niger, Burkina Faso and Benin; the OMVG/OMVS Power System Development programme connecting The Gambia, Guinea, Guinea Bissau, Mali, Senegal; the Côte d'Ivoire-Liberia-Sierra Leone-Guinea PowerSystem Re-development sub-programme linking Côte d'Ivoire, Sierra Leone Liberia and Guinea[32].

According to RasheedBaisie a Senior Engineer at GRIDCo:

> With the objective of being a net exporter of electricity, Ghana has committed to integrate its national power systems into the sub-regional system by facilitating the implementation of several regional projects geared towards enhancing generation and transmission[33].

In this connection, Ghana has participated in the World Bank sponsored Adaptable Programme Loan (APL), aimed at integrating its transmission lines into sub-regional lines.The WAPP APL programme is expected to: "help the ECOWAS Member States to develop a robust infrastructure platform for the WAPP implementation"[34]. It comprises threediverse but mutually reinforcing sub-regional infrastructural projects such as a.) the WAPP APL1- encompassing the construction of the Coastal Transmission Backbone (CTB) connecting Côte d'Ivoire, Ghana, Togo, Benin and Nigeria: b.) the WAPP APL 2: the Western Zone Power Pool mechanism; and c.) the WAPP APL 3, also known as the Sahel Zone Power Pool mechanism entailing the construction of the Inter-Zonal Transmission Hub project connecting Côte d'Ivoire, Ghana,Burkina Faso, Mali and Niger"[35].

3.2.1 Inter-Zonal Transmission Hub Project

The Inter-zonal Transmission Hub programme, under APL3, comprises the construction of a 206- kilometre long, 225 kV transmission line from Bolgatanga, in the Upper East Region of Ghana to Ouagadougou in Burkina Faso,to facilitate the availability of electric power to Burkina Fasofrom Ghana and enhance the establishment of a regional energy market in West Africa"[36]. In 2012, Ghana moved a step further toward its commitment to this project by procuring US$25.9 million loan facility from the International Development Association (IDA) to assistin its implementation[37].

The loan facility enabled the on-going construction of a 225kV transmission line inter-connection and connected sub-stations in Burkina Faso and Ghana. Part of the loan went into the development of measurable standards to synchronize electricity planning and operation of the WAPP[38]. Correspondingly, in 2005, Ghanasecured US $ 40 million loan, out of the US$ 350million credit line the Wold Bank had committed for the development of the WAPP projects, to implement the 330kV Aboadze-Volta Transmission Line[39].

3.2.2 Coastal Transmission Backbone

The Coastal Transmission Backbone (CTB), under APL 1, entails the construction of a 330 kV Ghana, Togo-Benin Inter-connector, which aims at establishing a robust inter-connection link and corridor for power exchanges among Côte d'Ivoire, Ghana, Togo, Benin and Nigeria. The project, when completed, would enhance the inter-connection capabilities and improve the existing technical and commercial capacities of the Volta River Authority (VRA) in Ghana and the CEB[40].

Although its implementation has faced some challenges, lots of benefits will accrue to participating countries since it will enhance cooperative power pooling by amalgamatingnational power operations into a unified sub-regional electricity market, reinforce inter-connection between Ghana, Togo and Benin and facilitate power exchanges beyondthe four utilities. The project's sub-programmes include 330 kV Aboadze to Volta line, 330 kV Volta line to Lome in Togo and to Sakete in Benin. A 330 kV Riviera line in Cote d'Ivoire to Prestea in Ghana and a 30kV Ghana to Togo and Benin Transmission inter-connector[41].

Prior to the APL programmes, the Volta River Authority (VRA) had been supplying power to the CEB, under anagreement signedbetween the Government of Ghana on one hand and that of Togo and Benin on another, which paved way for the VRA to supply guaranteed continuous

power of 25MW to CEB, which was increased to 50MW in 1971and currently stands at 100MW[42]. To add, Ghana's transmission system is inter-connected with the networks of Cote d'Ivoire since 1984 through the CompagnieIvoirienne d' Electricité (CIE). In 2016, 410.46 GWh of energy was exported to CEB, of which 186.52 GWh emanated from theVRA, whilst 223.94 GWh was wheeled from CIE"[43]. Ghana's transmission is equally connected with Burkina Faso through SONABEL and currently supplies power through a 33 kV transmission line, which is expected to be upgraded to a 225kV line in 2018, upon completion of the 225kV transmission project[44].

Vis-à-vis sub-regional generation projects, Ghana, together with Benin, Togo and Nigeria are involved in the construction of a 450 MW combined cycle thermal power plant. It is christened the "Domunli Regional Power Project",and it will rely on the Jubilee fields for gas supply. The project will serve as an emergency power supply to the regional inter-connection grid and utilises the Coastal Transmission Backbone (CTB), allowing for increased trade, regional integration and grid stability[45].

Another project, demonstrating Ghana's response to the WAPP is the West African Gas Pipeline (WAGP). The WAGP project consist of 678 kilometres pipeline constructed both onshore and offshore, to transport natural gas from Nigeria to fuel gas thermal power plants in Ghana, Togo and Benin. Ghana received its first natural gas from Nigeria in 2009, albeit insufficient, as the WAGP supplied about 36 million standard cubic feet per day (MMscf/d) of gas to Ghana in 2010[46]. Ghana also hosts the headquarters of the West African Gas Pipeline Company (WAPCo).

The theory of neo-functionalism explains Ghana's quest to deepen regional integration in the ECOWAS sub-region through cooperation with regional neighbours for functional reasons, such as ensuring energy security via regional power pooling arrangements. As a result, Ghana

has implemented regional transmission projects to facilitate cross-border electricity trading. The jointly constructed cross-border transmission lines, between Ghana and its neighbours will have a spill-over effect, over the years, since it laysthe foundation for further cooperation in other spheres, such as cross-border electric train services in the sub-region.

3.2.3 Implementation of the EREP

This sub-section evaluates the implementation of the EREP in Ghana and its contribution to the development of the RE sector. According to Dr. Nii Darko K. Asante, Director for Technical Regulation at the Energy Commission:

> Ghana is the primary mover of sub-regional energy protocols. As such, its renewable energy polices and targets pre-date and informed the basis of the EREP's policies and targets. For instance, the country's key objective, stated in the Energy Sector Strategy and Development Plan of 2010and the Renewable Energy Act (2011), was to have renewable energy (not including hydro above 100MW) represent 10% of installed capacity by 2020[47].

Nonetheless, Ghana has also responded to the EREP by taking a lot of measures recently, such as: the establishment of a licensing procedure for commercial activities in the renewable energy industry; a Feed-in tariff scheme for renewable energy- where electricity from renewable energy is to be purchased by distribution utilities at a guaranteed pre-determined rates; mandatory purchase policy - by which distribution utilities are obliged to procure a specified percentage of total electricity purchase from renewable energy (under the Renewable Energy Purchase Obligation); a fund to provide financial resources for the promotion, development and utilization of renewable energy resources-; and Bio-fuel and wood fuel regulations[48]. The overarching aim of these measures is to create an attractive environment for private sector participation in the RE sector in Ghana.

3.2.4 Initiatives to Facilitate the Implementation of the EREP

This sub-section seeks to evaluate the implementation of the EREP in Ghanaby examining initiatives put in place by the competent Ghanaian institutions andtheir implications to ensure energy security in the country.The GOG has adopted three national infinitives to facilitate the promotion, development and deployment of RE towards facilitating the implementation of the EREP. They include the Ghana Energy Development and Access Project (GEDAP); the Scaling-up Renewable Energy Programme (SREP) in Ghana Investment Plan; and the Technical support for the implementation of the Renewable Energy Act[49]. The GEDAP seeks to increase electricity access to hitherto inaccessible areas such as island and lakeside communities' where the only option for competitive electrification is decentralized renewable energy technologies[50].

GEDAP's main components encompass:

> The Development of renewable energy tariff methodology and scheme; Standardization of Power Purchase Agreement; Electricity Access and Renewable Energy Development- including the provision of Mini-grids and grid-connected renewable energy, Off-grid electrification with solar-PV systems; and Capacity building of staff of Ministry of Power, private sector, financial institutions and inspection agents on the development of renewable energy projects[51].

The Ministry of Power in 2015 developed the Scaling-up Renewable Energy Programme (SREP) in the Ghana Investment Plan (SREP-Ghana IP) to assist in the implementation of the Government's strategy to unlock financing opportunities to speed up the growth of a sustainable RE sub-sector. The SREP-Ghana IP has prioritized some projects, such as: a.) the Renewable energy mini-grids and stand-alone solar PV systems to encourage public and private financing for scaling-up renewable energy mini-grids and stand-alone solar PV systems; b.) theSolar PV based net metering with battery storage to assist in developing an all-inclusive net metering programme, roof-mounted solar PV systems to reduce the economic cost of power on small and medium-sized enterprises (SMEs) and households and increasing REcontribution to the electricity generation mix by 25-30 MW; and c.) theutility-scale solar

PV/wind power generation project which also aims at tackling barriers to the growth and expansion of the utility-scale solar PV and wind market in Ghana[52].

A national task force comprising the Ministry of Power, the EC, the National Development Planning Commission and Energy Centre developed a Renewable Energy Master Plan (REMP) for Ghana in 2016, with the objective to set unambiguous targets for the development of the RE resources of the country and map out strategies to achieve the targets. It further seeks to "priorities the use of RE, propose sustainable financing models, incentives and support systems and define institutional roles for the implementation of the Master plan and identify risks and mitigation measures for ensuring sustainability"[53].

Ghana, therefore, has secured institutional and regulatory framework consistent with sub-regional renewable energy policies; established a Renewable Energy Master plan (REMP) in 2014, with an associated implementation strategy, as required by EREP; and taken measures to attract private sector participation inRE power generation; and implement local content in the design and operation of RE technologies[54].

Concerning LPG penetration, in 1990, the GOG introduced an LPG Promotion Programme aimed at ensuring that households substitute the increasing use of wood fuels with LPG for domestic activities. The LPG project has been strongly pursued by successive governments. The main features of the LPG Promotion Programme were:

> Free distribution of 14.5kg and 5kg LPG cylinders to the public; LPG delivery service to registered private individuals for LPG retailing; Upgrading of TOR; LPG subsidy and other fiscal incentives; Free plant and equipment installations for educational institutions, hospitals and prisons; Establishment of the LPG Fund to fund the purchase and maintenance of LPG cylinders and kitchen equipment for institutions and Construction of the Ghana Cylinder Manufacturing Company (GCMC) factory in Accra[55].

According to the Energy Commission, as a result of the Programme, LPG consumption in Ghana has increased annually from 45,000 tons in 2000 to about 251,800 tons in 2013[56]. Similarly,the National Energy Policy of 2010 had a target of increasing household access to LPGto 50% by 2015, as the main fuel for cooking. The programme was reinforced in 2014 with the free distribution of 350,000 LPG cylinders and stoves since the target appeared unattainable[57]. Also, to curb the urban-biased nature of the free LPG cylinders distribution programme, the Ministry of Energy and Petroleum in March 2015, launched a Rural LPG Programme that re-introduced the free LPG cylinder distribution[58].

3.3 Implications of implementing the WAPP and the EREP

After examining Ghana's implementation of the WAPP and the EREP, this section of the study focuses on the policy implications of implementing regional policies and its bearings on ensure energy security. Ghana's participation in the implementation of regional energy polices, especially the WAPP has had some policy implications on the energy sector, especially in the areas of power trade, improvement in the national generation and transmission infrastructures, as well as improvements in the stability of its power system. For instance, constructions of transmission lines, towards implementing the WAPP priority projects have enabled the country to develop a robust infrastructure for electricity transmission. The construction of the 225kV transmission line linking Ghana and Burkina Faso via Bolgatanga and through the Prestea-Bolgatanga transmission line will reinforce the national transmission grid and accelerate the on-going rural electrificationproject, especially "localities along the right of way of the project"[59].

On several occasions, Ghana depended on its neighbours to avert national crisis in the power sector, by importing power to make up for shortfalls in national supplies. For instance in 2016, the net power inter-change between Ghana and Cote d'Ivoire was 511.37 GWh, with imports

and exports been 511.22 GWh and 0.15 GWh respectively[60]. A total of 613 GWh of energy import has been estimated for the year 2018, to make up for supply deficit expected to hit 4% of total national supply capacity[61].

Emergency exchanges between Ghana and Cote d'Ivoire have enabledboth countries to limit load shedding occasioned by major generation challenges. For instance onWednesday, 7thFebruary 2018, the EcofinAgency reported that:

> The Volta River Authority (VRA) wants to import 200 MW of power from Côte d'Ivoire to complement its local production and avoid the rationing of power due to the shutdown on 1st February, 2018, of the gas processing plant at Atuabo for maintenance purposes[62].

Similarly, writing under the topic, "Dumsor: Ghana to buy power from Ivory Coast for Easteron 2nd April, 2015, Citifmonline, quoting Mr. Frank Okyere, Systems Control Manager of GRIDCo , reported that:

> Ghanaians are likely to enjoy consistent power supply during the Easter season as the Ghana Grid Company (GRIDCo) is heading to Ivory Coast to buy power for the period. This is the second time in 2015 Ghana is buying power from that country. The first time was in February when it bought about 80 megawatts of power to provide additional power to enable Ghanaians watch the Black Stars semi-final match during the African Cup of Nations Tournament[63].

Ghana also exports power to Togo and Benin via the CEB and Burkina Faso through SONABEL. This has been a source of foreign exchange earner for the VRA. In 2016, "a total of 410.46 GWh of energy was transmitted to CEB"[64]. Under the guaranteed supply agreement, the VRA is obliged to supply a guaranteed amount of power monthly according tonegotiated tariffs to CEB. Currently the VRA exports to CEB are around 18 GWh on monthly basis[65]. According Dr. Nii Darko Asante, "Power export supply to CEB has been a major source of revenue to the VRA, especially when the Akosombo Dam was operating atfull capacity"[66]. He attributed VRA's previous success on power exports in the 70s through to the 80s and its present financial challenges on its inability to export cheap power from hydro[67]. Besides CEB, Ghana supplies power regularly to SONABEL in Burkina Faso and occasionally to CIE. The

amount of power being exported to Burkina Faso is expected to increaseto about 50 MW upon completion of the 225kV transmission line this year. This was revealed by Mr. Frank Okyere,the Systems Control Manager at GRIDCo, at a stakeholders' Forum on power outlook for 2018, organised by the Association of Ghana Industries (AGI) in February 2018[68].

Ghana's mission to become a net exporter of power in the West African sub-region and her commitment to implementing regional transmission projects have impacted positively on its power generation capacity. Implementation of the WAPPs generation projects, such as the 400MW thermal plant in Domunli, will increase Ghana's national installed capacity for electricity generation. According to Emmanuel Antwi, Principal Engineer (RE& ID) at the VRA:

> Ghana's installed generation capacity has increased significantly due to the energy crisis it faced recently and also due to its quest to become a net exporter of electricity in the sub-region. As a result, total installed as at June 2018 stood at 4,420 MW compared to 2,831MW in 2015[69].

Also, in line with the objectives of the EREP, Ghana has diversified its generation mix. Total non-hydro RE installed capacity stood at 22.5MW as at June, 2018[70]. This, together with an increased installed capacity from thermal, has rendered the country's entire generation system more robust and resilient towards ensuring system reliability. The inter-connection of Ghana's transmission infrastructure with others in the sub-region, coupled with the existence ofemergency exchanges facility, has guaranteed the import of power in case of unforeseen system failure, hence ensuring system stability in the country - "the ability of an electric system to maintain a state of equilibrium during normal and abnormal system conditions or disturbances"[71]. This is in consonance with the broader objective of participating in regional power pools world over.

The passage of the Renewable Energy Act, (Act 832) in 2011 led to the promotion of RE in Ghana culminating, especially, in the development of a grid-connected 20 MW project in Navrongo.A number of rooftop solar systems of different capacities have been installed under

different locations. Also, through the LPG promotion programme, "National LPG penetration rate increased from 6% in 2000 to 18% in 2010 and is currently around 23%."[72] The Energy Ministry has set LPG penetration target of 50% by 2020 and has therefore, revived the free LPG cylinder distribution programme and increase in the establishment private LPG sales outlets[73].

Finally, Ghana's participation and implementation of the WAPP and the EREP policies will go a long way in making her a regional electricity hegemon. The undertaking of projects such as the Bolgatanga-Ouagadougou transmission and its planned extension to Mali and beyond, will supply power to landlocked Sahelian countries, where less than 20% of people have access to electricity[74].

3.4 Challenges and Prospects

This section of the study ascertains the challenges militating against the implementation the WAPP and the EREP in Ghana.The Ghana Shared Growth and Development Agenda 2 (GSGDA-II) for 2014-17 identifies the following as some of the challenges confronting the electricity sector in Ghana:

> Inadequate infrastructure to support the delivery of energy services, high cost of electricity generation, weak regulatory enforcement, inefficiencies in the management of utilities, inadequate and obsolete electricity grid network, low adoption of energy efficiency technology and low involvement of private capital in the power sector[75].

3.4.0 High Cost of Electricity

Electricity generated in Ghana is increasingly coming from thermal sources. For instance, as at 2016, the generation mix reflected 40.6% hydro, 53.9% thermal and 0.2% solar[76].

Consequently, Ghana's power tends to be expensive than its neighbours, as indicated in the Table 2 below. As noted by ACEP, until recent reductions in electricity tariffs, Ghana had one of the highesttariffs for electricity in the world and in the sub-region. High tariffs affect the competiveness of every industry and in the Ghanaian context, the competitiveness of businesses are affected as well, leading to the decline in demand and ensuingabysmal industrial growth[77].

Tariff comparison in the sub-region for 2016 and 2018

	Domestic Average		Commercial Average	
	2016	2018	2016	2018
Ghana	19.28	13.23	32.6	19.21
Cote D'Ivoire	9	9	13	13
Benin	17	17	19	19
Togo	16	16	18	18
Nigeria	17	17	17	17

Source: ACEP.

3.4.1 Inadequate inter-connection and Low demand for power in the sub-region

The lack of adequate transmission infrastructure to inter-connect the various national electricity systems constitutes a major obstacle to Ghana's drive to integrate further into the regional market. Presently, Ghana's transmission network is inter-connected to only four out of the fifteen countries participating in the WAPP. They include Togo, Benin, Cote d'Ivoire, and Burkina Faso. Besides the limited inter-connection, total amount of electricity exported to CEB, CIE and SONABEL in 2017 stood at approximately 940 GWh, representing 6.9 % of total national consumption of 13,700 GWh[78]. Currently, Ghana's installed capacity is 4,420 MW against peak demand of 2,229 MW leaving excess of 1,460 MW which could not be exported since demand in Ghana's immediate neighbours is low. The leading economies in the

sub-region are Nigeria, Ghana and Cote d'Ivoire, with the three countries accounting for about 65% of total power demand while the remaining 35% goes to eleven countries[79].

The market for power in Nigeria and Cote d'Ivoire are virtually non-existence since the later presently is self-sufficient and a net exporterwhilst the former, although has excess installed generation capacity, its transmission infrastructure is limited and poorly inter-connected with regional neighbours on the CTB line[80].

3.4.2 Fuel Supply Challenges

About 53.9% of Ghana's present generation emanates from thermal sources that depend mainly on natural gas, Light Crude Oil (LCO), Heavy Fuel Oil (HFO) and Distillate Fuel Oil (DFO). Nonetheless, the supply of the above energy sources is fraught with challenges[81]. In 2016, the bulk of the thermal plants Takoradi and Tema enclaves were rendered inoperable, for longer periods, due to the lack of adequate stocks of LCO, occasioned by inadequate supply from Nigeria[82]. Elaborating further on this challenge, a respondent at the VRA, Mr. Emmanuel Antwi, intimated that:

> Shortfall in supply from the Ghana Gas, due to frequent breakdown of FPSO Nkrumah, which feeds plants in Aboadze. Also, Gas supply from the West African Gas Pipeline from Nigeria was erratic and sometimes wholly cut off due to non-fulfilment of financial obligations as well as occasional technical challenges in Nigeria[83].

Between April and August of 2016, WAPCo had challenges supplying gas to Ghana. This, together with faults on some thermal generating units, severely affected power generation in the country, culminating in load shedding and affecting the country's ability to meet its obligations under the WAPP. Also, in early 2017, the TT2PP and MRP plants were unavailable due to lack of sufficient natural gas supply from Nigeria[84]. Besides the erratic nature of gas supply from Nigeria, the cost of gas from the WAPCO tended to be expensive. According to

Dr. Nii Darko Asante, "the cost of transmitting gas from Nigeria to Ghana tends to be more expensive than the gas itself"[85].

3.4.3 Financial Challenges

Electricity companies tend to reel under financial distress due to their indebtedness to the Banks, occasioned by the non-payment of electricity bills by both state and private companies, including debt owned by CEB, high transmission loses and expensive thermal generation contracts[86]. Elaborating on the financial challenges confronting the power sector in Ghana, Mr. Benjamin Boakye - the Deputy Executive Director of the African Centre for Energy Policy asserts that:

> Recent attempts at restructuring their indebtedness to the banks have not yet translated to improved relationship and confidence in the sector by the banks. The Volta River Authority (VRA) for instance, still struggles to secure letters of credit to procure fuel for its plants. As a result of its financial challenges, VRA has missed important maintenance schedules which now threaten supply stability in the short term. The T1 plant will have to shut down because of non-compliance with maintenance agreement with Ansaldo, VRA's technical contractor, to which VRA owes about €2m. Another big challenge that deprives the ECG of adequate funds is failure of both state and private companies to pay their electricity bills. Many state institutions especially, have developed a sense of entitlement towards utilisation of electricity. Ironically, the state institutions are reported to owe ECG over 500 million dollars[87].

Financial challenges often make it difficult for the VRA and other generating companies to purchase adequate and timely quantities of fuel to run their thermal plants. The Electricity Supply Plan 2017, for the Ghana Power System, estimatedthat:

> An amount of US$ 951Million was expended on the running of thermal plants. VRA's plants were run on an estimated cost of US$ 296 Million, translating to nearly US$ 24.7 Million on monthly basis. Inadequate supply of LCO often necessitates switching between LCO and Natural gas, a process that reduces the output of plants. Although Ghana has adequate installed generating capacity, inadequate fuel supply constitutes a major risk to reliable electricity supply in the country since the unavailability of fuel to run thermal plants, due to the afore-mentioned challenges, render some thermal plants inoperable and hamper its ability to export power.Gas supply from the Jubilee Field

through the Ghana Gas was irregular due to some technical challenges with the FPSO during the year[88].

3.4.4 Transmission Loses

The effective functioning of every power pooling scheme is the ability of Member States to transmit their excess power into the pool. Ghana's ability to effectively participate in the WAPP is hampered by transmission related challenges, such as transmission losses, defined as "energy lost or wasted in the transmission of energy from the generator to the eventual customer"[89]. It is occasioned by inadequate and obsoleteelectricity grid network and congestion in some portions of the network. Technically, it occurs when "energy is transformed from kilowatt-hours (kWh) to waste heat in electrical conductors and apparatus"[90]. In 2016 alone, on the average, transmission losses recorded were estimated at 607.38 GWh representing 4.43 % of total energy transmitted compared to the PURC's requirement of 4 %[91]. The Table 3 below shows system transmission loses from 204-2016[92].

Year	2014	2015	2016
Transmission loses	4.22%	3.79%	4.4%

Source: Energy Commission (2017). Power Supply Outlook with Medium Term projections

Concerning the EREP, although the national LPG Promotion Programme registered some successes, it was fraught with many challenges such as periodic fall in charcoal prices and supply challenges from WAPCo[93]. Many households preferred charcoal to LPG since the former is relatively cheaper and more reliable in supply. As a result, national institutions, such as schools, which were hitherto using LPG, reverted to charcoal due to the shortages[94]. Also,

the Urban-biased nature of the LPG promotion programme, affected the national inability to attain its own target of 50% LPG access by 2015[95].

3.4.5 Environmental Challenges

Environmental and climate variability periodically cause drought and affect water levels in hydro Dams and their ability to generate adequate power, culminating in supply interruptions.In instance where the water level is low, the Akosombo hydro Dam operated only 3 units during off-peak and 4 units at peak instead of the total 6 units at full capacity, between January and February 2016[96].

3.4.6 Differences in National Capabilities of the WAPP

The Coastal Transmission line Backbone (CTB) project was undertaken by Ghana, Cote d'Ivoire Nigeria as exporters and Benin and Togo as importers. Differences in the national capabilities of Member States have affected its implementation. The economies of Togo and Benin are small. This constraints them financially and inhibits their ability to upgrade their national transmitting capacities to match regionalstandards[97]. As a result, there is the lack of convergence between the WAPP objectives and the priorities of some Member States, especially Togo and Benin. The non-completion CTB project has impeded Ghana's ability to transmit power to Nigeria, the biggest market in the sub-region.

3.4.7 Prospects

This section looks at Ghana's prospects following its participation in the implementation of regional energy policies and programmes on power pooling. The success of every power

pooling arrangement depends on the presence of regional hegemon to drive the sector. Currently, there is no regional electricity hegemon in the West African sub-region. Naturally, Nigeria has the energy resources to potentially play this role; however, presently it is struggling to even meet its domestic demand. As noted by the World Bank in 2014, until Nigeria meet its domestic demand, it is unlikely to play a hegemonic role in the electricity market in the region[98].

Ghana, nonetheless, is well-positioned to play that hegemonic role due to a number of factors. Geographically, the country occupies a strategic spot, being located centrally to Côte d'Ivoire,Nigeria, Sierra Leone and Liberia, which are important players in the sub-regional energy sector. Additionally, Ghana's potential lies in its relative stability, predictability and good relations with neighbouring countries. Stability and predictability are key factors in attracting investors and reducing the cost of transaction[99].

Ghana, moreover, is progressively becoming self-sufficient in energy production as it has made significant investments in the oil sector, including the Ghana Gas and attendant pipeline infrastructure to thermal generation plants. The country's second biggest oil field,Tweneboa, Enyenra, Ntomme (TEN), are expected to supply about 30 MMscf/d over the next five years and its has been projected to reach 100 MMscf/d by 2032[100].The ENI - Sankofa field,located in the Cape three points, is also expected to come on stream in 2018, with expected daily contract quantity supply of nearly 180MMscf/d[101]. The additional gas supply from domestic sources will be a giant step towards ensuring self-sufficiency in gas production, with a positive multiplier effect on power generation.

In the area of wind energy, the entire coast of Ghana has a wind speed of up to 9-99.9 m/s, strong enough to sustain wind energy with a projected gross wind power potential of 2000 MW[102]. Vis-à-vis solar energy, Ghana's endowed potential is estimated at 35 EJ,which is nearly 100 times the present power consumption with annual average working hours of 2670

equivalent to 53,000 MWh a year[103]. The country's huge potential in Tidal wave energy is equally being exploited with a 100MW project in Ada.

3.4.8 Conclusion

To help address energy insecurity in the sub-region, Ghana under ECOWAS has ratified protocols establishing the WAPP and the EREP, implemented regional priority programmes that has so far ensured that its electricity network is inter-connected with four out of the fifteen of the WAPP. The integration of its power system with the four other countries has guaranteed occasional stability in its supply system through power imports from Cote d'Ivoire. Power exports to the CEB, CIE and SONABLE have been a source of revenue to the VRA.

Under the regional plan, states are required to also integrate the WAPP policies into their national energy policies and mainstream them into national development programmes. Ghana, in this regard, has increased its commitments by mainstreaming the WAPP and the EREP into both the GSGDA for 2010-2013 and 2014-17. Prior to these, it had energy polices such as the National Energy Policy (2010), the Energy Sector Strategy and Development Plan (2010), the Renewable Energy Act (2011). All these policies have an overarching aim of making Ghana a net exporter of electricity. It recently adopted the Sustainable Energy for All (SE4ALL) Action Agenda.

Theimplementation of these policies is, however, fraught with challenges, emanating from both endogenous and exogenous sources. Notable among these problems arethe lack of funds to run thermal plants, the high cost of electricity occasioned by the imposition of taxes and levies and the procurement of expensive thermal generation plants, low levels of demand for power in Ghana's immediate neighbours who are net importers of electricity, inadequate transmission

lines in the sub-region and a partially liberalized power sector. As a result, Ghana is currently inter-connected with only four out of the fifteen Member States of the WAPP. Ghana, nonetheless, has a huge potential of playing a hegemonic rule in the sub-regional power sector, given its location, political stability, economic growth and huge prospects for renewable power generation.

Endnotes

1. Eberhard, Anton, et al. *Africa's power infrastructure: investment, integration, efficiency*. The World Bank, 2011.
2. United Nations Economic Commission for Africa (UNECA), "Assessment of Power-Pooling Arrangements in Africa", UNECA, Addis Ababa. 2004.
3. Kumi, Ebenezer Nyarko. *The Electricity Situation in Ghana: Challenges and Opportunities*. Center for Global Development, 2017.
4. Ministry of Power. Power News. The Official News Magazine for the Ministry of Power (2016).
5. Kemausuor, Francis, and Emmanuel Ackom. "Toward universal electrification in Ghana." *Wiley Interdisciplinary Reviews: Energy and Environment* 6.1 (2017): e225.
6. Energy Commission of Ghana. National Energy Statistics (2007 - 2016). 2017.
7. Mathrani, Sunil, et al. "Energizing economic growth in Ghana: making the power and petroleum sectors rise to the challenge." *Washington DC* (2013).
8. Energy Commission. Supply and demand outlook for Ghana. 2017. Retrieved from www.energy.gov.gh/data.
9. Ibid
10. Alam, M. Shahid. "Economic growth with energy." (2006). .
11. Energy Commission. Supply and demand outlook for Ghana. 2017. Retrieved from www.energy.gov.gh/data.
12. VRA. Power Generation: Facts & Figures. Retrieved from www.vra.com/resources/facts .2018.

13. Ministry of Power. Power News. The Official News Magazine for the Ministry of Power, Maiden Edition. Accra. 2016.
14. ibid
15. www. energypedia.info/Ghana_Energy_Situation.
16. ibid
17. www.Theredddesk.org/countries/plans/ghana-shared-growth-and-development-agenda
18. Interview with Prosper A. Amuquandoh, Inspector (Renewable Energy), Ghana Energy Commission, Accra, 08/06/2018.
19. The *Ghana Shared Growth and Development Agenda* (*GSGDA) II*, 2014-2017 .Retrieved from http://www.un-page.org/files/public/gsgda.pdf.
20. ibid
21. Ibid
22. ibid
23. ibid
24. ibid
25. www. energypedia.info/Ghana_Energy_Situation
26. ibid
27. Energy Commission. Sustainable Energy for All Action Plan (2012). Retrieved from http://energycom.gov.gh/files/pdf.
28. ibid
29. www.ghanaweb.com/GhanaHomePage/business/WAPP-has-what-it-takes-to-create-needed-electricity-market-Akufo-Addo.
30. ibid
31. United Nations Economic Commission for Africa (UNECA), "Assessment of Power-Pooling Arrangements in Africa", UNECA, Addis Ababa, 2004.
32. WAPP. *WAPP Business Plan 2016-2019 West African Power Pool*,(2015).
33. Interview with Mr. RasheedBaisie, a senior Engineer at GRIDCO, Accra 7/06/2018
34. World Bank The first Phase of the Inter-Zonal Transmission Hub project of the WAPP,2015. Retrieved from www.project.worldbank.org/p094919.
35. ibid
36. Ibid
37. Ghana secures multimillion dollar West African Power Pool project | West Africa. Retrieved from www. Theafricareport.com
38. ibid
39. www.ghanaweb.com
40. World Bank Project Information Document/ (PID/ISDS), 2017. Retrieved from http://documents.worldbank.org
41. ibid
42. Ghana's Experience in Power Inter-connections within the Framework of ECOWAS. Retrieved from www. repository.uneca.org/bitstream.
43. Energy Commission. Supply and demand outlook for Ghana. 2017. Retrieved from www.energy.gov.gh/data
44. GRIDCO. Electricity Supply Plan (2010). Retrieved from www.gridcogh.com/media
45. NEPAD. Gas-West African Power Pool Domunli Regional Power Project. Retrieved from http://www.nepad.org
46. www.ecowas.int/wp-content/uploads/2015/01/7-West-African-gas-Pipeline.pd
47. Interview with Dr. Nii Darko K. Asante, Director, Technical Regulation at the Energy Commission, Accra 06/06/2018.
48. www. energypedia.info/Ghana_Energy_Situation
49. Renewable Energy Policy Review, Identification of Gaps and Solutions in Ghana. http://www.gh.undp.org/content/dam/ghana
50. ibid
51. ibid
52. ibid
53. ibid
54. ibid
55. Broni-Bediako, Eric, and OhenewaaKakraDankwa. "Assessment of Liquefied Petroleum Gas (LPG) Utilisation in Ghana-A Study at Tarkwa." *International Journal of Scientific & Technology Research* 2.9 (2013): 6-10.
56. Energy Commission of Ghana, Strategic Planning and Policy Division. (2014). www.energycom.gov.gh/files
57. ibid
58. Mensah, GiftySerwaa, Francis Kemausuor, and Abeeku Brew-Hammond. "Energy access indicators and trends in Ghana." *Renewable and Sustainable Energy Reviews* 30 (2014): 317-323.

59. APL, West Africa Power Pool. "PROJECT INFORMATION DOCUMENT (PID) APPRAISAL STAGE." (2015).
60. Energy Commission. Supply and demand outlook for Ghana. 2017. Retrieved from www.energy.gov.gh/data.
61. ibid
62. www.ecofinagency.com.
63. Citifmonline. *Dumsor-Ghana to buy power from Ivory Coast for Easter* com 2015. Retrieved from citifmonline.com/2015/04/02/
64. Energy Commission. Supply and demand outlook for Ghana. 2017. Retrieved from www.energy.gov.gh/data.
65. ibid
66. Interview with Dr. Nii Darko K. Asante, Director, Technical Regulation at the Energy Commission, Accra 06/06/2018.
67. ibid
68. Myjoyonline. *GRIDCo to export electricity to Burkina Faso.* 2018.Retrieved from. /www.myjoyonline.com/business.
69. Interview with Mr Emmanuel Antwi, Principal Engineer (RE& ID) at the VRA, Accra 05/06/2018.
70. Energy Commission *Energy (Supply And Demand) Outlook for Ghana*. 2017. Retrieved from www.energycom.gov.gh.
71. Hamilton, Stephanie. The handbook of microturbine generators. Pennwell Books, 2003.pp.184
72. Energy Commission of Ghana, Strategic Planning and Policy Division. (2014).www.energycom.gov.gh/files
73. United Nations Development Programme in Ghana, Environment and Energy. Liquefied petroleum Gas (LPG) substitution for wood fuel in Ghana (2004). Retrieved from http://energyaccess.com/file/.
74. World Bank The first Phase of the Inter-Zonal Transmission Hub project of the WAPP, 2015. Retrieved from www.project.worldbank.org.
75. The *Ghana Shared Growth and Development Agenda* (*GSGDA) II*, 2014-2017 .Retrieved from http://www.un-page.org/files/public/gsgda.pdf.
76. Energy Commission. Supply and demand outlook for Ghana. 2017. Retrieved from www.energy.gov.gh/data
77. African Centre for Energy Policy(ACEP) Press Statement on Electricity Tariff Reduction 2018.Retrieved from www.acepghana.com/news/1323
78. Energy Commission. Supply and demand outlook for Ghana. 2017. Retrieved from www.energy.gov.gh/data
79. KarimKaraki . Understanding ECOWAS Energy Policy - *From national interests to regional markets and wider energy access*, (2017). Retrieved from cdpm.org/wp-content/uploads/ECOWAS
80. Interview with Dr. Nii Darko K. Asante, Director, Technical Regulation at the Energy Commission, Accra 06/06/2018.
81. Energy Commission. Supply and demand outlook for Ghana. 2017. Retrieved from www.energy.gov.gh/data.
82. ibid
83. Interview with Mr Emmanuel Antwi, Principal Engineer (RE& ID) at the VRA, Accra 05/06/2018
84. Energy Commission. Supply and demand outlook for Ghana. 2017. Retrieved from www.energy.gov.gh/data
85. Interview with Dr. Nii Darko K. Asante, Director, Technical Regulation at the Energy Commission, Accra 06/06/2018.
86. African Centre for Energy Policy *The energy sector challenges should be the "opening prayer" of the government of Ghana*, 2017. Retrieved from http://www.acepghana.com/news/
87. ibid
88. Energy Commission. Supply and demand outlook for Ghana. 2017. Retrieved from www.energy.gov.gh/data
89. www.energyvortex.com/energydictionary/energy_loss__transmission_loss.html.
90. ibid
91. Energy Commission. Supply and demand outlook for Ghana. 2017. Retrieved from www.energy.gov.gh/data
92. ibid
93. Energy Commission. Supply and demand outlook for Ghana. 2017. Retrieved from www.energy.gov.gh/data
94. Acharibasam, John Bosco, and GervineAneApatinga. "Ghana and The Liguidified Petroleum Gas Dilemma Critical Analysis of Ghana's LPG Policy." *International Journal of Energy and Environmental Research* 2.2 (2014): 1-8.
95. Energy Commission. Supply and demand outlook for Ghana. 2017. Retrieved from www.energy.gov.gh/data
96. ibid
97. Eyita, Ekeminiabasi Kingsley. *Energy security through transboundary cooperation: Case studies of the Southern African power pool (SAPP) and the West African pool (WAPP)*. Diss. 2014..
98. World Bank, World Bank. *Building integrated markets within the East African Community: EAC opportunities in public-private partnership approaches to the region's infrastructure needs*. The World Bank, 2014.
99. KarimKaraki . Understanding ECOWAS Energy Policy - *From national interests to regional markets and wider energy access*, (2017). Retrieved from cdpm.org/wp-content/uploads/ECOWAS.
100. www.pulse.com.gh/business/ghana-cote-divoire-a-new-country-ghanivoire-could-weld- together-west-africa.

101. Asante, Ben. "New Natural Gas Production to Propel Ghana's Power Production Prospects", 2018. Retrieved from www.newsghanan.com.gh.
102. Energy Commission. *On-going initiatives to accelerate sustainable uptake of renewable energy.* Presentation at the Renewable Energy Fair, November 2015, Accra, Ghana, 2015.
103. 1bid

CHAPTER FOUR

SUMMARY OF FINDINGS, CONCLUSION AND RECOMMENDATIONS

4.0 Introduction

The studyassessed Ghana's implementation of the ECOWAS regional energy policies relating to the WAPP and the EREP. It was study wasguided by the theory ofNeo-functionalism

whichstates that no state has the capabilities to fulfil the economic needs of its people, without cooperating with its neighbours. The goal of the study was to determine the extent to which the energy policies of Ghana reflect the WAPP and the EREP, andevaluate how Ghana has implemented the WAPP and the EREP. It crystallised the policy implicationsand challenges militating against the implementation the ECOWAS regional energy policies. This chapter summarises the findings of the study, make conclusions and profess recommendations.

4.1 Summary of Findings

The study realised that the ECOWAS has adopted energy policies geared towards the creation of a regional electricity market, to facilitate the harnessing of its vast energy resources to improve access to electricity and act as a medium for socio-economic development of the Region. Under the WAPP and the EREP, ECOWAS are required to harmonise their national energy policies with that of regional frameworks towards the creation of a common regional market for electricity. Member States are equally required to implement priority projects of the WAPP.

Regarding the integration of the WAPP's objectives into national development Agenda, Ghana's energy policy seeks to "provide adequate, reliable and affordable energy to meet the national needs and for export". As such, Ghana's Shared Growth and Development Agenda 2 (GSGDA-II) for 2014-17- the overarching national medium-term policy framework, clearly states that "the country supports and intensifies sub-regional power inter-connectivity under West African Power Pool (WAPP) , as a national strategy and seeks to harmonise its legal, regulatory and institutional regimes in conformity with the ECOWAS Energy Protocol".

The country has also implemented a number of priority projects of the WAPP such as the Coastal Transmissions Backbone and the Inter-zonal Transmission Hub. It single-handedly secured a loan to fund the construction of the 225kV transmission line between Ghana and Burkina Faso. Regarding the integration of its electricity network into the regional network, it was identified that Ghana's network is presently inter-connected with the networks of 4 out of the 15 countries of WAPP. They are Togo, Benin, Cote d'Ivoire and Burkina Faso.

Concerning targets set by the EREP,the study further revealed that Ghana had similar targets that pre-date the regional targets and that its targets informed the bases of regional targets. For instance, its Energy Sector Strategy and Development Plan of 2010 and the Renewable Energy Act of 2011, had an objective of attaining a 10% renewableenergy,excluding hydro above 100MW,by 2020. Ghana, thus, has been a primary mover in the WAPP power exchange protocols and a pioneer in cross border power exchange following the August 1969 agreement, which allowed the VRA to begin the export power to Benin and Togo in 1972.

A number of initiatives have also been adopted to promote the development and deployment of renewable energy towards facilitating the implementation of the EREP. They include: the Ghana Energy Development and Access Project (GEDAP); the Scaling-up Renewable Energy Programme (SREP) in Ghana Investment Plan; and the Technical support for the implementation of the Renewable Energy Act.The Country also had an LPG policy with a 50% by 2020 set in the Renewable Energy Act of 2011 and a promotion programme that has been in operation since 1990.

Both polices are well ahead of the launch of EREP in 2014. Despite the fact that Ghana's Renewable policy and targets pre-date the EREP, it adopted NREM in response to EREP to redefine its strategies and programmes towards achieving these targets. The study found out that installed capacity for non-hydro renewable energy for grid connection presently, accounts

for grid is 0,5%, two years ahead of the EREP deadline of 2020 to achieve 10%. LPG penetration rate as at 2016 was 23% ahead of a 50% penetration by 2020.

4.2 Conclusion

The main unified objective of the WAPP and the EREP is to ensure energy security in the sub-region, in a more sustainable way, by facilitating the availability, reliabilityand affordability of energy to ECOWAS citizens by pooling their power resources together in an integrated regional market. Ghana as a member of the ECOWAS has shown commitment to the objectives of the WAPP by pioneering its establishment and hosting two key institutions of the WAPP-the ECOWAS Regional Regulatory Authority (ERERA) and the West African Gas Pipeline Company limited (WAPCo). It has also implemented a number of theWAPP priority projects on power generation and transmissions and integrated theWAPP and the EREP policies into its national development agenda, as enshrined in the Ghana Shared Growth and Development Agenda II.

The study further revealed that Ghana's implementation of the WAPP yielded some financial dividends for the country through the earning of foreign exchange as a result of powerexport to four countries. The export of power is expected to increase due to on-going expansion of sub-regional transmission networks. The implications also encompass the imports of power, sometimes on critical occasions, to meet its domestic shortfalls and to avert national blackouts.

From the Study, it could be concluded that: Ghana’s energy policies are consistent with the ECOWAS regional energy policies relating to the WAPP and the EREP; Ghana has integrated its electricity transmission system into the WAPP by inter-connecting it with four countries of the WAPP, with high prospects to increase it to six. Regarding energy targets, the EREP's target

to increase renewable energy in the overall electricity mix, including large hydro, to 35% by 2020 is attainable since renewable energy in the overall electricity mix is already 34.05%.

However, the target to increase renewable energy in the overall energy mix, excluding large hydro, to 10% by 2020 will be missed because, presently, grid connected non-hydro renewable accounts for 0.5% corresponding to 22.5 MW, instead of 442MW, out of total installed capacity of 4,420MW. This is against the backdrop of the fact that Ghana had a similar target since 2011 in its Renewable Energy Act. In addition, the target to increase LPG for cooking to 36% by 2020 will be missed in rural communities but attainable in urban communities, where factors facilitating its usage,such as level of education, accessibility and income levels are high.

The implementation of both the WAPP and the EREP polices are faced with challenges, chiefly financial, culminating in the huge indebtedness of utility companies, downgrading their creditworthiness and ability to purchase fuel to run thermal plants, which account for 65% of total generation. Other challenges include differences in the national capabilities of the WAPP Member States; the Low demand for electricity by Ghana's neighbours; and Technical challenges such as transmission losses. The lack of adequate transmission infrastructure to link the various national power systems is the weakest link in Ghana's quest to integrate further into the regional market.

Moreover, given Ghana's present excess installed capacity of 1,460 MW, mainly from thermal sources, the motivation to bring onboard additional non-hydro renewable for grid connection is not strongenough. This situation is further compounded by the high upfront costs of non-hydro renewable energy equipments,the lack of local expertise in RE technology and the unreliability of weather-dependent RE resources.

With respect to the theoretical framework, the theory of neo-functionalism has been useful to this study by explaining why states cooperate to meet functional needs such as their energy needs. The issue of energy insecurity is multi-dimensional and widespread in the sub-region, hence the need for regional cooperation, among Member States, to resolve it. Moreover, the vast energy resources of the region are unevenly distributed geographically. Ghana cannot, therefore, rely solely on its energy resources to meet both national and sub-regional power needs, without cooperating with regional neighbours. This explains why the country joined the WAPP in 1999 and adopted the EREP in 2014 to promote regional energy security.

4.3 Recommendations

Given Ghana's current excess installed generation capacity, the implementation of WAPP's priority projects to expand regional transmission networks, its relative political stability and centralised geographic location in the sub-region, it has a huge potential of playing a hegemonic role in the sub-regional power sector. The Government of Ghana may wish to consider the following recommendations towards playing that role by addressing challenges in the power sector that often culminate in load shedding and its attendant effect on energy security, both at the national and regional levels:

Concerning the financial burden of utilities, the following recommendations are made; there should be a continuation and intensification of on-going programmes to support greater private sector involvement in the management of public utilities. Programmes to ensure full cost recovery such as the introduction of pre-paid metering and increase efficiency in energy should be strengthened to improve viability of utilities in the power sector.Cost reduction strategies, such as loss reduction and efficiency in revenue collectionand cost effective generation and

transmission technologies - via replacing obsolete generation and transmission equipments, should be pursued.

In addition, the power sector should be fully liberalized gradually, throughthe elimination of monopolistic rights and the introduction of competition, so as to attract more investments; diversifiedsources of generation; and enhancedquality and efficiency of services through improved competition. Full liberalization also has the advantage of assisting power producers to raise capital, reduce payment of subsidies and remove liabilities off government balance sheets. Ghana's power sector is currently partially liberalized, following the introduction of Independent Power Producers (IPPs) into power generation. Presently, IPP's share in the overall installed generation capacity is 35% against 65% by the VRA.

The huge debt of VRA is due to the inability of the ECG and NEDCo to ensure full cost recovery. The GOG must endeavour to deal withthe huge indebtedness to service providers,by coming out with a road map towards settling all its indebtedness to the ECG to enable the company pay its debts and undertake further investments. ECG indebtedness to the VRA affects the latter's operations and hampers its ability to export power.

Vis-à-vis RE, the following recommendations are made; The use of renewable technologies such as wind and solar are associated with high upfront capital costs which tend to discouragingly affect their viability when the usual sources of funding are used. GOG could explore the use of other sources of funding such as Carbon Credits as well as concessionary funding windows offered by the African Development Bank and the World Bank for renewable energy projects.

The use of LPG is directly linked to the income levels of households. GOG may wish to create more job opportunities in the rural areas, to boost LPG patronage and also to bridge urban/rural gap in LPG penetration. Given the low income levels in rural communities, subsidies could be

introduced on the cost of LPG for rural communities, to further encourage patronage and reduce preference for fuel woods. Rural communities could be sensitized on the dangers associated with the continuous use of wood fuels and its environmental ramifications.

Ghana can become competitive in the regional market only when its power is affordable. Corruption and over-pricing of contracts in the power sector continue to account for the high cost of electricity in the country. GOG could, therefore, continue the process of renegotiating power contracts, terminate non-performing contracts andimplement a competitive procurement procedurefor generation and transmission contracts, to guarantee value for money.

BIBLIOGRAPHY

A. BOOKS

1. Alleyne, Mr Trevor Serge Coleridge, and Mr MumtazHussain. Energy subsidy reform in Sub-Saharan Africa: Experiences and lessons. International Monetary Fund, 2013.
2. Haas, Ernst B., and Desmond Dinan. The uniting of Europe: Political, social, and economic forces, 1950-1957. Vol. 311. Stanford: Stanford University Press, 1958.
3. Hamilton, Stephanie. The handbook of microturbine generators. Pennwell Books, 2003.
4. Pollack, Mark A. Policy-making in the European Union. Oxford University Press, USA, 2015.
5. Sangiovanni, Mette, ed. Debates on European integration: A reader. palgrave, 2006.
6. Sivanagaraju, S. Power system operation and control. Pearson Education India, 2009.

B. JOURNAL ARTICLES

1. Acharibasam, John Bosco, and GervineAneApatinga. "Ghana and The Liguidified Petroleum Gas Dilemma Critical Analysis of Ghana's LPG Policy." *International Journal of Energy and Environmental Research* 2.2 (2014): 1-8.
2. Anyanwu, John C., and Nadege D. Yameogo. "What drives foreign direct investments into West Africa? An empirical investigation." *African Development Review* 27.3 (2015): 199-215.
3. Bhattacharyya, Subhes C. "Financing energy access and off-grid electrification: A review of status, options and challenges." *Renewable and Sustainable Energy Reviews* 20 (2013): 462-472.
4. Bowd, Richard, and Annie Barbara Chikwanha. "Understanding Africa's contemporary conflicts: origins, challenges and peacebuilding." *Institute for Security Studies Monographs* 2010.173 (2010): 281.
5. Broni-Bediako, Eric, and OhenewaaKakraDankwa. "Assessment of Liquefied Petroleum Gas (LPG) Utilisation in Ghana-A Study at Tarkwa." *International Journal of Scientific & Technology Research* 2.9 (2013): 6-10.
6. Cherp, Aleh, and Jessica Jewell. "The concept of energy security: Beyond the four As." Energy Policy 75 (2014): 415-421.
7. Ellabban, Omar, Haitham Abu-Rub, and FredeBlaabjerg. "Renewable energy resources: Current status, future prospects and their enabling technology." Renewable and Sustainable Energy Reviews 39 (2014): 748-764.
8. Eshun, MaameEsi, and Joe Amoako-Tuffour. "A review of the trends in Ghana's power sector." *Energy, Sustainability and Society* 6.1 (2016): 9.
9. Gnansounou, Edgard, et al. "Strategies for regional integration of electricity supply in West Africa." *Energy policy* 35.8 (2007): 4142-4153.

10. Kemausuor, Francis, and Emmanuel Ackom. "Toward universal electrification in Ghana." *Wiley Interdisciplinary Reviews: Energy and Environment* 6.1 (2017): e225.
11. Keohane, Robert O., and Joseph S. Nye Jr. "Power and interdependence in the information age." Foreign Affairs. 77 (1998): 81.
12. Kirubi, Charles, et al. "Community-based electric micro-grids can contribute to rural development: evidence from Kenya." *World development* 37.7 (2009): 1208-1221.
13. Lindberg, Leon N. "The European Community as a political system: notes toward the construction of a model." JCMS: Journal of Common Market Studies 5.4 (1967): 344-387.
14. Mensah, GiftySerwaa, Francis Kemausuor, and Abeeku Brew-Hammond. "Energy access indicators and trends in Ghana." *Renewable and Sustainable Energy Reviews* 30 (2014): 317-323.
15. Pineau, Pierre-Olivier. "Electricity sector integration in West Africa." *Energy Policy* 36.1 (2008): 210-223.
16. Sovacool, Benjamin K., and Marilyn A. Brown. "Competing dimensions of energy security: an international perspective." Annual Review of Environment and Resources 35 (2010): 77-108.
17. Tranholm-Mikkelsen, Jeppe. "Neo-functionalism: Obstinate or Obsolete? A Reappraisal in the Light of the New Dynamism of the EC." Millennium Journal of International Studies. 20.1 (1991): 1-22.
18. Valentine, Scott Victor. "Emerging symbiosis: Renewable energy and energy security." Renewable and Sustainable Energy Reviews 15.9 (2011): 4572-4578.
19. Yergin, Daniel. "Ensuring energy security." Foreign Affairs (2006): 69-82.

C. GOVERNMENT DOCUMENTS

1. Ministry of energy: National energy policy 2010.

2. Ministry of energy sector strategy and development plan 2010.

3. Ministry of energy renewable energy Act 2011.

4. Ghana Shared Growth and development Agenda (GSGDA) II, 2014-2017.

D. REPORTS AND PUBLICATIONS

1. Adeyemo, Babatunde. "West African power pool." *Being a Presentation Made at the South Asia Regional Workshop on Competitive Electricity Markets, Colombo, Sri Lanka*. 2014.
2. African Centre for Energy Policy *The energy sector challenges should be the "opening prayer" of the government of Ghana,* 2017. Retrieved from http://www.acepghana.com/news.
3. African Centre for Energy Policy (ACEP) Press Statement on Electricity Tariff Reduction 2018.Retrieved from www.acepghana.com/news/1323.
4. Alam, M. Shahid. "Economic growth with energy." 2006.
5. APL, West Africa Power Pool. "Project Information Document (PID) Appraisal Stage." 2015.
6. Auth, Katie, et al. "ECOWAS renewable energy and energy efficiency status report-2014." 2014.
7. Besant-Jones, John E. *Reforming power markets in developing countries: what have we learned?*. Washington, DC: World Bank, 2006.

8. Czisch, Gregor, and GregorGiebel. *Realisable scenarios for a future electricity supply based 100% on renewable energies*. No. RISO-R--1608 (EN). 2007.
9. Eberhard, Anton, et al. *Africa's power infrastructure: investment, integration, efficiency*. The World Bank, 2011.
10. ECREEE. Baseline Report for the ECOWAS Renewable Energy Policy (EREP). Vienna: United Nations Industrial Development Organization. 2012a.
11. ECREEE. ECOWAS Renewable Energy and Energy Efficiency Status Report. Paris: REN21 Secretariat.2014.
12. Energy Commission. Supply and demand outlook for Ghana, 2017. Retrieved from www.energy.gov.gh/data.
13. Energy Commission of Ghana, Strategic Planning and Policy Division.2014. www.energycom.gov.gh/files.
14. Energy Commission of Ghana. National Energy Statistics (2007 - 2016). 2017.
15. Energy Commission. Sustainable Energy for All Action Plan (2012). Retrieved from http://energycom.gov.gh/files/pdf.
16. Eyita, Ekeminiabasi Kingsley. *Energy security through transboundary cooperation: Case studies of the Southern African power pool (SAPP) and the West African pool (WAPP)*. Diss. 2014.
17. Flavin, Christopher, and Molly Hull Aeck. *Energy for development: the potential role of renewable energy in meeting the millennium development goals*. Prepared for the Renewable Energy Policy Network by the Worldwatch Institute, 2005.
18. Ghana's Experience in Power Inter-connections within the Framework of ECOWAS.www. repository.uneca.org.
19. IAEA Sustainable Electricity Supply Scenarios for West Africa. 2016.
20. IEA. *World Energy Outlook-2017*, OECD/IEA, Paris. 2017.

21. Infrastructure Consortium for Africa (ICA). Regional Power Status in African Power Pools. Tunis.2011.
22. IRENA. Second Ministerial Roundtable: 'The Role of Renewable Energy in Energy Security. 2015.
23. ISSER. Electricity insecurity and its Impact on Micro and Small Businesses in Ghana. Electricity Insecurity and Its Impact on the Economy of Ghana. Accra. 2015.
24. KarimKaraki . Understanding ECOWAS Energy Policy - *From national interests to regional markets and wider energy access.* 2017. Retrieved from cdpm.org/wp-content/uploads/ECOWAS.
25. Kojima, Masami, Robert Bacon, and Chris Trimble. "Political economy of power sector subsidies: a review with reference to Sub-Saharan Africa."2014.
26. Kumi, Ebenezer Nyarko. *The Electricity Situation in Ghana: Challenges and Opportunities*. Center for Global Development.2017.
27. Manz, D. Smart Grid Opportunities A Global Perspective. Irvine, California, USA. 2011.
28. Mathrani, Sunil, et al. "Energizing economic growth in Ghana: making the power and petroleum sectors rise to the challenge." *Washington DC* .2013.
29. Mbekeani, Kennedy K. "Making Regional Integration Supportive of Economic Development." *IMMIGRATION CRISIS*: 40.
30. Ministry of Power. Power News. The Official News Magazine for the Ministry of Power .2016.
31. Niyimbona, P. "The challenges of operationalizing power pools in Africa." *United Nations Commission for Africa, UNDESA Seminar on Electricity Inter-connection.* 2005.
32. PPPIRC. Theft / Non-Technical Losses (Water and Electricity.2014

33. Quansah, A. D., and E. W. Ramdé. "Potentials, Opportunities and Barriers for the Deployment and Usage of Solar Energy Technologies and Services in West Africa." 2010.
34. UN Population Division. (World Urbanization Prospects. New York, New York, USA. 2014.
35. United Nations Development Programme in Ghana, Environment and Energy. Liquefied petroleum Gas (LPG) substitution for wood fuel in Ghana (2004). Retrieved from http://energyaccess.com/file.
36. United Nations Economic Commission for Africa (UNECA), "Assessment of Power-Pooling Arrangements in Africa", UNECA, Addis Ababa. 2004, pp. 51-52.
37. Vilar (ed) . Renewable Energy in Western Africa: Situation, Experiences and Trends, ECREEE and Casa Africa.2012.
38. VRA. Power Generation: Facts & Figures. www.vra.com/resources/facts.2018.
39. WAPP,*Business Plan 2016-2019 West African Power Pool*. 2015.
40. World Bank, The first Phase of the Inter-Zonal Transmission Hub project of the WAPP, 2015. Retrieved from www.project.worldbank.org/p094919.
41. World Bank, Building *integrated markets within the East African Community: EAC opportunities in public-private partnership approaches to the region's infrastructure needs*. The World Bank, 2014.

E. INTERNET SOURCES

1. https://au.int/en/agenda2063.
2. https://esmap.org/node/374.
3. https://documents.worldbank.org: Project Information Document/ (PID/ISDS), 2017.
4. https://energypedia.info/Ghana_Energy_Situation.

5. https://Theafricareport.com; Ghana secures multimillion dollar West African Power Pool project | West Africa.
56. https://cdcgroup.com/Documents/Evaluations/economic growth and jobs.pdf 89.
6. https://Citifmonline.com "*Dumsor-Ghana to buy power from Ivory Coast for Easter*". https://ecofinagency.com.
7. https://ecowapp.org.
8. https://ecowas.int/wp-content/uploads/2015/01/7-West-African-gas-Pipeline.pd
9. https://ecreee.org.
10. https://energycom.gov.gh.
11. https://energyvortex.com/energydictionary/energy_loss__transmission_loss.html.
12. https://gdforum.org/global-energy-security-conference-2015.
13. https://undp.org/content/dam/ghana; Renewable Energy Policy Review, Identification of Gaps and Solutions in Ghana.
14. https://ghanaweb.com/GhanaHomePage/business/WAPP-has-what-it-takes-to-create-needed-electricity-market-Akufo-Addo.
15. https://gipcghana.com/quarterly-investment-report/file.(2017).
16. https://gridcogh.com/media: GRIDCO. Electricity Supply Plan (2010).
17. https://iaea.org/INPRO/activities.
18. https://Myjoyonline.com *GRIDCo to export electricity to Burkina Faso.* 2018.
19. https://nepad.org: NEPAD. Gas-West African Power Pool Domunli Regional Power Project.
20. https://pulse.com.gh/business/ghana-cote-divoire-a-new-country-ghanivoire-could-weld- together-west-africa.
21. https://Theredddesk.org/countries/plans/ghana-shared-growth-and-development-agenda.

22. https://weforum.org/agenda/2016/04/africas-fastest-growing-economies.

F. INTERVIEWS

1. Interview with Dr. Nii Darko K. Asante, Director, Technical Regulation at the Energy Commission, Accra 06/06/2018.
2. Interview with Mr Emmanuel Antwi, Principal Engineer (RE& ID) at the VRA, Accra 05/06/2018.
3. Interview with Mr. RasheedBaisie, a senior Engineer at GRIDCO, Accra 7/06/2018
4. Interview with Prosper A. Amuquandoh, Inspector (Renewable Energy), Ghana Energy Commission, Accra, 08/06/2018.

Appendix 1: Interview Guide

Interview Questions

- To what extent has Ghana's power or energy generation policy been influenced by the ECOWAS Renewable Energy Policy (EREP), and the initiatives of the West Africa Power Pool (WAPP)?
- How much of Ghana's electricity generation mix is from non-hydro renewable energy sources?
- What are the challenges confronting power generation from thermal and renewable energy sources in Ghana?
- What are the implications of Ghana's implementation of the ECOWAS Renewable Energy Policy (EREP), and WAPP initiatives, regarding electricity generation?
- To what extent is Ghana's electricity transmission network interconnected with sub-regional networks?
- What programmes have been put in place to inter-connect Ghana's transmission network with the rest of the sub-region?
- What are the challenges confronting the sub-regional inter-connected transmission system?
- What are the implications of Ghana's implementation of the ECOWAS Renewable Energy Policy (EREP), and WAPP initiatives on Ghana's inter-connected transmission system?
- To what extent is Ghana's electricity market integrated with the regional market?
- What are the programmes put in place to ensure that Ghana benefits from the sub-regional electricity market?
- What are the challenges confronting Ghana's participation in the sub-regional power market?
- To what extent are Ghana's energy policies, especially those relating to electricity generation, transmission and pricing, synchronised with regional policies (WAPP and EREP?)

- Have there been specific interventions in the energy sector in response to the WAPP and the EREP?
- What measures have been put in place to ensure the attainment of 10% target of installed renewable energy capacity by 2020 under the ECOWAS Renewable Energy Policies?
- What is the percentage of Ghanaians served with LPG and improved cook stoves vis-à-vis EREP target of up to 36% and 100% by 2020 for LPG and improved cook stoves, respectively?
- What are the implications of Ghana's implementation of the ECOWAS Renewable Energy Policy (EREP), and WAPP initiatives, regarding electricity generation?
- To what extent has Ghana's power or energy generation policy been influenced by the ECOWAS Renewable Energy Policy (EREP), and the initiatives of the West Africa Power Pool (WAPP)?
- How much of Ghana's electricity generation mix is from non-hydro renewable energy sources?
- What are the challenges confronting power generation from thermal and renewable energy sources in Ghana?
- What are polices put in place to ensure that electricity is affordable to Ghanaians?