# ELECTRICITY MARKET LIBERALISATION AND THE SECTOR'S PERFORMANCE IN SUB-SAHARAN AFRICA

**By**

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# CERTIFICATION

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# DEDICATION

I dedicate this Thesis to God Almighty for giving me the special grace to successfully complete the Ph.D Programme.

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## ABSTRACT

Sub-Saharan Africa (SSA) countries suffer severe electricity crisis despite over two decades of on-going Electricity Market Liberalisation (EML). Electricity access has been consistently low, averaging 26.0%, 31.0% and 44.1% in year 2000, 2010 and 2017, respectively. While existing studies had investigated the determinants and magnitude of EML in SSA, little attention was devoted to estimating the effect of this reform on the sector's outcomes. This study, therefore, was designed to investigate the effects of EML on Electricity Sector Performance (ESP) in 30 SSA countries between 1990 and 2017.

The New Institutional Economic theory provided the framework. A model which captured the dynamic effects of EML and other determinants of ESP (population growth, corruption, political stability, government effectiveness, GDP per capita and net development assistance) was explored. Three measures of ESP namely, electricity generation per capita, installed capacity per capita and electricity consumption per capita were considered. The EML was measured by four indices namely, ownership structure index, vertical unbundling index, effectiveness of regulatory agency index and overall market liberalisation index. The aggregated and disaggregated models were estimated. Disaggregation was into moderate and low electricity liberalised countries, and middle and low income countries to account for heterogeneity in ESP. The System Generalised Method of Moments estimation technique that took cognisance of feedback mechanism and controlled for the joint endogeneity of EML and other determinants of ESP in the presence of country-specific effects was adopted. Diagnostic tests (Hansen and Serial Correlation tests) were used to determine robustness of parameter estimates. Data were sourced from the World Development Indicators, Worldwide Governance Indicators, World Bank Electricity Regulatory Database and country's utilities reports. All estimates were validated at $\alpha_{0.05}$.

The EML had diverse effects on ESP in all the model. In the aggregate, both electricity generation per capita (1.20%) and installed capacity per capita (0.06%) improved as a result of a unit increase in overall market liberalisation index. When private ownership increased by 1.0 unit, electricity generation per capita improved by 2.30% and worsened installed capacity per capita by 0.03%. The dynamic effect of a unit increase in vertical unbundling, increased both electricity generation per capita (0.34%) and consumption per capita (2.37%), while installed capacity per capita dropped by 0.05%. Similarly, population growth and corruption deteriorated electricity generation and consumption per capita by 2.04% and 0.12%, respectively. A unit increase in overall market liberalisation index had positive impact on electricity generation per capita in moderate electricity liberalised and middle income countries by 2.10% and 0.04%, respectively. The effect of a unit increase in private ownership, increased electricity consumption per capita in low income (0.02%) and moderate liberalised countries (2.31%). Similarly, a unit increase in vertical unbundling, improved installed capacity per capita in middle income (0.10%) and moderate liberalised countries (0.01%).

The effects of electricity market liberalisation on the sector's performance were generally positive but varied in Sub-Saharan Africa. Therefore, effective regulatory policies should be designed to further strengthen electricity market liberalisation in the region.

**Keywords:** Electricity market liberalisation, Sector's performance, System Generalised Method of Moments, New Institutional Economic Theory

**Word count**: 489

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## LIST OF ABBREVIATIONS

| | |
|---|---|
| AfDB: | Africa Development Bank |
| APP: | Africa Power Project |
| AR: | autoregressive |
| BLS: | Bias-Corrected Least-Squares (BLS) |
| BPC: | Botswana Power Corporation |
| CAPP: | Central Africa Power Pool |
| CEB: | Central Electricity Board |
| CGE: | Computable General Equilibrium |
| CIE: | Compagnie Ivoirienne d'Electricité |
| CORRC: | Corruption Control |
| CVM: | Conjectural Variations Model |
| DISCO: | Distributing Companies |
| DoE: | Department of Energy |
| DPE: | Department of Public Enterprises |
| EAPP: | Eastern Africa Power Pool |
| ECB: | Electricity Control Board |
| ECG: | Electricity Company of Ghana |
| ECPC: | Electricity Consumption Per Capita |
| EGPC: | Electricity Generation Per Capita |
| ECM: | Error Correction Model |
| ECOWAS: | Economic Community of West African States |
| EDM: | Electricidade de Mozambique |
| EDMSA: | Energie du Mali Société Anonyme |
| EEPCO: | Ethiopian Electric Power Corporation |
| EGRI: | Economic Governance Reform Index |
| EML: | Electricity Market Liberalization |
| EIA: | Energy Information Agency |
| ENE: | Empresa Nacional de Electricidade |
| EPSRA: | Electric Power Sector Reform Act |
| ESCOM: | Electricity Supply Commission |

| | |
|---|---|
| EPPs: | Emergency Power Plants |
| ERA: | Electricity Regulatory Authority |
| ERB: | Electricity Regulatory Board |
| EBRD: | European Bank for Reconstruction and Development. |
| ERI: | Electricity Regulatory Index. |
| ESI: | Electricity Supply Industry |
| ET: | Energy Tribunal |
| EWRC: | Electricity and Water Regulatory Commission |
| FMoP: | Federal Ministry of Power, Nigeria |
| FSRI: | Financial Sector Reform Index |
| GDC: | Geothermal Development Company |
| GDP: | Gross Domestic Product |
| GDPCA: | GDP Per Capita |
| GENCOs: | Generating Companies |
| GOVTE : | Government Effectiveness |
| GMM: | Generalized Method of Moments |
| GridCo: | Grid Company of Ghana |
| GW: | Gigawatts |
| GWh: | Gigawatt Hour |
| IEA: | International Energy Agency |
| IGCPC: | Installed Generation Capacity Per Capita |
| IMF: | International Monetary Fund |
| IPPs: | Independent Power Producers |
| IRI: | Infrastructure Reform Index |
| KenGen.: | Kenya Electricity Generating Company |
| KETRACO: | Kenya Electricity Transmission Company Limited |
| KNEB: | Kenya Nuclear Electricity Board |
| KPLC: | Kenya Power and Lighting Company |
| KWh: | Kilowatt hour |
| MEMD: | Ministry of Energy and Mineral Development |
| MoE: | Ministry of Energy |

| | |
|---|---|
| MoEP: | Ministry of Energy and Petroleum |
| MW: | Megawatt |
| Nampower: | Namibia Power |
| NBET: | Nigeria Bulk Electricity Trading Company |
| NBS: | Nigeria Bureau of Statistics |
| NDA: | Net Development Assistant |
| NED: | Northern Electricity Department |
| NESI: | Nigerian Electricity Supply Industry |
| NEPA: | National Electricity Power Authority |
| NERC | Nigerian Electricity Regulatory Commission |
| NERSA: | National Energy Regulator of South Africa |
| NITS: | National Interconnected Transmission System |
| OECD: | Organization of European Community for Development |
| OELX: | Overall Electricity Market Liberalization Index |
| OMLI: | Overall Market Liberalization Index |
| OLS: | Ordinary Least-Squares |
| OWS: | Ownership Structure |
| PHCN: | Power Holding Company of Nigeria |
| POPGR: | Population Growth |
| PSAV: | Political Stability and Absence of Violence |
| PURC: | Public Utilities Regulatory Commission |
| REA: | Rural Electrification Authority |
| RED: | Regional Electricity Distributors |
| RECO: | Rwanda Electricity Corporation |
| REEEP: | Renewable Energy and Energy Efficiency Partnership |
| RGA: | Regulatory Governance |
| RGI: | Regulatory Governance Index |
| ROI: | Regulatory Outcome Index |
| RSI: | Regulatory Substance Index |
| SAPP: | Southern Africa Power Pool |
| SCP: | Structure Conduct Performance |

| | |
|---|---|
| SEEG: | The Société d'Electricité et d'Eaux du Gabon |
| SENELEC: | Société Nationale d'Electricité |
| SNEL: | The Société National d'Electricité |
| SONABEL: | Société Nationale Burkinabè d'Electricité |
| SONEL: | Société Nationale d'Electricité |
| SSA: | Sub-Saharan Africa |
| TANESCO: | Tanzania National Electric Supply |
| TCN: | Transmission Company of Nigeria |
| TFP: | Total Factor Productivity |
| TRANSCO: | Transmission Company |
| UEB: | Uganda Electricity Board |
| UEB: | Uganda Electricity Board |
| UETCL: | Uganda Electricity Transmission Company Ltd |
| VERTI: | Vertical Integration |
| VRA: | Volta River Authority |
| WBERD: | World Bank Electricity Regulatory Database |
| WDI: | World Development Indicator |
| WEC: | World Energy Council |
| WEO: | World Economic Outlook |
| WGI: | Worldwide Governance Indicator |
| ZESA: | Zimbabwe Electricity Supply Authority Holdings |
| ZESCO: | The Zambia Electricity Supply Corporation |

# CHAPTER ONE

# INTRODUCTION

## 1.1 Preamble

Over two decades ago, electricity sector liberalisation[1] has been a central policy path in most developed and developing countries. The motivation to liberalize and introduce competition in previously traditionally state controlled and regulated electricity sector, came at the end of the 1980s when Chile beganreforming its electricity sector (Newbery, 2002). At the present, electricity market liberalisationhave been implemented by over 50% of the countries in the world (Erdogdu, 2014). In the same vein, over 60% of Sub-Saharan Africa (SSA) countries have introduced electricity market liberalisation in their power sectors (Eberhad and Gratwick, 2015).

The principal factors driving electricity market liberalisation have been extensively investigated in the empirical literature (see Adenikinju, 2005; Jamasb, Newbery and Pollit, 2005a; Pollitt, 2009; Orvika and Haakon, 2012; Erdogdu, 2014; Palacios and Eduardo, 2017; Shinaand Managi,2017; Loi and Jia,2018; Gregorya and Sovacool, 2019;Urpelainen and Yang, 2019, and Bushnell, Alejandro and Pappas, 2019). According to Jamasb, et al.,(2005a) and Erdogdu (2014),these factors can be categorized into pull and push factors. The pull factors include: the signaling effects of the revolutionary power sector reforms in Chile, Norway and England during the late 1980s and early 1990s; encouragement of reforms by the IMF and World Bank as well as other international financial organizations; the advent of rapid technological development in the electricity generation and distribution value chain. On the other hand, the push factors include: the

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[1]Electricity market liberalisationimplies the removing of restrictions on entry and exit into the electricity sector, making it more competitive and open to prospective private investors. It sometimes implies minimal state intervention. Elements of liberalisation include restructuring or unbundling- the unpacking of vertically integrated state controlled electricity sector into separate entities

underperformance that characterized the state controlled power sectors, unreliability of power supply, inadequate state funding and expansion of electricity assets, the need to make the sector competitive and to remove electricity subsidies so as to channel public funds to critical areas of expenditure.In the literature, it is fairly settled that electricity is one of the engines of economic growth and development in any economy**.** Electricity supply plays several functions in the economy through multiple processes. First, it serves as a transitional input to production activities and hence, changes in electricity supply affects the economy and the profitability of firms as well as the levels of output, employment and income, (Adenikinju, 2005).

In line with the above reasoning, the rationale for electricity market liberalisation in SSA can be ascribed to both the pull and the push factors. Governments in SSA are desirous to attract private investments into their power sectors, as well as to reducethe burden on public finances and strengthen the performance of state-run utilities. In developed countries, the benefits of electricity market liberalisation appear to have been relatively significant, while in SSA, the paths towards a successful electricity market liberalisation to deliver real economic benefits in SSA have not been achieved (Imam, Jamasb and Llorca, 2019). Hence, policy makers, industrialists and academic experts have continued to debate several key issues militating the success of electricity market liberalisation in SSA.

The electricity gap between Sub-Saharan Africa countries and other regions in the world is widening. The total electricity generation capacity of the 49 countries in SSA is only 90 gigawatts (GW), however, without South Africa, this total is below 40GW. Nigeria, with a population that is three times the population of South Africa, has only one-tenth of South Africa's installed generation capacity (Eberhard, Gratwick, Morella, and Antmann, 2016). The Nigeria's electricity industry which was previously dominated by the state-run electricity sector, has been unable to provide constant and reliable electricity to its citizens. Iwayemi (2008) described Nigeria's electricity crisis as a paradox because its natural gas reserves and crude oil reserves estimated at185 trillion cubic feet and 35 billion barrels respectively, can comfortably provide enough electricity supply to the entire SSA for many decades. Also comparatively, installed capacity in SSA without South Africa is just only 44MW per million population, while it is 815MW in Latin America, 192MW in India and 590MW in (EIA, 2014).

Electricity consumption in Sub-Saharan Africa is significantly low, when comparing to other regions. Infact, Spain's electricity consumption is more than that of the entireSSA. Without South Africa, electricity consumption drops to an annual average of 162 kWh per capita, this is the lowest level of electricity consumption world over(APP, 2015). The world annual average consumption is about 2,800kWh. In South Asia it is 607kWh, rising to 1,285 kWh in East Asia and 1,931.2 kWh inthe Caribbean and Latin America (IEA, 2015). Furthermore, in 2015, SSA'shas the lowest electricity access in the world, specifically,not more than 40 percent of SSA total population have access to electricity, this is surprising when compared to about96 percent in Caribbean and Latin America, 96 percent inPacific and East Asia, and 77 percent in South Asia. Based on the current trends, out of the 800 million people in SSA, two in every three persons have no access to electricity (APP, 2015). However, it is observed by Gregorya and Sovacool (2019), that electricity poverty in some countries in SSA including, Kenya, Tanzania, and Mozambique is worsened by the inability to finance the construction of new electricity infrastructure in the region due to the excessive risks and volatile business environment that make such investment unattractive to the private sector.

### 1.2 Statement of the Problem

Sub-Saharan Africa countries still suffer electricity crisis despite over after two decades of on-going electricity market liberalisation. The region has the lowest electricity consumption per capita relative to other regions in the world. The region's insufficient electricity generation and consumption constraint economic growth and development.Electricity outages are frequent in the region, as such, own generation constitutes a substantial proportion of entire electricity consumption. The main aim of electricity market liberalisation is to increase the supply of electricity andenhance the competitiveness of the sector. Electricity Market liberalisation is also expected to increase electricity generation and installed capacity through the influx of private sectors investments in the sector. However, despite the determinations at liberalizing the electricity sectors in SSA countries to improve the sector's performance, a very different reality exists. In most SSA countries, liberalisation often occurred within ill-defined institutional and legal contexts, hence the states still control the power sectors, often through the presence of dominant national utilities, leading to chronic power problems and unreliable power supply, all of which constrain development. Electricity availability directly affects incomes, economic growth and job creation. Without adequate access to electricity, countries cannot sustain inclusive growth and accelerate progress towards eradicating poverty (Eberhard and Gratwick, 2010).

Further, electricity sector liberalisation have been a major policy path in most SSA countries for over two decades, this has introduced new development to the operation of the power sectors with major changes to utility structure, ownership, governance and the regulatory framework. But, since the inception of power sector liberalisation in SSA, no SSA country has accomplished the shift to a fully vertical and horizontal unbundling with private investors led electricity sector (Eberhad, 2015). Thus, electricity reforms in SSA countries are characterized with complex and uneven set of interface between the market and the state. In most cases, market liberalisation has resulted in hybrid power markets, where independent power producers and state-controlled utilities mutually operate without element of competition in the sector. Besides, establishing an effective independent regulation has been one of the difficult features of the liberalisation procedure in SSA. This practice is different fromthe standard model of liberalisation.

In addition, the electricity sectors in SSA differ considerably across countries in terms of size, structure and resource mix. In the same vein, electricity sectors liberalisation was implemented in different periods with varying contexts. However, in all SSA countries, two major factors seem to have characterized the liberalisation process. First, most of the liberalisation programmes were initiated without sufficient human resource with requisite skills and experiences regarding the nature and complexities of the electricity sector. Second, there seem to be a general fault in the regulatory and institutional framework in the electricity sector liberalisation. These faults may have originated from the overlaps, gaps and disagreements in the mandates and operations of these institutions. In most instances, the problem of which paricular institutionis answerable to a specific function in the electricty sector is often not certain.

More so, one of the reasons for liberalizing the electricity sectors in SSA is to lessen the power sectors dependence on government funds. However, after decades of liberalisation, many governments in SSA continue to be the major financier of the electricity sectors. Most SSA countries have separated the distribution transmission generation value chain and as well privatized some aspect of the utilities. However, the electricity sector reforms in SSA have not been able to attract adequate investment to improve electricity supply. Hence, persistent electricity scarcity has prevented the region from achieving its education, infrastructure, health and development goals. Further, most studies in SSA employed dummy variables to measure electricity market liberalisation. However, the key measurement of electricity market liberalisation such as vertical and horizontal unbundling of functions, independent power producers, privatization, independent regulations and wholesale markets, are being established. Hence, the measurement of these variables with dummy variables, do not reflect the actual intensity of electricity reform.

Paradoxically, while electricity market liberalisation has been on a steady and substantial increase over the last two decades in SSA, its effect on the performance of the electricity sector such as generation, installed capacity and consumption, has not been adequately researched. Emanating from the foregoing problems, the under stated research questions become pertinent: What are the indicators of electricity market liberalisation in SSA? What are the effects of electricity market liberalisation on electricity sector performance? Addressing these and related issues constitute the main thrust of this study

### 1.3 Objectives of the Study

In broad terms, this study investigates the effects of electricity market liberalisation in Sub-Saharan Africa. To achieve this, the following specific objectives are to:

i) Generate a set of electricity market liberalisation index for Sub-Saharan Africa.
ii) Investigate the effects of electricity market liberalisation on thesector's performance in Sub-Saharan Africa.

### 1.4 Justification for the Study

The rationale for this study is threefold underpinned by the observed gaps in the literature covering theoretical, empirical and methodological. In general terms, theoretical expositions on the effects of electricity market liberalisation on the sector's performance are still emerging. The NIE[2] theory has been widely used to examine this link. However, the theory focuses on institutional structure such as legal system; regulatory frameworks and structural changes, as the major determinants of effectiveness in electricity market liberalisation. Therefore, this study extends the frontier of the theory by exploring the effects of market liberalisation on specific indicators of electricity sector performance such as electricity consumption per capita, installed generation per capita and electricity generation per capita,.

Further, there are several studies (mostly for developed countries) that have examined the effects of electricity market liberalisation (see; Chang and Berdiev, 2011; Erdogdu, 2013 and 2014; Muhammad, Mohaned, and Mokhalad, 2016; Anupama, Nepal, and Jamasb, 2016). A little departure from the status-quo in the case of SSA, are: Eberhard and Gratwick, 2011 and 2013; Eberhard, 2015; Nadia, 2017; Eberhard, et al., 2017; Imam,Jamasb and Llorca, 2019). However, most of these few studies on SSA focused mainly on independent power projects without a comprehensive analysis of the effect of electricity market reforms. It is therefore apparent that despite the steady rise in electricity market liberalisation and the inherent poor power supply in the region, the experience of SSA is less investigated. Thus, this study contributes to the literature by examining the extent of electricity market liberalisation in SSA.

Markedly, the evidence of the effectiveness of electricity market liberalisation varies across developed and developing countries. Hence, power sectors in SSA present different characteristics from those of the developed countries. Thus there is need to re-investigate empirically the effect of electricity market liberalisation in SSA. Importantly, an in-depth research into the nexus between electricity market liberalisation and electricity sector performance would be an immense help to SSA countries, since the region's economies are plagued with acute power shortages. The emerging international evidence suggests

[2] New Institution Economic Theory

that correct implementation of electricity market liberalisation could lead to improvement in power supply.

Most of the methodologies adopted to examine the effects of electricity market liberalisation, focus on static framework with little attention to the dynamic process that may be responsible for the behaviour of electricity sector performance. More so, most studies have undermined the twin effects of endogeneity and country's heterogeneity problems when estimating the effects of electricity market liberalisation across countries (seeChang and Berdiev, 2011; Erdogdu, 2014). Therefore,to correct the aforementioned methodological issues, this studyemploys the System-Generalized Method of Moments estimation technique. The System-Generalized Method of Moments estimation technique propounded by Arellano and Bond, (1991) is an improvement over the deficiencies of existing methodologies found in the literature and can adequately cater for all the envisaged problems. Beck, Levine, and Loayza (2000)posited that the System-Generalized Method of Moments estimation technique for panel data is efficientby taking cognizance of unobserved specific effects and hence provide a more robust control in addressing endogeneity problems in the explanatory variables.

On the empirical front, some earlier studies on liberalisation (see Rufin, 2003; Limin and Jinchuan, 2008; Duso and Seldeslachts, 2010; Chang and Berdiev, 2011; Palacios and Eduardo, 2017) employed dummy variables to measure electricity market liberalisation. However, as argued by Erdogdu, (2014), the key measurement of electricity market liberalisation such as vertical and horizontal unbundling of functions, independent power producers, privatization, independent regulations and wholesale markets, are being established. Hence, the measurement of these variables with dummy variables, do not reflect the actual intensity of electricity reform. Therefore, to overcome these challenges, this study improves on existing studies by generating a set of electricity market liberalisation indicators to estimate the extent of electricity reform implemented in SSA.

Furthermore, away from the existing status-quo, this study identified that pooling together 30 SSA countries together may undermine the effects of country's heterogeneity. This is because electricity sectors liberalisation was implemented in different periods with varying contexts. Thus, beyond investigating the 30 SSA countries, the countries are further categorized into four groupsin order to account for heterogeneity in the model. These sub-groups include; middle income countries, moderate electricity liberalised countries, low income countries, and low electricity liberalised countries. The comparative result of the sub-groups will not only add to empirical literature but will also be compared to global best practices in order to provide more robust evidences and suggest innovative ways in which electricity sector liberalisation can improve electricity performance in SSA.

## 1.5 The Scope of the Study

This study focuses on the effects of electricity market liberalisation on the sector's performance in SSA, spanning from 1990 to 2017. The year 1990 is chosen because it markedthe beginning of electricity market reform in the region, specifically in Cote d'Ivoire. Also, the year 2017 is the year at which reasonable comparable data on electricity reform inthe region exist. However, annual time series data are pooled for thirty (30) countriesin SSA[3]. The choice of these countries is informed by data availability on electricity market liberalisation. Aside from the broad rationale for pooling data, which is to gain efficiency, the aspiration to reflect country differences in the region in terms of the extent of liberalisation implemented also influenced the choices. Further, this study also carried out a comparative analysis across the four sub-groups in SSA such as; middle income countries, moderate electricity liberalised countries, low income countries, and low electricity liberalised countries.

## 1.6 Outline of the Thesis

The remaining part of the thesis is structured in the following order. Literature review and background to the study are presented in chapter two. For clarity, the review is sectioned into theoretical, methodological and empirical. It also contains a detailed discussion of electricity sector performance in SSA. The theoretical framework, methodology and sources of data are presented in chapter three. It also contained the electricity market liberalization index for SSA. Chapter four contains data analysis and result interpretation.

[3] See appendix A for the list of countries selected for the study (Classification based on Regional blocs)

Summary of major findings, conclusion and policy implications along with the suggestions for further research are presented in chapter five.

# CHAPTER TWO

# LITERATURE REVIEWAND BAGROUND TO THE STUDY

## 2.1 Theoretical Review

There exist some theories that explain the rationale forliberalising public firms in the literature. Withinthe context of electricity, four theories are paramount in explaining the dynamics of electricity market liberalisation. These are: the New Institution Economic Theory, the Public Choice Theory, the Structure Conduct Performance Theory and the Neo-liberal Theory

### 2.1.1 New Institutional Economic (NIE) Theory

The new institutional economic theory was originated by Williamson in 1975. NIE holds that differences in economic performances could be explained by understanding the process of economic and institutional reforms. Simultaneously, the theory is concerned with explaining how to improve social welfare by recognizing the disequilibria caused by market. The theory further recognizes that markets need institutional support in order to function effectively, hence, the need for government intervention is emphasized when market fails to uphold the public interest in the provision of services. The theory began as a body of economic philosophy that emphasizes the importance of institutions in the analysis of economic occurrences. It analyses the evolution and nature of institutions and its consequences on the performance of the economy (Chavance, 2009). NIE is germane in the analysis of electricity sector liberalisation. First, that electricity market liberalisation is an institutional restructuring that requires structural changes and the rearrangement of the market structure. This nexus between institutions, electricity liberalisation and economic performance has been explored in the theoretical and empirical literature by Preetum and Pollitt, 2001; Joskow, 2008; Nepal and Jamasb, 2012; Erdogdu 2011; 2013; 2014; Helene, Frida, Sverker and Patrik, 2015.

Second, NIE suggests that institutions could determine the different process of liberalisation in various countries over time, implying that variations in countries electricity liberalisation experience are related to the nature of their institutional structures (Erdogdu, 2014). Hence, the rate of success or failure of electricity market liberalisation programmes hinges on the existence or otherwise of adequate regulatory framework, proper investment atmosphere and strong legal system.

The growing focus on NIE theory may not be unconnected with the World Bank 1997 lending policy. World Bank (1997) advises that states should liberalize public utilities and set up adequate regulatory framework and provide a business friendly environment that could be attractive to the private sector investment. The World Bank opined that public utility liberalisation is a solution to rent-seeking behavior and drain on public funds. It further argues that competition would promote efficiency in the electricity sectors.

### 2.1.2 The Public Choice Theory

The Public Choice theory posits that policy makers are altruistic and aim to implement policies that will be of public interests, hence some of the reasons for liberalizing public utilities is to stimulate market competition, eradicate market failure and reduce inefficiency arising from the monopolistic nature of the industry (see Joskow and Noll, 1981; Stigler, 1971; Joskow, 2008; Fiorio and Florio, 2013). According to Joskow (2008), the state controlled electricity sectors perform poorly because state officials are self-centered and they pursue their own personal interest rather than the interest of the public. Hence, it is hard to expect good performance and accountability from public utilities because of their monopolistic structure. However, Walsh, (1995) argued that one of the solutions to this problems is exposing the electricity sector to more competition through sector liberalisation. Specifically, public choice theorist, Niskanen, (1971), has criticized the monopolies of the electricity industries as not addressing the problem of cost reflective tariff given the huge gap between revenue and cost. He added that public utilities are not interested in performance improvement and hence they are not overtly motivated to be cost conscious.

Public choice theoryfurther stressed the inability of government to do things right because politicians and government officials are mostly interested in their self- interest at theexpense of the citizens. Therefore, most government policies rather than address the welfare of the citizens, ends up in the misallocation of resources to their benefits. In this wise,little or no government participation in the management of public utilities generate higher efficiency, hence the essence of liberalisation of government corporations. The theory of the public choice also draws a distinction between the behavior in the management of state-owned and privately owned firms, stating that privately managed firms perform better than the public controlled because of the different objectives they tend to pursue. These differences are attributed to the issue of incentives and motivation, leading to differences in behavior and productivity (Vickers, 1990).

Furthermore, the public choice literature shows that the rise in the public firm liberalisation is as a result of the continuous inefficiency that characterized the public monopoly of the sector and also the need to reduce the fiscal burden of the electricity sector on public finances. The monopoly of the public firms has also been criticised as lacking in the technical knowledge required to transform the electricity sector to higher productivity. It added that public firms are less efficient than private.

### 2.1.3 The Neoliberal Theory

The core of neoliberal theory is that open, competitive and minimal market regulations as well as little or no interference bythe government, represent the bestapproach to achieving economic growth in any economy. The intellectual root of this theory is drawn from classical economic philosophy of Adam smith in 1776. Adam Smith suggests a policy tool which limits government participation in the management of public utilities, arguing that government involvement in the economic activities in the economy could lead to under production, inefficiency and mismanagement of resources.

In generally, the liberalisation of state controlled electricity sectors, hinges on orthodox neoliberal theory that private sectors participation in the electricity market, bring greater efficiency and better improvement in power supplies (Newberry, 1997). On the contrary some scholars have argued that liberalisation and competition alone are not the only solution to electricity market efficiency but also strong institutional framework must be established (Bushnell, Borenstein, and Knittel, 1999). This is because, liberalisation efforts in many countries have been constraint by weak political support, low investment patronage by the private sector, and inappropriate regulatory framework. Theoretically, the principles of neoliberal theory are consistentwith neoclassical assumptions. The basic idea is that government continuous monopoly of the electricity sectors can lead to market failure. Consequently, government desire to create equilibrium in the market by correcting market failures is criticized by the neoliberals on the reason that such intervention could further worsen the situation rather than solving it.

However, in the theoretical literature,there has been an increasing debate as to whether electricity market liberalisation can improve or worsen electricity performance especially in developing countries. One of the key assumptions of the neo-liberal theory is the emphasizes on reducing the role of the state in public utilities management. Lewis (1996) added that thestrict dichotomybetween the state and the market regarding efficiency as posited by the neo-liberal theory is still subject to debate and empirical validation. He argued that some countries that have since adopted the neo-liberal theory are still battling with the problem of inefficiency and resource misallocation.

However, James and Dietz (2004),argued that the position of the neo-liberal theory advocating the reduction of state involvement in the management of the electricity sector in developing countries is incorrect. They asserted that the state was actively involved in the development of the electricity sectorsin countries such asUSA, Norway, Japan, Russia, Germany, China and the other developed countries. However,the basic idea is that government continuous monopoly of the electricity sector can lead to market failure.

### 2.1.4 The Structure Conduct Performance (SCP) Theory

The Structure Conduct Performance (SCP) theory istraced to the novel works of Manson (1939) and Bain (1956). Bain (1956) posited that in the industry, firms' conducts are determined by the structure and design of the market and this obviously influence the performance of firms. This theory which has its root from the Neoclassical theory of the firm, is applied in the electricity industry to analyze market behaviors as well as the nexus that exist among the structure of the market, market conduct and the performance of the market. The SCP framework is composed of three main parts viz: the structure of market, the conduct of market and market performance. In terms of conceptualization, the key elements in the market structure are the number of firms existing in the industry, product similarity and the rate of entry and exit in the market (Trucker, 2010). In the literature, the major factor that influences market structure include: barriers to entry and exit, the concentration of sellers and buyers, product differentiation and the rate of demand in the market (Lipczynski, Wilson, and Goddard, 2013). There are other factors that influencesthe structure of the market but these factors are usually not considered because of their difficulties in measurement and conceptualization. Bain (1968) further defined market conduct as a pattern of firm's behavioral adjustment to the market where buying and selling activities are carried out. According to Tung, Lin, and Wang(2010), market conduct is the pattern of behaviour of sellers and buyers amongst themselves and others. According to the postulation of Bain (1968), the performance of the market is centered on the type of economic result that comes from the system regarding its adaptive tendencies to changing situation and pricing efficiency.

The central proposition behind the (SCP) theory states that noticeable structural features of a market influences the attitude of firmsand the attitudes of firms to a greater extent decides assessable market performance (Lipczynski, et al., 2013). The SCP theory further posits that a market structure that is made up of several firms with similar goods and services, having related cost structure and equal sizes generates greater performance as a result of the competitivenessof the market. Over the years, the SCP has been used as a standard framework for empirical work in the field of industrial organization to analyze firms' behavioural actions and economic activities in an imperfect marketas well as competitive markets. Edwards, Allen, and Shaik (2006) classified the SCP framework into two distinct part, namely, the efficient-structure hypothesisand the traditional structure-performance. The argument of theefficient-structure hypothesis isthat firm's performance is directly and positively linked to its efficiency. This is because in a competitive market,firm's can only take advantage of reducing cost, increasing its market share and maximizing turnover and hence profits. The traditional structure-performance hypothesis on the other hand asserts that there exist a negative relationship between competition and this makes firms to collude in order to generate higher returns. Smit and Trigeorgis (2004) assert that the demand and supply conditions in the industrydictates its structure and themarket competition by firms influence company's dynamics. However, the SCP theoryhas been criticized that relationship between structure, conduct and performance are more complex than the simplistic approach assumed by the theory.

## 2.2 Methodological Review

### 2.2.1 Review of Estimation Techniques

Several methodologies have been adopted to investigate the effects of electricity market liberalisation. However, the review of literature relating to methodology will focus on the estimation issues associated with examining the effects of electricity market liberalisation on the sector's performance. In this regards, some of the basic estimation procedures found in the literature can be broadly classified into five. These include, the traditional Pooled OLS as found in the studies of Helene, et al., (2015); Erdogdu, (2011a; 2013; 2014a). The Panel Fixed/Random Estimation Techniques as in Anapuma and Jamasb, (2010); Fiorio and Florio, (2013); Michael, (2016); and Gasmi and Recuero, (2010). The Error Correction Model (ECM) as applied in Cubbin and Stern, (2006). The Bias-Corrected Least Squares (BLS) dummy variable model as in Chang and Berdiev, (2011a); Nepaland Jamasb, (2012). The Computable General Equilibrium (CGE) as evident in Akkemik and Oguz, (2011). The Two Stage Least Squares (2SLS) as used in Anupama, et al., (2016) and Pompei, (2013) and the conjectural variations model (CVM) as adopted in Lagarto, Sousa, Alvaro and Paulo, (2014).

Chang and Berdiev (2011a) examined a panel of 23 OECD countries between 1975 to 2007, adopting the Bias-Corrected Least Square (BLS) approach to investigate the effect of political factors, government ideology, and globalization on electricity industries liberalisation. Similarly, Erdogdu (2014a) examined how political economy variables affect the process of liberalisation in electricity markets, using Pooled OLS on 55 developing and developed economies between 1975–2010. These two studies (Chang and Berdiev, 2011a and Erdogdu, 2014a) conclude that higher political forces influence the direction of liberalisation in the electricity industry. A major fall out of these two studies, originated from the inadequate size of data used in the study and therefore, the impact of some other variables that are important in electricity market reform could not be accounted for in the study. These variables include; technological innovations, institutional characteristics, and regulatory practices. Besides, the Pooled OLS estimatorused in the study failed to control for the heterogeneity effects and the joint endogeneity of the explanatory variables.

Cubbin and Stern (2006) applied the Panel data modelling and Error Correction Models (ECM) to examine the effect of regulatory governance on electricity industry output for 28 developing countries between1980–2001. Also, Gasmi and Recuero (2010) adopted the Panel data modelling to examine the maincauses of some outcomes that constitutes the trust of reforms of the electricity industries. These studies revealed that financial and institutional factors constitute importantdeciding factors of the actual reforms carried out and outcomes in the electricity sector. In these studies (Cubbin and Stern, 2006; Gasmi and Recuero, 2010), time effects were not explicitly incorporated into the models. Also, the models failed to factor in regulatory changes and the establishment of independent regulators which are important elements of liberalisation.

Lagarto, et al. (2014) investigated the competitive activities of firms involved in electricity generation in aliberalised electricity industry, using a conjectural variations (CV) techniques. The study generated some indices to measure the extent of competition in each period by each generating firm. However, the methodology could not explain why firms are not independent on each other and their expectations regarding their rivals responses. Moreover, CV is a dynamic model and could not be applied in a static context as used in the study. Some studies have also applied the Computable General Equilibrium (CGE) analyze the impact of electricity liberalisation in the economy. Notably, Akkemik and Oguz (2011) used the CGEtechnique to investigate the nature of competition in the electricity industry in Turkey. The study emphasized that regulatory reforms have improved efficiency in the electricity industry, reduction in energy prices of households, welfare improvement and output gains. However one obvious disadvantage of the CGE modeling, is that its result can be too aggregative, thus may fail to shed light on specific factor or issue.

Anupama, et al. (2016) applied the Two Stage Least Squares (2SLS) estimation technique to analyze the electricity performance in 17 developing Asian economies that are non-OECD countries for the period of  23 years. The results indicate that institutional variables have dictated the performance of electricity. An important issue with this study is that it fails to provide practical validation on how political institutions affect regulatory performance. Besides, the study could not account for the significant variations and inter-relationship between political influence, environmental factor, and the choice of liberalisation model across countries. More so, the precision of the model could be biased based on the qualitative nature of the date used in the study. Further, the study fail to address the problem of endogeneity that may likely occur in the model.

It is obvious from the review that most of the methodologies adopted to empirically investigate the impact of electricity market liberalisation, focused on static framework with little attention given to the dynamic process that may better capture the extent of market liberalisation on electricity performance. Also, some of the studies employed methodologies that are incapable of resolving the likely bias that may arise when data from many cross sections are pooled. Besides, most estimators used by previous studies could not control for the presence ofendogeneity and heterogeneity of the explanatory variables. In addition, some of the studies used dummy to measure the extent of market liberalisation which is inappropriate and could not properly account for intensity of the reform implemented. In this wise, Jamasb, et al. (2005a) posited that empirical findings on the effects of electricity market liberalisation are extremely sensitive to the choice of variables and methodologies used. In this regards, this study improves on existing studies by providing a better capture of the nature and intensity of electricity market liberalisation using a set of electricity market liberalisation index. Against this backdrop, this study adopted the System Generalised Method of Moments (System-GMM) technique that can cater for the issues discovered in previous methodologies and also capable of estimating the dynamic effect of electricity market liberalisation in Sub-Saharan Africa, taking key cognizance of the factors that could matter in determining the level of the sector's performance in the region.

## 2.3 Empirical Literature Review

The objective of this sub-section is to present a survey of empirical findings on the effects of electricity market liberalisation on the sector's performance. While some studies have confirmed the existence of casual evidence, for example Erdogdu, (2011; 2014);

Maria,(2016); Helene, et al., (2015); Nagayama, (2007); Micheal, (2016), Several empirical studies have produced mixed results as evident in Fiorio and Florio, (2013); Erdogdu, (2013); Carvalho, (2017) and Anapuma and Jamasb, (2010).

Erdogdu (2011) questioned whether the rapid increases in electricity market reforms in both developing and developed countries have translated into improvement in the power sectors. The study used a panel data from 93 countries between 1982 -2008, the findings from the study reveal a slightly significant positive impact of reform on electricity industry performance. The result also suggests that electricity market liberalisation marginally enhance efficiency in electricity sector, after controlling for country's heterogeneity. The study further detects a significant positive relationship between the percentage share of losses in the network (both distribution and transmission) and electricity liberalisation processes. This implies that the losses in the network transmission as a share of total electricity generated seem to increase as countries implement more liberalisation steps. As such, the study argued that some other variables such as the country's development status and other country's heterogonous factors have crucial influence in determining the electricity sector performance than the process of liberalisation. However, as against the popular expectations that increasing electricity reform will increase the sector's efficiency, the study concludes that liberalised electricity market has limited positive impact on performance of the sector.

In similar trend, Erdogdu (2014) examined how political factors shapes the liberalisation of the electricity market in non OECD and OECD contries, the study covered 55 developing and developed countries between 1975 to 2010. Findings from the study indicated that liberalisation process is significantly influenced by political factors. The results also indicate that the more the presence of resilient pro-reform interest groups (e.g large industrial electricity consumers) in a country, the less likely the country would liberalise its electricity sector. This may imply the fact that most consumers could choose subsidized pricesin a public controlled market rather than reduced future prices in a competitive and liberalised market. More so, the findings further posit that aid receiving countries will be more willing to implement a liberalised electricity market, which highlights the fact that liberalisation may not always be voluntary.

Marie (2015) investigates the reforming of the electricity markets in Europe which began since the early 1990s. The study considered how the restructuring process affects industrial consumers electricity prices, using static panel-data techniques. The study finds that incomplete disentanglement of the transmission segment makes the industrial customers to pay higher electricity prices. On the flipside, the static model result shows that liberalised electricity wholesale market lower prices. Further, the study revealed the presence of path dependence in the industrial electricity prices in Europe.

Nagayama (2007) modeled electricity sector liberalisation, power performance and electricity prices for 83 countries between 1985-2002. The study specifically investigated how electricity prices are influenced by liberalisation policy in some developing and developed countries. The study found that electricity prices and power performance are influenced by a number of variables including; unbundling of the sector into different segments, the presence of regulatory agency, involvement of independent power projects and the introduction of competition, however, the magnitude and significance of these variables are not always in consonants with expected outcome. Further, the study revealed that neither competition nor unbundling on their own essentially increases electricity performance or reduces electricity prices. Similarly, it was shown in the study that electricity prices are lowered when retail competition, privatization and independent power projects were introduced in some regions.

Tocorroborate his findings also, Nagayama (2009) tests whether the impact of electricity market liberalisation on prices could be different between developed and developing countries or different across regions. The study used panel data set from four regions including; countries in Asia, Eastern Europe, former Soviet Union and Latin America and Asian countries. In these four regions, 78 countries were selected for the study covering 1985 to 2003. The conclusion from the study indicated that the inordinate cost of electricity prices necessitated the adoption of electricity market reform in most of the countries examined. Surprisingly, the study found that prices are not necessarily reduced with the increase in market liberalisation, in fact, the study argued that the tendency for price increment was high in all the regions investigated.

Michael (2016) examines the extent to which international differences in electricity performance are explained by competition, regulation and privatization between 1975-2011 in OECD countries. The study made use of three measures of electricity performance, namely; labour productivity, installed capacity per capita and net per capita electricity generation. The results from the study indicated that interaction between regulation and competitions have strongly significant effect on electricity performance. The study further establishes that achieving an electricity market that is competitive requires the establishment of an effective independent regulatory agency. However, in terms of magnitude of effects, the study finds that regulation has higher impact on the performance of the electricity sector, while privatization has ambiguous effect on electricity performance. Therefore, the study opines that the combined effects of the presence of competition, privatization and regulation on electricity performance are more potent in the long run.

Zhang, Parker and Kirkpatrick (2008) investigated how regulation, competition and privatization affect the performance of the electricity industry. Panel dataset from 36 developing and emerging countries from 1985 to 2003 were used. In specifics, the study investigated how labour productivity in the electricity industry, electricity generating capacity and electricity generated are affected by these variables. The study concluded that regulation and privatization only have a limited positive impact on electricity performance, however, some positive effects where observed when the variables were interacted. Also, notably, the results revealed that performance improvement can be enhanced by the introduction of market competition.

Olga and Dmitry (2012) studied the magnitude of electricity market liberalisation, the pattern of ownership of electricity, the level of government participation and price drivers in Russia wholesale electricity sector. The essence of the study was dictated by the difficulty of implementing full liberalisation of the Russian electricity market. Findings from the study indicated that the need for enticing new private investors into the electricty sector and the introduction of competition in the electricity market, are not supported by the pattern of ownership structure that are concentrated. As such, this development necessitated the involvement of government in the sector, thereby, preventing cost-reflective tariff reform to consumers.

Muhammad and Khan (2016) examined South Africa's electricity sector liberalisation and supply dynamics. The study used semi- structured interviews and primary data to elicit responses and also employed secondary data. The findings from the study indicated that the growth recorded in South Africa electricity sector was as a result of technological-economic industrialization factors, however, Apartheid-era policies were shown to influence the electricity sector only in some specific aspect

Cubbin and Stern (2006) investigate the effect of higher quality regulatory control and regulatory law on electricity market liberalisation outcomes. The study was carried out using panel data from 28 emerging economies, spanning between 1980-2001. The finding from the study shows that higher per capita generation capacity is positively and significantly influenced by higher quality regulatory governance and regulatory law

Filippo, Antonio, and Simone (2014) examine how political influences and privatization policies affect six network industries in 30 OECD countries between 1975 to 2007. The study disentangled privatization and liberalisation and studied their simultaneous effects. The study uncovered that liberalisations and privatizations are implemented by both left wing and right wing. However, despite that liberalisation rate is lower than privatization rate in right-wing environments, the reverse is the case under left-wing governments. The study further posited that pro-market reforms are still affected by ideological cleavages, particularly the combination of liberalisation and privatization. The conclusion from the study is that different political ideologies lead to different deregulation patterns.

Nadia (2017) adopted a scenario-based model to examine Africa's electricity demand. The study investigated four scenarios such as renewable energies deployment and the issues of energy efficiency in the demand and supply side. Overall, findings from the study indicate that for the alleviation from electricity poverty in SSA, there is need to increase the rate of electrification to more than 40 times the level at which it is today. The study recommended that this feat can be achieved by aggressively increasing the adoption of renewable power options for off-grid solutions as well as scaling up the number of new grid-connected generating capacity. Further, Chang and Berdiev (2011a) studied how globalization, the ideology of government and influence of politics affect electricity market liberalisation. The study covered 23 countries in OECD from 1975 – 2007. The study found that electricity sector liberalisation is promoted by leftwing governments. Also, deregulation of electricity industries is influenced by less politically fragmented institutions. Findings from the study further suggest that the impact of elongated regimes of current government does not seriously affect the liberalisation of the electricity market. However, the study established that electricity sector liberalisation is more possible in a globalized country

Helene, et al. (2015) investigated how household electricity consumption per capita in African countries are influenced byinstitutional quality and democratic regimes. Panel data from 44 countries spanning 1996 to 2009 were used. The result from the study revealed that per capita electricity consumption of household is strongly and positively influenced by institutional quality and democracy. The results further show that some qualitative variables such as legal and political procedures significantly contribute to a noticeable variation in per household electricity consumption. A crucial policy implication emanating from the study is that electricity market liberalisation process should critically give attention to institutional quality.

Nepal and Jamasb (2012) studied the concerns and reforming preferences of Nepal's small electricity system. The study considered political instability and high rate of demand for electricity and as two main difficult challenges facing the reform of the power sector in Nepal. The result from the analysis indicated that crucial factors to be considered before a successful reform include; restructuring and independent regulation and cost-reflective tariff. In small systems like Nepal, it was discovered that the unbundling of the sector is less important than the creation of independent regulatory framework. However, as the size of the power industry increases, vertical unbundling of the various segments includng horizontal separation is implemented. This process is then followed by privatization policy in the long run. In the same vein Nepal and Jamasb (2015) investigated developing countries experience in electricity sector liberalisation from 1990 to 2015. The result of the study indicated that there exist some resemblances in the power industries of transition and developing countries, despite that there are slight differences. The study further uncovered that adequate infrastructure has constrained the development of the electricity sector despite over two decades of reforms and argued that there is need to maintain adequate investment and balance economic efficiency, social equity and sustainability. The study therefore considers electricity reform as a work in progress whose chance of success or failure depends on the institutional factors as well as the interplay of micro and macro economics

Pompei (2013) studied the severity of regulation in the electricity sector and the Total Factor Productivity of 19 countries in Europe spanning the period, 1994 to 2007. The study unbundled both the total factor productivity growth index and the OECD regulatory indicators in a bid to uncover its interlinkages. Evidence from the study revealed that vertical integration shows an inverse and significant effect only on the process of catching up, while technological change was significantly reduced only by the severity of entry regulation. Further revelation from the study is that optimal scale of production is guaranteed when the high proportion of electronic companies are owned by the public.

Eberhard, et al. (2017) studied Sub-Saharan Africa electricity market structure and the inflow of Independent Power Projects. It highlighted that independent power projects (IPP) constitutes most rapid sources of electricity investment in the region. It argued that despite the fact that the region's electricity sector is in acute need of private sector investment, most government have shown little or no concern in attracting private investment. Hence, the study suggested that independent power investment inflow would more likely be channeled to countries with good regulatory quality, strong planning, and contracting capacity. It further stressed the important roles of development financing institutions in mitigating the financial risk inherent in IPP operations. However, the study reiterated the importance building a suitable risk mitigation mechanisms and the setting up of effective regulatory capacity

Kaseke and Hosking (2013) examined electricity supplyinadequacy and reforms implications in Sub-Saharan Africa. The rationale for the study is based on the fact that despite the region's natural resource endowment, it has continued to give inadequate and irregular electricity to the citizens. Findings from the study revealed that attempt to reform the electricity sector has generated a lot of criticisms and that several of the reforms implemented in the region are yet to produce reasonable outcome. The study further uncovered that the electricity crises experience in the region is due to lack of private sector involvement in the sector. As such, the failure of the several reforms to enhance electricity performance has made majority of the people, including firms and industries to rely on private back-up generators.

Pollitt (2012) studied the historical evolution of energy liberalisation and privatization from the 1980s. The result of the study revealed that the liberalisation of the energy market has given rise to some positive improvement in the power industry but most of the liberalisation rules and programmes do not have direct and obvious impact on households' welfare improvements in many countries. The study further emphasized that energy market liberalisation has tremendously enhanced the prospects for innovation and competition, monopoly utilities regulation and potent policy framework for emission control. However, in the area of carbon emission reduction, the study opined that it is the societies's willingness to bear that cost of emission reduction rather than just energy liberalisation.

Fiorio and Florio (2011) examined 15 European Union countries in order to ascertain if electricity consumers in Europe are satisfied with the electricity prices paid after more than twenty years of reforms in the electricity industry. The study was centered on various dimensions of privatization and liberalisation. Findings from the study indicated that the reduction in public ownership ( privatization) decreases the probability of consumers' satisfaction with electricity tariff, while liberalisation has the opposite effect. In conclusion, the study further posited that both public ownership and liberalisation make consumers happier with the electricity tariff they pay.

Fiorio and Florio (2013) studied the relationship between corporate ownership and net-of-tax residential prices of electricity. It considered the scenarios when the effect of liberalisation is detached from the effect of ownership. The study employed OECD and IEA data of 30 years period. The result showed that a lower residential net-of-tax electricity price is associated with public ownership in Western Europe. However, the study found a smaller impact of liberalisation on prices. In the same vein, Erdogdu (2013) investigated the relationship between the support of government to energy R&D and the process of reform in the electricity markets. The studied covered the period spanning 1974 to 2008, using data from27 countries. Contrary to the expected outcomes, the result showed that the progress made in reforming the electricity sectors is negatively correlated with government support to R&D programmes. This finding has policy implication for the likely challenges to energy efficiency and sustainability programmes in the electricity industry.

Akkemik and Oguz (2011) investigated the relationship between electricity market competition and efficiency of liberalisation in the electricity market. The study employed counter-factual simulation and computable general equilibrium (CGE) techniques. The result of the simulation revealed that there exists reduction in household energy prices, efficiency improvement in the electricity sector as well as an improvement in the level of consumers' utility. The study further found that a fall in electricity prices, has a favourable effect on industries depending on electricity and negatively affect electricity transmission and generating sectors. In conclusion, the study concluded that full electricity sector liberalisation will improve the sector positively. Anupama et al (2016) adopted instrumental variable technique to study the consequence of electricity market liberalisation in developing countries. Specifically, 17 non-OECD developing countries in Asia were chosen for the study covering the period of 23 years. The result indicated that the outcome of electricity market liberalisation has been influenced by institutional factors, implying that for electricity reforms to be successful, countries should take cognizance of their heterogeneous environment in designing electricity reform policies because the general model of electricity reform could not be applicable to all the countries.

Erdogdu (2014a) investigated the security of supply, investment and sustainability in developing and developed countries power sectors after over 30 years of reform of the electricity sector. The panel data used, covered 55 countries spanning the period 1975 to 2010. The study specifically examined how power sector liberalisation influences electricity supply security, investment and sustainability in the electricity. Evidence from the results indicate that a fall in the investment of the private sector in the electricity sector, lower carbon emission from electricity generation and increase in electricity supply are associated with rising electricity industry reform in developing countries.

Despite the rising episodes of electricity liberalisation in the region, SSA still lag behind with respect to electricity provision. As such, Lagarto, et al. (2012) investigated the reason behind the poor performance of Sub-Saharan Africa electricity sector. Some of the factors considered in the study include: rural population, gross domestic, population density, the level of poverty and gross fixed capital. Evidence from the study showed that factors influencing electricity provision in SSA region are not the same from those of other developing countries. The result also suggested that rural population size is a major factor with regards to electricity access in SSA than non- SSA. More so, greater variation in electricity status in SSA countries is explained by the effectiveness of government than non- SSA. The study also emphasized the imperative of good leadership and political factor in driving the electricity sector in SSA.

### 2.4 Conclusion from Literature Review

Markedly from the literature reviewed, the results of the effect of electricity sector liberalisation on electricity sector outcomes in developing and developed countries remain mixed. However, market liberalisation and sector performance measures are always constraint by the challenges posed by simultaneity and endogeneity. This may not be unconnected with the fact that market reforms are affected by several factors such as economic, social, institutional, regulatory and political factors. It is also revealed in the empirical literature that the intensity of electricity market liberalisation varies across developing countries and developed countries in terms of the dynamics of the electricity market composition, the commitment of government and political will, the effectiveness of regulatory agency, and the level of participation by private investors. Moreover, many countries have carried out various institutional reforms in different magnitude, dimensions and scales (i.e full restructuring, partial restructuring, competitive restructuring, regulatory reform involving the establishment independent regulatory agencies, vertical separation of industry, commercialization of public utilities and privatisation, etc), thus, making it very difficult to quantify their separate effects on electricity sector performance.

Furthermore, most empirical investigation that studied the effect of electricity market liberalisation on electricity sector performanceconcentrated more attention to developed countries, OECD and developing countries in Middle East and Asia. As such, studies with empirical evidence on the effect of electricity market liberalisation in SSA are quite limited. This is somewhat unexpected considering the magnitude of electricity market liberalisation that has been implemented in the region over two decades ago.

**Table 2.1: Summary of some of the Empirical Literature Reviewed.**

| Authors & Year | Title/ Study Area | Methodology + Variables | Findings |
|---|---|---|---|
| Helene, et al., (2015) | Electricity provision to African households: The importance of institutional quality and democracy. | Pooled / Cross section OLS<br><br>**Variables:**<br><br>Institutional quality<br>Democracy<br>Political stability<br>Control of corruption<br>GDP per capita<br>Population density<br>Rule of law | institutional quality and democracy have significant positive effects on per capita household electricity consumption |
| Erdogdu, (2011) | The issue of efficiency in electricity industries after reforms? | Pooled OLS<br><br>**Variables:**<br><br>Reform scores<br>optimal reserve margin,<br>net generation per employee in electricity industry,<br>GDP per capita,<br>transmission and distribution losses | There is a significant impact of reform on electricity performance. Also, the use of liberal market models increases efficiency in the power industry |
| Nepaland Jamasb, (2012) | Reforming the power industries in transition: Do institutions matter? | Bias corrected dynamic fixed effect analysis<br><br>**Variables:**<br><br>Other Infrastructure Reform | There is a high level of interdependence of power sector reform with other sectors reforms in the economy. |

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|---|---|---|---|
| | | Index (OIRI),<br>Installed capacity,<br>Operational impacts,<br>Financial Sector Reform Index (FRI),<br>Per capita renewable installed capacity,<br>Overall Market Liberalisation Index (OMLI),<br>Economic Governance Reform Index (EGRI),<br>GDP per capita,<br>Per capita electricity | |
| Carvalho, (2017) | Drivers of electricity service satisfaction in transition economies | Ordinal Logit Estimation<br><br>**<u>Variables:</u>**<br><br>Partly indep. Regulator ,<br>Fully indep. Regulator<br>Power Reform Index,<br>Electricity consumption,<br>Savings, Relative income<br>, age | Electricity consumers in countries that has full independent regulation, are more likely to enjoy greater levels of satisfaction than consumers in countries that has no independent regulation |
| Michael, (2016) | Current evidence on the effect of structural reforms on power industries performance | Panel fixed effect/ Diff-GMM<br><br>**<u>Variables:</u>**<br><br>Electricity generation, capacity utilization,<br>labour efficiency, reform | To attain a competitive electricity market, strong independent regulatory framework must be established. |

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|---|---|---|---|
| | | score, privitization competition and regulation | |
| Pompei, (2013) | Heterogeneous impact of electricity regulation on the efficiency of electricity sectors in some countries in European Union | dynamic panel model/ Diff-GMM<br><br>**Variables:**<br>R&D intensity,<br>Technological change,<br>Overall regulation of electricity sector,<br>Pure efficiency change,<br>Regulation of entry,<br>Vertical integration,<br>Public ownership,<br>Scale efficiency change | Greater public structure ownership of electric companies leads to improvements in electricity production |
| Fiorio and Florio, (2011) | How fair are the electricity prices? Consumers' satisfaction and the EU15 utility reforms | Probit Estimation<br><br>**Variables:**<br>per capita GDP growth,<br>privatisation, public ownership,<br>population<br>consumer choice scores, density, consumer price index,<br>Gini inequality index,<br>average electricity price<br>industry score, | Both liberalisation and public ownership make consumers happier with the electricity prices paid |
| Akkemikand | A general equilibrium | CGE | Reductions in energy prices for households, efficiency gains in the |

| | | | |
|---|---|---|---|
| Oguz, (2011). | analysis of Turkish electricity market liberalisation. | **Variables:**<br>Capital, total output and labor payments,<br>Electricity generation, imports, exports, electricity transmission; electricity distribution, indirect and direct taxes, | electricity market, and an improvement consumers' utility level are associated with full liberalisation |
| Fiorio and Florio, (2013). | Public ownership and the prices of electricity: Evidence from over thirty years of the EU15 experience. | Panel Fixed Effect/ Diff-GMM<br><br>**Variables:**<br><br>Entry regulation, vertical integration, electricity consumption, electricity prices, public ownership, | Lower residential electricity prices are associated with public ownership in Western Europe. There is small and uncertain effect of liberalisation on prices. |
| Erdogdu, (2013) | How the policies of liberalisation have supported government drive for Research and Development: Evidence from electricity markets. | Pooled OLS<br><br>**Variables:**<br><br>Electricity market reform scores,<br>GDP per capita,<br>Log of R& D budget,<br>energy intensity of GDP,<br>Energy self-sufficiency | An increase in electricity reform, reduces government support to R&D in the energy sector. This negatively affect efficiency improvements in the electricity sector |

| | | | |
|---|---|---|---|
| Erdogdu, (2014a). | Investment, sustainability and security of supply in over 30 years of power sector reform. | Panel Fixed Effect.<br><br>**Variables:**<br><br>Private investment in the power sector, electricity market openness index, industry value added, dummy variables, electricity consumption, polity score, GDP per capita, population density | Greater reforms in the electricity market reduce private investments in developing countries electricity industries. |
| Anupama, et al., (2016) | Reforming Electricity Reforms? Evidence from Asian Economies | Two Stage Least Squares (2SLS)<br>**Variables:**<br>regulatory funding and polity index,<br>per capital installed capacity,<br>electricity law, per capita electricity consumption,<br>real residential electricity prices, electricity access,<br><br>independent regulation, license fee | Institutional factors have dictated the dimension of electricity outcomes, supporting the importance of country's heterogeneity |
| Steiner, (2001) | The relationship between Regulation and restructuring and improved utilization rate in electricity generation. | -Panel data Estimator<br>-Random and fixed effects estimation.<br>**Variables:** | Utilization rate is significant and positively associated with both unbundling of generation, and private ownership. Third-party-access is not significant and the unbundling of generation and |

| | | | |
|---|---|---|---|
| | | -ratio of industrial end-user price.<br>-utilisation rate<br>-distance of actual from<br>-time to privatisation (years)<br>-ratio of industrial to residential prices in PPPs<br>-unbundling of generation prices,<br>-private ownership (multi-level<br>indicator)<br>-third party access (dummy)<br>-urbanisation | transmission has no significant impact on prices |
| Hattori and Tsutsui, (2003) | Whether Restructuring and Regulation bring about lower industrial electricity prices and industrial/residential price ratio. | Panel data Estimator<br>-Random and fixed effects estimation.<br>**Variables:**<br>-wholesale pool (dummy)<br>-industrial end-user price<br>-private ownership (multi-level<br>indicator)<br>-third party access (dummy<br>-time to privatisation (years)<br>-GDP per capita | The presence wholesale markets have a positive impact on prices. While the impact of third party access on prices is negative |

*Source: Author's compilation from several studies, 2018*

## 2.5 Background to the Study

### 2.5. I Electricity Sector Performance in Sub-Saharan Africa

The electricity gap between SSA and other regions in the world is widening. The total electricity generation capacity of the 49 SSA countries is just 90 gigawatts (GW), without South Africa, total generation capacity is less than 40GW (APP, 2015). When compared in terms of consumption per kilowatt hour (kWh), electricity consumption in SSA without South Africa is 180 kWh per capita annually, this is the lowest level of electricity consumption world over. In South Asia it is 607kWh, rising to 1,285 kWh in East Asia and 1,931 kWh in the Caribbean and Latin America (AfDB, 2018). This situation is even more dramatic in rural areas, where SSA's average electrification rate stands at 16% against 99% in North African countries (WDI, 2018). In the same vein, in the year 2017, electricity access rate in SSA is the least in the world, specifically, not more than 45% of SSA total population have access to electricity when compared to about 96% in Pacific and East Asia, 77% in South Asia, and 96% in the Caribbean and Latin America (WDI, 2018).Access is not the only challenge Sub-Saharan Africa faces. While two-thirds of SSA's population does not have access to electricity, the remaining one-third cannot consume as it would like, due to regular blackouts (Simonea and Bazilian, 2019). This can be seen in the wide disparities in electricity consumption levels between populations with access to electricity in SSA and other parts of the world as indicated in Table 2.3 below.

The social, economic and human costs of SSA electricity crises are sufficiently recognized. The electricity sector poor performances and power inadequacies cost the region about 2-4 percent of GDP annually, excluding the damage to job creation and investments (AfDB, 2018). The shortages of electricity supply in SSA have created a booming market in generators import and use. About 40% of businesses in Ethiopia, Tanzania and Angola make use of private generators, while it is over 50% in Uganda and Kenya (APP, 2015).

In Nigeria for instance, inadequate electricity supply ranks as one of the highest infrastructure challenges bedeviling the business sectors (Iwayemi, 2008). Nigeria generates less than 4500 megawatts (MW) of electricity yearly for a population of over

180 million. In terms of generators import, Nigeria ranks first in SSA and second in Africa behind Egypt.Report from NBS (2017) indicates that Nigeria spends N17.9 billion annually on generators import and about N800 billion annually fuelling its residential and industrial generating sets. The typical Nigeria's firms experience power failures or voltage fluctuations on a daily basis without the benefit of a prio signals. This increases the cost of the firms operation arising from material spoilage, loss of outputs, damages to equipment and restart costs (Adenikinju, 2005).

Low level of electricty generation are both symptoms and causes of broader economic development challenges, given that today's shortages in electricity availability is tomorrow's differences in economic growth (Eberhard, 2013). Figures 2.1 and 2.2 below show that in 2017, SSA has the least power production in the world with 434 billion kWh. This is one-third of the electricity production in South Asia and Middle East.

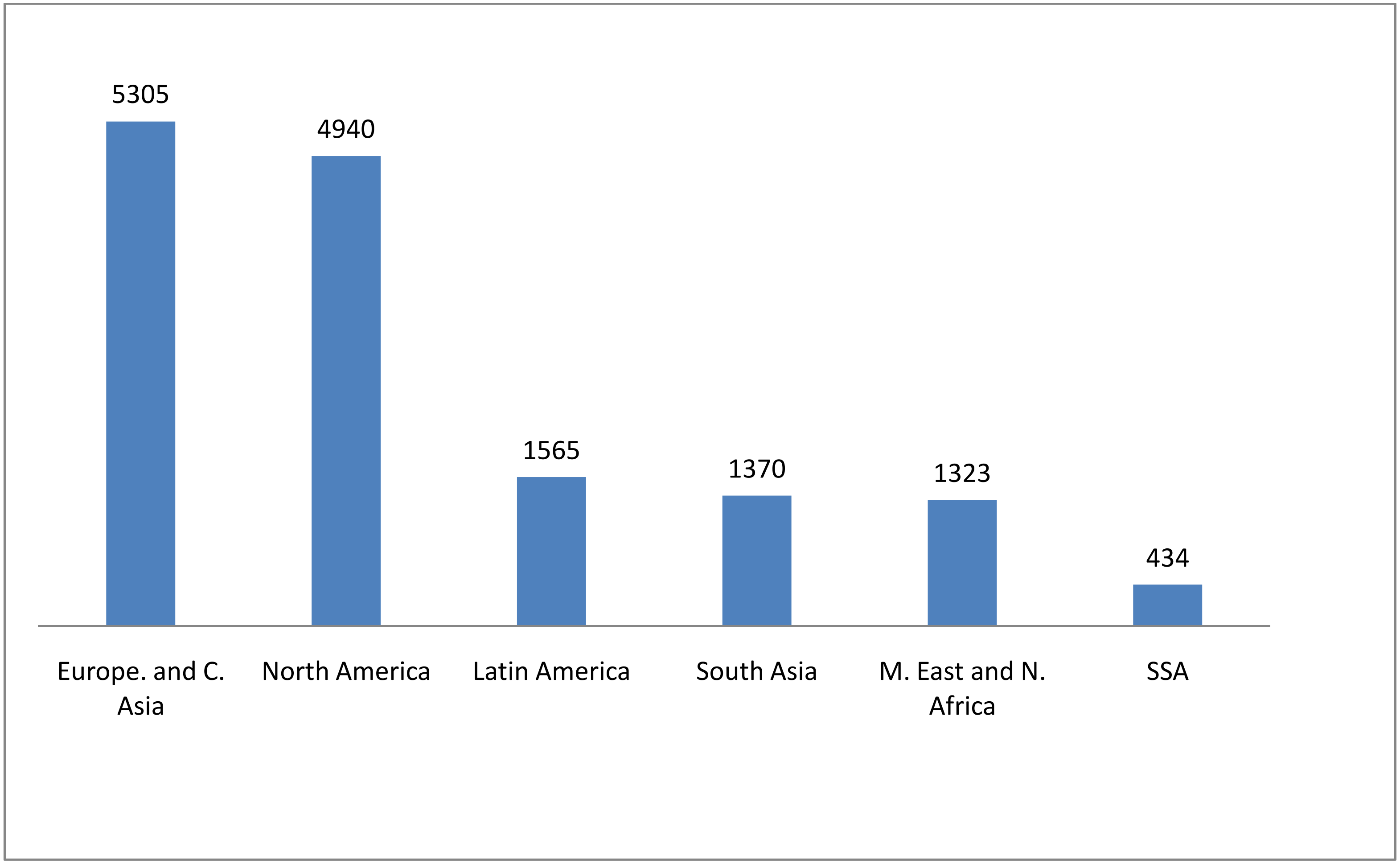


Fig 2.1 Electricity Generation Gap between SSA and the Other Regions (billion kWh),
*Source: WDI, 2018*

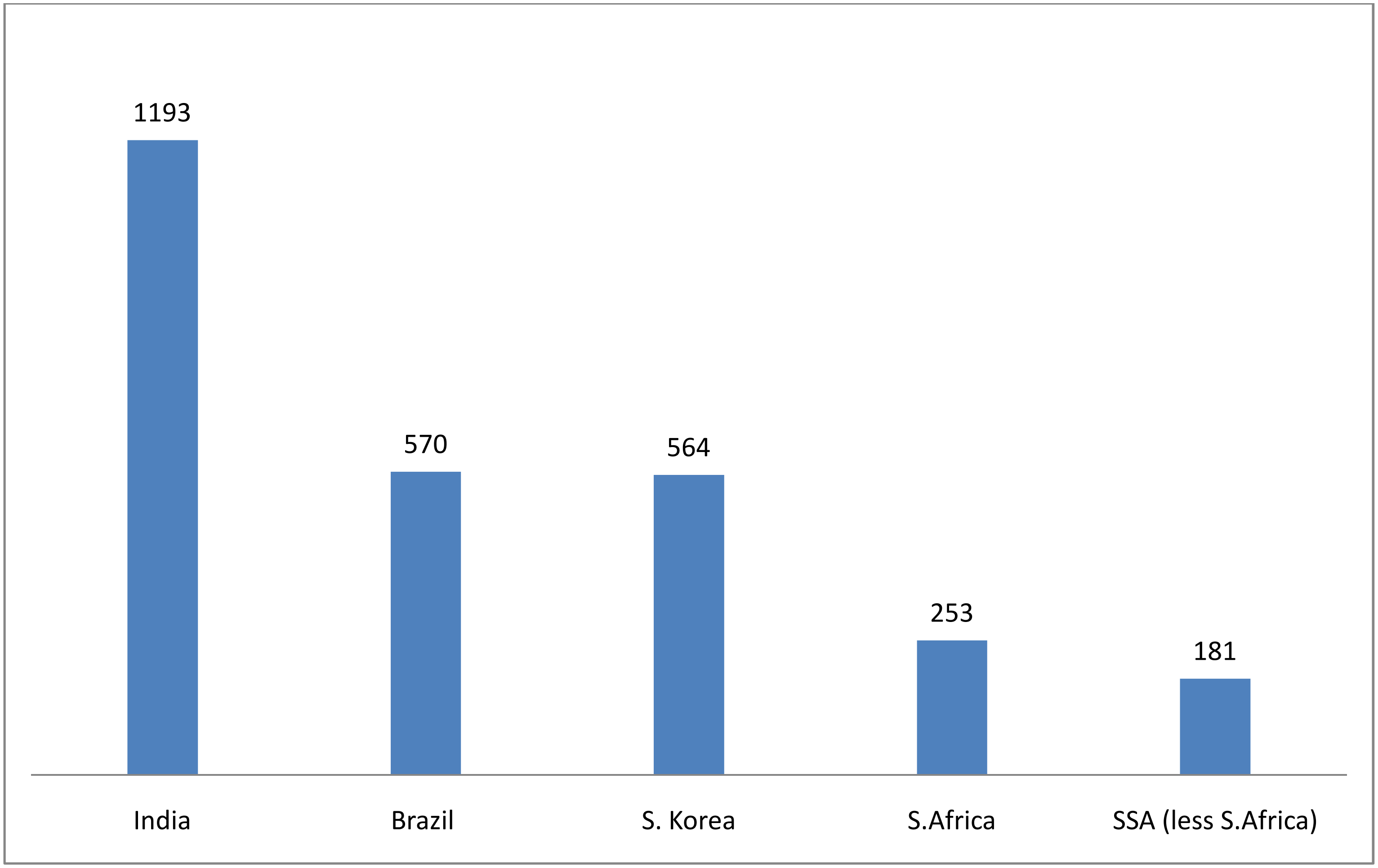


Fig 2.2: Electricity Generation in Emerging Economies (billion kWh)

*Source: (WDI, 2018)*

Inadequate power generation has been blight on SSA economic growth. Low level of electricity generation are both signals and causes of wider development challenges. Table 2.2 shows that SSA has continuously performed below other regions in terms of access to electricity and electricity consumption respectively. From 1990 to 2017, SSA is revealed to possesthe lowestelectricity access world over. Markedly in 2017, SSA electricity access rate was 44% compared to 98% in East Asia and Pacific, 89% in South Asia, 97% in North Africa and Middle East, and 98% in Latin America and Caribbean.

Similar trend is also reflected in Table 2.3 below depicting regional electricity consumption per capita. A critical look between SSA and other regions uncovered that from 1990 to 2017, SSA has the lowest electricity consumption per capita. However, an inward look in SSA electricity consumption from 1990 to 2017 indicates that it was higher in 1990 than in 2017. A probable explanation for this could be that while population in SSA is growing, electricity production has remain stagnated.

**Table 2.2: Electricity Access % of the Population for some Regions, 1990-2017**

| Regions | South Asia | The Caribbean and Latin America | Central Asia and Europe | Pacific and East Asia | North Africa and Middle East | North America | SSA |
|---|---|---|---|---|---|---|---|
| 1990 | 49 | 89 | 99 | 87 | 85 | 100 | 22 |
| 2000 | 61 | 92 | 99 | 92 | 90 | 100 | 26 |
| 2010 | 74 | 94 | 99 | 95 | 94 | 100 | 31 |
| 2015 | 77 | 96 | 100 | 96 | 96 | 100 | 35 |
| 2017 | 89 | 98 | 100 | 98 | 97 | 100 | 44 |

*Source: WDI, 2018*

**Table 2.3: Electricity Consumption by Regions (KWh Per Capita) 1990-2017**

| Regions | 1990 | 1995 | 2000 | 2010 | 2015 | 2017 |
|---|---|---|---|---|---|---|
| SSA | 535.8 | 510.9 | 510.8 | 508.9 | 488.6 | 498.49 |
| East Asia and Pacific | 1073.7 | 1367.0 | 1645.7 | 3062.7 | 3568.3 | 3315.5 |
| Europe and Central Asia | 5049.7 | 4647.7 | 4943.1 | 5526.7 | 5436.7 | 5781.7 |
| Latin America and Caribean | 1165.2 | 1335.6 | 1571.3 | 1950.4 | 2117.9 | 2304.5 |
| Middle East and North Africa | 1184.3 | 1431.6 | 1751.9 | 2680.1 | 2875.9 | 2978.6 |
| North America | 12153.7 | 13041.2 | 13997.5 | 13586.3 | 13238.9 | 13412.4 |
| South Asia | 246.3 | 325.1 | 357.1 | 575.2 | 672.63 | 693.9 |

*Source: WDI, 2018.*

In contrary to other emerging economiesand developing regions, several episodes of economic growth witnessed in SSAhas not transmitted to increased electricity supply in the region. Over the past 10 years, SSA GDP has been relatively increasing annually but per capita electricity use has been on the declining trend. For instance, in Bangladesh, income per capita is one-fifth compared to income per capita in Angola, but rural Bangladesh have access to electricity eight times more than their Angolan counterparts (McKinsey, 2015).

### 2.5.2 Electricity Performance in SSA Sub-Regional Groupings

As illustrated in Table 2.4, in West African countries, only Ghana seems to have access to electricity of little above 75% in 2017, this is followed by Senegal with electricity access rate of 61.7%, and while Nigeria is 54% . In Southern Africa, the access rate is unequally distributed, while South Africa and Botswana have access rate of 84% and 62% respectively in 2017, no other countries in the Southern region has up to 50% access rate. Further, in Eastern Africa, only Kenya has electricity access rate of 63%, the second is Sudan with only 56% access rate. While in Central Africa, Mauritius and Gabon have electricity access rate of 98% and 87% respectively in 2017. However, the summary of Table 2.4 reveals that most countries in SSA have low access to electricity. Similar trend is also reflected in Table 2.5 depicting electricity consumption (kWhPer Capita). As demonstrated in Table 2.5, on the average, electricity consumption in Southern Africa is higher than any other regions in SSA. South Africa has 4237.3 (kWh per capita) in 2017, this is followed by Mauritius and Gabon in Central Africa with electricity consumption per capita of 2190.7 and 1365.2 (kWh Per Capita) respectively.

However, no country in West and East Africa consumes up to 400 kilowatt of electricity per capita in 2017. The highest in West Africa is Ghana with only 365.6 ( kWh Per Capita), followed by Ivory Coast with 289.3 ( kWh Per Capita), while Nigeria is still struggling at 146.6 ( kWh per capita). In the same vein, Table 2.5 revealsthe losses in electricity power transmission and distribution as a percentage of total output. In Table 2.6, Mauritius seems to have the least losses in power transmission of about 5.3% of the total electricity distributed in 2017, followed by South Africa with 7.4%, while the country with the highest distribution losses is Togo with 71%.

**Table 2.4: Access to Electricity (% of population) in SSA Countries, 1990-2017**

| Countries | 1990 | 2000 | 2005 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2017 |
|---|---|---|---|---|---|---|---|---|---|---|
| **West Africa** | | | | | | | | | | |
| Ivory Coast | 36.65 | 47.63 | 54.78 | 57.96 | 59.03 | 55.83 | 61.18 | 61.92 | 62.21 | 67.51 |
| Ghana | 23.87 | 44.8 | 58.95 | 65.14 | 64.06 | 69.26 | 70.73 | 78.36 | 82.35 | 79.03 |
| Nigeria | 27.3 | 42.65 | 49.96 | 48.45 | 55.9 | 55.44 | 55.6 | 57.65 | 59.65 | 54.23 |
| Senegal | 19.54 | 36.81 | 48.39 | 53.45 | 56.53 | 56.87 | 57.32 | 61.54 | 65.54 | 61.70 |
| Togo | 11.75 | 16.97 | 31.32 | 37.14 | 39.72 | 41.08 | 43.05 | 45.74 | 49.78 | 48.61 |
| **Southern African Countries** | | | | | | | | | | |
| Botswana | 5.8 | 27.21 | 41.69 | 48.52 | 53.24 | 52.23 | 54.36 | 56.48 | 60.48 | 62.81 |
| Mozambique | 4.94 | 6.95 | 13.93 | 17.02 | 20.2 | 19.11 | 20.16 | 21.21 | 25.21 | 27.42 |
| South Africa | 56.53 | 70.55 | 82.67 | 82.92 | 84.73 | 85.36 | 85.46 | 86.98 | 90.45 | 84.46 |
| Zambia | 13.94 | 16.73 | 18.56 | 22.56 | 22.76 | 23.17 | 23.58 | 27.93 | 31.93 | 40.36 |
| Zimbabwe | 29.88 | 33.05 | 34.76 | 35.6 | 36.94 | 36.19 | 36.48 | 32.35 | 36.39 | 40.42 |
| Angola | 47.83 | 41.78 | 36.4 | 34.64 | 33.89 | 33.25 | 32.87 | 36.99 | 40.94 | 41.88 |
| **East African Countries** | | | | | | | | | | |
| Tanzania | 5.32 | 9.85 | 12.52 | 14.84 | 14.29 | 15.35 | 16.46 | 15.54 | 19.53 | 32.81 |
| Sudan | 32.87 | 34.59 | 36.54 | 37.49 | 37.81 | 38.14 | 38.47 | 44.95 | 48.94 | 56.45 |
| Kenya | 5.65 | 15.71 | 22.29 | 19.23 | 26.2 | 27.19 | 28.18 | 36.65 | 40.63 | 63.81 |
| Ethiopia | 10.22 | 12.76 | 18.59 | 21.86 | 23.87 | 24.06 | 25.17 | 27.26 | 31.27 | 44.33 |
| **Central African Countries** | | | | | | | | | | |
| D. R. Congo | 5.97 | 6.74 | 15.29 | 12.85 | 13.58 | 15.43 | 14.82 | 13.53 | 17.58 | 19.09 |
| Cameroon | 30.09 | 41.45 | 48.23 | 52.99 | 53.73 | 55.29 | 56.45 | 56.82 | 60.84 | 61.40 |
| Mauritius | 98.63 | 99.54 | 99.1 | 99.04 | 99.43 | 99.1 | 99.13 | 99.16 | 99.71 | 98.51 |
| Congo, Rep. | 17.73 | 28.61 | 35.73 | 36.77 | 37.12 | 38.88 | 39.95 | 41.6 | 42.09 | 43.09 |
| Gabon | 63.89 | 73.64 | 82.43 | 83.06 | 84.12 | 85.19 | 86.26 | 89.39 | 86.46 | 87.47 |

*Source: WDI, 2018*

**Table 2.5: Electricity Consumption (KWh Per Capita), 1990-2017**

| Countries | 1990 | 1995 | 2000 | 2005 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2017 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **West Africa** | | | | | | | | | | | |
| Ivory Coast | 157.2 | 173.8 | 173.3 | 173.7 | 219.3 | 200.9 | 239.7 | 252.3 | 280.8 | 283.8 | 289.3 |
| Ghana | 326.7 | 354.8 | 334.1 | 247.5 | 282.7 | 320.9 | 348.2 | 382.3 | 357.1 | 360.1 | 365.6 |
| Nigeria | 86.7 | 91.1 | 74.1 | 135.6 | 135.6 | 149.3 | 155.8 | 141.8 | 143.6 | 146.6 | 152.1 |
| Senegal | 103.8 | 109.1 | 101.9 | 157.6 | 198.5 | 198.8 | 209.5 | 219.2 | 221.5 | 224.5 | 230.4 |
| Togo | 90.5 | 99.4 | 96.2 | 109.1 | 124.7 | 135.3 | 144.9 | 147.5 | 155.1 | 158.1 | 163.6 |
| **Southern African Countries** | | | | | | | | | | | |
| Botswana | 717.4 | 872.3 | 1093.2 | 1413.6 | 1554.8 | 1523.1 | 1513.9 | 1563.5 | 1708.1 | 1711.1 | 1716.6 |
| Mozambique | 40.9 | 44.9 | 121.8 | 437.5 | 438.5 | 439.3 | 444.4 | 435.5 | 462.5 | 465.5 | 471.3 |
| South Africa | 4431 | 4403.6 | 4680.6 | 4696.8 | 4582.4 | 4606.5 | 4405.7 | 4325.52 | 4228.8 | 4231.8 | 4237.3 |
| Zambia | 751.9 | 698.4 | 587.9 | 681.9 | 577.3 | 617.9 | 717.3 | 731.4 | 702.6 | 705.6 | 711.1 |
| Zimbabwe | 861 | 803.8 | 853.4 | 829.5 | 551.1 | 589.1 | 561.8 | 531.7 | 542.8 | 545.8 | 551.3 |
| Angola | 56.6 | 52.6 | 81.9 | 118.5 | 227.2 | 228.5 | 219.5 | 226.8 | 347.2 | 350.2 | 355.7 |
| **East African Countries** | | | | | | | | | | | |
| Tanzania | 51.2 | 57.1 | 58.2 | 78.3 | 93.8 | 84.6 | 94.6 | 89.4 | 99.9 | 102.9 | 108.4 |
| Sudan | 49.7 | 45.1 | 62.4 | 75.8 | 131.1 | 141.6 | 156.9 | 158.6 | 159.6 | 162.6 | 168.1 |
| Kenya | 124.9 | 127.4 | 107.4 | 132.79 | 154.2 | 155.1 | 156.8 | 167.7 | 171.3 | 174.3 | 179.8 |
| Ethiopia | 22.5 | 24.2 | 22.6 | 33.4 | 48.3 | 52.7 | 57.5 | 64.6 | 70.3 | 73.1 | 78.7 |
| **Central African Countries** | | | | | | | | | | | |
| D. R. Congo | 129.5 | 107.3 | 94.6 | 87.3 | 102.4 | 105.9 | 104.7 | 110.3 | 106.9 | 109.9 | 115.4 |
| Cameroon | 194.2 | 156.2 | 170.7 | 182.3 | 258.3 | 253.7 | 260.7 | 278.6 | 274.2 | 277.5 | 282.8 |
| Mauritius | 670.5 | 945.2 | 1363.2 | 1683.6 | 1995.3 | 2025.7 | 2075.2 | 2148.3 | 2182 | 2185.5 | 2190.7 |
| Congo, Rep. | 171.8 | 96.1 | 130.7 | 141.6 | 147.3 | 155.3 | 225.8 | 224.1 | 213.3 | 232.6 | 229.9 |
| Gabon | 916.7 | 877.7 | 991.3 | 1011.7 | 1008.4 | 1032.7 | 1072.2 | 1188.8 | 1303.5 | 1412.5 | 1365.2 |

*Source: WDI, 2018.*

**Table 2.6: Electric Power Transmission and Distribution Losses (% of output), 1990-2017**

| Countries | 1990 | 1995 | 2000 | 2005 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2017 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **West Africa** | | | | | | | | | | | |
| Ivory Coast | 18.43 | 16.61 | 14.53 | 19.90 | 20.18 | 22.38 | 19.46 | 19.46 | 14.33 | 12.52 | 13.425 |
| Ghana | 3.14 | 3.33 | 19.47 | 24.57 | 23.22 | 23.11 | 21.53 | 21.54 | 22.58 | 20.78 | 21.68 |
| Nigeria | 38.41 | 37.71 | 38.14 | 23.70 | 17.21 | 9.54 | 8.66 | 15.34 | 16.10 | 14.30 | 15.20 |
| Senegal | 17.46 | 16.07 | 37.34 | 17.36 | 16.38 | 15.7 | 16.28 | 15.9 | 12.81 | 11.01 | 11.91 |
| Togo | 20.88 | 10.35 | 47.42 | 45.7 | 49.16 | 71.94 | 82.88 | 87.38 | 72.53 | 70.73 | 71.63 |
| **Southern African Countries** | | | | | | | | | | | |
| Botswana | 16.96 | 18.33 | 41.42 | 46.91 | 36.95 | 74 | 62.98 | 55.9 | 17.82 | 10.79 | 14.305 |
| Mozambique | 15.85 | 47.79 | 10.09 | 12.26 | 14.74 | 14.59 | 14.78 | 17.77 | 14.72 | 12.95 | 13.835 |
| South Africa | 6.03 | 6.22 | 8.2 | 8.49 | 9.53 | 8.47 | 8.71 | 8.48 | 8.39 | 6.59 | 7.49 |
| Zambia | 3.23 | 2.82 | 3.18 | 5.37 | 17.8 | 23.83 | 7.77 | 8.67 | 14.95 | 13.15 | 14.05 |
| Zimbabwe | 7.11 | 9.44 | 20.32 | 16.85 | 19.31 | 14.95 | 16.31 | 28.12 | 16.44 | 14.64 | 15.54 |
| Angola | 25.08 | 28.43 | 14.6 | 23.76 | 11.5 | 11.27 | 11.27 | 11.27 | 11.26 | 9.46 | 10.36 |
| **East African Countries** | | | | | | | | | | | |
| Tanzania | 19.95 | 12.78 | 22.12 | 15.34 | 19.84 | 22.75 | 18.75 | 20.45 | 17.64 | 15.85 | 16.745 |
| Sudan | 15.37 | 26.98 | 15.53 | 20.49 | 19.3 | 20.54 | 19.01 | 22.9 | 14.28 | 12.48 | 13.38 |
| Kenya | 15.02 | 18.33 | 21.64 | 18.98 | 15.95 | 17.13 | 18.45 | 17.98 | 17.55 | 15.75 | 16.65 |
| Ethiopia | 9.98 | 10.01 | 9.97 | 10.01 | 15.43 | 19.99 | 22.87 | 18.98 | 18.46 | 16.64 | 17.55 |
| **Central African Countries** | | | | | | | | | | | |
| D. R. Congo | 19.75 | 3.34 | 2.95 | 11.21 | 4.68 | 6.81 | 7.45 | 7.45 | 21.45 | 19.65 | 20.55 |
| Cameroon | 13.05 | 21.83 | 21.86 | 17.43 | 9.83 | 9.82 | 9.81 | 9.82 | 9.82 | 8.54 | 9.18 |
| Mauritius | 8.97 | 9.34 | 8.99 | 8.97 | 7.23 | 7.10 | 6.82 | 6.37 | 6.20 | 4.40 | 5.30 |
| Congo, Rep. | 19.67 | 87.5 | 78.93 | 76.78 | 70.31 | 59.43 | 51.89 | 44.54 | 44.52 | 44.54 | 44.53 |
| Gabon | 10.73 | 17.79 | 17.64 | 18.16 | 19.4 | 19.51 | 19.87 | 19.57 | 21.46 | 23.44 | 22.45 |

*Source: WDI, 2018*

### 2.5.3 Current Market Structure in Sub-Saharan Africa

One major features of the electricity sector liberalisation in SSA, is that not many of the countries have fully privatized the distribution and generation segment of the electricity industry, This implies that the generation and distribution segments of the electricity industry in these SSA countries operate in the form of hybrid market that is jointly owned by the private and the public sector. As such, the electricity marketis operated in the form of partial private and public ownership through management contracts, concessions and equity. Notably, of the 49 Sub-Saharan Africa countries, very few operate with no private sector participation. These are countries with small power generation systems of about 280 MW (EIA, 2015). All the other countries selected for the study in SSA have implemented one type of electricity liberalisation or the others. However, the most common of these reforms have been the implementation of independent power projects. Markedly, 29 countries in the region have implemented independent power projects, 12 of these countries with independent power projects, however, still have vertically integrated electricity sectors. Also, about 7 of these countries withindependent power projectshave unbundled their vertically integrated electricity sector into distribution,generation and transmission segments, that are controlled by different companies with varying levels of privatization and corporatization.

Most of the independent power projectsare in countries whose power sectors are vertically integrated, such as Angola, Gambia, Cameroon, Cape Verde, Madagascar, Togo, Rwanda, Senegal, Swaziland, Sierra Leoneand Mauritius. However, about nine countries, namely; Uganda, Kenya, Nigeria Zambia, Mozambique,South Africa, Namibia, Ghana and Zimbabwe, combine both unbundling of electricity generation and independent power producers. Sudan has also unbundled electricity generation, but does not have independent power producers. Other countries, namely, South Africa, Namibia,Sudan, Ghana, Uganda, Ethiopia and Nigeria, have separate generating and distributing companies. (Eberhard and Gratwick, 2015).Also, one of the widely implemented electricity reforms in the region is the establishment of independent regulatory agencies. Currently over 27 countries in the region have established such agencies (APP, 2015). Figure 2.3 illustrate the pattern of the electricity market in SSA.

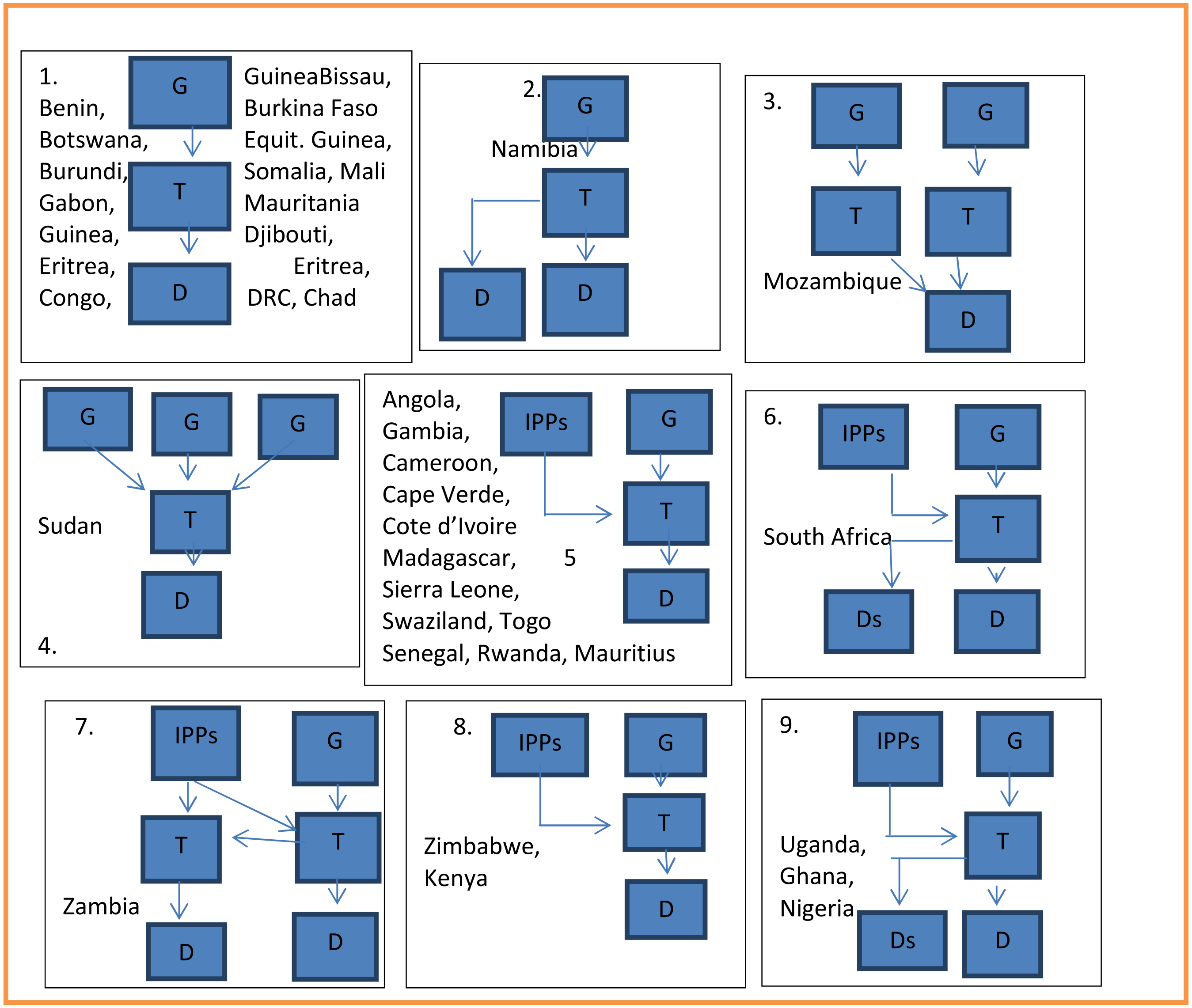


Figure 2.3 : Current Electricity Market Liberalisation Structures in Sub-Saharan Africa

*Note: IPPs= Independent power projects; T= Transmission; G= Generation;D= Distribution; Ds= Private Distribution

*Source: Adapted from Eberhard and Gratwick (2015)*

### 2.5.4 Electricity Sector Liberalisation in Sub-Saharan Africa

For the past two decades, SSA countries have witnessed a revolution of electricity market reforms. These reforms have moved the old structure of public monopoly to a hybrid electricity market, where the privateand the public sector jointly run the electricity sector. However, the electricity sectors in these countries are yet to attain a complete reform model where there is a complete privatization and unbundlingof the distribution, generation and transmission segments of the electricity sector. In most of the SSA countries including Nigeria, the transmission segments are still under the control of government.

The most common reform elements in SSA have been theestablishment of independent regulatory agencies, allowing independent power projects and vertical separation of utilities. Markedly, in 2017, over 75% of the countries in Sub-Saharan Africa have implementedmost of these reforms. However, despite these reforms, the power sectorsin the region are still operating below capacity, as consumers are yet to benefit from the gains of competitive electricity sector. Markedly, Kenya, Cote d'Ivoire, Uganda and Nigeria have carried out more reforms and have attracted more private investment in their electricity sectors than some other countries in SSA. Specifically, with the decoupling of the electricity industry in Uganda, Independent power producers (IPPs) operate side by side with the state generation and the private distribution companies which are under concession arebecoming more efficient in reducing electricity distribution losses. In the same vein, Nigeria has unbundled its power sector alongside the establishment of independent regulatory agency.

Notably, the distribution and generating companies are separated from the transmission company. Also, while the distribution companies as well as most of the electricity generating companies are privatized, the transmission company is still under the control of government. Mauritius and Ghana electricity sectors have also experienced a relatively successful liberalisation of their electric sectors due to the effective market structure. The electricity utilities in these countries have been unbundled alongside the establishment of independent regulatory agencies. On the other hand, Tanzania, Burkina Faso, Mali, Gabon and Guinea have a low patronage of private investments as the electricity sectors in these countries remain predominantly state controlled and integrated with financial and technical challenges despite the presence of independent regulators that seek to encourage more transparent and competitive electricity sector.

### 2.5.5 Electricity Regulatory Index for SSA

The electricity sectors in Sub-Saharan Africa have experienced a significant change following the wave of electricity market liberalisation.The Electricity Regulatory Index serves as the basis for carrying out periodic assessments of the sector's regulatory environment in line with international best practice. The Electricity Regulatory Index (ERI) is made up of three sub indicators namely, Regulatory Governance Index (RGI), Regulatory Substance Index (RSI), and Regulatory Outcome Index (ROI). The ERI measures the extent to which the development of electricity regulatory framework in Africa countries conforms to global best practices. First, the Regulatory Governance Index (RGI) assesses the development level of a country's electricity regulatory structure and the scope at which the laws, procedures, standards, and policies governing the electricity sector, provide for a transparent, predictable, and credible regulator up to par with international best practices. The RGI is based upon the following eight sub indicators namely:clarity of objectives and roles, Legal mandate, accountability, participation, predictability, independence, transparency and open information access.

Second, the Regulatory Substance Index (RSI) evaluates the extent to which electricity sector regulators are carrying out their mandate and operationalizing the regulatory practices and processes which affect regulatory outcomes. RGI and RSI constitute the two main pillars of ERI. The RSI is based upon the following four sub indicators namely: quality of electricity supply to consumers, framework for licensing, technical and economic regulation. Third, the Regulatory Outcome Index (ROI) measures the extent to which the power industry regulator influences the sector negatively or positively. The ROI adjusts the combined average of the RGI and RSI, correcting for discrepancies between the development level and performance of a country's electricity sector regulatory environment, vis-a-vis the real impact that the regulator has on the power utility and ultimately on the sector. The ROI considered the following four indicators namely:

Financial strengths, reliability and quality of electricity supplied to consumers, electricity access and electricity prices.

As illustrated in Table 2.7, Uganda and Namibia top the lead in ERI scores with an average of 0.8 points. This is followed by Tanzania and Nigeria, while many of the sampled countries scored above 0.5 points. Three of the high performers, namely Uganda, Namibia and Tanzania, had their RGI scores adjusted upwards owing to the impact of the ROI. This resulted in Tanzania overtaking Nigeria in the final ERI rankings. In the same vein, the top five performers of the ROI include: Ghana, Uganda, Namibia, Malawi and Tanzania. This result connotes that regulator's actions have more positive impact onthese five countries as viewed from the utilities' perspective than in Cameroon, Nigeria, Kenya, and even South Africa.

**Table 2.7: Ranking of Countries by the Results of Electricity Regulatory Index (ERI), 2018**

| Countries | ROI | RGI | RSI | ERI | Rankings |
|---|---|---|---|---|---|
| Uganda | 0.8750 | 0.7974 | 0.7661 | 0.8271 | 1 |
| Namibia | 0.8563 | 0.7634 | 0.7865 | 0.8146 | 2 |
| Tanzania | 0.7573 | 0.7606 | 0.7232 | 0.7496 | 3 |
| Nigeria | 0.7188 | 0.7476 | 0.7719 | 0.7390 | 4 |
| Kenya | 0.7031 | 0.8266 | 0.6448 | 0.7192 | 5 |
| Ghana | 0.8979 | 0.7216 | 0.4889 | 0.7156 | 6 |
| Malawi | 0.7938 | 0.7443 | 0.4803 | 0.6971 | 7 |
| Cameroon | 0.6854 | 0.7175 | 0.4979 | 0.6454 | 8 |
| South Africa | 0.5958 | 0.7780 | 0.5875 | 0.6378 | 9 |
| Togo | 0.7500 | 0.5686 | 0.3531 | 0.5879 | 10 |
| Senegal | 0.4375 | 0.7216 | 0.7345 | 0.5644 | 11 |
| Cote d'Ivoire | 0.6281 | 0.5908 | 0.3834 | 0.5531 | 12 |
| Lesotho | 0.3938 | 0.6821 | 0.4940 | 0.4812 | 13 |
| Zimbabwe | 0.4542 | 0.6120 | 0.3834 | 0.4763 | 14 |
| Gambia | 0.4479 | 0.6389 | 0.0784 | 0.4008 | 15 |

*Source: Electricity Regulatory Index, AfDB 2018.*

*Note:* ROI-Regulatory Outcome Index; RGI-Regulatory Governance Index; RSI-Regulatory Substance Index; ERI-Electricity Regulatory Index

Figure 2.4 presents the Electricity Regulatory Index for Selected Countries in SSA. Overall, the figure revealed that on the average most of the countries sampled scored above Electricity Regulatory Index (ERI) of 0.5. This highlights that a well- developed electricity regulatory system exist these countries. The reason for this is because these countries have implemented regulatory and legal framework for the electricity sector regulation. Moreover, the effectiveness of these regulatory agencies to execute their core mandates makes a distinction between the high performer and the others. Notably, Namibia and Uganda achieved the greates ERI scores because the effectiveness of their regulatory actions had positive influence on the electricity sector performance. Unlike low performers such as Gambia Zimbabwe and Lesotho that haveweakregulatory impact on the electricity sector performance.

It is imperative to note thatthe main aim of the ERI is to measureregulatory development at the national level.As such, the Electricity Regulatory Index scores forsome countries with powersector issues and lowelectricity access such as Malawi and Nigeriamay be slightly greater than countries that their electricity sectors are relatively more developed, such as South Africa and Kenya. This can be partly explained by the existence of a myriad of other factors other than the level of regulatory development that may influence investment and access, such as government policy decisions, political stability, and environmental security, in addition to macro-economic factors like foreign exchange risks, interest rate risks and capital market risks.

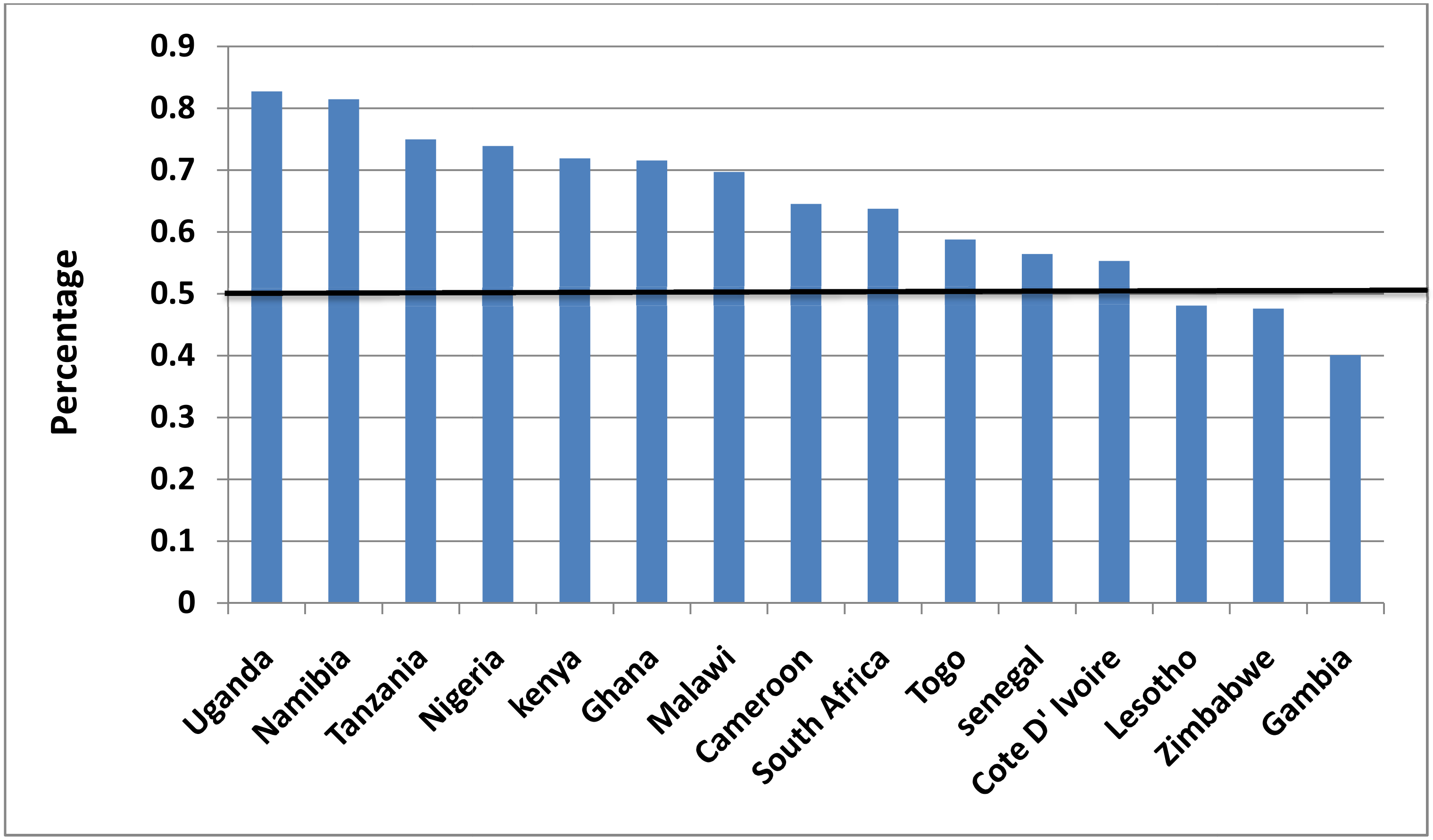


Figure 2.4: The Electricity Regulatory Index (ERI) for Selected Countries in SSA (2018)
*Source: Electricity Regulatory Index, AfDB 2018.*

### 2.5.6 Electricity Reform Status insome SSA Countries.

Over the last decades, most SSA electricity sectors were dominated by state-owned and integrated power companies with few or no private sector participations. The Volta River Authority was dominant utility company in Ghana. In Namibia, Nampower (previously Swawek) was the main electricity company.In Mali, Energie du Mali Société Anonyme (EDMSA) controlled the electricity sector.In Tanzania, it was Electric Supply Company (TANESCO). Also, in Eskom dominated the electricity sector (previously Escom) in South Africa, and the National Electricity Power Authority (NEPA) was in charge of the power industry in Nigeria.

Following the increase in reform of the electricity sector in SSA and the experience of reforms in developed countries in the beginning of 1980s and 1990s, some SSA countries started to explore new models of electricity market by unpacking the traditional monopolies model of the industries. In line with this development, the first country in SSA to implement electricity market reform in 1990 was Cote d'Ivoire. This is followed by South Africa in 1994, Ghana in 1997, Kenya in 1998, Uganda in 1999, Gambia, Mauritania, Rwanda, Tanzania and Malawi in 2001 respectively, Zimbabwe in 2002. The following section presents the electricity reform structures in some SSA countries.

#### 2.5.6.1 Ghana Electricity Market Structure

In Ghana, the Volta River Authority (VRA) was the state utility given the taskof electricity transmission, distribution and generation prior to 1994. The establishment of theelectricity sectorreform committeein 1994 marked the beginning of electricity market liberalisation in Ghana. The need for reform was stressed in 1997 and 1998, when inadequate power supply began to be witnessed. The main reasonfor carrying out these reforms was to increase the competitivenessof the electricity market and also to lure private sectors into the ownership and operation of the electricity sector. Following this development, the Ghana Public Utilities and Regulatory Commission Act 1997, established the Public Utilities Regulatory Commission (PURC). In this wise, the PURC and the Energy Commission were set up to manage the electricity supply industry. The duty of the Energy Commission is to advice the energy ministry and it also has the function for technical regulation.

In the year 2008, the unbundling process was completed and this necessitated the establishing the ECG(Electricity Company Ghana) with the responsibility for wholesale buying of electricity from the Volta River Authority and to distribute power in the southern regions. The ECG is a private company that is solely government owned.

However, after amending the Act of the Volta River Development in 2005, the generation and distribution side was open to competition. This initiative has led to the entrants of a number of IPPs. Following this development, the main function of the VRA was limited to the generation of electricity, while the Grid Company of Ghana (GridCo) took over the function of electricity transmission from the Volta River Authority. The (GridCo)is thus saddled with the duty of operating the Ghana NITS-National Interconnected Transmission Systemand also responsible for bulk purchasing electricity from generating companies and sale to ECG and as well as to NED (Northern Electricity Department). The new system creates a national distribution utility, whereby generating companies that wantconnection to national transmission network must sign a contract with GridCo.

One of the majordrivers for the decoupling of the electricity sector in Ghana in the year 2008, was to bring conducive atmosphere for private sector participation. Though, while independent power projects (IPP) operate in the electricity sector, the VRA maintains the monopoly of power generation in the country.

With this new system, three companies are given the responsibility to manage Ghana electricity sector, viz; the NED and the ECG are responsible for electricity distribution; GridCo is in charge of the transmission of electricity and the VRA controlsthe electricity generation and also operates all Ghana power plants. This reform has giving rise to the influx of numerous private sector participations into the power sector and as at the year 2013, more IPPS have been given provisional licenses to carry out electricity distribution and generation. Figure 2.5 shows the power sector structure in Ghana.

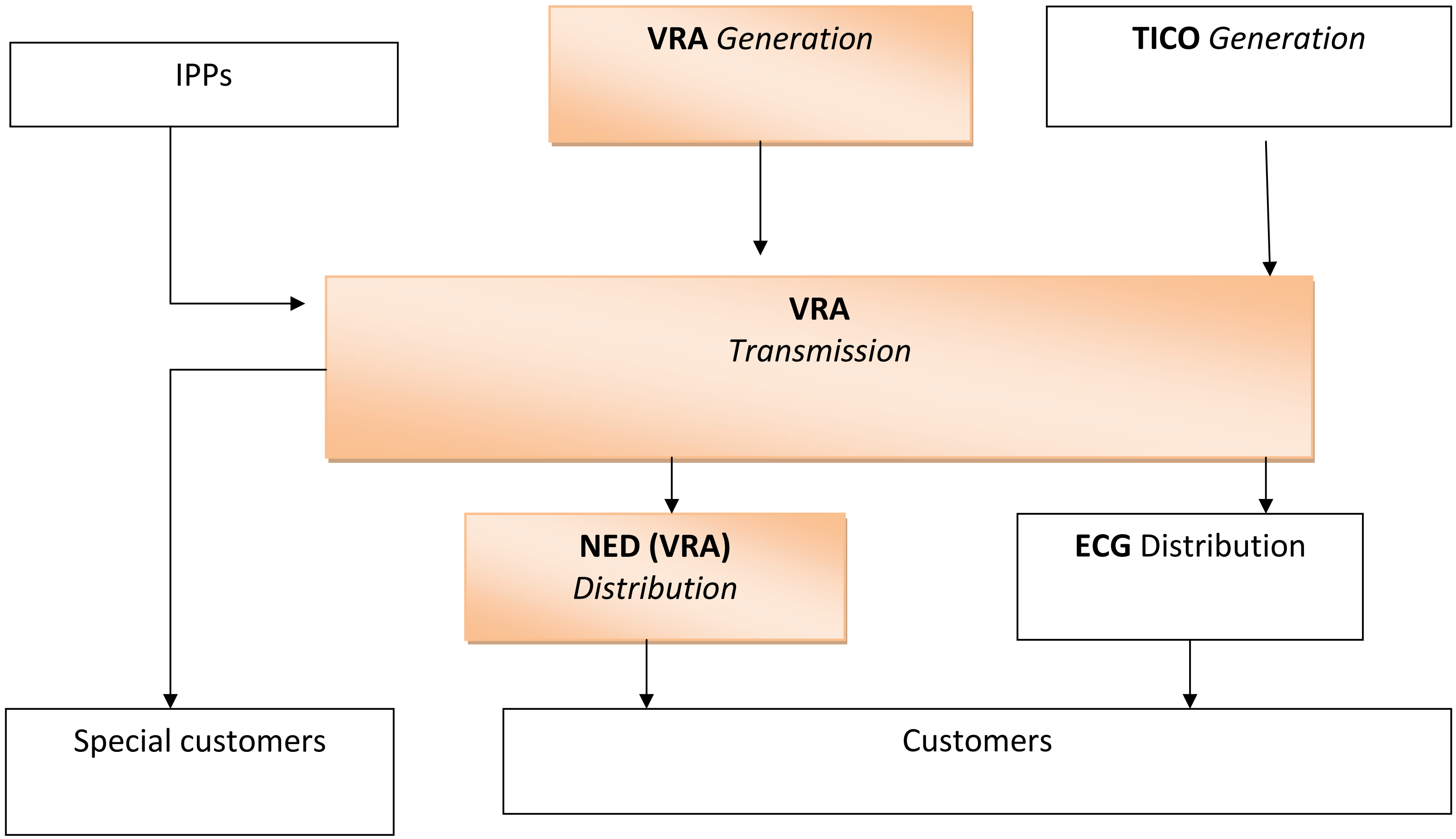


Figure 2.5: The Structure of Ghana's Electricity Sector

*Source: Ministry of Energy, Ghana, 2018*

#### 2.5.6.2 Mali Electricity Structure

In Mali, the Énergie du Mali (EDM-SA) dominated the power sector prior to 1998. EDM-SA is a government owned company that is almost entirely saddled with the function todistribute, transmitand generate electricty. However, in the 1998 and 1999, there was a major power crisis in Mali which necessitated the need for a reform. Before this period, the government made an attempt to liberalize the power sector in 1994 but the move was unsuccessful because of the huge debt of EDM-SA. Consequently, the shares of EDM-SA was made available in 2000, with this development, 60 percent of the shares was sold to SAUR/Industrial Promotion Service–West Africa, while the government of Mali retain 40% of the shares. The SAUR/Industrial Promotion Service agreed to a 20year concession of providing electricity in the entire country. The agreement also required SAUR/Industrial Promotion Service to extend electricity access up to 97% to urban centers across the country by 2020 (APP, 2015).

The main competition in Mali power sector is: the Independent auto-producers; the Mali EDM-SA; AMADER supervised local power distributors and the decentralized private energy services companies. There is also the captive power generation in two regions of Mali that generates about132 MW, this is about 40% of the grid electricity supply by EDM-SA. The AMADER which is the rural energy national agency regulates the activities of service providers in the off-grid, with a generation capacity of 250 kW and below, whilethe electricity and water sector is regulated by the CREE (Electricity and Water Regulatory Commission). The CREE is an independent organization that is distinct from government control with financial independence and operational powers and, however,the Prime Minister supervises CREE. Besides, the CREE makes sure that good tariff policies are designed. More so, it is responsible for the development of policies regarding consumer protection, quality control and the setting and approval of tariff.

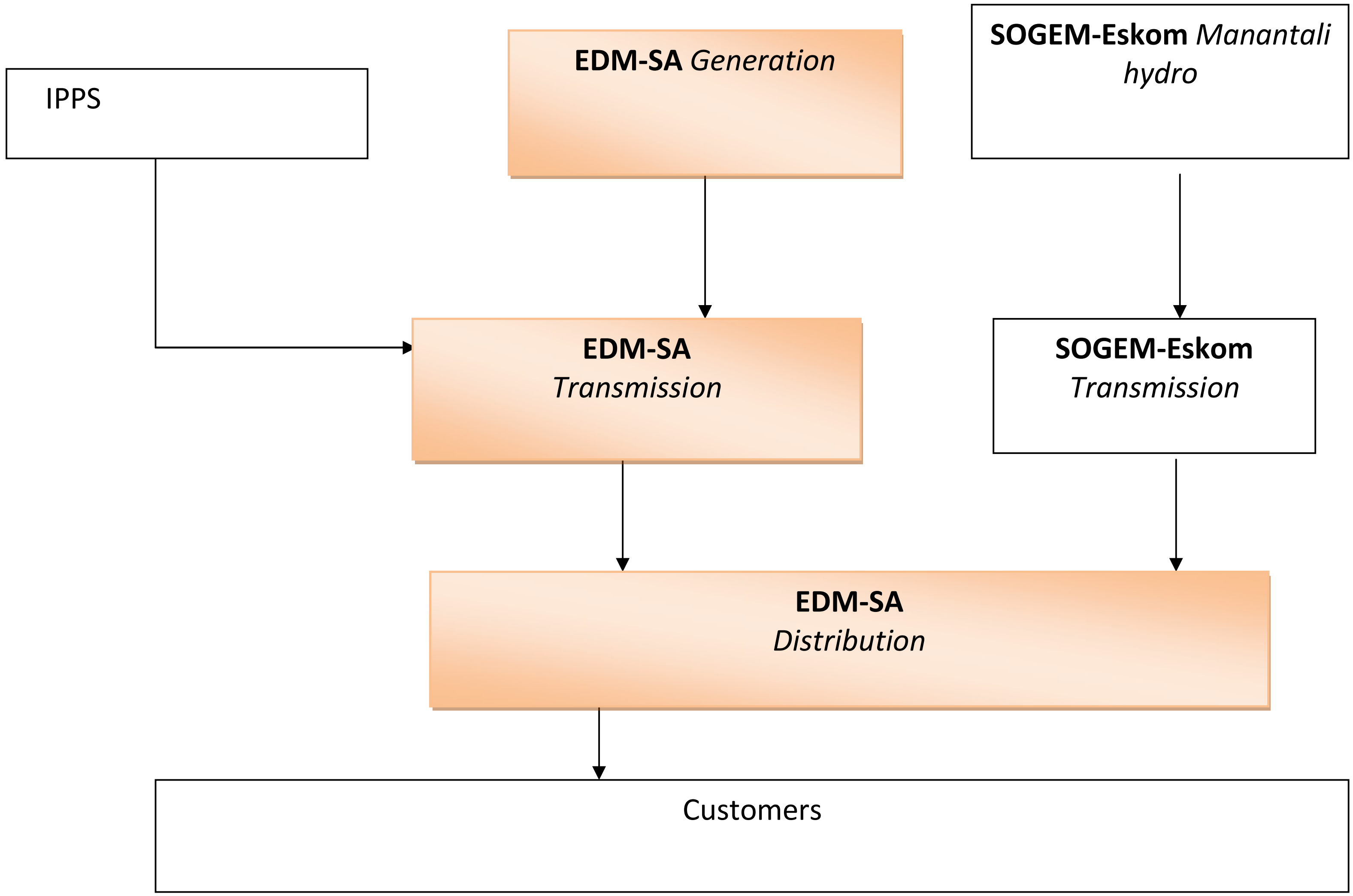


Figure 2.6: Structure of the Electricity Sector in Mali

*Source: Ministry of Energy and Water resources, Mali, 2018*

#### 2.5.6.3 The Electricity Sector in Namibia

The Namibia power industry has undergone series of reforms beginning from 1997, with the aim to attract the influx of private investments into the sector. The state owned Nampower generates, transmit and manages the power sector, while the state owned regional electricity distributors have the responsibility of electricity distribution and supply in the regions and local areas. In Namibia, the state-owned NamPower plays a dominant role in the electricity sector. The NamPower owns and manage the country's whole transmission,generation facilities and part of the distribution segments in the metropolitan and municipal areas of southern Namibia. The City of Windhoek (Namibia biggest electricity distributor) is tasked with the duty of distributing the bulk of the electricity generated. The other small portion is operated by the regional electricity distribution (RED) companies and the Erongo regional electricity distribution companies (RED). The operation of RED in the Northern part also covers the surrounding environment spreading to Caprivi Strip. The central coast and part of the western region including Walvis Bay and Swakopmund is managed by Erongo RED.

The trading of electricity and the transmission network are managed and controlled by Nampower which is the main and single electricity buyer in the country. Electricity is generated and distributed to the grid by the IPPs through a contractual agreement in the form of PPA (power purchase agreement). In this system, the Nampower operates as a monopoly because it controls the transmission, generation and trading sectors of the country. More so, all the existing power plants feed the grid directly and it is not unbundled.

In 2000, the Electricity Control Board (ECB) was established by the Statutory Regulatory Authority.As stipulated in the new electricity act, the core responsibility of the ECB is to regulate and supervise the activities in the electricity sector. The board also has the function of setting tariffs and the issuance of licenses. However, inspite of this reform and the electricity Act of 2007 that created the independent regulator, private sectors involvement in the electricity sector are still below expectations.

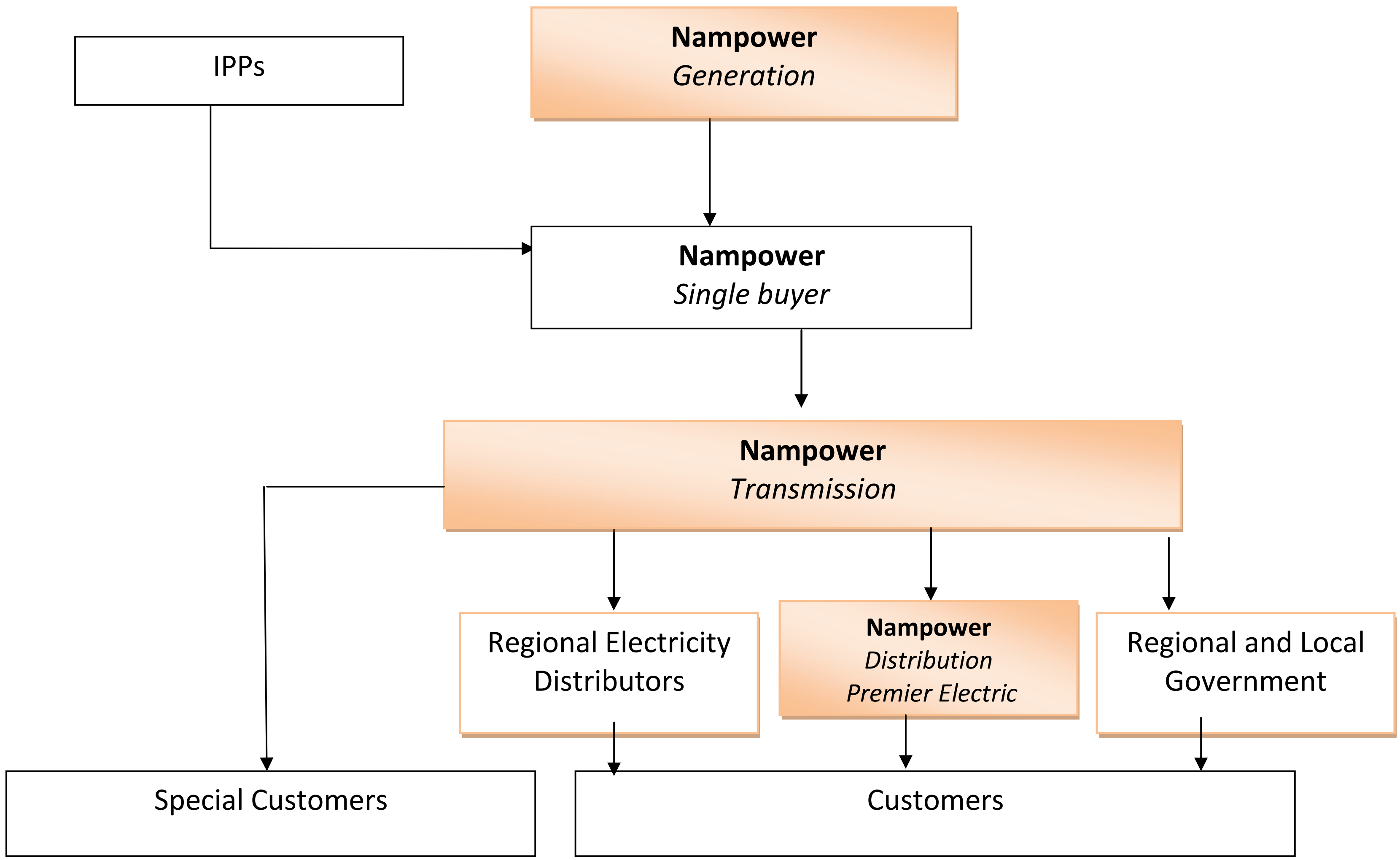


Figure 2.7: The Structure of Namibia's Electricity Sector

*Source: Namibia Electricity Control Board (ECB), 2017*

#### 2.5.6.4 South Africa Electricity Sector

The total electricity generated in South Africa's is greater than half of the entire Sub-Saharan Africa 80 gigawatts (GW) of installed generating capacity. Eskom which is the government-owned and vertically integrated utility manages the electricity supply industry. South Africa electricity sector has not been fully decoupled. ESKOM's still has the monopoly of the sector with about 95% control of the electricity market (World Bank, 2016). With a capacity of around 42 GW, it also manages the national transmission network and distributes roughly 50% of the power produced to the consumers.

The other 50% is disseminated across 179 regions. Private sector generates around 3% of national electricity generation, and districts contribute an extra 1 percent (World Bank, 2016). The electricity planning and procurement framework in South Africa was well-organized and centralized until 2006 when Eskom accepted sole mandate for electricity management and the procurement of new electricity generation equipment. TheDepartment of Energy(DoE) supervises the electricity industry, while the Public Enterprises Department (DPE) supervises Eskom. The task of regulating the activities of the electricity industry by endorsing taxes and authorizing power generators, transmitters and distributors and also granting licenses to private operators was handled by the NERSA (National Energy Regulator, South Africa)

Though,the exclusive right to generate electricity in South Africa does not belong to ESKOM, but it has an unlimited monopoly in controlling the majority of the electricity generated in South Africa. ESKOM also has the responsibility of managing the national electricity grid. However, ESKOM became a public limited liability company entirely owned by the government in South Africa. In 2003, government attempted to raise the number of private investments in the power sector by sharing some segment of electricity generation IPPs and ESKOM.Also, in 2003, the reform established the Regional Electricity Distributors (REDs). As of now, ESKOM still produces around 95% of the power expended in South Africa.

In 2010, after various issues relating with accumulations of debts and poor performance, by the REDs,Cabinet decided to restructure and to end the contract of the REDs. Though, the REDs have been very instrumental to the smooth operation of South Africa electricity sector, specifically, the RED involves in the bulk buying of electricity from ESKOM and retailing to the final consumers at a regulated tariff approved by the NERSA. Notably, South Africa's electricity sector experience shows that huge investment in the capacity to generate electricitycould be achieved with little reform in the power industry. However, despite the inflow and operation of IPPs and the establishing of independent electricity regulator, Eskom has occupied a principal position in the electricity market.

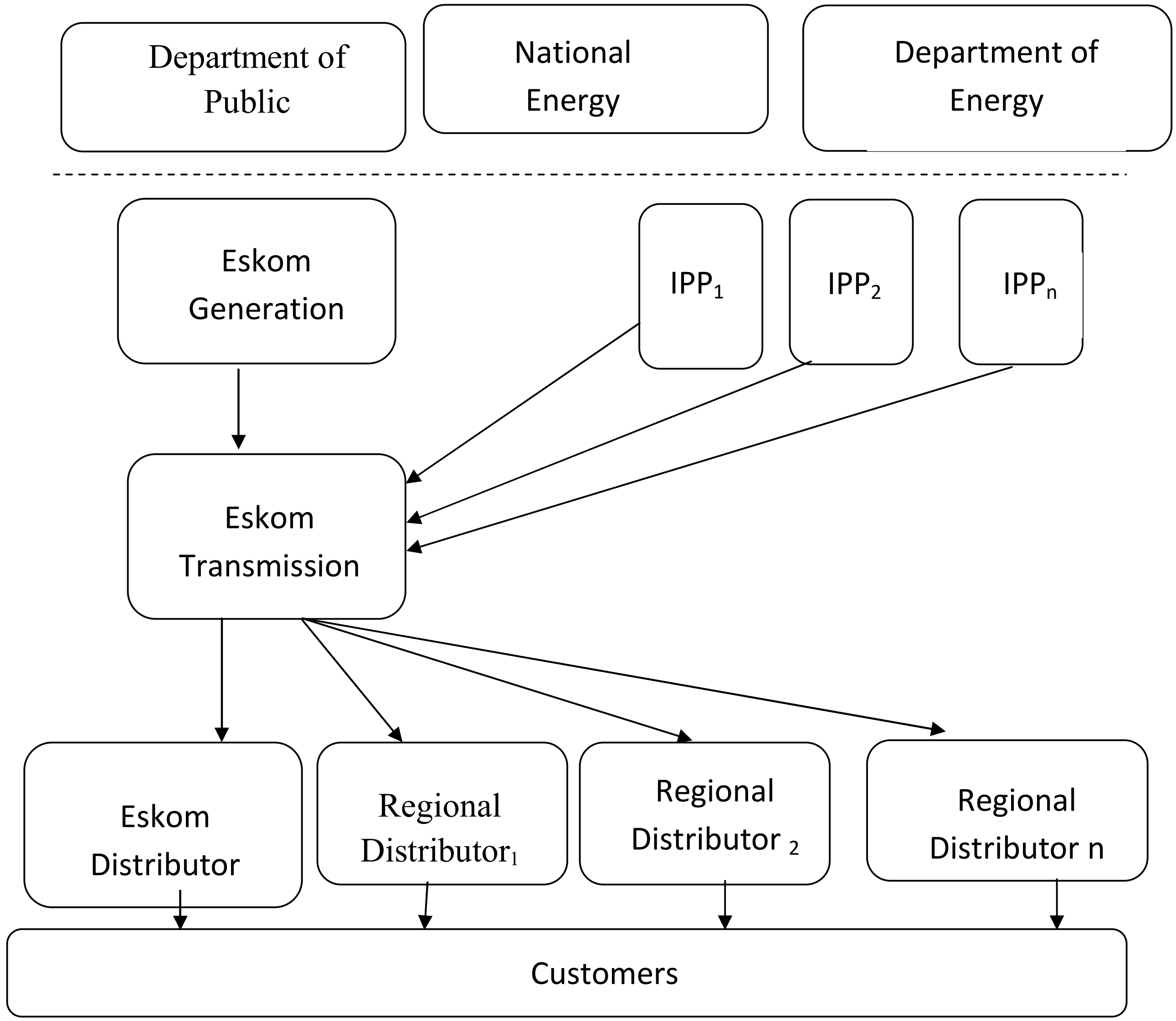


Figure 2.8: Structure of the Electricity Sector in South Africa

Source: National Energy *Regulator* of *South Africa*, 201

### 2.5.6.5 The Reform of the Electricity Sector in Nigeria

Before the reform of the Nigeria's electricity sector, the state owned electricity company namely, the National Electric Power Authority (NEPA) established in 1972, operated as monopoly and a vertically integrated utility with the control of 94% of the electricity generated and 100% of the transmission network as well as about 100% of distribution and retailing to the consumers. However, the poor performance of electricity and mismanagement of the sector over several decades brought the need for a reform. Since the late 1990s, Nigeria has evolved several episodes of electricity sector reforms but in 2005, the main reform started by establishing the Electric Power Sector Reform Act (EPSRA) and the NERC (Nigerian Electricity Regulatory Commission asa regulatory agency). The EPSRA of 2005 gave the legal and institutional framework and paved way for the unbundling of National Electric Power Authority. One of the provisions of the EPSRA Act was the formation of the PHCN (Power Holding Company of Nigeria) to acquire the assets and liabilities of NEPA; and oversee the unbundling of PHCN into several companies.

Following the provision of the EPSRA Act, NEPA was unbundled into eighteen different companies. This includes; six generating companies (GENCOs), one transmission company (TRANSCO) and eleven distributing companies (DISCOs). This reform finally phased out the monopoly of NEPA to these new companies. The aims of the reforms are to; enhance the effectiveness of the sector, pull in private sectors into the industry, and reposition the power industry for better performance. Presently, the government owns 100% shares of TRANSCO, 20% of the generating company (with 80% of value sold to private investors) is also owned by the government. In the in distribution segment of the industry, the government still retains 40% of the shares. The TCN is exclusively managed by the government (however, Manitoba Hydro Company, a Canadian company, manages the TCN) (FMoP[4] , 2015). Figure 2.9 shows the market structure of the Nigerian electricity industry.

[4] Federal Ministry of Power, Nigeria

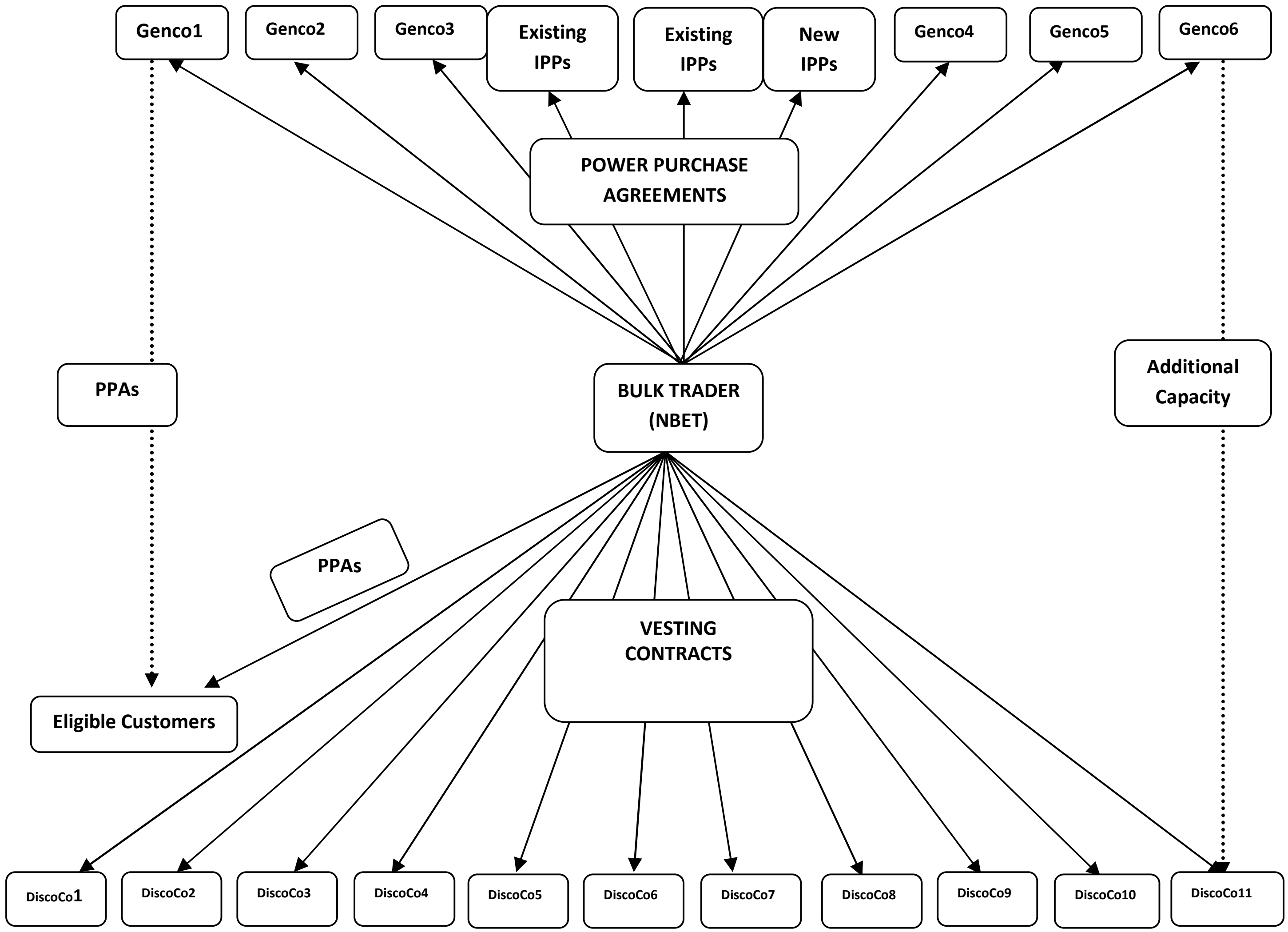


*Figure 2.9: Market Structure of the Electricity Sector in Nigeria*
*Note: NBET-Nigerian Bulk Electricity Tading; PPA-Power Purchase Agreements; IPPs-Independent Power Producers*

*Source: Federal Ministry of Power, Nigeria, 2017*

#### 2.5.6.6 Kenya Electricity Sector Reforms

Kenya is among Sub-Saharan Africa countries that has implemented extensive electricity reform in its electricity supply sector. The Kenya electricity sector reform was anchored on the need to attract huge inflow of private investment into the sector and to reduce the huge burden on public finance. The electricity sector in Kenya has evolved several electricity reform since the beginning of 1990s. However, in 1997, the decoupling of the Kenya Power and Lighting Company (KPLC) necessitated the establishment of an independent regulator. With this development, KenGen (Kenya Electricity Generating Company) was assigned the responsibility to generate electricity in the country. In 1998, the tasked of electricity regulation was given to the ERB (Electricity Regulatory Board), while the responsibility of policy formation is handledby the Energy and Petroleum Ministry (MoEP). The essence of this reform was to facilitate restructuring, disentangle the commercial and regulatory roles of the sector in a bid to enhance the influx of private sector into the electricity sector. Hence, beginning from 1998, the KPLC, started to concentrate only on the function to transmitand distribute electricity to consumers. However, IPPs were permitted to generate electricity and to compete with the state owned KenGen.

However, the electricity supply in Kenya has remained unreliable despite several episode of reforms. In a bid to savage the situation, another reform was carried out by the government in 2004, this reform necessitated establishing the Geothermal Development Company (GDC) with a responsibility to undertake an assessment of the geothermal resources in Kenya. It also has the mandate toaid the rapid expansion of electricity generation and make it competitive. Also, in 2008, there was the establishment of the KETRACO(Kenya Electricity Trans. Company Ltd) to fast track and consolidate concessionary agreements. However, the responsibility for operating the grid was retained by KPLC.

Consequently,in 2010, witnessed the establishment of the ElectricityNuclear Board of Kenya (KNEB), to facilitate nuclear energy generation. At the present, there are 11 independent power producers in the industry, 10 KenGen and the KPLC (state –owned enterprise with significant number of private shareholders).

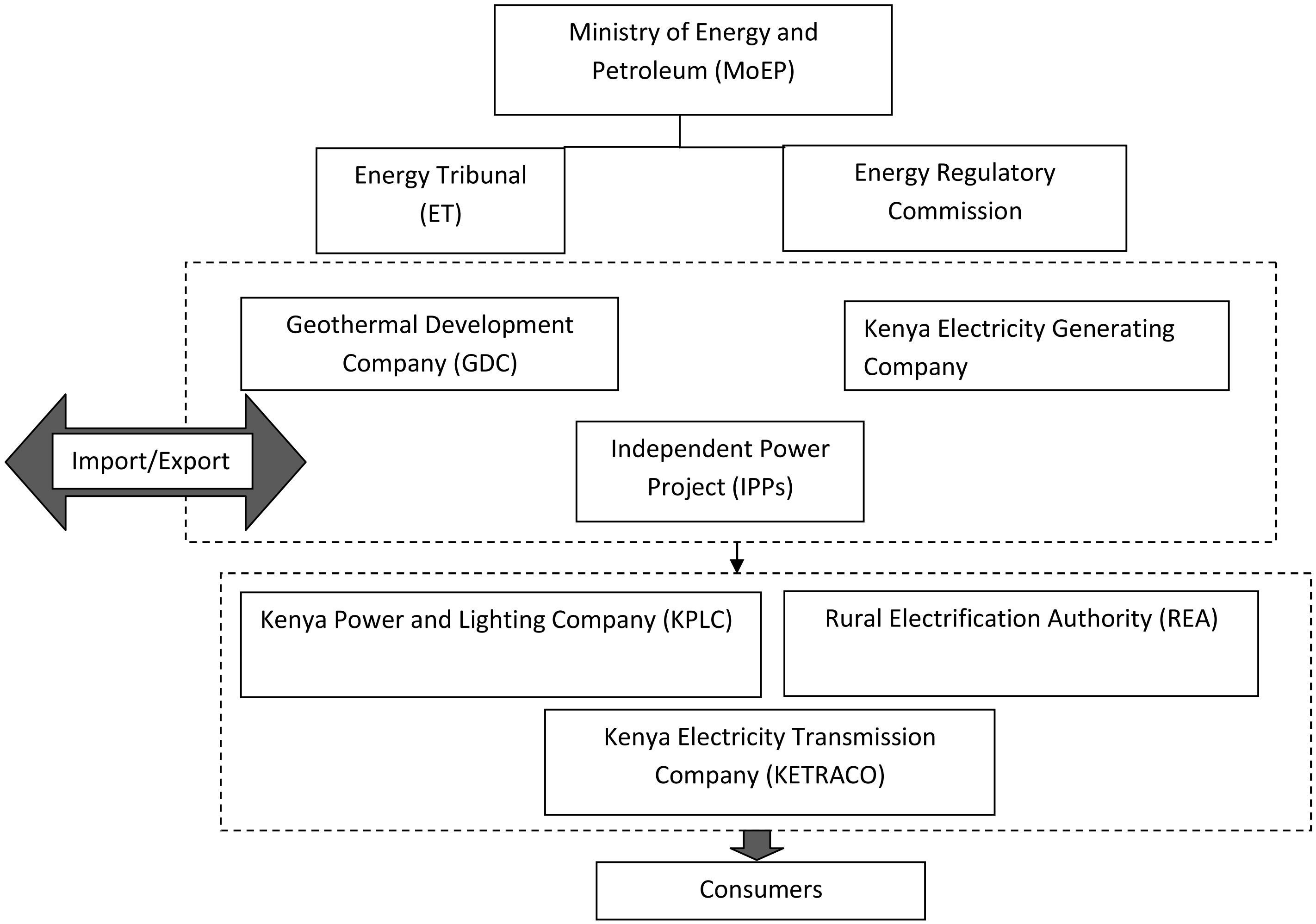


Figure 2.10: Structure of the Electricity Sector in Kenya.
*Source: Kenya's Ministry of Energy (MoE), 2017*

#### 2.5.6.7 Uganda Electricity Sector Reforms

The reform of the electricity sector in Uganda is one of the foremost electricity reforms in SSA region. The reforms of the electricity sector in Uganda began in the beginning of 1990s. Prior to this period, poor performance and mismanagement, inadequate electricity supply characterized the sector under the management and control of the UEB(Uganda Electricity Board). The main aim of the reform that continued till the Electricity Act of 1990 could be termed as; to revamp the electricity sector performance, to support the MEMD (Ministry of Energy and Mineral Development) in designing adequate policy framework for the industry, to enhance consistent electricity supply to the consumers and to encourage significant number of private investments into the sector mostly in the segment that is responsible to generate and distribute electricity. This commitment was further re-emphasized by the National Energy Policy of 2000. Markedly in the 2002 energy policy was the drive to massively attract private investment into the sector. Before this period, the Electricity Act of 1999 also emphasized the significance of private sector involvement with the formation of the ERA (Electricity Regulatory Authority) with the responsibility to control the energy throughout the country. The act also provided for decoupling of the Uganda Electricity Board into three different segments for better performance.

Between 1999 and 2005, the process of restructuring commenced and hence theElectricity Board of Uganda (UEB) was disentangled and its sole function of controlling the sector was given to various companies. These companies are: theUETCL (Uganda Electricity Transm. Com. Ltd.) The UETCL is owned by the government with the responsibility to transmitelectricity; the UEGCL (Uganda Electricity Gen. Com. Ltd) which is in charge to distribute the majority of electricity generated and the UEDC (Uganda Electricity Dist. Com. Ltd) charged with the function to distribute electricity to the consumers. This reform designed the expansion path of the electricity sector with the intention of attracting private participation. However, the UETCL has remained the main controller of all electricity transmitted into the main grid. The experience of Uganda in independent power producers' development is among the most successful in SSA, in 2012, it has 11 independent power projects with different sizes of generating capacities.

Also, the National Energy Policy reform of 2012, was carried out to; audit the energy profile and demand in Uganda; improve management in the energy sector and facilitates administrative performance in the energy sector and increase the availability of electricity supply to reduce poverty. More so, the National Development Plan of 2010-2017 was centered on; construction of generating facilities; enhancing energy regulatory and institutional framework enhancing supply side energy efficiency; expansion of the transmission network; and the promotion of research to greener energies.

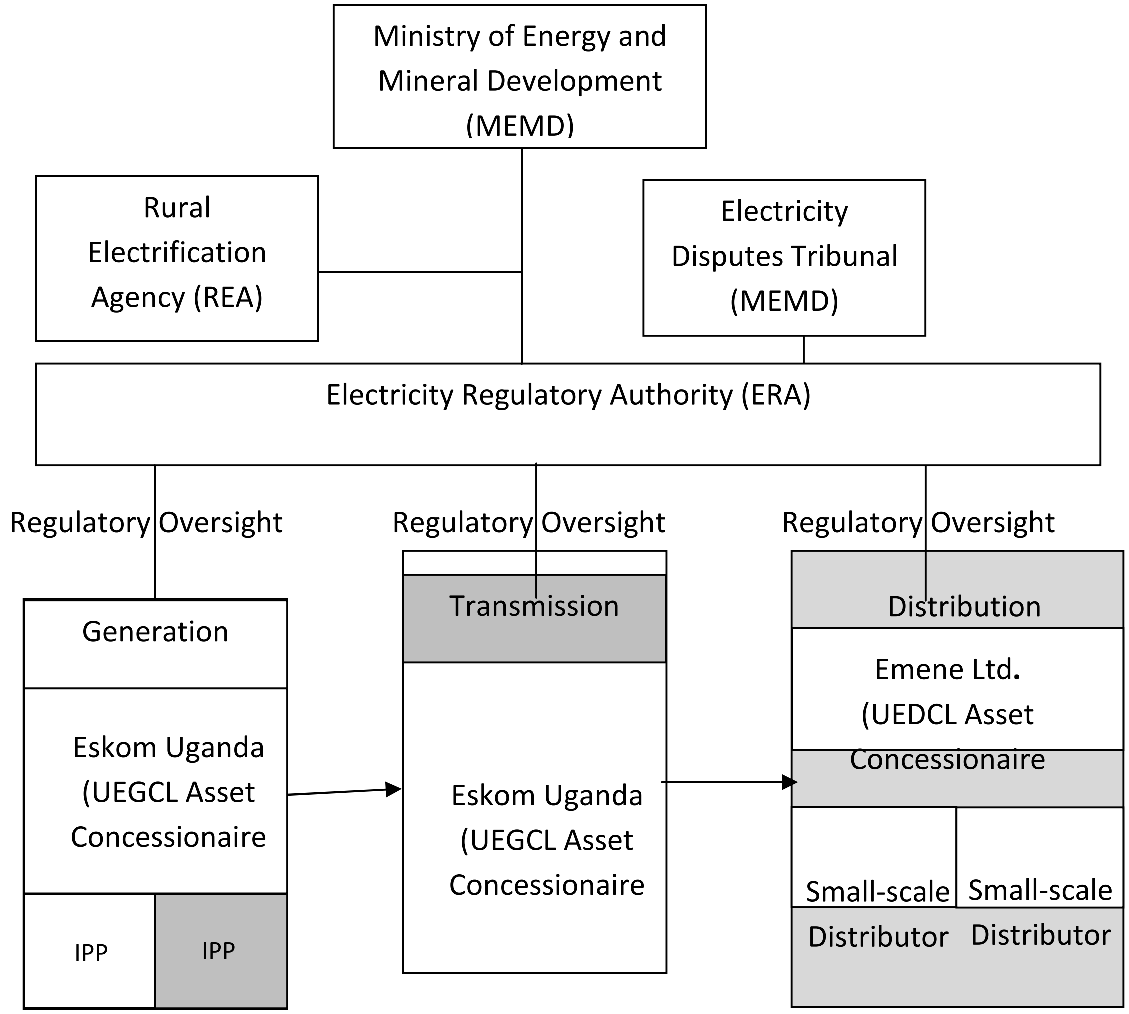


Figure 2.11: The Structure of the Electricity Sector in Uganda
*Source: Ministry of Energy and Mineral Development, Uganda, (2017)*

### 2.5.6.8 Tanzania Electricity Sector Reform

The Tanzania Electricicity sector was dominated by Tanzania Electric Supply Company (TANESCO) prior to 1990. However, because of the sector deterioration and inadequate supply, the government made several attempt to reform the electricity sector. Consequently, the national energy policy was established in 1992 and this development gave impetus to the inflow of private investment into the sector,mostly in areas that are not covered by the Tanzania Electric Supply Company. However, given the poor performance of the industry and also considering the support given by the International financial organizations such as the World Bank, TANESCO was decided to be privatized in 1997. Also, despite the high electricity tariff, the reliability and quality of electricity supply is still very abysmal, and the financial position of the still very weak, hence attention was centered on reforming TANESCO. The main aim of the reform was to reposition TANESCO financial viability in order to privatize it.

However, TANESCO was removed from privatization in 2005, as a result of the change in government policy. After, three years, an Electricity Act was passed, specifically in 2008. This act marked a new beginning and it reinforces government earlier decision to reposition the sector, so as to attract private sector investment. With this development, also in 2008, the REA(Rural Energy Agency) was formed in the Ministry of Energy and Minerals, with the responsibility to supervise and direct the electrification programmes in the rural areas of the country. In 2010 there was another Power Sector Reform Strategy for restructuring the country's electricity supply industry to attract private players and improve performance and the 2015 Electricity Sector Roadmap and Reform Strategy which seeks to unbundle TANESCO and to strengthen the governance and performance of the sector and attracting private investment.

With this development, there was high involvementof private investment in the sector as TANESCO started to relinquish some of its responsibilities to private investors. Also, these private companies were licensed by the government to produce electricity from various sources and sell to TANESCO and other consumers. Despite this development, TANESCO has remained the sole controller of electricitydistribution, generation and transmission throughout Tanzania.

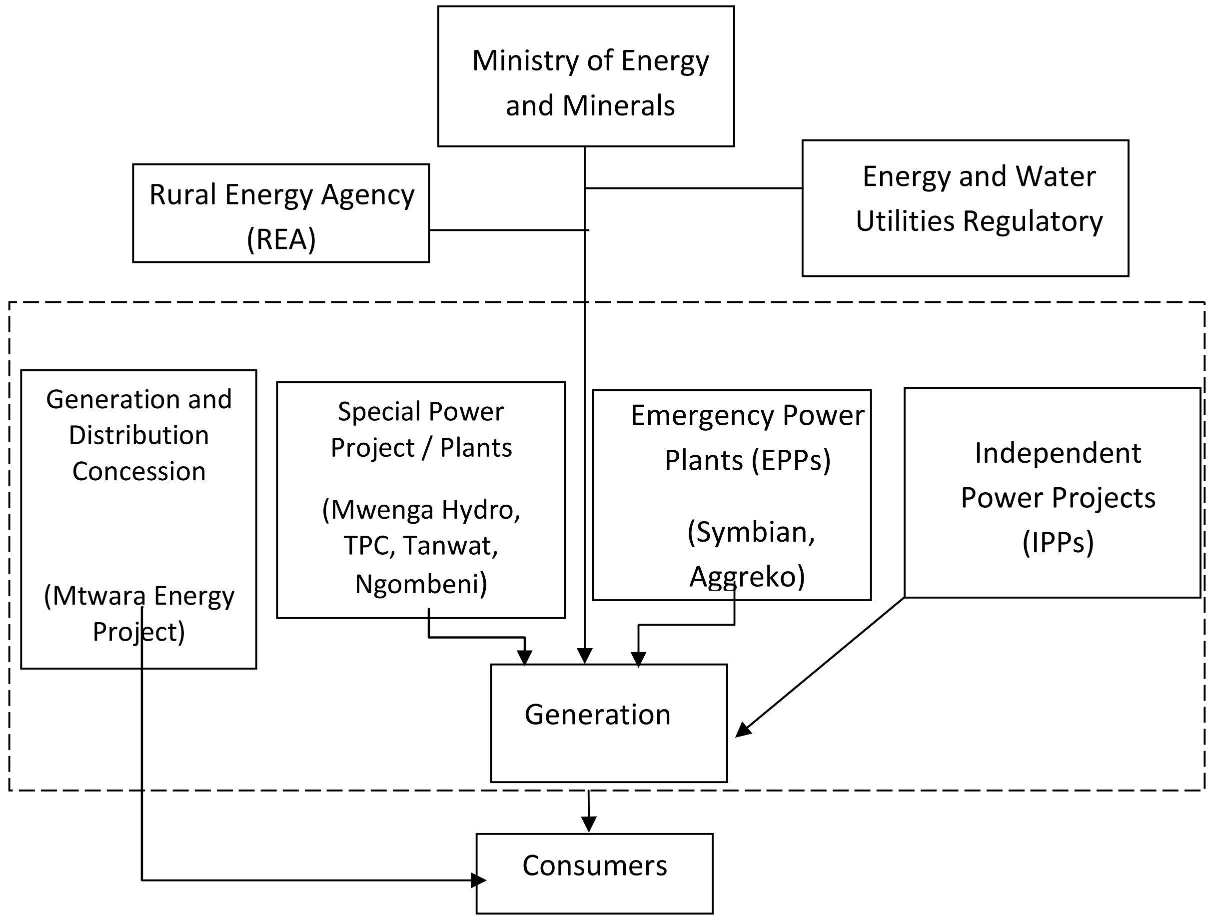


Figure 2.12: Power Sector Structure in Tanzania

*Source: Tanzania's Ministry of Energy and Minerals (MEM), 2018*

### 2.5.7 The Prevalence of Back-up Generators in SSA

Poor electricity supply as well as weak distribution facilities and transmission segment of the electricity sector in SSA has constrained the rapid economic growth and tranformation in the region. Moreover, majority of the SSA countries are characterized with frequent electricity interruption as well as low access. This lackluster performance has compelled consumers ranging from household to large industrial consumers to rely on back-up generator and generate their electricity through private generating set. Unarguably, this possess a huge cost on the firms as it raises the cost of business activities, thereby leading to the general increase in the price of goods and services, and also slows down economic growth in the region.

The acute shortages of electricity supply in the region has caused economic losses of about 2% of GDP and about 5% of firms' annual sales in the region (Castellano, Kendall, Nikomarov, and Swemmer, 2015). However, the shortages of electricity supply in the region is not unconnected with several years of lack of development and investment in new power generating and transmission facilities as most of the existing facilities are already deteriorated. The high rate of the region's dependence back up and private generating sets, highlights the huge electricity gaps in the region Figure 2.13 depicts the extent of back-up generator reliance in some SSA countries.

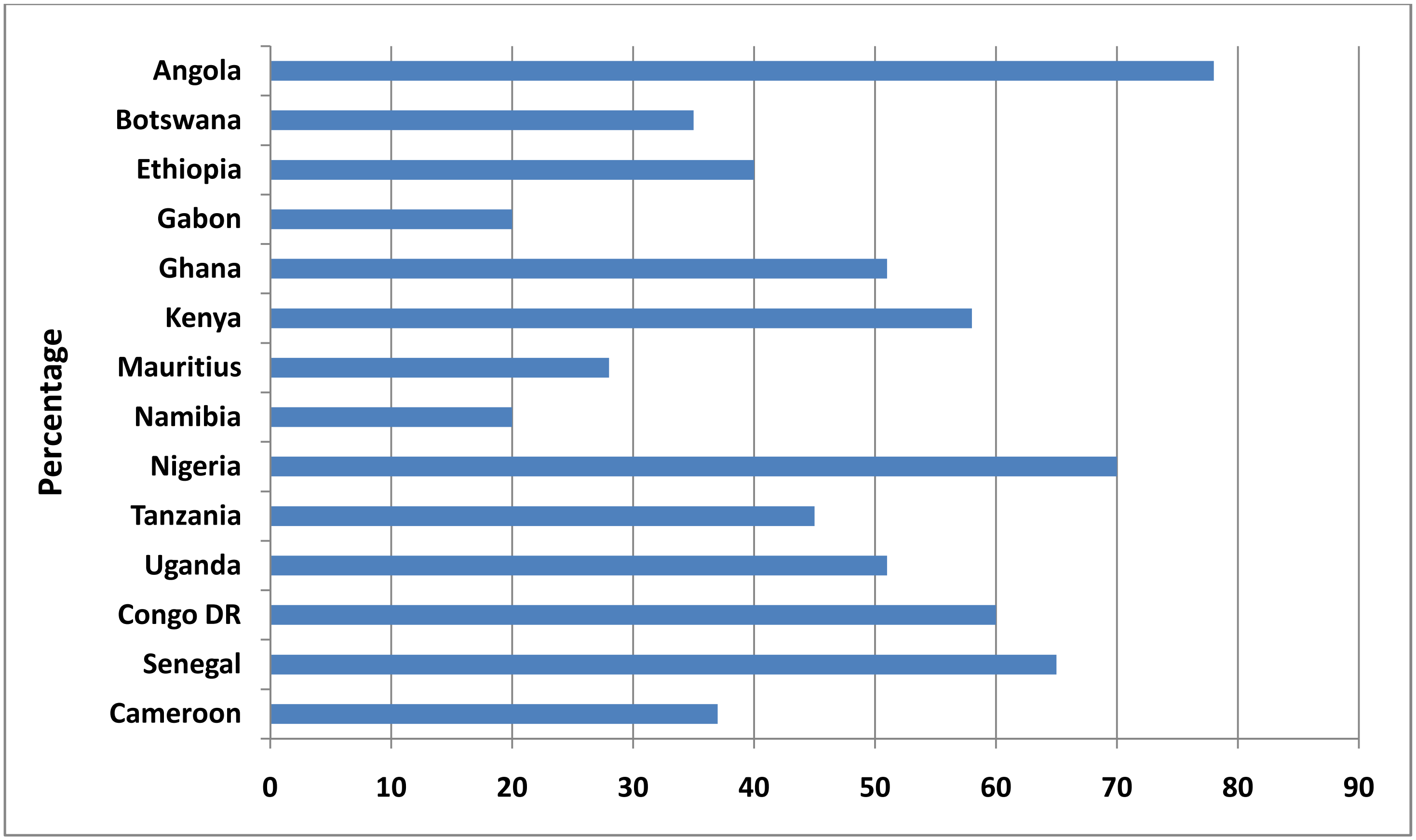


Figure 2.13: Firms Reliance on Back-up Generators in some SSA Countries in 2018 (percentage)
*Source: World Bank, 2018*

### 2.5.8 Rationale for Electricty Sector Liberalisation in SSA

Since the beginning of the last two decades, many SSA countries have carried several reforms aimed at liberalizing their power sectors. The main motivation for these reforms areto resolve the perennial electricity crises in the region. Specifically, two main reasons could be adduced for the radical electricity reforms in the region. First, the inability of government controlled electricity sector to generate adequate fund for the sector's development and expansion. Second, the dissatisfaction over the inefficient management and inadequate electricity supply in the region

However, other reasons for liberalizing the electricity sector in the region are to:

- Introduce competition by allowing an increased level of private sector involvement into the sector in order to ensure increased quality of electricity services
- Make electricity affordable, reliable and extend access to electricity
- Reduce government participation and shift the mandate of electricity regulation from the conventional ministry of Energy/Department to an "independent" regulatory agency. This is done in order to make the sector competitive and ensure a level playing field and efficiency in utility regulation
- Enhance the commercial positions and financial performance of public utilities
- Improve electricity acts to establish a comprehensive legal and institutional framework to enhance power sector performance.
- Amending electricity tariffs in a bid to remove subsidies and making tariff cost-reflective.

Notably, another main driver for SSA electricty sector liberalisation is the push emanating from international financial aid giving agencies including the World Bank and the IMF. Most countries in SSA have been forced to liberalizing their electricity industry as a prerequisite to access loans, as stated in the World Bank's Electricity Sector Lending Policy of 1993, mandating developing countries to show evidence of real commitment to power sector reform. Following this development and in order to access these loans, most developing countries including SSA countries decided to liberalize their power sectors.

### 2.5.9 Elements of Electricity Market Liberalisation

There are various options of electricity industry reforms, however, electricity reforms could differ considerably across countries, considering their resources and status of economic growth. This factor could also lead to significant variability of reforms across countries. But generally, according to Joskow (2008) and Newbery (2002a), the main electricity liberalisation options involve a mixture of some or all of the following basic components

- Commercialization and Corporatisation of government controlled vertical integrated utilities;
- Electricity assets privatization;Decoupling of previously vertically- integrated state-run electricity sector into different segment viz; distribution, transmission and generation
- Proving of licenses and granting of third party access to electricity business value chain;
- Breaking of the age-long public monopoly of public utilities and making the sector competitive
- Establishing independent regulator for effective electricity sector regulation
- Instituting of a competitive wholesale generation and distribution market;
- Amendment of electricity laws to give enabling environment for private sector participation
- Reviewing electricity tariff to make it cost-reflective
- Designing consumer protection rules and regulations

### 2.5.10 Regional Integration for Electricity Supply in SSA

Regional electricity integration is a crucial step at pulling electricity from a surplus region to electricity deficient region and ensuring a larger electricity economics of scale. The regional integration is designed to enhance electricity sector investment by pulling and expanding the market for electricity beyond national borders. Consequently, the envisioned advantages of motives, dictated the formation of regional power pools in South, Central, West, and East Africa. It is the believe that these electric power pools will serve to solve the perennial power crises in the region. Notably, the four major power pools in SSA region are:

- Southern Africa Power Pool (SAPP): SAPP was established by 12 countries in 1995. This is the most structured and active power pool in the region with operational short-term energy markets and international energy trades.  These countries include: Tanzania, Zimbabwe, Mozambique, , Swaziland, Zambia, Malawi, Namibia, DR Congo, Botswana,  Angola, South Africa and Lesotho
- The Central Africa Power Pool (CAPP). CAPP was formed in 2003, it is composed of Burundi, Equatorial Guinea, Central African Republic Chad, Congo, Gabon, and Sao Tome, Angola, Cameroon, and DR Congo
- The Eastern Africa Power Pool (EAPP) which was established in 2005 include the following countries; Rwanda, Egypt, Burundi, DRC, Kenya, Ethiopia, and Sudan. It was created as a specialized to enhance power interconnectivity by the heads of state of the Eastern and Southern Africa. Since then, Uganda, Tanzania and Libya, have joined the EAPP.
- The West African Power Pool (WAPP). WAPP is an off-shoot ECOWAS. It is made up of 14 countries namely: Sierra Leone, Niger, The Gambia, Guinea, Liberia, Senegal, Burkina Faso, Benin, Côte d'Ivoire, Ghana, Mali, Nigeria and Togo.

# CHAPTER THREE

# THEORETICAL FRAMEWORK AND METHODOLOGY

This chapter presents the theoretical framework for the study. In specific, the theoretical exposition between electricity market liberalisation and the sector's performance is examined. Further, the empirical model and the estimation procedures are described. In addition, the electricity market liberalization index for SSA is presented. The nature and sources of data used for the empirical analysis are defined.

## 3.1 Theoretical Framework

Several theories of electricity market liberalisation are identified in the literature. However, leaning on the theoretical literature review, the framework for this study is adopted from the New Institutional Economic (NIE) theory originated by Williamson (1975). NIE holds that differences in economic performances could be explained by understanding the process of economic and institutional reforms. Simultaneously, the theory is concerned with explaining how to improve social welfare by recognizing the disequilibria caused by market. The theory further recognizes that markets need institutional support in order to function effectively, hence, the need for government intervention is emphasized when market fails to uphold the public interest in the provision of services. Unlike the Public interest and the Neoliberal theories, the NIE[5] is germane in the analysis of electricity market liberalisation because it provides important insight into the link between liberalisation, institutional structure and electricity performance. This theory has been extensively applied in several studies (see Pollitt, 2001; Joskow, 2008; Erdogdu, 2011; 2013; 2014;Nepaland Jamasb,2012 and Helene, et al., 2015).

NIE posits that electricity market liberalisation is an institutional restructuring that brings about structural changes, establishment of new market and reorganization of the ones in

[5] New Institution Economic Theory

existence (Erdogdu, 2014). The underlying assumption of the theory is that electricity market liberalisation is an institutional reform that matter for electricity performance. This implies that differences in electricity sector performances across countries are related to the nature of market liberalisation and institutional structures. According to Pollitt and Preetum (2001), the liberalisation of utilities is a complex affair connecting three important elements. First, there is a corporate restructuring leading to the creation of new or reorganized companies. Second, there is a paradigm shift from purely public to both private and state ownership, the third is a change in pattern of sector operations and new regulatory policies, standards and practices often accompany these changes. Depending on the combination of these factors, electricity market liberalisation tend to bring about a noticeable method in which electricity businesses are carried out.

However, most of the theoretical postulations of NIE are centered on the effects of electricity sector liberalisation on productive capacity (Zhang, Parker, and Kirkpatrick, 2005; Pollitt, 2009; Erdogdu, 2014; Michael, 2016). In corollary to the above, Pollitt (2009) recognizes three theoretical points concerning the likely effects of liberalisations. First, liberalisation may change the objective functions of managers being faced with private sector incentives. Second, liberalisation can improve performance by reallocating property rights from the public to the private sector. Third, there may be occurrence distortionary resource allocation caused by some inappropriate regulation leading to inefficiency. The conclusions of these studies are widely consistent in showing that electricity market liberalisation lead to performance change in electricity supply output and utilization of the available generating capacity. This corroborates with the submission of Akkemikand Oguz (2011), who found that electricity market liberalisation lead to efficiency gains in the electricity market.

The NIE theory articulated above is represented by a simple schematic model of electricity market liberalisation and the sector's performance. As shown in Figure 3.1, the whole liberalisation processes occur and it is being influenced directly by the whole institutional system of the country such as the legal system, investment environment and regulatory governance structure. In the model, pre-liberalisation structure depicts centrally controlled public utilities or regulated private utilities. However, the Poor performance of the sector such as insufficient electricity generating capacity, poor reliability and high costs necessitate several liberalisation measures, such as vertical and horizontal unbundling of functions, Introduction of IPPs, electricity reform laws, privatization and corporatization. The post-liberalisation structure indicates an electricity market characterized with competition at the various segments, such as generation transmission and at least wholesale level are possible leading to improvementin the sector's performance such as electricity generation, installed capacity expansion and electricity consumption.These processes of liberalisation producesocial, political, economic and environmental impacts. All these have significant influences on the pattern and direction of liberalisation.

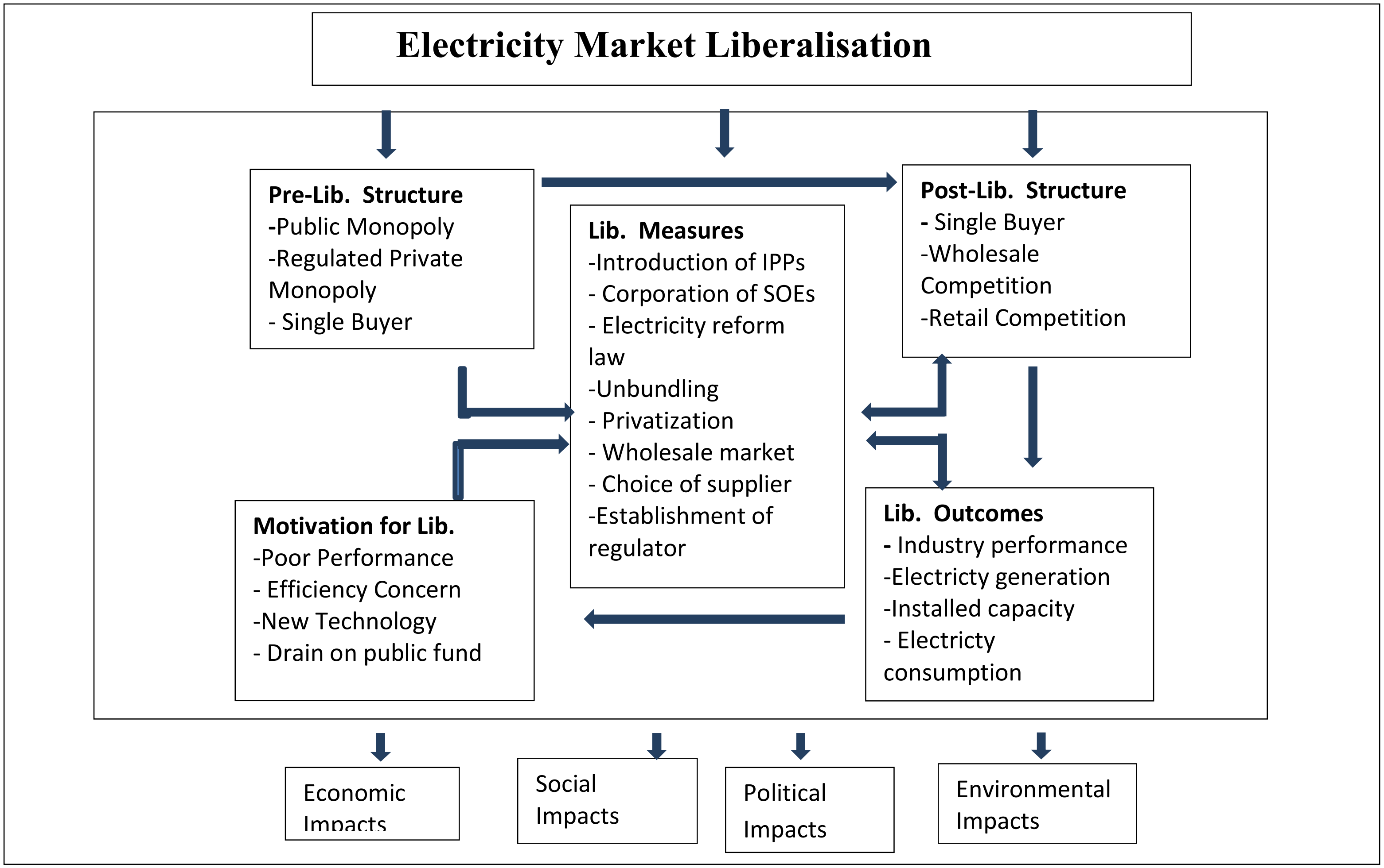


Figure 3.1: NIE Framework for Electricity Market Liberalisation
*Source: Adapted from Eberhard and Gratwick (2015)*

From the NIE theory, the electricity industry being considered here is dominated by government as a state owned firm, hence it is a monopoly. The production function focuses on output ( $Q(t)$ ), capital ( $K(t)$ ), and effective labour ( $A(t)$ ( $L(t)$ ). The production function takes the form:

$$Q(t) = f\ (K(t), A(t)L(t)) \qquad 3.1$$

To account for the respective shares of input in outputs, equation (3.1) is transformed into the baseline Cobb Douglas production function as

$$Q(t) = (K(t)^{a}\ (AL(t))^{1-a} \qquad 3.2$$

Where α and 1-α are relative shares of factor inputs. The model assumes that the marginal products are positive such that

$$\frac{dQ}{dK} = aAK^{a-1}\ L^{1-a} \quad > 0 \qquad 3.3$$

$$\frac{dQ}{dL} = 1 - aAK^{a}\ L^{-a} \quad > 0 \qquad 3.4$$

Leaning on Zheng and Zhaoguang (2013), equation (3.1) can be expressed in terms of electricity performance and market liberalisationsuch that:

$$Q(t) = K(t)^{\beta}\ A(t)L(t)^{\gamma}\ Eml(t)^{\lambda} \qquad 3.5$$

Where: $Q(t)$ is electricity performance $K(t)$ is capital input into electricity performance, $A(t)L(t)$ is effective labour input, $Eml(t)$ represents electricity market liberalisation and β, λ, ϒ are relative shares of factor inputs. Equation (3.5) is transformed into a loglinear function as:

$$InQ(t) = \beta InK(t) + \gamma(InA(t)In\,L(t)) + \lambda InEml(t) \qquad 3.6$$

Differentiating both sides with respect to time, equation (3.6) becomes

$$gQ = \beta gK + \gamma(n+g) + \lambda gEml \qquad 3.7$$

At the balance growth path, the growth rate of output (Q) and capital (K) are the same, hence

$$gQ = gK \qquad 3.8$$

$$gQ - \beta gQ = \lambda gEml + \gamma(n+g) \qquad 3.9$$

To determine the impact of liberalisation on electricity performance, equation (3.9) is decomposed as:

$$gQ\,(1 - \beta) = \lambda gEml + \gamma(n + g) \qquad 3.10$$

Dividing both side by $(1-\beta)$ , gives

$$gQ\frac{1 - \beta}{1 - \beta} = \frac{\lambda}{1 - \beta}(Eml) + \frac{\gamma}{1 - \beta}(n + g) \qquad 3.11$$

$$gQ = \frac{\lambda}{1 - \beta}(Eml) + \frac{\gamma}{1 - \beta}(n + g) \qquad 3.12$$

Equation (3.12) implies that the growth rate of electricity market liberalisation ($\frac{\lambda}{1-\beta}$) is a determinant of electricity performance. Since the main objective of this study is to examine the effect of electricity market liberalisation on the sector's performance, there is need to express the fundamental equation in a form that would enable the estimate of impact analysis. Hence, following Zhang, et al. (2008) and Anupama, et al. (2016), equation (3.12) can be re-specified as:

$$Q(t) = f\,(Eml(t), Y(t), X(t)) \qquad 3.13$$

Where Q(t) represents electricity sector performance, Eml(t) is electricity market liberalisation, Y(t) is institutional and economic variables, and X(t) is control variables. However, according to Fiorio and Florio (2013), Pompei (2013) and Erdogdu (2014), electricity market liberalisation is measured by the degree of entry barrier (enb), ownership structure (ows), vertical integration (verti), establishment of independent regulatory agency (rga) and the overall market liberalisation index (oelx) in the electricity industry. Therefore, in a bid to examine their effect on the sector's performance, Electricty market liberalisation (Eml) in equation (3.13) is decomposed as:

$$Eml = f\,(ows, verti, enb, rga, oelx) \qquad 3.14$$

Thus, expressing equation (3.13) in terms of equation (3.13) yields:

$$Q(t) = f\,(ows, verti, enb, rga, oelx, y(t), x(t) \qquad 3.15$$

A number of empirical studies have established the effects of some institutional and economic variables and some control variables on electricity performance. Hence, in order to analyze the effects of these variables as used in empirical studies ( See Nepal and Jamasb, 2012;Erdogdu, 2014;Helene, et al., 2015;Michael, 2016 and Anupama, et al., 2016), equation (3.15) is augmented with GDP per capita (gdpca), political stability and absence of violence (psav), net development assistance (nda), population growth (popgr), corruption control (corrc) and government effectiveness (govte). Therefore, equation (3.15) becomes:

$$Q(t) = f\ (ows, verti, enb, rga, oelx, gdpca, nda, popgr, corrc, psav, govte) \qquad 3.16$$

However, as revealed in Zhang et al. (2008) and Anupama et al. (2016), measures of electricity sector performance include; electricity generation per capita (egpc), installed generation capacity per capita (igcpc) and electricity consumption per capita (ecpc). Hence the LHS of equation (3.16) is unbundled as:

$$egpc = f\ (ows, verti, enb, rga, oelx, gdpca, nda, popgr, corrc, psav, govte) \qquad 3.17$$

$$igcpc = f\ (ows, verti, enb, rga, oelx, gdpca, nda, popgr, corrc, psav, govte) \qquad 3.18$$

$$ecpc = f\ (ows, verti, enb, rga, oelx, gdpca, nda, popgr, corrc, psav, govte) \qquad 3.19$$

Equations (3.17), (3.18) and (3.19) expressthe various components of electricity sector performance( egpc, igcpc and ecpc) as a function of electricity market liberalisation, economic and institutional variables and some control variables.

## 3.2 Model Specifications

The theoretical framework presented abovehas described the nature of the relationship that exist between the sector's performance and electricity market liberalisation in SSA. In this wise, based on the theoretical framework for the study and following Zhang et al. (2008), the model for the study is thus stated as:

$$egpc_t = f\ (ows_t, verti_t, enb_t, rga_t, oelx_t, gdpca_t, nda_t, popgr_t, corrc_t, psav_t, govte_t) \quad 3.20$$

$$igcpc_t = f\ (ows_t, verti_t, enb_t, rga_t, oelx_t, gdpca_t, nda_t, popgr_t, corrc_t, psav_t, govte_t) \quad 3.21$$

$$ecpc_t = f\ (ows_t, verti_t, enb_t, rga_t, oelx_t, gdpca_t, nda_t, popgr_t, corrc_t, psav_t, govte_t) \quad 3.22$$

Equation (3.20) to (3.22) imply that the various indicators of electricity sector performance depend on the dynamics of electricity market liberalisation variables such as: ownership structure, vertical integration, regulatory agency and overall electricity market liberalisation index, as well as some economic and institutional variables, as well as some control variables such as: GDP per capita, net development assistance, population growth, corruption control, government effectiveness and political stability/ absence of violence. However, within the GMM framework, the models for this study are expressed as:

$$Inegpc_{it} = \alpha_0 + \alpha_1 Inegpc_{it-1} + \alpha_2 ows_{it} + \alpha_3 verti_{it} + \alpha_4 rga_{it} + \alpha_5 oelx_{it} + \alpha_6 gdpca_{it} + \alpha_7 ndai_{it} + \alpha_8 popgri_{it} + \alpha_9 corrc_{it} + \alpha_{10} psav_{it} + \alpha_{11} govte_{it} + e_{it} \quad 3.23$$

$$Inigcpc_{it} = \beta_0 + \beta_1 Inigcpc_{it-1} + \beta_2 ows_{it} + \beta_3 verti_{it} + \beta_4 rga_{it} + \beta_5 oelx_{it} + \beta_6 gdpca_{it} + \beta_7 ndai_{it} + \beta_8 popgri_{it} + \beta_9 corrc_{it} + \beta_{10} psav_{it} + \beta_{11} govte_{it} + e_{it} \quad 3.24$$

$$Inecpc_{it} = \varphi_0 + \varphi_1 Inecpc_{it-1} + \varphi_2 ows_{it} + \varphi_3 verti_{it} + \varphi_4 rga_{it} + \varphi_5 oelx_{it} + \varphi_6 gdpca_{it} + \varphi_7 ndai_{it} + \varphi_8 popgri_{it} + \varphi_9 corrc_{it} + \varphi_{10} psav_{it} + \varphi_{11} govte_{it} + e_{it} \quad 3.25$$

Equations (3.23) to (3.25) are the models that form the fulcrum of this study. Where $i = 1, \ldots, N$ is the number of groups, $t = 1, \ldots, T$ is the number of periods. 'In' is natural log, $egpc_{it}$, $igcpc_{it}$, and $ecpc_{it}$ are the growth rate of electricity generation per capita, installed generation capacity per capita and electricity consumption per capita respectively. Again, $egpc_{it-1}$, $igcpc_{it-1}$ and $ecpc_{it-1}$ are the initial level of the performance indicators, $ows_{it}$ is the ownership structure which measures the prevailing ownership structure in the generation, transmission and distribution segment of the electricity industry, depending on whether the sector is publicly owned, mixed or privately owned. $verti_{it}$ is vertical integration that captures whether the natural monopoly of the electricity industry is unbundled into separate segment, $rga_{it}$ measures whether electricity regulatory agency operates as an independent body or a department under ministerial control, again the $oelx_{it}$ which is the overall electricity market liberalisation is a composite measure of the entire reform carried out in the electricity sector. Economic and institutional variables in the model include: $gdpca_{it}$ is GDP per capita measured in US\$, $popgr_{it}$ is population growth (%), $nda_{it}$ is net development assistance measured in constant US\$million, $corrc_{it}$ is corruption control (%), $govte_{it}$ is government effectiveness ((%) $psav_{it}$ is political stability (%).

However, using equation (3.16), equations (3.23) to (3.25) could be written in compact form as:

$$Q_{it} = \delta_0 + \delta_1 Q_{it-1} + \delta_2 ows_{it} + \delta_3 verti_{it} + \delta_4 rga_{it} + \delta_5 oelx_{it} + \delta_6 gdpca_{it} + \delta_7 ndai_{it} + \delta_8 popgri_{it} + \delta_9 corrc_{it} + \delta_{10} psav_{it} + \delta_{11} govte_{it} + e_{it} \quad 3.26$$

In equation (3.26), the error term $\varepsilon_{it}$ has two components: the observed specific error ( $\mu_{it}$ ) and the unobserved country specific effects ( $\upsilon_i$ ). Substituting this into equation (3.26) yields

$$Q_{it} = \delta_0 + \delta_1 Q_{it-1} + \delta_2 ows_{it} + \delta_3 verti_{it} + \delta_4 rga_{it} + \delta_5 oelx_{it} + \delta_6 gdpca_{it} + \delta_7 ndai_{it} + \delta_8 popgri_{it} + \delta_9 corrc_{it} + \delta_{10} psav_{it} + \delta_{11} govte_{it} + \upsilon_i + \mu_{it} \qquad 3.27$$

### 3.3 A priori Expectations of the Parameters in Equation (3.27)

$\delta_1 > 0$: An increase in electricity performance in the previous year, is expected to increase electricity performance in the present year

$\delta_2 > 0$: An increase in private sector ownership of the electricity industry is expected to improve electricity performance

$\delta_3 > 0$: The unbundling of the electricity sector into separate segments of generation, transmission and distribution is expected to enhance electricity performance

$\delta_4 > 0$: The establishment of independent regulatory agency should result in improving electricity performance

$\delta_5 > 0$: As electricity market liberalisation increases, power is also expected to improve

$\delta_6 > 0$: An increase in GDP per capita, increases industrialization, therefore electricity supply is also expected to increase

$\delta_7 > 0$: Net development assistance to developing countries is expected to enhance improvement in electricity sector's performance if the fund is channeled to the development of the electricity sector

$\delta_8 > 0$: As population grows, economic activities increase, hence, electricity supply is also expected to increase

$\delta_9 < 0$: An increase in corruption is expected to deteriorate electricity sector performance

$\delta_{10} > 0$: Political stability and absence of violence is expected to improve electricity performance

$\delta_{11} > 0$ The effectiveness of government should increase electricity performance

However, in estimating equation (3.27), several econometric problems may arise, such problems include correlation of the explanatory variables with the error term, correlation of time-invariant country characteristics with independent variables, autocorrelation due to the presence of the lagged dependent variable $Q_{i\,t-1}$ and the likelihood of the panel dataset to have a longer time dimension in relation to country dimension. The estimation technique of the Generalized Method of Moment (GMM) for panel data analysis proposed by Arellano and Bond (1991) adequately caters for all the identified problems. The System GMM panel estimator is good at exploiting the time-series variation in the data by accounting for unobserved individual specific effects and therefore provides better control for endogeneity of all the explanatory variables. Factoring the lagged level of the regressors into the right hand side of equation (3.27) gives:

$$(Q_{it} - Q_{it-1}) = \delta_1(Q_{it} - Q_{it-2}) + \delta_k(\pi_{it-1} - \pi_{it-2}) + (\upsilon_i - \upsilon_i) + (\mu_{it} - \mu_{it-1}) \qquad 3.28$$

Where $\delta_k$ *and* $\pi$ are vectors denoting $[\delta_2, \delta_3, \delta_4, \delta_5, \delta_6, \delta_7, \delta_8, \delta_9, \delta_{10}, \delta_{11}]$ and [ows, verti, rga,, oelx, gdpca, nda, popgr, corrc, psav, govte ] respectively. The above equation expresses the explanatory variables as predetermined and therefore, not correlated with the error term in equation (3.26). Transforming equation (3.28) using first-differences result in:

$$\Delta Q_{it} = \delta_1 \Delta Q_{it-1} + \delta_k \Delta \pi_{it} + \Delta \mu_{it} \qquad 3.29$$

Equation (3.29) reveals that the fixed country specific effects are removed because it does not vary with time. Similarly, the lagged dependent variable that may give rise to autocorrelation has been taken care of. However, the use of instruments is required to avail the possibility that the error term ($\mu$) is not serially correlated and that the explanatory variables are weakly exogenous. These assumptions make the following moment conditions to be written as

$$E[Q_{it-s} - (\mu_{it} - \mu_{it-1})] = 0 \;\; for\, s \geq 2; \;\; t = 3, ......, T \qquad 3.30$$

$$E[\pi_{it-s} - (\mu_{it} - \mu_{it-1})] = 0 \;\; for\, s \geq 2; \;\; t = 3, ......, T \qquad 3.31$$

The Differences estimator[6] (another type of GMM estimator) is based on the moment conditions in equations (3.30) and (3.31). Although the estimator is asymptotically consistent, it has large biases in small samples and low asymptotic precision. Additional moment conditions are required for system GMM specified in the equations below:

$$E[Q_{it-K} - Q_{it-K-1}\ (\upsilon_{it} + \mu_{it})] = 0 \ \ for\ k = 1 \qquad 3.32$$

$$E[\pi_{it-k} - \pi_{it-k-1}\ (\upsilon_{it} + \mu_{it})] = 0 \ \ for\ k = 1 \qquad 3.33$$

Employing the moment conditions stated in equations (3.30), (3.31), (3.32) and (3.33), in addition to suggestions of Arellano and Bond (1991) and Arellano and Bover (1995), consistent estimates of the parameters of interest can be generated through a GMM procedure. The consistency of the GMM estimator depends on whether lagged values of the explanatory variables are valid instruments in the electricity performance regression. Amid the GMM estimators, the system GMM is preferred above other GMM estimators. For instance, the pooled OLS estimator does not control for the joint endogeneity of the explanatory variables nor for the presence of country-specific effect; the levels GMM estimator controls for joint endogeneity but not for country-specific effects; and the difference GMM estimator accounts for both joint endogeneity and country-specific effects but eliminates valuable information and uses weak instruments. Some of these shortcomings are well taken care of in the system GMM estimator. To be specific, the system GMM estimator joins in a single system the regression equation in both levels and differences given in equations (3.23), (3.24) and (3.25) respectively, using the moment conditions given in equations (3.30), (3.31), (3.32) and (3.33).

[6]Difference GMM estimator first proposed by Holtz-Eakin, Newey and Rosen (1998).

## 3.4 Electricity Market Liberalisation Index for SSA

As noted by Jamasb, et al. (2004), there are lack of universally recognized indicators for measuring the effects and outcome of electricity market liberalisation. Against this backdrop, this study faces the same challenges as it attempts to examine the impact of electricity market liberalisation on the sector's performance in SSA. Markedly, the sector's performance indicators such as electricity generation per capita, electricity consumption per capita and installed generation per capita are measured in physical unit and hence, are easily included in the study. On the other hand, the core electricity liberalisation measures, such as ownership structure, corporatization, vertical integration (unbundling of functions), independent regulatory governance etc, are gradually established with a qualitative dimension. However, as noted in Erdogdu (2014), denoting these variables with dummies do not reflect the magnitude or intensity of reforms. Therefore, to overcome these challenges and as evident from Jamasb, et al. (2004), a useful method would be to generate a set of liberalisation index by allocating reform scores or values to the magnitude of reforms implemented.

In generating the index, the methodological framework used in Erdogdu (2014) was adopted because the methodology captures the dynamics of electricity reform in the region. The index ranges from 0 to 6, the minimum score of 0 represents a closed market with full public monopoly, while a maximum score of 6 represents a fully open competitive market with private sector led electricity sector. This implies that a country's liberalisation score increases as it implements more reform steps and moving farther away from monopoly. Specifically, this score is allocated to countries yearly based on the degree of reform implemented. It is suffice to say that these scores are indicators of reform progress rather than reform success. The variables used for computing the index are; ownership structure, vertical integration and regulatory governance. The indicator for ownership structures is based on the ownership structure in the generation, transmission and distribution segment of the electricity sector, depending on whether the electricity sector privately owned, mixed, or fully public. Indicator for vertical integration is based on whether the natural monopoly of the electricity industry is unbundled into separate segments. Indicator for regulatory governance focuses on whether electricity regulatory agency operates as department under ministerial control or an independent body. Again indicator for the overall electricity market liberalisation is a weighted average of ownership structure, vertical integration and regulatory agency. It is a composite measure of the entire reform carried out in the electricity sector.Table 3.1 reports the adapted methodological framework used for the composition of the index for SSA.

**Table 3.1 :Composition of Electricity Market Liberalisation Index for SSA**

| | Weights by theme ($b_j$) | Questions Weights ($c_k$) | Index Score |
|---|---|---|---|
| **Ownership Structure** What is the ownership structure in the electricity industry | 1/3 | | |
| • Generation | | 1/3 | Public 0; Mostly Public 1.5; Mixed 3; Mostly Private 4.5; Private 6 |
| • Transmission | | 1/3 | Public 0; Mostly Public 1.5; Mixed 3; Mostly Private 4.5; Private 6 |
| • Distribution | | 1/3 | Public 0; Mostly Public 1.5; Mixed 3; Mostly Private 4.5; Private 6 |
| **Vertical Integration** What is the overall degree of vertical integration in generation, transmission and distribution segment of the electricity industry | 1/3 | 1 | Integrated 0; Mixed 3; Unbundled 6 |
| **Regulatory Agency** How is the electricity industry regulated | 1/3 | 1 | Dependent Agency 0; Mixed 3; Independent Agency 6 |
| **Country scores (0-6)** | | | $\sum_j b_j \sum_k c_k \, answer_{jk}$ |

*Source: Author's, adapted from Erdogdu, (2014)* Figures 3.2 and 3.3 present the electricity market liberalisation scores for SSA countries between 1990 and 2017. The scores are allocated yearly to each country based on the intensity of the electricity sector reform in that year. It ranges from 0 to 6, the minimum score of 0 represents a closed market with full public monopoly, while a maximum score of 6 represents a fully open competitive market with private sector led electricity sector. This implies that a country's liberalisation score increases as it implements more reform steps and moving farther away from monopoly. It is sufficed to say that these scores are indicators of reform progress rather than reform success. One of the criteria adopted to decide the liberalisation score in each year is the level of private sector involvement in the electricity sectors. It is obvious from the figures that in 1990 electricity sectors in these countries were predominantly state controlled with limited or no private sector involvement. Hence, most of these countries have a minimum score close to 0 in 1990, indicating public monopoly of the electricity sectors. While in 2017, the liberalisation scores in these countries have increased as a result of the several liberalisation process that have been implemented; such as vertical and horizontal unbundling of utilities, private ownership, establishment of independent regulatory agencies, independent power projects etc.

The score differs in each country since the type of reforms options implemented also differs. For instance, in 1990, electricity liberalisation index for Ethiopia was 0.5 but rose to 2.88 in 2017 because it has enacted electricity act, implemented management contract and vertically unbundled generation from transmission and distribution. Senegal, Zambia and Zimbabwe electricity score in 1990 were 0.87, 0.92 and 0.83 respectively, implying that the electricity sectors in these countries were predominantly state controlled. But in 2017, their score increased to 2.83, 2.85 and 2.66 respectively, as a result of the reform implemented such as, the establishment of independent regulation, vertical unbundling, privatization, and concession contracts. Similar, the electricity liberalisation score in Guinea, Tanzania, Gabon, and Equitorial Guineawere 0.5 and below 1.5, respectively in 1990 and 2017 because the electricity sectors in these countries are less liberalised relative to others. However, Uganda, Nigeria, Cote d' Ivoire, and Kenya are ahead of other countries in the region because of the depth of reform implemented in these countries and the prevalent of private participation in their electricity sectors.

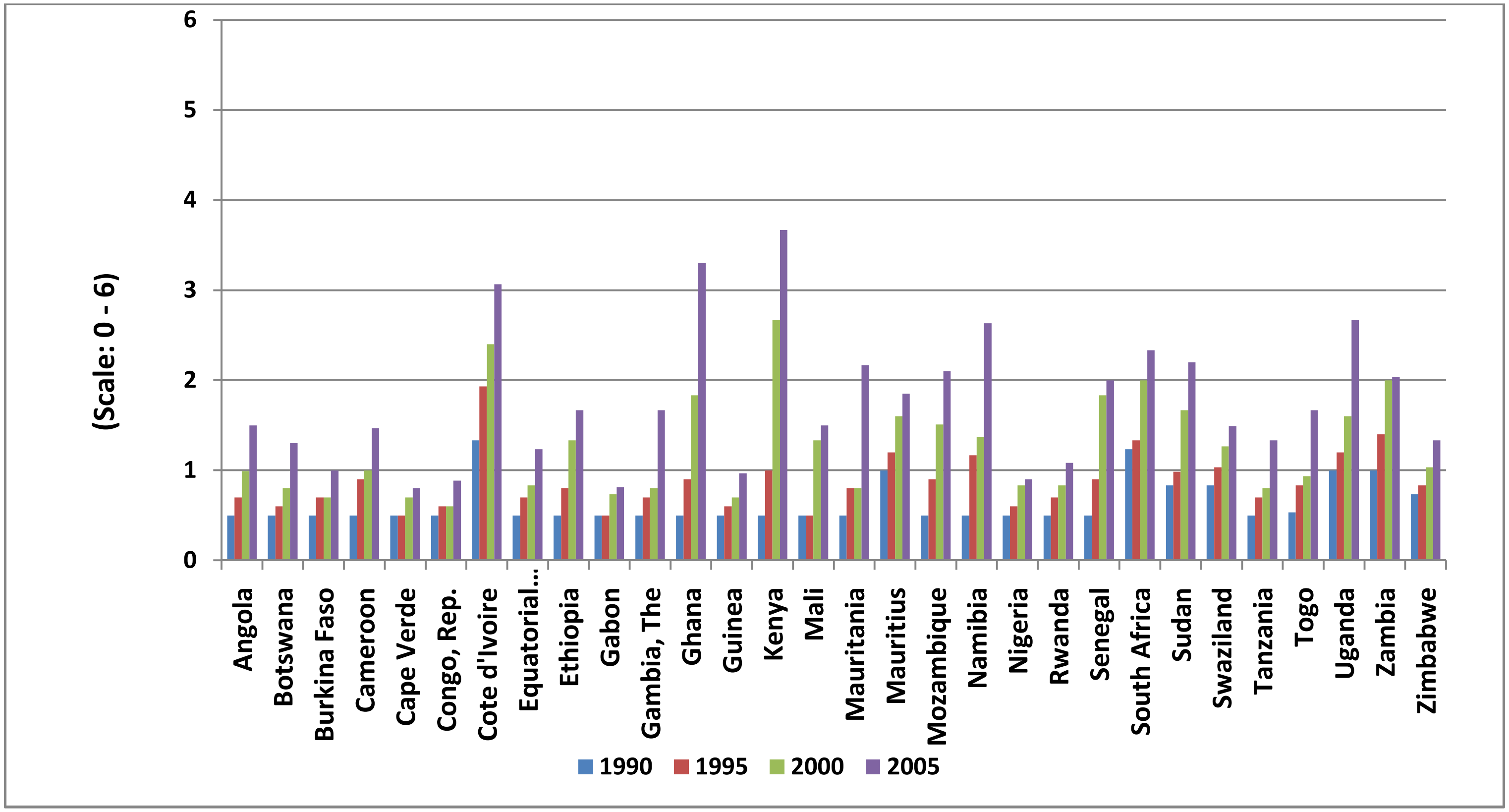


Figure 3.2: Electricty Liberalisation Index in SSA (1990-2005)

*Source: Author's Computation with Data Derived from Various Sources[7] (2017)*

[7],[2] Word Bank Electrcity Regulatory Database, Renewable Energy and Energy Efficiency Database, EIA, WEC and Country's Electricity Reforms Policy Briefs (2017)

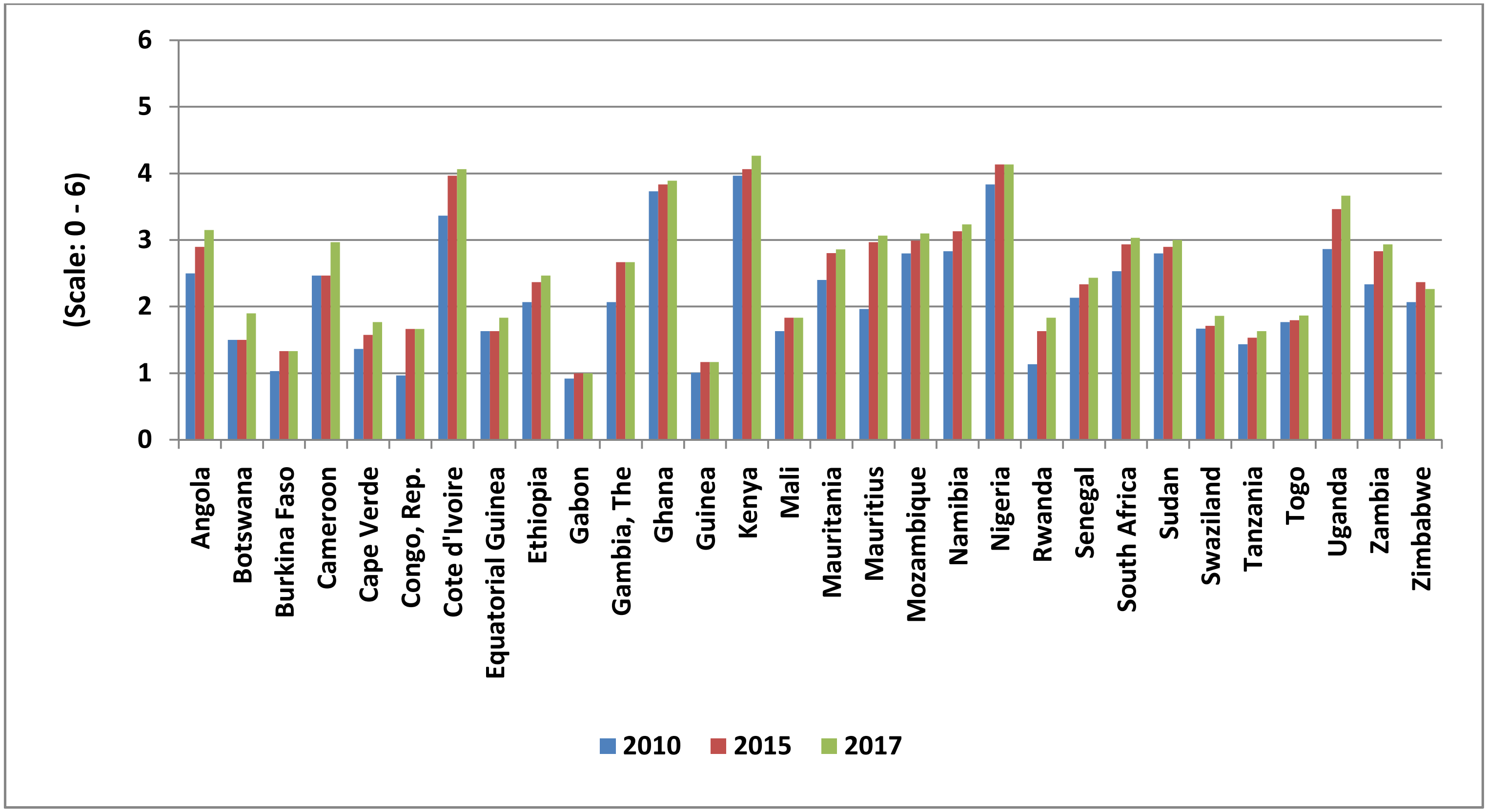


Figure 3.3: Electricty Liberalisation Index in SSA (2010-2017)

*Source: Author's Computation with Data Derived from Various Sources[8] (2017)*

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[8], [2] Word Bank Electrcity Regulatory Database, Renewable Energy and Energy Efficiency Database, EIA, WEC and Country's Electricity Reforms Policy Briefs (2017)

### 3.4.1: Classification Based on Moderate and Low Liberalized Countries

Countries are classified into moderate and low electricity liberalized based on the magnitude of reform implemented and the reform scores. Specifically, in the index generated, a score of 3 represents mixed ownership of the electricity sector between the public and the private sector. As such, a weighted score of 3 point is adopted as the threshold for the classification. Hence, countries that have a weighted score of 3 point and above in the year 2017 are classified as moderate electricity liberalized countries, while countries that score below 3 points are grouped as low electricity liberalized countries.Markedly, Kenya, Nigeria, Uganda, Ghana and Cote d'Ivoir, etc are classified as moderate electricity libaralised countries because they have implemented more reform steps in their electricity sectors such as the unbundling of the electricity sector, establishment of independent regulatory agencies, commercialization of utilities, the involvement of independent power producers and distributors, corporatization, enactment of laws for electricity sector liberalisation etc. As such, the liberalisation scores in these countries increases above 3 points in 2017, indicating mixed ownership of the electricity sectors between the public and the private sectors. Notably, Cote d'Ivoire, Nigeria, Kenya and Ghana have an average score of 4 points, indicating that more reforms steps that have been implemented.

On the flipside, the electricity sectors in Tanzania, Zimbabwe, Botswana, Congo Rep, Burkina Faso, Gabon and Guinea are grouped as low electricity liberalised countries because they are yet to implement reasonable magnitude of reform and have also exhibited reluctance towards the reform of the electricity sectors. However, the most widespread electricity sector liberalisation in these countries have been a small scale privatization, establishment of independent power projects (IPPs) and independent regulators. As such, their liberalisation scores average around 2 points in 2017, indicating predominantly state controlled electricity sectors. Specifically, while the liberalization score of Tanzania, Zimbabwe, Botswana, Congo Rep, Burkina Faso, Gabon and Guinea were below 0.6 points in 1990, it marginally increased to 1.68, 2.26, 1.92, 1.66, 1.30, 1.04, 1.16 in 2017 respectively.

However, country's liberalisation score is not always a determinant of electricity performance across countries. As earlier mentioned, the electricity liberalisation score for Nigeria in 2017 averages 4.1 points, indicating the prevalence of private sector participation and the extent of reforms implemented, while that of South Africa is about 3.0 points, indicating that its electricity sector is mixed. On the average, these scores Imply that the electricity industry in Nigeria is more liberalised than the electricity industry in South Africa, however, South Africa's electricity sector performs much better than that of Nigeria, Kenya and Uganda that have unbundled utilities alongside partial privatization and the establishment of independent regulators. Figures 3.4 and 3.5 present the classification of countries in SSA based on moderate and low liberalised

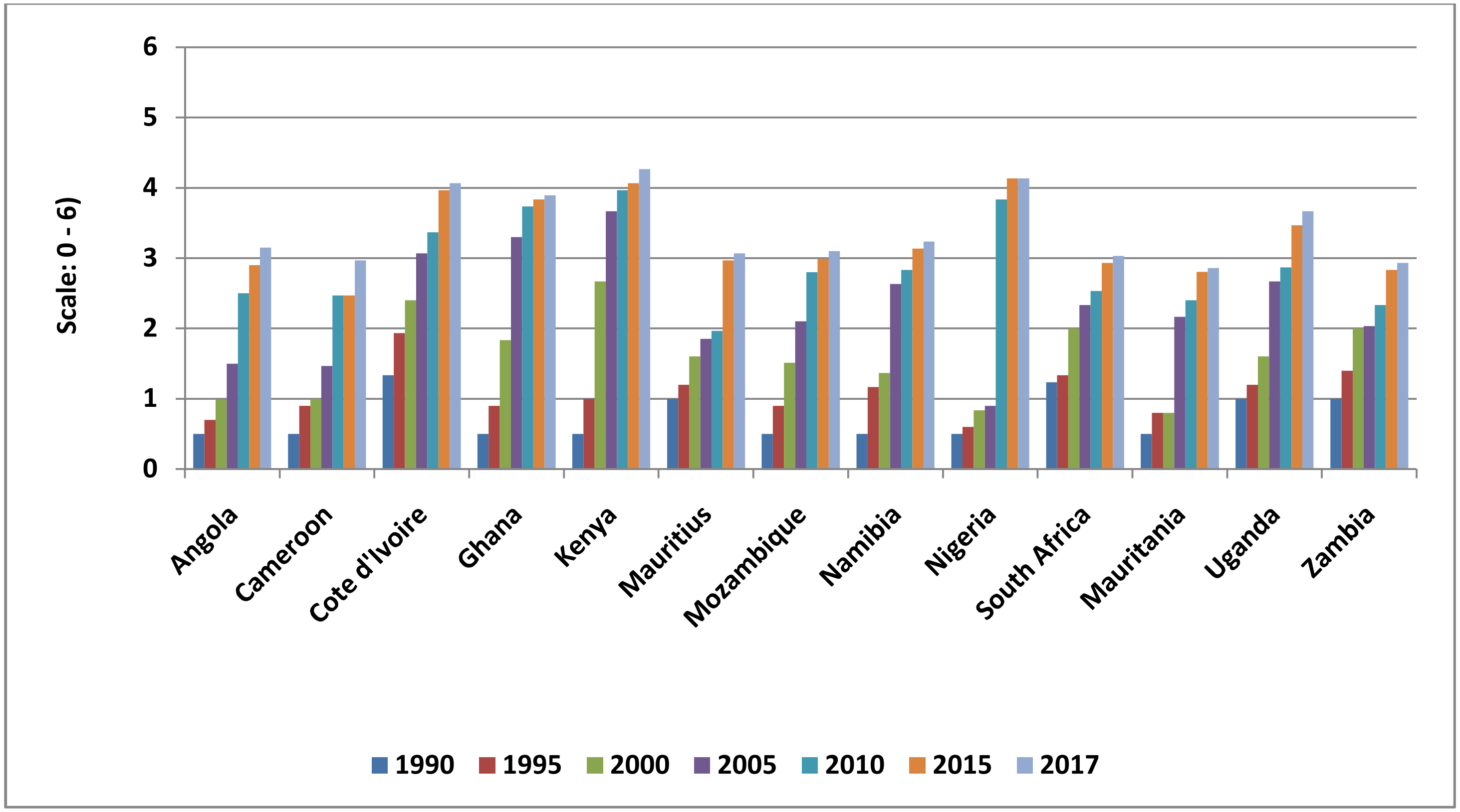


Figure 3.4: Liberalisation Index inModerate Electricty Liberalised countries (1990- 2017)

*Source: Author's Computation with Data Derived from Various Sources[9] (2017)*

[9],[2] Word Bank Electrcity Regulatory Database, Renewable Energy and Energy Efficiency Database, EIA, WEC and Country's Electricity Reforms Policy Briefs (2017)

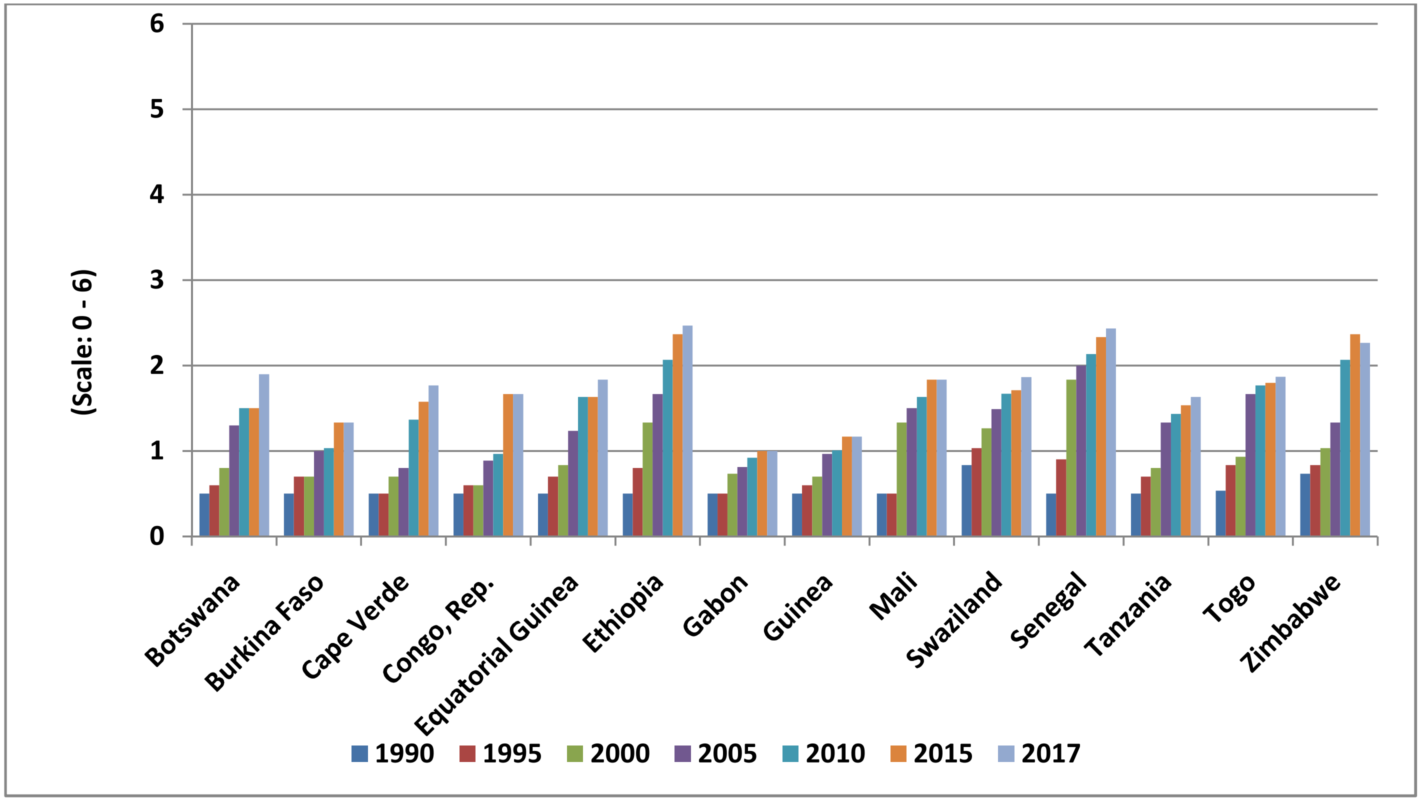


Figure 3.5: Liberalisation Indexin Low Electricty Liberalised countries (1990- 2017)

*Source: Author's Computation with Data Derived from Various Sources*[10]*(2017)*

[10], [2] Word Bank Electrcity Regulatory Database, Renewable Energy and Energy Efficiency Database, EIA, WEC and Country's Electricity Reforms Policy Briefs (2017)

Further, as demonstrated in Table 3.2below, the 30 Sub-Sahara Africa countries selected for this study are grouped into four classification based on their electricity market liberalisation score in 2017. For instance in 2017, Mali, Rwanda Ethiopia Namibia, Angola and Mozambique have vertically unbundled and corporatized their electricity sectors but while Mali, Rwanda and Ethiopia are placed in group 2, Namibia, Angola and Mozambique are classified in group 3 because aside unbundling and corporatization, the electricity sectors in these countries are more open to private participations. Gabon, Burkina Faso, Guinea and Tanzania have also enacted electricity act and vertical unbundling but they are grouped into group 1, because the electricity sectors in these countries are predominantly state controlled. Nigeria, Uganda, Kenya and Cote d' Ivoire are categorized into group 4 because these countries have unbundled and privatized their electricity sector, while South Africa, Angola, Mozambique are classified into group 3 because they are yet to fully privatized their electricity sector, although, they have enacted electricity act, unbundled and implemented concession contract.

Also, Rwanda, Gambia and Equatorial Guinea electricity liberalisation index in 1990were at the average of 0.5 but rose to 1.83, 2.60 and 1.83 respectively in 2017 because they haveimplemented some reform steps, namely; management contract and vertically unbundled, thus, they are grouped in group 2. Also, Zimbabwe and Senegal electricity score in 1990 were 0.83 and 0.87 respectively, implying that the electricity sectors in these countries were predominantly state controlled. But in 2017, their score increased to 2.66 and 2.83 respectively, as a result of the reform implemented such as, the establishment of independent regulation, vertical unbundling, privatization, and concession contracts. Therefore, these countries fall in group 2. Similar trend is also reflected in group 1. In 1990, the electricity liberalisation score in Guinea, Gabon,Congo Rep, Tanzania, Burkina Faso, etc were around 0.5 and about 1.5 in 2017, hence, these countries are categorized into group 1 because the electricity sectors in these countries are less liberalised relative to other groups. However, Uganda, Nigeria, Cote d' Ivoire, and Kenya are ahead of other countries regarding the depth of electricity reform in the region, hence, they are grouped into group 4 because of the depth of reform implemented in these countries and the prevalent of private participation in their electricity sectors. However, electricity sector in South Africa perform better relative to the other countries in group 4, implying that electricity market liberalisation score is not the sole determinant of electricity sector performance in SSA

Table 3.2: Countries Grouping By Electricity Liberalisation Index in 2017

| **Score 0-1.5 (Group 1)** | **Score 1.5-3.0 (Group 2)** | **Score 3.0-4.0 (Group 3)** | **Score 4.0-6.0 (Group 4)** |
|---|---|---|---|
| Burkin Faso | Cape Verde | Mozambique | Cote Ivoire |
| Guinea | Ethiopia | Angola | Kenya |
| Tanzania | Mali | Cameroon | Nigeria |
| Congo Rep | Rwanda | Ghana | Uganda |
| Equitorial Guinea | Sudan | Namibia | |
| Gabon | Mauritania | South Africa | |
| Togo | Mauritius | | |
| | Senegal | | |
| | Zambia | | |
| | Zimbabwe | | |
| | | | |

*Author's Grouping Based on Electricity Market Liberalisation Index, 2017*

### 3.4.2 Electricity Market Liberalisation Performance by Regions in SSA

The Electricity Supply Industries (ESI) in SSA countries have been under continuous reforms. Many countries in the region have implemented a restructured electricity market and introduced competition in order to attractive private sectors' investment. The role of private sector investmentin the power sector is perceived as the most crucial aspect in the liberalisation process. For many reforming SSA countries, private sectors participation is considered the alternative source for securing the required investment for the industry.Moreover, the experiences of electricity sector reform in most countries in SSAhave not transmitted into competitive electricity market and hence, consumers are yet to reap the full benefits from the several episodes of electricity reform in SSA. This could be attributed to the fact that most SSA countries have not adopted the standard model of electricity sector reform. However, despite these challenges, three-quarter of the countries in the region have attracted private participation, 65% have establishedelectricity regulatory agencies, and over 35% have implemented independent power projects, twenty four countries have passed electricity sector reform law and almost all the countries have corporatized their electricity utilities.

Table 3.3summarizes the electricity market liberalisation performance by region in SSA. Markedly, Cote d'Ivoire, Ghana, Nigeria, Namibia, Kenya, Cameroon, Uganda and South Africa are the high performers in the regions because they have implemented more reforms steps and have attracted more private sector investment in their electricity sectors than the other countries in in SSA. Specifically, with the unbundling of the power sector in Uganda, Nigeria, Cote d'Ivoire, andGhana, Independent Power Projects (IPPs) work side by side with the state- owned generation, distribution and transmission companies without conflict in their roles. This has significantly reduced generation and distribution losses. On the other hand, Burkina Faso, Mali, Zimbabwe, Gabon, Rwanda, Sudan, Congo Rep and Guinea have a low patronage of private investments as the electricity sectors in these countries remain predominantly state controlled and vertically integrated electricity sectors characterized with financial and technical challenges, despite the presence of independent regulators that seek to encourage more transparent and competitive electricity sector.

**Table 3. 3: Electricity Market Liberalisation Performance by Regions in SSA (2017)**

| West Africa | | Southern Africa | | East Africa | | Central Africa | |
|---|---|---|---|---|---|---|---|
| High performers | Low Performers | High performers | Low Performers | High performers | Low Performers | High performers | Low Performers |
| Nigeria | Burkina Faso | Namibia | Botswana | Kenya | Ethiopia | Cameroon | Equatorial Guinea |
| Ghana | Cape Verde | South Africa | Zimbabwe | Mauritania | Sudan | Mauritius | Gabon |
| Cote D' Ivoire | Togo | Angola | Swaziland | Uganda | Rwanda | | Congo Rep |
| | Senegal | Mozambique | | | | | |
| | Mali | Zambia | | | | | |
| | Guinea | | | | | | |
| | Gambia | | | | | | |

*Source: Author's Classification based on Electricity Market Liberalisation Scores and REEEP Database, 2017*

**Table 3. 4: Definition and Sources of Variables**

| Variable | Description | Units | Database |
|---|---|---|---|
| egpc | Electricity generation per capita | kWh per capita, | (WDI and EIA)[11] |
| igcpc | installed generation capacity per capita | kWh per capita, | (WDI and EIA) |
| ecpc | Electricity consumption per capita | kWh per capita, | (WDI and EIA) |
| ows | Ownership structure : measures the ownership structure in the generation, transmission and supply segment of the electricity industry | Index number (0-6) | Constructed[12] |
| verti | Vertical integration: captures the extent of unbundling in the generation, transmission and distribution of electricity | Index number (0-6) | Constructed |
| rga | Regulatory governance: defined as the extent of independent regulatory agency | Index number (0-6) | Constructed |
| oelx | Overall electricity market liberalisation index: A composite measure of the extent of liberalisation implemented | Index number (0-6) | Constructed |
| gdpca | GDP per capita | US$ | WDI |
| nda | Net development assistant | Constant (US$million) | WDI |
| corrc | Corruption Control | percentage | WGI[13] |
| popgr | Population growth | percentage | WDI |
| psav | Political stability and absence of violence | percentage | WGI |
| govte | Government effectiveness | percentage | WGI |

Source: Compiled by the author

[11] World Development Indicator and Energy information Administration
[12] Word Bank Electrcity Regulatory data base, Renewable energy and energy efficiency database, EIA, WEC and Countyry's electricity reforms policy briefs
[13] World Governance Indicator

## 3.5 Estimation Procedures

The characteristics of the panel data used in the analysis were first evaluated. The summary statistics of installed electricity generation per capita, consumption per capita,generation per capita, ownership structure, vertical integration, net development assistance, population growth, corruption control, regulatory agency and overall electricity market liberalisation were presented. The statistical properties of the variables provide information about the means, medians, standard deviations, skewness, kurtosis and jarque-Bera statistics of each variable. Mean is the average value of the series, the median is the middle value of the series when the values are ordered from smallest to the largest. Of the two, the median is a robust measure of the centre of the distribution that is less sensitive to outliers. The statistics also indicated the maximum and minimum values of the series in the employed sample. Standard deviation captures the dispersion in the series. Skewness measures asymmetry of the distribution of the series around its mean and it is expected to be zero for normal distribution. Positive/negative skewness means that the distribution has a long right/left tail. Kurtosis measures the peak or flatness of the distribution of the series while Jarque-Bera is a test statistic for testing whether the series is normally distributed.

As a general rule, non-stationary time series should not be used in regression models in order to avoid the problem of spurious regression. In this wise, two types of panel unit root tests were carried out, these include the Im, Pesaran, and Shin W-test, and Levin, Lin and Chu-test assuming intercept only. Levin, Lin, and Chu (2002) extended the work of Quah (1994) that derived asymptotically normal distributions for standard unit root tests in panels for which the time series and cross-sectional dimensions grew large at the same rate. They considered the case in which both dimensions grew large independently and derived asymptotic distributions for panel unit root tests that allowed for heterogeneous intercepts and trends across individual members. Im, Pesaran, and Shin (2003) developed a panel unit root estimator based on a group mean approach (Levin, Lin, and Chu, 2002; Im, Persaran and Shin, 2003). However, Kao (1999) showed that estimates of the structural parameter combining two independent non-stationary variables collapse to zero if it is panel data, but it is a random variable if it is a time series data. This suggests that although non-stationary panel data may lead to biased standard errors, the point estimations of the value of parameters are consistent. Again, correlation test was also executed to ascertain the strength of the relationships that exist between the variables in the model.

In order to establish the impact of electricity market liberalisation on the sector's performance in SSA, The Two-Step System GMM estimator was employed to estimate the models specified in equations (3.23), (3.24) and (3.25). Five versions of the results were derived from five sub-groups of the sampled countries. The first version of the results is obtained from pooled data from all the selected thirty (30) SSA countries, while the remaining four versions were estimated by re-grouping the sampled countries in line with the IMF and World Bank classification, which are middle-income countries, low-income countries and classification of countries based on the extent of liberalization. Data on Moderate-electricity liberalised countries and low-electricity liberalised countries[14] are obtained from Electricity Regulatory Database, and Renewable Energy and Energy Efficiency Partnership (REEEP) Database.

Furthermore, in estimating the effect of electricity market liberalisation in SSA, the Two-Step System GMM is employed because of its several abilities. Several specifications and diagnostic tests are undertaken to authenticate the results and establish their robustness. The first is a Hansen test of over-identifying restrictions, which test the overall validity of the instruments by analysing the sample analogue of the moment conditions used in the estimation process. Failure to reject the null hypothesis gives support to the model. The second test examines the hypothesis that the error term is first- or second order serially correlated. First-order serial correlation of this error term is expected, while the second-order serial correlation of the differenced residual indicates that the original error term is serially correlated and follows a moving average process at least of order one. Failure to reject the null hypothesis of absence of second-order serial correlation implies that the original error term is serially uncorrelated.

[14] Out of the thirty (30) countries used in the study, countries in the sub-groups are composed as follows; thirteen (13) are from middle-income countries, twelve (12) are from moderate electricity liberalized countries, thirteen (13) are from low-income countries and fourteen (14) are from low electricity liberalized countries. See Appendix (A2) for the list of various countries that fall into each group.

### 3.6 Data Description and Sources

The data set used in the study is based on a panel of 30 Sub-Saharan Africa countries, spanning from 1990 to 2017. The choice of countries used in this study is dictated by the availability of data, particularly electricity market reforms data. Importantly, the year 1990 was chosen as the starting year because it marked the beginning of significant reforms of the electricity sector in Sub-Saharan Africa. In total, 10 variables are used in this study, out of these variables, 3 are dependent variables and the remaining 7 are explanatory variables. The dependent variables are; electricity generation per capita (kWh), installed generation capacity per capita (kWh) and electricity consumption per capita (kWh). These indicators capture electricity sector performance and the extent of electricity available in the economy.

The explanatory variables are vertical integration, ownership structure, regulatory agency and overall electricity market liberalisation. Others include population growth (%), net development assistance (constant US$billion) and corruption control (%). Data for vertical integration, ownership structure, regulatory agency and overall electricity market liberalisation are generated using data from the World Bank Electricity Regulatory Database (WBERD), Renewable Energy and Energy Efficiency Partnership (REEEP) Database Energy Information Administration (EIA), World Energy council (WEC) and SSA country's electricity reform policy briefs. Data for corruption control is sourced from Worldwide Governance Indicator (WGI). Data for net development assistance and population growth are sourced from World Development Indicator (World Bank).

# CHAPTER FOUR

# ANALYSES OF RESULTS

This section presents the estimated result of the model specified in chapter three. It starts with the descriptive statistics of the sectoral aggregate variables employed. This is followed by the panel unit root test in order to ascertain the stationarity of the variables. The correlation analysis of the variables is also conducted to determine the relationship and association between electricity market liberalisation and the sector's performance. Further, the Two-Step System GMM is adopted to estimate the model.

## 4.1 Statistical Properties of the Variables

The descriptive statistics of the variables used in this study are presented in Table 4.1. It provides information on the basic characteristics of the variables such as; the mean, median, standard deviation, skewness, kurtosis and Jarque-Bera statistics. Instructively, the descriptive statistics show that the average yearly electricity consumption per capita is 477.97kWh, with the minimum consumption of 11.63kWh while the maximum is 4875.11kWh. Electricity generation per capita also depicted similar behavior with an average generation per capita of 806.32kWh, with a minimum and maximum value of 19.63kWh and 12261.20kWh respectively, implying a significant disparity in electricity generation and consumption across the region. It is obvious from the data that average generation is higher than average consumption, this might indicate that the region has electricity surplus. However, the data does not factor in transmission losses which may have contributed to electricity shortages in the region.The mean value of installed generation capacity per capita is 0.18 GWh, with a minimum value of 0.04GWh, while the maximum is 2.36GWh, indicating the low level of installed generation capacity in the region. Further, the overall electricity liberalisation variable (oelx) averages 2.12 with a minimum of 0.50 and a maximum of 4.67, implying that most of the countries in SSA have carried out liberalisation in their electricity sectors. Other variables of liberalisation such as ownership structure (ows), regulatory agency (rga) and vertical integration (verti) also have similar mean, minimum and maximum, indicating the intensity of electricity market liberalisation in the region. Similarly, the average net official development assistance is U$109.27 million and it fluctuates between a minimum of U$14.16 million and a maximum of U$3632.88 million. Again, this shows large disparity in terms of net development assistance inflow in the region. Further, the mean value of government effectiveness and political stability are below 35%, indicating that most of the countries in the region are still politically unstable with ineffective government policies. In the same vein, the mean value of corruption control is below 35%, implying the pervasiveness of corruption in the region. More so, GDP per capita averages U$2319.74, with a maximum of U$20333.94 and a minimum of U$161.3. Again, this illustrates the uneven economic development in the region.

Markedly, it can be observed from Table 4.1 that the mean values of all the variables employed are not too different from their respective median values. This illustrates the absence of excessive outlier and an indication of the stability of the variables. More so, the standard deviation, skewness and kurtosis of the main variables in the model imply that the distribution of the variables approaches normal distribution with a moderate variance.

**Table 4.1: Summary Statistics of Electricity Performance and its Determinants**

| Variables | Mean | Median | Max. | Min. | Std. Dev. | Skewness | Kurtosis | Jarque-Bera | Prob. | Obs |
|---|---|---|---|---|---|---|---|---|---|---|
| egpc (kWh) | 806.32 | 147.81 | 12261.20 | 19.63 | 1899.44 | 3.80 | 18.45 | 9631.89 | 0.00 | 838 |
| ecpc (kWh) | 477.97 | 139.32 | 4875.11 | 11.59 | 853.64 | 3.52 | 16.31 | 7369.83 | 0.00 | 838 |
| igcpc (kWh) | 0.18 | 0.04 | 2.36 | 0.09 | 0.39 | 3.83 | 18.08 | 3302.13 | 0.00 | 838 |
| oelx (0-6) | 2.12 | 1.93 | 4.67 | 0.50 | 1.12 | 0.73 | 2.52 | 77.04 | 0.00 | 838 |
| ows (0-6) | 1.94 | 1.88 | 4.50 | 0.50 | 1.02 | 0.38 | 2.17 | 40.70 | 0.00 | 838 |
| verti (0-6) | 2.39 | 2.01 | 5.50 | 0.50 | 1.54 | 1.51 | 4.04 | 332.57 | 0.00 | 838 |
| rga (0-6) | 2.85 | 1.74 | 5.50 | 0.50 | 1.45 | 0.51 | 2.32 | 49.39 | 0.00 | 838 |
| nda (US$ mil) | 109.27 | 50.16 | 3632.88 | 14.16 | 321.03 | 6.80 | 56.53 | 9131.65 | 0.00 | 838 |
| popgr(%) | 2.58 | 2.69 | 7.92 | 1.99 | 0.99 | 1.96 | 21.70 | 1861.14 | 0.00 | 838 |
| corrc (%) | 34.53 | 30.73 | 85.85 | 0.47 | 23.34 | 0.40 | 1.95 | 56.56 | 0.00 | 838 |
| gdpca (US$) | 2319.74 | 1064.29 | 20333.94 | 161.3 | 3017.58 | 2.70 | 11.77 | 3448.89 | 0.00 | 838 |
| govte (%) | 32.61 | 27.80 | 81.25 | 1.44 | 21.23 | 0.50 | 2.08 | 60.22 | 0.00 | 838 |
| psav(%) | 34.91 | 31.96 | 92.78 | 2.94 | 23.47 | 0.41 | 2.28 | 38.61 | 0.00 | 838 |

*Source: Authors' computation using Eviews 9.*

## 4.2 Panel Unit Root Test

Most economic variables evolve, grow and change overtime in real and nominal terms. Consequently, running a regression among such variables with the false assumption that they are stationary will result to spurious regression. Thus, any analysis, forecast and policy recommendation based on such results would be misleading. Against this backdrop, the Levin, Lin and Chu test and the Im, Persaran and W-test were adopted to test for the stationarity of the variables.

The two approaches employed for the stationarity test, produced consistent results. The results indicated that the null hypothesis that all the variables are stationary at levels could be rejected except for installed electricity generating capacity per capita (igcpc), net official development assistance (nda), GDP per capita (gdpca) and government effectiveness (govte). Specifically, electricity generation per capita, electricity consumption per capita, ownership structure and vertical integration were stationary after first difference. Similarly, overall electricity liberalisation (oelx), corruption control (corrc), government effectiveness (govte), population growth (popgr), and political stability and absence of violence (psav) were also stationary after first difference. However, Kao (1999) showed that estimates of the structural parameter combining two independent non-stationary variables collapse to zero if it is panel data, but it is a random variable if it is a time series data. This suggeststhat the point estimates of the value of parameters of non-stationary panel data may be consistent, although, its standard errors may be biased.

**Table 4.2: The Unit Root Test Results for the Selected Variables**

| Variable | | Levin, Lin and Chu test | Im, Pesaran and Shin W-test | Conclusion |
|---|---|---|---|---|
| egpc | Level | -1.98 | -0.27 | I(1) |
| | I$^{st}$ difference | -2.15 | -2.47 | |
| ecpc | Level | 1.37 | 2.99 | I(1) |
| | I$^{st}$ difference | -2.7 | -3.02 | |
| igcpc | Level | -4.21 | -3.56 | I(0) |
| ows | Level | -0.38 | -1.15 | I(1) |
| | I$^{st}$ difference | -5.29 | -3.79 | |
| verti | Level | 0.15 | 0.68 | I(1) |
| | I$^{st}$ difference | -1.85 | -1.99 | |
| rga | Level | 0.76 | 1.02 | I(1) |
| | I$^{st}$ difference | -2.62 | -3.45 | |
| oelx | Level | 0.42 | 1.63 | I(1) |
| | I$^{st}$ difference | -2.13 | -3.93 | |
| nda | Level | -3.42 | -2.91 | I(0) |
| corrc | Level | -1.4 | -0.55 | I(1) |
| | I$^{st}$ difference | -2.2 | -4.05 | |
| popgr | Level | -1.09 | -0.68 | I(1) |
| | I$^{st}$ difference | -11.99 | -14.73 | |
| gdpca | Level | -9.52 | -7.06 | I(0) |
| psav | Level | -2.01 | -2.63 | I(1) |
| | I$^{st}$ difference | -6.13 | -5.97 | |
| govte | Level | -3.04 | -1.82 | I(0) |

*Source: Author's Computation using Stata 15*

*Note: The critical values are -3.74, -2.85 and -2.63 at 1%, 5% and 10% significance levels respectively.

## 4.3 Correlation Analysis

Correlation shows the strength of a relationship between variables. It evaluates the degree of association between two variables. The correlation matrices of the three indicators of electricity performance and its determinants are presented in Tables 4.3a, 4.3b and 4.3c. In these tables, the various correlation coefficients show positive and negative relations between per of variables.

As demonstrated in Table 4.3a electricity generation per capita (egpc) has a moderate positive relationship with net development assistance and a weak positive association with ownership structure (ows) and GDP per capita (gdpca). In the same vein, it is positively but weakly associated with overall electricity liberalisation (oelx), vertical integration (verti), government effectiveness (govte), regulatory agency (rga) and political stability and absence of violence (psav). On the other hand, its association with corruption control (corrc) and population growth (popgr) were negative and weak. Similarly, in Table 4.2b, installed generating capacity per capita (igcpc) has a week positive association with most of the independent variables such as; GDP per capita, net development assistance, ownership structure, government effectiveness, overall electricity liberalisation, amongst others.

On the other hand, it is negatively but weakly associated with vertical integration and population growth. Again, in Table 4.3c, electricity consumption per capita (ecpc) is negative and weakly correlated with ownership structure, net development assistance, corruption control and population growth. On the flip side, it is positively but moderately associated with government effectiveness and weakly associated with GDP per capita, overall electricity liberalisation and regulatory agency, vertical integration, as well as political stability and absence of violence. Thus, there is need to further examine these variables to ascertain their individual impacts in the model.

**Table 4.3a: Correlation Matrices of EGPCand its Determinants**

| | egpc | gdpca | govte | nda | oelx | ows | popgr | psav | rga | verti | corrc |
|---|---|---|---|---|---|---|---|---|---|---|---|
| egpc | 1 | | | | | | | | | | |
| gdpca | 0.2493 | 1 | | | | | | | | | |
| govte | 0.1788 | 0.1840 | 1 | | | | | | | | |
| nda | 0.5294 | -0.0069 | -0.0854 | 1 | | | | | | | |
| oelx | 0.0916 | -0.0284 | 0.0029 | -0.0233 | 1 | | | | | | |
| ows | 0.2659 | 0.0751 | 0.0215 | 0.1090 | 0.5174 | 1 | | | | | |
| popgr | -0.1836 | -0.0504 | -0.3182 | 0.0247 | -0.0220 | -0.0638 | 1 | | | | |
| psav | 0.0750 | 0.3505 | 0.6239 | -0.0497 | -0.1543 | -0.0526 | -0.1928 | 1 | | | |
| rga | 0.0962 | -0.1383 | 0.0546 | -0.0103 | 0.7555 | 0.4439 | -0.0601 | -0.1093 | 1 | | |
| verti | 0.0666 | 0.0188 | -0.0592 | -0.1126 | 0.6298 | 0.5120 | 0.0507 | -0.1977 | 0.4948 | 1 | |
| corrc | -0.0583 | 0.1011 | 0.6285 | -0.1484 | -0.1091 | -0.0797 | -0.3308 | 0.2755 | 0.0168 | -0.2002 | 1 |

*Source: Author's Computation using Eview 9*

**Table 4.3b: Correlation Matrices of IGCPC and its Determinants**

| | Igcpc | gdpca | govte | nda | oelx | ows | popgr | psav | rga | verti | Corrc |
|---|---|---|---|---|---|---|---|---|---|---|---|
| igcpc | 1 | | | | | | | | | | |
| gdpca | 0.2387 | 1 | | | | | | | | | |
| govte | 0.1483 | 0.1840 | 1 | | | | | | | | |
| nda | 0.1901 | -0.0069 | -0.0854 | 1 | | | | | | | |
| oelx | 0.0555 | -0.0284 | 0.0029 | -0.0233 | 1 | | | | | | |
| ows | 0.2222 | 0.0751 | 0.0215 | 0.1090 | 0.5174 | 1 | | | | | |
| popgr | -0.1566 | -0.0504 | -0.3182 | 0.0247 | -0.0220 | -0.0638 | 1 | | | | |
| psav | 0.0602 | 0.3505 | 0.6239 | -0.0497 | -0.1543 | -0.0526 | -0.1928 | 1 | | | |
| rga | 0.0584 | -0.1383 | 0.0546 | -0.0103 | 0.6055 | 0.4439 | -0.0601 | -0.1093 | 1 | | |
| verti | -0.0806 | 0.0188 | -0.0592 | -0.1126 | 0.6298 | 0.5120 | 0.0507 | -0.1977 | 0.49477 | 1 | |
| corrc | -0.0261 | 0.1011 | 0.6285 | -0.1484 | -0.1091 | -0.0797 | -0.3308 | 0.2755 | 0.01680 | -0.2002 | 1 |

*Source: Author's Computation using Eview 9*

**Table 4.3c: Correlation Matrices of ECPC and its Determinants**

| | Ecpc | gdpca | govte | nda | Oelx | ows | popgr | psav | rga | Verti | Corrc |
|---|---|---|---|---|---|---|---|---|---|---|---|
| ecpc | 1 | | | | | | | | | | |
| gdpca | 0.4351 | 1 | | | | | | | | | |
| govte | 0.5482 | 0.1840 | 1 | | | | | | | | |
| nda | -0.0604 | -0.0069 | -0.0854 | 1 | | | | | | | |
| oelx | 0.1347 | -0.0284 | 0.0029 | -0.0233 | 1 | | | | | | |
| ows | -0.1513 | 0.0751 | 0.0215 | 0.1090 | 0.5174 | 1 | | | | | |
| popgr | -0.3226 | -0.0504 | -0.3182 | 0.0247 | -0.0220 | -0.0638 | 1 | | | | |
| psav | 0.2659 | 0.3505 | 0.6239 | -0.0497 | -0.1543 | -0.0526 | -0.1928 | 1 | | | |
| rga | 0.1075 | -0.1383 | 0.0546 | -0.0103 | 0.6055 | 0.4439 | -0.0601 | -0.1093 | 1 | | |
| verti | 0.0920 | 0.0188 | -0.0592 | -0.1126 | 0.6298 | 0.5120 | 0.0507 | -0.1977 | 0.4948 | 1 | |
| corrc | -0.4402 | 0.1011 | 0.6285 | -0.1484 | -0.1091 | -0.0797 | -0.3308 | 0.2755 | 0.0168 | -0.2002 | 1 |

*Source: Author's Computation using Eview 9*

### 4.4 Results of the Two-Step System GMM Estimation

In examining electricity market liberalisation and the sector's performance in SSA, three models are estimated for each of the dependent variables measuring electricity sector's performance, namely; electricity generation per capita (egpc), installed generation capacity per capita (igcpc) and electricity consumption per capita (ecpc). The essence ofestimating these three models is to ensure robustness in the study. Each model consists of two sub-groups of explanatory variables: one for electricity market liberalisation variables (verti, ows, rga and oelx) and the other for economic and institutional variables (gdpca, nda, corrc, popgr, psav and govte). However, in order to minimize the heterogeneous effects on the aggregate result due to differences in electricity sector performance, industry composition and resource endowment, this study further disaggregated the analysis into various sub groupings in the region namely; low income countries, moderate electricity liberalised countries, middle income countries, and low electricity liberalised countries.

Markedly, the System Generalized Method of Moments estimator is dependent on two main specification tests; First, the Hansen test for over-identification restrictions and the Arellano and Bond (1991) test for serial correlation (AR) of the disturbances up to the second order. The Hansen test of over-identification restrictions is a joint test of model specification and suitability of the instrument vector. If the null hypothesis is not rejected, it indicates that the instruments used in estimation are valid and the model is correctly specified. The appropriate check of the Arellano and Bond (1991) test for serial correlation (AR) relates only to the absence of second-order serial correlation (AR2), since the first differencing induces first serial correlation in the transformed errors. Further, the autocorrelation tests (AR1 and AR2) revealed the absence of second order serial correlation problems.

#### 4.4.1 Results for the Aggregate SSA Countries

The results for the aggregate SSA countries reported in Table 4.4 reveals that one period lag for all the dependent variables are positive and significant, implying a reasonable degree of persistence. In the same vein, the overall electricity market liberalisation is significant in both electricity generation per capita and installed generating capacity per capita. This is in alignment to the findings by Zhang et al. (2008), and Akkemik, and Oguz, (2011) that in developing countries, electricity market liberalisation and competition have resulted in improved operating capacity and increased output. However, the coefficient of overall electricity market liberalisation is not significant in electricity consumption per capita. This is not unanticipated given that most of the electricity generated in the region do not get to the final consumers, due to transmission and output losses. The summary of the results in each of the models are presented below.

#### 4.4.1.1 Results for Electricity Generation Per Capita (egpc)

The results for electricity generation per capita reveal that most of the explanatory variables are statistically significant and plausibly signed. Markedly, the coefficient of overall electricity market liberalisation is positive and significant at 1%. This finding is in alignment with theory. In terms of magnitude, a unit increase in overall electricity market liberalisation, triggers 1.2% rise in per capita electricity generation. This implies that electricity market liberalisation is an effective driver of electricity generation in SSA. The positive significance of the estimated coefficient of vertical integration and ownership structure, suggest that electricity generation per capita increases as the sector is increasingly unbundled away from public monopoly and tilting towards private ownership. The results further indicate that a unit increase in vertical integration and private ownership increase electricity generation per capita by 0.34% and 2.3% respectively. An explanation for this outcome could be that the influx of private investors into the electricity sector increases electricity generation. This is plausible given that the core objective of private investors is output and profit maximization. This result conforms to theoretical revelation as evident in Erdodgu (2014).

Further, the coefficient of regulatory agency is positive but not significant. Again, this result is not surprising given the extent of independence of electricity regulatory agencies in Sub-Saharan Africa. As argued by Michael (2016), effective independent regulatory framework must be established in order to attain a competitive electricity sector. Suggesting that establishing an independent regulator in place of direct government department regulation, improves electricity generation per capita. In the same vein, a well-designed regulatory system shields investors from arbitrary political interference, while also protecting consumers from undue exploitation by the investors. More so, considering the effect of economic and institutional variables, GDP per capita and political stability are shown to have significant positive effect on electricity generation per capita. As expected, the larger the degree of industrialization in a country, the higher the average quantity of electricity generation available to each citizen. On the other hand, population growth has a negative effect on electricity generation per capita. This result is intuitively appealing given the quantity of electricity generated and the upsurge in population across the region.

#### 4.4.1.2 Results for Installed Generation Capacity Per Capita (igcpc)

The results for installed generation capacity per capita are also similar to those of electricity generation per capita. Again, the coefficient of overall electricity market liberalisation is significant at 10%, implying that installed generation per capita increases by 0.6% as the structure of the electricity sector becomes one unit more liberal. However, the coefficients of ownership structure and vertical integration are negative. The negative coefficients of these variables imply that an increase in private ownership and unbundling of the electricity sector, would deteriorate the installed generation capacity per capita by an amount of 0.03% and 0.05% respectively. Thisresult is counter intuitive and it is not in alignment with theoretical expectations (see Erdogdu,2014a). A plausible explanation could be that institutional deficiencies, absence of appropriate regulation and unhealthy business environment could discourage private investment on capacity expansion. The opposite holds in a situation where a well-functioning regulation and effectiveness of institutions could mitigate investment risk and provide the necessary incentives for private investment. This is shown in Cubbin and Stern (2006) that controlling for other relevant variables and allowing for country specific fixed effects, a regulatory law and higher quality governance is positively and significantly associated with higher per capita generation capacity levels and higher generation capacity utilization rates.

In the same vein, turning to institutional and economic variables, the coefficient of corruption control is significant and negative, implying that the pervasiveness of corruption depreciates installed generation capacity per capita. This is not surprising, given the widespread corruption in the region. Further, the coefficient of net development assistance is positive and statistically significant at 5%. In terms of magnitude, a unit increase in net development assistance, increases installed generation per capitaby 0.07%. This finding conforms to the result of Erdogdu (2014) that foreign development aid increases the extent of electricity market reforms, thereby leading to capacity expansion. Also, foreign aid is of high importance given the poor situation of electricity sectors in many developing countries and the magnitude of resources that are required to transform the sector to deliver necessary outcomes for increased electrification. This result seems plausible, if the bulk of the net development inflow in the region is adequately and effectively channeled to the electricity sector. However, the result could not establish any significant effects of; political stability, GDP per capita and government effectiveness on installed generation capacity per capita.

#### 4.4.1.3 Results for Electricity Consumption Per Capita (ecpc)

In the result for electricity consumption per capita, the coefficient of overall electricity market liberalisation is positive but not significant. This result is not unanticipated given the electricity consumption experience in SSA, where access, availability and quality of electricity consumed are fraught with several challenges such as; shortages of gas supplies, poorly maintained distribution networks, transmission and output losses amongst others. These recurrent phenomena are mostly noticeable in Botswana, Ethiopia, Senegal, Mali Nigeria, Zimbabwe, Congo Rep, Gabon etc. The results further indicate that vertical integration is positive and significant at 10%. The significance of vertical integration could be that unbundling of the electricity sector into separate segment of distribution, transmission and generation could strengthen the distribution network, thereby enhancing the quality and quantity of electricity delivered to the consumers. Additionally, regulatory agency is statistically significant at 10%, implying that a unit increase in the effectiveness of independent regulation, improves electricity consumption per capita by 0.18%. This is in line with theory, given that the independent effective regulation can provide substantial monitoring on the quantity and quality of the electricity delivered to the consumer.Again this result is counterintuitive in SSA because independent regulation has not been effective enough in designing appropriate regulatory framework to monitor or gauge the quantity and quality of electricity consumed by the customers. Besides, most of the regulatory agencies are still not independent as they operate under ministerial controls.

The result further indicates that institutional and economic variables namely, corruption and population growth have significant negative effects on electricity consumption per capita at 5% and 1% respectively. The negative coefficients of these variables are quit anticipated given the peculiarity of the countries in the region. As revealed in the result, a unit increase in corruption and population growth, decrease electricity consumption per capita by 0.12% and 0.30% respectively. However, the negative relation between population growth and electricity consumption percapita is not consistent with the findings of Mohammed, et al. (2016), who opined that electricity consumption grows directly and significantly with population growth. A probable reason for the negative effect of population growth on electricity consumption per capita in SSA could be that while population has been on the steady increase, electricity supply shortages are still prevalent in the region. Again, the result also shows that political stability and absence of violence has a positive effect on electricity consumption per capita at 10% level of significance. This result is in line with empirical evidence asrevealed in Helene, et al. (2015) that political stability and institutional quality have significant positive effects on per capita household consumption of electricity

**Table 4.4: Two-Step System GMM Results for all the Selected Countries**

| Dependent Variables | Inegpc | Inigcpc | Inecpc |
|---|---|---|---|
| Cons | 2.4541<br>(0.60) | 0.0114*<br>(2.93) | 4.3604*<br>(3.24) |
| Inegpc (-1) | 1.0288*<br>(3.62) | | |
| Inigcpc (-1) | | 0.9752**<br>( 2.05) | |
| Inecpc (-1) | | | 0.5833**<br>(2.17) |
| **Electricity Liberalisation variables** | | | |
| verti | 0.3449**<br>(2.01) | -0.0586*<br>(-3.52) | 2.3741***<br>(1.93) |
| ows | 2.3011**<br>(2.14) | -0.0389***<br>(-1.90) | 1.2334<br>(0.95) |
| rga | 0.6511<br>(0.38) | 0.0283<br>(0.69) | 0.1821***<br>(1.76) |
| oelx | 1.2096*<br>(4.63) | 0.0671***<br>(1.88) | 1.7284<br>(1.09) |
| **Institutional and Economic variables** | | | |
| gdpca | 0.0431**<br>(2.33) | 1.8980<br>(1.09) | 0.0139<br>(0.11) |
| nda | 0.0216<br>(1.46) | 0.0742**<br>(1.99) | 0.0927<br>(1.23) |
| corrc | 0.0547<br>(1.09) | -0.0134**<br>(2.14) | -0.1281**<br>(-2.28) |
| popgr | -2.0447**<br>(-2.42) | -0.0821<br>(0.60) | -0.3042*<br>(-3.87) |
| psav | 0.3299**<br>(2.24) | 0.0177<br>(0.90) | 0.1146***<br>(1.87) |
| govte | -0.1061<br>(-1.00) | 0.0441<br>(1.06) | 0.3176<br>(0.27) |
| Hansen test | 2.349<br>[1.000] | 2.75<br>[0.934] | 1.71<br>[1.000] |
| AR(1) | -1.12<br>[0.064 ] | -1.33<br>[0.185] | -1.93<br>[0.048] |
| AR(2) | 0.92<br>[ 0.358 ] | -0.62<br>[0.610] | -1.43<br>[0.490] |

Note: The dependent variables are natural log of electricity generation per capita (egcp), installed generation capacity per capita (igcpc) and electricity consumption per capita (ecpc). The t-ratios are in parenthesis, while the figures in bracket are the p values for Hansen test and serial correlation test. *, ** and *** represent statistical significance at 1%, 5% and 10% respectively.

### 4.4.2 Results for Middle Income Countries

#### 4.4.2.1 Results for Electricity Generation Per Capita (egpc)

As shown in Table 4.5, the results reveal that the lagged value of electricity generation per capita is significant and positive at 1%. The magnitude of the coefficient suggests that electricity generation per capita has been persistent. The results further show that vertical integration and ownership structure have positive and significant effects on electricity generation per capita. In terms of magnitude, a unit increase in vertical integration and ownership structure would improve electricity generation per capita by 0.8% and 0.14% respectively. This result corroborates with the findings of Meletioua, et al**.** (2018), Akkemikand Oguz, (2011). Again, the coefficient of overall electricity market liberalisation is shown to be positively significant at 10%. The size of the coefficient suggests that electricity reform could marginally increase electricity output in middle income countries of SSA.

However, the coefficient of regulatory agency is not significant in the model. The effects of some economic and institutional variables were also shown to be significant in the model. Notably, GDP per capita, political stability and government effectiveness have significant effects on electricity generation per capita. Although it is possible that the impact of these variables could not be overtly noticeable because of the peculiarity and the structure of the electricity sectors in the region, the result is consistent with the findings of Anupama, et al. (2016) who found that institutional and economic factors have significant influence on electricity output. However, the impacts of net official development assistance, population growth and corruption control are found to have no significant effects in the model.

#### 4.4.2.2 Results for Installed Generation Capacity Per Capita (igcpc)

The results for installed generation capacity per capita indicate that vertical integration has a positive and significant effect on installed generation capacity per capita. The significance of vertical integration may not be unconnected with the fact that, the unbundling of the electricity sector into separate segment of; generation, transmission and distribution, could strengthen the generation segment, thereby enhancing the quality of investment in installed capacity. However, ownership structure is shown to have asignificant negative effect on installed generation capacity per capita. The negative sign of ownership structure is quite unexpected and surprising. Economic theories support the view that increasing privatization of the electricity sector would increase installed generation capacity per capita as evident in Pollitt, (2007).A probable reason for the inverse relationship between ownership structure and installed generation capacity per capita could be that private sector investment might be restrained on investing in generation capacity especially when considering the likely returns on investment, thus this might deteriorate installed generation capacity per capita. Further, the result also indicates that regulatory agency and overall electricity market liberalisation do not have effect on installed generation capacity per capita. More so, considering the effect of economic and institutional variables, the result show that net development assistance has a significant positive effect on installed generation capacity per capita.

On the other hand, corruption is shown to have a significant negative effect on installed generation capacity per capita. In terms of magnitude, a unit increase in corruptiondepreciates installed generation capacity per capita by 0.3%.This result is consistent with both a priori expectation and empirical evidence. As demonstrated in Kihwele,et al. (2012),corruption,poor management and electricity theft contribute to lack of investment in generation capacity. However, the study could not detect any significant impact of the other institutional and economic variables such as; GDP per capita, government effectiveness, population growth and political stability on installed generation capacity in middle income countries.

#### 4.4.2.3 Results for Electricity Consumption Per Capita (ecpc)

As displayed in Table 4.5 (column 4), the results for electricity consumption per capita show that vertical integration exerts significant positive influence on electricity consumption per capita. The significance of the vertical integration implies that the unbundling of the electricity sector and further strengthening of the distribution segment of the electricity industry could increase electricity consumption per capita. Although, this result concurs with some empirical findings (see Anupama, et al. (2016), it does not express the current situation in these middle income countries where electricity supply outcomes seem not to have significantly improved. The results also indicate that regulatory agency has a significant positive effect on electricity consumption per capita. However, the positive significance of the regulatory agency suggests that a unit increase in effective independent regulation, would improve electricity consumption per capita by 0.22%. This result is in alignment with theory, although, it is appeared to be counterintuitive in SSA because independent regulation has not been effective enough in guaranteeing adequate electricity consumption in the region. In addition, the signs of overall electricity market liberalisation and ownership structure are consistent with a priori expectations but their coefficients are not statistically significant.

Again, it is noticed that institutional and economic variables such as population growth and corruption control exert significant negative influence on electricity consumption per capita at 10% level. Given this scenario, it is not surprising to find that an increase in corruption reduces electricity consumption per capita. A further implication of the negative effect of population growth on electricity consumption per capita could be that while population has been on the steady increase, electricity supply shortages are still prevalent in middle income countries. More so, the coefficient of political stability and absence of violence is also shown to have a positive significant effect on electricity consumption per capita. This result corroborates the findings of Helene, et al. (2015) who found that political stability and institutional quality have significant positive effects on per capita household consumption of electricity.

**Table 4.5: Two-Step System GMM Results for Middle Income Countries**

| Dependent Variables | lnegpc | lnigcpc | lnecpc |
|---|---|---|---|
| Cons | 1.7294**<br>(2.24) | -0.0487<br>(0.35) | 2.1101*<br>(3.41) |
| lnegpc (-1) | 1.6237*<br>(3.03) | | |
| lnigcpc (-1) | | 0.2106*<br>(2.87) | |
| lnecpc (-1) | | | 0.8988<br>(1.21) |
| **Electricity liberalisation variables** | | | |
| verti | 0.8057*<br>(3.17) | 0.1078**<br>(2.19) | 0.4331***<br>(1.86) |
| ows | 0.1416**<br>(2.01) | -0.0362*<br>(-2.95) | 1.3729<br>(1.11) |
| rga | 0.9601<br>(0.10) | 0.0134<br>(0.52) | 0.2277**<br>(2.28) |
| oelx | 0.0416***<br>(1.92) | 0.0811<br>(0.74) | 0.4322<br>(0.57) |
| **Institutional and Economic variables** | | | |
| gdpca | 0.0239*<br>(3.71) | 0.4807<br>(1.42) | 0.0038<br>(0.79) |
| nda | 0.0111<br>(1.10) | 0.1183***<br>(1.91) | 0.0981<br>(0.42) |
| corrc | 0.0237<br>(1.28) | -0.344***<br>(-1.96) | -0.5211***<br>(-1.83) |
| popgr | - 1.1668<br>(-0.56) | 0.0312<br>(0.40) | -0.0618***<br>(-1.95) |
| psav | 1.0950*<br>(2.99) | -1.2701<br>(-0.15 | 0.0395*<br>(2.73) |
| govte | 0.7364**<br>(2.27) | 2.0194<br>(1.32) | 0.0523<br>(0.81) |
| Hansen test | 7.94<br>[0.998] | 1.59<br>[0.963] | 4.92<br>[1.000] |
| AR(1) | -1.10<br>[ 0.027] | -1.32<br>[0.187] | -2.43<br>[0.015] |
| AR(2) | 0.82<br>[ 0.357 ] | -0.65<br>[0.517] | -1.30<br>[0.495] |

Note: The dependent variables are natural log of electricity generation per capita (egcp), installed generation capacity per capita (igcpc) and electricity consumption per capita (ecpc). The t-ratios are in parenthesis, while the figures in bracket are the p values for Hansen test and serial correlation test. *, ** and *** represent statistical significance at 1%, 5% and 10% respectively.

### 4.4.3 Results for Low Income Countries

#### 4.4.3.1 Results for Electricity Generation Per Capita (egpc)

The empirical result for low income countries is reported in Table 4.6. The result displayed seemingly similar characteristics with the results obtained in middle income countries. Markedly, one period lagged electricity generation and installed generation capacity per capita have positive effects on their current performance, implying a reasonable degree of persistence among the variables. On the contrary, one period lagged electricity consumption per capita does not have significant effect on current electricity consumption per capita.Further, the estimated coefficients of vertical integration and ownership structure are statistically significant at 5% and 10% respectively. The statistical significance of these variables imply their crucial role in explaining the behaviour of electricity generation per capita in low income countries of SSA. However, the coefficients of regulatory agency and overall electricity market liberalisation turned out positive but not significant. This is probably because electricity liberalisation in these countries has not been deeply implemented in such a way that will improve electricity generation per capita in low income countries.

More so, in examining the effects of economic and institutional variables, the results indicate that corruption has significant negative effects on electricity generation per capita in low income countries. This result is however, not unanticipated given the prevalence of corruption in the region. More so, the coefficient of net development assistance is positive and significant. This result suggests that foreign aid is very instrumental to the development of the electricity sectors in low income countries of SSA. This is illustrated in Easterly, (2013) that low income countries or indebted countries may be more likely to enact donor-initiated electricity sector reforms in order to access funds for necessary infrastructure projects, especially since alternative options for capital and technical assistance are usually limited in these countries. In addition, the result revealed that political stability and absence of violence has positive effect on electricity generation per capita. Government effective and population growth were found to have insignificant effects on electricity generation per capita.

#### 4.4.3.2 Results for Installed Generation Capacity Per Capita (igcpc)

As displayed in Table 4.6, the results indicate that ownership structure is significant and have positive impact on installed generation capacity per capita. In terms of magnitude, a one unit increase in private ownership would improve installed generation capacity per capita by 0.8%. This finding is in alignment with empirical evidence, given that one of the objectives of electricity market liberalisation is that it will lead to more capital investment by the private investors (see Zhang, et al., 2008). However, the coefficients of overall market liberalisation, vertical integration and regulatory agency have the expected positive signs but are not significant in explaining the behaviour of installed generation capacity per capita in low income countries. The effects of some economic and institutional variables were also shown to be significant in determining the behaviour of installed generation capacity per capita. Notably, the coefficients of net development assistance and government effectiveness were found to be significant. Intuitively, the positive significance of the coefficient of net development assistance further intensifies the relevance of foreign aid to installed electricity generation capacity in low income countries.

Expectedly, the coefficient of corruption is shown to have negative significant effect on installed generation capacity per capita. However, the negative coefficient of corruption control is in line with empirical findings as evident in Kihwele, et al. (2012). Further, the study could not establish any significant effects of; GDP per capita, population growth and political stability on installed generation capacity per capita in low income countries.

#### 4.4.3.3Results for Electricity Consumption Per Capita (ecpc)

The results for electricity consumption per capita as indicated in Table 4.6 show that ownership structure and independent regulatory agency have significant positive effect on electricity consumption per capita. This result suggests that private investment in the electricity sector together with effective independent regulatory agency is connected with increased electricity consumption per capita. This result is supported by the findings of Michael and Thanasis (2017), that the transfer of the state-run electricity sector into a more competitive and privatized scheme, increases the performance of the electricity sector, thus increasing electricity consumption. Again, the coefficient of overall electricity market liberalisation and vertical integration are rightly signed but not significant in low income countries.

Further, considering the effect of economic and institutional variables, the result indicates that net development assistance has significant positive effect on electricity consumption per capita. In terms of the magnitude, a unit increase in net development assistance would result in 0.28% increase in electricity consumption. This result is similar to the finding of Erdogdu (2014), who found that countries that are recipient of foreign financial aid are more likely to have better improvement in their power supply. This implies that rrfinternational donor agencies influence electricity sector performancethrough financial supports.

The result also shows that population growth and corruption control exert significant negative influence on electricity consumption per capita. As earlier justified, the negative coefficient of population growth does not conform to theoretical expectations, however, that of corruption control is in line with theory. However, the negative effect of corruption on electricity consumption is not surprising given the widespread corruption in the region. A plausible implication of the negative effect of population growth on electricity consumption per capita could be that while population has been on the steady increase, electricity supply shortages are still prevalent in low income countries.

**Table 4.6: Two-Step System GMM Results for Low Income Countries**

| Dependent Variables | Inegpc | Inigcpc | Inecpc |
|---|---|---|---|
| Cons | -2.714<br>(1.32) | -0.0926<br>(-0.64) | 2.9712<br>(1.66) |
| Inegpc (-1) | 0.9024*<br>(2.76) | | |
| Inigcpc (-1) | | 0.4308*<br>(3.33) | |
| Inecpc (-1) | | | 0.4860***<br>(1.86) |
| **Electricity Liberalisation Variables** | | | |
| verti | 0.2159**<br>(2.10) | 0.0772<br>(1.08) | 0.4929<br>(1.41) |
| ows | 1.4781***<br>(1.99) | 0.0816***<br>(1.91) | 0.0210*<br>(3.17) |
| rga | 0.5627<br>(0.92) | 0.0533<br>(1.63) | 0.1317**<br>(2.38) |
| oelx | 1.0853<br>(0.66) | 0.0145<br>(0.91) | 1.0782<br>(0.06) |
| **Institutional and Economic variables** | | | |
| gdpca | 0.0574<br>(1.12) | 1.3307<br>(0.59) | 0.0054<br>(1.24) |
| nda | 0.7143*<br>(2.90) | 0.2106**<br>(2.35) | 0.2856*<br>(2.67) |
| corrc | -0.1724***<br>(-1.89) | -0.0160**<br>(-2.24) | -0.1843**<br>(-2.13) |
| popgr | -0.7834<br>(-0.46) | 0.0141<br>(1.15) | -0.0572*<br>(-2.93) |
| psav | 0.1620**<br>(2.43) | 2.9141<br>(1.44) | 0.0402<br>(0.34) |
| govte | 1.5691<br>(0.91) | 0.6629***<br>(1.87) | 0.7213<br>(0.11) |
| Hansen test | 2.33<br>[1.000] | 2.41<br>[1.000] | 1.64<br>[1.000] |
| AR(1) | -1.12<br>[0.026] | -2.18<br>[0.079] | 1.11<br>[0.013] |
| AR(2) | -0.71<br>[ 0.481] | 1.14<br>[0.367] | 2.27<br>[0.276] |

Note: The dependent variables are natural log of electricity generation per capita (egcp), installed generation capacity per capita (igcpc) and electricity consumption per capita (ecpc). The t-ratios are in parenthesis, while the figures in bracket are the p values for Hansen test and serial correlation test. *, ** and *** represent statistical significance at 1%, 5% and 10% respectively.

### 4.4.4 Results for Moderate Electricity Liberalised Countries

#### 4.4.4.1 Results for Electricity Generation Per Capita (egpc)

The results for moderate electricity liberalised countries are presented in Table 4.7. Markedly as displayed in Table 4.7, one time lagged dependent variables in the three models (egpc, igcpc, ecpc) are positive and significant, implying a reasonable degree of persistence.The results further indicate that overall electricity market liberalisation and vertical integration are both statistically significant at 1% level. This is in agreement with the findings of Pollitt, (2012); Zhang, et al., (2008) and, Akkemik and Oguz, (2011). These results suggest that an increase in overall electricity market liberalisation and vertical integration respectively improve electricity generation per capita. In the same vein, ownership structure and regulatory agency are also revealed to have significant positive impact on electricity generation per capita at 10% and 5% level respectively. This result suggests that the influx of private investment in the electricity sector together with effective independent regulatory agency are associated with increased electricity generation per capita. Expectedly, the positive significance of vertical integration, ownership structure, overall market liberalisation and regulatory agency, seem true from theoretical and empirical evidence. This is shown in Gore, et al. (2018), that liberalizing the electricity sectors would increase performance through market competition. This is plausible given that the core objective of private investors is output and profit maximization as evident in in Erdodgu, (2014).

In the same vein, considering the effect of economic and institutional variables, the results indicate that GDP per capita and political stability are indicated to have significant positive effects on electricity generation per capita. This result supports the proposition that the larger the degree of industrialization in a country, the higher the average quantity of electricity generated. However, the positive significance of political stability and absence of violence is in line with empirical findings (see Helene, et al., 2015). On the other hand, it is revealed that population growth has a negative effect on electricity generation per capita. This result is intuitively appealing given the upsurge in population across the region and the small quantity of electricity generated.

However, the coefficient of corruption control, government effectiveness and net development assistance are not significant. The statistically insignificance of net development assistance could suggest that for moderate electricity liberalised countries, foreign aid seems not to be channeled to the development of the electricity sectors.

#### 4.4.4.2 Results for Installed Generation Capacity Per Capita (igcpc)

Similar to the results obtained in electricity generation per capita above (Table 4.6), the results for installed generation capacity per capita show that vertical integration, overall electricity market liberalisation and regulatory agency have positive and significant effects on installed generation capacity per capita. Again these relationships portray the inter-linkage effects of electricity market liberalisation on the sector's performance in moderate electricity liberalised countries. This result corroborates the findings of Akkemik and Oguz (2011), that electricity sector liberalisation is found to result in efficiency gains in the electricity market, reductions in energy prices for households and improvement in utility level of the consumers. The significance of these variables haveimportant policy implications for many SSA countries that are currently undertaking electricity sector reforms.

Another variable that turn out positive though not significant is ownership structure. Also, the coefficients of net development assistance and corruption control are not significant. However, the coefficient of ownership structure turned out positive but not significant. Further, considering the effect of institutional and economic variables, the coefficient of corruption control is significant and negative, implying that the pervasiveness of corruption depreciates installed generation capacity per capita. However, this result is not unanticipated given the level of corruption in the region. More so, political stability and absence of violence are also shown to have significant and positive effect on installed generation capacity per capita. Nevertheless, the result could not establish any significant effects of; GDP per capita, government effectiveness, net development assistance, and population growth on installed generation capacity per capita.

#### 4.4.4.3 Results for Electricity Consumption Per Capita (ecpc)

The results for electricity consumption per capita as reported in Table 4.7 show that vertical integration, ownership structure and regulatory agency have positive significant effects on electricity consumption per capita. The positive significance of the regulatory agency is in line with theory, given that an independent effective regulation can provide substantial monitoring on the quantity and quality of the electricity delivered to the consumer. However, this result is counterintuitive in SSA because independent regulation has not been effective enough in designing appropriate regulatory framework to monitor the quality of electricity supplied to the consumers. Again, the positive significance of vertical integration could be attributed to the fact that the unbundling of the electricity industry into separate segment could strengthen the distribution network, thereby enhancing the quality and quantity of electricity delivered to the consumers. However, the coefficient of overall electricity market liberalisation is not significant though positive. This result is not unanticipated given the electricity consumption experience in SSA, where electricity supplies have been grossly inadequate.

The result further indicates that institutional and economic variables such as GDP per capita and political stability have significant positive effect on electricity consumption per capita. This result is in line with empirical evidence as revealed in Helene, et al. (2015) that political stability and institutional quality have significant positive effects on per capita household consumption of electricity. On the other hand, population growth and corruption have negative significant effects on electricity consumption per capita. As earlier stated, a plausible reason for the negative significance of population growth could be that while population is on the increasing trend, electricity supply has not kept pace with it. However, this is not the experience in developed countries as shown in Mohammed, et al. (2016) that electricity consumption grows with population.

**Table 4.7:Two-Step System GMM Results for Moderate Electricity Liberalised Countries**

| Dependent Variables | Inegpc | Inigcpc | Inecpc |
|---|---|---|---|
| Cons | 11.3083*** (1.87) | 0.0662*** (1.98) | 5.216*** (1.90) |
| Inegpc (-1) | 1.3647* (3.21) | | |
| Inigcpc (-1) | | 0.4982* (2.56) | |
| Inecpc (-1) | | | 0.9558* (4.81) |
| **Electricity Liberalisation Variables** | | | |
| verti | 1.8337* (3.21) | 0.0133** (2.07) | 1.4233** (2.17) |
| ows | 0.5216*** (1.89) | 0.0466 (1.28) | 2.3184* (2.96) |
| rga | 1.0403** (2.18) | 0.0813*** (1.99) | 0.7888* (4.07) |
| oelx | 2.1088* (2.97) | 0.0722** (2.31) | 2.6857 (0.92) |
| **Institutional and Economic Variables** | | | |
| gdpca | 0.5210*** (1.90) | 0.2881 (0.16) | 1.3885* (4.02) |
| nda | 0.0888 (0.71) | -0.0122 (-1.21) | 1.8411 (1.33) |
| corrc | 0.7724 (1.09) | -0.0313** (-2.21) | -0.0052 (-0.02) |
| popgr | -1.1713** (-2.02) | -0.1964 (-0.28) | -0.7273*** (-1.84) |
| psav | 0.0643* (3.83) | 0.1429*** (1.79) | 0.0302*** (1.96) |
| govte | 0.0276 (1.44) | 0.0131 (0.04) | 1.2021 (0.65) |
| Hansen test | 7.73 [0.999] | 2.51 [0.962] | 3.70 [1.000] |
| AR(1) | -1.31 [ 0.237] | -1.27 [-0.205] | -1.59 [0.111] |
| AR(2) | 0.95 [ 0.434 ] | -0.62 [0.533] | -1.60 [0.318] |

Note: The dependent variables are natural log of electricity generation per capita (egcp), installed generation capacity per capita (igcpc) and electricity consumption per capita (ecpc). The t-ratios are in parenthesis, while the figures in bracket are the p values for Hansen test and serial correlation test. *, ** and *** represent statistical significance at 1%, 5% and 10% respectively.

### 4.4.5 Results for Low Electricity Liberalised Countries

#### 4.4.5.1 Results for Electricity Generation Per Capita (egpc)

The results for low liberalised countries as presented in Table 4.8 show that most of the electricity market liberalisation variables are not statistically significant. This is probably because electricity market liberalisation in these countries has not been deeply implemented. Though, some remarkable progress has been made but the market still exhibit a high degree of public ownership. In most of these countries, government has continued to control a large share of the electricity market which does not allow for competitive activities. However, as the results reveal, vertical integration and regulatory agency have positive significant effect on electricity consumption per capita. Both variables are significant at 5%, in terms of the magnitude, a unit increase in vertical integration and independent effective regulatory agency would improve electricity consumption per capita by 0.4% and 0.08% respectively. On the other hand, the coefficients of ownership structure and overall electricity market liberalisation were not significant in the model.

However, considering the effects of some economic and institutional variables, the results indicate thatnet development assistance has a positive and significant effect on electricity generation per capita. This implies that foreign aid is very instrumental to the development of the electricity sectors in low electricity liberalised countries of SSA. Again, corruption is also shown to havesignificant negative effect on electricity generation per capita. This result is in line with theoretical and empirical postulations (see Kihwele, et al., 2012).However, this result is not unanticipated given the prevalence of corruption in the region. Further, the result revealed that government effectiveness has positive effect on electricity generation per capita. The result of this study is similar to that of Lagarto, et al. (2012) who argued that government effectiveness appears to explain more of the variation in electricity performance in SSA countries. On the other hand, population growth, GDP per capita and political stability were found to have insignificant effects on electricity generation per capita in low electricity liberalised countries.

#### 4.4.5.2 Results for Installed Generation Capacity Per Capita (igcpc)

The results for installed generation capacity per capita also depicted similar characteristics to those of electricity generation per capita. This may not be unconnected with the fact that the electricity sectors in these countries are less liberalised. As shown in Table 4.8, the results indicate that all the liberalisation variables were statistically insignificant except for ownership structure. However, the effect of ownership structure on installed generation capacity per capita turned out negative. The negative sign of ownership structure is not in alignment with theory. A plausible reason for this could be that private investment on capacity expansion has been on a decreasing trend due to the uncertainties that characterized the electricity industries in the region.

Again, some economic and institutional variables, such as net development assistance was shown to significantly and positively impact on installed generation per capita. This conforms to a priori expectations implying that a large portion of foreign aid received in these countries is channeled to boosting installed generation per capita. Intuitively, the positive significance of the coefficient of net development assistance further intensifies the relevance of foreign aid to installed electricity generation capacity in low income countries. Expectedly, the coefficient of corruption is shown to have negative significant effect on installed generation capacity per capita.

#### 4.4.5.3 Results for Electricity Consumption Per Capita (ecpc)

Similar to the above results, the result for electricity consumption per capita (ecpc) also indicates that all the liberalisation variables were statistically insignificant except for vertical integration. In terms of the magnitude, a unit increase in vertical integration would improve electricity consumption per capita by 0.8%. As earlier suggested, a probable reason for the positive effect of vertical integration on electricity consumption per capita could be that the unbundling of the electricity sector could strengthen the distribution segment of the electricity industry, thereby increasing electricity consumption per capita. Although, this result concurs with some empirical findings (see Anupama, et al., 2016), it does not express the current situation in these countries where electricity supply outcomes seem not to have significantly improved.

Further, considering the effect of economic and institutional variables, the result indicates that political stability and absence of violence has significant positive effect on electricity consumption per capita. On the other hand, population growth and corruption control exert significant negative influence on electricity consumption per capita. As earlier justified, the negative coefficient of population growth does not conform to theoretical expectations, however, that of corruption control is in line with theory. However, the negative effect of corruption on electricity consumption is not surprising given the widespread corruption in the region. A plausible reason for the negative effect of population could be that increasing rate of population does not translate into increased electricity generation. However, a closer look at the results for low liberalised countries reveal that the success in electricity market liberalisation has been limited as the electricity industries are still controlled by public ownership. At the same time, in most of these countries, electricity liberalisation is still ongoing and not yet complete.

**Table 4.8: Two-Step System GMM Results for Low Electricity Liberalised Countries**

| Dependent Variables | Inegpc | Inigcpc | Inecpc |
|---|---|---|---|
| Cons | -4.8871**<br>(-2.37) | 0.0742<br>(0.85) | 2.5866<br>(0.90) |
| Inegpc (-1) | 0.7808*<br>(3.04) | | |
| Inigcpc (-1) | | 0.2135<br>(0.71) | |
| Inecpc (-1) | | | 0.6922<br>(1.14) |
| **Electricity Liberalisation Variables** | | | |
| verti | 0.4040**<br>(2.13) | 0.0432<br>(0.56) | 0.8007***<br>(1.84) |
| ows | -0.7930<br>(-1.69) | -0.0197***<br>(-1.92) | 1.8484<br>(0.35) |
| rga | 0.0803**<br>(2.09) | 0.0082<br>(0.94) | 0.0336<br>(1.27) |
| oelx | 1.6935<br>(1.51) | -0.0290<br>(-1.02) | 1.3300<br>(0.19) |
| **Institutional and Economic Variables** | | | |
| gdpca | 0.0169<br>(1.27) | 0.2584<br>(0.43) | 3.0921<br>(0.61) |
| nda | 0.0311**<br>(2.26) | 0.0533**<br>(2.13) | 2.4603<br>(0.08) |
| corrc | -0.0224***<br>(-1.83) | -0.0262*<br>(-3.11) | -0.0108*<br>(-2.79) |
| popgr | -3.0026<br>(-1.44) | 0.0021<br>(0.32) | -0.8127***<br>(-2.04) |
| psav | 0.9142<br>(0.03) | 0.1048<br>(1.13) | 0.0172*<br>(2.66) |
| govte | 0.1362**<br>(2.38) | 0.0725<br>(0.92) | 2.3016<br>(0.59) |
| Hansen test | 4.79<br>[1.000] | 1.76<br>[0.999] | 1.90<br>[1.000] |
| AR(1) | -1.71<br>[ 0.087] | -1.57<br>[0.118] | -1.16<br>[0.244] |
| AR(2) | -0.93<br>[ 0.345 ] | 0.33<br>[0.741] | -1.78<br>[0.642] |

Note: The dependent variables are natural log of electricity generation per capita (egcp), installed generation capacity per capita (igcpc) and electricity consumption per capita (ecpc). The t-ratios are in parenthesis, while the figures in bracket are the p values for Hansen test and serial correlation test. *, ** and *** represent statistical significance at 1%, 5% and 10% respectively.

### 4.4.6Comparison of the Results for Electricity Generation Per Capita (egpc) Across Groups in SSA

In this session, comparisons of the Two-Step System GMM results for electricity generation per capita (egpc) across groups are presented in Table 4.9. It is worth noting that in all the sampled groups, one period lagged electricity consumption per capita are positive and significant at 1% level. Noticeably, persistence is higher in middle income countries than the other groups as it has the highest coefficient. A further inspection of the results reveal that vertical integration exerted positive significant impact on electricity consumption per capita in all sampled groups. However, the coefficient of vertical integration is highest in moderately electricity liberalised countries, while it is lowest in low income countries

Another remarkable observation from the Table4.9 is that the coefficient of overall electricity market liberalisation is significant in the aggregate countries, middle income countries and moderate electricity liberalised countries. However, it is not significant in low income and low electricity liberalised countries. This result has implication with respect to the type and magnitude of electricity market liberalisation implemented in these countries. The coefficient of ownership structure is significant and rightly signed in the aggregate countries, low income countries, middle income countries and moderate electricity liberalised countries. On the contrary, the coefficient is positive but statistically insignificant in low income countries. In terms of magnitude, ownership structure exerted significant higher impact on the aggregate countries than the other sub-groups. Similarly, the coefficient of regulatory agency is rightly signed in all the sub-groups but significant in moderate electricity liberalised and low electricity liberalised countries. It is however, not significant in the aggregate countries, middle income countries and low income countries. The insignificance of regulatory agency in these countries, may not be unconnected with the fact that regulatory law and effective independent regulation have not been potent enough to be associated with higher electricity per capita generation.

More so, considering the effect of economic and institutional variables, the coefficient of GDP per capita is significant in the aggregate countries, middle income countries and moderate electricity liberalised countries. However, it is not significant in low income and low electricity liberalised countries. The coefficient of net official development assistance is positive in all the subgroups but only significant in low income countries and low liberalised countries. A probable interpretation of this could be that these countries seem to channel the bulk of the foreign aid received to the development of the electricity sector.

Digging further, Table4.9 revealed that the negative impact of corruption control is more visible in low income and low liberalised countries as its coefficient turned out insignificant in the other subgroups. The negative signs of corruption control in the low income and low electricity liberalised countries reinforce an empirical standpoint that corruption, poor management and electricity theft worsen electricity generation per capita. Similarly, it is revealed that population growth has a negative sign in all the subgroups but significant in aggregate and moderate electricity liberalised countries. This result is intuitively appealing given the upsurge in population across the region and the small quantity of electricity generated. Further, the coefficient of political stability and absence of violence is positive and significant in all the sub-groups except for low income countries. However, the coefficient of government effectiveness is only significant in middle income and low liberalised countries.

**Table 4.9: Comparison of the Results for Electricity Generation Per Capita (egpc) Across Groups in SSA**

| Variables | Aggregate | Middle income countries | Low income countries | Moderate Liberalised | Low Liberalised |
|---|---|---|---|---|---|
| Cons | 2.4541 (0.60) | 1.7294**(2.24) | -2.714(1.32) | 11.3083***(1.87) | -4.8871**(-2.37) |
| Inegpc (-1) | 1.0288*(3.62) | 1.6237*(3.03) | 0.9024*(2.76) | 1.3647*(3.21) | 0.7808*(3.04) |
| Electricity Liberalisation Variables | | | | | |
| verti | 0.3449** (2.01) | 0.8057* (3.17) | 0.2159** (1.84) | 1.8337* (3.21) | 0.4040** (2.13) |
| ows | 2.3011** (2.94) | 0.1416** (2.01) | 1.4781*** (1.99) | 0.5216*** (1.89) | -0.7930 (-1.69) |
| rga | 0.6511 (0.38) | 0.9601 (0.10) | 0.5627 (0.92) | 1.0403** (2.18) | 0.0803** (2.09) |
| oelx | 1.2596* (4.63) | 0.0416*** (1.92) | 1.0853 (0.66) | 2.1088* (2.97) | 1.6935 (1.51) |
| Institutional and Economic Variables | | | | | |
| gdpca | 0.0431** (2.33) | 0.0239* (3.71) | 0.0574 (1.12) | 0.5210*** (1.90) | 0.0169 (1.27) |
| nda | 0.0216 (1.46) | 0.0111 (1.10) | 0.7143* (2.90) | 0.0888 (0.71) | 0.0311** (1.96) |
| corrc | 0.0547 (1.09) | 0.0237 (1.28) | -0.1724*** (-1.89) | 0.7724 (1.09) | -0.0224*** (-1.83) |
| popgr | -2.0447** (-2.24) | - 1.1668 (-0.56) | -0.7834 (-0.46) | -1.1713** (-2.02) | -3.0026 (-1.44) |
| psav | 0.3299** (2.24) | 1.0950* (2.99) | 0.1620** (2.43) | 0.0643* (3.83) | 0.9142 (0.03) |
| govte | -0.1061 (-1.00) | 0.7364** (2.27) | 1.5691 (0.91) | 0.0276 (1.44) | 0.1362** (2.38) |
| Hansen test | 2.349 [1.000] | 7.94 [0.998] | 2.33 [1.000] | 7.73 [0.999] | 4.79[1.000] |
| AR(1) | -1.12 [0.064 ] | -1.10 [ 0.027] | -1.12 [0.026] | -1.31 [ 0.237] | -1.71 [ 0.087] |
| AR(2) | 0.92 [ 0.358 ] | 0.82 [ 0.357 ] | -0.71 [ 0.481] | 0.95 [ 0.434 ] | -0.93 [ 0.345 ] |

Note: The dependent variables are natural log of electricity generation per capita (egcp). The t-ratios are in parenthesis, while the figures in bracket are the p values for Hansen test and serial correlation test. *, ** and *** represent statistical significance at 1%, 5% and 10% respectively.

### 4.4.7 Comparison of the Results for Installed Generation Capacity Per Capita (igcpc) Across Groups in SSA

The comparisons of the results for installed generation capacity per capita across the various sub-groups are reported in Table 4.10. Similar to the results obtained in electricity generation per capita, the coefficient of one period lagged installed generation capacity per capita is also positive and significant across all the sampled countries except for low electricity liberalised countries. The coefficient of vertical integration is positive and significant in middle income countries and moderate electricity liberalised countries, while it is negative and significant in the aggregate countries. However, the sign of the coefficient of vertical integration for low income countries and low electricity liberalised countries is positive but not significant. This implies that vertical integration has more negative effect on the aggregate countries than in the other subgroups.

Markedly, the coefficient of overall electricity market liberalisation is positively significant in both the aggregate countries and the moderate electricity liberalised countries. However, it is not significant in both the middle income countries and low income countries. Also, it is negatively insignificant in low liberalised countries. This observation is very crucial to this analysis given that the coefficient of overall electricity market liberalisation is a composite measure of the depth of reforms implemented in these countries. Further, ownership structure is negatively significant in the aggregate countries, middle income countries and low electricity liberalised countries, while it is positively significant in low income countries. The rationale behind this result could be that private investors are probably divesting in installed generation capacity. Further, the coefficient of regulatory agency is positive in all the countries but only significant in moderate electricity liberalised countries. Intuitively, this could be responsible for the decline in installed generation capacity because private investors would be unwilling to invest in capacity expansion when independent regulatory framework is non-existent.

In the same vein, considering the effects of some economic and institutional variables, the result indicates that the coefficient of GDP per capita is not significant in all the sub-groups. This result is very surprising and it is contrary to empirical findings. A plausible reason for this could be that there is a disconnect between the economic activities and installed generation capacity in the region. Studies have shown that the higher the GDP per capita, the larger the degree of industrialization in a country and thus, the higher the average installed electricity generation capacity (see Helene, et al., 2015). Also noticeably from Table 4.10 is that the coefficient of net development assistance is positive and significant in all of the sampled groups except for moderate electricity liberalised countries.

However, in terms of magnitude, the coefficient of net development assistance exerted more positive significant impact on low income countries than the other sub-groups. Instructively, the coefficient of corruption control is negative and statistically significant in all the sampled groups. This indicates the pervasiveness of corruption and its deteriorating effects on installed generation capacity per capita. This is an important observation for policy makers. More so, the coefficient of population growth is revealed not have significant effect on installed generation capacity across all the sampled groups in the region. In the same vein, while political stability and absence of violence is only significant in moderate electricity liberalised countries, the coefficient of government effectiveness is only significant in low income countries.

**Table 4.10: Comparison of the Results for Installed Generation Capacity Per Capita (igcpc) Across Groups in SSA**

| Variables | Aggregate | Middle income countries | Low income countries | Moderately Liberalised | Low liberalised |
|---|---|---|---|---|---|
| Cons | 0.0114*(2.93) | -0.0487(0.35) | -0.0926(-0.64) | 0.0662***(1.98) | 0.0742(0.85) |
| Inigcpc (-1) | 0.9752**(2.05) | 0.2106*(2.87) | 0.4308*(3.33) | 0.4982*(2.56) | 0.2135(0.71) |
| Electricity Liberalisation Variables | | | | | |
| verti | -0.0586*<br>(-3.52) | 0.1078**<br>(2.19) | 0.0772<br>(1.08) | 0.0133**<br>(2.07) | 0.0432<br>(0.56) |
| ows | -0.0389***<br>(-1.90) | -0.0362*<br>(-2.95) | 0.0816***<br>(1.91) | 0.0466<br>(1.28) | -0.0197***<br>(-1.92) |
| rga | 0.0283<br>(0.69) | 0.0134<br>(0.52) | 0.0533<br>(1.63) | 0.0813***<br>(1.99) | 0.0082<br>(0.94) |
| oelx | 0.0671***<br>(1.88) | 0.0811<br>(0.74) | 0.0145<br>(0.91) | 0.0722**<br>(2.31) | -0.0290<br>(-1.02) |
| Institutional and Economic Variables | | | | | |
| gdpca | 1.8980<br>(1.09) | 0.4807<br>(1.42) | 1.3307<br>(0.59) | 0.2881<br>(0.16) | 0.2584<br>(0.43) |
| nda | 0.0742**<br>(1.99) | 0.1183***<br>(1.91) | 0.2106**<br>(2.35) | -0.0122<br>(-1.21) | 0.0533**<br>(2.13) |
| corrc | -0.0134**<br>(2.14) | -0.0344***<br>(-196) | -0.0160**<br>(-2.24) | -0.0313**<br>(-2.21) | -0.0262*<br>(-3.11) |
| popgr | -0.0821<br>(0.60) | 0.0312<br>(0.40) | 0.0141<br>(1.15) | -0.1964<br>(-0.28) | 0.0021<br>(0.32) |
| psav | 0.0177<br>(0.90) | -1.2701<br>(-0.15 | 2.9141<br>(1.44) | 0.1429***<br>(1.79) | 0.1048<br>(1.13) |
| govte | 0.0441<br>(1.06) | 2.0194<br>(1.32) | 0.6629***<br>(1.87) | 0.0131<br>(0.04) | 0.0725<br>(0.92) |
| Hansen test | 2.75 [0.934] | 1.59[0.963] | 2.41[1.000] | 2.51[0.962] | 1.76[0.999] |
| AR(1) | -1.33[0.185] | -1.32[0.187] | -2.18[0.079] | -1.27[-0.205] | -1.57[0.118] |
| AR(2) | -0.62[0.610] | -0.65[0.517] | 1.14[0.367] | -0.62[0.533] | 0.33[0.741] |

Note: The dependent variables are natural log of installed generation capacity per capita (igcpc). The t-ratios are in parenthesis, while the figures in bracket are the p values for Hansen test and serial correlation test. *, ** and *** represent statistical significance at 1%, 5% and 10% respectively.

### 4.4.8 Comparison of the Results for Electricity Consumption Per Capita (ecpc) Across Groups in SSA

A synopsis of the results for electricity consumption per capita obtained across groups in SSA is presented in Table 4.11. Notably in all the sampled countries, one period lagged electricity consumption per capita is significant the aggregate countries, low income countries and moderate electricity liberalised countries. Again, the coefficient of vertical integration is positive and significant all the sampled countries except low income countries. However, the positive impact of vertical integration exerts more influence in the aggregate countries.

Contrary to expectation, the coefficient of overall electricity market liberalisation is not significant in all the sampled groups, though positive. This result is counter intuitive and does not conform to theoretical expectation. A plausible reason could be that the potential short run trade-off between service quality and profitability by private investors could prevent the benefits of electricity market liberalisation being passed to the consumers. On the other hand, the coefficient of regulatory agency is significant in all the sampled groups except for low electricity liberalised countries. As earlier stated, the positive significance of the regulatory agency is in line with theory, given that effective independent regulation can provide substantial monitoring on the quantity and quality of the electricity delivered to the consumer. However, this result is counterintuitive in SSA because independent regulation has not been effective enough in designing appropriate regulatory framework to monitor the quality of electricity supplied to the consumers

More so, turning to the effect of some economic and institutional factors, it is surprising that the coefficient of GDP per capita is only positively significant in moderate electricity liberalised countries. A probable reason for this could be that most of the electricity consumed in the region are not channeled to productive activities; this is a reflection of the low level of industrialization in the region. Similarly, the coefficient of net development assistance is positively significant only in low income countries. Expectedly, the coefficient of corruption control is negative and significant in all the sampled countries except for moderate electricity liberalised countries. Markedly, corruption worsens electricity consumption more in middle income countries. This result reflects the negative effect of the pervasiveness of corruption that characterized the electricity sector in SSA. Importantly, it is observed that the coefficient of population growth is negative and significant in all the sampled groups. The implication of this result is that the electricity supplied in the region is grossly inadequate for the fast increasing population. However, the inverse relation between population growth and electricity consumption per capita does not align with the empirical evidence. As noted in Mohammed, et al. (2015), the demand for electricity grows directly with population growth. Noticeably, the impact of political stability and absence of violence is positive and significant in all the subgroups except low income countries. On the other hand, government effectiveness is revealed not to have significant effect in electricity consumption per capita across all the subgroups. This is an important lesson for policy makers.

**Table 4.11:Comparison of the Results for Electricity Consumption Per Capita (ecpc) Across Groups in SSA**

| Variables | Aggregate | Middle income | Low income | Moderate Liberalised | Low liberalised |
|---|---|---|---|---|---|
| Cons | 4.3604*(2.24) | 2.1101**(3.41) | 2.9712(1.66) | 5.216***(1.90) | 2.5866(0.90) |
| Inecpc (-1) | 0.5833**(2.17) | 0.8988(1.21) | 0.4860***(1.86) | 0.9558*(4.81) | 0.6922(1.14) |
| Electricity Liberalisation Variables | | | | | |
| verti | 2.3741***<br>(1.93) | 0.4331***<br>(1.86) | 0.4929<br>(1.41) | 1.4233**<br>(2.17) | 0.8007***<br>(1.84) |
| ows | 1.2334<br>(0.95) | 1.3729<br>(1.11) | 0.0210*<br>(3.17) | 2.3184*<br>(2.96) | 1.8484<br>(0.35) |
| rga | 0.1821***<br>(1.76) | 0.2277**<br>(2.28) | 0.1317**<br>(2.38) | 0.7888*<br>(4.07) | 0.0336<br>(1.27) |
| oelx | 1.7284<br>(1.09) | 0.4322<br>(0.57) | 1.0782<br>(0.06) | 2.6857<br>(0.92) | 1.3300<br>(0.19) |
| Institutional and Economic Variables | | | | | |
| gdpca | 0.0139<br>(0.11) | 0.0038<br>(0.79) | 0.0054<br>(1.24) | 1.3885*<br>(4.02) | 3.0921<br>(0.61) |
| nda | 0.0927<br>(1.23) | 0.0981<br>(0.42) | 0.2856*<br>(2.67) | 1.8411<br>(1.33) | 2.4603<br>(0.08) |
| corrc | -0.1281**<br>(-2.28) | -0.5211***<br>(-1.83) | -0.1843**<br>(-2.13) | -0.0052<br>(-0.02) | -0.0108*<br>(-2.79) |
| popgr | -0.3042*<br>(-3.87) | -0.0618***<br>(-1.95) | -0.0572*<br>(-2.93) | -0.7273***<br>(-1.84) | -0.8127***<br>(-2.04) |
| psav | 0.1146***<br>(1.87) | 0.0395*<br>(2.73) | 0.0402<br>(0.34) | 0.0302***<br>(1.96) | 0.0172*<br>(2.66) |
| govte | 0.3176<br>(0.27) | 0.0523<br>(0.81) | 0.7213<br>(0.11) | 1.2021<br>(0.65) | 2.3016<br>(0.59) |
| Hansen test | 1.71[1.000] | 4.92[1.000] | 1.64[1.000] | 3.70[1.000] | 1.90[1.000] |
| AR(1) | -1.93[0.048] | -2.43[0.015] | 1.11[0.013] | -1.59[0.111] | -1.16[0.244] |
| AR(2) | -1.43[0.490] | -1.30[0.495] | 2.27[0.276] | -1.60[0.318] | -1.78[0.642] |

Note: The dependent variables are natural log of electricity consumption per capita (ecpc). The t-ratios are in parenthesis, while the figures in bracket are the p values for Hansen test and serial correlation test. *, ** and *** represent statistical significance at 1%, 5% and 10% respectivel

### 4.4.9 Comparison of Result of the Study with Empirical Findings

This study carried out investigation on the effect of electricity market liberalisation on the sector's performance in selected 30 countries in SSA, spanning 1990 to 2017, while that of Zhang, et al. (2008) provided an econometric assessment of the effects of privatization, competition and regulation on the performance of the electricity generation industry using panel data for 36 developing and transitional countries, over the period 1985 to 2003. In terms of similarity, both studies considered the effect of electricity market reforms on electricity generation per capita and installed generation capacity per capita. Table 4.12 presents the result of similar findings between the two studies. It is revealed from Table 4.12 that while an increase in independent regulatory agency was not significant in determining the level of electricity generation per capita and installed generation capacity per capita in this study, it was found to increase electricity generation per capita by 0.05% and decrease installed capacity per capita by 0.54% in Zhang, et al. (2008).

Further, similar results were obtained in both studies when the proportion of private investors in the electricity industry increases by one unit. In this study, it was found that a unit increase in private ownership, increases electricity generation per capita by 2.3% and decreases installed generation capacity per capita by 0.03%. Also, in Zhang, et al. (2008), it was found to increase electricity generation per capita by 0.05% and decrease installed capacity per capita by 0.18%. However, the negative effects of an increase in private ownership on installed generation capacity per capita in both studies is counter intuitive and it is not in alignment with theoretical expectations (see Erdogdu, 2014a). A plausible explanation could be that institutional deficiencies, absence of appropriate regulation and unhealthy business environment could discourage private investment on capacity expansion. The opposite holds in a situation where a well-functioning regulation and effectiveness of institutions could mitigate investment risk and provide the necessary incentives for private investment.

More so, there were obvious differences in both results when there is a unit increase in unbundling and competition in the electricity industry. In this study, it was found to increase electricity generation per capita by 0.3% and decrease installed capacity per capita by 0.05 %. While in Zhang, et al. (2008), it was found to increase electricity generation per capita by 1.90% and also increase installed capacity per capita by 2.26%. However, the negative effect of unbundling and competition on installed capacity per capita in this study is not completely unexpected, as variations are likely between transitions economies in Asia and that of Sub-Saharan Africa. Differences in the results may reflect a superior management of the privatization process in these countries. Also, this result is intuitively appealing given knowledge of widespread institutional weaknesses in Sub-Saharan Africa.

**Table 4.12 : Comparing the result of the Study with Empirical Findings ( Zhang et al. (2008))**

| | This study | | Zhang et al. (2008) | |
|---|---|---|---|---|
| Variables | Electricty generation per capita | Installed Gneration capacity per capita | Electricty generation per capita | Installed generation capacity per capita |
| One unit increase in independent regulatory agency | Not Significant | Not Significant | 0.05% increase in electricity generation per capita | 0.54% decrease in installed capacity per capita |
| When the proportion of private investors increase by one unit, there will be | 2.3 % increase in electricity generation per capita ↑ | 0.03 decrease in installed capacity per capita ↓ | 0.05% increase in electricity generation per capita ↑ | 0.18% decrease in installed capacity per capita ↓ |
| when there is one unit increase in unbundling/competition, there will be | 0.3% increase in electricity generation per capita ↑ | 0.05 % decrease in installed capacity per capita ↓ | 1.90% increase in electricity generation per capita ↑ | 2.26% increase in installed capacity per capita ↑ |

Source: Author's Compilation, 2018.

# CHAPTER FIVE

# SUMMARY, CONCLUSION AND RECOMMENDATION

## 5.1 Summary of Major Findings

Sub-Saharan Africa is characterized by acute electricity shortages, including inadequate generation capacity, poor transmission and output losses, weak distribution network and service unreliability, all of which constrain economic development. It is fairly settled in the literature that electricity plays a critical role in the economic development of any nation. Thus, countries that are able to meet the electricity needs of its citizens are wealthier, more resilient and better able to advance human development. However, over the last two decades, electricity sector liberalisation has been a central policy path in most SSA countries but despite the spate of electricity reforms in the region, improvements in power supplies seem elusive.

Against this backdrop, this study empirically examined the effect of electricity market liberalisation on electricity sector performance in SSA. In specific, two main objectives were considered. First, the study generated a set of electricity market liberalisation index for SSA. Second, it investigated the effects of electricity market liberalisation on electricity sector performance in SSA. In addressing the aforementioned objectives, the study used aggregate data covering the period 1990 to 2017. The descriptive statistics showed that all the variables employed in the analysis were found to be systematically distributed given the distribution of their means, median, maximum and minimum values. Further, the Im, Pesaran, and Shin W-test, and Levin, Lin and Chu-test indicated that most of the variables were stationary after first differencing. Finally, the models were estimated using Two-Step System Generalized Method of Moments.

Markedly, a number of interesting and important results emerged. First, the results of the aggregate countries revealed that overall electricity market liberalisation has positive and significant effect both on electricity generation per capita and installed generation per capita. The effect of electricity market liberalisation on electricity consumption per capita was found to be insignificant. Further, other components of electricity market liberalisation such as; vertical unbundling, ownership structure and regulatory agency were also found to have significant effects in the models. Specifically, while vertical integration and ownership structure were found to have positive significant effects on electricity generation per capita, their effects on installed generation capacity per capita were negatively significant. Similarly, the coefficient of regulatory agency was only found to have positive significant effect on electricity consumption per capita. More so, considering the effect of economic and institutional variables, GDP per capita and political stability are shown to have significant positive effects on electricity generation per capita. In the same vein, net development assistance has a positive significance only on installed generation capacity per capita. On the other hand, population growth and corruption are revealed to deteriorate electricity generation per capita, installed generation capacity per capita and electricity consumption per capita in the model.

However, there were obvious variations in the results when the sampled countries were disaggregated into sub-groups. In the results for electricity generation per capita, the coefficient of overall electricity market liberalisation was revealed to have positive significant effect only in the middle and moderate electricity liberalised countries. Notably in all the sampled groups, the coefficient of vertical integration was positive and significant. Similarly, ownership structure and political stability were also revealed to be positive and significant in all the sampled groups except for low liberalised countries. On the other hand, while population growth has negative effect in moderate electricity liberalised countries, corruption was revealed to worsen electricity generation per capita in low income and low electricity liberalised countries.

Again, in the result for installed generation capacity per capita, vertical integration was found to be positive and significant in both middle income and moderate electricity liberalised countries. In the same vein, overall electricity market liberalisation and regulatory agency were also found to have significant positive effect in moderate electricity liberalised countries. On the contrary, ownership structure was revealed to deteriorate installed generation capacity per capita in the middle income and low electricity liberalised countries. Noticeably, net development assistance was also shown to have positive effect in middle income, low income and low electricity liberalised countries. On the other hand, while GDP per capita and population growth were not significant in any of the sub-groups, corruption was conspicuously revealed to have negative impact on installed generation per capita in all the sampled groups.

Similarly, in the result for electricity consumption per capita, vertical integration is significantly positive in all the sampled groups except for low income countries. In the same vein, while regulatory agency is positive and significant in all the sampled groups except for low liberalised countries, ownership structure was significant and positive only in low income and moderate electricity liberalised countries. However, contrary to expectation, the coefficient of overall electricity market liberalisation was not significant in all the sampled groups, though positive. This result is counter intuitive and does not conform to theoretical expectation. A plausible reason could be that the potential short run trade-off between service quality and profitability by private investors could prevent the benefits of electricity market liberalisation being passed to the consumers. More so, the coefficient of corruption was negative and significant in all the sampled countries except for moderate electricity liberalised countries, while population growth was negative and significant in all the sampled groups. Noticeably, the impact of political stability and absence of violence is positive and significant in all the subgroups except low income countries. In sum, the effects of electricity market liberalisation on electricity sector performance in SSA vary across countries depending on the extent of liberalisation implemented and the type of reform models adopted. However, moderate electricity liberalised countries are characterized with greater improvement in electricity sector performance relative to the other sub-groups.

## 5.2 Conclusion

The persistent electricity shortages in developing countries and specifically in Sub-Saharan Africa has generated heated discussions over the likely effects of electricity market liberalisation on electricity sector performance. While many scholars have argued that market liberalisation has brought about improvement in the electricity sector and electricity supply, some other scholars opined that market liberalisation is a failure as it has not steered the desired transformation in the electricity sector. It is instructive to state that electricity market liberalisation is an evolving and dynamic process rather than a one-off event. Hence, in the presence of political instability, incomplete liberalisation, weak macroeconomic policies, ineffectiveness of government and electricity regulatory framework, market liberalisation may not yield the desired outcome.

In sum, given all the discussions and findings on the likely effect of market-oriented electricity reform, this study has been able to provide reasonable theoretical, methodological and empirical insight into the effects of electricity market liberalisation on electricity sector performance in SSA. Findings from this study empirically validate that the effect of electricity market liberalisation on electricity sector performance were generally mixed. This may not be unconnected with the depth of market liberalisation implemented and the type of reform models adopted. However, electricity market liberalisation has largely improved some indicators of electricity sector performance. Markedly, there were obvious variations in the results when the sampled countries were disaggregated into sub-groups. Notably, moderate electricity liberalised countries were revealed to have higher improvement in electricity sector performance relative to the other sub-groups. This suggests that Sub-Saharan Africa countries should pursue market-oriented electricity sector reforms in order to improve the sector's performance. Again liberalizing the electricity market is not the end but a means. It is necessary, but not sufficient condition for attaining the optimal performance in the electricity sector. Thus, strong political will, effective regulatory framework and conductive environment are vital, also to achieve the desired outcome, the right people to manage the sector are equally important. More so, it is very imperative to pay attention to local conditions. Market liberalisation designs that are imported from outside and imposed on the people without considering local status may not be successful.

## 5.3 Policy Recommendations

The empirical evidence established in this study reinforces the assertion that the effect of electricity market liberalisation on electricity sector performance in SSA remains mixed for varied reasons. While some countries have witnessed relative success, others have continued to perform below expectations. In this wise, several policy lessons emerged from the study. First, it is empirically revealed in the study that electricity performed better in moderately electricity liberalised countries than the other countries in SSA. Intuitively, this implies that policy makers and governments in SSA should pursue liberal electricity policies geared towards improving the sector's performance.

Second, electricity market liberalisation exerts more significant positive effect on electricity generation per capita than electricity consumption per capita. A plausible explanation for the low level of electricity consumption per capita could be that most of the electricity generated do not get to the final consumers due to transmission and output losses. Thus, there is need to strengthen the transmission and distribution network so as to enhance the quantity and quality of electricity delivered to the consumers

Third, the capacity of most SSA countries to establish and maintained an imported electricity liberalisation models have been fraught with several challenges, including incomplete liberalisation and prolonged state of partial liberalisation. Hence, given the peculiarity of the electricity structure in the region, there is need to focus and adopt indigenous electricity models and solutions that are suitable for the region. Of course, the political influences are still vibrant factors of the degree of reforms carried out in SSA, however, this study has no reason to assert that it is the cause of electricity market failure in the region but certainly this factor cannot be ruled out. Therefore, policy makers in the electricity sector should take into cognizance the political economic environment of these countries.

Finally, differences in electricity sector performance across countries in SSA are also a manifestation of the nature of institutional and regulatory framework in various countries.

Weak institution and ineffective regulatory framework could dim the chances of private investment in the sector. Again, cost reflective pricing remains central to a well-functioning market based reform because private investors may be unwilling to invest in a market whose price is determined. Thus the importance of effective independent regulatory agency to maintain the balance between efficiency and equity considerations is paramount in SSA. In the same vein, the government should focus on continuously evolving an effective institutional framework that guarantees sustainability of the reform efforts and managing post-liberalisation challenges.

## 5.4 Contribution to Knowledge

This study has been able to extend the New Institution Economic Theory (NIE) to explain the dynamics of electricity market liberalisation in SSA. Also, this study has strived to produce suitable measures of electricity market liberalization. To the best of the author's knowledge, this study signifies the first attempt to generate a set of electricity market liberalization index for SSA region. This index would serve as a useful tool to better understand the magnitude of electricity market reform implemented in the region. Again, this study also contributes to the literature by revealing that electricity market liberalization is more potent in increasing electricity generation per capita than electricity consumption per capita. Importantly, the results from the analysis carried out in this study will provide critical input into the formulation of policy framework that would address the challenges facing the electricity sectors in SSA. Moreover, this study will be of immense benefit to policy makers, energy regulators, power utility companies, academics and others interested in power sector reforms.

## 5.5 Limitation of the study and areas for further research

Arguably, there is no doubt that the spate of electricity market liberalisation has tended to move faster than the literature can catch. However, it is affirmed that the research findings reported in this study has satisfactorily achieved the objectives set in chapter one. It cannot claim that all dimensions of the various reform implemented in SSA are reflected in the study. It is worth noting that aside the electricity sector performance and liberalisation indicators used in the study, other indicators such as cost, prices, tariff, technological innovations and quality of services could not be estimated due to lack of sufficient comparable data across SSA region. Again, some characteristics of electricity market liberalisation are not readily measurable in monetary or physical units, thus making comparison across countries apparently difficult. This of course, could be an area for future studies.

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## Appendix A1

**Countries Selected for the study in SSA (Classification based on Regional blocs)**

| **West Africa** | **Southern Africa** | **East Africa** | **Central Africa** |
|---|---|---|---|
| Burkina Faso | Angola | Ethiopia | Cameroon |
| Cape Verde | Botswana | Kenya | Congo Rep. |
| Cote d'Ivoire | Mozambique | Mauritania | Equatorial Guinea |
| Gambia | Namibia | Rwanda | Gabon |
| Ghana | South Africa | Sudan | Mauritius |
| Guinea | Swaziland | Tanzania | |
| Mali | Zambia | Uganda | |
| Nigeria | Zimbabwe | | |
| Senegal | | | |
| Togo | | | |

*Source: IMF, African Department database, (2013) and IMF, World Economic Outlook (WEO) database (2013)*

## Appendix A2

**Classification of Countries in SSA based on Economic Performance and Electricity Structure.**

| **Middle Income Countries** | **Low Income Countries** | **Moderate electricity liberalized countries** | **Low electricity liberalized countries** |
|---|---|---|---|
| Angola | Burkina Faso | Cameroon | Botswana |
| Botswana | Ethiopia | Mauritius | Burkina Faso |
| South Africa | Gambia | Namibia | Cape Verde |
| Nigeria | Mali | Nigeria | Congo Rep |
| Mauritius | Mozambique | South Africa | Ethiopia |
| Namibia | Rwanda | Kenya | Tanzania |
| Congo Rep. | Cape Verde | Angola | Mali |
| Mauritania | Tanzania | Ghana | Togo |
| Ghana | Togo | Uganda | Gabon |
| Cameroon | Uganda | Mozambique | Guinea |
| Zambia | Guinea | Mauritania | Equatorial Guinea |
| Equatorial Guinea | Kenya | Zambia | Swaziland |
| Gabon | Cote d'Ivoire | | Senegal |
| Senegal | Sudan | | Zimbabwe |

*Source: IMF, African Department database, (2013) and World Bank Development report on SSA Power Projects (2016) and REEEP Database*