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# The impact of Independent Power Producers on electricity generation capacity, tariff and access in Sub-Saharan Africa

A Dissertation

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by

**Mduduzi L Mhlanga**

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Supervisor: Dr Abdul Latif Alhassan

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**ABSTRACT**

Sub-Saharan Africa is the most electricity-poor region in the world with an estimated 62.5 percent or just above 600 million people without access to electricity and those who have access, are connected to an unreliable system that does not meet their energy needs. The introduction of Independent Power Producers (IPPs) is perceived to be the panacea to all the sector's problems in that it will attract much-needed private investment, increase generation capacity, reduce electricity tariffs due to efficiency and competition and ultimately increase the rate of access to electricity by the general population for the region. This study examined the impact of IPPs on electricity generation growth, tariffs and access in 48 countries in Sub-Saharan Africa using panel data from 1990 to 2013. The findings suggest that over the 23-year period, only 40 percent of the sampled countries had used IPPs for power generation. In addition, results from the panel regression estimations confirmed that the use of IPPs has increased regarding electricity generation growth and electricity access in Sub-Saharan Africa and also led to a reduction in electricity tariff. The policy implication of this study is that Sub-Saharan African countries should allow for the participation of IPPs to achieve increased generation capacity, reduction of tariffs and increased access to electricity by the general population.

**Keywords**: Independent Power Producers, Sub-Saharan Africa electricity supply industry, electricity supply industry investment in Sub-Saharan Africa.

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| | |
|---|---|
| EIA | Energy Information Administration |
| ESI | Electricity Supply Industry |
| EU | European Union |
| GW | Gigawatt |
| IEA | International Energy Agency |
| IPP | Independent Power Producer |
| MDG | Millennium Development Goal |
| MW | Megawatt |
| NUG | Non-Utility Generator |
| PPA | Power Purchase Agreement |
| PURPA | Public Utility Regulatory Policy Act |
| QF | Qualifying Facility |
| SDG | Social Development Goal |
| SSA | Sub-Saharan Africa |
| UAE | United Arab Emirates |
| UK | United Kingdom |
| UN | United Nations |
| US | United States |

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# CHAPTER 1: INTRODUCTION

## 1.1 Background of study

Electricity is a very important ingredient of developing and improving the quality of human life, specifically in developing countries. Saila *et al.* (2016) and the World Bank (2017) in the "State of Electricity Access Report" argued that electricity access is intrinsically linked to "Sustainable Developmental Goals", in particular those that improve the quality of life such as health, education, food security, gender equality, poverty reduction, and climate change.

Electricity is a prerequisite for a properly functioning and efficient economy, globally. The industrial, commercial and domestic use of electricity has become so intertwined with human existence and development that any interruption causes major economic loss and inconvenience to all spheres of life; non-availability also stalls human development.

Despite the global consensus of the importance of universal electricity access (Lucas2017) as evidenced by the adoption of Agenda 2063 and the UN 2030 Agenda for Sustainable Development in which global leaders committed to achieving universal access to electricity by 2030, there are still over "one billion" people with no access to electricity in the world. Just over six hundred (600) million of these people are in Sub-Saharan Africa (SSA).

Sub-Saharan Africa as a region remains a dark region. Avila *et al*. (2017) referred to Sub-Saharan Africa as "the most electricity-poor region in the world" with an estimated 62.5 percent of its population without access to electricity and those that have access, are connected to an unreliable system that does not meet their energy needs.

Consistent with the World Bank (2017) observation that "countries with the highest levels of poverty tend to have lower access to modern energy services", there seems to be a positive correlation between well-being and access to modern energy services. In the same report, SSA is said to have an average electricity access rate of 37.5 percent against the global average of 85 percent.

With the realisation that access to electricity is a "developmental imperative" and *sine qua non* to achieving sustainable development, the United Nations (UN) included the need for "universal access to electricity" as Sustainable Development Goal (SDG) 7. Amongst others, one of the targets under SDG 7 is "to ensure universal access to affordable, reliable and modern energy services by 2030".

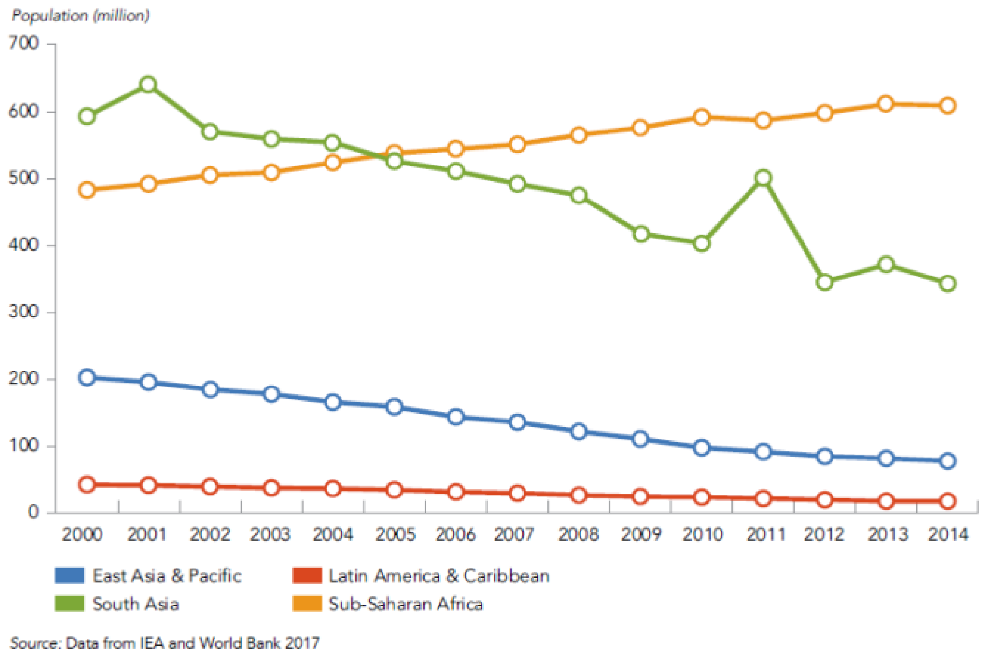


**Figure 1.1: Access to electricity decreases as population grows in SSA**

Figure 1.1 above illustrates a historical analysis by the International Energy Agency (IEA) and World Bank (2015) for the 14-year period between 2000 and 2014. When looking at access rate to electricity in relation to the population growth rate, they discovered that all developing regions, apart from SSA, indicated a trend of closing the "access deficit" gap, meaning the number of people without access was showing a downward trend. The only region with an upward trend of an increasing number without access to electricity as its population grew is SSA.

Quite clearly, the electricity supply sector challenges of Sub-Saharan Africa must be studied extensively to be able to unlock potential solutions. This study explored the impact of private players in this sector, in the form of "Independent Power Producers" (IPPs), their impact on electricity generation growth, tariffs and access to electricity.

The interest in extensively examining the impact of IPPs in SSA is due to the policy advocated, mainly by the World Bank (1993), in the early 1990s to reform the ESI by deregulation, liberalisation and encouraging private participation. These reforms were adopted by almost all developed countries and initially a few countries in SSA who embraced this policy. These sector reform policies are now almost adopted, whether in part or in whole, by most if not all Sub-Saharan African countries, just as the other developing regions in the world. The reforms were seen to be a precursor to abundant, cheap electricity for all.

This can be seen from recently published reports and Figure 1.1 above. Sub-Saharan Africa is still plagued by limited electricity generation growth, high tariffs and very low electricity access. It is therefore important to assess the impact of IPPs in the countries where they exist as opposed to the impact of the conventional state-owned utilities in the countries that depend on these for the development of the sector.

The Electricity Supply Industry (ESI) for many years has been predominately sector owned and controlled by governments directly or through utility companies. The sector reforms in the past two decades, precipitated by the inability of governments to sustain these operations or finance further investments in new power plants to keep up with growing demand, have seen a shift in the policy direction to encourage private participation and investment in this sector.

The introduction of independent power producers in this sector has been perceived and continues to be hailed as the panacea for all the sector's deficiencies under state ownership and control. Harris (2006) described the resultant expectations of the sector reforms to be "abundant, cheap and reliable energy". This research endeavoured to study whether the opening of the sector to IPPs does result in "abundant" and "cheap" electricity by measuring the impact of IPPs on "electricity generation growth" and tariff. With abundant and cheap electricity, the expectation would further be higher rates of access to electricity by the general population.

In Africa, Cote d'Ivoire was the first country to open its market to private participation, followed by Egypt, Ghana, Kenya, Morocco, Tanzania, Tunisia, Uganda and most recently, South Africa and other countries have followed suit, to a large extent making the continent to be open for private participation and investment. Eberhard *et al.* (2016) reported that there are currently 126 IPPs in 18 countries of SSA out of 19 countries with an electricity sector structure that permits IPPs. Despite the opening-up of the sector to private participation, governments and utilities are still accounting for the highest proportion of investment and addition of electricity generation capacity.

Notwithstanding all this investment by governments, utilities and IPPs, Africa remains with chronic shortages of electricity. This study evaluated, in a comparative form, the rate of generation growth, tariff and access rate growth of the countries that have IPPs and those that still rely on government/utilities to establish whether the policy decision of having IPPs is delivering the "abundant, cheap and reliable" electricity against the ESI markets that are dominated by state-owned utilities.

Though Africa has a power sector funding requirement of $40.8 billion a year, equivalent to 6.35 percent of its GDP as reported by Shkaratan *et al.* (2011), the actual expenditure is 80 percent funded by domestic public funds and the remaining 20 percent split between Official Development Assistance and private investment which accounts for 16 percent and four percent, respectively. With the latest market developments in South Africa, these figures have improved slightly. The detail of this is analysed in the data.

### 1.2 Problem statement

The ESI market in SSA has two contending schools of thought that permeate in government policies and if not in policy, in practice, despite the officially adopted policy. The first school of thought, which for years justified the existence of a single-national electric utility operating as a public monopoly, as proposed by Saunders *et al.* (1993), is the view that "electricity is a strategic and publicly provided good and that people have a right to power at low prices".

This was once been a world-wide view and a foundation on which the ESI was built in all the "now developed" countries. Also, the capital-intensive nature of this sector and governments' belief that low-priced electricity is critical in achieving economic and social development, perpetuated the public utility monopoly structure. However, due to declining technical performance, deteriorating financial positions and generally tough economic conditions, public utilities became a burden and a drain on the public purse, as reported by the World Bank (1993), and as such, a new school of thought emerged which advocated for the participation of private players in the ESI.

The participation of the private players in the form of IPPs was perceived to be the panacea to all the sector's problems. The evident demand of electricity in developing countries "conjured up images of multiple billions of dollars in investment" by the private sector in the form of project finance, as described by Churchill (1993), efficient operations and management of generating assets by the private sector better than public utilities can operate and manage. With the abundance of cheap electric power, greater access to electricity will be achieved.

The participation of private players gained impetus in the 1990s with most developed countries reforming, unbundling and privatising their sectors, while in developing countries, these reforms were a "condition precedent" to access World Bank financing as it has become the Bank's policy to lend only to those countries that have implemented the reforms or are in the process of implementing them.

In SSA, a country would seemingly have an ESI structure that shows dominance of one of the above schools of thought. Some countries have opened up their sectors to be led by private players while others maintained the erstwhile structure of public utility monopoly. According to Eberhard *et al.* (2016), there are 19 countries in Sub-Saharan Africa with fully integrated state-owned utilities with no private sector participation and 19 countries where IPPs can participate. The other eight countries, though they do have IPPs, their state-owned utilities are not fully integrated. The table below indicates the countries with fully integrated state-owned utilities, those that operate a hybrid structure where IPPs operate along state-owned utilities and those countries without IPPs but that also do not operate fully integrated state-owned utilities.

**Table 1.1: SSA country categorisation according to ESI structure**

| Countries with "fully integrated state-owned utilities" | Countries with IPPs | Countries with no IPPs but also not "fully integrated" |
|---|---|---|
| Benin, Burkina Faso, Burundi, CAR, Chad, Congo, DRC, Djibouti, Equatorial Guinea, Eritrea, Gabon, Guinea, Guinea-Bissau, Liberia, Malawi, Mali, Mauritania, Niger, Somalia | Angola, Cape Verde, Cote D'Ivoire, Kenya, Madagascar, Mauritius, Rwanda, Senegal, Sierra Leone, Tanzania, The Gambia, Togo, Uganda, Zambia, Zimbabwe | Ethiopia, Mozambique, Namibia, Seychelles |

The problem with these industry structures in place is that SSA remains electricity-poor despite these various structural permutations. We need to understand if there is a correlation between any of these structures and the electricity growth rate, tariff and access rate. The reformation of the ESI structure in some countries in SSA is to an extent the outcome of opening their market for the participation by IPPs. An understanding is required of how this has impacted on those countries' electricity generation growth, tariff and general access by the population.

Figure 1.2 below summarises the information presented by Eberhard *et al.* (2016) regarding the countries that have and those that do not have IPPs as part of their ESI. For the purposes of this study, irrespective of whether a country has a state-owned fully integrated monopoly utility or an unbundled structure for as long as that country does allow IPPs to coexist with that structure, those countries are classified as countries with IPPs.

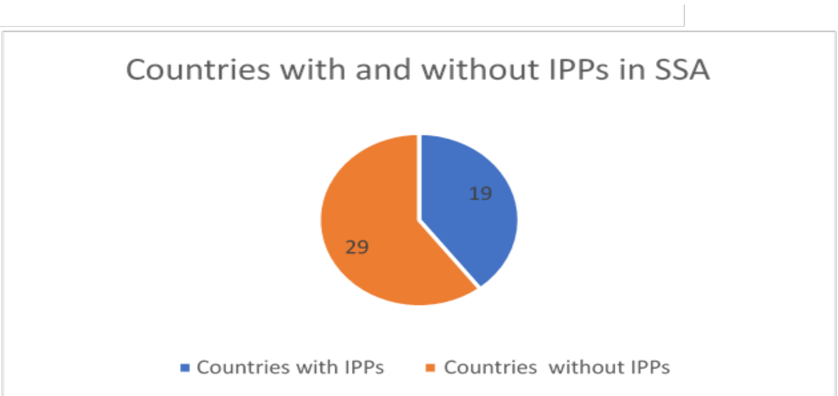


**Figure 1.2: Countries with and without IPPs**

*Data Source: Eberhard et al., 2016*

The problem statement or research question can then be framed as follows:

*"Have countries that reformed their ESI and introduced IPPs managed to grow their electricity generation capacity, achieved lower electricity tariffs and increased electricity access rates compared to those countries whose ESI structure still remains predominately reliant on state-owned monopoly utilities?".*

This research question is informed by the factors used as motivation by proponents in favour of the reforms, the encouragement of IPP participation in the market and benefits associated with it. From this research question, the research assumption or hypothesis was then formulated as such and  informed the research objectives.

The policy reforms of unbundling, privatisation and encouraging private participation and investment in the ESI are generally observed as a phenomenon that gained impetus in the 1990s with the likes of the United Kingdome (UK), Norway, the United States (US) and many other countries adopting this approach. Gartwick and Eberhard (2008) suggested that the primary reasons, amongst others, why these governments adopted the policy shift were insufficient public funds, poor plant performance and encouraging competition to ultimately achieve cheap electricity. However, developing countries were  coerced to adopt the same policies to gain access to funding from the World Bank and attract private investment into this sector to accelerate development. This study evaluated the exact impact of this policy on electricity generation, tariffs and access to electricity by the population of those countries in order to assess whether there are traces of the reform objectives being met.

### 1.3  Purpose and justification of the research

The purpose of this research was to test the two established schools of thought in the Sub-Saharan African ESI as observed, which mainly inform government policy and ultimately the sector structure, for a comparative assessment of these two predominant structures to determine which one has had a positive impact on (1) electricity generation, (2) delivery of lower electricity tariffs, and (3) increased electricity access.

As chronicled by Khatib (2003) and many others, the ESI was initially founded by private initiatives and investors. Due to the technological and capital-intensive nature of this industry, it created a situation of local and national monopolies and international oligopolies, affording the private participant the exclusive right to charge exorbitant prices as there was no competition. One concern was the neglect of mainly rural areas as these were not as economically attractive as cities and urban areas.

Later, governments, almost globally, with the exception of a few countries such as Germany, nationalised the entire ESI value chain, creating state-owned vertically integrated monopolies which could provide electricity even to rural areas and substantially limited the market abuse which was prevalent during the epoch of private ownership.

This, however, later caused inefficacies because of state ownership which eventually led to the deregulation and unbundling in the early 1990s, again encouraging participation of private sector players, effectively bringing the industry back full circle to private ownership which may still present the problems earlier encountered with market abuse, focus on only economically attractive segments of society and depriving the less privileged access to electricity.

This study, especially the juxtaposition of the IPPs' impact on electricity generation, tariff and access against the performance of state-owned utilities, will help in giving context to the discourse of whether IPPs are the future of the industry especially in Sub-Saharan Africa.

Of note, is that most of the countries that successfully deregulated and unbundled their ESI were mainly well developed and industrialised with very high electricity access by their population. However, to achieve that state of development, their governments had to intervene and invest heavily in this sector to achieve the developmental agenda of growing their industries and access to electricity at very low tariffs.

Therefore, the premature adoption of policies appropriate for matured markets to be implemented in "developing markets" may prove disastrous if not understood in the context of those countries and customised to the local challenges. While no extensive data analysis was conducted on the experiences of "other developing" regions such as South America and parts of Asia, the documented experiences are extensively covered in the literature review.

The justification of this research is that it considered all Sub-Saharan African countries by analysing and evaluating the performance of countries with IPPs and their impact on electricity generation growth, tariff and access to electricity by the population. A similar analysis was carried out for the countries that rely on state-owned utility monopoly. Lastly, the results of the analysis were compared between the group of countries with different policies to evaluate which of the structures have the most positive impact on the three dimensions tested and further to test for correlation in the policy choices and the results thereof.

### 1.4 Research objective(s)

Based on the framing of the research problem statement as stated above, the following were the research objectives of this study:

1. Evaluate and assess the impact of IPPs on electricity generation growth in Sub-Saharan Africa.
2. Examine the effect of IPPs on electricity tariffs in Sub-Saharan Africa.
3. Investigate the relationship between the introduction of IPPs and electricity access rate in Sub-Saharan Africa.

### 1.5 Research hypotheses

Premised from the associated benefits of deregulation, unbundling and mainly the participation of IPPs in the ESI of a country, the following null and alternative hypotheses were formulated for this research study:

$H_1$: The use of IPPs has a significant positive effect on electricity tariff in Africa

$H_2$ : The use of IPPs has a significant negative effect on electricity tariff in Africa

$H_3$ : The use of IPPs has a significant positive effect on electricity access in Africa

### 1.6 Organisation of the dissertation

After this first chapter, Chapter 2, by means of the literature that was reviewed, lays the foundation for understanding the concept of IPPs, how they developed and the contextual factors that gave rise to this concept in the electricity supply industry. Chapter 2 also covers an in-depth historical development of the ESI, how it was founded by private parties, the move to consolidate the industry, moving towards nationalisation and the unbundling and privatisations in the early 1990s. The global experience of privatisation and IPPs is also well covered and more related to Sub-Saharan Africa. Chapter 3 covers the research methodology, theoretical framework, model specification, empirical framework as well as the panel data model equation used as the basis formula from which the variant formulas to test the hypotheses were derived and applied to the secondary data sourced for this study. This is followed by a brief discussion of the difference between fixed and random effects models and the motivation of the selected model for this study. This chapter also defines the measurements and variables used in the formula and data sources. In Chapter 4, the research findings are presented and discussed expansively, including recommendations from the observations of the research. The conclusion sums up the general outcome of this study and suggests further areas of research that can be undertaken in the future to further enhance areas of this subject.

# CHAPTER 2: LITERATURE REVIEW

## 2.1 Introduction

This chapter covers the definitions of terms of this study, and provides the overview of independent power producers in Sub-Saharan Africa. The theoretical framework is discussed in detail, providing the theoretical foundation for this research. The chapter concludes with the detailed empirical literature on independent power producers and their impact.

## 2.2 Definition of terms

The term 'Independent Power Producer' appears self-explanatory and implies producers of power that are independent. Despite various attempts by many authors, such as Joskow and Kahn (2002), there is no universally accepted scholarly definition of this term. Many others who write on this subject seldom attempt to define the term, creating the impression that all and sundry can understand what it means without any technical explanation.

Other concepts, such as Non-Utility Generator (NUG) or Qualifying Facility (QF), are used interchangeably for Independent Power Producer. This further compounds the problem of properly defining this concept, as the definition will have to encompass these other concepts that are used interchangeably.

Before defining terms, it is very important to trace their genesis and associated concepts. The concept of Independent Power Producers is first seen in the US Public Utility Regulatory Policies Act (PURPA) of 1978. In this Act, the concept of IPPs is not succinctly defined as such, but the terms Non-Utility Generator and Qualifying Facility are prominently used and defined in this Act. It is important to highlight that these definitions are in the context of the US ESI.

In this context, Zucchet (1995) defined Independent Power Producers as "a wholesale electricity producer that is unaffiliated with franchised utilities in the area in which the IPP is selling power and that lacks significant marketing power. Unlike traditional utilities, IPPs do not possess transmission facilities that are essential to their customers and do not sell power in any retail service territory where they have a franchise".

He further defined a Non-Utility Generator as an "Electric generation by end-user, independent power producers, or small power producer under PURPA, to supply electric power for industrial, commercial, and military operations, or sells to electric utilities".

Eberhard *et al.* (2017) offered another definition of IPPs as "power projects that are mainly privately developed, constructed, operated, and owned; have a significant proportion of private finance; and have long-term Power Purchase Agreement (PPA) with a utility or another off-taker".

In the US ESI structure, an Investor-Owned Utility could be deemed a utility in a state in which it has a franchise or a utility status, while also becoming an Independent Power Producer if it sets up operations in another state where it did not have a utility status. Therefore, the US definition of an IPP would have these elements of differentiating between location and utility status.

Generally, in many other places  globally, because of the prevailing structure of a publicly-owned integrated utility monopoly, an Independent Power Producer would mean an electricity generator that is not state- or utility-owned, but owned by private sponsors or investors.

Although the whole concept of private sector participation as a reform principle of the World Bank (1993) is  fully unpacked in the next section, it is important to clarify at this stage that IPPs are but part of the whole proposition of private sector participation. The policy of the World Bank explains private sector participation in the ESI to include the sale of some or all assets, stock exchange listing, franchising, leasing, contracting out, and non-utility power generation.

This suggests the participation of private entities in the entire value chain of the ESI and singles out non-utility generation, also using the term found in the US PURPA, further giving evidence of the influence the US ESI reforms had on the World Bank's policy formulation.

The specialised nature of the ESI industry, especially the engineering design, construction and maintenance, nevertheless required that developing countries procure these services from foreign entities and import both the products and service to the developing countries. The formalisation of this requirement did not suggest anything new; however, the concept of non-utility generators was a new concept in a predominately state-utility monopoly structure of the developing countries. For the purposes of this study, reference to private participation is mainly focused on the participation in the ESI by Independent Power Producers.

### 2.3 Overview of Independent Power Producers in Sub-Saharan Africa

Eberhard and Gartwick (2011) and Eberhard et al. (2016) provided contextual literature and detailed reports on the experience of IPPs in SSA. They found that in the early 1990s, almost all major electricity generation assets in SSA were financed through public finances and concessionary loans from Development Financial Institutions (DFIs). However, as public funds became insufficient to finance new electricity-generating assets, generally poor performance of the vertically integrated state-owned utilities, Sub-Saharan African countries were compelled to adopt a new model for the ESI, which included IPPs.

The reforms adopted by some Sub-Saharan African countries were coerced through the World Bank's lending policy which made it difficult for these countries to access concessionary loans if they did not reform their ESI. The World Bank (1995) document, *Lending for Electric Power in Sub-Saharan Africa,* explicitly stated that the Bank "should avoid making large power loans unless the sector is operating reasonably well or substantially on its way to reform", validating the institutionalisation of coerced reforms, as suggested by Henisz and Zelner (2005).

The Sub-Saharan African countries as dependent actors were coerced to undertake institutional change by institutions such as the World Bank, that had the necessary power and legitimacy. The "political economy" of electricity market liberalisation as proposed by Erdogdu (2014) appeared in overwhelming strength to those actors who were proposing these reforms and the Sub-Saharan African countries had no other pragmatic alternative but to succumb to the new policies.

This was evidenced by Eberhard and Gartwick (2011) who reported that multilateral and bilateral development institutions were withdrawing their funding from state-owned power projects. Urged by this, Sub-Saharan African governments adopted plans to unbundle and introduce IPPs as these were considered a solution to resolving the supply constraints, and they also had the potential to compete with state-owned utilities. Although the reforms were adopted, the prevalent structure is still dominated by vertically integrated state-owned utilities but allowing the entrance of IPPs.

Eberhard *et al.* (2016) reported 126 IPPs in SSA, spread over 18 countries and accounting for approximately 25 percent of SSA's installed capacity when excluding South Africa. The countries with the most IPPs are Kenya, Nigeria, South Africa, Tanzania and Uganda.

**Table 2.1: IPPs per country**

| COUNTRY | NO. OF PROJECTS | CAPACITY (MW) | INVESTMENT VALUE (US$m) |
|---|---|---|---|
| Angola | 2 | 46 | 135 |
| Cabo Verde | 1 | 26 | 80 |
| Cameroon | 2 | 304 | 467 |
| Cote d'Ivoire | 6 | 866 | 940 |
| The Gambia | 1 | 25 | 36 |
| Ghana | 5 | 1,006 | 1,680 |
| Kenya | 16 | 1,066 | 2,334 |
| Madagascar | 1 | 15 | 18 |
| Mauritius | 6 | 272 | 520 |
| Nigeria | 5 | 1,971 | 2,597 |
| Rwanda | 1 | 100 | 200 |
| Senegal | 5 | 351 | 615 |
| Sierra Leone | 1 | 15 | 30 |
| Tanzania | 4 | 427 | 598 |
| Togo | 1 | 100 | 196 |
| Uganda | 22 | 539 | 1,659 |
| Zambia | 1 | 170 | 302 |
| South Africa | 67 | 4,308 | 14,924 |
| **Total** | **147** | **11,606** | **27,331** |

Lucas *et al.* (2017) estimated that to close the electricity access gap in SSA by 2030, an amount between USD300-350 billion or USD15 – 19 billion per year, is needed, while Eberhard *et al.* (2017) estimated USD40.8 billion will be needed to invest in production capacity, transmission and distribution infrastructure. This kind of funding cannot be raised on the strength of the governments' balance sheets or their utilities and hence the need to attract private investment.

IPPs have added 11 GW of installed generation capacity and have invested a total of USD25.6 billion in SSA. Despite this reported upsurge in IPP added capacity, this capacity is still relatively small compared to the additions by state-owned utilities. The idea that due to poor financial and technical performance of state-owned utilities, the introduction of IPPs would introduce competition has not been maximised in SSA at this stage .

Eberhard *et al.* (2017) reported that 21 countries out of 48 in SSA still maintain the fully integrated state-owned utility structure, while the other 18 countries who have allowed IPP participation have only allowed the IPPs to operate parallel to their state-owned utilities. Perhaps this is a model that is unique to the Sub-Saharan context, that is to continue attracting private investment while making the state-owned utilities push the ESI issues with socio-economic imperatives into consideration, thus creating a hybrid market structure of the coexistence of both public and private players moving in sync towards dealing with the unique challenges prevalent in SSA.

Cote d'Ivoire was the first country to open its ESI, followed by Ghana, Kenya, Nigeria, Senegal, Tanzania, and Uganda. The key determinants, according to Eberhard *et al.* (2017), for creating a conducive environment that can easily attract IPPs, are planning expansion of generation using the least-cost option, streamlining procurement and contracting processes, and ensuring the financial health of off-taker utilities. The proposition of having off-taker utilities having good financial health, leads to a circular argument. The state utilities are the main off-takers, and to anchor the IPP project they need to provide a credible Power Purchase Agreement, failing which, financial closure of the project under "project finance" will not be achieved. If the state-owned utilities have the ability to access funding on the strength of their balance sheet, then they can access funding at much cheaper borrowing costs than IPPs and can also save on the rate of return requirements which are likely to be higher for IPPs than for the utilities.

The fundamental question would be why would IPPs be needed if the financial health of the utilities suggests they could be able to pull through the projects the IPPs are developing. The reality, however, as reported by Eberhard *et al.* (2017), is that of the countries able to attract IPPs, none had a good credit rating, except for South Africa and Mauritius. This means these countries were able to attract investments which they would not normally be able to attract, based on their credit rating and financial strength without private participation and collaboration.

Many writers give a positive account of the impact of IPPs in the Sub-Saharan African ESI. Traore (2013) shared the Ivorian experience that IPPs enable the country to add generation capacity expeditiously since the decision to fully privatise in 1994. He further reported that through the IPPs, the Ivory Coast became a net exporter to Benin, Burkina Faso, Ghana, Mali and Togo, and that the Ivory Coast national electricity access rate improved significantly to 34 percent with a much higher access rate in urban areas, estimated at 74 percent. IPPs added 866 MW to the Ivorian system, representing a 74 percent growth in the installed generation capacity between 1990 and 2013 and IPPs accounting for 44 percent of the installed capacity. Providing 'comfort letters' and guarantees to reduce financial, operational and commercial risks for the IPPs to access financing for the proposed projects, adds to the challenges seen as a tedious part of dealing with IPPs.

Based on the literature review, the concept of *take-or-pay* has become contentious in the Sub-Saharan Africa market, where the PPA stipulates the amount of power that will be supplied to the utility or whoever is the off-taker. The off-taker must then pay a fixed capacity charge for the agreed volumes of power whether or not this volume has actually been used. This practice is standard to guarantee that the cash-flows of the project are sufficient to service its financial obligations. The off-takers often feel that they are made to pay for what they have not used, and this constitutes a waste of financial resources which could be applied elsewhere if the generating assets were owned by a state-owned utility. This discourse has also been observed in Uganda after its unbundling and privatisation.

In Kenya, IPPs account for about 26 percent of the installed capacity. Eberhard *et al.* (2016) reported that IPPs have reported a higher "availability factor" when compared with generating plants operated by the state-owned utility. However, in the Kenyan experience, the state-owned utility tariff output was lower than IPPs. It is important to highlight that despite Kenya having opened its ESI for IPPs, this did not result in the achievement of Kenya's expectations for electricity capacity growth.

In 2003, the government of Kenya expressed disappointment with the performance of the sector and had to incorporate in its strategy the state-owned utility playing a bigger role in developing new-generation capacity and growing investment in the entire ESI value chain in Uganda.

Similarly, in a *Gazette* Vol. CVII (September 2014), the Ugandan government expressed its concern that the tariff outputs from privately-owned generation plants were much higher, resulting in high ultimate costs for consumers. The Ugandan government has argued that the high electricity tariffs are negatively affecting the country's ability to achieve its socio-economic objectives. In that regard, the two big power projects under construction, Karuma (600MW) and Isimba (180MW), will be owned and operated by the state-owned generation utility, a reversal of the government-adopted position of allowing generation to be operated by private players.

**2.4 Theoretical framework of Independent Power Producers**

The concept and phenomenon of Independent Power Producers, in its current form and definition, is a relatively new concept that can be traced to the early 1990s as a result of the electricity supply industry policy reforms that swept across the world, as a result of factors that are discussed in detail hereunder.

Cooper (1948) and Melling (1998) proposed that the ESI was started and remained in the hands of private owners in the late 1800s, when the industry became formal and commercially viable after the breakthrough of Edison's demonstration of electrical application. Bradley (2011) supported this position by asserting that the formal rise of the ESI took shape through the private investors such as JP Morgan in supporting Edison in establishing General Electric. This private ownership can be argued to be the original form of independent power production. However, at that time it was not termed as such as there had never been any alternative to independent power production, therefore the concept of IPPs would not suffice to define the ESI structure .

Strange (1979) and Bowers (1982) presented the view that the private ownership of the ESI resulted in the access to electricity being a novelty for a privileged few in densely populated cities to the exclusion of rural areas. The private ownership of the ESI further resulted in standardisation challenges and anomalies in technology management and employment contracts.

The ESI remained in the hands of private investors and pioneers for a very long time. However, according to McDonald (1962), Insull in the US advocated for state-wide public utility regulation and consolidation of the ESI to realise economies of scale by building bigger generation assets that reduced the per unit costs, thus facilitating increased access at a cheaper price. According to Bradley (2011), this was achieved with the promulgation of the Federal Power Act and Public Utility Holding Company Act of 1935 in the US, effectively creating utilities which were regulated, controlled and supported by government. In the UK, the watershed moment came in 1947 when the ESI was nationalised by the Labour Government. By the mid-50s, the ESI, almost globally, was in the hands of publicly-owned monopoly utilities.

According to Vanderlinden (1988), the US experienced challenges in 1973 as a result of dependence on foreign-produced oil for power generation when OPEC imposed oil embargoes. This resulted in the Public Utility Regulation Policies Act of 1978, which encouraged local independent power producers to reduce reliance on oil for power generation. The modern-day concept of Independent Power Producers started to take form at this time. Due to the success of the US experience of introducing private producers in the ESI, many more countries followed in opening up the ESI for private participation. In 1993, the World Bank made known its official position to encourage developing countries to move away from state-owned utilities to unbundling and privatisation.

The main arguments that form the basis of this research study are explained by Mizrahi and Tevet (2014) that developed countries' need for reforming their ESI was aimed at "improving the performance of a relatively efficient system", whereas, according to Jamasb (2006) and Newbery (2002), developing countries needed to reform their ESI to solve problems of price subsidies, poor service quality, inadequate rates of fee collection, frequent network outages and service coverage that governments were no longer willing or able to support under the state-owned monopoly arrangement.

As the developing countries adopted the reforms in their ESI to solve the issues as highlighted above, the resultant expectation as proposed by Saunders *et al.* (1993) was that developing countries will be able to attract private investment that will (1) increase electricity generation, (2) drive-down tariffs, and (3) increase access to electricity by the general population. The opening up of the sector for private producers would bring competition amongst the players who will strive to produce more cheaply, leading to the increase of generation capacity and driving down tariffs, and in order to sustain this position would seek to grow their market by connecting customers not having access, thus also increasing the access rate in a country or market.

This study tested whether the IPPs have had this impact, especially in Sub-Saharan Africa, by testing the impact of IPPs on those countries that implemented the reforms with regards to (1) electricity generation growth, (2) tariff, and (3) access to electricity by population. This impact was compared to those countries that have not implemented any reforms and remain driven by state-owned monopoly utilities.

The reason for comparing countries with IPPs and those without IPPs, measuring the three variables, is because of the argument also observed by Saunders e*t al*. (1993), that the proponents who were against the reformation of the ESI in favour of single national utility monopoly model, argued that "electricity is a strategic and public-provided good that people should have a right to at low prices". Therefore, the juxtaposition of the two policy models is important in order to determine which has had a much more positive impact in Sub-Saharan Africa.

This study used a panel data model to test the correlation between the policy choice of either having IPPs in the ESI or not and the impact it has on the three variables. The policy choice was the 'dependent variable' in the study and the other three variables were the independent variables.

### 2.5 Empirical literature on Independent Power Producers and their impact

Borenstein *et al.* (2002), Joskow and Kahn (2002), Puller (2004) and Ishii (2006) all traced the concept and introduction of Independent Power Producers to the passing of the US Public Utility Regulatory Policies Act of 1978. Vanderlinden (1988) chronicled the events that led to the US implementing this policy, which effectively introduced IPPs, emanating from the 1973 OPEC oil embargo which raised concerns in America that the country was heavily dependent on foreign nations for its energy. The dependence on oil for power generation was the primary problem the US desired to solve by introducing IPPs under the PURPA.

Despite the fact the US ESI had other challenges at the time, such as environmental concerns associated with coal and nuclear power generation, acid rain, safe disposal of nuclear waste and disruptions caused by new transmission lines, the main focus as reported by Goodwin (1978) was not to solve all these industry woes, but to reduce oil imports. White (1996) suggested that after the passing of the PURPA, most of the American states adopted the reforms introducing IPPs because of "high electricity prices suffered" by consumers in those states, especially when compared to neighbouring states. According to Ishii (2006), the IPPs were mainly subsidiaries of the existing investor-owned utilities that were already operating in other states, enjoying a utility status.

The introduction of IPPs in the US ESI started a global phenomenon that was later followed by other developed and developing countries all for different reasons. The US sought to implement IPPs to reduce oil dependence but other developed countries, according to Mizrahi and Tevet (2014), aimed "to improve the performance of a relatively efficient system".

To properly understand the significance of the arguments between state-ownership versus private participation in the ESI, it is important to revisit how this sector developed under private ownership, how it was later nationalised and the contextual considerations for the nationalisation and its ultimate unbundling and privatisation again in the 1990s.

Strange (1979) traced the start of what would eventually become the electricity supply industry to the earliest application of electricity to lighting in Paris during the period 1875 to 1878. This sparked great public interest in the technology of electric lighting and enquiries were made by municipal authorities of this technology, specifically for the application in street lighting as reported by *The Electrician* (1878).

The breakthrough development and defining moment for the ESI, as reported by Hammond (1944), was on 21 October 1879 when Edison demonstrated an electric lamp using a carbonised thread as filament and managed to keep it burning steadily for two days. This led to the first commercial installation of Edison's lamps in steamship *Columbia* in May 1880 consisting of 115 electric lights that were successfully operated for 15 years.

Although static electricity had been a known phenomenon from as early as 600BC, according to Peregrinus (1986), it is argued that Edison's invention and success of the incandescent lamp contributed immensely to the commercialisation of electricity and the development of the ESI.

The first commercial power station was commissioned in New York City in September 1882 as the Pearl Street Power Station

Bradley (2011) proposed that the formal rise of the ESI took shape when private investors such as J. P. Morgan supported Edison in the launch of the business that would later become General Electric. As also observed by Cooper (1948) and Melling (1998), the ESI was developed and controlled by private owners.

Cooper (1948) argued that measures were taken to improve efficiencies and reliability of the ESI, but generation and distribution were mainly in the hands of hundreds of independent undertakings and companies and these presented major challenges for the industry. Despite the ESI being mainly a business of private owners, the development and growth of the sector seem to have taken the same trajectory as initially observed in the UK and US.

In the UK, as reported by Cooper (1948), the ESI was in the hands of hundreds of independent undertakings and companies. Melling (1998) suggested that as early as 1882, with the passing of the Electricity Act, 1882, the government intended that the industry should be under public ownership and control to avoid abuses that had already been experienced in the gas and water companies. However, this proposition was met with resistance and strong opposition from both the private owners and local-authority interest. Two major commissions, namely Williamson Committee in 1917 and Birchenough Committee in 1919, had similar recommendations of putting the ESI under public ownership. The latter committee resulted in the passing of the Electricity (Supply) Act of 1919 which established the Electricity Commission, leaving generation and distribution in the hands of the private owners and thus allowing the formation of Joint Boards with limited planning powers.

Two more committees were set up in the UK, the Weir Committee of 1925 and the McGowan Committee in the early 1930s. The Weir Committee resulted in the formation of the Central Electricity Boards who were mandated to own and operate transmission systems, but still leaving the generation and distribution to private players.

It could be argued that the UK ESI at this juncture had reached a stage of what contemporary advocates of open market could call “an optimal ESI structure”. Private players were in charge of generation and distribution, while transmission was a function of a public entity. This, however, did not present a perfect structure under which the ESI could be sustainable and flourish. As reported by Strange (1979) and Bowers (1982), access to electricity remained a novelty for a few elite located in densely populated areas, while this structure presented major technical challenges as there were anomalies in the standards of service, tariffs and conditions of employment as recorded by Cooper (1948).

Harris (2006) propounded that the development of the ESI in every country has largely been shaped by the political model and paradigm of that country. Erdogdu (2014) further supported this observation by suggesting that developments or reform experiences in countries can be explained by the differences in the relative strength of interest groups. As early as 1882, the UK government had intended to put the ESI under public ownership and control; however, the interest groups that were against such a proposition were powerful and enjoyed much political support which led to failure of any attempts to reorganise the industry.

In a watershed moment for the UK ESI in 1947, with a Labour Government in power, the 1947 Electricity Act was passed which effectively nationalised the UK ESI to remedy the defects and anomalies as they existed then under the predominant private ownership structure. At the time of privatisation of the ESI in the UK, there were already 625 electricity companies which had to be merged and incorporated within 12 area electricity boards.

Similarly, according to Bradley (2011), the US ESI development followed the same trajectory as the UK, where private players were the champions of the industry. The slight variation in the US ESI was the early consolidation of small generators in preference of bigger efficient generating units which provided "economies of scale" mainly led by an early prominent ESI mogul, Samuel Insull. This consolidation led to the creation of what can be called a "modern power grid" which could serve more customers more cheaply as observed that as a result of the large efficient generating units and advanced high-voltage transmission, electricity tariffs fell year after year between 1902 and 1930. The early experience could be used to argue that when privately-owned entities are given the space to innovate and self-regulate, they may come with the best solutions for society. However, as far as the ESI global experience is concerned, this was an exception rather than the norm.

Geddes (1992) recounted the role of politics in the early development of the US ESI, by suggesting that as the industry grew, it became intertwined with city politics, mainly over lighting contracts and trying to defend itself from other political proponents who sought to impose takeovers of the generators by local authorities or cap their tariffs. According to McDonald (1962), the likes of Insull advocated for state-wide public utility regulation as the best way to provide low-cost electricity and potential takeovers. Around 1914, state-level commissions were formed to play an oversight role of electric utilities. At this point it is important to draw attention to some similarities of the discourses being had in the contemporary ESI in relation to developing region. UK ESI developed through a number of private generators and distributors driving the industry development. This resulted in a disjointed and uncoordinated development that became expensive to operate, manage and service and had a high tariff output. In the US, the process of consolidating small generators in favour of large efficient generators delivered sustained lower tariffs and much greater access.

Bradley (2011) reported that the great depression had very dire implications for the ESI, and the Federal Power Act and Public Utility Holding Company Act of 1935 were promulgated changing the structure of the US ESI. This established the public utilities and bolstered more intervention and control by the Federal government. Private ownership was effectively replaced by public utilities that were owned at local level but federally regulated.

Other countries whose ESI was still predominately in the hands of private ownership followed in the path of nationalisation as done in Canada (1944), France (1946) and Argentina (1958), to name a few, seeking consolidation, economies of scale and better planning. The developmental trajectory of other countries was also mainly informed by the dominant political paradigm in that country; however, for a very long period the global structure of the ESI remained being that of a fully vertically integrated public utility responsible for generation, transmission and distribution.

In Germany, the development of the industry was quite different to both the experiences in the UK and US, in that the German ESI grew from shareholder-owned manufactures who held contracts with cities for supply of light and power. The prices were set by regulation and compulsory purchases protected by the state. There were attempts to nationalise the ESI in 1919 but this was not carried through.

Much was achieved under the predominant ESI structure both in developed and developing countries. The World Bank (1993) reported that the "single national electricity utility operating as public monopoly has facilitated the expansion of power supplies, captured technical economies of scale and made effective use of scarce managerial and technical skills". This monopolistic structure also had challenges of its own.

According to the World Bank (1993), the challenges that were observed in the developing countries under the state-owned utility monopoly were (1) decline in real power tariffs, (2) quality of service deterioration, (3) technical and non-technical losses and fuel consumption, (4) poor maintenance of plants, and (5) poor commercial performance as a result of inadequate metering, billing, and collection inefficiencies. Furthermore, the state-owned utilities were observed to have a low rate of return on revalued assets and low self-financing ratio.

Jamasb (2006) and Newbery (2002) succinctly argued that the need for reforms in the ESI during the early 1990s can be explained and understood in the context of "developing" and "developed countries". Jamasb (2006) proposed that developing countries' need to reform the ESI was intended to solve problems of price subsidies, poor service quality, inadequate rates of fee collection, frequent network outages and poor service coverage that governments were no longer willing or able to support under the existing arrangement.

In contrast to the reasons advanced for developing countries, Mizrahi and Tevet (2014) suggested that the reforms in "developed countries" were mainly aimed "to improve the performance of a relatively efficient system". A systematic approach was then adopted for the reform of the sector, applying a singular framework to solve different problems.

Developing countries had little option available to them but to implement or commit to implement the proposed sector reforms, as the World Bank (1993) made it policy to support countries that embraced the principles of reforms. The observations by Henisz and Zelner (2005) in regard to "coerced reforms" were that some actors that coerce dependent actors to undertake institutional change are often assumed to succeed on account of both power and legitimacy. In adopting the "1993 Lending Policy to Developing Countries Electric Power Sector", which left "developing countries" with very little option but to reform if they still intended accessing borrowing facilities of the World Bank demonstrated coercive power using its power and legitimacy.

According to the Electricity Deregulation Report (2006), the deregulation and privatisation process has resulted in different experiences in different parts of the globe influenced by many factors. In Europe, ten of the EU countries swiftly moved to open up their retail markets ahead of schedules from the EU directive while others moved very slowly. Smaller countries in the EU requested to be exempted from the process of deregulation and privatisation based on evidence that these reforms were not effective in smaller markets, because there is not enough volume to justify large enough number of participants at the various levels. It is important to highlight that although there was a clear indication that the reforms may not be effective for smaller markets, the policy to coerce Sub-Saharan Africa through the World Bank Lending Policy for SSA, compelled countries in SSA to implement the reforms irrespective of their market size.

The report explains that even in the UK, the unbundling resulted in higher overhead costs that even though the market was bigger, for any retail private company to be profitable it should have at least a million customers. This meant that with the number of customers, there would still be very few players and the benefits of economies of scale would not be realized, resulting in the costs associated with decentralisation increasing the sector overheads and directly pushing up the electricity tariffs.

As reported by Eberhard *et al.* (2016), countries in SSA had very small market sizes, even in today's terms. They reported that only 13 countries out of 48 have power systems larger than 1 Gigawatt (GW), 27 countries with a power system smaller than 500 Megawatt (MW) and the remaining 14 countries' systems smaller than 100MW. If the reforms were inadequate for the smaller European countries, logic would suggest that the same reforms would be inadequate for countries in SSA with smaller markets.

In the Americas around 1992 there was deregulation that paved the way for independent generators to sell power directly to the local distribution and supply companies, rather than to the generators. As such, Standard Market Design was established. In Canada, most utilities are vertically integrated and owned by the provinces, with varying degrees of competition. South America was the early leader in electricity deregulation, as reported by Harris (2006). Chile led the deregulation, followed by Argentina (1992), Peru (1993), Bolivia and Columbia (1993), Central American countries (1997), Brazil, Mexico, Ecuador in late 1990s. In 2002, the Inter-American Development Bank reported private ownership in generation was 90 percent in Chile, 60 percent in Argentina, 60 percent in Peru, 40 percent in El Salvador, 30 percent in Brazil, 20 percent in Ecuador, 10 percent in Costa Rica and also 10 percent in Mexico.

In Australasia, Australia’s industry is substantially unbundled and private, with state ownership being highly corporatized. New Zealand also had a vertically integrated state-owned monopoly, which was unbundled and deregulated in 1995, thus creating a wholesale market since 1996.

In Asia, China is reported to be the fastest-growing ESI in the world, perhaps consistent with Khatib’s (2003) observation that electricity growth rate is correlated to the economic growth in a country. China has a State Power Corporation. According to the Energy Information Administration (EIA), India is the sixth largest energy consumer in the world; however, as also reported in the State of Electricity Report (2017), India still has an estimated 270 million people without access to modern electricity supply. In India, the industry was liberalised in 1990 to encourage investment by independent power producers and to attract foreign investment. However, third party access to the grid and complex cross subsidies created commercial challenges which in turn resulted in very limited foreign investment.

In Japan, the ESI was monopolised during the Second World War and converted into state-owned vertically integrated monopolies. A process of reforming the industry in Japan began in 1995 with little change in the ownership structure and in 2012 Japan nationalised its generation after the Fukushima accident.

In the Middle East countries, though their governments are predominately conservative, there are reported intentions of privatisation and liberalisation of the ESI to be able to attract necessary investment, while the UAE have proceeded speedily in implementing privatisation.

In Africa, Cote d’Ivoire was the first country to open up its market followed by Egypt, Ghana, Kenya, Morocco, Tanzania, Tunisia, and Uganda. As reported by Eberhard (2016), most of the countries in the African continent have implemented some form of reforms such as introducing regulators, corporatizing their utilities and even introducing independent producers.

Thus far this study looked at the historical development of the ESI in the global context. What can be deduced from this historical information, is that the ESI was established through private ownership and for various reasons, went through a process of nationalisation, creating vertically integrated utility monopolies. In the 1990s there was a process of deregulation and liberalisation introducing and encouraging private ownership again in this sector.

This historical overview of how the ESI developed and contextualising the contentious issues in its development is critical in laying a foundation for understanding the rest of this study. The emphasis is on the structure that dominated in the inception of the industry, the challenges related to them, subsequent developments and the iteration of these structures as influenced by many factors and the impact of those structures to the fundamentals of the industry.

The successes of the voluntary ESI reforms in the US, and later also in the UK, played a major role in influencing the World Bank's policy in the early 1990s towards developing countries. The World Bank (1993) suggested the successes in both the US and UK are examples of pioneering endeavours that challenged that notion that the electricity sector is a natural monopoly. As privatisation gained momentum in the developed countries, the developing countries were left with little option as the World Bank had made it an official policy to lend to only those countries committed to implementing the reforms. As Pollitt and Bouckaert (2004) suggested, public reforms are not a radical, one-time change, but a gradual process that is incremental. In a memorandum circulated by the World Bank (1995) to its Executive Directors and President, the bank explicitly stated that the Bank should avoid making large power loans, mainly to Sub-Saharan African countries unless the sector is operating reasonably well or is substantially on its way to reform.

The five guiding principles of the World Bank that signified a reformed ESI of a developing country were (i) Transparent Regulatory Process, (ii) Commercialisation and Corporatisation, (iii) Importing Services, (iv) Committed Lending and (v) Private investment.

Summarising the first four principles, the Transparent Regulatory Process was explained as government needing to set objectives, articulate overall policies and coordinate sector development to enable the greatest possible degree of accountability and separation of responsibilities between the government and the entities responsible for power supply. This further required the establishment of an autonomous regulatory agency to enforce regulation and settle disputes.

The need was for power enterprises to commercialise and corporatize so as to operate on commercial principles and be treated as commercial enterprises, paying interest and taxes, and earning commercially competitive rates of return on equity capital. Further, Importing Services and Committed Lending were advocated for the utilities in developing countries to continue importing services and products from foreign entities and fulfilling their borrowing commitments.

The historical account of the ESI reforms, in particular the introduction of IPPs, is never complete without the recounting of the colossal failure experienced in California. The Californian experience resulted in the ESI global fraternity briefly suspending the reform programme and rethinking the implications of a privately-led ESI. According to the Electricity Deregulation Report (2006), California was the first state to enact an electricity restructuring plan. Subsequent to these reforms, the electricity tariffs began to increase astronomically, causing the public to question the reforms introduced. By the 2000s the state was experiencing limited power supply and increased demand which drove the wholesale price of electricity to soar in California and pushing up the retail prices to as much as double the customary electricity bill. The problem further intensified in the winter of 2000 as the state's utilities experienced a financial crisis and consumers experienced electricity shortages and high prices. This was certainly not the experience envisaged by Harris (2006), who described the resultant expectation of the sector reforms to be abundant, cheap and reliable energy. The Californian crisis resulted in many governments around the globe suspending plans of reforming the sectors and even gave justification to those governments that were really not in favour of the reforms programme from the start, citing the reform failure in California.

The experience in California was not the only negative experience of the impact of IPPs in the ESI. A study conducted by Albouy and Bousha (1998) evaluating the impact of IPPs on developing countries and even Asian countries plus Turkey, Morocco and Colombia, at a time that these countries represented 85 percent of the developing market, found the following:

- The private sector had assumed some of the industry risk, such as construction risk and operational risk.
- IPPs were highly leveraged and mainly sourced their funding from international markets, which increased the exposure to foreign exchange risk.
- In most of the countries, IPPs added new capacity that avoided supply interruptions or displaced more expensive generation.

- IPPs were largely responsible for more price increases due to the high market-related costs of borrowing, unsubsidised capital costs and operations as opposed to state-owned utilities.

Greacen and Greacen (2004) similarly chronicled the history of privatisation in Thailand and the impact of IPPs. The experience in Thailand included an increase in generation and tariff. The most important observation was the reaction of government in a time of financial crisis. According to Greacen and Greacen (2004), the Asian financial crisis of 1994 resulted in low demand for electricity and devaluation of Thailand's currency, the Baht. This tested how Thailand would respond under such circumstances, whether measures to protect the consumer would be implemented or interventions to favour mainly the IPPs. As already reported by Albouy and Bousha (1998), IPPs are by nature highly levered as they are financed through "project finance" and cash-flows guaranteed through PPAs that are concluded on a "take-or-pay" basis. Louw and Bhengu (2012) explained the "take-or-pay" concept as a contractual agreement where the producer agrees to sell to the power purchaser its output up to a certain annual amount or for all of its produced output. In turn, the power purchaser agrees to pay the agreed amount for the agreed volume regardless of whether it actually takes delivery or not.

In circumstances such as the Asian financial crisis, there is a reduction in electricity demand and the currency is devalued; however, the financial and contractual commitments remain standing against the purchaser and the costs of such arrangements are often passed to or recovered from the consumer. Greacen and Greacen (2004) confirmed that all these factors prevailed in the Thailand financial crisis, and the government response to this crisis sought to guarantee the returns of the IPP investors, thus giving priority to IPPs over benefits to the consumer.

Vanderlinden's (1988) analysis of the impact of IPPs or "non-utility generator" under PURPA suggests that these reforms resulted in the social costs of electricity production being completely replaced by the commercialisation without consideration of social imperatives. Bayliss and McKinley (2007) made a very strong argument of the failure of privatisation to deliver much needed electricity access to reach many Millennium Development Goals (MDGs) such as eradicating poverty, education and health goals. They further propounded that privatisation worsens poverty in that it focuses on financial sustainability rather than on social imperatives. Pearson (2014) further proposed that in the contemporary discourse the added dimension of “climate change” which has also imposed certain limitation on the technology that developing countries can deploy in closing their electricity needs contradicts the central proposition by subordinating poverty eradication to climate policy objectives.

The balance between commercial and social imperatives has always been a contentious matter in the ESI development, especially in developing countries. Saunders *et al.* (1993) observed that the proponents that continued to favour the single national utility monopoly model, largely held the view that “electricity is a strategic and publicly-provided good and that people have a right to power at low prices”. This, according to the World Bank (1993), resulted in the average real power tariffs in developing countries declining from around 5.2 cents to 3.8 cents/kWh. The World Bank further noted that many governments had also attempted to use the power sector and other publicly provided infrastructure services to address issues of social equity despite experience showing that such policies are costly and ineffective in dealing with the issues of social equity.

These observations by the World Bank, instead of being long-held views, were an evolution of the Bank’s perspective as evidence of policy during the public utilities paradigm supported by the bank, electricity at all cost to the poor in the form of social equity was a paramount policy.

In supporting public utility monopolies in the 1970s and 1980s, the World Bank in its Operational Manual Statement (OMS) 3.72 articulated its broad policy objectives in accord with the public utilities paradigm prevailing at that time. The objectives of the World Bank were to (i) help to provide power services on the basis of least cost development programmes, (ii) strengthen the sector’s institutions and improve their efficiency, (iii) increase local resource mobilisation and catalyse co-financing, and (iv) improve access to electricity disadvantaged groups.

The fourth objective of improving access to electricity by disadvantaged groups was one of the objectives with social consideration and in today’s terms could be understood in the context of the importance of electricity access to achieving Millennium Development Goals (MDGs) and Social Development Goals (SDGs) as proposed by Bayliss and McKinley (2007), Ekoevi *et al.* (2017) and Lucas *et al.* (2017), that electricity access is linked to the achievement of the MDGs and SDGs.

However, with the new World Bank policy in which it pushes for reforms in the ESI, the main emphasis is more on “Commercialisation and Corporatisation” of the utilities suggesting that they should charge tariffs that will give adequate rates of returns, make profits and pay taxes.

In fact, Covarrubias *et al.* (1995) observed a notable shift of the World Bank in its new policy, that it no longer emphasised “access to basic electricity services by the poor” as it did in the Operational Manual Statement 3.72, but now focused on encouraging the sector to be commercially operated and to a very great extent led by Independent Power Producers and other private entities in the entire ESI value chain.

The World Bank (1995) justified the policy shift from pursuing electricity access by the poor, particularly in SSA, by reporting that “improving access by the poor was arguably the most least feasible objective for SSA countries, given their financial and fiscal woes, their low per capita income and their stage of economic development and this situation will remain as such for the foreseeable future”. In doing so, the Bank had to reaffirm its new position of abandoning access to minimal electricity service as a welfare objective.

The World Bank position is consistent with Munasinghe *et al.*’s (1988) general pricing principle for electricity in that the tariff charged to the consumer should be reflective of the true cost of providing electricity. The counterarguments advanced by Vanderlinden (1988) and Bayliss and McKinley (2007) were that through the introduction of IPPs the social cost of electricity has been replaced by commercialisation without consideration of social imperative and in particular the access by the poor to electricity to advance the achievement of MDGs. Such thinking has been the reason governments in developing countries have been providing electricity at below the true costs of providing it.

Selling electricity at below its true costs, though it seems an easy way to give electricity access to many, has very negative externalities, as reported by the IMF (2013), in that providing subsidised energy causes economic harm and  distortions. Amongst the negative implications of subsidised or under-priced electricity tariff are the following:

- **Crowding out growth-enhancing or pro-poor public spending**
  Funds that could be used for economic growth enhancement or in advancing other social priorities are channelled to subsidise energy and this puts unnecessary burden on

the public finances. Energy subsidies are not an optimal mechanism for distributing wealth compared to other public spending options.

- **Discouraging investment in the sector**

  The subsidies artificially keep the prices of electricity low which results in lower profits or even losses. This inhibits state-owned utilities from being able to increase generation capacity as they cannot borrow using their balance sheet and the sector remains unattractive to the private investors to come in. This may eventually result in underinvestment in expansions and culminate in a supply crisis.

- **Creating harmful market distortions**

  Because of artificially low electricity tariffs, energy-intensive industries tend to invest more in high energy-consuming technology at the expense of labour-intensive sectors that could create much-needed jobs.

- **Subsidised energy stimulates demand, encourages inefficient use and unnecessary pollution**

  Subsidised electricity consumption from unclean sources of generation leads the consumer to be prone to wasteful consumption and further contributing to pollution.

- **Subsidised energy does not benefit the poor**

  Subsidies disproportionately benefit industrial users and high-income households who consume more electricity than the poor groups and all these are subsidised with public finances that could be put to better social use.

Most recently, Eberhard et al. (2018) who investigated how Tanzania's ESI sector facilitated investment, using qualitative techniques and triangulating the results to ensure integrity of the findings, found, amongst other factors, deficiencies in the planning and a lack of competitive procurement of the IPP capacity which resulted in costly deals and resources spent on disputes. In Tanzania the desires impact of increased generation capacity, lower tariff and increased access was not achieved. A similar study by Eberhard et al. (2018), evaluating the impact of IPPs in Kenya, found that contrary to Tanzania's experience that IPPs accounted for 43 percent of installed capacity with operational availability of power plants operated by IPPs at an average above 90 percent against a target of 85 percent, the tariff output of IPPs was higher than that of the state-owned utility company. This study did not consider the rate of access to electricity by the population as an integral part of the study.

Montmasson-Clair and Ryan (2014), in their study of renewable IPPs in South Africa between the period 2008 to 2011, found that competitive bidding resulted in a tariff output below the capped tariff and every successive bidding window further reduced the tariff from the last bidding window. This suggest that, unlike in Kenya and Tanzania, if the principles of competition are fully applied in introducing IPPs in a market, it does result in the reduction of tariff. In the South African market, the IPPs were only limited to renewable technologies, and as such, although the generation capacity was increased it could not be comparable to the fossil fuel plant capacity of the state-owned utility. IPP capacity remains very marginal. This study also did not incorporate the access factor by the population.

A quantitative study using the Multi-Period Stochastic Optimization Model was conducted by Afful-Dadzie et al. (2016) to study the long-term generation capacity planning for Ghana under budget constraint and developed a predictive Multi-Period Stochastic Integer Linear Programming Model (MILP) that can quantify the savings required to fund all future generation capacity. The assumption of this model is that savings are periodically made to finance new capacity and unused savings are used in subsequent periods. The findings suggested that Ghana required to save 0.75 percent per year to finance additional generation capacity between 2016 and 2035. The limitation of this study is that it assumed all new capacity to be added by the state-owned utility, did not consider project finance where only marginal equity would be required and the rest of the project value financed through debt, but worked on the premise of total funding through the government's balance sheet. Other variables of interest to this study were not part of this study, such as tariff and access.

A much more comprehensive quantitative study was conducted by Dertinger et al. (2019) to evaluate the impact of reforming the electric power sector in developing economies, with an analysis of data of more than 30 years and 100 developing countries with a focus on efficiency and access to electricity. The finding by Dertinger et al. (2019) suggests that the full implementation of the reforms increased connections by a 20 percent point and per capita consumption by 62 percent. Furthermore, there was no evidence that the reforms reduced network losses. The only limitation of this study it did not evaluate the impact on the tariff.

The dominant proposition from the literature review is that the introduction of IPPs does increase electricity generation in a country, but also increases tariffs to reflect the true costs of providing electricity. The policy chosen by a country of whether to introduce IPPs or maintain a state-owned monopoly utility is an outcome of many considerations. As much as the literature review covers electricity generation extensively, electricity access and correlation of these three factors is not explored in most of the studies.

With regards to tariff levels, the literature suggests that many governments view electricity as a public good that must be accessed by many at low costs. Despite these compelling arguments in favour of the social dimensions of electricity, the literature also warns about the setbacks in the ESI that may result from artificially low electricity tariffs.

This suggests that policy makers must try to balance the interest of all in the ESI, namely those of the consumer, investors, producers etc. This research evaluated whether this balance was achieved in measuring the growth in electricity generation, tariff level and access to electricity by the population.

Since electricity has the potential of improving the standard and quality of life, especially of poor people, as evidenced by the SDG 7 being a catalyst to enable the achievement of all other SDGs, policy makers must choose and implement policies that will make access to electricity possible for all at a tariff that is as low as possible, yet reflective of the true costs of providing electricity to ensure the sustainability of the ESI by being able generate enough revenues to cover operational costs, create reserves for future investment and provide returns that enable borrowing and attract investment.

# CHAPTER 3: RESEARCH METHODOLOGY

## 3.1 Introduction

This chapter focuses on the theoretical framework for this study, which forms the basis for the estimated model. It specifies the statistical model used in the study, elaborates on the estimation technique and reasons for the variables chosen. The chapter also covers the explanation of the data source, period and sample size.

## 3.2 Data source and period

This panel data study was for a period of 23 years from 1990, when the ESI reforms were initiated, to 2013. The multi-dimensional data tracked in this panel data, was (1) the growth in electricity generation, (2) electricity tariff, and (3) access rate to electricity by population, for all 48 Sub-Saharan African countries. The decision to limit the study up to 2013 was due to data availability in electricity generation classification. The data pertaining to the breakdown of electricity generation growth between governments and IPPs was available only up to 2013.

The data used for the quantitative analysis was sourced from the World Bank databases and its related institutions, such as the International Monetary Fund (IMF) and the International Finance Corporation (IFC). Other data was collated from publications of reports that used data from these institutions. These institutions are credible and command worldwide recognition in world statistical information.

Some challenges of secondary data collection, as identified by Hawkins (1990), are that there might be a need for surrogate data due to unavailability or the relevant data may be available but not for the required periods. During the data collection process, some information for smaller countries in SSA was not available in the World Bank Databases. In such cases, alternative reliable sources were used, and the data is identified as such in this dissertation. Tustin (2005) argued that one trademark of a good researcher is the skilful application of less than ideal data in the course of his work. The statistical model used in this study was selected with the quality of data in mind and its ability to still provide accurate outcomes even with missing information.

To counter the limitation of data availability, data triangulation became very critical. Erlandson *et al*. (1993) proposed that researchers seek out several different types of sources that can provide insights about the same events or relationship.

### 3.3 Analytical framework

The basic panel data equation which serves as the foundation for the analytical framework applied in this study is expressed as:

$y_{it} = x_{it}\beta + \alpha_i + u_{it}$ for t = 1, …,T and i = 1…, N
where:
$y_{it}$ is the dependent variable for individual i at time t
$x_{it}$ is the time variant 1 x K (the number of independent variables) regressor vector
$\beta$ is the K x 1 matrix of parameters
$\alpha_i$ is the unobserved time-invariant individual effect.

### 3.4 Model specification and empirical framework

This study applied a model that describes the relationship between the tested variables, namely electricity generation capacity, tariff increase and access to electricity in relation to the implementation of IPPs in Sub-Saharan African countries.

The effect of IPPs on electricity generation capacity was modelled using the static panel data model in equation 1

$$n_{i,t} = \beta_0 + \beta_1 ipps_{i,t} + \beta_2 gdppc_{i,t} + \beta_2 pop_{i,t} + \beta_2 private_{i,t} + \varepsilon_{i,t} \qquad 1$$

here $i$ and $t$ denote country and year respectively, $gen$ refers to electricity generation, $ipps$ refers to the IPP status of a country, 1 if a country uses IPP and 0 zero otherwise; $gppc$ is GDP per capita; $pop$ is country's population, and $private$ refers to private participation in electricity generation.

Equation 2 presents the panel data modelling the effect of IPPs on electricity tariffs across the sample countries

$$etrf_{i,t} = \beta_0 + \beta_1 ipps_{i,t} + \beta_2 gdppc_{i,t} + \beta_2 pop_{i,t} + +\beta_2 ecpc_{i,t} + \beta_2 eden_{i,t} + \varepsilon_{i,t} \qquad 2$$

where $etrf$ denotes electricity tariff measured as US cents, $ecpc$ is electricity consumption per capita, and $eden$ refers to energy dependency. All other variables are as defined before.

Finally, the IPP and electricity access relationship is presented in equation 3;

$$access_{i,t} = \beta_0 + \beta_1 ipps_{i,t} + \beta_2 gdppc_{i,t} + \beta_2 pop_{i,t} + +\beta_2 rpop_{i,t} + \beta_2 eden_{i,t} \qquad 3$$

where $access$ is electricity access measured as the electricity consumption per capita, $rpop$ is rural population growth; other variables are as defined before.

### 3.5 Variable description and expected signs

The subjects of this study are the 48 countries in Sub-Saharan Africa, and according to the literature reviewed by the researcher, 29 of these 48 countries still maintain a utility monopoly structure while 19 have IPPs. The results of the IPP countries were compared with those of the 29 countries with monopoly structures. The variable that was then tested for these sample countries was the impact of IPPs on electricity generation, tariff increase and access to generation by the population.

#### 3.5.1 Dependent variable

The dependent variable in this study was chosen based on the study hypotheses to be tested to achieve the objectives of the study.

#### 3.5.2 Electricity generation capacity

This variable was measured on the installed capacity of the country and growth thereof, tracked from when IPPs were introduced or not. The installed capacity has been expressed in MW and addition as a percentage indication of the actual MW.

#### 3.5.3 Electricity tariff

The electricity tariffs were measured in US cents and because for domestic customers the commercial and industrial tariffs are different, the average tariff and any changes were measured in percentages.

#### 3.5.4 Access to electricity

The access rate to electricity was measured in a form of a percentage of the people with access to electricity over the total population. The change over the years has been expressed in percentages.

### 3.5.5 Independent variables

The independent variables included in the study were premised on the literature review that suggested that countries that adopt a policy of IPPs (1) tend to have higher growth in electricity generation capacity, (2) electricity tariffs become cheaper, and (3) because of the high generation capacity and cheater tariffs, this results in the population of that country having higher access to electricity. The policy choice of a country whether it has implemented IPP or a non-IPP country was the dependent variable. This was because for the purpose of this study was to assess the impact of a country that has IPPs versus that without IPPs on the independent variable, and more importantly, the three independent variables that were a focus of this study. The expression of this dependent variable in the model equation was denoted by 1 if a country has IPPs and 0 (zero) if otherwise.

## 3.6 Estimation approach

### 3.6.1 Fixed effects and random effects model

Kreft and De Leeuw (1998) defined 'fixed effects' as constants across individual entities having different intercepts for each entity with a constant slope for all entities, while random effects vary, and the model's intercept is a random outcome variable. For example, in a growth study, a model with random intercepts $a_i$ and fixed slope $b$ corresponds to parallel lines for different individuals $i$, or the model $y_{it}=a_i+bt.$ thus distinguishing between fixed and random coefficients.

There is much debate about the difference between fixed and random effects models because of the 'conditional' versus 'unconditional issue. The choice to use a fixed or random effects model, to a great extent, was influenced by the homogeneity of the effect-size parameters. If all of the studies estimate a common effect-size parameter, then 'fixed effect' analysis is appropriate. However, if there is heterogeneity among the population effects estimated, then the 'random effect' procedure is the most appropriate.

The most important consideration in selecting the appropriate model to use, that is choosing between a 'fixed' and 'random' effects model, is the nature of the inference desired. Where the desired inference is related to the effect-size parameters in the study observed, then this means a 'conditional inference' is desired and as such the 'fixed effect model' is the most appropriate to be used. Furthermore, where an explicit generalisation beyond the observed study is to be made, the ‘random effect’ model is appropriate to be used to draw an unconditional inference. For the purposes of this study, due to the conditional nature of the desired inference, the ’random-effects model was determined to be the most appropriate.

# CHAPTER 4: RESEARCH FINDINGS AND DISCUSSION

## 4.1 Introduction

This section details the findings of the research with regards to (1) generation growth, (2) tariff, and (3) electricity access, comparing the performance of countries with IPPs against those countries without IPPs in Sub-Saharan Africa. The three variables observed in this research are individually discussed and observed phenomenon described. A statistical model is presented which was applied to test the relationship between these variables and whether the policy choice of a country has an impact on how these variables move.

## 4.2 Generation growth analysis

Sub-Saharan Africa had a total installed electricity generation capacity of 54 916 MW in the beginning of 1990. The average installed capacity per country can be said was at 1 168MW; however, this is not a true reflection, as only six countries had installed capacity greater than 1000 MW then and the other countries had installed capacity below 1000 MW. South Africa accounted for 59 percent of the total installed capacity of the entire Sub-Saharan Africa.

In 2013, the reported installed capacity was 92 651MW, indicating a total addition of 37 735 MW. This represented an increase of 69 percent in installed capacity between 1990 and 2013. The average installed capacity per country improved from 1 168 MW in 1990 to 1 971MW in 2013. However, again only 15 countries had installed capacity with more than 1000 MW while the rest had installed capacity below 1000 MW. South Africa's capacity and growth distorts the average for the region: some instances of the analysis looked at the comparative analysis, with and without South Africa.

The generation capacity added between 1990 and 2013 could further be broken down to distinguish the capacity added by IPPs and Non-IPP.  IPPs account for 31 percent or 11 608 MW of installed capacity added during the period under review, whereas non-IPP accounted for 69 or 26 375 of installed capacity added. Figure 4.1. summarizes this split for the period under review.

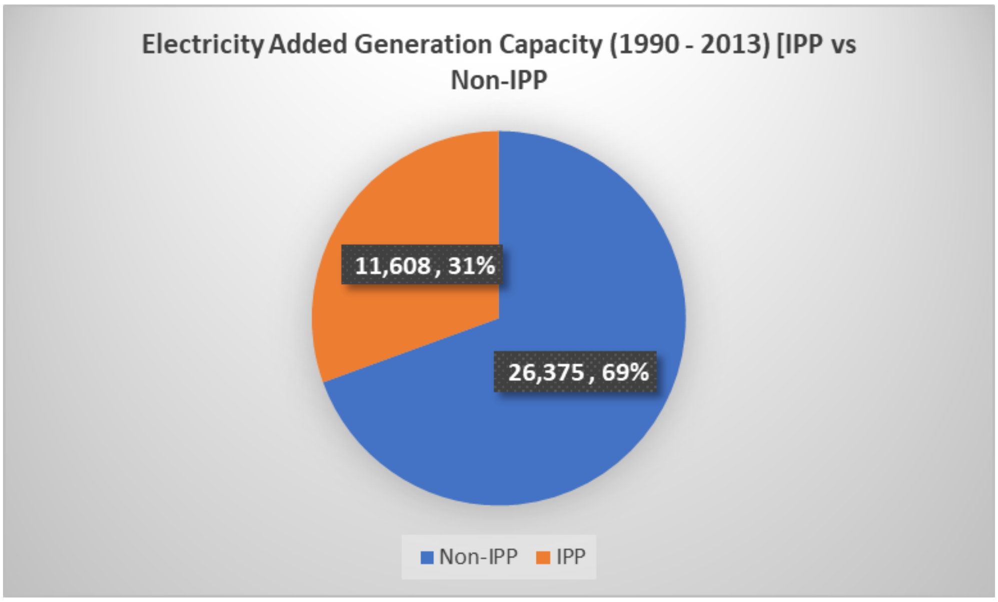


**Figure 4.1: Added electrical generation capacity 1990 to 2013**

Although the IPP projects were many, they added smaller quantum of power, whereas the non-IPPs undertook fewer larger projects. The researcher could not establish the associated costs of closing each project to compare the economic efficiency of concluding a project between the IPPs and non-IPPs. In terms of greater impact, the non-IPPs not only added more capacity, but each project had a higher contribution to generation capacity, bringing the economies of scale.

What has been presented thus far, is the total installed electricity generation growth that the study assessed and analysed in terms of how much capacity was added by IPPs and non-IPP. However, this information had not as yet revealed which of the countries added more capacity based on policy choice of having IPPs in the ESI or not. It should be borne in mind that the countries which have embraced IPPs still maintain state-owned utilities that continue to exist parallel to IPPs. Therefore, in those countries the installed capacity growth is a contribution by both IPPs and state-owned utilities.

For the period under review, countries without IPPs added 5 371MW or 14 percent while the countries with IPP added 32 364 MW or 86 percent. This suggests that the countries with IPPs added more capacity. In the countries with IPPs, government utilities still dominated by contributing more than IPPs. Of the 32 364 MW added in those countries, IPPs contributed 36 percent or 11 608 MW, while government utilities added 64 percent or 20 756MW.

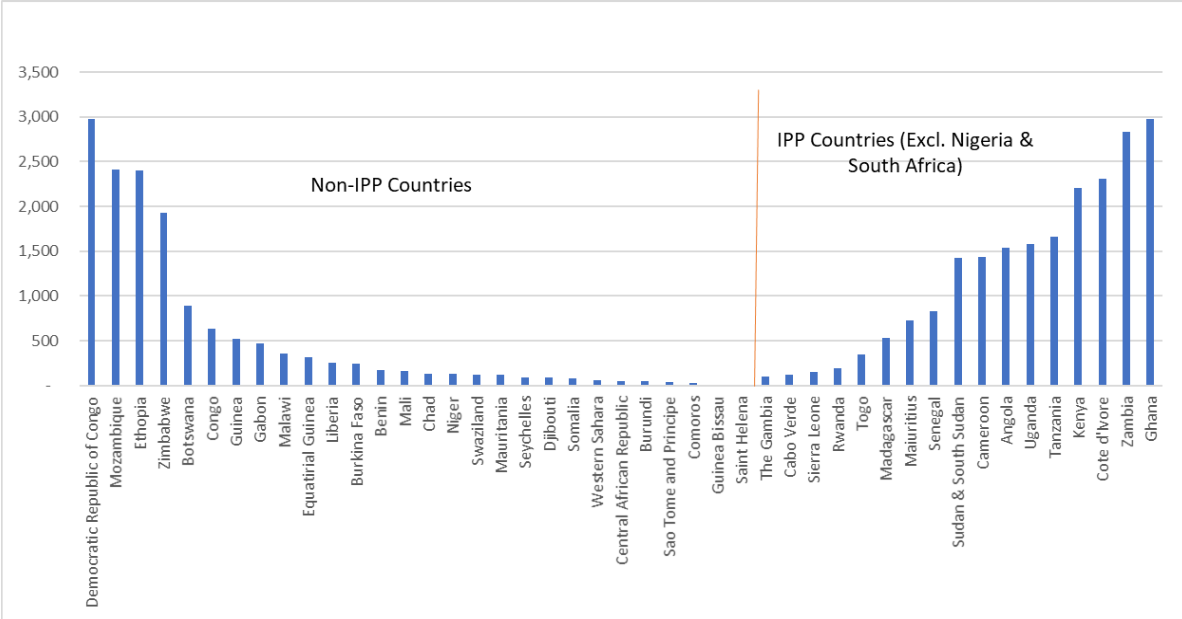


**Figure 4.2: Installed electricity generation (MW) 2013**

*Source: Researcher's estimate from research data*

The coexistence of IPPs and government utilities may be proving to be a model which can assist in propelling the increase in electricity generation growth, where the utilities lead the development and IPPs augment government's efforts. An alternative argument could be that the IPPs are nevertheless targeting countries where the conditions are already favourable in terms of market conditions and financial standing of those countries. This could be evidenced by the concentration of IPP projects in countries that have a certain economic profile. As can be seen in Figure 4.2, the countries with IPPs already reflect a higher level of installed capacity. Correlation with economic growth, credit rating and other factors were not tested in this study; however, these elements also explain some of the observable phenomena.

The graph in Figure 4.3 delineates the added generation capacity according to the countries and demarcated according to policy choice from 1990 to 2013. Again, the countries with IPPs added more installed generation compared to the non-IPP countries.

The juxtaposition of Figure 4.2 and Figure 4.3 confirms that IPP countries have higher installed capacity and also account for higher growth in the installed generation capacity. Although utilities lead by adding more capacity than IPPs, it can be argued that the existence of IPPs in a particular ESI market  adds momentum to the growth of generated electricity more than what the utilities would achieve alone.

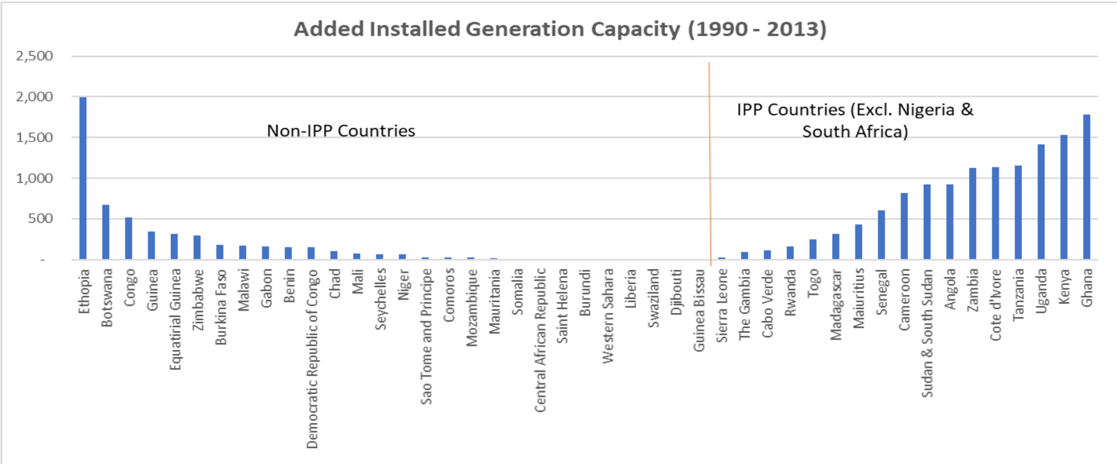


**Figure 4.3: Added generation capacity 1990 – 2013**
*Source: Researcher's estimate from research data*

The juxtaposition of Figure 4.2 and Figure 4.3 confirms that IPP countries have higher installed capacity and also account for higher growth in the installed generation capacity. Although utilities lead by adding more capacity than IPPs, it can be argued that the existence of IPPs in a particular ESI market adds momentum to the growth of generated electricity more than what utilities would achieve alone.

Although this study's main focus was on the impact of IPPs, the results as indicated in this section highlight the role and contribution of state-owned utilities as still significant. As such, the importance of the role played by state-owned utilities must be accentuated especially in Sub-Saharan Africa. Contemporary policy and literature focus are more on introducing private participation in the ESI and less focus is on the models to make state-owned utilities more efficient and progressive.

In SSA, almost 29 countries depend exclusively on state-owned utilities to pioneer solutions for those countries to close the energy access gap. The introduction of IPPs in these markets may not necessarily be the solution as most of these ESI markets are small. Drawing from the experiences of the smaller European countries which requested derogation from the policy implementation of liberalisation of their ESI due to their market sizes, the solution of some of the smaller countries is dependent on the state-owned utilities.

## 4.3 Tariff analysis

The average electricity tariff in SSA is determined to be US$0.19 per KWh as depicted in Figure 4.4

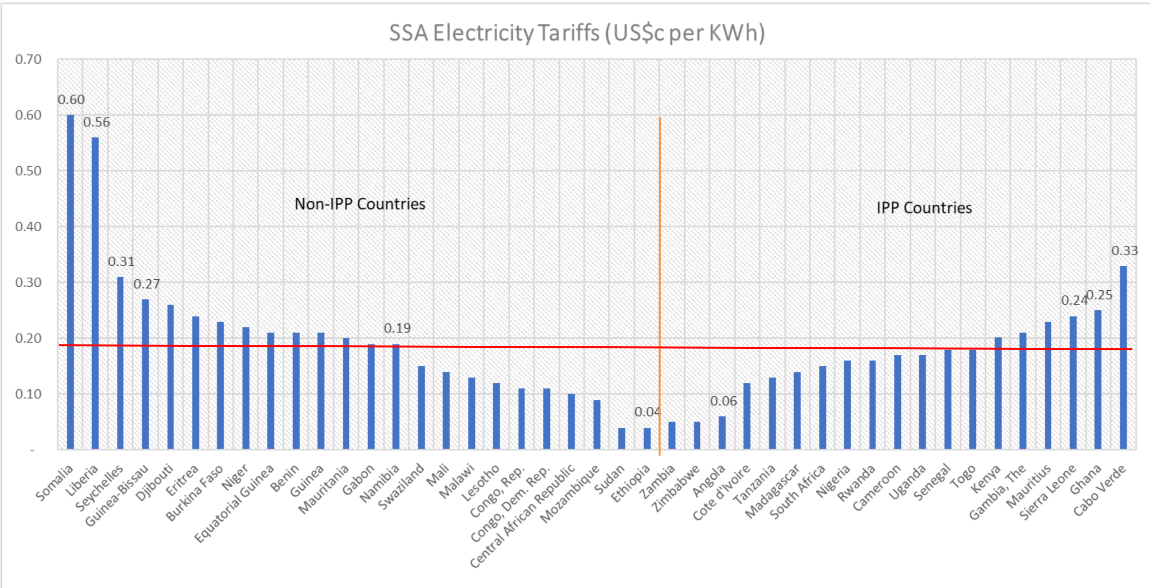


**Figure 4.4: SSA electricity tariffs ((US$c per KWh)**
*Source: Researcher's estimate from research data*

The figure above further suggests that there are more non-IPP countries whose tariff are above the total average of US$0.19 per KWh with 48 percent of non-IPP countries having tariffs above the average while only 32 percent for IPP countries have that. This information is particularly important in that there is a belief that where private participation in the form of IPPs is present, the tariffs get to be higher than those ESI markets that are dominated by state-owned utilities. Contrary to that, state-owned utilities keep electricity tariffs artificially low to try and stimulate economic activity and growth and also to make it accessible to the poor.

The results as analysed in Figure 4.4 suggest that countries in SSA that still have only state-owned utilities are more likely to have higher electricity tariffs. A question that must then be asked, is if tariffs are generally higher in the IPP countries, should this then be a favourable condition to attract investment as the tariff is higher than in the other markets?

To properly understand this dynamic, reference must be made to Figure 4.2, as there seems to be a correlation between the tariff and installed capacity. The countries that have higher installed capacity have lower tariffs, while the countries that have smaller installed capacity have high tariffs. This can be explained by the market size, in that when looking at countries such as Somalia and Liberia, it is evident that they have small installation and fewer customers must then share the total cost of the ESI. In countries where there is larger installation and a higher access rate, the tariff is low because of economies of scale, and thus the more customers that are connected, the lower the tariff gets.

This observation highlights the need to have more high-impact generation in SSA to increase the number of customers that are connected so that the unit price of electricity is low due to many customers sharing the costs associated with providing electricity. As it is common knowledge that SSA is plagued by poverty and inequality, the expectation that the majority who survive on less than US$1 a day, are able to afford electricity at an average tariff of US$0.19 per KWh is not based on the reality of progressing the ESI in this region.

For the purposes of this study, the tariff methodology, structure and philosophy were not extensively evaluated. It is important to highlight that most of the countries provide subsidised electricity up to a certain level, i.e. the first 15KWh is either provided free or highly subsidised to enable even the poorest of the poor to have basic access to electricity. While other countries connect customers to the grid for free, most countries also require customers to pay to be connected. In some countries the connection fee is minimal while in others very prohibitive. This highlights some of the issues that impact the ESI other than the factors covered in this study.

One of the issues in ESI is setting the right tariff to strike a balance between the ESI business imperatives and societal needs. The ESI requires a certain level of tariff to be able to recover all its costs of providing electricity and be able to invest in future infrastructure needs, such as generation assets, transmission and distribution networks. Society, with the constraint of limited financial resources, requires the tariff to be as low as possible. Since a low tariff makes it difficult to attract funding and investment in the sector, this results in the inability to invest in new assets as the old ones reach the end of economic life.

These opposing and conflicting objectives often result in mistrust and even conflict between these players. To mitigate this problem, most countries have independent regulators charged with the responsibility to consider all the factors affecting all players or interested parties and after taking these into consideration, set a transparent, fair and equitable tariff.

Most countries are increasing their tariffs to achieve a tariff that is “cost reflective”. However, this makes electricity expensive for the poor but to make the tariff  as cheap as possible, there needs to be customers connected to the grid so that they may share the associated costs.

The prevalent challenge related to tariff setting in SSA is for governments to have a systematic approach choosing to first connect as many customers and once they are connected, gradually move towards a cost reflective tariff. Such an approach would have a dual benefit in that (1) the access rate gap would be closed and the quality of life for those who are connected will improve, and (2) a clear commitment to achieve a cost reflective tariff after maximising connection would still provide a blueprint for sustainability which will be attractive to investors.

The ideology of keeping tariffs artificially low, meaning the tariff set at a low level that does not allow the recovery of operating and capital costs, does not benefit any of the ESI players. It makes customers to be used to an artificial tariff but later exposing them to very steep increases where expansions must be funded and to avoid the collapse of the ESI.

Similarly, an exorbitantly high tariff has an impact of driving customers to investigate alternative sources of energy outside the grid. This results in intensive electricity users finding their own energy sources and resulting in low volume uptake from the main grid and some other industrial customers looking at investing in other countries, regions or even continents to avoid high electricity costs, which is a basic input in many production processes forming a substantial part of a company’s operating costs.
Whether an artificially low tariff encourages economic growth and growth in access to electricity, is still out on jury as there is no evidence of higher economic activity or return for those countries that have kept their tariff low. Sudan, Ethiopia, Zambia, Zimbabwe, Angola, and many other countries had the lowest tariffs in SSA as indicated in Figure 4.4. However, they are not the leaders in economic growth nor counting high in access to electricity by the general population.

## 4.4 Electricity access as percentage of the population

The most important indicator of whether an ESI in a country is doing well, is the access by the general population to electricity. In SSA, the customer profile reflects that at least 60 percent of the electricity generated is consumed by industrial consumers.

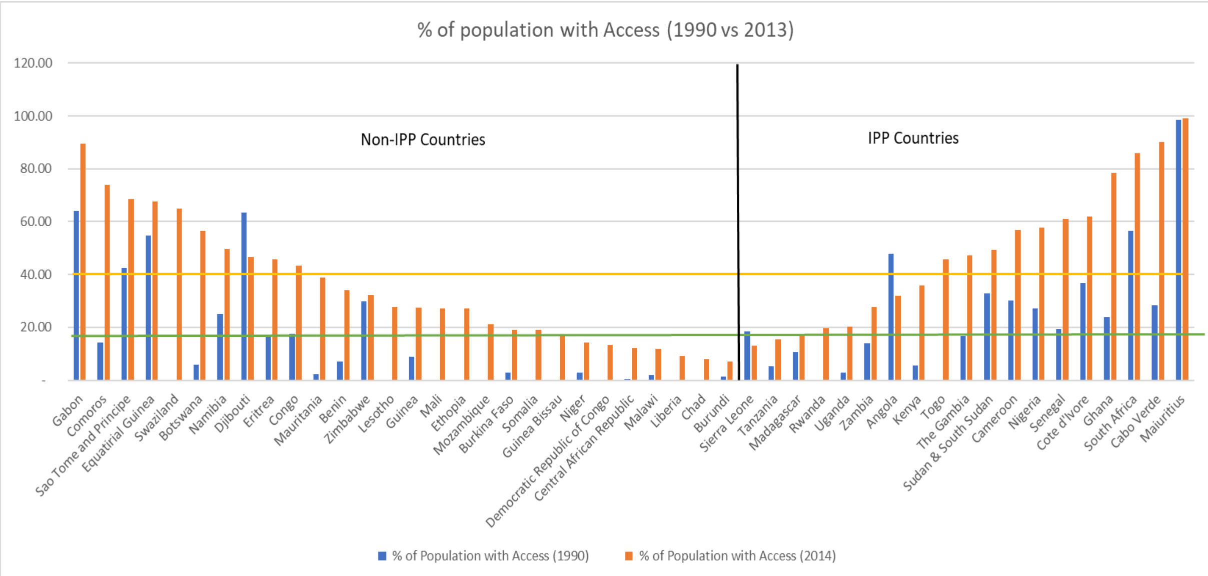


**Figure 4.5: Percentage of population with access to electricity (1990 vs 2013)**

In 1990, the now IPP countries had an average electricity access rate of 25 percent and this improved to 48 percent in 2013. These figures are both above the average for the total of the Sub-Saharan Africa region in 1990 and in 2013. The non-IPP countries reported an average of 13 percent in 1990 and 35 percent for 2013, below the total average of 19 percent and 41 percent for 1990 and 2013, respectively.

The average percentage change of all the SSA countries in the access rate between 1990 and 2013 is 22 percent. Countries without IPPs and those with IPPs indicate an average change of 20.3 percent and 23.15 percent, respectively. Again, this indicates that the countries with IPPs register a slightly higher percentage change in the access rate above the total average.

Figure 4.5 further indicates that 58 percent of countries with IPP have an access rate average total of 41 percent, whereas, only 34.5 percent of countries without IPPs tallied an access rate above the average. It is also noted that there are countries who lost installed capacity between the period under review, which means that when comparing the installed capacity between 1990 and 2013, there was a reduction in the countries' installed capacity.

## 4.5 Descriptive statistics

Table 4.1below presents the descriptive statistics results for the variables electricity generation (EGEN), electricity tariff (ETARIFF), electricity access (EACCESS), IPP status, GDP per capita (GDPPC), population (POP), electricity consumption per capita (ENCONPC) and electricity dependency per capita (ENDEPPC). The results in Table 4.1 reveal that means for all the variables are greater than their corresponding medians, implying that the distributions of all the variables considered in this study are right-skewed. That is, all the variables in Table 4.1 are positively distributed. The difference between the maximum value (Max) and minimum value (Min) gives the range. The range and standard deviation (Std. Dev.) are measures of absolute variability. Larger values of the standard deviation and range indicate a lot of variability or volatility between the minimum value and the maximum value. The values of both the range and standard deviation for all the variables in Table 4.1 are relatively large indicating a lot of variability or volatility in the data sets for the variables considered in this study.

Table 4.2 presents the IPP status of the countries in the sample data. The results reveal that about 60 percent of the countries in the sample are Non-IPP (that is, they do not have independent power producers) while about 40 percent of the countries in the study are IPP (that is, they have independent power producers).

**Table 4.1: Descriptive statistics**

| Stats | Mean | Median | Std Dev. | Min | Max | N |
|---|---|---|---|---|---|---|
| **EGEN** | 1464.447 | 189 | 5672.982 | 4 | 47643 | 1200 |
| **ETARRIFF** | 0.112 | 0.100 | 0.091 | -0.160 | 0.600 | 1200 |
| **EACCESS** | 29.299 | 22.215 | 25.497 | 0.010 | 99.440 | 1200 |
| **IPP_STATUS** | 0.397 | 0.000 | 0.489 | 0.000 | 1.000 | 1200 |
| **GDPPC** | 1498.186 | 576.630 | 2556.935 | 102.640 | 22742.380 | 1151 |
| **POP** | 1.51E+07 | 8216896 | 2.32E+07 | 69507 | 1.76E+08 | 1197 |
| **ENCONPC** | 546.717 | 150.705 | 930.4558 | 21.63 | 4777.06 | 584 |
| **ENDEPPC** | 627.4124 | 437.925 | 576.8816 | 9.58 | 3103.97 | 620 |

*Notes: EGEN=Electricity Generation; ETARIFF=Electricity Tariff; EACCESS=Electricity Access; IPP=IPP Status; GDPPC=GDP Per capita; POP=Population; ENCONPC=Electricity Consumption per capita; ENDEPPC=Electricity dependency per capita*

Table 4.2 presents the correlation analysis results of the variables. The results show that there is a highly significant positive correlation ($p < 0.01$) between electricity generation (EGEN) and electricity access, electricity tariff, IPP status, GDP per capita, population, electricity consumption per capita, and electricity dependency per capita. The results further reveal that there is a highly significant strong positive correlation between electricity generation and population (r =0.707), electricity access and GDP per capita (r = 0.792), GDP per capita and electricity consumption per capita (r = 0.645), and electricity consumption per capita and electricity dependency per capita (r = 0.848).

Based on equation 2, there is a significant weak positive correlation between electricity tariff and IPP status, population and GDP per capita. There is no significant correlation between electricity tariff and electricity consumption per capita, and electricity dependency per capita.

**Table 4.2: Correlation analysis**

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|
| **1.EGEN** | 1.000 | | | | | | | |
| **2.EACCESS** | 0.188*** | 1.000 | | | | | | |
| **3.ETARIFF** | 0.199*** | 0.200*** | 1.000 | | | | | |
| **4.IPP_STATUS** | 0.388*** | 0.174*** | 0.147*** | 1.000 | | | | |
| **5.GDPCC** | 0.161*** | 0.792*** | 0.238*** | 0.027 | 1.000 | | | |
| **6.POP** | 0.707*** | 0.386*** | 0.190*** | 0.365*** | 0.411*** | 1.000 | | |
| **7.ENCONPC** | 0.487*** | 0.553*** | 0.014 | 0.080** | 0.597*** | 0.117*** | 1.000 | |
| **8.ENDEPPC** | 0.395*** | 0.597*** | 0.024 | 0.007 | 0.645*** | 0.119*** | 0.848*** | 1.000 |

*Notes: EGEN=Electricity Generation; ETARIFF=Electricity Tariff; EACCESS=Electricity Access; IPP=IPP Status; GDPPC=GDP Per capita; POP=Population; ENCONPC=Electricity Consumption per capita; ENDEPPC=Electricity dependency per capita; ***, ** and * denotes significance at 1%, 5% and 10% respectively.*

## 4.6 Regression results

The regression results of the effect of IPPs on electricity generation are presented in Table 4.3 (Equation 1). The equation was estimated using the random effects (REM), generalised least squares (GLS) and the panel-corrected ordinary least square (OLS-PCSE) estimation techniques. The coefficient of determination (R-squared) shows that approximately 55.5 percent and 79.13 percent variations of electricity generation are explained by the models for the REM and OLS-PCSE techniques respectively. The results also reveal that based on REM, GSL and OLS-PCSE approaches, there is a significant ($p<0.001$) multiple linear relationship between electricity generation and the explanatory variables (IPP Status, GDP per capita and population). Overall, the electricity generation model is a very good fit. Most importantly, the regression models were estimated by considering the error structure, which was found to be heteroskedastic and autocorrelated.

The coefficient of IPP status is observed to be positive across all the techniques, but only significant in the GSL and OLS-PCSE models at one percent, which indicates that countries with IPPs generate higher electricity compared to non-IPP countries. This result is consistent with the findings of Traore (2013) .

The coefficients GDP per capita and population are both positive and significant at one percent across all three estimation techniques. This indicates that higher income levels and population are associated with higher electricity generation. This is consistent with the findings of Poloamina and Umoh (2013)

Results from Table 4.4 reveal that based on REM and GLM approaches, there is a significant ($p<0.001$) multiple linear relationship between electricity tariffs and the explanatory (or independent) variables IPP Status, GDP per capita, population and electricity consumption per capita. The R-squared value (which is the coefficient of determination) is 51.3 percent based on the REM approach. This suggests that just over 51 percent of the variation in electricity tariffs is accounted for by a combination of the explanatory variables IPP Status, GDP per capita, population and electricity consumption per capita. This suggest a moderate good fit model for electricity tariffs based on REM and GLM. However, in this case the OLS approach suggests the poor fit with an r-squared value of just less than 20 percent. The multiple linear regression model based on all the three approaches suggests that IPP Status contributes negatively to electricity tariffs which is in support of the hypothesised claim. Overall, the electricity tariffs model is a reasonably good fit.

**Table 4.3: IPP and electricity generation**

| Electricity generation | REM | GLS | OLS-PCSE |
|---|---|---|---|
| | Coef. | Coef. | Coef. |
| Constant | -15.845 | -13.588*** | 16.026*** |
| | (11.901) | (5.647) | (7.745) |
| IPP Status | 0.291 | 0.437*** | 0.391*** |
| | (0.366) | (0.079) | (0.099) |
| GDP Per capita | 0.274*** | 0.259*** | 0.336*** |
| | (0.054) | (0.023) | (0.032) |
| Population | 0.897*** | 0.784*** | 0.806*** |
| | (0.158) | (0.027) | (0.033) |
| R-squared | 0.555 | | 0.7913 |
| Wald $\chi^2$ (4) | 152.570 | 1682.430 | 949.73 |
| Prob > $\chi^2$ | 0.000 | 0.000 | 0.000 |
| Year Dummy | Yes | Yes | Yes |
| Hettest $\chi^2$ | 7.33 | | |
| Prob > $\chi^2$ | 0.0068 | | |
| AR (1) | 295.898 | | |
| Prob > F | 0.000 | | |
| Countries | 48 | 48 | 48 |
| Observations | 1,150 | 1,150 | 1,150 |

*Notes: IPP=IPP Status; GDPPC=GDP Per capita; POP=Population; Hettest= test for heteroskedasticity; AR(1)=Test for first order autocorrelation. ***, ** and * denotes significance at 1%, 5% and 10% respectively.*

Table 4.5 presents the results of the relationship between IPP status and electricity access. The results reveal that based on all the three approaches, REM, GLM and OLS, there is a significant (p<0.001) multiple linear relationship between electricity access and the explanatory (or independent) variables IPP Status, GDP per capita, population and electricity dependency per capita. However, the R-squared value (which is the coefficient of determination) of less than 40 percent based on all the three approaches suggests a poor fit. This suggests that less than 40 percent of the variation in electricity access is accounted for (or explained) by a combination of the explanatory (or independent or predictor) variables IPP Status, GDP per capita, population and electricity dependency. Overall, the electricity access model is not a good fit.

**Table 4.4: IPP and electricity tariffs**

| **Electricity tariffs** | **REM** | **GLS** | **OLS-PCSE** |
|---|---|---|---|
| | **Coef.** | **Coef.** | **Coef.** |
| Constant | -1.338***<br>(0.085) | -0.716***<br>(0.096) | -0.308***<br>(0.082) |
| IPP Status | -0.085***<br>(0.021) | -0.058***<br>(0.018) | -0.027**<br>(0.014) |
| GDP Per capita | 0.023***<br>(0.003) | 0.003**<br>(0.001) | 0.006***<br>(0.002) |
| Population | 0.080***<br>(0.006) | 0.049***<br>(0.006) | 0.023***<br>(0.005) |
| Electricity consumption per capita | 0.000***<br>(0.000) | 0.000**<br>(0.000) | 0.00001<br>(0.00001) |
| R-squared | 0.513 | | 0.1965 |
| Wald $\chi^2$ (4) | 1978. | 81.69 | 518.04 |
| Prob > $\chi^2$ | 0.000 | 0.0000 | 0.000 |
| Year Dummy | Yes | Yes | Yes |
| Hettest $\chi^2$ | 55.670 | | |
| prob > $\chi^2$ | 0.000 | | |
| AR (1) | 20.308 | | |
| Prob > F | 0.0002 | | |
| Countries | 24 | 24 | 24 |
| Observations | 583 | 583 | 583 |

*Notes: EGEN=Electricity Generation; ETARIFF=Electricity Tariff; EACCESS=Electricity Access; IPP=IPP Status; GDPPC=GDP Per capita; POP=Population; ENCONPC=Electricity Consumption per capita; Hettesr= test for heteroskedasticity; AR(1)=Test for first order autocorrelation. ***, ** and * denotes significance at 1%, 5% and 10% respectively.*

The coefficient of IPP status is observed to be positive and significant across all estimation techniques which suggests that countries with IPP have higher access to electricity, as proposed by Traore (2013). In addition, the results suggest GDP per capita has a highly significant effect on electricity access while population and energy dependency have a negative effect on electricity access.

**Table 4.5: IPP and electricity access**

| **Electricity access** | **REM** | **GLS** | **OLS-PCSE** |
|---|---|---|---|
| | Coef. | Coef. | Coef. |
| Constant | -19.363*** | -14.334*** | -16.678*** |
| | (1.006) | (1.519) | (1.159) |
| IPP Status | 0.106** | 0.132*** | 0.132*** |
| | (0.053) | (0.022) | (0.020) |
| GDP Per capita | 0.020*** | 0.047*** | 0.034*** |
| | (0.006) | (0.007) | (0.006) |
| Population | -0.029** | -0.043*** | -0.047*** |
| | (0.014) | (0.007) | (0.005) |
| Energy dependency per capita | -0.00006*** | 0.000 | 0.000*** |
| | (0.00001) | (0.000) | (0.000) |
| R-squared | 0.2043 | | 0.396 |
| Wald $\chi^2(5)$ | 1295.74 | 297.29 | 1128.82 |
| Prob > $\chi^2$ | 0.0000 | 0.0000 | 0.0000 |
| Year Dummy | Yes | Yes | Yes |
| Hettest $\chi^2$ | 2.38 | | |
| prob > $\chi^2$ | 0.1225 | | |
| AR (1) | 6.925 | | |
| Prob > F | 0.0131 | | |
| Countries | 32 | 32 | 32 |
| Observations | 616 | 616 | 616 |

*Notes: EGEN=Electricity Generation; ETARIFF=Electricity Tariff; EACCESS=Electricity Access; IPP=IPP Status; GDPPC=GDP Per capita; POP=Population; ENDEPPC=Electricity dependency per capita; Hettesr= test for heteroskedasticity; AR(1)=Test for first order autocorrelation. ***, ** and * denotes significance at 1%, 5% and 10% respectively.*

# CHAPTER 5: RESEARCH CONCLUSION AND RECOMMENDATION

## 5.1 Introduction

This section provides the conclusion of the study based on the descriptive statistics analysis and statistical model results. Policy recommendations are also made for consideration by the users of this research report. Avenues for future research that will add greater insight in this subject and positively contribute to the development of the ESI in Sub-Saharan Africa are highlighted herein.

## 5.2 Summary and conclusion of the study

The results of the study provide empirical evidence that countries with IPPs in Sub-Saharan Africa tend to have (1) higher electricity generation growth, (2) lower tariffs on average, and (3) higher population access to electricity on average compared to countries without IPPs. The results of the panel data estimations on 48 African countries over a 23-year period established a significant relationship between the IPP status of a country and electricity generation, tariff and access rate. The main conclusions drawn from the study include the following:

- The use of IPPs improves the electricity generation capacity of Sub-Saharan African countries.
- The use of IPPs reduces electricity tariff in Sub-Saharan African countries.
- The use of IPPs improves electricity access in Sub-Saharan African countries.

## 5.3 Policy recommendation

Developing adequate ESI policy for the Sub-Saharan African region will forever be a complex endeavour because of issues that impact this industry. However, solutions must be found that will accelerate the development of the ESI in SSA as the achievement of most of the SDGs and Agenda 2063 are intrinsically linked to access to reliable electricity. There can never be a one-size fits all solution for this region as the challenges are not the same.

Based on this study, there are considerable benefits in opening up the ESI to include Independent Power Producers as this has proven to increase generation capacity, reduce tariffs and increase access to electricity by the general population. It must be borne in mind that policy decision alone to open up to IPPs is never sufficient, there are other factors that support the achievement of the desired end state.

The study compared the performance of countries where IPPs were present and those that did not have IPPs. It must further be highlighted that the countries that had IPPs still also had state-owned utility companies that coexisted with the IPPs. Policy should also consider the contribution of these institutions and seek to strengthen them to continue to close the gap which IPPs cannot fulfil.

### 5.4 Avenue for future research

Future research should focus on "ideal conditional factors" that a country should have to attract investment in electricity infrastructure in Sub-Saharan Africa whether the ESI structure permits IPPs or not. An untested observation is that the IPPs would invest in countries with certain economic fundamentals in place, such as credit rating, quality of government guarantees and political and economic stability.

The argument can then be made that the IPPs did not bring any new form of funding that the government would not access through the strength of its balance sheet or on the merit of its economic performance. It is for this reason that countries that are not doing well in electricity generation growth, tariff and access, would not attract IPP investment even if their ESI structure allowed IPP investments.

Considering the continued importance of the state-owned utilities, further research on state-owned utility sustainability under current market conditions and institutional strengthening is important.

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