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ABSTRACT

Using time series and the Uganda National Household Survey data, this paper seeks to examine the impact of the electricity reforms on the performance of the sector. Specifically, we investigate the effectiveness of the reforms in terms of sector performance taking into consideration various performance indicators such as electricity access, generation per capita, distribution efficiency, price trends, subsidies and customer growth. These indicators were selected on the basis of the rationale of the reforms.

Results show that connectivity is increasing, but cannot be statistically linked to the reforms. In addition, we show that the reforms have tended to favour the urban dwellers with connectivity levels rising from 36 percent in 1992 to 46 percent in 2009 while the rural dwellers have benefitted less due to the slow rural electrification rate. Electricity generation per capita remains low and there is a widening demand - generation gap, increased reliance on thermal generation, and rising cost per unit of electricity.

Overall, the results do not generate significant evidence linking improved sector performance to the reforms. However, we recommend that these results be interpreted with caution due to the short time periods involved.

Keywords:
Electricity, Uganda, Reforms, Restructuring, Privatization

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1. INTRODUCTION

During the past two decades, a number of developing countries, including Uganda, have undertaken electricity sector reforms. Such reforms have mainly involved the unbundling of vertically integrated government utilities into three separate segments for generation, transmission and distribution (ERA and MoFPED 2008). The major aim of these reforms was to improve quality of service, improve connectivity, improve reliability, reduce losses, attract private capital investment into the sector and thus enhance overall sector efficiency.

Uganda initiated electricity reforms in 1997 with the formulation of a comprehensive strategic plan for transforming the electricity sector into a financially viable industry. The aim was to enable efficient electricity supply at reasonable prices. In 1999, the strategic plan was reviewed to address the key problems in the sector and in particular those of very poor financial and commercial performance by Uganda Electricity Board (UEB) and the need to finance a relatively large investment program.

In developing the proposals, Government also took into account the likely impact of privatization and sectoral restructuring options on tariffs. Specifically the plan was designed to achieve the following objectives: Making the sector financially viable and able to perform without subsidies; increasing the sector efficiency; Improving the sector commercial performance; meeting the growing demands for electricity and increasing area coverage; improving the reliability and quality of electricity supply; attracting private capital and entrepreneurs ; and Taking advantage of export opportunities.

The revised plan placed particular emphasis on the role of competition in promoting efficiency within the electricity sector and on private sector participation. Private sector participation was viewed as an engine of growth for the sector in the supply and connectivity of electricity to customers. The proposed reforms were to focus on generation, transmission, distribution, ownership, regulation and implementation program for the reforms.

Prior to the reforms, the electricity sector was faced with a number of fundamental challenges, including but not limited to: very poor supply reliability; inadequate investment in the sector particularly in generation and distribution; very poor commercial performance by UEB; high technical and non-technical losses, exceeding 30 percent; and low productivity (UETCL 2008). In addition to the above problems, which related directly to the UEB, there was a further problem of dependence on the Government's budget. Power outages caused by both system breakdowns and planned fluctuations, imposed heavy costs on consumers and the economy (UNECA and UNEP 2007).

To address these challenges, the Government undertook major restructuring measures. These included splitting up the government utility, the Uganda Electricity Board (UEB), and attracting private sector participation in the electricity sector. However, after more than a decade of reforms, the sector appears to be still faced with challenges that the reforms intended to address. These challenges are mostly reflected in the unreliable and costly electricity supply that has crippled many businesses while threatening to arouse public unrest. In addition, empirical evidence suggests that system losses have not reduced as quickly as expected (ERA 2011).

The major policy question, therefore, remains as to whether the reforms have achieved the intended objectives. The specific policy related research questions include: How effective have these reforms been? What needs to be done to improve the sector's efficiency and effectiveness in the delivery of services to the public? It is against this background that this paper provides insights into the effectiveness of these reforms in achieving the intended objectives. More specifically, the paper seeks to establish whether the reforms resulted in reduced sector reliance on public subsidies; increase sector efficiency in terms of actual electricity loss reductions; higher connectivity for both rural and urban areas; improved electricity generation capacity and reduced electricity deficits; and affordable and competitive prices.

The paper employed both descriptive and time series analysis to investigate the effectiveness of the reforms on the performance of the electricity subsector. The descriptive analysis mainly explores the trends of key variables before and after the reforms. The time series analysis employs the least square dummy variable estimation methods to examine whether the reforms resulted into accelerated growth in generation, and connections, while leading to reductions in prices and losses.

The rest of the paper is organized as follows. Section2 provides background information on the electricity sector reforms including the policy and regulatory framework, while section 3 provides a summary of related literature and the conceptual framework. The data and methods of analysis are presented in section 4. Section5 provides a detailed assessment of the reforms prior to conclusions and emerging policy implications in section 6.

2. OVERVIEW OF UGANDA ELECTRICITY REFORMS

2.1 Motivation for the reforms

The motivation behind electricity reforms in Uganda follows a global theoretical framework that has been adopted by international lending agencies such as the World Bank, the European Bank for Reconstruction and Development and the Inter-American Development Bank, as well as organizations such as the World Energy Council. According to this framework, electricity reforms are driven by: a) the poor performance of state run electricity utilities in terms of high overhead costs b) the inadequate expansion of electricity access to the population, c) the inability of the state sub-sector to finance needed new investments d) the need to remove subsidies to the sub-sector in order to release resources for pressing public expenditure needs (Bacon and Besant-Jones (2001) and e) the desire to raise immediate revenue for the government through the sale of assets from the sector (Zhang et al. 2008).

According to Bacon and Besant-Jones (2001)electricity sector reforms can bring about gains in economic performance from three separate sources: better allocation of resources, efficient use of inputs and reduced costs of production. It is argued that these would arise from the need to do away with subsidies, the profit motive and competition in the sector. It is this framework that this paper follows.

The Government's idea was that a large number of financially viable distribution companies would be created out of existing UEB distribution business. In addition, Government was to be advised by the private sector with regards to new distribution companies. However, the objective of multiple distributors was dropped following ministerial changes over the restructuring period.

2.2 The reform process

In the pre-reform era, the state assumed total control of most productive sectors. This resulted in the creation of public enterprises for reasons that kept shifting depending on the regime that was making the policy. The electricity sector was thus dominated by a state owned and controlled body, the UEB. This was charged with managing the generation, transmission and distribution of electricity in the country as well as the planning for future expansion. From 1971 to 1986 Uganda's economy was marred by economic crises resulting from extreme political instability. During that period, real GDP per capita fell by a quarter, and by 1987 most productive sectors, including the electricity sector, were struggling. Electricity production had fallen from 150MW in 1963 to 60MW(Kuteesa et al. 2010). The economy was characterized by huge energy deficits and a struggling industrial sector.

In an attempt to increase investment and improve efficiency, international agencies generally advised countries to open their infrastructure sectors to the private sector (Estache and Wren-Lewis 2009). In mid 1987, the Uganda Government embarked on an extensive Economic Recovery Program. This was supported by the World Bank and the IMF and was intended to recover the growth of the economy. The structural adjustment programs also helped Uganda achieve some growth. The Government embarked on some policy reforms that mostly focused price stabilization, privatization and liberalization (Kuteesa et al. 2010). In particular the reforms in the electricity subsector were aimed at making the sector financially viable and able to perform without subsidies from the Government budget; increasing the sector's efficiency; improving the sector's commercial performance; meeting the growing demand for electricity and increasing coverage; improving the reliability and quality of electricity supply; attracting private capital and entrepreneurs; and taking advantage of export opportunities after satisfying local demand (UNECA and UNEP 2007).

By 1997, the Government had developed a strategic plan that was expected to transform the electricity sector into a financially viable industry. It was thought that improved private sector participation would enable increased supply of reasonably priced and reliable electricity (Karekezi et al. 2004).

Table 1: The Sequencing of the electricity reforms

Dates	Reforms
June 1999	Government Approves the electricity sector restructuring and Privatization Strategy
Nov 1999	The new electricity Act is passed
April 2000	The Electricity Regulatory Authority becomes operational
March 2001	The Uganda Electricity Board is unbundled and three companies created and registered namely: UEGCL, UETCL and UEDCL
May 2001	Concessions for generation and distribution are advertised
Nov 2002	Concession for generation awarded to Eskom Enterprises
Feb 2003	Appointment of the Rural Electrification Board to oversee the Rural Electrification Trust Fund (RETF)
2005	UMEME awarded 20 year concession contract to purchase electricity in bulk from UETCL to distribute and sell it to end customers

Source: Karekezi et al (2004)

2.3 Policy and Institutional Framework

Following the decision to restructure the electricity sector that resulted into different business entities for generation, transmission and distribution of electricity, a new electricity act was

passed by parliament to provide for the regulation of the sector. The electricity act was necessary to provide for the establishment of the Electricity Regulatory Authority to among others; provide for the generation, transmission, distribution, sale and use of electricity; to provide for the licensing and control of activities in the electricity sector; to liberalise and introduce competition in the electricity sector; and to provide for a successor company to the UEB.

The energy policy for Uganda was finally completed in 2002. The overarching policy goal is to meet the energy needs of Uganda's population for social and economic development in an environmentally sustainable manner. The energy policy is premised on five broad policy objectives as follows: i) to establish the availability, potential and demand for the various energy resources in the country; ii) to increase access to modern affordable and reliable energy services as a contribution to poverty reduction; iii) to improve energy Governance and administration; iv) to stimulate economic development; and v) to manage energy related environmental impacts.

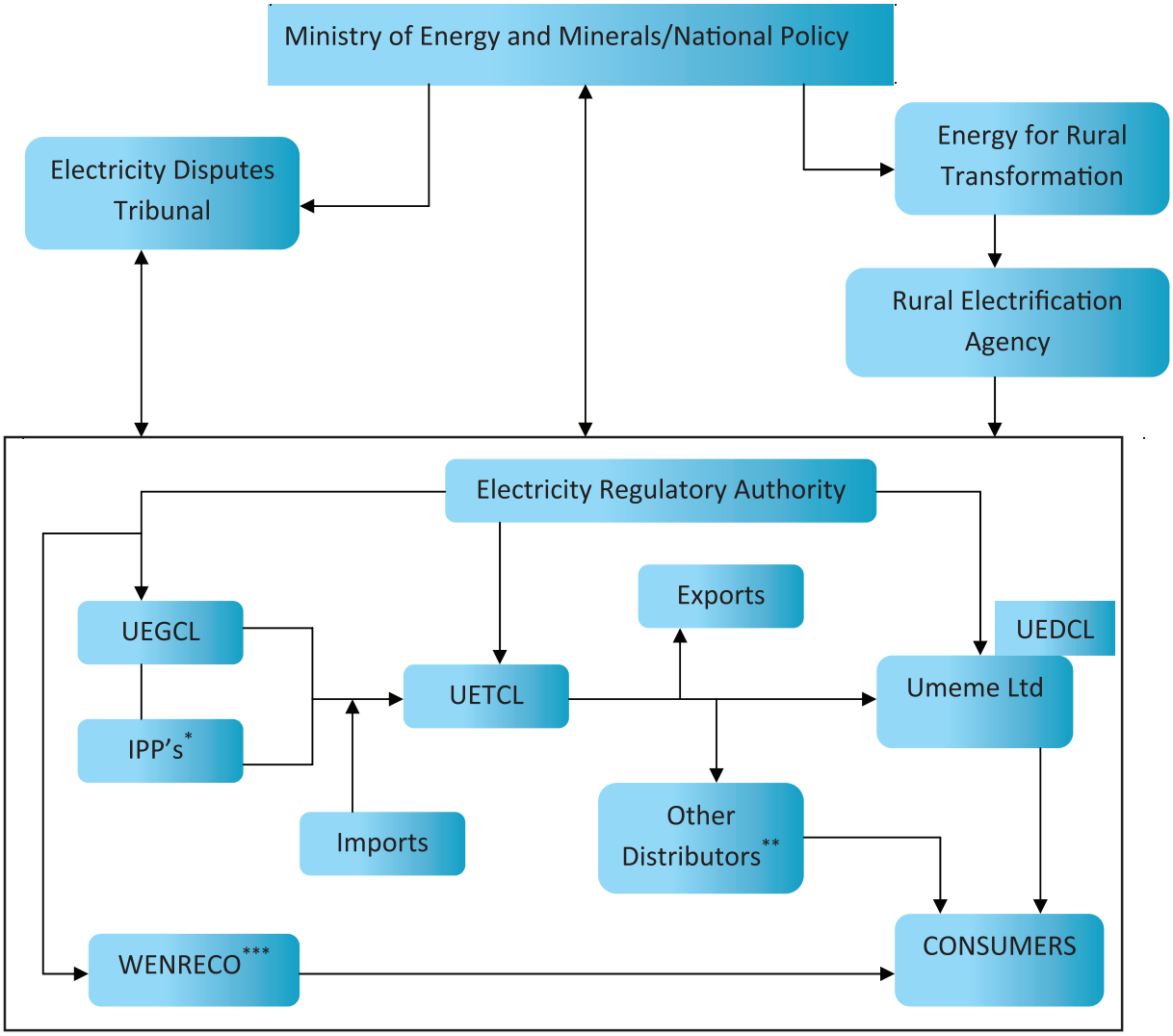
In addition, other organs such as the electricity disputes tribunal were established under section 93 of the electricity act to specifically hear and determine all matters relating to the electricity sector with respect to generation, transmission, distribution and consumption. Subsequently, the ERA formulated guidelines for resolution of sector disputes in respect of electricity consumers, licensees, land acquisition and royalties. Similarly, the Rural Electrification Agency (REA) and Board (REB) were established "to promote, support and provide for rural electrification programs".

2.4 Market Structure

Following the liberalisation and the introduction of a new legislation, the electricity sector in Uganda transformed from a state owned vertically integrated entity to a more private sector oriented venture. These reforms aimed at transforming the sector into a financially viable and profitable industry, with a view of reducing system losses and fast tracking rural electricity access through the rural electrification program.

The new electricity legislation provided for the liberalization of the electricity sector, the introduction of new private sector electricity infrastructure providers and the privatisation of existing assets. The legislation also provided for the establishment of an autonomous authority to regulate the electricity industry and a Rural Electrification Trust Fund (RETF) to promote increased access to electricity, particularly for the poor. In 2001, the UEB was unbundled and three companies created and registered, namely: The Uganda Electricity Generation Company Ltd; The Uganda Electricity Transmission Company Ltd; and, The Uganda Electricity Distribution Company Ltd (UEDCL) (see Figure 1). Currently the electricity distribution system is managed and operated by UMEME, a distribution company in Uganda, under a 20-year concession agreement signed in May 2004 with UEDCL.

Figure 1: The Uganda Electricity market structure



Notes: * IPP's Include: Aggreko[1], Jacobsen, Sugar co generators, Kilembe, Kasese Cobalt, Tronder Power, Electro Maxx., EMS Mpanga, ECO Power Ishaka. ** Other distributors include: Ferdsult Engineering Services (Kabaale/Kyenjojo), Kilembe Investments (Kasese) and Cooperatives ***WENRECO is an independent power producer and distributor for the West Nile Region

Source: Electricity Regulatory Authority

At the time of enforcing the reforms only one hydro power plant at Nalubaale (180MW) was generating electricity for the National Grid(ERA & MoFPED 2008).The 200MW Kiira Plant was completed in 2003. However, the entry of independent power producers has created some competition in generation. More than 50 mini hydro power sites with a combined potential of 210MW have so far been identified. Currently, six generation plants are in operation. These are: Nalubaale (180MW), Kiira (200MW), Tronder power (13MW), Kasese Cobalt (10MW), Kilemebe Mines (5.4MW) AND Kisiizi (0.29MW). The Bujagali project (250 MW) is expected to be completed by end of 2012. Thermal generation accounts for generation of 171.5 MW as follows Aggreko - Kiira (50MW), Aggreko – Mutundwe (50MW), Jacobsen (50MW), Electro-Maxx Ltd (20MW) and WENRECO (1.5MW). Sites for which licences have been issued but

[1] The Aggreko thermal plants will be decommissioned following the commissioning of Bujagali Hydro Electricity Plant in 2012

not yet operational include: Nyagak (3.5MW), Kikagati (10MW), Ishasha (6.5MW), Buseruka (9MW) and Mpanga (18MW).

2.5 Key Markets Players

A key component under the reform period was putting in place a regulatory system. The sector regulator, the ERA, was established in 1999 and became operational in 2000. This was to ensure regulation and monitoring compliance of the sector players at various levels of the value chain. The objective of the regulation has been to: protect consumers; set tariffs; promote fair competition and collect and disseminate information. Under the Energy Policy of 2002, the key role of Government is policy and strategy formulation and implementation. The reform of the reallocated roles and responsibilities between institutions in the sector as follows:

a) Ministry of Energy and Mineral Development

The ministry is responsible for overall policy framework, strategies, and development of the electricity sector. The ministry is mandated to provide policy guidance in the development of the Energy and Mineral sector. Specifically, the mandate of the ministry is: "To establish, promote the development, strategically manage and safeguard the rational and sustainable exploitation and utilization of energy and mineral resources for social and economic development."

b) Electricity Regulatory Authority

As was mentioned earlier, the Electricity Regulatory Authority (ERA) was established by act of parliament, the Electricity Act of 1999. The regulatory body is mandated with overseeing and regulating the electricity industry. This includes issuing various permits and licenses for generation, distribution and sale of electricity as well as setting of tariffs. In addition, the ERA is mandated to develop and enforce codes of conduct, performance and quality standards. The ERA is expected to conduct its functions in such a manner that is open and objective, fair and reasonable, non-discriminatory and that promotes fair competition.

c) Rural Electrification Agency

This is the Secretariat of the Rural Electrification Board (REB), which was inaugurated in May 2002 and became functional in July 2003. The REA has a broad mandate in rural electrification including providing policy advice to the REB and the Minister responsible for Energy, operationalization of Uganda's Rural Electrification Strategy and Plan, administering the Rural Electrification Fund (REF) on behalf of the Board, and maintaining a reliable and comprehensive database to facilitate RE policy planning and investment decisions. The birth of the Rural Electrification Agency arose out of the inability of the private sector distributor to extend electricity lines to non profitable rural poor areas. The projects under the agency are

supported by the World Bank. The Rural Electrification Strategy and Plan 2001-2010 (RESP) was passed by Cabinet in February 2001, and its overall goal is to facilitate achievement of a target of 10 percent rural electrification access by 2012.

d) The Uganda Electricity Generation Company Ltd

The UEGCL is a limited liability company limited by guarantee incorporated in March 2001. The Company's major functional areas include concessioning and monitoring the concessioned facilities to ensure quality and reliable electricity generation. In addition, the UEGCL is mandated to offer technical services that may involve: oversight of the operations and maintenance of the complex; safety surveillance of civil and dam structures.

e) The Uganda Electricity Transmission Company Ltd (UETCL)

The UETCL is a public limited company incorporated in March2001 after unbundling of Uganda Electricity Board into successor companies. It owns and operates the transmission infrastructure operating above 33kV. It is responsible for the transmission, dispatch, bulk electricity buying from generators and for the export and import of electricity. The mandate of the UETCL includes the following, coordinating the power system to achieve balance between supply and demand, responsible for dispatching generation facilities, responsible for bulk power purchase and sales as the Single Buyer, in addition UETCL is responsible for Power Exports and Imports. In this regard, UETCL has two core businesses, Transmission System Operator and Single Buyer.

f) The Uganda Electricity Distribution Company Ltd (UEDCL)

UEDCL is the state owned distribution company. UEDCL builds, owns distribution network at 33kV and below in the areas where UEB used to operate with a few additions made by REA and Umeme. Umeme is operating UEDCL's distribution network under a concession agreement. UEDCL owns the grid –connected electricity supply infrastructure at 33kv and below. It leased out its assets to Umeme limited. Currently, Umeme Limited is the distribution concessionaire. It is responsible for operating and maintenance of the network as well as the retail function that includes metering and billing.

3. RELATED LITERATURE ON ELECTRICITY REFORMS

The empirical literature puts across mixed findings about the successes of electricity sector reforms in developing countries. A few studies have shown that electricity market reforms by themselves may not deliver reliable services and stable competitive prices (Borenstein 2002). This is especially true in the face of inadequate performance based regulation that can benefit the consumers with prices and efficiency in operations (Woo *et al*. 2003). On the other hand, reforms can be successful in increasing operational efficiency and expanded access (Jamsb *et al*. 2005).

In some instances, electricity reforms have been shown to be very successful. Chile in particular is widely regarded as the most successful reformer having seen tremendous improvements in quality of service and in other areas. In particular technical losses are reported to have decreased significantly from 19.8 percent in 1987 to about 5.6 percent in 2003. In addition rural electrification rates improved from 38 percent to 86 percent of the total population in 2002 while average electricity prices fell by almost 30 percent in real terms (Pollitt 2005).

In other instances, the reforms have encountered significant challenges in part due to the nature of the commodity which requires real time balance between demand and supply and the huge amounts of investments required. The literature identifies three major reasons for the failure of markets reforms to deliver the expected outcomes. First, generation and transmission markets are not usually competitive (Borenstein et al. 2000), second market restructuring may lead to higher prices especially in times of excess capacity and high demand growth(Woo et al. 2003); and third regulatory uncertainty may discourage plant developments (Ishii and Yan 2004). Moreover, the markets reforms may be driven by rent seeking behaviour among interest groups not necessarily consistent with efficiency goals (Joskow 1997).In such circumstances, it is very important to strengthen the country institutions and Sector Governance.

Woo et al. (2003)analyzed the market reforms that took place in the United Kingdom, Norway, Canada and the USA state of California. They show that electricity market reforms may fail in countries characterized by high demand growth, limited generation capacity and without indigenous fuels. Moreover, reforms are depicted to be highly risky and irreversible and may thus lead to disastrous outcomes.

The UNECA and UNEP (2007) in assessing the impact of electricity reforms in Sub Saharan Africa focused on the social, economic and environmental impacts, and the gaps in the legal and institutional frameworks. They fault the motivation of the reforms arguing that they were designed to overcome short term generation deficits and to improve the financial viability

of the public utilities, but not to ensure long term sustainability of the sector. Moreover, the reforms have generally resulted in higher electricity unit costs and the establishment of the rural electrification funds has not helped increase electrification levels.

In Uganda, just like in some developing countries such as Kenya, the sequencing of the electricity reforms appear to have been detrimental to the electrification especially of the rural poor, with rural electrification reforms appearing at the tail end of the entire reform process.In addition Uganda's rural electrification target of 10 percent by 2012 is depicted to be low and unlikely to make any substantial impact (Karekezi et al. 2004).This is because the high costs and low specific consumption would imply that high levels of subsidy are required to cover both the capital and operating costs.

Haselip and Hilson (2005) attempt to critique the IMF and World Bank led market reforms particularly of the Privatization of state-owned enterprises, both in the industrial and public utility sectors. While they acknowledge the numerous positive experiences in various developed countries that have managed to balance economic efficiency with issues of social equity, they argue that experiences in many LDCs suggest otherwise. They show that over the last 15–20 years reforms have not solved the problem of chronic public-sector debt, and that poverty and socioeconomic inequalities have increased. This they explain is due to the fact that governments in developing countries lack the technical capacity to negotiate favourable and equitable deals for the sale of formerly state owned public utilities. Besides, once signed the terms and conditions are irreversible or "locked-in".

Jamasb at al et al. (2005) carried out a review of empirical evidence on electricity reform in developing countries. They show that country institutions and sector governance play an important role in success and failure of reform. In addition they show that reforms boosted operating efficiency and expanded electricity access to urban customers. However, they have to a lesser degree passed on efficiency gains to customers, tackled distributional effects, or improved rural access. The authors further propose a set of indicators as part of a coherent framework for analyzing the successes and shortfalls of electricity reforms in developing countries. They define indicators as "simple measures or parts of a formal model helping in understanding complex issues and systems that could be constrained by bounded rationality". They developed a set of indicators that are based on the following broad pillars that form the basis for the analysis:sector endowments and their characteristics, key reform steps, market structure, regulation, governance and institutions, sector performance, firm level indicators, macro level indicators, economic impacts, social impacts and environmental impacts.

The conceptual framework

This paper follows the framework proposed by Jamasb et al.(2005) above. Specifically, the paper examines the old market structure and compares it with the new structure. The framework (table 2) outlines the most important issues andthe causal effects that are generally involved in the reform.

In the Ugandan context, the sector reforms and restructuring were expected to attract private sector participation in generation and distribution thus resulting into improved generation growth and efficiency gains in distribution. The idea was to address the long standing challenges of limited generation capacity coupled with the high distribution losses. Improved generation and reduced losses were expected to result into improved access at affordable prices.

The creation of the rural electrification agency under the ministry of energy was intended to facilitate the achievement of Uganda's target of 10 percent rural electrification by 2012.Thus the reforms were expected to fast track generation growth, increase sector efficiency in terms of actual loss reductions, lead to higher connectivity at affordable and competitive prices, and reduce reliance on subsidies. The diagram below gives the conceptual framework that forms the basis of the evaluation of the electricity sector reforms.

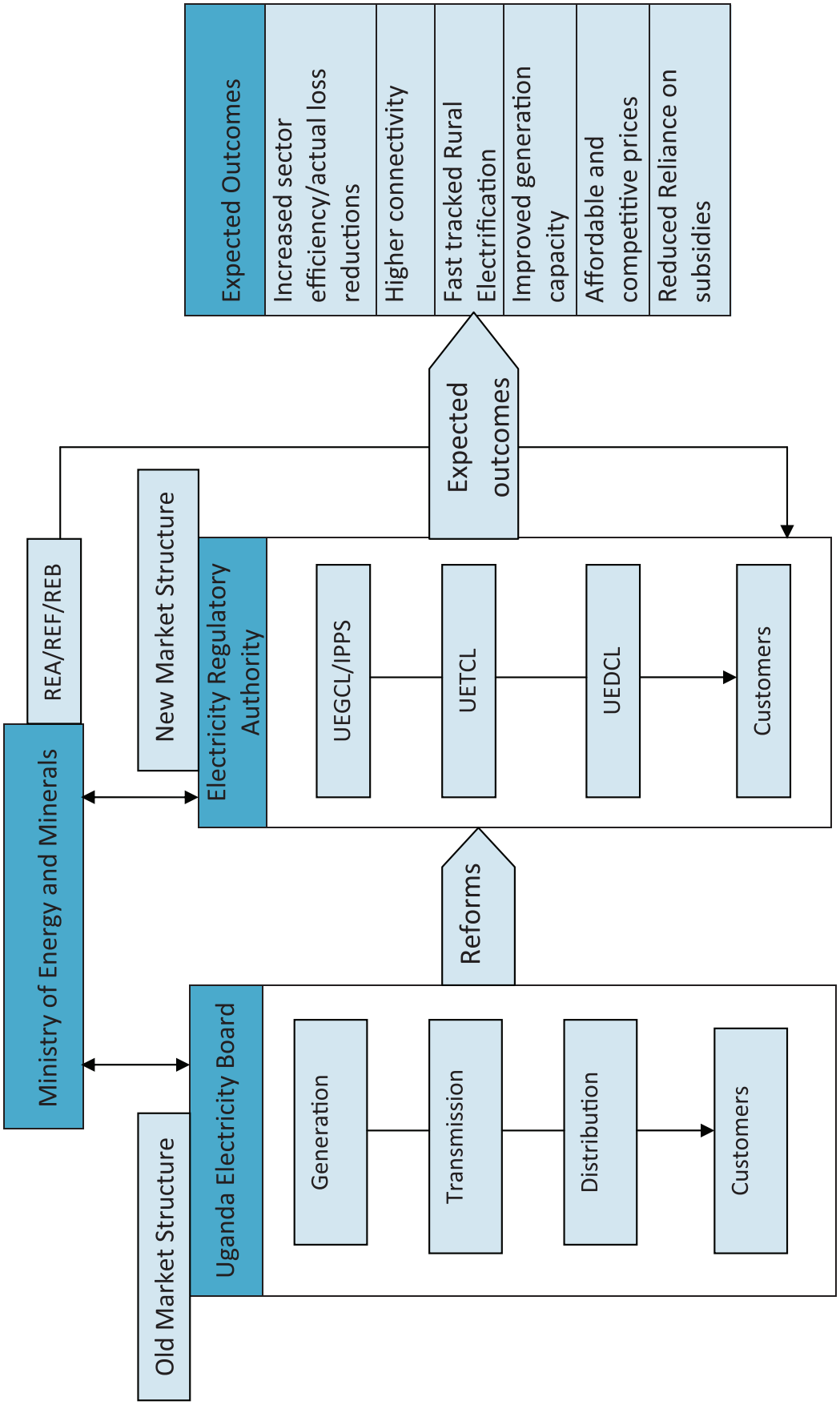


Figure 2: Conceptual framework

Source: Adopted with modifications from Jamsb et al. 2005

4. METHODOLOGY

4.1 Linking sector performance to the reforms

This paper employs both descriptive and time series analysis to investigate the effectiveness of the reforms on the performance of the electricity subsector. The descriptive analysis mainly explores the trends of key variables before and after the reforms. Specifically, for electricity access we employ a simple t-test to investigate if there is a significant change in the proportion of households accessing electricity off the national grid. We also investigate whether there are significant changes between rural and urban households.

Specifically, the time series analysis employs the least square dummy variable estimation methods, first introduced by Chow (1960) and later used by Gujarati (1970) to examine whether the savings-income relations in the United Kingdom differed for the time periods 1946-1954 and 1955-1963. It is this approach that this study followed to examine whether the reforms resulted into accelerated growth in generation, and connections, while leading to reductions in prices and losses, taking into consideration two time periods: before the reforms (1990-2000) and after the reforms (2001 – 2010).Specifically, the paper tested whether the two sets of coefficients in the two time periods differ. To achieve this, a simple growth model is developed specified as Eq. (1), which is transformed into linear variable as in Eq. (2):

$$y = ae^{bt} \tag{1}$$

Equation 1) above is converted to linear form by taking natural logarithms and expressed in eq. 2) below.

$$\log y = \log a + bt \tag{2}$$

Where y is a dependent variable, a is a constant, b is a growth rate, and t is a time variable.

Transforming equation one into natural logarithm form has two advantages: on the on hand linear equations are easier to work with, while on the other, natural logarithms helps to smoothen out any extreme variations and thus makes different data sets easily comparable.

Using dummy variable estimation to establish if there is a significant change (structural break) in the rate of growth for both periods before and after, this paper estimatesthe model as specified in Eq. (3).

$$Y = A + A_1 D + bt + b_1 Dt + \varepsilon_i \tag{3}$$

Where $Y = \log y$

$A = \log a$

$D = 1$ For periods after the reforms (<2000)

$D = 0$ For periods before the reforms (>2000)

Any changes in the rate of growth for the periods before and after the reforms would be exhibited in the significance of the additive (D) and multiplicative (Dt) dummy variables. Specifically, the additive dummy variable captures the changes in the rate of growth due to changes in the intercept, while the multiplicative dummy variable captures the changes in the slope of the growth equation. Therefore, if any of the coefficients A_1 and b_1 or both are shown to be statistically significantly different from zero, then we can conclude that the reforms have a significant impact on the variable under consideration.

4.2 Data

The paper utilized secondary annual data collected from four major sources: ERA, the Uganda Bureau of Statistics (UBOS), the Ministry of Energy and Mineral Development (MEMD), and the literature. Data from the UBOS is mainly from the Uganda National Household Surveys for the years 1992, 1999, 2002, 2006 and 2009. This data provided us with in-depth insights into household electricity access and use.

The data from the Electricity Regulatory Authority (ERA) and the Ministry of Energy and Mineral Development (MEMD) spanned the time periods 1990 – 2010. These sources provided the data on important variables used in this study that include: generation, demand, customers, subsidies, losses, and price data. These data were augmented by additional data from the literature, to fill in any missing gaps. Specifically studies by Karekezi *et al*. (2004) and the United Nations Commission for Africa (2007) provided very useful data on the state of the electricity sector before the reforms.

The reform process was finalised in the early 2000's with the enactment of the electricity act and the splitting of the former UEB. Specifically, the electricity act was passed in 1999 and unbundling of the UEB was completed in 2001. Thus the data was divided into two time periods: before the reforms (1990-2000) and after the reforms (2001 – 2010). The descriptive statistics are presented in Table 2.

Table 2: Descriptive statistics on selected characteristics

Variable	Number	Mean	Sd	Min.	Max.	1990	2010
Generation, Gwh	21	1203	59	738	2533	738	2486
Demand, MW	21	243	95	95	443	123	443
Hydro, MW	21	240	70	151	342	151	324
Thermal, MW	21	38	70	2	216	4	216
Surplus, MW	21	-3	43	-119	61	28	-119
Generation pc, kwh	21	58	9	41	77	42	75
Customers	21	200,983	87,918	95,596	368,048	103,920	368,048
Subsidies, Ushs BN	6	230	144	78	447	8	351
Losses, %	21	35	3	30	40	38	30
Tariff, $ Cents*	21	7.57	3.53	7.57	21.71	9.3	13.99

Source: Authors' computations, Tariffs in 2005 constant prices.

5. RESULTS AND DISCUSSIONS

5.1 Electricity Access

One of the objectives of this paper was to establish if the electrification levels have significantly changed over the years. To assess this, we use the UBOS UNHS data sets to examine the changes at various points in time between 1992 (pre reform) and 2009 (post reform). We also do examine the pattern of electrification levels for all periods before and after the reform. Results show that between 1992 and 1999, despite a slight overall increment in electrification levels, there was a drop in rural electrification levels from 1.9 percent to 1.4 percent. Results also show that there was a small rise in the rural electrification levels from about 1.9 percent in 1992 to about 3 percent in 2002, with overall electrification rates improving marginally from about 6.8 percent to about 9.5 percent. Between 2002 and 2006, results indicate slight changes in the rural electrification rates to about 4 percent for rural and 41.2 percent for urban households. The electrification changes are presented in Table 3.

Table 3: Trends in electrification level, %

	Rural	Urban	National
1992	1.9	36.1	6.8
1999*	1.4	40.1	7.5
2002	3.0	41.0	9.5
2006	4.0	41.2	10.5
2009	2.7	46.5	11.0

Notes: The 1999 UBOS UNHS dataset excluded five districts including: Bundibugyo, Kasese, Gulu, Kitgum and Pader

Source: Authors Calculations from UNHS Datasets

However, overall, between 1992 and 2009 results indicate significant increment in electrification rates, with overall electricity access rates rising from 6.834 percent in 1992 to 10.976 percent in 2009 (table 4). This was due to significant increments for the urban households whose electrification rates increased from 36.1 percent in 1992 to 46.5 percent in 2009. However, there was no significant change observed for rural electrification. This implies that whereas the country may achieve its target of achieving overall electrification rates of up to 10 percent by 2012; this is likely to happen at the expense of rural electrification.

Table 4: Electrification rates

Years	Indicators	Rural	Urban	National
1992	Observations	8702	1221	9923
	Mean	0.02(0.00)	0.36(0.03)	0.07(0.01)
2009	Observations	6080	695	6775
	Mean	0.03(0.00)	0.47(0.03)	0.11(0.01)
	Difference in Means	-0.01	-0.10**	-0.04***
	t-values	-1.41	-2.35	-3.51

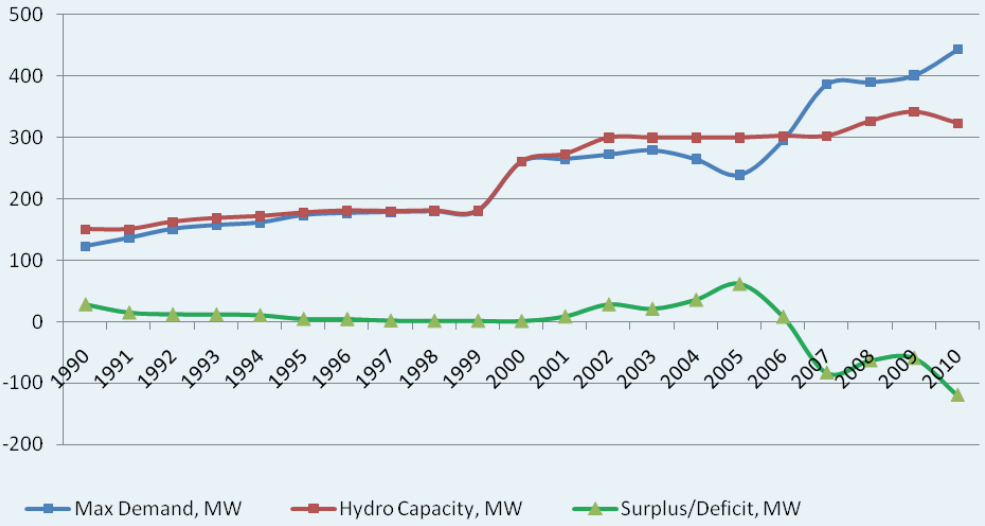
*=significant at the 10% level ** =significant at the 5% level *** =significant at the 1% level
Mean values tabulated, standard deviations in parentheses

5.2 Generation Capacity Growth

The results show that before the reforms, available generation capacity was sufficient to meet the demand for electricity. However, demand surpassed supply after the reforms thus plunging the country into an energy deficit (Figure 3). Following a decade of reforms we expected to see significant progress in generation growth to match growth in demand due to robust economic growth. However, this has not been the case especially for two reasons: a) hydro projects are generally expensive, thus requiring huge capital b) projects take time to complete c) hydro projects are classified as extremely risky by the private sector. The above reasons could explain the slow growth in generation to meet the growing demand for electricity.It should be remembered that the reforms made it possible for projects such as Bujagali to be conceived. However, the delays to start construction works on the Bujagali project, due to a combination of environmental concerns and the Enron scandal could have exacerbated the problem.

Until 2005, most of Uganda's electricity was generated from hydro sources with the Nalubaale and Kiira Power stations churning out a combined capacity estimated at 380MW. Independently, the Nalubaale Power Station has a maximum capacity of 180MW and the Kiira station has a maximum capacity of 200MW. The plan was to jointly run the plants in combination at 300 MW and at full capacity of 380 MW at peak demand times.

Figure 3: Electricity generation demand and supply trends



Source: Electricity Regulatory Authority and the Uganda Bureau of Statistics.

Electricity generation in Uganda showed an abrupt decline in 2006 as water levels in Lake Victoria dropped. The combined output of the two power stations was temporarily reduced to between135-140 MW, leaving a large shortfall in electricity supply (Rugumayo 2006).This gap was to some extent addressed by the opening of three new thermal power plants running on diesel. Two of these plants were operated by Aggreko and the third by Jacobsen. The two Aggreko plants diesel were only anticipated to be stop gap emergency solutions. The third Jacobsen plant runs on HFO. However, thermal electricity proved to be expensive. The total output of these three thermal power plants is approximately 150 MW. The remainder of the supply comes from sugar cane waste (approx 17 MW) and smaller hydro-electric schemes (approx 14.5 MW). In total Uganda has a regular supply of grid electricity of approx. 305 MW, still 75 MWshort of the 380 MW peak demand.

The increased reliance on emergency thermal generation and its costly nature necessitated Government to bridge the financing gap by way of direct subsidies to the electricity sector without further increments to the end user tariffs. By early 2006, thermal generation accounted for 23 percent of total generation and by 2010 this had risen to 41 percent (table 5). Thermal costs currently account for 85 percent of total generation costs.

Table 5: Electricity generation mix

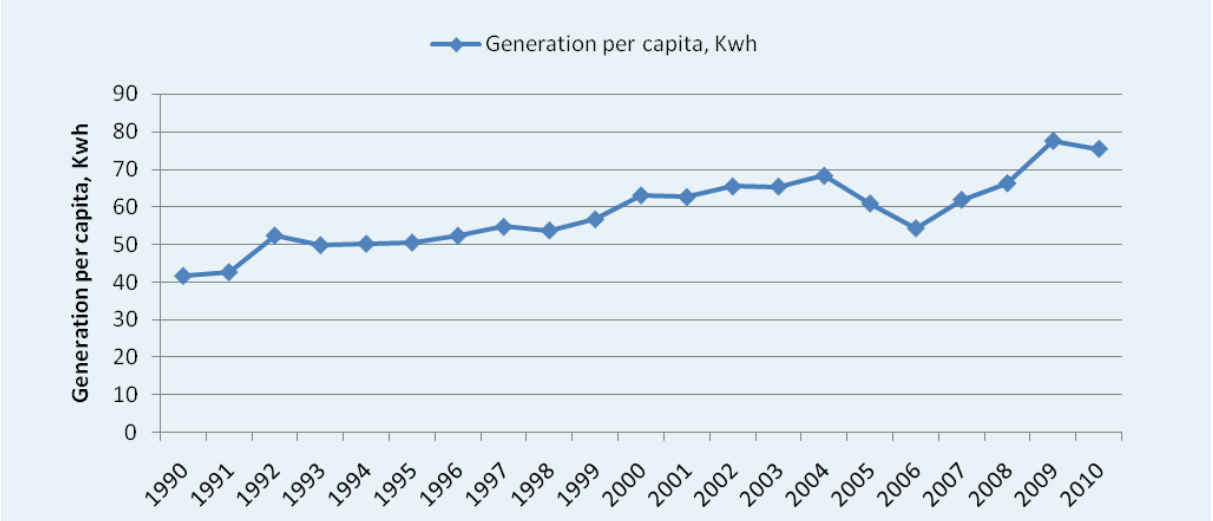
Generation in GWh	Time periods					
	2006	2007	2008	2009	2010	2011
Hydro	1,160	1,264	1,374	1,230	1,255	1,308
Renewable and other imports	79	91	132	171	209	347
Thermal	370	539	590	896	1022	1029
Total Generated	1,609	1,894	2,096	2,298	2,486	2,684
Thermal as a % of total generation	23	29	28	39	41	38

Source: Electricity regulatory Authority

5.3 Generation per capita

Results show that generation per capita[2] has grown slowly, possibly due to constraints in generation (Figure 4).

Figure 4: Generation per capita growth



Source: Electricity Regulatory Authority and Uganda Bureau Of Statistics

Thus, assuming a constrained electricity system as is the case with the Ugandan market, it could be argued the entire generating capacity ends up being consumed hence generation per capita would equal consumption per capita. Moreover, if we account for system losses, the actual consumption per capita would be considerably much lower than the generation per capita.

It is also worth noting that Uganda's generation annual generation per capita does not compare well with consumption per capita in the rest of the countries in sub-Saharan Africa, which stands at 457kWh annually. However, the situation in the SSA region too is grim, with the average falling to 124kWh if South Africa is excluded. By contrast, the annual average per capita consumption in the developing world is 1,155 KWh and 10,198 kWh in high-income countries (Eberhard *et al*. 2008).

5.4 Distribution efficiency

Over the last ten years the systems losses have averaged 34 percent. The bulk of the systems losses (on average over 60 percent) are due to technical losses resulting from the long distances between points of production and consumption and the need for network rehabilitation. As a result of the refurbishment and rehabilitation programs and the construction of new lines, the

[2] Due to data constraints, the study uses generation per capita as a proxy for consumption per capita

losses were expected to decline to about 28 percent by 2010.

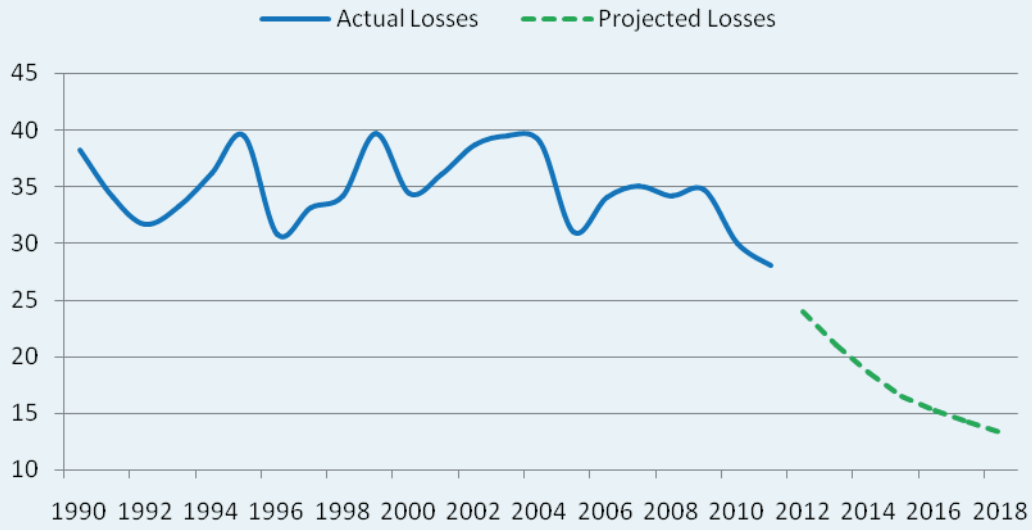
According to ERA's 2011 study on distribution system losses the high electricity losses are due to: the poor network condition, electricity theft, non payment, and low billing and collection rates. According to targets set in its concession agreement, the private distribution company was expected to reduce losses to about 30 percent by 2010 and to about 28 percent by 2011. Although the distribution losses are still high (Figure 5), the company's management has made some progress in reducing the distribution losses from about 38 percent in 2002 to about 30 percent in 2010. In this regard, the distribution company achieved the regulator's target.

The average billing collection rate in 2010 was 95.1 percent. This is good progress considering that distribution losses averaged about 35 percent in 2009. In addition, the regulatory body and the distribution company have workedout an impressive loss reduction trajectory that, if enforced, will ensure that distribution losses drop to 13.25 percent by 2018. It should be emphasized however that these can only be achieved if the distribution company put in place measures in line with sector best practices as recommended in the regulator's report on distribution system losses[3]. However, these gains in operational efficiency fade in comparison other countries such as Kenya and Ethiopia at 18 percent, Tanzania at 20 percent and South Africa at 5 percent. It should be remembered that the distribution concessionaire was awarded to UMEME in 2005, and this brought with it some investments in the distribution network bringing down the distribution losses. We argue that for the distribution company to continue on this impressive loss reduction path, it needs sound legal and regulatory support to enforce good customer practises with the objective of reducing electricity theft.

In addition to improvements in the distribution efficiency, the distribution company has also made commendable improvements in the quality of customer service with a dedicated full time call centre. The distribution company has also turned to social networking internet sites such as Facebook to keep at arm's length with its customers.

3 See ERA's October 2011 study on distribution system losses and collection rates by Umeme Ltd.

Figure 5: Electricity distribution efficiency



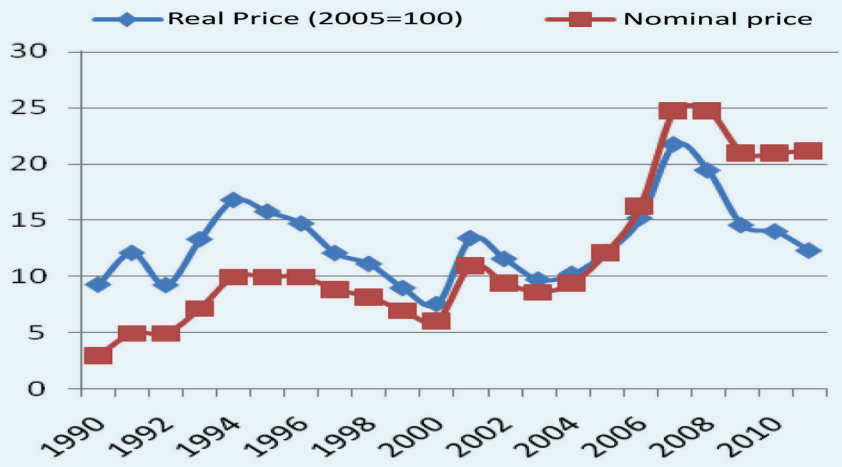
Source: Electricity Regulatory Authority

The good progress notwithstanding, concerns have been raised about the distribution company's commitment to reducing these losses further, especially since Government pays a compensation the equivalent of USD 4.5 million for every percentage lost per year. Reports from ERA show that approximately 50 percent of total losses are estimated to be commercial losses (i.e. power theft). On the basis of current performance, 33.4 percent (30 percent losses and 4.9 percent non-collection) of electricity delivered to Umeme is not paid for. For every 1 percent of uncollected revenues, USh4.76 billion (US$2.24 million) is currently lost (based on present average tariff and forecast sales for 2011). It is also reported that USh83 billion (US$35 million) can be recovered annually through efficiency gains assuming optimum losses and non-collection of 19.25 percent (15percent losses and 5 percent non-collection).

5.5 Electricity Price Competitiveness

Computed in 2005 constant prices, Uganda's average real price increased by about 42 percent from USD cents 9.45/kWh in 2004 to USD cents14.55kWhin 2009 before dropping by about 4 percent in real terms to USD cents 20.99 in 2010 (Figure 6). The rising prices can be explained by the increased reliance on thermal electricity which in itself reflects failure of the reforms to deliver increased and cheaper hydro electricity. In addition, the prices have been consistently rising at an annual rate of about 5 percent in real terms over the last years. However, over the last five years, the price of a unit of electricity has reduced from about USD cents 19.41 in 2008 to about 12.30 in 2001.

Figure 6: Uganda's average Electricity price per unit



Source: Electricity Regulatory Authority

Before the reform period, during the time period 1990-2000, prices were generally stable and increasing marginally. However, after the reform period, during the time period 2001 – 2010, prices started increasing at an increasing rate. In particular, the average prices increased by about 18 percentage points in real terms from an average of USD cents 11.91 before the reforms to an average of USD cents 14.03 after the reforms. It is generally argued that the high prices are not competitive (table 6) and that they are higher than the average tariffs in the region (PSFU 2011) especially in comparison with countries such as Rwanda and Tanzania.

Table 6: Regional Electricity tariff comparisons, US$/kwh

Country	Domestic	Commercial	Medium industries	Large industries	Street lighting
Uganda	0.212	0.198	0.186	0.127	0.198
Kenya	0.215	0.225	0.187	0.175	0.208
Tanzania	0.205	0.165	0.099	0.088	0.136
Rwanda	0.186	0.186	0.174	0.174	0.186

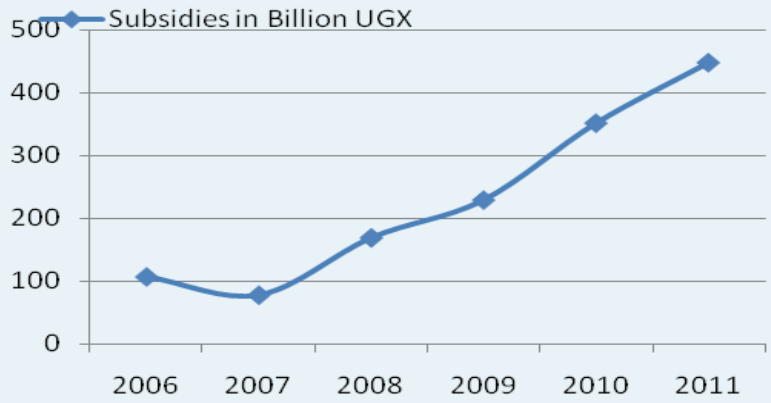
Notes: Prices are valid as of January 20th 2012 and are subject to change.

Source: Electricity Regulatory Authority.

5.6 Subsidies in the Electricity Sector

In Uganda the application of subsidies has been minimal, mostly directed to the electricity sector. Subsidies and price controls in other sectors are nonexistent. Karekezi et al. (2004) estimated that by 1999 subsidies in the Uganda electricity sector amounted to over Ushs 7 billion in nominal terms. This has grown to Ushs 447 billion, about 37 percent of the entire energy and mineral development budget in 2011 (ERA 2011) (see Figure 7).

Figure 7: Electricity subsidies, Ushs Billion



Source: Electricity Regulatory Authority 2011

This therefore indicates that contrary to electricity reform objective of reducing subsidies, the subsidies increased instead, as is evident from figure seven above. The surge in subsidies was necessitated by the severe energy shortfalls that prompted Government to procure emergency diesel generation as a stop-gap measure for the short to medium term. The resultant effect was price increases of 35 percent and 41 percent in June and November 2006 respectively. However, the price increases were not sufficient to meet the financing gap. By 2010 the domestic electricity prices were UGX 385.6 against a cost reflective tariff of UGX 828, the difference being footed from Government budget by way of subsidies. However, subsidies have their own downsides: first, subsidies are costly, and second they do not always benefit the intended target. In the case of Uganda, subsidies distribution in the electricity market has been skewed to favour the non-poor (Karekezi *et al*. 2004).

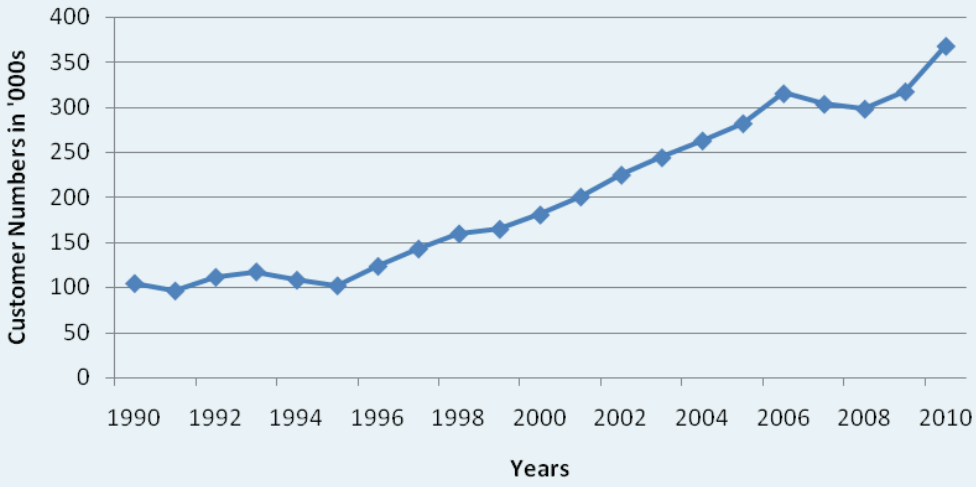
In January 2012, the Government announced that it would review all subsidies to the electricity sector with a view of phasing them out completely. This they explained would free up resources to invest in future generation projects, such as Karuma, to ensure that the future availability of electricity is not compromised.

5.7 Customer growth

Before the reforms, for the period 1990 to 1995 customer numbers stagnated. As a matter of fact, the numbers fell by 2.5 percent from 103,920 in 1990 to 101,409 in 1995. However we see continued growth from 1996 up to 2006. During that time period customer numbers more than doubled growing from 123,049 in 1996 to 315,249 in 2006. The growth in customer numbers coincides with a period of considerable growth in urban electrification rates from 36 percent in 1992 to 46 percent in 2009. It should be remembered that in the same time periods rural electrification only increased marginally from 1.9 percent in 1992 to 2.7 percent

in 2009. Thus the increase in customer growth seems to have been urban based and not rural centred.

Figure 8: Trends in customer numbers 1990-2010



Source: Electricity Regulatory Authority and the World Bank

The slowdown in growth from 2006 coincides with a period when the water levels in lake Victoria fell due to a prolonged drought. It is that drought that plunged the country into the massive energy deficits that were described earlier in this paper. The energy deficits could have affected the rolling out of the electrification programs, thus affecting growth in customer numbers. In particular, the rural electrification programme was greatly affected by the acute power shortages because most of the financial resources were directed towards electricity subsidies to buy down the high tariffs arising out of the expensive thermal power generation, besides, there was no incremental energy available for sale. Overall, new customer connections have been growing at an average rate of 3 percent per annum without any significant changes observed for the periods before or after the reforms. The paper therefore fails to link the growth in customers to the reforms. The strong customer growth at a time of massive electricity deficits could point to the possibility of large un-served demand for electricity.

5.8 Empirical Validation of the Results

In order to validate the trends for the variables examined above, we carried out some multivariate analyses with the intention of determining whether the reforms resulted into accelerated growth in generation, and connections, while leading to reductions in prices and losses, taking into consideration two time periods: before the reforms (1990-2000) and after the reforms (2001 – 2010).

To achieve this, we make use of the growth models that were introduced in the previous

chapter. If the reforms resulted into accelerated growth for generation and new connections and increased efficiency, we expect to have the coefficients for the additive dummy and the multiplicative dummies to be statistically significant.This would imply that the growth paths for the two time periods are different and therefore, we would conclude that the reforms achieved the intended objective. It is important to remember that the reform period is 1997 – 2000.For purposes of this study, the year 2000 was taken a as the reference point for completion of the reforms.

We thus estimated four models to determine if there are significant changes in the rates of change in the observed levels of generation, distribution losses, prices and rate of growth in new connections.

The results as presented in Table 7show that the generation, prices and connections models exhibit significant growth. The model with losses as a dependent variable on the other hand does not exhibit any significant growth or recession at all.

Table 7: OLS estimations

	Dependent variables (Natural Logarithms)			
	Real Prices	Losses	Generation	Connections
Constant	1.110(0.077)***	3.381(0.177)***	6.593(0.046)***	4.942(0.026)***
Additive Dummy	-0.203(0.156)	0.609(0.219)**	0.172(0.110)	0.091(0.050)
Multiplicative Dummy	0.021(0.014)	-0.047(0.023)**	-0.016(0.008)*	-0.001(0.004)
Growth rate	-0.008(0.011)	0.021(0.022)	0.064(0.006)***	0.025(0.003)***

*=significant at the 10% level ** =significant at the 5% level *** =significant at the 1% level
Mean values tabulated, robust standard errors in parentheses

The expectation was that the reforms would result into cheaper electricity. However, the empirical evidence suggests that this did not happen. This could partly be explained by the fact that a sizeable proportion of electricity is generated from imported diesel which is much more expensive than other possible alternatives such as hydro or even solar. It should also be remembered that the diesel generators were brought on board when the country experienced a prolonged drought that led to a drastic fall in the water levels in Lake Victoria.

There is evidence to suggest that the losses went up and then started declining after the reforms. The negative coefficient for the multiplicative dummy variable coupled with a positive albeit insignificant growth rate could point to the fact that losses have started reducing, but slowly. The expectation was that the reforms would lead to efficiency gains and thus both technical and commercial losses would fall.

As a matter of fact the losses have oscillated between the 30 percent and 40 percent marks without significantly reducing. This would imply that the transmission and distribution companies may not have done enough to reduce these losses.

Turning to generation, there is a significant growth rates at 4.7 percent. However, there is no difference in generation growth for both the periods before and after the reform. This shows that the investment in generation has been much slower than is desired to meet the growing demand for electricity. According to the ERA, there are a number of reasons that could explain the low investments in Uganda's generation and these include financial, institutional and other domestic factors. The financial factors include the high bank interest rates and limited availability of local long term financing. The institutional factors include low feed in tariffs, and long and costly litigation processes, among others. The domestic constraints include a severe lack of skilled manpower and the high infrastructural risk that includes both transport and transmission infrastructure (ERA and MoFPED 2008).

However, investment constraints into the sector acknowledged, the paper finds it rather surprising that the county has not recovered from the alleged drought in terms of actual hydro electricity generation capacity. Some commentators have pointed to the fact that there were flaws in the design and construction of the 200MW Kiira extension at the old Nalubaale dam. This is said to have affected the flows through the dams and was responsible for the receding water levels in Lake Victoria. These low water levels would late plunge the country into electricity deficits, worse than before. Apunyo (2007), in his paper presented at 10th International River symposium and Environmental Flows Conference, Brisbane Australia does well to explain thus:

> *"In Uganda, miscalculations and technical errors resulting from the construction of a second dam (Kiira) parallel to the old Nalubaale dam on River Nile has forced Lake Victoria water level to drop by about 2 meters between 2002 and 2005. The most articulated effects of the drop in the lake level are various and these range from: a severe decline in power generation by about 30 percent (from 265 MW in 2003 to 185 MW in 2006)".*

However, other commentators, referring to an earlier piece of work by Yousef and Amer (2000)argue that the dropping water levels were purely due to natural causes, determined by activity in the sun due to the Wolf-Gleissberg Solar Cycles. Against the evidence above, various stakeholders seem to concur that the logical thing would have been to construct the dams in series and not in parallel as was the case for the Nalubaale-Kiira extension dam.

The model for the estimation of connection growth rates used data collected from two sources: the ERA and the World Bank. The findings show that despite an annual growth rate of approximately 2.4 percent in new customer connections, there is not a significant change in the customer growth levels for the periods before and after the reforms. This is consistent with our earlier results on the household electrification rates. It should also be remembered that from the household level analysis, we discovered that the reforms could have favoured more the urban dwellers as opposed to the rural consumers. As a matter of fact records accessible from ERA indicate that UMEME's customers are largely urban based, with Kampala alone contributing about 52 percent of all the distributors' connections.

6. CONCLUSIONS AND IMPLICATIONS FOR POLICY

6.1 Conclusions

Whereas some progress has been made especially with consumer connections and urban access, results from the analysis presented in this paper have pointed to the fact that the electricity sector in Uganda is still faced with challenges from both the supply and demand sides. The paper highlights that distribution losses, though steadily falling, are still high. In addition anticipated private sector investments into the sector have been much slower to meet the growing demand for electricity and rural electrification rates, at less than 5 percent against a target 10 percent by 2012, are still low. The country still faces massive energy deficits and prices have remained high and uncompetitive. To address these challenges, the paper suggests some policy actions necessary to revamp the electricity sector in Uganda. In particular the Government should continue prioritising interventions in generation to sustain the growing domestic and regional demand; promote alternative electricity generation options such as wind, solar PV, bagasse-based cogeneration and geothermal; ensure efficiency in distribution; institute a supportive legal and regulatory framework to ensure compliance so as to bring down the losses due to non payment; and finally fast track the rural electrification exercise so as to unlock rural growth.

6.2 Emerging policy implications

While the reforms that were envisaged to transform the Uganda electricity sector had ambitious targets, there are mixed public reactions about the performance of the sector. This paper sets out to highlight the achievements as well as the areas that still face challenges. This led the researchers to think of some policy questions that guided the analysis and discussions in this paper: How effective have these reforms been? Who are the winners and losers under these reforms? What needs to be done to improve the sector's efficiency and effectiveness in the delivery of services to the public?

We argue that the challenges that have hindered the speedy realization of planned outcomes are due to poor planning, coupled with the numerous constraints to the investments in the sector as earlier discussed. This has resulted into: low generation and access, high transmission and distribution costs, increased power outages to domestic as well as industrialconsumers and high subsidies by government to domestic consumers at 60 percent and very high tariffs compared to other countries in the region. This dismal performance of the sector has negative implications for industrial competitiveness, household welfare, as well as medium-long term economic growth.

a) Electrification and Access

The NDP target is to achieve universal electrification by 2035. To achieve this, the Government should consider prioritizing actions on both the demand and supply side. The demand side actions could include making the (rural) electrification programs pro-poor while minimizing the costs of access. To ensure increased access to the poor at an affordable cost, the study recommends that low cost electrification technologies and technologies should be fast tracked. . Another possible option of minimizing the cost of electricity among the poor is by providing targeted subsidies to enable them afford the relatively high cost per unit of electricity.

Moreover, power concessions and purchase agreements to private sector power distributors should have specific targets for electrifying the poor. This should be enforced through making the targets as part of the agencies' annual reporting as well as renewal of the contracts of the board members as well as the executive employees of the agencies. Another option is the promotion of decentralized electricity generation in rural areas using hydro, wind, bagasse-based cogeneration and where applicable geothermal. This would greatly reduce the need for transmission lines to transverse long distances and sometimes difficult terrain. However, while these technical options are attractive, the policy framework has to provide adequate incentives to realize the benefits of these options.

b) Generation Growth

By opening the sector to private investors, the Government hoped to realize generation growth in partnership with the private sector. However, this necessitates a conducive legal and regulatory framework. In particular, the enabling law on Public-Private partnerships should be fast tracked. What is required is the creation of structures and mechanisms for increased and sustainable electricity generation. Government has put in place measures to provide for an enabling legal and regulatory framework in the recent past including prioritizing public private partnerships to support Private Sector participation in infrastructural development. However, the PPP Bill should be passed into law to provide for the framework for the implementation of selected public infrastructure by harnessing Private Sector financial and human resource skills, while sharing the construction and operational risks between Public and Private Sectors.

Of equal importance, the Electricity Regulatory Authority (ERA) could play a significant role in promoting proven environmentally friendly electricity generation options such as wind, solar PV, bagasse-based cogeneration and geothermal. The ERA could promote these technologies through setting of specific targets as well as providing for preferential tariffs for their electricity sales. This in addition to providing attractive incentives to investors willing to install electricity generation plants based on these energy sources. We believe proper planning and improved generation growth will solve the availability and reliability of electricity supply while at the same time taking advantage of the export opportunities.

c) Efficiency and distribution loss management

With a generation capacity of about 310MW and distribution losses averaging above 30 percent, the country loses well over 90MW in distribution losses. If the losses are cut back to about 20 percent, the country would have well over 30MW extra electricity – the equivalent of a small to medium sized dam hydro project. This highlights the need and urgency to invest in efficiency enhancing technologies. However, as pointed out earlier questions have been raised about the distribution company's commitment to reducing these losses, "*especially since Government pays a compensation the equivalent of USD 4.5 million for every percentage lost per year*".

What is required is to strengthening the regulation, monitoring and evaluation arms of the regulatory body while ensuring its independence. In particular, the distribution company should be able to commit to reasonable investment levels that would trigger efficiency gains in distribution.

In addition, the distribution company should pursue technologies through which the collection rates can be increased and the receivables increase overtime, thus reducing losses. Such technologies include pre-paid meters, and comparatively seem to be working in Rwanda.

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