Uganda’s Electricity Sector Reforms: Lessons and Challenges

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Abstract
Uganda is one of many developing countries to have undertaken electricity sector reforms. The reforms were intended to improve sector performance. The paper employed descriptive data analysis methods augmented by empirical estimations of least square dummy variable models to estimate whether the reforms are on track to meet their intended objectives. The results indicate that progress has been slow in achieving the objectives of the reforms.

Keywords: Uganda, Electricity, Reforms

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 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.

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, 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 sector, particularly in generation and distribution. This paper set out to examine the extent to which the restructuring processes have achieved 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 empirical analyses to investigate the effectiveness of the reforms on the performance of the electricity subsector. The descriptive analysis mainly explored the trends of key variables before and after the reforms. The empirical analysis employed 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. Section 2 provides an overview of the reforms in the Uganda electricity sector. Section 3 provides the conceptual framework. The data and methods of analysis are presented in section 4. Results are presented in section 5, while conclusions and emerging policy implications are discussed 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 and other development institutions. 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).

Thus, international agencies generally advised countries to open their infrastructure sectors to the private sector in an attempt to increase investment and improve efficiency (Estache and Wren-Lewis 2009).

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 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 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 on 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).
2.3 Policy and Institutional Framework

Following the decision to restructure the electricity sector, 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 the sector regulator, the Electricity Regulatory Authority (ERA) became operational in 2000.

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.

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).

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.

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

3. The conceptual framework

The 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 (Eberhard et al 2008; Haselip and Hilson 2005; 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 have been shown to increase the operational efficiency and expanded access (Jamsb et al. 2005), and competitive prices (Pollit 2005).

The literature identifies five 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); third regulatory uncertainty may discourage plant developments (Ishii and Yan 2004);
fourth markets reforms may be driven by rent seeking behaviour among interest groups not necessarily consistent with efficiency goals (Joskow 1997); and fifth reforms especially in sub Saharan Africa were not designed to ensure long term sustainability of the sector (UNECA and UNEP 2007).

In some developing countries such as Uganda and 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.

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.

This paper builds on a framework developed by Jamasb et al (2005) to examine if the reform process has resulted into improved sector performance. Five areas of investigation are identified and these are: increased sector efficiency, higher connectivity, improved rural electrification, increased generation, competitive prices and reduced reliance on subsidies. The diagram below (figure 1) gives the conceptual
framework that forms the basis of the evaluation of the electricity sector reforms in Uganda.

Figure 1: Conceptual framework
Figure 2: Conceptual framework

Source: Adopted with modifications from Jamsb et al. 2005
4. Data and Methods

4.1 Linking sector performance to the reforms

This paper employs both descriptive and multivariate 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.

The empirical 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). 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).

\[ y = ae^{bt} \]

Equation 1) above is converted to linear form by taking natural logarithms and expressed in eq. 2) below.
\[ \ln y = \ln a + bt \]

(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 one hand linear equations are easier to work with, while on the other, natural logarithms help 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 estimates the model as specified in Eq. (3).

\[ Y = A + A_1D + bt + b_1Dt + \varepsilon \]

(3)

Where

\( Y = \ln y \)
\( A = \ln a \)
\( D = 0 \) For periods before the reforms (<2001)
\( D = 1 \) For periods after 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 1.

Table 1: Descriptive statistics for selected variables

<table>
<thead>
<tr>
<th>Variable</th>
<th>No.</th>
<th>Mean</th>
<th>Sd</th>
<th>Min.</th>
<th>Max.</th>
<th>1990</th>
<th>2010</th>
</tr>
</thead>
<tbody>
<tr>
<td>Generation, Gwh</td>
<td>21</td>
<td>1203</td>
<td>59</td>
<td>738</td>
<td>2533</td>
<td>738</td>
<td>2486</td>
</tr>
<tr>
<td>Demand, MW</td>
<td>21</td>
<td>243</td>
<td>95</td>
<td>95</td>
<td>443</td>
<td>123</td>
<td>443</td>
</tr>
<tr>
<td>Hydro, MW</td>
<td>21</td>
<td>240</td>
<td>70</td>
<td>151</td>
<td>342</td>
<td>151</td>
<td>324</td>
</tr>
<tr>
<td>Thermal, MW</td>
<td>21</td>
<td>38</td>
<td>70</td>
<td>2</td>
<td>216</td>
<td>4</td>
<td>216</td>
</tr>
<tr>
<td>Surplus, MW</td>
<td>21</td>
<td>-3</td>
<td>43</td>
<td>-119</td>
<td>61</td>
<td>28</td>
<td>-119</td>
</tr>
<tr>
<td>Generation pc, kwh</td>
<td>21</td>
<td>58</td>
<td>9</td>
<td>41</td>
<td>77</td>
<td>42</td>
<td>75</td>
</tr>
<tr>
<td>Customers</td>
<td>21</td>
<td>200,983</td>
<td>87,918</td>
<td>95,596</td>
<td>368,048</td>
<td>103,920</td>
<td>368,048</td>
</tr>
<tr>
<td>Subsidies, billion</td>
<td>6</td>
<td>230</td>
<td>144</td>
<td>78</td>
<td>447</td>
<td>8</td>
<td>351</td>
</tr>
<tr>
<td>Losses, %</td>
<td>21</td>
<td>35</td>
<td>3</td>
<td>30</td>
<td>40</td>
<td>38</td>
<td>30</td>
</tr>
<tr>
<td>Real Tariff in UGX*</td>
<td>21</td>
<td>167</td>
<td>93</td>
<td>12</td>
<td>427</td>
<td>37</td>
<td>224</td>
</tr>
</tbody>
</table>

Source: Authors’ computations, tariffs in 2005 constant prices, all prices in Uganda Shillings

5. Results

We 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 2 show that the models for generation and new connections exhibit significant growth. The models with losses and real prices as dependent variables on the other hand do not exhibit any significant growth or recession at all.
5.1 Electricity price competitiveness

One of the objectives for the reforms was to provide more reliable electricity at affordable prices. The expectation was that the reforms would result into cheaper electricity. Whereas there seems to have been reductions in real prices between 2007 and 2011 as evidenced in figure 2, the empirical model suggests that on the overall prices have been growing by about 10 percent per annum. Moreover, the coefficient for the additive dummy is positive and significant implying that prices increased after the reforms. The negative coefficient on the multiplicative dummy implies that prices have started coming down, but this is not significant. Computed in 2005 constant prices, Uganda’s domestic real price increased by about 59 percent from UGX 186/kWh in 2004 to UGX 295 kWh in 2009 before dropping by about 13 percent in real terms to UGX 257 in 2010 (Figure 3). 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.
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 and that they are higher than the average tariffs in the region (PSFU 2011).

5.2 Distribution efficiency

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.

Over the last ten years the systems losses have averaged 34 percent. The bulk of the system 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 losses were expected to decline to about 28 percent by 2010.

According to ERA (2011) 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 4), 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 worked out an impressive loss reduction trajectory that, if enforced, will ensure that distribution losses drop to 13.25 percent by 2018.

Thus we recommend that the distribution company puts in place measures in line with sector best practices as recommended in the regulator’s report on distribution system losses\(^1\). 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 requires 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.

\(^1\) See ERA’s October 2011 study on distribution system losses and collection rates by Umeme Ltd
The distribution company has also turned to social networking internet sites such as Facebook to keep at arm’s length with its customers.
5.3 Generation capacity growth

Electricity generation has recorded impressive growth rates at 6.4 percent per annum over the period under review. The coefficient for the multiplicative dummy is negative and significant implying that generation growth suffered after the reforms. This could be due to two factors; the various constraints in generation expansion and the sharp fall in hydro electricity generation in 2006.

According to the Electricity Regulatory Authority and the Ministry of Finance Planning and Economic Development (2008), 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.

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 5). 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.
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 between 135-140 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 heavy fuel oil. 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 MW short of the 380 MW peak demand.
However, investment constraints into the sector acknowledged, it is rather surprising that the county has not recovered from the alleged drought in terms of actual hydroelectricity 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. 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, earlier work by Yousef and Amer (2000) seems to suggest 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, it is not clear whether the dropping water levels were a consequence of flaws in the design and construction of the dams, or the natural solar cycles or a combination of the two.

5.4 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)

<table>
<thead>
<tr>
<th>Years</th>
<th>Subsidies in billion UGX</th>
</tr>
</thead>
<tbody>
<tr>
<td>2006</td>
<td>107</td>
</tr>
<tr>
<td>2007</td>
<td>78</td>
</tr>
<tr>
<td>2008</td>
<td>169</td>
</tr>
<tr>
<td>2009</td>
<td>229</td>
</tr>
<tr>
<td>2010</td>
<td>351</td>
</tr>
<tr>
<td>2011</td>
<td>447</td>
</tr>
</tbody>
</table>

Source: Electricity Regulatory Authority

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 4). Thermal costs currently account for 85 percent of total generation costs.

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, they are costly, and second they do not always benefit the intended target. In the case of Uganda, subsidies in the electricity market has been skewed to favour the non-poor (Karekezi et al. 2004).
Table 4: Electricity generation mix

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

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.

5.5 Customer growth

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 2.5 percent in new customer connections, there is not a significant change in the customer growth levels for the periods before and after the reforms.

Prior to 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 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 5: Trends in customer numbers 1990-2010

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.

**5.6 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, the paper used the UBOS UNHS data sets to examine the changes at various points in time between 1992 (pre reform) and 2009 (post reform). Results indicate significant increment in electricity access, between 1992 and, with overall electricity access rates rising from 7 percent in 1992 to 11 percent in 2009 (table 5). 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 achieved 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 5: Change in Electrification rates |
|-----------------|--------|--------|--------|
| Years | Observations | 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
6 Conclusions and policy implications

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. This poor performance of the sector has negative implications for industrial competitiveness, household welfare, as well as medium-long term economic growth.

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.

6.1 Emerging policy implications

6.1.1 Electrification and access

The National Development Plan 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.

6.1.2 Electricity 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.

6.1.3 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. 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 they seem to be
working in Rwanda.

References

10th International River symposium and Environmental Flows Conference,
Brisbane Australia.

Bacon, R. W. & Besant-Jones, J. 2001. Global electric power reform, privatization and
liberalization of the electric power industry in developing Countries. Annual

Restructured Wholesale Electricity Market. National Bureau of Economic
Institute.


Chow, G. C. 1960. Tests of Equality Between Sets of Coefficients in Two Linear

Eberhard, A., Vivien, F., Briceño-Garmendia, C., Ouedraogo, F., Camos, D. &
Shkaratan, M. 2008. Underpowered: Th State of the Power Sector in Sub-

ERA and MoFPED. 2008. Constraints to Investment in Uganda’s Electricity Generation
Industry

ERA. 2011. Study on distribution system losses and collection rates by Umeme Ltd:
Electricity Regulatory Authority Uganda.

Countries: Following Jean-Jacques Laffont’s Lead. Journal of Economic

Gujarati, D. 1970. Use of Dummy Variables in Testing for Equality between Sets of
Coefficients in Two Linear Regressions: A Note. The American Statistician, 24
(1): 50-52.


