# The Cost of Power Outages on Enterprise Performance in Kenya

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*Abstract*: - The literature argues that inadequacies in the power sector in many developing countries especially sub-Saharan Africa constrains economic growth and development. While it is widely acknowledged that Kenya has a high number of outages, there is limited evidence on how these outages affect firm performance. Thus, the study investigates the effect of power outages on firm performance using World Bank Enterprise Survey data for 2018. We employ instrumental variable regression to overcome endogeneity as well as causality effect between power outages and enterprise profitability. The results show a negative and significant relationship between power outages and firm profitability. On the other hand, we report a positive relationship between efficiency levels, energy utilization and firm profits. The study recommends that the government should invest heavily in electricity generation, and address inefficiency within the power sector to ensure a reliable supply of electricity, and enhance enterprise performance.

*Key Words:* Power Outage, Enterprise Performance, OLS, 2SLS, Electricity.

## I. INTRODUCTION

Accessibility to reliable, quality and efficient supply of electricity is regarded as a key conduit for economic growth and development across the world (Abotsi, 2015). Nevertheless, most African countries experience perennial electricity deficiencies with numerous power outages. World Bank report of 2019 on access to electricity in sub-Saharan Africa argues that Africa presents the lowest rates of electrification among the developing world with only 43% of people having connected to the national grid, and approximately 25% of electrification in the rural set-ups (World Bank, 2019). International Energy Agency (IEA) and World Bank report of 2017 on electricity access estimates that around 92% of the rural population (370 million people) in Sub-Saharan Africa lacked access to electricity; 70% (690) in south Asia; 48% (60 million) in Latin America; 22% (30 million) in North Africa (IEA & World Bank, 2017). This is particularly crucial for African countries since research shows that electricity access and consumption causes economic growth implying that the economy depends on energy for survival and vice versa (Lee et al., 2016)). This calls for energy growth paradigm that focuses on expanding access to energy services through innovative models. Using clean energy efficiently and applying cost-effective technologies and systems to all sectors of the economy within a capital-constrained context remains a major challenge in Africa. This makes the availability of electrical energy an absolute pre-requisite to economic and social development in Africa. Electrification in Kenya is below the sub-Saharan Africa (SSA) with national access of 32% compared to an average of 43% for SSA and only 19% access in rural areas compared to 25% for SSA (World Bank, 2019).

Part of the reasons for the low supply of power in the SSA and Kenya, in particular, is low power generation capacity and inefficiencies within the electricity institutions. According to data from World Bank Enterprise Surveys, most enterprises in Africa encounters regular power outages, which could number to as high as 100 times in a month. Studies have reported that these power blackouts have a negative impact on foreign ownership of enterprises in the continent (Eberhard et al, 2011; Briceño-Garmendia & Shkaratan, 2010). In addition, power outages render many enterprises inefficient in production. These affect the performance of firms in terms of expansion and revenue generation and hence, their contribution to the national Gross Domestic Product (GDP). Efficiency in production could imply producing on a large scale given a set of inputs. This means that any environmental factors that could raise input requirements for the production process and the firm's technical features could be termed inefficient. Because energy and electricity, in particular, is a key input in the production process, its absence has the capability of adverse effects on products which could lead to inefficiencies in production and low levels of output. According to the study by Cissokho and Seck (2013), power outages have the potential to interfere with business activities, which could lead to adverse effects.

Transmission and distribution of power in Kenya are undertaken by two companies. The first is the Kenya Electricity Transmission Company (KETRACO) whose role is to design, construct, operate and maintain high voltage transmission lines. The second is Kenya Power (KP), which is responsible for buying electric energy in bulk from Kenya Electricity Generating Company (KENGEN) and other Independent Power Producers (IPPs) which is then transmitted, distributed and supplied to both corporate and individual consumers. In the year 2010, Kenya Power projected to connect 150,000 consumers annually (KPLC, 2012). This is generally influenced by high costs of expanding the grid, high connection costs, upfront investments, low

demand and low population densities, which thereby proves expensive to start.

Power outages in Kenya are partly blamed on poor infrastructural facilities and fraud, and vandalism of infrastructures such as transformers and power lines. However, challenges of enhancing the supply of electricity could be attributed to other factors and not just investment in physical infrastructure alone (Pless & Fell 2017). Corruption, politics and poor governance in the power institutions could partly explain the problem of power outages.

Empirical studies have observed that access to reliable and quality energy sources leads to sustainable growth, speedy industrialization, enhanced living standards, reduced unemployment and poverty rates (Ozturk, 2010; Stern et al., 2017). Rud (2011) found that in India, there is a positive relationship between rural electrification and the output in the industries. Similarly, Fisher-Vaden et al., (2015) for the case of China, noted that a shortage of electricity had a significant and negative relationship with firm revenues. Doe and Emmanuel (2016) established that poor supply of electricity reduces firm output and revenues in Ghana. However, this kind of literature is scanty in the Kenyan context. We, therefore, use instrumental variable method to explore the effect of power outages on Kenya. In addition, the study advances empirical evidence in energy economics and its impact on economic activities. Furthermore, the study controls for endogeneity which has been assumed by past researchers.

## II. METHODOLOGY

The study employs a production theory where the output of a firm is a combination of various inputs. We assume that firm managers are rational and therefore, they seek to maximize profit given a set of inputs. This can be expressed as:

$$Max\ (\pi|z) = P.Y\ (X|z) - C(X|z)\dots\dots\dots\dots\dots\dots (1)$$

Where $\pi$ denotes farm profits, $P$ is output market price, $Y$ is the output, $Z$ relates to the power outage, $C$ denotes a cost function while X is a set of production inputs such as energy, capital and labour among others.

Assuming $Y$ is the enterprise performance, equation 1 can be written to us:

$$Y_i = f(X_i, Z_i)\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\ (2)$$

Where $Y_i$ is the performance of firm $i$, $X_i$ is the vector of inputs (capital, labour, energy), $Z_i$ is power outage.

We can, therefore, parameterize equation 2 above as:

$$Y_i = AK_i^{\beta_1}L_i^{\beta_2}Ag_i^{\beta_3}PO_i^{\beta_4}{}_i + E_i^{\beta_5} + \varepsilon\dots\dots\dots\dots\dots (3)$$

Where $A$ captures the effects of technological progress as well as policy-relevant factors, $Y_i$ relating to the firm's performance, $K_i$ is the capital employed by firm $i$, $L_i$ denotes labour of firm $i$, $Ag_i$ denotes age of the firm, $PO_i$ is the power outage, $E_i$ denotes energy requirements, $\beta_s$ stands for the parameters estimated.

Taking the logarithm of equation (3), a linearized relationship between performance and explanatory variables is expressed as:

$$Y_i = In\ A + \beta_1 InK_i + \beta_2\ In\ L_i + \beta_3 InAg_i + \beta_4 In\ PO + \beta_5 lnE + \varepsilon\dots\dots\dots (4)$$

### 2.1 Measurement of Variables

*Enterprise Performance:* The study employs profit to measure firm performance. Profit was considered because it represents the financial viability of the firm. In addition, any form of business can employ profitability to measure its performance.

*Electricity Outage:* this was measured by the number of times in a typical month, a firm experienced an outage.

*Labour:* number of permanent staff of the firm.

*Capital:* this was measured by the total amount of money spent in the acquisition of fixed assets. More capital-intensive enterprises are perceived to be more profitable due to the application of superior technology.

*Firm Age:* This was measured by how many years the enterprise has been in operation. Older enterprises are perceived to be more experienced and hence more profitable.

*Energy:* was measured by the amount of money spent on paying electricity bills and fuel.

*A:* the total factor productivity, which measured enterprise efficiency. It was computed by dividing firm output (sales) by the number of employees.

### 2.2 Data type and Sources

The study used the 2018 World Bank enterprise survey (ES) data. This is the latest dataset in Kenya. This data was collected from 1,001 firms spread across all economic sectors (manufacturing, service and retail). The data covered Nairobi (305 firms), Kiambu (106 firms), Nakuru (100firms), Mombasa (94 firms), Kirinyaga (74 firms), Kisumu (73 firms), Kilifi (70 firms), Uasin Gishu (70 firms), Machakos (69 firms), Trans Nzoia (40 firms). Among the key aspects comprised in the dataset are firm characteristics, service/production, operational costs, inputs, sales among others.

### 2.3 Estimation Techniques

The study used a cross-sectional Ordinary Least Squares (OLS) and Two-Stage Least Squares ((2SLS) technique to estimate equation 4. The 2SLS technique was ideal due to its ability to overcome potential endogeneity as well as causality effect between power outages and enterprise profitability (Pless & Fell, 2017).

## III. EMPIRICAL RESULTS

This study aimed to investigate the effect of power outages in Kenya. This section presents descriptive and econometric results.

## 3.1 Descriptive Statistics

Table1:  Sample

| Region | Freq. | Percent |
|---|---|---|
| Mombasa | 94 | 9.39 |
| Kilifi | 70 | 6.99 |
| Machakos | 69 | 6.89 |
| Kirinyaga | 74 | 7.39 |
| Kiambu | 106 | 10.59 |
| Trans Nzoia | 40 | 4.00 |
| Uasin Gishu | 70 | 6.99 |
| Nakuru | 100 | 9.99 |
| Kisumu | 73 | 7.29 |
| Nairobi | 305 | 30.47 |
| Total | 1,001 | 100.00 |

Source: World Bank Enterprise Survey (2018)

The World Bank Enterprise survey for 2018 covered a total of 1001 firms distributed across the country. Table 1 indicates that Nairobi with many business enterprises had the largest sample followed by Nakuru, Kiambu and Mombasa. We also sought to find out the number of power outages per region whose results are presented in Table 2.

Table 2: Power outage per region

| Region | Obs | Mean | Std. Dev. | Min | Max |
|---|---|---|---|---|---|
| Mombasa | 94 | 7.057471 | 4.578403 | 1 | 20 |
| Kilifi | 70 | 6.59322 | 4.468737 | 2 | 20 |
| Machakos | 69 | 5.816667 | 9.833343 | 1 | 60 |
| Kirinyaga | 74 | 5.107143 | 6.403631 | 1 | 30 |
| Kiambu | 106 | 4.191489 | 3.559862 | 1 | 30 |
| Trans Nzoia | 40 | 11.15789 | 14.21367 | 1 | 84 |
| Uasin Gishu | 70 | 3.873016 | 2.082895 | 1 | 10 |
| Nakuru | 100 | 4.736264 | 5.658494 | 1 | 48 |
| Kisumu | 73 | 10.34694 | 17.20411 | 1 | 120 |
| Nairobi | 305 | 8.242063 | 20.36619 | 1 | 240 |
| Total | 1,001 | 6.731449 | 13.06257 | 1 | 240 |

Source: World Bank Enterprise Survey (2018)

The results show that Trans Zoia has the highest number of power outages with a mean of 11.15 followed by Kisumu at 10.34 with a maximum of 120. The statistics show that Nairobi is leading in terms of the maximum number of power outages (240) with most firms experiencing an average of about 8.2 power interruptions per month. This is a serious issue given that Nairobi is the business hub not just for Kenya but, East Africa region and that electricity is very critical in production/service delivery for almost all enterprises. Other regions with highest power outages include Mombasa with a mean of 7.06, Kilifi with a mean of 6.59, Machakos at 5.8, and Kirinyaga with a mean of 5.1. Generally, these findings indicate that on average, any given enterprise has 6.7 times power outage per month. This likely has an adverse effect on business operations and hence, revenue generation.

Summary statistics on variables (see Table 3) show that average profit reported by the enterprises during the year 2018 was 1.03 billion Kenya shillings with a minimum of 48.4 billion (loss) and a maximum of Kshs 420 billion. Mean fixed capital was Kshs. 6.67 billion while that of energy (electricity bills) was Kshs. 15.79 million. Concerning firm age, the results indicate a mean of 21 years with a maximum of 124 years, while the number of permanent employees (labour) ranged between a minimum of 1 and a maximum of 1978 with a mean of 26.

Table 3: Summary Statistics

| Variables | Obs | Mean | Std. Dev. | Min | Max |
|---|---|---|---|---|---|
| Enterprise Performance (Y) | 1,001 | 1.03273 | 19.91688 | -48.4 | 420 |
| Power Outage | 1,001 | 6.731449 | 13.06257 | 1 | 240 |
| Capital | 1,001 | 6.67640 | 13.02312 | 0 | 240 |
| Labor | 1,001 | 26.8707 | 96.29742 | 1 | 1978 |
| Firm Age | 1,001 | 21.9680 | 18.40264 | 0 | 124 |
| Energy | 1,001 | 15.7993 | 138.6152 | 0 | 3500 |
| Total Factor Productivity(A) | 1,001 | 124.372 | 2923.168 | 0.003 | 85000 |

Source: Stata output (2020)

*3.2 Effect of power outages on Enterprise Performance in Kenya*

The study sought to establish the effect of power outages on the performance of enterprises. Profit was computed to measure performance. We employed the 2SLS technique as opposed to OLS to overcome potential endogeneity as well as causality effect between power outages and enterprise profitability. The estimated results are presented in Table 4.

| Enterprise Performance (Y) | Coef. | Std. Err. | t | P>t |
|---|---|---|---|---|
| Power Outage | -.4054 | 0.0899 | -4.51 | 0.000 |
| Capital | -.470994 | 3.794482 | -0.12 | 0.901 |
| Labor | -.00549 | .0035942 | -1.53 | 0.128 |
| Firm Age | -.00545 | .0185829 | -0.29 | 0.770 |
| Energy | .0066908 | .0012215 | 5.48 | 0.000 |
| Total Factor Productivity(A) | .0049399 | .000048 | 101.51 | 0.000 |
| _cons | 4.553383 | 1.503646 | 3.03 | 0.003 |
| Obs | 1,001 | | | |
| Adj R-squared | 0.9856 | | | |
| Prob > F | 0.0000 | | | |

Source: Stata output (2020)

We find that power outages have a negative effect on enterprise profit given the negative coefficient (-0.4054). In addition, the coefficient is highly significant at 1% level (P-value=0.000). These results imply that power outages experienced in Kenya have an adverse effect on business performance. According to these findings, an interruption in power supply leads to about 40.54% drop in the profits. This explains why electricity is key to the production process. Similar results have been reported by Eberhard et al. (2011), Briceño-Garmendia & Shkaratan (2010) who noted that power outages impede operations of enterprises. Reliability of electricity supply is thus critical in firm performance.

Other significant results related to energy and TFP (A). The study has found a positive and highly significant relationship between firm profits and the amount of electricity consumed (0.007, P-value=0.000). This means that an additional Kenya shilling spend on electricity bill increases profits by about 0.7%. This underscores the role of electricity as an input in the production process. Similarly, total factor productivity has a positive and significant effect on firm profitability. An increase in productivity (firm efficiency) by one unit leads to about a 0.5% increase in firm profits.

### IV. CONCLUSIONS AND RECOMMENDATIONS

We conclude that power outages in Kenya have an adverse effect on the performance of firms. Since electricity accounts for more than 95% of energy sources used by firms in Kenya as an input in production, its unreliability poses great challenges to the performance of business enterprises. In addition, studies have argued that electricity is a key input in the production process, and therefore, the interruption in its supply could have serious consequences on firms (Cissokho& Seck, 2013). It has been argued that deficiency in the energy sector, especially in Africa, is to blame for the slow pace of economic and social development (Eberhard e*t al.,* 2011) with serious challenges on employment. Thus, the findings of this current study argue that the unreliable power supply harms firm performance is a matter of concern to both the government and the business community. Power outages are partly attributed to low power generation capacity, deficient power infrastructure and managerial inefficiencies.

Therefore, we recommend that the government of Kenya should fully exploit its electricity generation capability. This can be done through heavy investment in power generation projects which could ameliorate the negative effect of power outages on business enterprises. In addition, the issue of inefficiency in power supply should be addressed through institutional reforms in the electricity sub-sector. Ensuring a reliable supply of electricity could also help the current Jubilee government to achieve the big four agenda on manufacturing. It could enhance firm profitability and create a conducive environment for business expansion, establishment of new firms (industrialization). The results will be used to eenhance living standards, reduced unemployment and poverty rates Ozturk (2010); Stern et *al.*(2017).

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