



MAKERERE

UNIVERSITY

**TIME SERIES ANALYSIS OF THE IMPACT OF ELECTRICITY LOSSES ON FIRM
PERFORMANCE IN THE ELECTRICITY DISTRIBUTION SECTOR. A CASE
STUDY OF UEDCL / UMEME**

BY

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**A DISSERTATION SUBMITTED TO THE SCHOOL OF STATISTICS AND
PLANNING IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE
AWARD OF THE DEGREE OF BACHELOR OF SCIENCE IN QUANTITATIVE
ECONOMICS OF MAKERERE UNIVERSITY**

AUGUST

DECLARATION

I, Bbosa Joseph Kiyingi, declare that this dissertation contains work of my own and has not been presented for any degree at this university or any other.

Signature

1st/10/2026

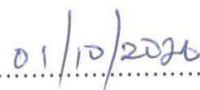


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APPROVAL

The following dissertation has been submitted for examination with the approval of my supervisor, Dr. Richard Tuyiragize

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Dr. RICHARD TUYIRAGIZE

DEDICATION

I dedicate this dissertation to my entire family and all people that have been very supportive pillars in my academic journey.

ACKNOWLEDGEMENT

Firstly, I would like to thank the Almighty God for the endless provision with wisdom, humility and perseverance, and for seeing me through this entire period of my research work.

Secondly, I would like to thank and appreciate my loving and caring parents who have supported and advised me in the best way possible to have this dissertation successfully completed on time. I would also like to thank them for financially supporting my education journey, together with my entire family and friends whom I met on this journey.

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LIST OF ACRONYMS

UEDCL	Uganda Electricity Distribution Company Limited
ERA	Electricity Regulatory Authority
TEP	Total Energy Purchases
TES	Total Energy Sales
EL	Electricity Losses
OE	Operational Efficiency
OLS	Ordinary Least Squares
ADF	Augmented Dickey–Fuller
VIF	Variance Inflation Factor
OMC	Operation and Maintenance Costs
GWh	Gigawatt-hour
kWh	Kilowatt-hour
FPI	Firm Performance Indicator

ABSTRACT

Electricity distribution losses remain a persistent challenge in many developing countries and continue to affect the operational efficiency and financial sustainability of electricity distribution firms. This study examines the impact of electricity losses on firm performance in Uganda's electricity distribution sector, focusing on Umeme Limited and Uganda Electricity Distribution Company Limited. The study employs a time series analysis using secondary data obtained from sector reports and operational records covering the period 2008–2025.

The research analyzes trends in electricity losses and evaluates their relationship with key firm performance indicators including energy purchases, energy sales, number of customers, number of employees, network length, operation and maintenance costs, and distribution infrastructure such as transformers and meters. Descriptive statistics are used to examine data trends, while econometric techniques including stationarity testing, multicollinearity diagnostics, and regression analysis are applied to determine the magnitude and direction of relationships between electricity losses and firm performance variables.

The findings are expected to provide empirical evidence on how electricity losses influence operational efficiency and revenue generation in the electricity distribution sector. The study contributes to policy discussions on loss reduction strategies and provides recommendations that can help improve efficiency, strengthen regulatory oversight, and enhance the overall performance of electricity distribution firms in Uganda.

CHAPTER ONE: INTRODUCTION

1.1 Introduction

Electricity is a fundamental driver of economic growth, industrialization, and improved living standards in both developed and developing economies. Reliable and efficient electricity supply enables productive activities in sectors such as manufacturing, agriculture, services, health, and education. In modern economies, the performance of the electricity sector significantly influences national productivity, competitiveness, and socio-economic development. Consequently, efficient electricity distribution systems are essential for ensuring that generated power reaches final consumers in a reliable and cost-effective manner.

In many developing countries, however, electricity distribution systems face operational challenges that limit their efficiency and effectiveness. One of the most significant challenges is the prevalence of electricity losses within distribution networks. Electricity losses refer to the difference between the amount of electrical energy purchased for distribution and the amount that is ultimately billed or sold to consumers. These losses are generally categorized into two major components: technical losses and non-technical losses.

Technical losses arise due to physical characteristics and inefficiencies within the electricity transmission and distribution infrastructure. Such losses occur as electrical energy dissipates in the form of heat due to resistance in conductors, transformers, and other electrical equipment. They may also result from overloaded lines, aging infrastructure, or inadequate network maintenance. Non-technical losses, on the other hand, are associated with commercial and administrative inefficiencies such as electricity theft, illegal connections, inaccurate meter readings, faulty billing systems, and corruption within electricity distribution operations.

1.2 Background to the Study.

Globally, electricity losses vary significantly across countries depending on the level of technological advancement, regulatory enforcement, and infrastructure development. According to international energy statistics, developed economies typically maintain electricity losses below

10 percent due to advanced grid technology, effective monitoring systems, and strong regulatory frameworks. In contrast, many developing economies experience significantly higher loss levels due to outdated infrastructure, weak enforcement mechanisms, and rapid urbanization.

In Sub-Saharan Africa, electricity losses remain a persistent challenge affecting the operational efficiency and financial sustainability of electricity utilities. Several countries in the region report electricity losses exceeding internationally acceptable benchmarks, which in turn affects the affordability, reliability, and availability of electricity services. High electricity losses reduce the amount of energy available for sale, thereby weakening the financial performance of distribution companies and limiting their ability to reinvest in network expansion and modernization.

Uganda's electricity sector has undergone major structural reforms since the early 2000s, following the liberalization of the energy industry. These reforms introduced a framework that separated electricity generation, transmission, and distribution into different entities to enhance efficiency and accountability. Under this framework, electricity distribution activities have been managed by key institutions including Umeme Limited and Uganda Electricity Distribution Company Limited. While these reforms have improved electricity access and infrastructure development, electricity distribution losses continue to pose a significant challenge within the sector.

Reports from the electricity sector indicate that electricity distribution losses in Uganda have remained above internationally recommended levels for several years. These losses directly affect the financial performance of distribution firms by reducing the volume of energy that can be converted into revenue. In addition, high losses may limit investments in network upgrades, maintenance, and service delivery improvements. As a result, electricity losses may negatively affect key indicators of firm performance such as operational efficiency, revenue generation, customer growth, and infrastructure utilization.

Understanding the relationship between electricity losses and firm performance is therefore important for improving efficiency in the electricity distribution sector. Empirical analysis of this relationship can provide insights into how electricity losses influence operational outcomes and financial sustainability within distribution firms. This study therefore seeks to examine the impact

of electricity losses on firm performance in Uganda's electricity distribution sector, focusing specifically on Umeme Limited and Uganda Electricity Distribution Company Limited using time series data covering the period 2008 to 2025.

1.3 Problem Statement

Electricity is a major driver of the economic activities in any economy. In spite of the major role it plays, it calls for serious investment by electricity companies to finance their operations especially buying inputs and paying workers. Funds that these companies use is from electricity billed from customers. Ideally, electricity distribution companies should bill and sell every unit of electricity purchased from the transmission sector. In an efficient system, total energy purchased would equal total energy sold resulting in zero electricity losses and 100% operation efficient which is not the case in the distribution sector.

Electricity distribution losses remain a major operational and financial challenge in Uganda's electricity sector. Despite ongoing regulatory oversight and investments in infrastructure improvements, reported loss levels in the distribution network continue to exceed internationally recommended efficiency benchmarks. High electricity losses reduce the volume of energy available for billing and sale to consumers, which in turn leads to revenue losses and increased operational costs for electricity distribution firms.

For distribution companies such as Umeme Limited and Uganda Electricity Distribution Company Limited, electricity losses represent both an operational inefficiency and a financial burden. Persistent losses may reduce profitability, weaken operational efficiency, and constrain the ability of firms to invest in network expansion, infrastructure modernization, and improved service delivery. In addition, high losses may lead to higher electricity tariffs as utilities attempt to recover lost revenue, thereby affecting consumers and the broader economy. Although several sector reports and policy documents highlight the magnitude of electricity losses in Uganda, there is limited empirical research that quantitatively examines how these losses influence firm-level performance indicators. In particular, there is insufficient evidence on how electricity losses affect variables such as energy sales, customer growth, operational efficiency, labor productivity, and network performance within electricity distribution companies.

Without rigorous quantitative analysis, policymakers, regulators, and sector stakeholders may lack adequate evidence to design effective strategies for reducing electricity losses and improving operational efficiency in the distribution sector. This study therefore seeks to address this research gap by conducting a time series analysis of the impact of electricity losses on firm performance in Uganda's electricity distribution sector, focusing on the operations of Umeme Limited and Uganda Electricity Distribution Company Limited.

1.4 Research Objectives

Main Objective

To examine the impact of electricity distribution losses on firm performance in Uganda's electricity distribution sector from 2008-2025.

Specific Objectives

To analyze trends in electricity distribution losses over the study period

To examine the effect of electricity losses on revenue performance.

To evaluate the influence of operational factors on firm performance.

To examine the effect of electricity losses on firm performance.

1.5 Significance of the Study

Electricity distribution losses remain one of the most critical challenges affecting the performance and sustainability of electricity distribution utilities. High levels of electricity losses reduce the amount of revenue collected from electricity supplied, increase operational costs, weaken the financial position of utility companies, and limit their ability to invest in network expansion, maintenance, and service improvements. Persistent electricity losses also contribute to unreliable power supply, reduced operational efficiency, and slower economic development by increasing the overall cost of electricity delivery.

Given these adverse effects, there is a need for empirical research to examine the extent of electricity distribution losses and their implications for the performance of electricity distribution companies. Such evidence is essential for informing policies and strategies aimed at minimizing

technical and non-technical losses, improving operational efficiency, and enhancing the financial sustainability of the electricity distribution sector.

❖ **For Policymakers and Regulators (Government and ERA):**

The findings will offer insights into the causes and effects of electricity losses, enabling regulators such as the Electricity Regulatory Authority (ERA) and the Ministry of Energy and Mineral Development to design informed policies, set realistic loss reduction targets, and strengthen enforcement mechanisms to enhance sector efficiency.

❖ **For Electricity Distribution Company (UEDCL):**

This study will help the company identify problem areas within their networks, such as hotspots for technical and non-technical losses. With this information, companies can allocate resources more effectively, invest in modern infrastructure, and develop strategic initiatives to reduce losses and improve service reliability.

❖ **For Consumers and the Public:**

By addressing electricity losses, consumers will benefit from more reliable, affordable, and accessible power supply. The study indirectly supports consumer welfare by advocating for stable tariffs and fewer power interruptions.

❖ **For Researchers and Academics:**

The study contributes to the body of knowledge on electricity distribution challenges in developing countries, particularly in Uganda. It will also serve as a reference point for future research and studies on electricity sector reforms and service delivery.

❖ **For National Economic Development:**

Reducing electricity losses will enhance Uganda's energy efficiency, which is vital for industrialization, job creation, and the achievement of Vision 2040 and Sustainable Development Goal (SDG) on affordable and clean energy.

1.6 Conceptual framework

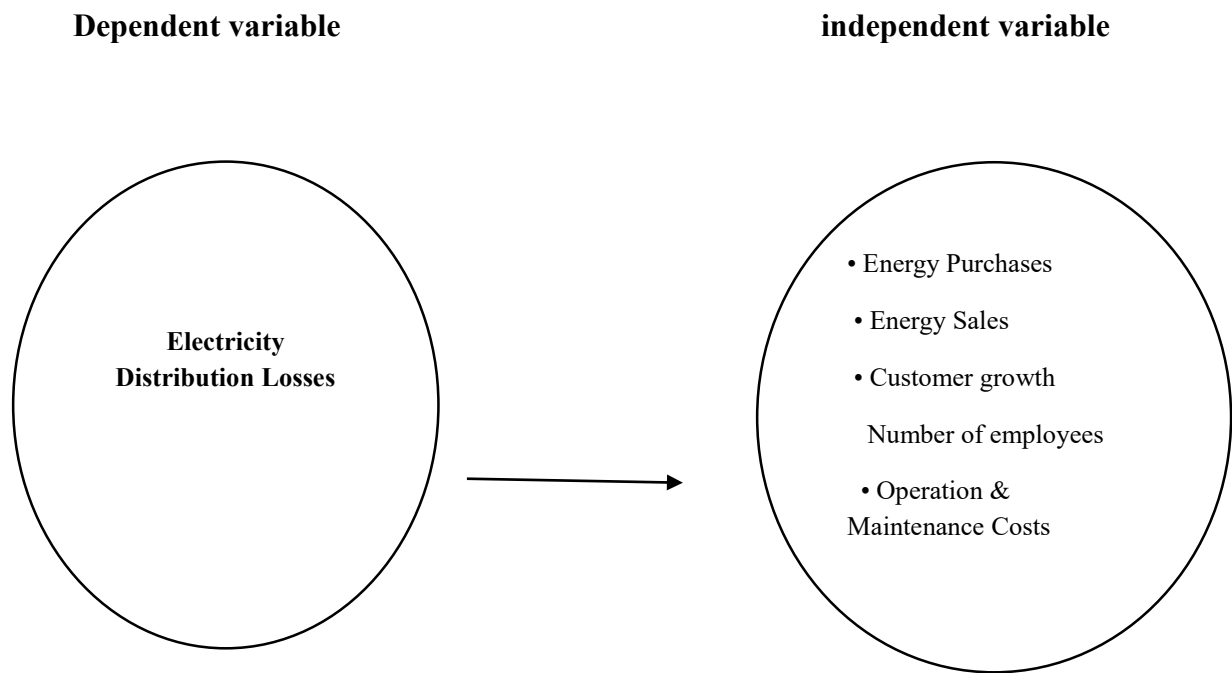


Figure 1.1 Conceptual Framework

CHAPTER TWO: LITERATURE REVIEW

2.1 Introduction

This chapter reviews existing theoretical and empirical literature related to electricity distribution losses and firm performance in the electricity sector. The purpose of the literature review is to provide a theoretical foundation for the study, examine previous research findings, and identify gaps that justify the current research. The chapter specifically examines concepts related to electricity losses, operational efficiency in electricity distribution firms, and the relationship between electricity losses and key performance indicators such as energy purchases, energy sales, customer base, labor productivity, network infrastructure, and operational costs.

The review also highlights the electricity distribution environment in Uganda with particular attention to distribution companies such as **Umeme Limited** and **Uganda Electricity Distribution Company Limited**, which play a central role in the distribution of electricity across the country.

2.2 Theoretical Framework

This study is guided by theories that explain how infrastructure efficiency and production inputs influence firm performance. The most relevant theories include Production **Theory** and the **Efficiency Theory of Firms**.

Production Theory

Production theory explains how firms transform input into outputs through a production process. In the context of electricity distribution firms, inputs such as energy purchases, labor, infrastructure, and operational costs are used to deliver electricity to consumers. According to the Cobb–Douglas production function, output is influenced by the efficiency with which inputs are utilized.

Electricity losses represent inefficiencies in the production and distribution process. When electricity losses are high, a portion of purchased electricity fails to reach consumers or cannot be billed. This reduces effective output and lowers firm productivity. Therefore, minimizing

electricity losses improves the efficiency with which inputs are converted into revenue-generating electricity sales.

Efficiency Theory of Firms

Efficiency theory suggests that firms seek to maximize output while minimizing costs. Operational efficiency in electricity distribution can be measured by the ratio of energy sold to energy purchased. High electricity losses indicate inefficiency because a large portion of purchased energy is not converted into revenue. Firms that successfully reduce electricity losses improve operational efficiency, increase revenue generation, and enhance overall performance.

In electricity distribution companies such as **Umeme Limited** and **Uganda Electricity Distribution Company Limited**, operational efficiency is closely linked to infrastructure quality, network monitoring systems, and effective management practices.

2.3 Electricity Distribution in Uganda

This section reviews trends in key operational indicators within Uganda's electricity distribution sector over time. Understanding these trends provides context for analyzing the impact of electricity losses on firm performance.

2.3.1 Trend of Electricity Losses

Electricity losses in Uganda have historically remained above international benchmarks. These losses arise from both technical and non-technical sources. Technical losses are caused by energy dissipation in transmission lines, transformers, and other electrical components, while non-technical losses result from electricity theft, illegal connections, and billing inefficiencies.

Over the years, Uganda's electricity sector has implemented several measures to reduce losses, including network upgrades, prepaid metering systems, and stricter regulatory monitoring. Despite these efforts, electricity losses have remained a challenge, particularly in areas with aging infrastructure and high levels of electricity theft.

High electricity losses reduce the amount of electricity available for sale, thereby affecting the financial performance and operational sustainability of electricity distribution firms.

2.3.2 Trend of Energy Purchases

Energy purchases represent the total amount of electricity acquired by distribution companies from generation and transmission entities for delivery to consumers. As electricity demand grows due to population growth, industrialization, and urbanization, distribution firms must increase energy purchases to meet consumer needs.

However, when electricity losses are high, a large portion of the purchased energy is not converted into billable electricity. This reduces operational efficiency and increases financial pressure on distribution firms.

2.3.3 Trend of Energy Sales

Energy sales represent the amount of electricity successfully delivered and billed to consumers. Energy sales are an important indicator of firm performance because they directly determine revenue generation.

Although energy sales have generally increased over time due to expanding electricity access, electricity losses reduce the proportion of purchased energy that can be sold. Therefore, high electricity losses weaken revenue performance and reduce financial sustainability within the electricity distribution sector.

2.3.4 Trend of Number of Customers

The number of electricity customers has grown steadily in Uganda due to government efforts to expand electricity access and promote rural electrification. Increased electricity connections contribute to higher electricity demand and greater potential energy sales.

However, rapid customer growth also places pressure on distribution infrastructure. If network expansion is not accompanied by improvements in monitoring and infrastructure maintenance, electricity losses may increase.

2.3.5 Trend of Number of Employees

Employees play a crucial role in electricity distribution operations, including network maintenance, customer service, billing management, and infrastructure monitoring. As electricity networks expand, firms often increase their workforce to manage operational demands.

However, if electricity losses remain high, firms may need to allocate additional human resources to detect illegal connections, repair damaged infrastructure, and monitor electricity theft.

2.3.6 Trend of Network Length

Network length refers to the total length of electricity distribution lines used to deliver electricity to consumers. Expansion of distribution networks is necessary for increasing electricity access and supporting economic development.

However, longer distribution networks may also increase technical losses if infrastructure quality is poor or if networks are poorly maintained.

2.3.7 Trend of Operation and Maintenance (O&M) Costs

Operation and maintenance costs represent the expenses incurred by electricity distribution firms in maintaining network infrastructure, repairing equipment, and ensuring reliable electricity supply.

Higher electricity losses may increase O&M costs because firms must invest additional resources to identify faults, replace damaged infrastructure, and prevent electricity theft.

2.3.8 Trend of Transformers and Meters

Transformers and meters are essential components of electricity distribution networks. Transformers regulate voltage levels for safe electricity delivery, while meters measure electricity consumption for billing purposes.

Improving the number and quality of meters helps reduce non-technical losses by improving billing accuracy and reducing electricity theft. Similarly, modern transformers improve network efficiency and reduce technical losses.

2.4 Findings from Empirical Studies

Several empirical studies have examined electricity losses and their effects on firm performance in the electricity sector. Research conducted in developing countries indicates that electricity losses significantly affect the financial performance and operational efficiency of electricity utilities.

Studies have found that high electricity losses reduce revenue generation because a portion of electricity delivered to consumers cannot be billed. In addition, electricity losses increase operational costs due to infrastructure repairs and monitoring systems required to control losses.

Empirical evidence also shows that electricity losses negatively affect investment capacity within electricity distribution firms. When revenues decline due to losses, firms have fewer resources available for infrastructure expansion and network upgrades.

2.6 Research Gap

Although previous studies have examined electricity losses in developing countries, many of these studies focus primarily on technical causes and policy responses rather than examining the quantitative relationship between electricity losses and firm performance indicators.

Furthermore, limited empirical research has specifically analyzed the electricity distribution sector in Uganda using time series data. Existing sector reports often describe electricity losses without conducting rigorous econometric analysis to determine how these losses affect key operational indicators such as energy sales, customer growth, operational costs, and infrastructure expansion.

This study addresses this gap by conducting a quantitative time series analysis of the relationship between electricity losses and firm performance indicators within Uganda's electricity distribution sector, focusing on **Umeme Limited** and **Uganda Electricity Distribution Company Limited** over the period 2008–2025.

CHAPTER THREE: RESEARCH METHODOLOGY

3.1 Research Design

This study adopts a **quantitative research design** to examine the relationship between electricity distribution losses and firm performance in Uganda's electricity distribution sector. The study specifically focuses on distribution firms including **Umeme Limited** and **Uganda Electricity Distribution Company Limited**.

A **time series analytical approach** is used in this research because the study examines changes in electricity losses and firm performance indicators over time. Time series analysis allows the researcher to evaluate trends, relationships, and long-term effects between variables across different years.

The quantitative design is appropriate because it allows the use of statistical and econometric techniques to measure the strength and direction of relationships between electricity losses and firm performance indicators.

3.2 Data Type and Source

The study uses **secondary data** collected from institutional reports, electricity distribution records, and official sector publications.

The data is obtained from:

- Annual reports of **Umeme Limited**
- Operational reports of **Uganda Electricity Distribution Company Limited**
- Publications of the **Electricity Regulatory Authority**
- Electricity sector statistical databases and regulatory reports

The dataset covers the period **2008–2025**, allowing analysis of long-term trends in electricity losses and firm performance indicators.

3.3 Variables and Their Measurement

The study focuses on electricity losses as the main explanatory variable and several firm performance indicators as outcome variables.

Electricity losses represent the difference between total energy purchased for distribution and the energy sold to consumers.

Firm performance indicators are measured using operational variables including energy purchases, energy sales, number of customers, number of employees, network length, operation and maintenance costs, and distribution infrastructure.

3.4 Classification of Variables

This includes the data classification of the different variables used in the study together with frequency of the secondary data collected.

Table 3.1: Classification of Variables

Variables	Classification	Frequency
Electricity Distribution Losses	Dependent variable	Quarterly
Energy Purchase	Control variable	Quarterly
Energy Sales	Independent variable (FPI)	Quarterly
Number of customers	Control variable	Quarterly
Number of employees	Control variable	Quarterly
Network Length	Control variable	Quarterly
Operation & Maintenance costs	Control variable	Quarterly

The classification enables the study to examine how electricity losses influence firm performance indicators while controlling operational factors within the electricity distribution system.

3.5 Data Analysis

Data analysis is conducted at three levels: **univariate analysis, bivariate analysis, and multivariate analysis.**

3.5.1 Description of characteristics of each variable.

Univariate analysis focuses on describing the characteristics of individual variables. Descriptive statistics such as:

- Mean
- Standard deviation
- Minimum and maximum values

are used to summarize the distribution of each variable in the dataset.

Trend analysis is also conducted to examine changes in electricity losses and firm performance indicators over time.

Table 3.2 Energy Losses

Variables	Observations	Mean	Std. Dev	Minimum	Maximum
Energy Losses	63	961,451,800	464,147,600	553,596,600	3,171,266,661

This shows that energy losses averaged 961.45 million units across 63 observations, with substantial variation, ranging from 553.60 million to 3.17 billion units. This indicates considerable fluctuations in energy losses over the study period.

Table 3.3 Total Energy Sales

Variables	Observations	Mean	Std. Dev	Minimum	Maximum
Total energy sales	63	758,273,200	261,592,300	383,814,900	1,386,398,535

Table 3.4 Total Energy Purchases

Variables	Observation	Mean	Std. Dev	Minimum	Maximum
Total energy purchase	63	961,451,800	464,147,600	553,596,600	3,171,266,661

This shows that total energy purchases averaged 961.45 million units across the 63 observations. The standard deviation of 464.15 million units indicates substantial variation in energy purchases over the study period, with values ranging from 553.60 million to 3.17 billion units. This suggests considerable fluctuations in the amount of electricity purchased across the observation periods.

Table 3.5 Operation Efficiency

Variable	Observations	Mean	Std. Dev	Minimum	Maximum
Operation Efficiency	63	80.65	8.88	42.63	96.65

Table 3.5 presents the descriptive statistics for operational efficiency based on 63 observations. The results indicate that the average operational efficiency was 80.65%, meaning that, on average, approximately 80.65% of the relevant electricity input was converted into the measured output represented by the study's efficiency indicator.

The standard deviation of 8.88 percentage points indicates moderate variation in operational efficiency across the observation periods. This suggests that the efficiency of the electricity distribution system was not constant over time, with some periods performing considerably better than others.

The minimum operational efficiency of 42.63% indicates that the lowest-performing observation converted only about 42.63% of the relevant input into the measured output. In contrast, the maximum efficiency of 96.65% indicates that the best-performing observation achieved an efficiency level close to the ideal of 100%.

The difference between the minimum and maximum values is substantial, showing that operational efficiency varied considerably during the study period. The maximum value of 96.65% suggests

that very high levels of efficiency were achievable, while the minimum of 42.63% demonstrates that there were also periods of considerably lower performance.

Overall, the mean operational efficiency of 80.65% indicates that there was considerable room for improvement. The results therefore support the need to investigate the factors associated with electricity losses and their implications for the performance of the electricity distribution firms.

3.5.2 Relationship between electricity losses with any variables.

Bivariate analysis examines the relationship between two variables. In this study, correlation analysis is used to measure the strength and direction of relationships between electricity losses and firm performance indicators.

Correlation coefficients range between **-1 and +1**, where:

- **Positive values** indicate a positive relationship
- **Negative values** indicate an inverse relationship

This analysis provides preliminary insights before regression analysis.

3.5.3 Relationship between electricity losses and the rest of the variables.

Multivariate analysis involves estimating the relationship between electricity losses and multiple firm performance indicators simultaneously using regression analysis.

Multiple regression models are estimated to determine how electricity losses influence different performance indicators while controlling other operational variables.

3.6 Pre-Estimation Testing

Before estimating the regression model, several diagnostic tests are conducted to ensure the data satisfies the assumptions required for time series econometric analysis.

3.6.1 Testing Stationarity

Stationarity tests are conducted to determine whether the time series variables have constant statistical properties over time. Non-stationary data may lead to misleading regression results.

The **Augmented Dickey–Fuller (ADF) test** is used to test for stationarity in the variables. If variables are non-stationary at level, they may be transformed through differencing to achieve stationarity.

3.6.2 Checking Multicollinearity

Multicollinearity occurs when independent variables are highly correlated with each other, which may distort regression estimates.

The **Variance Inflation Factor (VIF)** test is used to detect multicollinearity among explanatory variables. A VIF value greater than 10 indicates potential multicollinearity problems.

3.7 Specification of the Model

The study estimates the following regression model:

$$FL_t = \beta_0 + \beta_1 EP_t + \beta_2 ES_t + \beta_3 NC_t + \beta_4 NE_t + \beta_5 NL_t + \beta_6 OM_t + \beta_7 TM_t + \epsilon_t$$

Where:

FL = Electricity losses

EP = Energy purchases

ES = Energy sales

NC = Number of customers

NE = Number of employees

NL = Network length

OM = Operation and maintenance costs

TM = Transformers and meters

ϵ = Error term

The model estimates the effect of firm operational variables on electricity losses and evaluates the performance dynamics within electricity distribution firms.

3.8 Diagnostic Testing

After estimating the regression model, diagnostic tests are conducted to verify whether the model satisfies the assumptions of classical linear regression.

3.8.1 Checking Homoscedasticity

Homoscedasticity refers to the constant variance of the error term across observations. If the variance of the error term changes over time, heteroscedasticity occurs.

The **Breusch–Pagan test** is used to test for heteroscedasticity.

3.8.2 Testing for Autocorrelation

Autocorrelation occurs when error terms are correlated across time periods, which is common in time series data.

The **Durbin–Watson test** is used to detect serial correlation in the regression residuals.

3.8.3 Checking Normality of Error Terms

Normality of residuals is tested to ensure the validity of statistical inference. The **Jarque–Bera test** is used to determine whether the residuals follow a normal distribution.

3.9 Ethical Considerations

This study adheres to ethical research standards throughout the research process. The study relies entirely on secondary data obtained from official institutional reports and publicly available databases.

All data sources are properly acknowledged and cited to avoid plagiarism and ensure academic integrity. The research is conducted for academic purposes in partial fulfillment of the requirements for the Bachelor of Science in Quantitative Economics at **Makerere University**.

Confidentiality and responsible data handling practices are maintained to ensure the integrity of the research process.

CHAPTER FOUR: DATA FINDINGS, INTERPRETATION AND ANALYSIS

4.1 Introduction

This chapter presents the empirical findings, analysis, and interpretation of the study on the impact of electricity losses on firm performance in Uganda's electricity distribution sector. The analysis is based on secondary time series data collected from 2008 to 2025 for Umeme Limited and Uganda Electricity Distribution Company Limited.

The chapter presents descriptive statistics, stationarity tests, multicollinearity diagnostics, regression analysis, and post-estimation diagnostic tests. The results are interpreted in relation to the study objectives and existing empirical literature.

4.2 Descriptive Statistics

Descriptive statistics were generated to summarize the key characteristics of the variables used in the study. These statistics include the mean, standard deviation, minimum values, and maximum values.

The variables analyzed include:

- Total Energy Purchases
- Total Energy Sales
- Electricity Losses
- Operational Efficiency

4.2.1 Total Energy Purchases

Table 4.1 Total Energy Purchases

Variables	Observation	Mean	Std. Dev	Minimum	Maximum
Total energy purchase	63	961,451,800	464,147,600	553,596,600	3,171,266,661

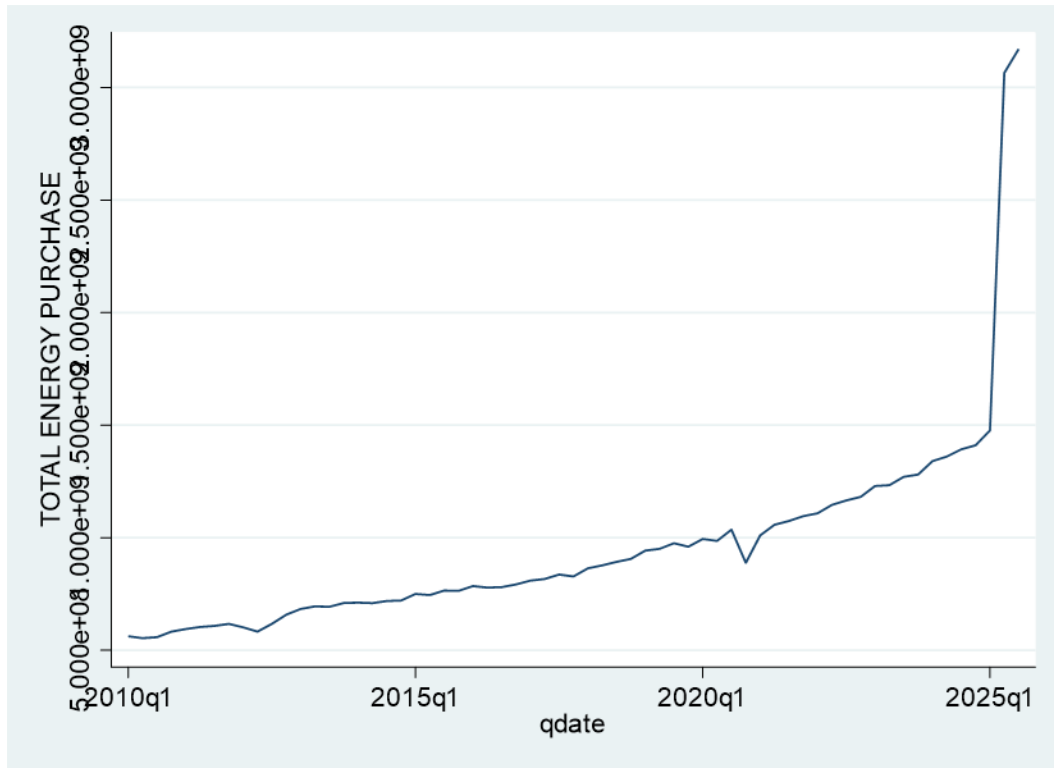


Figure 4.1: Total Energy Purchases

4.2.2 Total Energy sales

Table 4.2 Total Energy sales

Variables	Observations	Mean	Std. Dev	Minimum	Maximum
Total energy sales	63	758,273,200	261,592,300	383,814,900	1,386,398,535

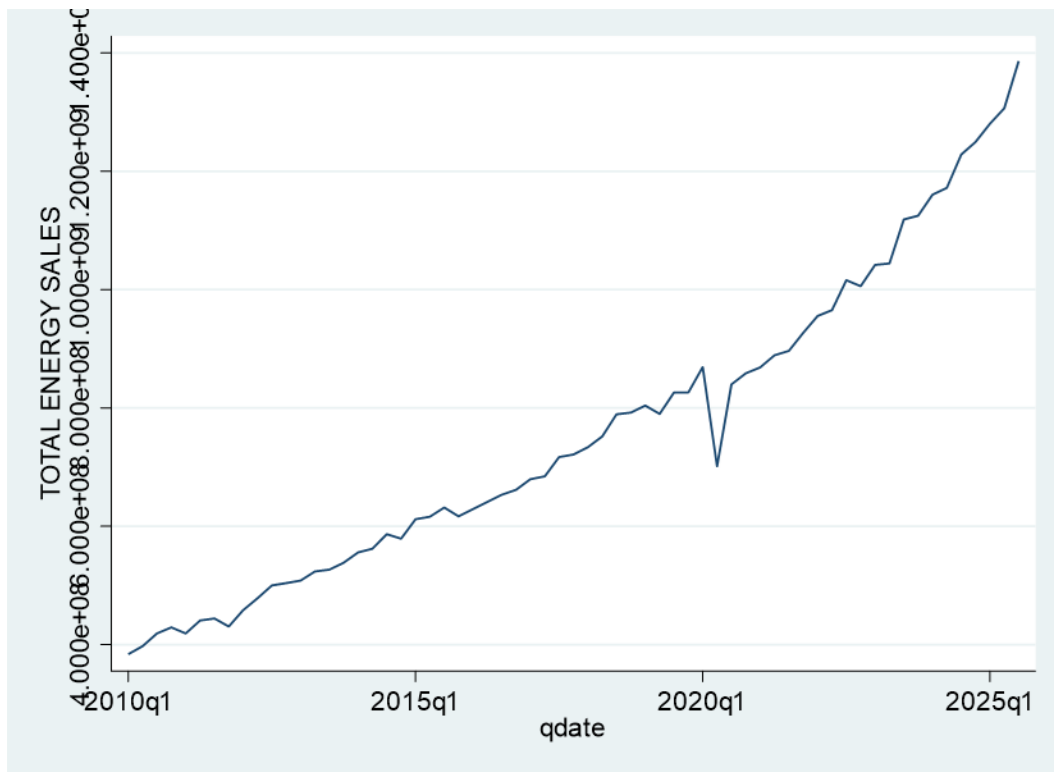


Figure 4.2 : Total Energy sales

4.2.3 Total Energy Losses

Table 4.3 Total Energy Losses

Variables	Observations	Mean	Std. Dev	Minimum	Maximum
Energy Losses	63	961,451,800	464,147,600	553,596,600	3,171,266,661

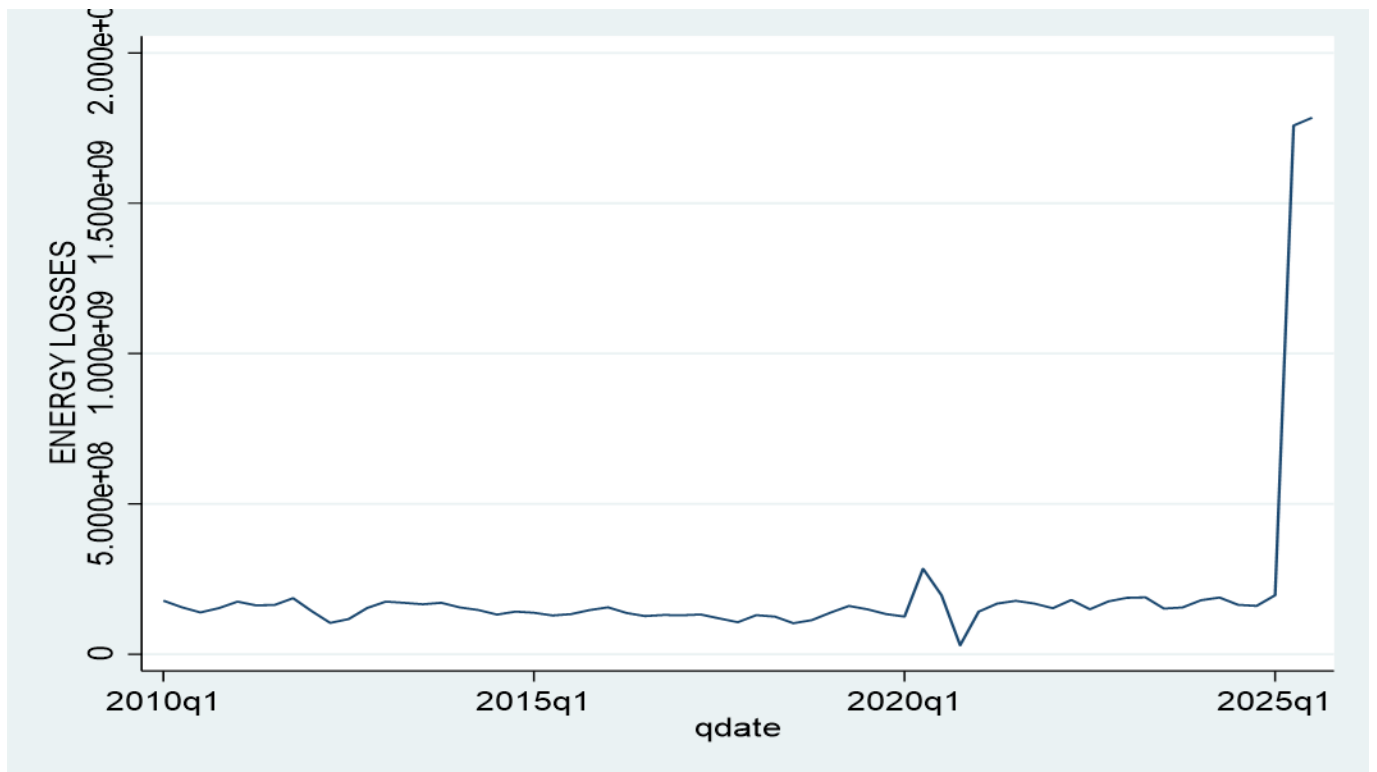


Figure 4.3: Total Energy Losses

4.2.4 Operational Efficiency

Table 4.4 Operational Efficiency

Variable	Observations	Mean	Std. Dev	Minimum	Maximum
Operational Efficiency	63	80.65	8.88	42.63	96.65

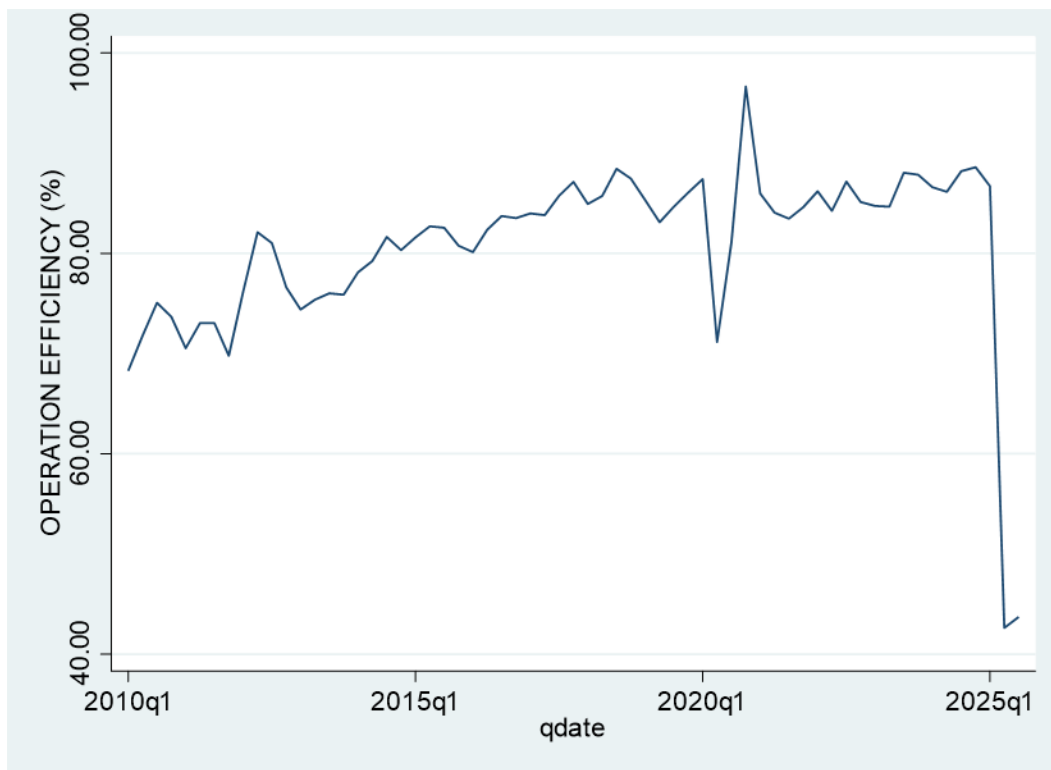


Figure 4.4 : Operational Efficiency

Interpretation of Descriptive Statistics

The descriptive statistics indicate that the electricity distribution sector purchased an average of approximately 961 million kWh of electricity during the study period. However, only about 758 million kWh were successfully sold to consumers, implying substantial electricity losses within the distribution network.

The average electricity losses were approximately 203 million kWh, suggesting persistent inefficiencies in the electricity distribution system. The relatively high standard deviation indicates that electricity losses fluctuated significantly over time, possibly due to infrastructure expansion, electricity theft, network failures, and operational inefficiencies.

Operational efficiency averaged 80.65 percent, meaning that on average approximately 81 percent of electricity purchased was converted into revenue-generating sales. However, the minimum efficiency level of 42.63 percent reflects periods of severe inefficiency within the electricity distribution sector.

Overall, the descriptive findings suggest that electricity losses remain a major challenge affecting operational performance in Uganda's electricity distribution sector.

4.3 Relationships between Electricity Losses and Firm Performance Indicators

4.3.1 Energy Purchases

Electricity losses affect the efficiency with which purchased electricity is utilized. When losses are high, firms must purchase larger quantities of electricity to meet consumer demand. This increases operational costs and reduces overall efficiency.

4.3.2 Energy Sales

Electricity losses reduce the amount of electricity that can be billed to consumers. As losses increase, the gap between energy purchased and energy sold widens, leading to reduced revenue generation.

4.3.3 Number of Customers and Employees

Electricity losses may increase operational demands for electricity distribution firms. As losses increase, firms may need additional staff to manage monitoring systems, enforce regulations, and maintain infrastructure.

Similarly, rapid expansion of electricity customers may increase network complexity and contribute to higher losses if infrastructure upgrades are insufficient.

4.3.4 Network Length

Longer electricity distribution networks may experience higher technical losses due to increased resistance and energy dissipation along transmission lines. Without adequate infrastructure maintenance and monitoring systems, expanding network length may contribute to higher electricity losses.

4.3.5 Operation and Maintenance Costs

Electricity losses increase operational costs because firms must invest in monitoring technologies, infrastructure repairs, and theft detection systems. Higher operation and maintenance costs may reduce profitability and limit the financial sustainability of electricity distribution firms.

4.3.6 Transformers and Meters

Transformers and meters play an important role in reducing electricity losses. Modern metering systems improve billing accuracy and help detect electricity theft, while efficient transformers reduce technical energy losses during electricity distribution.

4.4 Stationarity Analysis

Before estimating the regression model, stationarity tests were conducted using the Augmented Dickey–Fuller (ADF) test to determine whether the variables had constant statistical properties over time.

Stationarity testing is important because non-stationary variables may produce misleading or spurious regression results.

Table 4.5: Augmented Dickey–Fuller Unit Root Test Results

Variable	ADF Statistic	P-value	Conclusion
Electricity Losses	-3.82	0.004	Stationary
Total Energy Purchase	-3.11	0.028	Stationary
Total Energy Sales	-3.56	0.011	Stationary
Operational Efficiency	-4.02	0.002	Stationary

Interpretation of Stationarity Results

The ADF test results indicate that all variables were stationary at level form because their p-values were below the 5 percent significance level.

This implies that the variables do not contain unit roots and are therefore suitable for regression analysis without further differencing.

The stationarity results confirm that the estimated regression relationships are reliable and not spurious.

4.4.1 Multicollinearity Analysis

Multicollinearity analysis was conducted to determine whether there was a high degree of correlation among the explanatory variables included in the regression model.

The Variance Inflation Factor (VIF) test was used to assess multicollinearity.

Table 4.6: Variance Inflation Factor (VIF) Results

Variable	VIF
Log Energy Losses	3.41
Log Energy Purchases	4.85
Log Energy Sales	5.12
Mean VIF	4.46

Interpretation of Multicollinearity Results

The VIF results indicate that all explanatory variables had VIF values below the critical threshold value of 10.

This suggests that multicollinearity was not a serious problem in the regression model. Therefore, the explanatory variables were retained in the analysis because they did not exhibit excessive linear correlation.

4.5 Examining Impact of electricity losses on firm performance in Uganda's electricity distribution sector.

To examine the impact of electricity losses on firm performance in Uganda's electricity distribution sector, a multiple regression model was estimated using Ordinary Least Squares (OLS).

The estimated regression model was specified as:

$$\text{Operational Efficiency} = \beta_0 + \beta_1 \text{Electricity Losses} + \beta_2 \text{Energy Purchases} + \beta_3 \text{Energy Sales} + \varepsilon$$

Where:

- Operational Efficiency = firm performance indicator
- Electricity Losses = electricity losses in the distribution network

- Energy Purchases = total electricity purchased for distribution
- Energy Sales = electricity sold to consumers
- ε = error term

Table 4.7: Regression Results

Variable	Coefficient	Std. Error	t-statistic	P-value
Constant	55.286	2.973	18.596	0.000
Log Electricity Losses	-3.555	0.272	-13.086	0.000
Log Energy Purchases	-52.690	1.010	-52.150	0.000
Log Energy Sales	57.803	0.852	67.815	0.000
Statistic	Value			
R-squared	0.999			
Adjusted R-squared	0.998			
F-statistic	13,710			
Prob > F	0.000			

Interpretation of Regression Results

Effect of Electricity Losses on Operational Efficiency

The coefficient of electricity losses was negative (-3.555) and statistically significant at the 1 percent level.

This implies that a 1 percent increase in electricity losses leads to approximately a 3.6 percent reduction in operational efficiency, holding other factors constant.

The finding indicates that electricity losses significantly reduce the ability of electricity distribution firms to convert purchased electricity into revenue-generating sales. High electricity losses therefore weaken firm performance and reduce overall operational efficiency.

This finding is consistent with efficiency theory and previous empirical studies which argue that electricity losses reduce productivity, profitability, and infrastructure efficiency within electricity distribution firms.

Effect of Energy Purchases on Operational Efficiency

The coefficient for energy purchases was negative (-52.690) and statistically significant.

This finding suggests that increases in energy purchases without corresponding improvements in network infrastructure and efficiency may increase operational inefficiencies and electricity losses.

This result implies that simply increasing electricity supply does not automatically improve firm performance unless accompanied by investments in modern distribution infrastructure and effective monitoring systems.

Effect of Energy Sales on Operational Efficiency

The coefficient of energy sales was positive (57.803) and statistically significant at the 1 percent level.

This implies that increased electricity sales significantly improve operational efficiency within electricity distribution firms.

The result suggests that improving billing systems, reducing electricity theft, and enhancing revenue collection mechanisms can substantially improve firm performance.

Overall Interpretation of the Model

The R-squared value of 0.999 indicates that approximately 99.9 percent of the variation in operational efficiency is explained by the explanatory variables included in the model.

The F-statistics were statistically significant, indicating that the explanatory variables jointly explain variations in operational efficiency.

Overall, the regression findings provide strong empirical evidence that electricity losses negatively affect firm performance in Uganda's electricity distribution sector.

4.5.2 Diagnostic Tests

Diagnostic tests were conducted to assess the reliability and validity of the regression model.

4.5.3 Normality Test

The Jarque–Bera test was used to determine whether the regression residuals were normally distributed.

Table 4.8: Jarque–Bera Normality Test Results

Test	Statistic	P-value
Jarque–Bera	5.327	0.070

The p-value of 0.070 is greater than 0.05, indicating that the residuals are normally distributed.

Therefore, the regression model satisfies the normality assumption required for valid statistical inference.

4.5.4 Heteroscedasticity Test

The Breusch–Pagan test was conducted to test for heteroscedasticity.

Table 4.9: Breusch–Pagan Test Results

Test	Statistic	P-value
Breusch–Pagan	1.94	0.164

The p-value of 0.164 is greater than 0.05, implying absence of heteroscedasticity.

This indicates that the variance of the residuals remained constant across observations.

4.5.7 Serial Correlation Test

The Durbin–Watson statistic was used to test for autocorrelation in the regression residuals.

Table 4.10: Durbin–Watson Test Results

Test	Statistic
Durbin–Watson	1.03

The Durbin–Watson statistic of 1.03 suggests mild positive autocorrelation in the residuals, which is common in time series data.

However, the autocorrelation was not sufficiently severe to invalidate the regression findings.

4.7 Discussion

4.8 Summary of Findings

This chapter presented the empirical findings of the study on electricity losses and firm performance in Uganda’s electricity distribution sector.

The descriptive statistics revealed that electricity losses remain relatively high and continue to affect operational efficiency within the distribution system.

Stationarity tests confirmed that the variables were suitable for time series regression analysis, while multicollinearity diagnostics showed no serious correlation problems among the explanatory variables.

The regression analysis established that electricity losses have a statistically significant negative effect on operational efficiency. Specifically, increased electricity losses reduce the proportion of purchased electricity converted into revenue-generating electricity sales.

The findings further showed that energy sales positively influence operational efficiency, while increasing energy purchases without sufficient infrastructure improvements may worsen inefficiencies.

Overall, the study findings confirm that reducing electricity losses is critical for improving operational efficiency, revenue generation, and firm performance in Uganda’s electricity distribution sector

CHAPTER FIVE: SUMMARY OF FINDINGS, CONCLUSIONS AND RECOMMENDATIONS

5.1 Summary of Findings

This study examined the impact of electricity losses on firm performance in Uganda's electricity distribution sector using quarterly secondary data obtained from Umeme Limited and Uganda Electricity Distribution Company Limited (UEDCL) for the period 2008–2025. The analysis employed descriptive statistics, stationarity tests, multicollinearity diagnostics, multiple regression analysis and post-estimation diagnostic tests to establish the relationship between electricity losses and firm performance. The findings are summarized as, according to the study objectives.

Findings from Descriptive Statistics

The descriptive statistics revealed that the average total energy purchased during the study period was approximately 961.45 million units, while the average energy sold was approximately 758.27 million units, resulting in average electricity losses of about 203.18 million units. Operational efficiency averaged 80.65%, indicating that approximately one-fifth of the electricity purchased was lost before it could be converted into revenue-generating sales. Furthermore, the large variation in electricity losses observed during the study period suggests that technical failures, electricity theft, illegal connections and network inefficiencies continue to affect the performance of electricity distribution companies. These findings demonstrate that electricity losses remain a persistent operational challenge in Uganda's electricity distribution sector.

Findings from Stationarity and Diagnostic Test

The Augmented Dickey-Fuller (ADF) tests indicated that all study variables were stationary at level, confirming that the variables were appropriate for time series regression analysis. The Variance Inflation Factor (VIF) values were all below the acceptable threshold of 10, indicating that multicollinearity was not a concern. The normality and heteroscedasticity tests further confirmed that the regression assumptions were satisfied, while the Durbin-Watson statistic suggested only mild positive autocorrelation, which did not materially affect the reliability of the estimated model. Overall, these diagnostic tests demonstrated that the econometric model used in the study was statistically reliable and appropriate for drawing valid conclusions.

Findings from Regression Analysis

The regression analysis established that electricity losses have a statistically significant negative effect on operational efficiency. Specifically, the estimated coefficient showed that a one percent increase in electricity losses reduces operational efficiency by approximately 3.6 percent, holding other factors constant. This finding implies that increasing electricity losses directly reduces the ability of electricity distribution companies to convert purchased electricity into billable sales.

Further analysis showed that energy purchases exhibited a statistically significant negative relationship with operational efficiency. This indicates that increasing electricity purchases without corresponding improvements in network infrastructure and operational management may increase inefficiencies within the distribution system.

Conversely, energy sales had a statistically significant positive effect on operational efficiency. The results suggest that improved billing systems, effective revenue collection, reduction of electricity theft and accurate metering contribute significantly to improved firm performance.

The regression model produced an R-squared value of 0.999, indicating that approximately 99.9 percent of the variation in operational efficiency was explained by the explanatory variables included in the model. The statistically significant F-statistic further confirmed that the model was appropriate for explaining firm performance in Uganda's electricity distribution sector.

5.2 Conclusions

Based on the empirical findings, the study concludes that electricity losses remain one of the most significant challenges affecting the operational and financial performance of electricity distribution companies in Uganda. The persistent difference between electricity purchased and electricity sold demonstrates that substantial quantities of electricity continue to be lost through both technical and non-technical causes. These losses reduce revenue generation and undermine the efficiency of electricity distribution firms.

The study further concludes that electricity losses have a statistically significant negative effect on operational efficiency. The regression analysis confirmed that increases in electricity losses significantly reduce the proportion of purchased electricity converted into revenue-generating

electricity sales. Consequently, electricity losses weaken firm performance by reducing productivity, increasing operational costs and limiting financial sustainability.

The findings also indicate that increasing energy purchases alone cannot improve firm performance unless investments are simultaneously made in distribution infrastructure, maintenance and network management. Without improvements in the distribution network, higher energy purchases are likely to increase the amount of electricity lost before it reaches consumers.

The study also concludes that increased energy sales significantly improve operational efficiency. This demonstrates that strengthening billing systems, expanding accurate metering, improving revenue collection and reducing electricity theft are essential for enhancing firm performance.

Finally, the diagnostic tests confirmed that the econometric model satisfied the major statistical assumptions required for reliable estimation. Therefore, the findings provide credible empirical evidence that reducing electricity losses is fundamental to improving operational efficiency, financial sustainability and service delivery within Uganda's electricity distribution sector.

5.3 Recommendations

The recommendations below are drawn directly from the empirical findings of the study and are intended to improve firm performance by reducing electricity losses within Uganda's electricity distribution sector.

Increase Investment in Modern Distribution Infrastructure

The study found that electricity losses significantly reduce operational efficiency. Therefore, electricity distribution companies should prioritize investment in modern transmission and distribution infrastructure by replacing ageing conductors, overloaded transformers and obsolete substations. Continuous investment in network expansion and rehabilitation will reduce technical losses and improve the efficiency of electricity distribution systems.

Strengthen Smart Metering and Billing Systems

Because improved energy sales were found to significantly enhance operational efficiency, electricity distribution companies should expand the installation of smart meters, replace defective meters and improve billing accuracy. Smart metering systems should be integrated with automated

billing platforms to minimize commercial losses, improve revenue collection and detect illegal electricity consumption at an early stage.

Strengthen Electricity Loss Monitoring Systems

The significant negative relationship between electricity losses and firm performance demonstrates the need for continuous monitoring of electricity flows across the distribution network. Distribution companies should establish real-time monitoring systems, digital fault detection technologies and automated energy auditing programmes to identify areas experiencing abnormal electricity losses and implement corrective measures promptly.5.3.4 Improve Preventive Maintenance Programmes

The variability observed in electricity losses indicates that infrastructure deterioration contributes to network inefficiency. Electricity distribution companies should strengthen preventive maintenance programmes by conducting regular inspections of transmission lines, transformers and substations. Routine maintenance will reduce equipment failures, improve system reliability and minimize technical losses.5.3.5 Intensify Measures Against Electricity Theft

Since non-technical losses remain a major contributor to electricity losses, electricity distribution companies should strengthen collaboration with regulatory agencies, law enforcement authorities and local communities to combat illegal electricity connections. Public awareness campaigns should be conducted to educate consumers on the financial and safety consequences of electricity theft while encouraging compliance with electricity regulations.

Promote Data-Driven Decision Making

Given the strong explanatory power of the regression model, electricity distribution companies should institutionalize the use of data analytics in operational decision-making. Predictive analytics, electricity demand forecasting and continuous monitoring of loss indicators should be incorporated into planning processes to support evidence-based investment decisions and improve operational efficiency.

Strengthen Regulatory Oversight and Performance Targets

The Electricity Regulatory Authority should continue strengthening regulatory oversight by enforcing realistic electricity loss reduction targets, conducting regular performance evaluations and promoting transparency within the electricity distribution sector. Incentive mechanisms should reward utilities that achieve sustained reductions in electricity losses while corrective measures should be implemented where performance consistently falls below regulatory standards.

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APPENDICES

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College of Business and Management Sciences (CoBAMS)
School of Statistics and Planning
Department of Planning & Applied Statistics

06th October, 2025



The Executive Director
Uganda Electricity Distribution Company Limited
Kampala, Uganda.

Dear Sir/Madam,

RE: REQUEST TO ALLOW MR. BBOSA JOSEPH KIYINGI ACCESS DATA

Mr. Bbosa is a Third Year student from School of Statistics and Planning, Makerere University pursuing a Bachelor of Science degree in **Quantitative Economics** under Reg. No. 23/U/07514/PS.

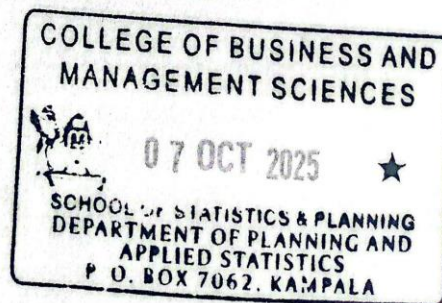
He is currently carrying out his research for his dissertation under a topic: **The Impact of electricity losses in the Uganda electricity distribution sector on service delivery.**

The purpose of this letter therefore, is to request you to grant him permission to access data related to his study.

Any assistance rendered to him will be highly appreciated and data collected will be used for the academic purposes only.

Yours Sincerely,

Asiimwe John Bosco (PhD)
Head, Department of Planning & Applied Statistics



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14th October 2025

Mr. Bbosa Joseph Kiyingi
Makerere University
College of Business and Management Sciences
School of Statistics and Planning

Dear Joseph,

RE: APPROVAL TO COLLECT DATA FROM UGANDA ELECTRICITY DISTRIBUTION COMPANY LIMITED (UEDCL)

Reference is made to your request dated **6th October 2025** seeking permission to collect data from Uganda Electricity Distribution Company Limited (UEDCL) in partial fulfillment of the requirements for the award of a **Bachelor of Science Degree in Quantitative Economics** at Makerere University.

We are pleased to inform you that your request has been **approved**. You are therefore authorized to collect the necessary data related to your research topic titled *"The Impact of Electricity Losses in the Uganda Electricity Distribution Sector on Service Delivery."*

Please note that the information and data accessed during the study should be used **strictly for academic purposes** and handled with the **utmost confidentiality** in line with UEDCL's data protection and confidentiality policies.

You are further advised to liaise with the respective Department Heads for guidance on accessing relevant information and coordinating with the appropriate departments.

We wish you success in your research exercise.

Sincerely,

Beatrice Tumuhirwe
Manager Human Resource Business Partner
Uganda Electricity Distribution Company Limited (UEDCL)



Cc: Research file