TECHNO-ECONOMIC ASSESSMENT OF ENERGY LOSSES AND UNSERVED ENERGY IN A TYPICAL 11KV DISTRIBUTION FEEDER

(A CASE STUDY OF GRA 11KV DISTRIBUTION FEEDER)

BY

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UNIVERSITY OF BENIN

DECEMBER, 2025

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BEING A PROJECT SUBMITTED TO THE DEPARTMENT OF ELECTRICAL/ELECTRONICS ENGINEERING

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CERTIFICATION

This is to certify that this research work titled "TECHNO-ECONOMIC ANALYSIS OF ENERGY LOSSES AND UNSERVED ENERGY IN A TYPICAL 11KV DISTRIBUTION FEEDER (A CASE STUDY OF GRA 11KV DISTRIBUTION FEEDER)" was carried out by Godwin Effiong Usanga in the Department of Electrical/Electronics Engineering, University of Benin.

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Engr. Dr. Omorogiuwa Samuel **Date**

Head of Department

DEDICATION

I dedicate this project to the Almighty God, in profound gratitude for the abundant grace and guidance granted to me throughout this entire process.

ACKNOWLEDGEMENT

I sincerely thank Almighty God, without whose grace and guidance this project would not have been possible.

My heartfelt appreciation also goes to my family for their unwavering support and encouragement throughout this work.

I am deeply grateful to my understanding supervisor, Engr. (Prof.) S. O. Onohaebi, for his constructive criticism, guidance, and continuous support.

My appreciation also extends to our Head of Department, Engr. Dr. Omorogiuwa Samuel, and to all others who, in one way or the other, made valuable contributions to the successful completion of this project.

ABSTRACT

This project evaluates the techno-economic impact of energy losses and unserved energy on a typical 11kV distribution feeder, using the GRA feeder as a case study. Data were collected over one month from the GRA 33/11kV injection substation and the Transmission Company of Nigeria (TCN), then analyzed and simulated in PSS/E to estimate technical losses and voltage profiles.

The study found that active power losses of 277.72 kW (equivalent to 277.72 kWh per hour) significantly contribute to network inefficiencies. When converted to monetary value using current tariff structures, these losses result in substantial financial costs across all customer bands, with Band A alone exceeding ₦1.39 million daily if sustained.

Overall, the findings show that even moderate technical losses and outages can lead to significant financial burdens. This underscores the importance of improving network efficiency and reliability to reduce energy losses and minimize the economic impact of unserved energy.

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LIST OF ABBREVIATIONS

AC	Alternating Current
BEDC	Benin Electricity Distribution Company
DISCOs	Distribution Companies
DSO	Distribution System Operator
PSS/E	Power System Simulator for Engineering
kW	Real Power
kVAr	Reactive Power
KVA	Kilo-Volt-Ampere
TCN	Transmission Company of Nigeria
ATC&C	Aggregate Technical Commercial and Collection Losses
ENS	Energy Not Served
EUE	Expected Unserved Energy
VoLL	Value of Lost Load
OPF	Optimal Power Flow
API	Application Programming Interface
MWT	Model Writing Tool
AVR	Automatic voltage Regulator
NERC	Nigerian Electricity Regulatory Commission
IBRs	Inverter Based Resources
HT	High Tension
LT	Low Tension

LIST OF NOTATIONS

Ω	Ohms
p.u	Per Unit
$C_{P_{loss}}$	Cost of simulated active power loss
P_{loss}	Active power loss (kW) for the network,
c	Average prevailing unit energy cost
T	Time
D	Downtime of feeder,
H	Time in (The time of day at which the feeder was restored)

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CHAPTER ONE

INTRODUCTION

1.1 Background of Study

Nigeria’s power distribution system continues to face critical challenges stemming from technical losses, inadequate infrastructure, and frequent outages (Adeyemi-Kayode et al., 2022). These issues are especially severe at the 11kV distribution level, where load centers are often far from injection substations, and feeder lines are overloaded or poorly maintained. Consequently, significant amounts of generated electricity are lost before reaching end users, leading to reduced supply reliability, higher operating costs, and economic inefficiencies (Okundamiya and Omorogiuwa, 2017).

Furthermore, power outages are common and prolonged, resulting in unserved energy that negatively impacts residential, commercial, and industrial consumers. A detailed and feeder-specific techno-economic analysis is essential to quantify these inefficiencies and propose informed solutions tailored to Nigeria's electricity distribution realities.

1.2 Problem Statement

Nigeria's electric power distribution sector is characterized by persistent challenges that hinder efficient service delivery and economic growth. Among the most critical issues are high technical losses and frequent power outages along the distribution feeders, particularly at the 11kV level, where aging infrastructure, poorly maintained lines, and suboptimal feeder configurations are prevalent (Egwaile et al., 2019). Technical losses occur due to energy dissipation in electrical components such as conductors and transformers and are often intensified by unbalanced phase loads, long feeder lines, and overloaded equipment. These losses reduce the amount of electricity that reaches end-users and increase operational costs for distribution companies (DisCos), which already struggle with revenue shortfalls and high aggregate technical, commercial, and collection (ATC&C) losses (Uchechukwu and Ephraim, 2021).

Equally concerning is the issue of unserved energy, which results from prolonged or frequent feeder outages due to equipment failures, load shedding, or poor fault response mechanisms. These outages affect residential, commercial, and industrial consumers alike, disrupting daily life, economic activities, and the productivity of small and large enterprises. The financial impact of these outages is rarely quantified, leading to an underestimation of the economic burden imposed on consumers and the national economy (Akomolafe, 2024).

Despite the critical nature of both technical losses and outage-related energy deficits, Nigerian utilities often treat these problems in isolation. There is a lack of integrated analytical frameworks that jointly evaluate the technical and economic dimensions of these inefficiencies on specific feeders. Without such a comprehensive assessment, it is difficult for decision-makers to prioritize investments, implement targeted upgrades, or justify expenditure on loss reduction strategies and reliability improvement programs.

This study, therefore, addresses this gap by combining load flow analysis to estimate technical energy losses with outage data analysis to compute unserved energy. It further translates both inefficiencies into economic terms, thereby providing actionable insights that support better planning, budgeting, and policy-making within Nigeria's distribution sector. The GRA 11/0.415 kV power distribution is used as the case study for the radial distribution feeder.

1.3 Aim and Objectives

This research aims to carry out a comprehensive techno-economic assessment of technical energy losses and unserved energy on the GRA 11kV distribution feeder.

The objectives that would be deployed to achieve the above aim are;

i. To carry out an extensive study of the distribution network and collection of the base data of the distribution network under study.
ii. To perform a load flow analysis to estimate technical losses on the selected 11kV feeder.
iii. To calculate the economic cost of these losses over a given period.
iv. To analyze the frequency and duration of outages on the feeder.
v. To estimate unserved energy due to outages and its economic impact.
vi. To recommend strategies for reducing both losses and outage-related downtimes.

1.4 Methodology

i. Collect feeder data: single-line diagram, load data, transformer ratings, and line data outage logs.
ii. Simulate load flow using PSS/E and extract total technical losses and voltage profiles.
iii. Calculation of the financial implications of the recorded losses based on the current average tariff system for associated customers.
iv. Discussion of the frequency and duration of outages on the feeder under study and the possible causes or categories of outages.
v. Analyze outage logs to compute unserved energy: ENS = Average Load (kW) × Outage Durations (hours). Then evaluate the economic implications of the ENS using the average tariff rate.
vi. Suggest improvement measures to improve the overall feeder and reduce outages and downtime.

1.5 Scope of the Study

The scope of this study is limited to the GRA 11kV distribution feeder. The study will focus on estimating technical energy losses through load flow simulations, quantifying unserved energy due to outages, and analyzing the economic implications of both. It will not address non-technical losses such as energy theft or billing inefficiencies, although comparisons may be drawn where relevant.

1.6 Significance of The Study

This study will provide empirical insights into the actual extent of losses and outage-related downtimes within Nigeria's distribution network. By translating these inefficiencies into monetary terms, the study will enable utilities, policy makers, and investors to prioritize technical interventions and justify funding for network upgrades. Moreover, the findings will support better planning strategies aimed at improving energy reliability, enhancing operational efficiency, and reducing financial losses due to inefficiencies.

1.7 Structural Outline

This research work will proceed as follows:

- Chapter two (Literature review):

  Here, past related work (s) related to this current research work will be examined. Also, the gra 33/11kV injection substation will be discussed.

- Chapter three (Methodology):

  In this section, data obtained from the GRA 33/11 kV Injection Substation and the Transmission Company of Nigeria (TCN) will be presented. The simulated data include parameters such as line resistance, line reactance, voltage profile, estimated energy loss values, and the outage log record for June 2025. Furthermore, the financial implications of the simulated energy losses and unserved energy resulting from feeder outages will be evaluated using the prevailing tariff rates.

- Chapter four (Discussion of results):

  This chapter focuses on discussing the financial implications of the simulated energy losses and unserved energy, as well as their impact on both the utility and consumers. Additionally, it explores possible strategies for mitigating these energy losses and improving overall system efficiency.

- Chapter Five (Conclusion and Recommendation):

  Here, a summary of the work and possible recommendations on how to mitigate technical losses will be given.

CHAPTER TWO

2.1 Overview of Benin Electricity Plc. (BEDC)

BEDC Electricity Plc. (BEDC) is one of the successor Distribution companies (Discos) created following the unbundling and privatization of the state-owned Power Utility, Power Holding Company of Nigeria Plc. BEDC is responsible for the retail distribution of electricity in Delta, Edo, Ekiti, and Ondo States, covering a geographical area of 57,353 square kilometres. The company operates from nine (9) regional districts, twenty-nine (29) business units with approximately 350 offices located across four (4) states with about 18 million people, about 4 million households. (www.beninelectric.com)

2.1.1 Overview of GRA 33/11kV Injection Substation

The GRA 33/11kV Injection Substation is situated along High Court Road, adjacent to the EFCC office, off Central Road, in Benin City, Edo State. It receives its electrical supply via the GRA 33kV feeder, which originates from the 330/132/33kV transmission substation located along Benin-Sapele Road, Benin City.

This injection substation is equipped with two (2) 15 MVA power transformers and serves four (4) 11kV outgoing feeders, namely:

- Airport Road Commercial
- Gra 11kV Feeder
- Oba Palace Feeder
- Reservation Feeder

Transformer T1 supplies power to the Airport Road Commercial and Gra 11kV feeders, while Transformer T2 is connected to the Oba Palace and Reservation feeders.

All transformers and feeders are fitted with corresponding protection relays and current transformers (CTs) for metering and protective functions. The CTs are rated at 600/1 A, and the voltage transformers (VTs) are rated at 33,000/330V.

Below is a picture of the Gra 33/11kV substation.

Fig 2.1: Picture showing the GRA 33/11kV Injection Substation

2.1.2 Description of The Case Study Feeder (GRA 11kv Feeder) And Associated Data Collected

The GRA 11kV feeder is tied to the GRA injection substation. The substation is fed from the GRA 33kV feeder. The GRA 11kV feeder has a total length of 11.9km.

The GRA 11kV feeder is made up of 50 active distribution transformers in circuit. The table below outlines all active distribution transformers in-circuit, their associated transformer ratings, current, transformer status, and load profile of each transformer under the GRA 11kV feeder.

Bus No	Name of Substation	Transformer Rating (KVA)	Transformer Status	Population
1	Owena River Basin	300	In Circuit	6
2	SSS	200	In Circuit	1
3	Police Comms	300	In Circuit	3
4	CEO	200	In Circuit	8
5	SCID1	50	In Circuit	3
6	SCID2	300	In Circuit	10
7	Alonge	200	In Circuit	10
8	Presidential Lodge	300	In Circuit	1
9	A&K	200	In Circuit	1
10	Deputy governor	300	In Circuit	2
11	Crown Estate	200	In Circuit	12
12	Folake Oke	500	In Circuit	1
13	Iruasa	500	In Circuit	15
14	Okorontun2	300	In Circuit	2
15	Afe Miracle	500	In Circuit	66
16	Okorontun3	300	In Circuit	13
17	Okorontun1	300	In Circuit	7
18	Aehomire	100	In Circuit	1
19	Aiguobasimwin2	500	In Circuit	18
20	Customary Court	300	In Circuit	1
21	Gregory Uansery	200	In Circuit	1
22	Aiguobasimwin1	300	In Circuit	15
23	Tony Uwaifor	100	In Circuit	1
24	Tony Anenih	300	In Circuit	10
25	Delta Crescent	300	In Circuit	9
26	St. Mary Dedication Sch.	300	In Circuit	1
27	Govt. Laundry	200	In Circuit	7
28	Market Square	300	In Circuit	1

29	Leventis	500	In Circuit	15
30	Emporium	200	In Circuit	1
31	JBS2	500	In Circuit	10
32	JBS1	100	In Circuit	37
33	Aimure	500	In Circuit	30
34	Chris Ogiemwonyi	100	In Circuit	1
35	New Langer Hotel	500	In Circuit	17
36	Imuetiyan1	500	In Circuit	20
37	Odubu	50	In Circuit	3
38	Imuetiyan2	300	In Circuit	14
39	Ogbomoatu	500	In Circuit	29
40	Okonga	500	In Circuit	33
41	Godwin Omonuwa	500	In Circuit	63
42	Gen. Charles Airewele	200	In Circuit	1
43	Obasogie2	50	In Circuit	3
44	E-Jerry	50	In Circuit	2
45	NOA	300	In Circuit	1
46	Oni-Okpaku	500	In Circuit	21
47	Ishegie	100	In Circuit	1
48	Zain mast	50	In Circuit	1
49	Adun Close	200	In Circuit	2
50	Obasogie1	50	In Circuit	4

Table 2.1: Table showing all Distribution Transformers and Population under GRA 11KV Feeder

The GRA 11kV feeder radiates from the GRA 33/11kV injection substation, and it feeds a total of 535 customers within the GRA metropolis. This feeder has a previous monthly average consumption of 927.2502 kW. This feeder experiences characteristics common to other feeders in Nigeria, including potential technical issues like voltage fluctuations and power losses due to aged infrastructure, vegetation, and undersized components.

2.2 Understanding Energy Losses and Unserved Energy in Nigeria’s Grid

Most, if not all, input-output systems have losses, where some of the inputs are lost in conversion and do not come out as output. Electric power systems are not an exception, as losses are inherent in the electricity value chain. Energy is lost during the transportation of electricity from generation through transmission to distribution.

Losses in power systems can be either technical or non-technical. Technical losses occur due to the design and the state of the physical infrastructure used to generate, transmit, and distribute electricity. Unlike their technical counterparts, non-technical losses are not a result of the design and operating characteristics of the system's components. Instead, non-technical losses are usually caused by deliberate human actions or errors. (The Effect of Technical, Commercial and Collection Losses on Electricity Supply, 2020)

i. Technical Losses

Energy is lost in generation, transmission, and distribution due to equipment inefficiencies, including heat dissipation, aging infrastructure, and poor maintenance. (The Effect of Technical, Commercial and Collection Losses on Electricity Supply, 2020)

In Nigeria’s distribution networks, technical losses alone were measured to be 12% in 2014 Science and Education Publishing.

Losses occur in distribution systems as energy moves through the various equipment that make up the network. These losses are attributed to the physical characteristics of distribution lines, transformers, and other components within the distribution system. They occur as heat dissipates from transformers when voltage is stepped down from one level to another. Losses also occur in distribution lines and other apparatuses due to heating and other physical phenomena.

Technical losses cannot be eliminated, but can be controlled and minimized. They are usually worsened by poor maintenance, ageing equipment, poor planning and design, poor operational practices, overloading of lines and transformers, and use of sub-standard equipment. Consequently, adequate distribution planning and design, coupled with efficient operation and maintenance practices, help in reducing technical losses. (The Effect of Technical, Commercial and Collection Losses on Electricity Supply, 2020)

ii. Commercial (Non-Technical) Losses

These losses occur when energy delivered is not billed due to meter tampering, bypass, unmetered connections, inaccurate billing, or energy theft. (The Effect of Technical, Commercial and Collection Losses on Electricity Supply, 2020)

Some regions record commercial losses as high as 34%, with aggregated ATC&C losses reaching up to 60% in extreme cases. (Mitigating Electricity Theft in Nigeria, 2018)

iii. Collection Losses

This type of loss occurs when the billed amount is not collected. In 2019, the average collection loss was 32.2% as DisCos struggled to collect payments from consumers (The Effect of Technical, Commercial and Collection Losses on Electricity Supply, 2020).

By December 2024, overall collection efficiency had dropped to only 74.7%, meaning that a quarter of billed revenue remained unrealized. (Lucas, 2025)

2.2.1 Aggregate ATC&C Losses—The Big Picture

- ATC&C losses combine technical, commercial, and collection inefficiencies.
- As of Q3 2024, DisCos averaged around 39.1% ATC&C losses. (Jeremiah, 2025).
- Disco’s performance remains weak—e.g., Abuja at 38.5% (vs. the target of 25%) and Kaduna at 66.5% showcasing a sector-wide challenge (Jeremiah, 2025).

The diagram below illustrates the measurement and topology of ATC&C (Aggregate Technical, Commercial & Collection) losses.

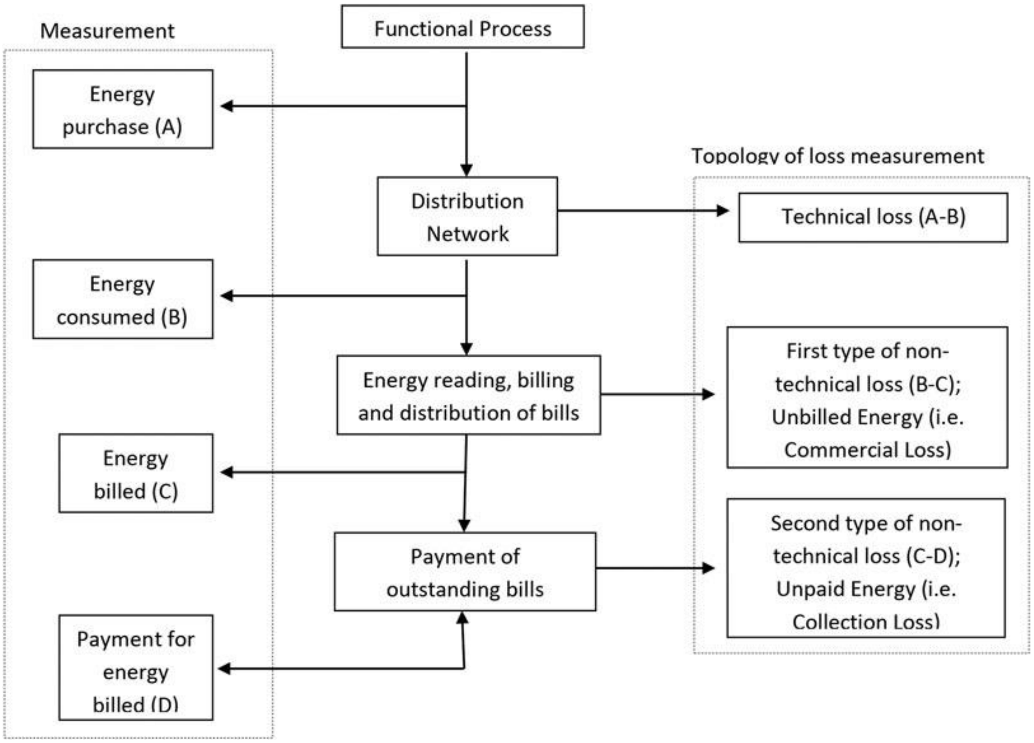


Fig 2.2: A block diagram illustrating the measurement and topology of ATC&C (Aggregate Technical, Commercial & Collection) losses

2.2.2 Economic and Operational Impacts on Utilities (DISCOS, GENCOS, TCN)

i. Revenue Shortfalls:

Reduced billing and collection undermine financial viability, preventing timely remittances to GenCos and the Transmission Company (TCN) (The Effect of Technical, Commercial and Collection Losses on Electricity Supply, 2020)

ii. Debt & Subsidies:

The sector has incurred a massive debt of over ₦7.2 trillion, some of which is passed on to consumers in the form of subsidies and recovery charges (Jeremiah, 2025)

iii. Receiverships & Financial Crisis:

Amid a ₦2 trillion shortfall, key firms like Ikeja Electric and KEPCO’s Egbin are under court receivership, signaling deep-sector distress. (Anyaogu, 2025)

iv. Structural Strain:

Aging infrastructure and vandalism exacerbate technical losses, grid collapses (160+ since 2013), and economic losses pegged at $29 billion annually (Jeremiah, 2025)

2.2.3 Economic and Operational Impacts on Customers

i. Higher Electricity Tariffs:

Consumers shoulder the cost of unrecovered losses—every ₦100 energy supply loses about ₦40 to ATC&C inefficiencies (Jeremiah, 2025)

ii. Unreliable Supply & Outages:

Frequent blackouts force reliance on diesel, generators, or other costly backup power solutions (Anyaogu, 2025)

iii. Billing Disputes & Consumer Distrust:

Estimated billing (due to lack of meters) leads to overpaying and undermines trust in the sector (Anyaogu, 2025)

2.2.4 Expected Unserved Energy (EUE) – A Critical Gap

While specific EUE figures for Nigeria are limited, the following illustrates the impact:

Installed vs. Delivered Capacity: Nigeria's generation capacity stands around 13,300 MW (net approximately 11,800 MW), but only about one-third of that is actually delivered due to losses and inefficiencies (Anyaogu, 2025)

Economic Strain: Unserved energy throttles industry growth, discourages investment, and stalls development.

2.2.5 Measures Toward Improvement

- Metering Acceleration

Nigeria plans to procure 3.5 million meters by the end of 2025, and finance up to 10 million over 5 years (approximately $946M) to close the metering gap (Anyaogu, 2025).

- Smart Meter Deployment

Scaling up smart metering can significantly reduce ATC&C losses, for example, a 25% increase in metered customers yields approximately a 20% reduction in losses (The Effect of Technical, Commercial and Collection Losses on Electricity Supply, 2020).

- Infrastructure and System Upgrades

Upgrading network design, transformers, conductors, and deploying HVDS and smart grid technologies can reduce technical losses (The Effect of Technical, Commercial and Collection Losses on Electricity Supply, 2020).

- Decentralization & Mini-Grids

Developing localized solar or mini-grid solutions can provide resilience and EUE relief, particularly in rural areas (Anyaogu, 2025)

2.3 Power System Simulator for Engineering (PSS/E)

Power System Simulator for Engineering (PSS/E) is a software tool used by power system engineers to simulate electrical power transmission networks in steady-state conditions as well as over timescales of a few seconds to tens of seconds. It is a high-performance power system simulation software developed by Siemens PTI, used globally for the analysis and planning of electrical transmission networks. It enables engineers to model, simulate, and analyze electric power grids with a high level of detail and accuracy.

Since its introduction in 1976, it has evolved from a simple command-line interface to an integrated, interactive program for simulating, analyzing, and optimizing power system performance, and it can provide probabilistic and dynamic modeling features.

Core Capabilities:

- Load Flow (Power Flow) Analysis – to calculate voltage magnitudes, power flows, and losses across the network.
- Short Circuit Analysis – to determine fault currents and assist in protection coordination.
- Dynamic Simulation – to model system behavior over time during disturbances (transient stability, etc.).
- Optimal Power Flow (OPF) – for economic dispatch, loss minimization, etc.
- Contingency Analysis (N-1, N-2) – to identify system vulnerabilities if a component fails.
- Voltage Stability and Transfer Limit Studies
- Automation/Scripting – using Python APIs or PSS/E's own scripting language (PSS/E Command Language and Python API).

Advantages of PSS/E for Simulation and Modeling

1. Comprehensive Simulation Capabilities
   - Supports steady-state (load flow), dynamic (transient), and short-circuit analysis.
   - Enables contingency studies, voltage stability, and optimal power flow (OPF).
   - Used for both planning and operational analysis.
2. High Accuracy and Reliability
   - Trusted by utilities worldwide for mission-critical studies.
   - Proven track record in producing credible and regulatory-compliant results.
   - Capable of modeling large, complex power systems with thousands of buses.
3. Powerful Modeling Tools
   - Extensive library of component models (generators, transformers, FACTS, loads, renewables, etc.).
   - Support for user-defined dynamic models using the Model Writing Tool (MWT).
   - Models real-world control systems like AVRs, governors, stabilizers, and inverter controllers.
4. Automation and Customization with Python API
   - Full support for Python scripting: automate repetitive tasks, build custom tools, batch simulations, etc.
   - Enables integration with data analytics, dashboards, and custom interfaces.
   - Reduces manual errors and increases productivity for bulk studies.
5. Flexible Data Management
   - Supports multiple data formats: .sav,.raw,.dyr,.idv,.py, etc.
   - Easy to import/export models and results.
   - Integration with external databases and Excel for data manipulation.
6. Visualization and Reporting
   - Built-in visualization tools for: One-line diagrams, Voltage and power flow profiles.
   - Time-domain plots for dynamic results.
   - Generates detailed and customizable reports.
7. Industry Standard Tool
   - Recognized globally as a benchmark for transmission system studies.
   - Compatible with regulatory requirements (e.g., NERC in North America, ENTSO-E in Europe).

  - Used in grid codes, interconnection approvals, and reliability assessments.

8. Renewable and DER Integration
    - Supports modeling of inverter-based resources (IBRs) like solar PV and wind.
    - Includes grid-following and grid-forming inverter models.
    - Allows accurate dynamic simulation of renewables under grid disturbances.
9. Scalability
    - Scales from small microgrids to national transmission systems.
    - Efficient memory and performance handling for large datasets and long simulations.
10. Scenario Analysis and “What-If” Studies
    - Quickly modify system conditions to test different planning or operational scenarios.
    - Supports seasonal, hourly, and event-driven scenario studies.

2.4 Previous Related Work

Some studies have been carried out with respect to dampening of technical losses in electricity networks. (Odiase & Agbonaye, 2017) were able to achieve technical losses minimization within a network by improving the power factor.

(Mufutau, W. O; Jokojeje, R. A.; Idowu, O. A.; Sodunke, M. A., 2015) carried out technical losses evaluation of eight feeders within a DisCo and found out that a particular feeder had the highest amount of the said losses due to the feeder span and unauthorized connection by energy consumers, and suggested the creation of new substations and routine maintenance as a means of curbing the losses. (Anumaka, 2012) presented various mathematical approaches to determining technical losses, while (Audu, Musa, Ba'ams, & Dubukumah, 2019) and (Uchechukwu & Ephraim, 2021) both utilized specific approaches for technical losses estimation. (Obi, Amako, & Ezeonye, 2022) carried out a financial assessment of technical losses in the Southeast part of Nigeria and thereafter suggested that capacitor banks be installed in substations for improved profit realization. (Amadi, Okafor, & Izuegbunam, 2016) and (Egwaile, Ogbeide, & Osahenvemwen, 2018) both looked at the cost effects of technical losses in the distribution networks of various DisCOs and suggested corresponding mitigative measures.

Furthermore, (Anyanor, Atuchukwu, & Okonkwo, 2020) presented mitigation of technical losses in transmission networks. The reviewed works presented only specific solutions to technical losses tailored only for specific situations but in this study, the various causes of technical losses will be harmonized and presented as well as practicable solutions will be proposed.

Technical losses are losses that result from energy dispersed in conductors, equipment utilized for distribution line, transmission line, sub-transmission line, and magnetic losses in transformers. They are generally 22.5 per cent, and depend on the network features and the style of operation. The secondary and primary distribution lines are where the bulk of the losses occur in a typical power system. Whereas transmission and sub-transmission lines make for about 30 per cent of the total losses only (Electrical India. (n.d). Losses in Distribution & Transmission Lines., 2024). They are also known as 'Physical losses' as they denote energy transformed to noise and heat while distributing electricity and thus, are lost physically. This energy discharge leads to carbon emissions and costs end-users of electricity money. This loss type is induced due to the physical features of electrical equipment utilized in distribution networks. They rely on the electrical grid's design, power line length, transformation levels, and voltage. Furthermore, they relate to long-term signals (a tradeoff between investment costs and

operational expenditure) and investment in equipment
(Transformers, lines). They are also associated with the design and efficient planning of distribution networks. (CIRED, 2024).

CHAPTER THREE

3.1 METHODOLOGY

This chapter details the materials and methodologies employed to accomplish the research objectives. It systematically outlines the resources utilized, followed by a step-by-step discussion of the analytical approaches adopted. The methodology covers an extensive study of the GRA 11/0.415 kV distribution feeder and the collection of its base data, the performance of load flow analysis to estimate technical losses, the calculation of the economic cost of these losses over a specified period, the analysis of outage frequency and duration, and the estimation of unserved energy and its economic impact. Finally, strategies for minimizing both technical losses and outage-related downtimes are proposed. Figure 3.1 is a flow chart of the method employed in the study

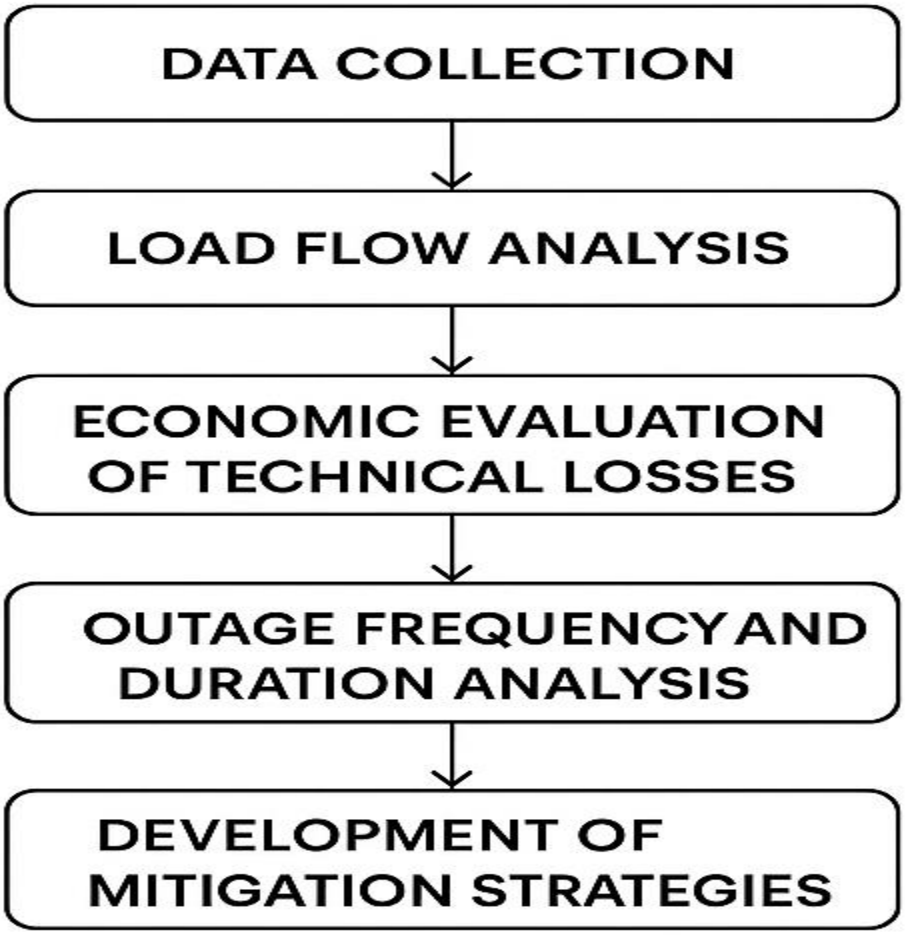


Figure 3.1: Flow chart of the method deployed

3.2 Study Area and Data Collection

An extensive study of the GRA 11/0.415 kV distribution feeder was conducted to obtain a comprehensive understanding of its operating characteristics. The GRA 11/0.415 kV feeder examined in this study supplies electricity to a mix of residential and public consumers. It extends over a total route length of approximately 11.41 km and comprises about fifty (50) distribution substations.

For the load flow analysis, the route lengths of the various substations were combined with the resistance and reactance values of the different cable sizes presented in Table 3.1 to determine the corresponding per-unit (p.u.) line resistance and reactance. Expressing network parameters such as resistance and reactance in per-unit form is standard practice because it normalizes these values relative to a base quantity, enabling consistent comparison and analysis across systems of varying capacities.

Table 3.1: Cable size and associated parameters

Feeder	**Conductor size**	**Resistance (Ω/km)**	**Reactance (Ω /km)**	**Impedance (Ω /km)**
GRA 11kV	150mm2	0.2468	0.3016	0.3897

The line data include the resistance and reactance associated with each feeder bus connection. These values, originally in ohms (Ω), were converted to per-unit by dividing them by the base impedance. The complete network line diagram for the GRA 11/0.415 kV feeder is as shown in Figure 3.2, while Table 3.3 shows the bus and line arrangement of the feeder.

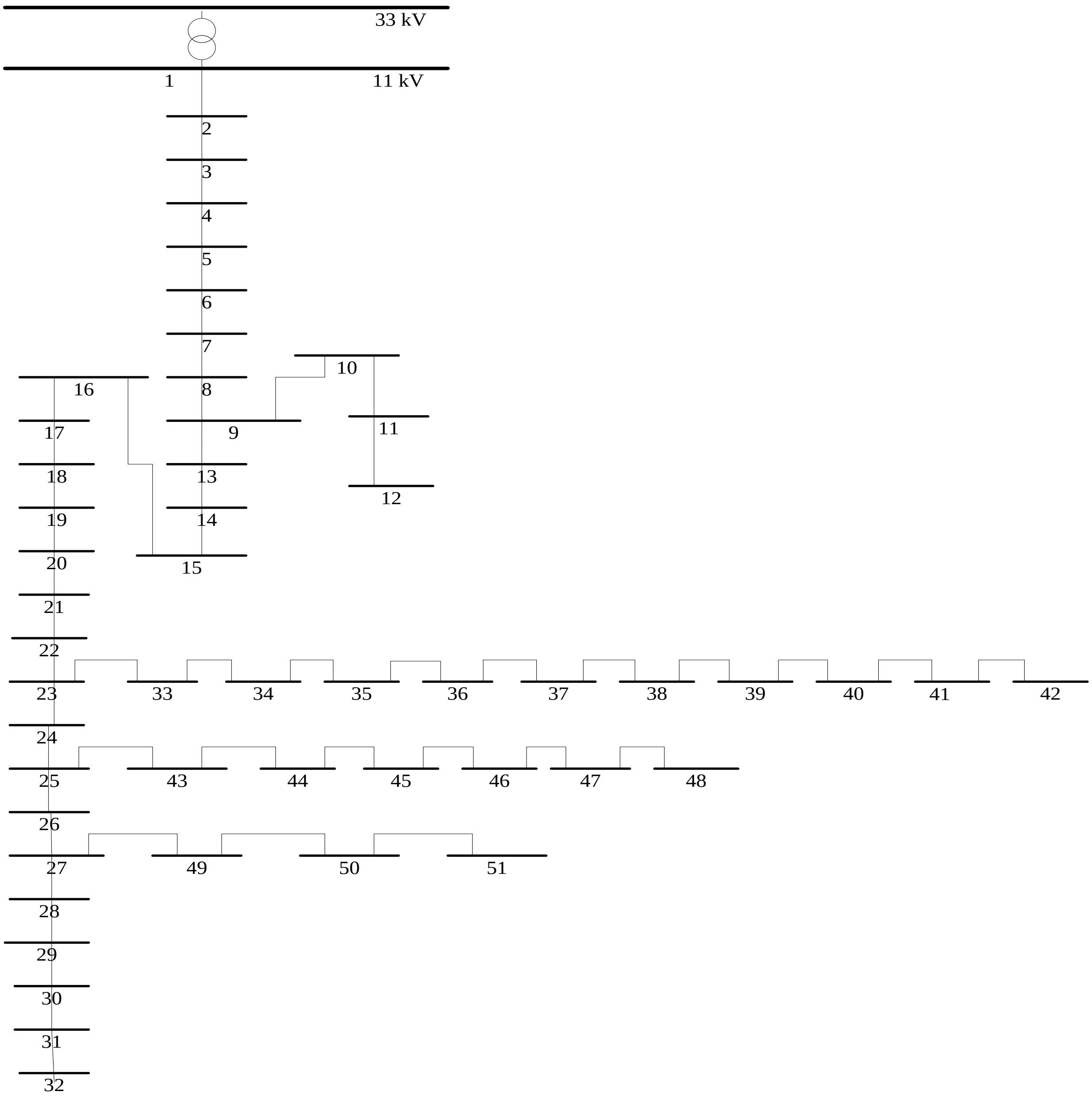


Figure 3.2: Single Line diagram of GRA 11KV Feeder

Table 3.3: Bus and line arrangement of the feeder

GRA feeder with bus and line arrangement				
S/No.	**Bus Name**	**From Bus**	**To Bus**	**Line No.**
1	Slack Bus	1		
2	Owena River Basin	1	2	1
3	SSS	2	3	2
4	Police Comms	3	4	3
5	CEO	4	5	4
6	SCID1	5	6	5
7	SCID2	6	7	6
8	Alonge	7	8	7
9	Presidential Lodge	8	9	8
10	A&K	9	10	9
11	Deputy governor	10	11	10
12	Crown Estate	11	12	11
13	Folake Oke	9	13	12
14	Iruasa	13	14	13
15	Okorontun2	14	15	14
16	Afe Miracle	15	16	15
17	Okorontun3	16	17	16
18	Okorontun1	17	18	17
19	Aehomire	18	19	18
20	Aiguobasimwin2	19	20	19
21	Customary Court	20	21	20
22	Gregory Uansery	21	22	21
23	Aiguobasimwin1	22	23	22
24	Tony Uwaifor	23	24	23
25	Tony Anenih	24	25	24
26	Delta Crescent	25	26	25
27	St. Mary Dedication Sch.	26	27	26
28	Govt. Laundry	27	28	27
29	Market Square	28	29	28
30	Leventis	29	30	29
31	Emporium	30	31	30
32	JBS2	31	32	31

33	JBS1	23	33	32
34	Aimure	33	34	33
35	Chris Ogiemwonyi	34	35	34
36	New Langer Hotel	35	36	35
37	Imuetiyan1	36	37	36
38	Odubu	37	38	37
39	Imuetiyan2	38	39	38
40	Ogbomoatu	39	40	39
41	Okonga	40	41	40
42	Godwin Omonuwa	41	42	41
43	Gen. Charles Airewele	33	43	42
44	Obasogie2	43	44	43
45	E-Jerry	44	45	44
46	NOA	45	46	45
47	Oni-Okpaku	46	47	46
48	Ishegie	47	48	47
49	Zain mast	43	49	48
50	Adun Close	49	50	49
51	Obasogie1	50	51	50
Note: Slack bus assumed bus number 1				

Shown in Table 3.4 is the line data of the GRA 11kv feeder.

Line Data for the 11 kV Feeder			
From Bus	**To Bus**	**X (pu)**	**R(pu)**
1	2	0.1839	0.1505
2	3	0.4081	0.3339
3	4	0.1489	0.1218
4	5	0.2942	0.2408
5	6	0.2662	0.2178
6	7	0.2645	0.2164
7	8	0.8530	0.6980
8	9	0.6078	0.4973
9	10	0.4484	0.3669
10	11	0.3608	0.2952
11	12	0.3906	0.3196

9	13	0.1909	0.1562
13	14	0.3433	0.2809
14	15	0.8687	0.7109
15	16	0.6939	0.5676
16	17	0.4309	0.3526
17	18	0.6515	0.5332
18	19	0.4168	0.3411
19	20	0.8354	0.6836
20	21	0.2575	0.2107
21	22	0.1786	0.1462
22	23	0.2312	0.1892
23	24	0.4274	0.3497
24	25	0.8635	0.7066
25	26	0.3678	0.301
26	27	0.5237	0.4285
27	28	0.5324	0.4357
28	29	0.2049	0.1677
29	30	0.2259	0.1849
30	31	0.4816	0.3941
31	32	0.4326	0.354
23	33	0.5657	0.4629
33	34	0.3223	0.2637
34	35	0.4746	0.3884
35	36	0.5815	0.4758
36	37	0.4676	0.3827
37	38	0.4309	0.3526
38	39	0.3065	0.2508
39	40	0.4852	0.397
40	41	0.5762	0.4715
41	42	0.5202	0.4257
33	43	0.2872	0.235
43	44	0.1699	0.139
44	45	0.1997	0.1634
45	46	0.7461	0.6106
46	47	0.4781	0.3913
47	48	0.2067	0.1691
43	49	0.4239	0.3468
49	50	0.4203	0.344

50	51	0.1594	0.1304

Table 3.4: Line data of the GRA 11kV feeder

Data collected included the capacities of the various transformers, the daily peak load demand at each load bus or substation over 30 days in June 2025, and other relevant information on the associated feeders obtained from the Distribution System Operator (DSO). From these time-based measurements, the average load was determined and adopted as the base load for the GRA 11/0.415 kV feeder. This radially connected feeder has a total load demand of 9864.35 KW and 3490.78 KVAr.

Table 3.5: Network load demand

Bus No	**Name of Substation**	**Transformer Rating (KVA)**	**Route Length (km)**	**Real Power (P) (kW)**	**Reactive Power (Q) (kVar)**
1	Owena River Basin	300	0.105	340.88	89.32
2	SSS	200	0.233	184.14	46.84
3	Police Comms	300	0.085	125.65	48.04
4	CEO	200	0.168	188.17	104.68
5	SCID1	50	0.152	31.97	14.16
6	SCID2	300	0.151	260.37	64.7
7	Alonge	200	0.487	105.9	30.04
8	Presidential Lodge	300	0.347	181.79	66.49
9	A&K	200	0.256	223.96	53.94
10	Deputy governor	300	0.206	230.7	78.57
11	Crown Estate	200	0.223	164.54	73.67
12	Folake Oke	500	0.109	312.65	133.86
13	Iruasa	500	0.196	303.15	177.35
14	Okorontun2	300	0.496	338.68	79.05
15	Afe Miracle	500	0.396	122.32	73.64
16	Okorontun3	300	0.246	293.43	112
17	Okorontun1	300	0.372	221.92	58.27
18	Aehomire	100	0.238	66.32	34.04

19	Aiguobasimwin2	500	0.477	210.4	86.36
20	Customary Court	300	0.147	292.8	127.52
21	Gregory Uansery	200	0.102	130.25	50.75
22	Aiguobasimwin1	300	0.132	367.31	153.34
23	Tony Uwaifor	100	0.244	75.33	18.17
24	Tony Anenih	300	0.493	199.38	81.71
25	Delta Crescent	300	0.21	354.16	168.18
26	St. Mary Dedication Sch.	300	0.299	309.44	143.6
27	Govt. Laundry	200	0.304	134.63	40.75
28	Market Square	300	0.117	273.26	151.1
29	Leventis	500	0.129	206.06	105.33
30	Emporium	200	0.275	190.03	50.07
31	JBS2	500	0.247	200.18	88.08
32	JBS1	100	0.323	366.86	97.04
33	Aimure	500	0.184	260.28	69.38
34	Chris Ogiemwonyi	100	0.271	44.43	10.52
35	New Langer Hotel	500	0.332	172.29	49.95
36	Imuetiyan1	500	0.267	206	57.19
37	Odubu	50	0.246	45.56	4.46
38	Imuetiyan2	300	0.175	283.65	75.96
39	Ogbomoatu	500	0.277	247.39	71.25
40	Okonga	500	0.329	262.77	67.66
41	Godwin Omonuwa	500	0.297	254.35	80.55
42	Gen. Charles Airewele	200	0.164	212.07	64.38
43	Obasogie2	50	0.097	32.48	8.34
44	E-Jerry	50	0.114	56.47	18.53
45	NOA	300	0.426	291.65	80.31
46	Oni-Okpaku	500	0.273	157.86	66.3
47	Ishegie	100	0.118	64.96	16.51
48	Zain mast	50	0.242	36.02	8.01
49	Adun Close	200	0.24	144.9	14.78

50	Obasogie1	50	0.091	84.59	26.04
			TOTAL	**9864.35**	**3490.78**

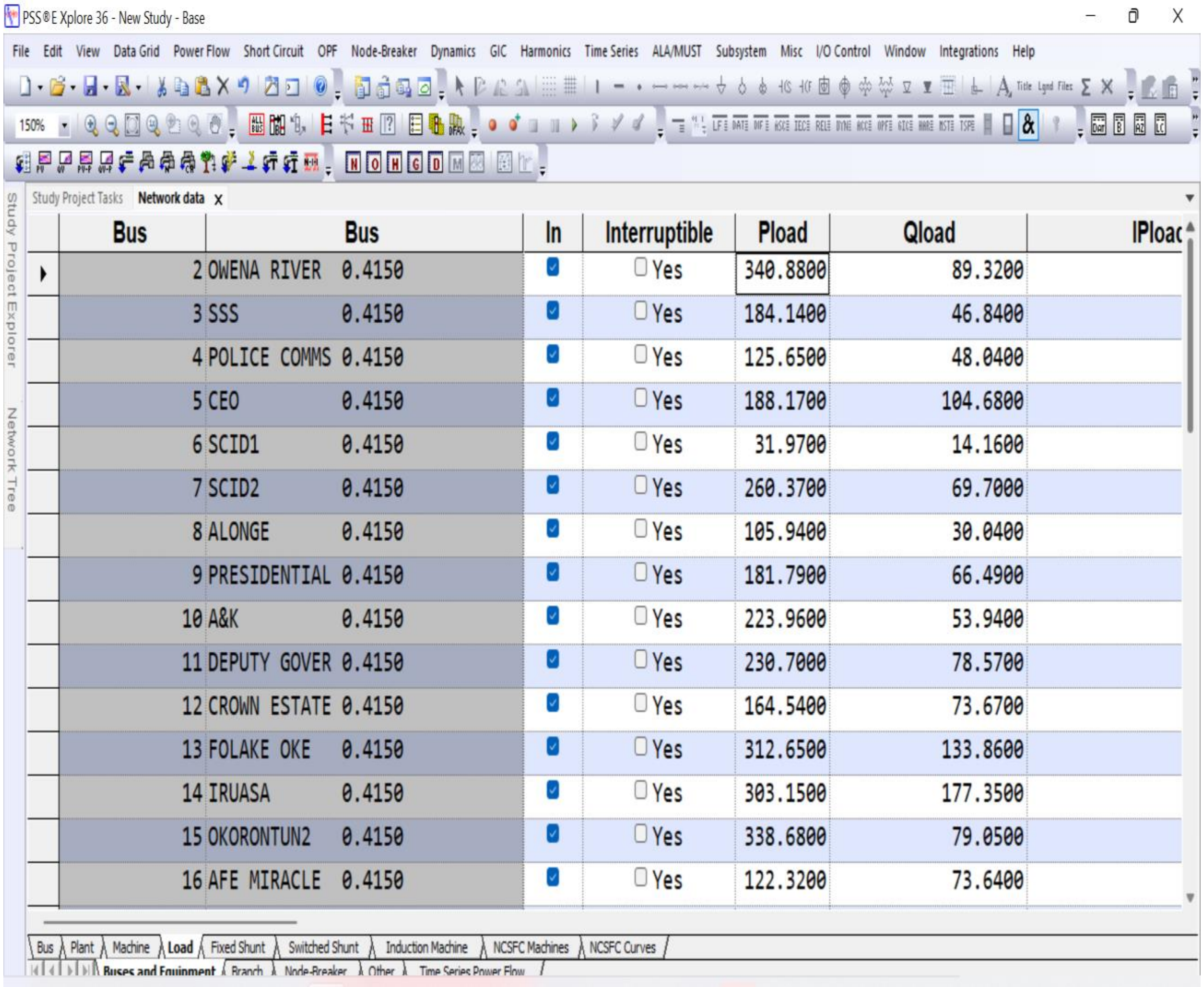
3.3 Load Flow Analysis

Using the collected network data, a detailed load flow analysis was performed to estimate the technical losses on the feeder. Appropriate power system simulation software PSS/E was employed to model the feeder, define operating parameters, and compute real and reactive power flows, voltage profiles, and system losses under various loading conditions. The results provided a quantitative measure of technical energy losses within the distribution system.

Load flow studies are essential for evaluating the steady-state performance of power systems. They provide vital information on voltage magnitudes, phase angles, real and reactive power flows, and system power factors, typically represented using one-line diagrams and per-unit systems. By carrying out load flow analysis, system operators can ensure reliable operation through accurate assessment of current flows, power losses, and equipment loading.

The Newton–Raphson (N-R) method, one of the most widely adopted load flow techniques, is particularly valued for its robustness, accuracy, and rapid convergence. It solves the nonlinear algebraic equations of power flow iteratively by constructing and updating a Jacobian matrix that relates power mismatches to bus voltage corrections. This approach enables efficient and precise determination of system states even for large-scale and complex networks.

Using the Newton–Raphson method for load flow simulations supports a broad range of applications, including voltage regulation, VAR planning, state estimation, distributed generation analysis, and network optimization. Its strong mathematical foundation and proven reliability make it a preferred technique for modern power system studies, providing fast and dependable solutions necessary for real-time and planning operations alike.



Bus	Bus	In	Interruptible	Pload	Qload	IPloa
2	OWENA RIVER 0.4150	☑	☐ Yes	340.8800	89.3200	
3	SSS 0.4150	☑	☐ Yes	184.1400	46.8400	
4	POLICE COMMS 0.4150	☑	☐ Yes	125.6500	48.0400	
5	CEO 0.4150	☑	☐ Yes	188.1700	104.6800	
6	SCID1 0.4150	☑	☐ Yes	31.9700	14.1600	
7	SCID2 0.4150	☑	☐ Yes	260.3700	69.7000	
8	ALONGE 0.4150	☑	☐ Yes	105.9400	30.0400	
9	PRESIDENTIAL 0.4150	☑	☐ Yes	181.7900	66.4900	
10	A&K 0.4150	☑	☐ Yes	223.9600	53.9400	
11	DEPUTY GOVER 0.4150	☑	☐ Yes	230.7000	78.5700	
12	CROWN ESTATE 0.4150	☑	☐ Yes	164.5400	73.6700	
13	FOLAKE OKE 0.4150	☑	☐ Yes	312.6500	133.8600	
14	IRUASA 0.4150	☑	☐ Yes	303.1500	177.3500	
15	OKORONTUN2 0.4150	☑	☐ Yes	338.6800	79.0500	
16	AFE MIRACLE 0.4150	☑	☐ Yes	122.3200	73.6400	

Figure 3.3: System network on PSS/E 36 Simulation Interface

3.4 Economic Evaluation Based on Simulated Line Losses

The monetary cost of the technical losses was determined over a specified time period using prevailing electricity tariffs and loss factors. This involved converting the estimated energy losses from the load flow analysis into annual kWh values and applying the relevant energy charges to quantify the economic impact on the utility and consumers. $C_{P_{loss}} = P_{loss} X c$

Where;

$C_{P_{loss}}$ = cost of simulated active power loss

P_{loss} = active power loss (kW) for the network, c = average prevailing unit energy cost for Band B Customers(₦/kWh)

Downtime of feeder

This aspect considered the duration for which the feeder remains out of service due to a fault or maintenance in the month of June. That is, the interval between the moment the feeder trips and the moment it is restored. Therefore

$D = H - T\ (Hrs)$

where; D = downtime of feeder, T = time out (the time of the day at which the feeder tripped or under scheduled maintenance, H = Time in (The time of day at which the feeder was restored).

Table 3.6: Outage Log record for June, 2025

Date	Outage Classification	Causes	Time of Outage	Downtime of feeder
05/06/2025	Planned outage	Vegetation control	11:17hrs - 18 : 58hrs	07:41hrs/mins
10/06/2025	Planned outage	vegetation control	17:20hrs - 23:19hrs.	05:59hrs/mins
12/06/2025	Planned outage	To erect HT pole.	12:00hrs - 15:00hrs	03:00hrs
15/06/2025	Planned outage	Maintenance work	13:00hrs - 16:00hrs	03:00hrs
18/06/2025	Fault outage	Street light twisted with HT conductor (wire)	09:35hrs- 10:57hrs.	01:29hrs/mins
			Total downtime	**21 hrs, 09 mins**

From table 3.6, the total downtime duration was 21hrs, 09 mins

3.5 Estimation of Unserved Energy and Economic Impact on BEDC

Based on the outage frequency, duration, and load profiles, the amount of unserved energy was estimated using standard reliability analysis methods. The associated economic impact was then evaluated by multiplying unserved energy with the value of lost load (VoLL) or applicable compensation rates, providing an estimate of the cost of supply interruptions to customers and the utility.

The monetary value of losses was estimated in naira. In Nigeria, electricity supply is categorized into different bands based on the number of hours of daily power supply that consumers receive. Customers in Band A receive between 20 to 24 hours of electricity supply daily. Those in Band B enjoy from 16 to 20 hours of supply each day. Band C customers typically have between 12 and 16 hours of electricity daily, while Band D subscribers get 8 to 12 hours. Lastly, Band E customers receive the shortest supply, with only 4 to 8 hours of electricity each day (Adamu *et al.*, 2022). Prior to undertaking these computations, the study outlines the existing service bands (A–E) for Benin Electricity Distribution Company (BEDC) customers and presents a table detailing the tariff structure.

Table 3.7: Tarrif/Band Reclassification

Band	A	B	C	D	E
Price/kWh (₦)	209.5	68.56	56.91	41.20	41.21

Cost implication (or revenue loss) to BEDC = Load loss (kW) x downtime duration (hr) x average prevailing tarrif per unit for 11 kV customers. Used in this calculation is the average prevailing tarrif per unit for customers on the various bands.

3.6 Development of Mitigation Strategies

Findings from the technical and economic analyses were used to propose strategies for reducing both technical losses and outage-related downtimes. Recommendations include network reinforcement, load balancing, preventive maintenance programs, and the possible integration of automation and protection upgrades to improve reliability and service quality.

CHAPTER FOUR

4.1 Results and Discussions

This chapter presents and interprets the findings derived from the materials, data, and analytical approaches described in the previous chapter. Building upon the methodology, the results are organized to show how the GRA 11/0.415 kV distribution feeder performs technically and economically under present operating conditions.

Firstly, the outcomes of the load flow analysis are discussed, including voltage profiles, real and reactive power flows, and the magnitude of technical losses across the feeder. These results provide insight into the feeder's steady-state operating behavior and highlight sections of the network with significant loss contributions.

Next, the economic evaluation of the estimated losses is presented. Here, the technical energy losses obtained from the simulation are converted into monetary values using prevailing tariffs to quantify their impact on the utility and consumers.

The chapter then analyses the reliability aspects of the feeder by examining the recorded outage, downtime durations, and the associated unserved energy. The economic implications of these interruptions expressed as potential revenue losses or costs of supply unreliability also evaluated.

Finally, the chapter integrates these technical and economic findings to inform and justify proposed mitigation strategies aimed at minimizing technical losses and outage-related downtime. This combined approach not only reflects the current performance of the feeder but also provides a data-driven basis for improving its efficiency, reliability, and service quality.

4.2 Obtained results for the load flow

Table 4.1 highlights the obtained results from the load flow study. It has the voltage profile at the buses and the various load demands at the buses.

Table 4.1: Radial Distribution Load flow solution for the voltage profile at the Buses

Radial distribution load flow solution for the voltage profile at the buses

				Load		**Substation**	
Bus No.	**Name of Substation**	**Voltage Magnitude at Bus (p.u.)**	**Angle (Deg.)**	**Real Power (kW)**	**Reactive (kVAr)**	**Real (kW)**	**Reactive (kVAr)**
1	Slack Bus	1.0022	-0.0116	0.0	0.0	13883.4982	8326.0931
2	Owena River Basin	0.9834	-0.0278	349.651	93.9697	0	0
3	SSS	0.9696	-0.0423	189.5596	51.8947	0	0
4	Police Comms	0.963	-0.0691	128.8221	51.8339	0	0
5	CEO	0.9604	-0.1009	194.8038	107.8683	0	0
6	SCID1	0.9513	-0.146	36.1083	18.9739	0	0
7	SCID2	0.9472	-0.1514	264.3313	70.0693	0	0
8	Alonge	0.9181	-0.2636	127.7044	34.4726	0	0
9	Presidential Lodge	0.9159	-0.3195	191.8761	70.2899	0	0
10	A&K	0.9088	-0.2986	234.1233	57.4229	0	0
11	Deputy governor	0.9109	-0.3145	232.3538	84.2274	0	0
12	Crown Estate	0.9147	-0.3186	169.546	77.3906	0	0
13	Folake Oke	0.9093	-0.3258	311.5254	142.2378	0	0
14	Iruasa	0.9117	-0.3515	315.7791	186.2848	0	0
15	Okorontun2	0.9236	-0.4312	351.3204	81.8858	0	0
16	Afe Miracle	0.9302	-0.5106	125.7803	77.4038	0	0
17	Okorontun3	0.932	-0.5529	300.918	118.1862	0	0
18	Okorontun1	0.9496	-0.5902	228.4037	62.1852	0	0
19	Aehomire	0.9615	-0.6214	69.8344	38.1787	0	0
20	Aiguobasimwin2	0.9686	-0.68	218.7927	93.7473	0	0
21	Customary Court	0.9875	-0.667	298.5036	133.0849	0	0
22	Gregory Uansery	0.9903	-0.6801	137.5111	55.6586	0	0
23	Aiguobasimwin1	0.9905	-0.7158	372.9881	161.044	0	0
24	Tony Uwaifor	0.9909	-0.7112	77.9229	23.5975	0	0
25	Tony Anenih	1.0103	-0.7389	202.2237	85.0993	0	0
26	Delta Crescent	1.003	-0.7246	348.8049	168.9918	0	0
27	St. Mary Dedication Sch.	1.002	-0.7501	322.5355	147.9853	0	0
28	Govt. Laundry	1.0045	-0.7634	142.8029	45.5402	0	0
29	Market Square	1.0174	-0.766	283.7974	155.7912	0	0
30	Leventis	1.0142	-0.7548	208.6224	111.8464	0	0
31	Emporium	1.0184	-0.7686	189.8569	55.6428	0	0

32	JBS2	1.0175	-0.7566	209.8336	95.784	0	0
33	JBS1	1.003	-0.7102	381.8322	99.5814	0	0
34	Aimure	1.0131	-0.7355	258.6849	73.9454	0	0
35	Chris Ogiemwonyi	1.0074	-0.7493	49.3885	15.3704	0	0
36	New Langer Hotel	1.0149	-0.7261	172.7075	56.1424	0	0
37	Imuetiyan1	1.0229	-0.7511	214.2992	61.2521	0	0
38	Odubu	1.022	-0.7722	51.3664	9.3428	0	0
39	Imuetiyan2	1.0278	-0.7767	282.2141	80.7104	0	0
40	Ogbomoatu	1.0253	-0.7776	252.0157	75.8926	0	0
41	Okonga	1.0291	-0.7595	268.5702	71.6945	0	0
42	Godwin Omonuwa	1.0189	-0.7541	255.694	84.2658	0	0
43	Gen. Charles Airewele	0.9996	-0.7323	221.9206	71.142	0	0
44	Obasogie2	1.0012	-0.7477	37.3072	13.2945	0	0
45	E-Jerry	0.9983	-0.736	60.4071	24.0402	0	0
46	NOA	1.0027	-0.7154	297.3494	85.5676	0	0
47	Oni-Okpaku	1.0011	-0.7351	165.1068	69.3774	0	0
48	Ishegie	1.004	-0.7176	68.7056	22.1544	0	0
49	Zain mast	1.0069	-0.7158	40.5566	13.2723	0	0
50	Adun Close	1.0031	-0.7506	154.3534	20.3366	0	0
51	Obasogie1	1.0032	-0.7224	90.3957	31.8341	0	0
			Total	**10,159.5118**	**3,737.8057**	**13883.4982**	**8326.0931**

The radial voltage profile shows bus voltages profile, with total feeder load at roughly 10,159.51 kW and 3,737.81 kVAr. The pattern of declining voltage from the slack toward intermediate bus (Folake Oke bus) at 0.9093 and slight rises at 0.9117 at Iruasa bus points is typical of a radial network with concentrated loads. Twelve buses such as; SCID2, Alonge, Presidential Lodge, A&K, Deputy governor, Crown Estate, Folake Oke, Iruasa, Okorontun2, Afe Miracle, Okorontun3 and Okorontun1 fell below 0.95 p.u., which is outside the ideal statutory voltage range. Low voltages near mid-feeder are caused by line impedance combined with high local real and reactive loads, high kVAr demand exacerbates voltage drop across line reactance, and tap settings or absence of mid-feeder voltage regulation leave downstream buses vulnerable to undervoltage.

Table 4.2: Line Power flow along the 11KV line

Line No.	Line Power flow along 11kV Line				Line Losses	
	From Bus	**To Bus**	**kW**	**kVAr**	**kW**	**kVAr**
1	Slack Bus	Owena River Basin	2938.8663	3530.637	26.7825	32.7263
2	Owena River Basin	SSS	2556.9561	3070.6982	45.8243	56.0075
3	SSS	Police Comms	2255.8541	2719.215	13.4936	16.4958
4	Police Comms	CEO	2045.1951	2564.2045	22.1759	27.0936
5	CEO	SCID1	1742.2866	2148.3755	14.8839	18.1915
6	SCID1	SCID2	1553.1029	1910.7466	11.9551	14.6124
7	SCID2	Alonge	1122.2487	1344.3975	20.4433	24.9830
8	Alonge	Presidential Lodge	650.6512	806.1583	5.0799	6.2087
9	Presidential Lodge	A&K	155.3421	186.0143	0.2170	0.2652
10	A&K	Deputy governor	111.3663	135.1298	0.0900	0.1100
11	Deputy governor	Crown Estate	53.1381	66.8504	0.0222	0.0272
12	Presidential Lodge	Folake Oke	222.2485	273.9028	0.1891	0.2311
13	Folake Oke	Iruasa	14.2473	17.4718	0.0014	0.0017
14	Iruasa	Okorontun2	-333.8783	-412.5092	1.9456	2.3775
15	Okorontun2	Afe Miracle	-635.9437	-793.4443	5.5737	6.8139
16	Afe Miracle	Okorontun3	-854.5096	-1061.559	6.1406	7.5042
17	Okorontun3	Okorontun1	-1023.4149	-1230.1486	13.1275	16.0401
18	Okorontun1	Aehomire	-1156.3059	-1373.2574	10.4513	12.7708
19	Aehomire	Aiguobasimwin2	-1325.1783	-1601.5152	27.0231	33.0239
20	Aiguobasimwin2	Customary Court	-1450.1455	-1747.5499	9.5799	11.7078
21	Customary Court	Gregory Uansery	-1453.0402	-1744.2733	6.5833	8.0423
22	Gregory Uansery	Aiguobasimwin1	-1471.4722	-1845.9047	8.6616	10.5844
23	Aiguobasimwin1	Tony Uwaifor	-460.7700	-575.8658	1.5518	1.8966
24	Tony Uwaifor	Tony Anenih	-454.7403	-549.5359	3.0331	3.7066
25	Tony Anenih	Delta Crescent	-420.1609	-518.1942	1.0883	1.3298
26	Delta Crescent	St. Mary Dedication Sch.	-343.6264	-417.3401	1.0312	1.2603
27	St. Mary Dedication Sch.	Govt. Laundry	-271.6210	-340.1604	0.6511	0.7956
28	Govt. Laundry	Market Square	-230.6316	-281.0957	0.1798	0.2197
29	Market Square	Leventis	-170.3899	-205.2357	0.1080	0.1320
30	Leventis	Emporium	-120.8525	-145.4395	0.1157	0.1414
31	Emporium	JBS2	-55.1836	-67.6846	0.0216	0.0264
32	Aiguobasimwin1	JBS1	-981.7640	-1182.7128	9.3243	11.3950
33	JBS1	Aimure	-564.9618	-694.0133	1.7263	2.1099
34	Aimure	Chris Ogiemwonyi	-489.9687	-613.0012	1.9002	2.3220
35	Chris Ogiemwonyi	New Langer Hotel	-483.0029	-586.7399	2.2452	2.7439

36	New Langer Hotel	Imuetiyan1	-434.9535	-522.4957	1.4505	1.7723
37	Imuetiyan1	Odubu	-371.0502	-466.9837	0.9663	1.1809
38	Odubu	Imuetiyan2	-355.2041	-434.3393	0.6266	0.7658
39	Imuetiyan2	Ogbomoatu	-259.5907	-309.4756	0.5279	0.6452
40	Ogbomoatu	Okonga	-177.0596	-210.4973	0.2905	0.3550
41	Okonga	Godwin Omonuwa	-84.4510	-100.7811	0.0595	0.0727
42	JBS1	Gen. Charles Airewele	-332.0771	-408.944	0.5315	0.6495
43	Gen. Charles Airewele	Obasogie2	-177.9104	-221.2712	0.0900	0.1100
44	Obasogie2	E-Jerry	-168.0508	-204.4248	0.0942	0.1152
45	E-Jerry	NOA	-152.6155	-181.5992	0.2901	0.3544
46	NOA	Oni-Okpaku	-61.3687	-74.4492	0.0299	0.0366
47	Oni-Okpaku	Ishegie	-21.2363	-26.731	0.0015	0.0019
48	Ishegie	Zain mast	-92.9641	-113.8303	0.0613	0.0749
49	Zain mast	Adun Close	-81.1562	-101.9594	0.0462	0.0565
50	Adun Close	Obasogie1	-25.1601	-31.4213	0.0017	0.0021
				Total	**277.72**	**340.11**

4.3 11 kV Line Load-Flow (Losses)

The load-flow results show a total active power loss of 277.72 kW and reactive power loss of 340.11 kVAr across the 11 kV feeder. The feeder carries 2,938.87 kW and 3,530.64 kVAr out of the Slack Bus toward Owena River Basin, and the Slack Bus to Owena River Basin line itself incurs 26.78 kW (≈0.91% of that line's flow) and 32.73 kVAr of losses. Expressed another way, the feeder's total active loss (277.72 kW) represents about 9.45% of the power injected at the Slack Bus, which is a material loss and indicates room for efficiency improvement. The single largest line contributor to active losses is Owena River Basin →SSS with 45.82 kW and 56.01 kVAr, representing 16.5% of the feeder's kW losses and about 1.79% of the power flowing on that line. Other major contributors are Aehomire → Aiguobasimwin2 (27.02 kW, 9.73% of total losses, ≈2.04% loss relative to that line's flow), Slack Bus → Owena River Basin (26.78 kW, 9.64% of total), Police Comms → CEO (22.18 kW, 7.98% of total) and SCID2 → Alonge (20.44 kW, 7.36% of total). Loss intensity (loss per unit of flow) is particularly high on Aehomire → Aiguobasimwin2 (≈2.04% of that line's flow) and elevated on SCID2 → Alonge and Owena River Basin → SSS (≈1.82% and 1.79% respectively). Many end-spurs are lightly loaded with negligible losses (for example Folake Oke → Iruasa loss is only 0.0014 kW), so the loss problem is concentrated in a few heavy segments rather than uniformly distributed.

Reactive flows and reactive losses mirror the active picture: the largest reactive flows and reactive losses occur at the head (Slack Bus → Owena River Basin 3,530.64 kVAr and 32.73 kVAr loss; Owena River Basin → SSS 3,070.70 kVAr and 56.01 kVAr loss), suggesting heavy inductive loading or poor power factor concentrated near the head or large motor loads that would benefit from local compensation. Operational and planning implications are clear: field-verify topology and measurement/sign conventions and confirm whether embedded generation or closed ties exist downstream, investigate the conductor sizes and lengths on Owena River Basin → SSS and in the Aiguobasimwin–Okorontun group, consider targeted conductor upgrades or sectionalizing to shorten high-current paths, and apply localized reactive compensation (shunt capacitors or D-STATCOM) at high reactive-demand nodes such as Owena River Basin and the Aiguobasimwin area. Because reverse flows can adversely affect protection coordination and voltage regulation, review protection settings and tap-changer/regulator plan around Aiguobasimwin1 → JBS1 and the Okorontun group to ensure safe operation under export conditions. Finally, convert the 277.72 kW feeder loss into annual energy and monetary cost (using local tariff/operating hours) to compare the economic case for mitigation measures versus the expected energy savings.

4.4 Financial Implications Due to Active Power Line Losses

Simulated Losses: 277.72 kW

Energy Lost (per hour): 277.72 kWh

Table 4.3: Tariff-Based Monetary Implication (per hour)

Band	Tariff (₦/kWh)	Energy Lost (kWh)	Cost of Loss (₦)
A	**209.5**	**277.72**	**₦58,182.34**
B	**68.56**	**277.72**	**₦19,040.48**
C	**56.91**	**277.72**	**₦15,805.05**
D	**41.2**	**277.72**	**₦11,442.06**
E	**41.21**	**277.72**	**₦11,444.84**

The simulated active power line losses of 277.72 kW represent a significant source of technical losses on the network. When converted into energy for a one-hour period, this equates to 277.72 kWh of electricity lost before reaching the end-users. Using the prevailing BEDC tariff structure, the monetary implication of this energy loss differs across the various customer service bands. For Band A customers who pay ₦209.50 per kilowatt-hour, the financial value of the loss is about ₦58,182 for every hour the loss persists. For Band B customers the cost is approximately ₦19,040 per hour, while for Band C the value stands at about ₦15,805. Bands D and E, which are billed at the lowest rates, would register about ₦11,442 and ₦11,445 respectively for the same loss. Although these hourly amounts may seem moderate, they accumulate quickly over time. For example, if the same losses continue for twenty-four hours, the cost to Band A alone would exceed ₦1.39 million in a single day. This indicates that even modest technical losses in active power lines carry a heavy financial burden for both the utility, which loses revenue, and for customers, who indirectly bear the costs through higher tariffs or reduced supply quality.

4.5 Financial Implications Due to Unserved Energy Due to Planned/Unplanned Outages

Outage Duration: 21 hrs 09 mins = 21.15 hrs

Load Demand: 9,864.35 kW

Unserved Energy: 9,864.35 kW × 21.15 hrs = 208,631 kWh

Table 4.4: Tariff-Based Monetary Implication considering total outage duration.

Band	**Tariff (₦/kWh)**	**Unserved Energy (kWh)**	**Cost of Unserved Energy (₦)**
A	209.5	208,631	**₦43,708,195.02**
B	68.56	208,631	₦14,303,741.53
C	56.91	208,631	₦11,873,190.35
D	41.2	208,631	₦8,595,597.30
E	41.21	208,631	₦8,597,683.61

In the case of the unserved load due to planned and unplanned network maintenance lasting 21 hours and 9 minutes, the financial implications are even more pronounced. At a load demand of 9,864.35 kW, the total unserved energy over this period amounts to about 208,631 kWh. Valued at the prevailing tariffs, the cost of this lost energy reaches staggering figures. For Band A, where customers are entitled to the highest level of service and pay ₦209.50 per kilowatt-hour, the unserved energy corresponds to approximately ₦43.7 million for just one of such event. For Band B the cost is about ₦14.3 million, for Band C about ₦11.9 million, and for Bands D and E roughly ₦8.6 million each. These figures demonstrate that unserved energy resulting from outages, whether scheduled or due to faults, has a far greater economic impact than the steady-state line losses, especially in high-demand areas.

4.6 Implications

The results highlight several important implications for both network operators and policy makers. The cost associated with line losses, though smaller in absolute terms than outage costs, remains a persistent drain on system efficiency. Over months or years it leads to substantial lost revenue for the utility and undermines cost recovery. The large disparity in tariffs across the service bands further means that technical or unserved losses in premium service areas (Band A) are disproportionately expensive. For customers in these bands, who pay the highest rates and expect near-continuous service, every hour of outage or unserved load translates to a high monetary cost and loss of productivity. This makes reliability in such areas particularly crucial.

The magnitude of the financial loss from a single 21-hour outage underscores the importance of effective maintenance planning and fault-prevention strategies. Planned maintenance should be scheduled in ways that minimize downtime for high-value feeders, while investments in redundancy, real-time monitoring, and rapid fault location can drastically cut unplanned outages. These measures directly reduce the cost of unserved energy and improve customer satisfaction. Moreover, quantifying the financial implications of technical and unserved losses provides a strong evidence base for justifying network upgrades, grid automation, and the integration of energy storage systems to buffer critical loads during outages. In turn, these investments can reduce both the frequency and severity of outages, lower aggregate technical losses, and protect revenue streams.

In summary, the analysis shows that a relatively modest active power loss of 277.72 kW already represents a considerable financial drain when evaluated against current tariffs, while a single prolonged outage at high demand can cost tens of millions of naira in unserved energy. Understanding these costs in monetary terms is essential for prioritizing interventions that enhance network reliability and efficiency, and it reinforces the economic case for reducing both technical losses and outage durations across all customer bands.

4.7 Mitigation Strategies

Based on the technical and financial findings, the following are some effective mitigation strategies;

i. Targeted Conductor Upgrades and Network Reinforcement

The simulated losses in the Owena River Basin → SSS, Aehomire → Aiguobasimwin2, Police Comms → CEO, and SCID2 → Alonge segments show that the lines carry high current relative to conductor size. Upgrading conductor cross-sections or installing an additional feeder to split the load will cut ohmic losses significantly and reduce voltage drop at mid-feeder buses, helping undervoltage buses such as SCID2, Alonge, Presidential Lodge, and Folake Oke move back into the statutory range.

ii. Local Reactive Power Compensation

Reactive demand is high at the feeder head and in the Aiguobasimwin–Okorontun cluster. Installing shunt capacitor banks or a dynamic compensator (e.g., D-STATCOM) at or near these substations reduces reactive current on upstream lines, thereby cutting both reactive and active losses and improving voltage profiles.

iii. Load Balancing and Phase Re-allocation

Because this feeder supplies a mix of residential and public customers, load is likely uneven across phases and between substations. A systematic audit and re-allocation of single-phase loads across phases at the LV side of distribution transformers can reduce neutral currents, limit transformer overloading, and improve feeder power factor, thereby reducing technical losses.

iv. Preventive and Predictive Maintenance

The outage table shows a concentration of planned outages for vegetation control and maintenance. Moving from reactive to predictive maintenance (e.g., periodic thermal scanning of joints, real-time fault current monitoring, vegetation growth mapping with GIS) will shorten outage durations and allow work to be scheduled at lower-demand periods. This directly cuts the unserved-energy cost, which dwarfs the cost of steady losses.

v. Embedded Generation or Energy Storage for Critical Loads

For Band A clusters or high-value customers, consider deploying strategically located battery energy storage or encouraging customer-sited solar + storage to ride through scheduled maintenance or short faults. This buffers the load and sharply lowers the economic impact of unserved energy.

vi. Tariff-Informed Maintenance Scheduling

Because the financial cost of unserved energy is much higher in premium bands, prioritize outage minimization and redundancy in these areas. Shift planned maintenance to off-peak periods and coordinate with customers to reduce socio-economic disruption.

CHAPTER FIVE

5.1 CONCLUSION AND RECOMMENDATIONS

This study has quantified the financial implications of both technical line losses and unserved energy resulting from planned and unplanned outages on a distribution feeder. The simulated active power line loss of 277.72 kW was shown to translate into significant hourly revenue losses across all customer bands, with the magnitude being particularly high in premium tariff categories. Similarly, a single 21-hour interruption of supply at a demand of 9,864.35 kW resulted in over 208 MWh of unserved energy, corresponding to tens of millions of naira in lost value. These findings demonstrate that technical inefficiencies and extended outages are not only operational challenges but also substantial economic burdens for both the utility and its customers.

The analysis underscores the necessity of targeted interventions to improve network efficiency and reliability. Reducing technical and non-technical losses through network upgrades and improved metering, strengthening preventive and predictive maintenance practices, and adopting automated switching and fault location technologies will collectively mitigate both energy losses and outage durations. Incorporating reliability indices alongside financial metrics will provide a robust framework for prioritizing investments and benchmarking performance. Furthermore, tailoring maintenance and redundancy strategies for high-value customer bands can minimize socio-economic disruption and protect revenue streams.

In conclusion, by explicitly valuing technical losses and unserved energy in monetary terms, this research provides an evidence-based justification for strategic investment in network reinforcement, automation, and reliability enhancement measures. Implementing these recommendations will improve operational efficiency, enhance customer satisfaction, and contribute to a more stable and financially sustainable electricity distribution system.

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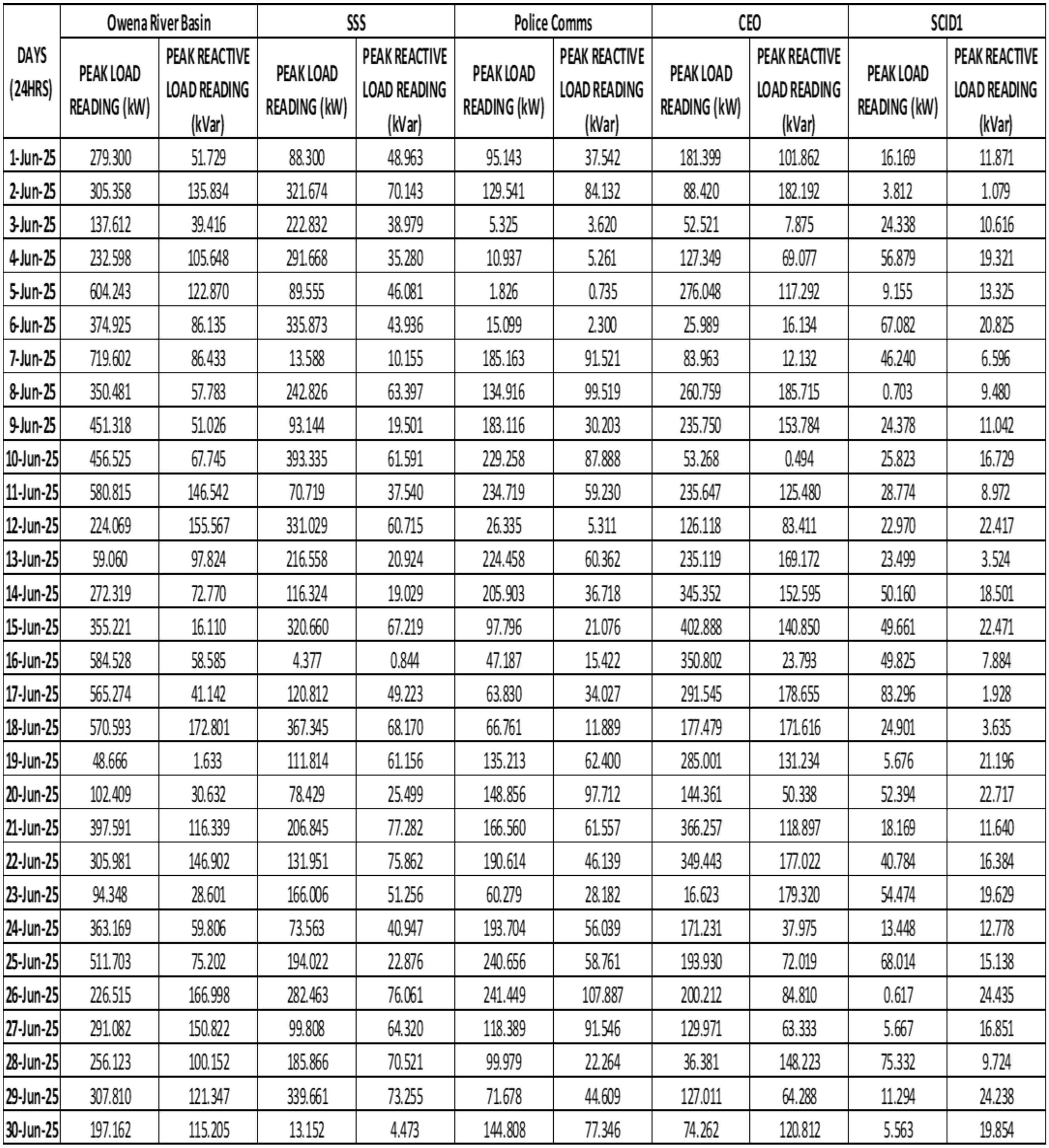
APPENDICES

APPENDIX A: GRA 11kV INJECTION SUBSTATION DATA

Table 3.2: Daily Peak Load Data for June 2025 (BEDC Electricity PLC, 2025a)



DAYS (24HRS)	Owena River Basin		SSS		Police Comms		CEO		SCID1	
	PEAK LOAD READING (kW)	PEAK REACTIVE LOAD READING (kVar)	PEAK LOAD READING (kW)	PEAK REACTIVE LOAD READING (kVar)	PEAK LOAD READING (kW)	PEAK REACTIVE LOAD READING (kVar)	PEAK LOAD READING (kW)	PEAK REACTIVE LOAD READING (kVar)	PEAK LOAD READING (kW)	PEAK REACTIVE LOAD READING (kVar)
1-Jun-25	279.300	51.729	88.300	48.963	95.143	37.542	181.399	101.862	16.169	11.871
2-Jun-25	305.358	135.834	321.674	70.143	129.541	84.132	88.420	182.192	3.812	1.079
3-Jun-25	137.612	39.416	222.832	38.979	5.325	3.620	52.521	7.875	24.338	10.616
4-Jun-25	232.598	105.648	291.668	35.280	10.937	5.261	127.349	69.077	56.879	19.321
5-Jun-25	604.243	122.870	89.555	46.081	1.826	0.735	276.048	117.292	9.155	13.325
6-Jun-25	374.925	86.135	335.873	43.936	15.099	2.300	25.989	16.134	67.082	20.825
7-Jun-25	719.602	86.433	13.588	10.155	185.163	91.521	83.963	12.132	46.240	6.596
8-Jun-25	350.481	57.783	242.826	63.397	134.916	99.519	260.759	185.715	0.703	9.480
9-Jun-25	451.318	51.026	93.144	19.501	183.116	30.203	235.750	153.784	24.378	11.042
10-Jun-25	456.525	67.745	393.335	61.591	229.258	87.888	53.268	0.494	25.823	16.729
11-Jun-25	580.815	146.542	70.719	37.540	234.719	59.230	235.647	125.480	28.774	8.972
12-Jun-25	224.069	155.567	331.029	60.715	26.335	5.311	126.118	83.411	22.970	22.417
13-Jun-25	59.060	97.824	216.558	20.924	224.458	60.362	235.119	169.172	23.499	3.524
14-Jun-25	272.319	72.770	116.324	19.029	205.903	36.718	345.352	152.595	50.160	18.501
15-Jun-25	355.221	16.110	320.660	67.219	97.796	21.076	402.888	140.850	49.661	22.471
16-Jun-25	584.528	58.585	4.377	0.844	47.187	15.422	350.802	23.793	49.825	7.884
17-Jun-25	565.274	41.142	120.812	49.223	63.830	34.027	291.545	178.655	83.296	1.928
18-Jun-25	570.593	172.801	367.345	68.170	66.761	11.889	177.479	171.616	24.901	3.635
19-Jun-25	48.666	1.633	111.814	61.156	135.213	62.400	285.001	131.234	5.676	21.196
20-Jun-25	102.409	30.632	78.429	25.499	148.856	97.712	144.361	50.338	52.394	22.717
21-Jun-25	397.591	116.339	206.845	77.282	166.560	61.557	366.257	118.897	18.169	11.640
22-Jun-25	305.981	146.902	131.951	75.862	190.614	46.139	349.443	177.022	40.784	16.384
23-Jun-25	94.348	28.601	166.006	51.256	60.279	28.182	16.623	179.320	54.474	19.629
24-Jun-25	363.169	59.806	73.563	40.947	193.704	56.039	171.231	37.975	13.448	12.778
25-Jun-25	511.703	75.202	194.022	22.876	240.656	58.761	193.930	72.019	68.014	15.138
26-Jun-25	226.515	166.998	282.463	76.061	241.449	107.887	200.212	84.810	0.617	24.435
27-Jun-25	291.082	150.822	99.808	64.320	118.389	91.546	129.971	63.333	5.667	16.851
28-Jun-25	256.123	100.152	185.866	70.521	99.979	22.264	36.381	148.223	75.332	9.724
29-Jun-25	307.810	121.347	339.661	73.255	71.678	44.609	127.011	64.288	11.294	24.238
30-Jun-25	197.162	115.205	13.152	4.473	144.808	77.346	74.262	120.812	5.563	19.854

DAYS (24HRS)	SCID2		Alonge		Presidential Lodge		A&K		Deputy governor	
	PEAK LOAD READING (kW)	PEAK REACTIVE LOAD READING (kVar)	PEAK LOAD READING (kW)	PEAK REACTIVE LOAD READING (kVar)	PEAK LOAD READING (kW)	PEAK REACTIVE LOAD READING (kVar)	PEAK LOAD READING (kW)	PEAK REACTIVE LOAD READING (kVar)	PEAK LOAD READING (kW)	PEAK REACTIVE LOAD READING (kVar)
1-Jun-25	204.245	94.043	70.467	7.639	300.880	14.620	66.559	40.904	404.094	129.854
2-Jun-25	0.772	113.903	164.769	51.118	14.952	100.497	319.805	20.564	308.379	6.371
3-Jun-25	451.348	97.149	221.578	40.518	22.103	65.418	129.501	134.342	26.493	10.790
4-Jun-25	377.823	100.269	36.939	49.504	219.963	61.999	396.293	103.560	346.487	80.466
5-Jun-25	543.765	54.240	149.633	22.029	291.775	27.535	162.355	96.188	231.674	101.337
6-Jun-25	270.291	57.578	107.680	3.935	236.322	35.484	298.007	47.506	202.228	22.643
7-Jun-25	229.972	92.513	119.233	25.864	216.272	83.467	34.957	42.610	70.775	18.281
8-Jun-25	539.746	30.963	73.616	13.256	64.370	18.058	175.125	27.692	318.655	52.732
9-Jun-25	44.012	60.236	145.474	3.365	116.496	130.747	281.725	24.881	322.831	136.486
10-Jun-25	37.709	70.513	157.654	12.180	316.000	10.621	118.015	10.997	170.995	85.735
11-Jun-25	161.674	55.152	140.159	1.811	116.066	78.160	381.835	2.051	285.202	126.093
12-Jun-25	523.418	110.163	100.333	16.831	203.272	37.439	270.670	113.443	109.106	21.757
13-Jun-25	207.798	19.980	203.053	21.877	251.962	18.453	122.353	22.957	358.894	85.893
14-Jun-25	33.543	5.269	77.269	19.009	127.161	98.382	169.620	53.344	215.181	108.362
15-Jun-25	257.441	10.511	43.679	65.999	241.980	8.526	379.383	55.317	181.082	89.534
16-Jun-25	302.282	32.780	202.880	45.487	270.117	51.895	161.518	115.755	410.369	48.904
17-Jun-25	501.932	10.615	131.588	60.740	220.035	17.492	172.888	98.499	390.512	59.487
18-Jun-25	292.399	17.749	200.904	20.008	207.238	69.797	175.380	45.436	78.982	132.005
19-Jun-25	141.266	29.630	51.205	14.324	312.350	100.678	177.212	94.139	213.331	129.931
20-Jun-25	374.906	107.357	80.133	66.158	132.988	97.855	363.634	40.685	149.644	87.133
21-Jun-25	482.226	47.777	35.878	44.945	126.501	55.722	287.850	73.610	189.329	93.266
22-Jun-25	184.408	92.719	5.241	66.258	279.489	130.613	7.311	25.400	67.974	93.582
23-Jun-25	23.293	92.075	12.880	7.986	10.747	122.573	328.738	96.343	159.170	31.181
24-Jun-25	13.975	76.055	25.669	17.385	248.649	3.980	40.382	54.846	401.700	105.660
25-Jun-25	547.055	19.745	88.847	18.707	167.147	106.742	155.486	78.162	4.754	128.858
26-Jun-25	130.487	56.956	100.335	28.916	291.894	80.893	248.228	9.650	181.482	16.526
27-Jun-25	315.823	96.480	16.161	33.329	43.271	106.295	378.903	3.526	339.685	93.244
28-Jun-25	313.064	97.537	179.696	19.713	143.192	133.345	349.547	46.652	150.994	92.429
29-Jun-25	165.398	77.400	59.644	68.243	48.972	24.301	384.398	17.115	233.237	119.137
30-Jun-25	139.028	113.643	174.401	34.065	211.536	103.113	181.121	22.027	397.762	49.418

DAYS (24HRS)	Crown Estate		Folake Oke		Iruasa		Okorontun2		Afe Miracle	
	PEAK LOAD READING (kW)	PEAK REACTIVE LOAD READING (kVar)	PEAK LOAD READING (kW)	PEAK REACTIVE LOAD READING (kVar)	PEAK LOAD READING (kW)	PEAK REACTIVE LOAD READING (kVar)	PEAK LOAD READING (kW)	PEAK REACTIVE LOAD READING (kVar)	PEAK LOAD READING (kW)	PEAK REACTIVE LOAD READING (kVar)
1-Jun-25	321.748	65.355	436.127	222.402	463.270	134.011	300.132	141.220	225.562	107.598
2-Jun-25	211.750	13.201	443.981	162.307	488.146	14.505	322.494	68.212	164.252	79.114
3-Jun-25	27.606	88.778	171.721	185.825	264.423	126.130	548.003	79.673	97.815	96.066
4-Jun-25	160.977	139.299	507.293	43.838	318.441	304.129	697.744	64.214	148.380	69.679
5-Jun-25	80.814	105.399	87.466	220.074	104.655	152.105	31.241	56.026	66.309	152.047
6-Jun-25	9.283	34.345	690.440	24.195	360.819	278.717	357.843	65.221	206.754	28.133
7-Jun-25	355.567	19.410	400.471	142.043	75.442	78.081	696.337	121.070	221.881	24.086
8-Jun-25	32.954	81.401	257.729	111.702	284.794	126.606	141.822	106.889	153.140	106.992
9-Jun-25	58.277	16.615	347.242	89.979	544.394	171.087	66.040	130.317	207.808	24.856
10-Jun-25	146.526	27.368	335.872	75.255	524.320	329.853	144.656	50.152	90.007	119.428
11-Jun-25	28.773	70.538	320.398	49.646	355.646	61.529	577.475	5.456	203.789	33.682
12-Jun-25	62.520	60.330	213.033	233.231	473.263	263.614	21.221	53.172	156.064	24.897
13-Jun-25	4.091	146.042	280.692	72.439	498.229	167.440	193.415	38.205	48.973	150.063
14-Jun-25	328.563	108.298	75.064	180.075	226.593	329.240	552.415	34.873	147.446	43.942
15-Jun-25	234.653	146.641	115.584	106.468	567.064	238.614	231.229	140.029	40.683	31.330
16-Jun-25	403.320	12.727	184.231	187.628	514.283	128.677	388.736	91.052	113.634	34.299
17-Jun-25	360.666	73.507	421.342	60.649	0.999	214.317	125.023	100.299	80.365	102.295
18-Jun-25	370.003	4.955	138.694	205.437	110.231	174.582	488.128	54.279	37.720	39.375
19-Jun-25	359.899	143.092	548.801	163.645	133.477	74.974	113.076	132.064	28.153	151.681
20-Jun-25	386.302	82.693	449.026	97.793	348.046	71.892	569.905	142.821	199.603	13.858
21-Jun-25	183.711	63.102	322.163	172.118	131.243	180.855	228.105	75.054	119.293	137.624
22-Jun-25	46.665	84.117	598.352	48.136	119.683	56.366	0.578	142.549	38.046	137.624
23-Jun-25	20.001	139.004	412.320	81.638	87.740	283.546	420.897	11.687	17.116	42.837
24-Jun-25	84.845	38.513	595.805	202.578	228.138	325.337	46.780	50.181	91.847	15.653
25-Jun-25	157.866	75.190	89.603	142.478	153.912	96.611	258.474	50.670	60.334	34.183
26-Jun-25	50.832	42.144	78.720	131.056	299.670	39.597	287.878	63.929	123.805	115.614
27-Jun-25	36.644	25.938	483.736	65.740	245.202	264.746	294.570	96.835	204.877	58.899
28-Jun-25	373.970	94.170	109.381	231.550	494.368	222.912	605.574	69.740	163.143	91.565
29-Jun-25	20.387	141.066	74.332	213.602	401.222	126.733	733.697	110.052	176.818	89.465
30-Jun-25	16.987	66.863	189.881	92.271	276.787	283.693	716.911	25.559	35.983	52.313

DAYS (24HRS)	Okorontun3		Okorontun1		Aehomire		Aiguobasimwin2		Customary Court	
	PEAK LOAD READING (kW)	PEAK REACTIVE LOAD READING (kVar)	PEAK LOAD READING (kW)	PEAK REACTIVE LOAD READING (kVar)	PEAK LOAD READING (kW)	PEAK REACTIVE LOAD READING (kVar)	PEAK LOAD READING (kW)	PEAK REACTIVE LOAD READING (kVar)	PEAK LOAD READING (kW)	PEAK REACTIVE LOAD READING (kVar)
1-Jun-25	184.214	117.998	421.201	49.183	53.721	14.971	24.330	34.501	475.996	53.101
2-Jun-25	398.372	174.418	87.297	80.791	143.169	21.128	316.480	43.920	520.809	106.163
3-Jun-25	185.471	114.446	285.916	42.610	121.330	59.129	246.823	87.927	163.570	128.992
4-Jun-25	237.715	99.492	251.621	34.782	38.595	32.976	161.958	147.025	303.241	167.976
5-Jun-25	359.005	99.870	102.153	60.462	34.163	73.841	99.901	149.079	246.298	231.417
6-Jun-25	557.545	60.796	206.125	48.336	76.725	2.630	342.467	165.544	508.880	122.859
7-Jun-25	186.507	45.749	21.094	69.956	46.763	26.794	111.657	9.294	356.083	102.887
8-Jun-25	518.066	136.938	67.261	76.064	69.698	19.307	357.028	112.449	212.694	254.896
9-Jun-25	380.996	166.659	104.740	102.520	87.849	12.106	268.336	110.559	34.450	188.246
10-Jun-25	80.511	135.327	103.388	78.890	20.763	85.332	113.239	136.281	85.064	125.849
11-Jun-25	292.954	82.922	31.177	30.197	64.249	16.870	317.307	42.126	616.197	86.301
12-Jun-25	344.337	172.891	523.320	37.577	11.090	26.284	360.344	127.665	199.504	36.846
13-Jun-25	316.488	153.201	85.059	9.884	30.983	6.663	281.023	143.167	116.926	178.754
14-Jun-25	514.350	130.590	138.851	12.114	88.129	14.583	0.370	147.903	226.848	129.145
15-Jun-25	120.981	25.248	378.655	98.268	64.008	34.102	143.692	84.230	164.363	132.007
16-Jun-25	263.290	149.508	320.360	88.570	69.935	23.750	194.642	68.613	380.705	142.157
17-Jun-25	381.818	62.663	521.261	41.477	30.262	29.942	215.642	129.726	589.097	142.925
18-Jun-25	43.567	99.857	289.422	9.557	39.492	16.488	300.977	29.274	190.217	75.949
19-Jun-25	188.250	128.436	23.066	79.893	93.651	43.791	261.789	83.539	158.942	97.709
20-Jun-25	10.249	109.638	466.326	57.813	141.442	3.314	250.572	26.739	503.725	130.232
21-Jun-25	178.372	129.896	167.924	5.650	10.814	13.663	323.849	32.704	132.620	29.429
22-Jun-25	274.937	135.598	156.080	63.897	129.783	52.031	71.322	85.698	88.858	72.877
23-Jun-25	365.463	145.297	430.883	29.456	104.568	83.717	362.536	83.860	613.018	234.820
24-Jun-25	537.973	116.831	369.341	33.239	2.271	11.917	148.292	39.863	273.021	77.830
25-Jun-25	179.600	12.810	122.611	110.079	8.131	66.638	151.961	159.281	176.017	81.637
26-Jun-25	289.476	83.773	179.357	114.800	112.258	47.269	84.427	98.289	356.321	58.570
27-Jun-25	488.327	58.739	276.405	76.961	80.726	10.329	64.515	3.954	276.305	117.617
28-Jun-25	473.599	120.312	19.580	53.481	80.220	43.181	107.029	56.192	210.910	256.125
29-Jun-25	304.932	160.683	47.010	114.100	117.133	75.318	338.485	15.365	526.260	106.889
30-Jun-25	145.536	129.414	460.118	37.494	17.678	53.136	291.008	136.032	77.063	155.393

DAYS (24HRS)	**Gregory Uansery**		**Aiguobasimwin1**		**Tony Uwaifor**		**Toney Anenih**		**Delta Crescent**	
	PEAK LOAD READING (kW)	**PEAK REACTIVE LOAD READING (kVar)**	**PEAK LOAD READING (kW)**	**PEAK REACTIVE LOAD READING (kVar)**	**PEAK LOAD READING (kW)**	**PEAK REACTIVE LOAD READING (kVar)**	**PEAK LOAD READING (kW)**	**PEAK REACTIVE LOAD READING (kVar)**	**PEAK LOAD READING (kW)**	**PEAK REACTIVE LOAD READING (kVar)**
1-Jun-25	148.732	58.041	191.561	189.708	40.423	9.093	94.710	140.404	371.654	168.964
2-Jun-25	33.906	18.558	787.143	85.090	120.629	22.409	28.637	135.732	669.753	170.692
3-Jun-25	182.565	83.322	702.371	321.952	90.212	9.598	235.868	134.623	649.697	146.270
4-Jun-25	172.353	55.795	573.008	119.469	132.104	14.723	164.666	23.896	571.835	27.400
5-Jun-25	69.914	59.217	491.783	118.253	44.761	25.864	401.811	97.046	539.486	188.889
6-Jun-25	57.691	52.569	119.614	233.434	53.055	24.807	282.512	123.373	698.245	125.101
7-Jun-25	121.757	72.145	470.348	8.414	98.255	7.404	282.618	20.708	418.547	23.239
8-Jun-25	200.501	28.998	834.924	253.439	71.135	30.447	14.492	109.741	95.908	198.104
9-Jun-25	133.081	77.619	24.350	47.367	17.701	25.075	197.727	8.911	384.923	232.445
10-Jun-25	95.594	42.414	186.503	49.430	121.598	18.548	269.257	48.014	396.026	302.225
11-Jun-25	71.470	17.150	48.671	27.987	95.250	35.000	137.584	43.497	353.513	123.181
12-Jun-25	199.256	34.745	66.057	50.774	26.704	31.582	267.462	89.616	272.142	182.840
13-Jun-25	149.715	27.638	284.051	186.301	59.160	31.309	223.174	51.999	431.752	61.085
14-Jun-25	107.347	34.289	536.917	172.817	36.738	21.838	225.098	25.500	478.686	21.477
15-Jun-25	221.678	55.855	477.922	196.714	147.828	29.975	256.614	2.088	277.739	224.897
16-Jun-25	84.508	52.091	319.189	289.227	40.584	12.865	175.524	14.132	251.875	142.587
17-Jun-25	76.733	67.887	436.118	234.361	13.308	12.232	325.737	148.064	309.716	215.344
18-Jun-25	158.472	18.416	282.684	125.020	46.203	1.601	76.852	123.595	272.342	262.129
19-Jun-25	253.146	83.345	114.003	89.879	101.204	19.767	278.565	64.592	233.684	285.176
20-Jun-25	142.193	66.253	133.726	178.725	6.362	8.631	309.577	109.885	195.512	228.453
21-Jun-25	66.478	23.889	762.589	26.609	153.011	5.430	198.054	143.707	577.630	281.632
22-Jun-25	218.045	62.560	341.946	314.699	140.993	18.048	149.557	145.808	342.368	15.409
23-Jun-25	104.062	57.677	242.073	222.408	119.748	5.038	286.671	79.558	435.784	74.619
24-Jun-25	90.932	53.266	180.574	57.018	1.621	7.718	275.151	17.908	165.734	306.272
25-Jun-25	185.783	39.558	711.554	311.136	79.501	32.537	138.204	38.096	35.667	284.669
26-Jun-25	61.113	53.392	233.908	52.647	14.246	24.344	75.392	19.770	134.874	208.302
27-Jun-25	103.294	59.077	618.044	93.312	139.239	9.114	138.038	147.219	3.253	28.231
28-Jun-25	102.086	79.436	66.943	327.409	130.760	12.118	170.568	117.955	246.569	41.599
29-Jun-25	96.681	71.758	478.229	134.745	40.533	7.587	182.369	56.711	681.169	252.769
30-Jun-25	198.412	15.539	302.497	81.857	77.033	30.397	118.912	169.154	128.717	221.400

DAYS (24HRS)	St. Mary Dedication Sch.		Govt. Laundry		Market Square		Leventis		Emporium	
	PEAK LOAD READING (kW)	PEAK REACTIVE LOAD READING (kVar)	PEAK LOAD READING (kW)	PEAK REACTIVE LOAD READING (kVar)	PEAK LOAD READING (kW)	PEAK REACTIVE LOAD READING (kVar)	PEAK LOAD READING (kW)	PEAK REACTIVE LOAD READING (kVar)	PEAK LOAD READING (kW)	PEAK REACTIVE LOAD READING (kVar)
1-Jun-25	60.354	82.102	183.476	12.723	360.020	116.314	64.033	9.781	266.388	25.925
2-Jun-25	105.697	194.282	218.866	63.935	278.607	238.266	127.477	148.272	167.704	22.487
3-Jun-25	28.277	202.302	204.404	43.171	75.563	44.269	180.147	132.031	61.655	20.027
4-Jun-25	419.565	99.661	50.988	42.612	208.935	227.138	247.400	102.170	27.929	66.868
5-Jun-25	450.804	73.565	265.463	36.712	433.200	40.357	14.036	147.578	185.129	77.859
6-Jun-25	284.386	106.474	50.108	38.768	100.238	78.189	49.209	11.987	304.287	93.274
7-Jun-25	605.310	51.206	158.658	21.814	283.140	54.238	142.138	162.651	351.590	39.619
8-Jun-25	384.059	194.813	92.899	6.283	169.877	183.276	286.821	182.404	23.715	22.182
9-Jun-25	496.402	84.559	266.385	13.980	284.329	69.906	330.387	70.085	145.758	35.733
10-Jun-25	331.739	218.473	127.601	80.429	274.234	175.876	156.727	207.374	224.932	37.345
11-Jun-25	226.171	119.760	7.014	68.835	455.954	109.935	344.622	173.809	315.246	2.257
12-Jun-25	43.044	101.106	70.612	17.808	29.703	150.904	144.615	133.797	127.396	29.646
13-Jun-25	514.818	244.766	104.870	87.001	417.749	258.332	384.020	13.415	340.946	25.571
14-Jun-25	597.648	80.491	167.151	65.637	183.538	262.873	75.853	92.335	15.826	8.201
15-Jun-25	369.201	156.907	105.498	35.943	345.152	160.809	396.732	87.320	93.943	27.052
16-Jun-25	370.522	145.524	36.806	9.724	190.694	188.588	161.967	201.820	271.882	43.578
17-Jun-25	389.921	206.444	54.017	4.829	258.645	148.659	238.568	109.040	172.478	49.688
18-Jun-25	465.225	171.149	64.578	74.192	393.177	175.009	13.878	115.058	292.974	99.791
19-Jun-25	261.558	20.516	145.353	19.566	101.135	208.062	35.411	104.490	365.200	20.973
20-Jun-25	221.712	88.689	77.994	41.893	205.943	11.485	380.717	176.029	98.305	39.769
21-Jun-25	165.979	229.255	97.259	61.351	71.397	136.245	226.241	57.356	316.052	93.456
22-Jun-25	257.603	162.060	197.619	47.130	445.719	221.393	296.638	41.215	86.924	91.410
23-Jun-25	462.520	165.994	241.361	29.205	256.593	78.581	356.899	70.171	210.169	16.143
24-Jun-25	392.972	29.742	241.625	0.261	430.822	12.037	129.207	179.059	113.288	57.562
25-Jun-25	180.044	183.992	69.763	21.220	368.510	261.502	108.721	69.475	114.074	73.539
26-Jun-25	95.094	147.456	100.944	44.039	453.312	220.796	393.437	92.309	364.610	73.518
27-Jun-25	222.147	50.839	194.889	86.993	306.792	200.379	188.421	145.859	240.194	26.939
28-Jun-25	551.325	273.965	236.236	75.726	236.379	114.353	322.725	85.372	110.164	100.193
29-Jun-25	255.739	273.715	152.393	21.600	421.381	134.887	45.475	32.296	0.668	81.446
30-Jun-25	73.364	148.192	54.067	49.119	157.062	250.341	339.280	5.341	291.472	100.047

DAYS (24HRS)	JBS2		JBS1		Aimure		Cris Ogiemwonyi		New Langer Hotel	
	PEAK LOAD READING (kW)	PEAK REACTIVE LOAD READING (kVar)	PEAK LOAD READING (kW)	PEAK REACTIVE LOAD READING (kVar)	PEAK LOAD READING (kW)	PEAK REACTIVE LOAD READING (kVar)	PEAK LOAD READING (kW)	PEAK REACTIVE LOAD READING (kVar)	PEAK LOAD READING (kW)	PEAK REACTIVE LOAD READING (kVar)
1-Jun-25	177.281	62.798	92.582	105.910	531.887	120.991	29.731	14.365	225.816	14.892
2-Jun-25	152.082	141.734	546.756	15.125	94.990	28.791	58.238	15.815	47.260	17.085
3-Jun-25	164.777	87.958	137.061	125.584	343.917	31.358	0.371	5.713	65.970	58.468
4-Jun-25	149.080	132.402	248.001	126.158	255.187	130.757	12.622	18.844	286.560	64.142
5-Jun-25	14.955	76.428	208.297	176.208	38.343	116.679	68.626	10.043	161.831	78.513
6-Jun-25	217.095	146.508	180.628	121.993	401.171	19.963	51.494	0.683	295.534	73.536
7-Jun-25	313.082	150.270	91.149	98.934	517.248	26.891	54.270	4.565	81.961	12.954
8-Jun-25	141.240	143.294	683.893	84.072	190.761	39.423	2.089	9.127	276.729	46.845
9-Jun-25	231.276	155.843	517.364	102.412	244.721	149.594	47.684	8.812	156.583	82.514
10-Jun-25	94.443	19.823	138.564	73.591	352.241	116.813	8.095	13.623	65.783	74.837
11-Jun-25	337.286	103.146	63.415	55.714	48.610	4.002	77.980	10.119	274.956	55.954
12-Jun-25	235.321	119.130	545.181	101.694	283.214	99.647	27.734	9.944	279.156	27.153
13-Jun-25	169.181	154.800	739.405	71.328	266.975	40.360	77.191	3.584	40.233	48.478
14-Jun-25	41.386	103.375	697.295	153.464	259.947	30.629	63.940	6.107	254.139	58.753
15-Jun-25	247.460	72.977	238.717	150.096	184.090	28.817	80.081	8.366	206.441	36.193
16-Jun-25	294.753	21.063	307.905	12.235	258.893	124.644	0.495	0.947	174.851	41.713
17-Jun-25	232.245	4.687	694.929	35.666	517.209	136.170	28.527	20.072	107.210	75.186
18-Jun-25	252.568	125.558	727.941	27.215	88.244	5.591	23.531	8.157	114.025	54.638
19-Jun-25	209.695	14.303	54.333	181.817	530.998	121.002	21.342	15.290	172.775	56.683
20-Jun-25	49.413	4.021	634.363	6.146	425.653	135.865	61.016	8.674	112.542	15.200
21-Jun-25	149.704	107.304	768.999	109.375	16.385	7.667	69.707	3.486	39.055	70.099
22-Jun-25	338.529	96.101	74.126	85.804	548.838	144.973	27.176	14.644	160.860	45.273
23-Jun-25	195.423	66.445	574.072	38.303	157.579	41.674	71.092	9.221	276.453	68.469
24-Jun-25	177.060	146.341	292.751	135.030	121.576	26.222	57.853	18.284	252.155	23.107
25-Jun-25	339.271	51.145	212.183	117.523	216.266	75.731	16.830	16.613	340.766	40.724
26-Jun-25	320.962	48.291	543.707	153.111	36.017	56.222	90.912	15.259	83.659	74.667
27-Jun-25	313.687	132.254	405.563	113.277	264.729	132.186	0.173	11.078	137.224	56.963
28-Jun-25	11.918	16.539	50.331	84.263	453.658	3.026	83.037	13.656	198.551	78.122
29-Jun-25	107.705	63.217	109.557	101.056	36.546	75.408	29.840	9.229	82.595	25.910
30-Jun-25	326.519	74.643	426.731	148.098	122.507	10.308	91.222	11.279	197.028	21.427

DAYS (24HRS)	**Imuentiyan1**		**Odubu**		**Imuentiyan2**		**Ogbomoatu**		**Okonga**	
	PEAK LOAD READING (kW)	**PEAK REACTIVE LOAD READING (kVar)**	**PEAK LOAD READING (kW)**	**PEAK REACTIVE LOAD READING (kVar)**	**PEAK LOAD READING (kW)**	**PEAK REACTIVE LOAD READING (kVar)**	**PEAK LOAD READING (kW)**	**PEAK REACTIVE LOAD READING (kVar)**	**PEAK LOAD READING (kW)**	**PEAK REACTIVE LOAD READING (kVar)**
1-Jun-25	151.270	100.652	85.493	7.948	97.143	34.314	310.036	148.724	431.535	119.678
2-Jun-25	25.428	110.320	88.291	7.793	294.637	73.914	54.895	100.222	310.829	98.032
3-Jun-25	106.502	7.725	14.790	3.504	475.798	95.259	52.112	89.438	290.955	97.016
4-Jun-25	303.138	12.665	4.327	6.222	329.863	100.347	238.961	97.491	130.254	38.382
5-Jun-25	294.463	97.987	26.517	6.195	533.102	25.724	358.559	43.220	426.880	120.958
6-Jun-25	383.099	13.454	61.155	8.079	305.070	120.470	289.075	16.361	51.882	105.414
7-Jun-25	190.101	32.494	93.541	3.056	363.681	117.204	276.855	9.340	24.956	27.060
8-Jun-25	31.327	93.105	84.420	7.061	433.113	45.552	279.761	6.916	487.622	9.979
9-Jun-25	41.724	89.801	43.051	2.252	196.650	125.845	198.121	107.625	228.858	30.752
10-Jun-25	375.653	78.473	27.873	1.024	199.943	86.513	6.949	113.406	153.175	102.552
11-Jun-25	158.918	72.660	70.950	2.096	376.569	80.508	64.196	118.847	111.281	80.383
12-Jun-25	192.417	56.871	65.190	7.865	126.851	110.251	276.714	25.803	226.263	68.875
13-Jun-25	332.154	3.570	42.796	1.019	468.478	110.781	536.659	155.953	237.908	43.216
14-Jun-25	252.949	103.017	64.980	7.533	70.293	117.278	570.889	116.019	329.315	35.968
15-Jun-25	190.555	1.386	70.133	7.570	537.457	70.318	342.058	57.042	327.399	0.111
16-Jun-25	113.469	24.181	8.001	5.866	387.054	89.202	166.874	56.968	324.325	118.605
17-Jun-25	34.735	41.927	55.088	0.221	398.457	81.440	228.372	33.037	185.084	55.512
18-Jun-25	343.908	105.219	20.363	4.707	99.528	52.062	403.355	113.146	46.015	68.599
19-Jun-25	315.420	6.930	23.165	4.586	486.154	112.902	47.517	124.613	31.020	111.858
20-Jun-25	244.136	10.153	51.227	4.498	151.363	77.157	170.083	17.289	31.019	93.378
21-Jun-25	159.469	42.526	5.344	2.414	78.751	65.533	481.496	3.779	179.244	79.641
22-Jun-25	35.168	50.550	87.685	2.682	381.526	39.868	211.672	2.401	447.520	78.075
23-Jun-25	168.386	44.230	17.819	2.686	33.625	4.802	434.117	49.380	21.705	104.350
24-Jun-25	286.286	1.553	5.979	6.873	98.183	108.515	33.212	22.605	510.846	104.877
25-Jun-25	129.379	95.629	80.813	3.678	250.547	51.645	118.165	34.425	477.458	57.740
26-Jun-25	73.329	104.674	18.735	2.735	263.448	115.579	2.137	15.964	274.240	18.553
27-Jun-25	165.462	91.772	19.533	1.792	267.004	47.139	64.327	86.174	196.151	35.202
28-Jun-25	356.634	58.881	19.061	0.932	250.843	22.583	24.174	111.044	482.185	14.469
29-Jun-25	336.315	111.800	88.307	6.269	408.613	89.795	597.845	129.687	497.194	11.622
30-Jun-25	388.206	51.493	22.173	4.646	145.755	6.301	582.511	130.579	409.981	98.945

DAYS (24HRS)	Godwin Omonuwa		Gen. Charles Airewele		Obasogie2		E-Jerry		NOA	
	PEAK LOAD READING (kW)	PEAK REACTIVE LOAD READING (kVar)	PEAK LOAD READING (kW)	PEAK REACTIVE LOAD READING (kVar)	PEAK LOAD READING (kW)	PEAK REACTIVE LOAD READING (kVar)	PEAK LOAD READING (kW)	PEAK REACTIVE LOAD READING (kVar)	PEAK LOAD READING (kW)	PEAK REACTIVE LOAD READING (kVar)
1-Jun-25	149.797	58.170	114.035	112.000	33.406	10.884	91.035	33.910	547.844	134.496
2-Jun-25	78.423	23.405	297.579	86.250	50.108	7.754	100.175	16.508	45.587	76.004
3-Jun-25	306.284	90.178	218.306	88.100	55.818	10.641	65.789	29.576	571.404	154.735
4-Jun-25	463.535	30.343	8.023	10.775	26.189	11.497	100.796	14.452	368.950	86.772
5-Jun-25	211.604	44.888	120.522	25.074	25.572	2.018	44.793	16.509	2.888	119.331
6-Jun-25	180.987	8.266	289.488	74.364	37.388	0.518	36.957	32.242	60.868	51.135
7-Jun-25	125.503	103.608	307.310	56.289	48.209	9.989	64.348	17.536	379.769	45.808
8-Jun-25	58.821	58.137	318.780	110.116	53.782	1.487	40.822	22.331	51.900	89.045
9-Jun-25	113.869	48.933	141.256	114.328	40.449	11.658	39.755	2.782	528.782	14.528
10-Jun-25	362.348	151.157	132.216	61.270	33.283	9.355	91.569	7.340	64.314	88.236
11-Jun-25	339.803	81.976	132.955	95.732	23.012	6.817	126.558	16.844	172.938	38.185
12-Jun-25	430.615	21.485	229.588	61.261	49.003	5.486	90.793	25.925	380.613	118.043
13-Jun-25	413.668	32.172	403.085	50.949	32.989	3.586	17.946	17.604	576.345	14.726
14-Jun-25	47.497	40.241	61.573	107.214	52.152	10.180	32.387	19.930	472.074	66.003
15-Jun-25	184.031	7.972	306.160	21.776	51.170	7.671	78.319	28.790	400.085	98.214
16-Jun-25	305.662	119.768	428.347	38.993	1.877	10.587	18.454	6.845	222.690	87.242
17-Jun-25	216.519	188.756	91.296	24.559	16.268	8.285	19.233	22.206	430.522	55.658
18-Jun-25	375.779	14.157	170.144	105.572	1.493	3.500	127.527	34.229	311.507	149.448
19-Jun-25	310.861	93.634	371.072	100.269	3.012	13.045	11.961	3.931	461.439	72.160
20-Jun-25	87.807	98.541	200.435	84.224	30.744	3.140	30.280	16.983	247.434	74.784
21-Jun-25	282.925	51.726	96.097	29.905	25.360	3.640	42.904	15.269	398.679	44.733
22-Jun-25	425.701	185.017	146.685	12.361	32.304	9.509	82.146	19.839	34.867	89.341
23-Jun-25	446.434	8.825	171.564	83.147	37.311	12.991	10.726	25.470	155.146	146.592
24-Jun-25	174.665	196.049	167.696	15.718	34.997	11.590	31.072	5.932	188.820	95.675
25-Jun-25	122.040	148.622	233.617	7.726	56.236	10.325	104.614	24.144	35.489	23.741
26-Jun-25	384.976	133.347	106.004	82.157	17.256	12.690	26.615	28.561	74.575	113.015
27-Jun-25	67.394	95.618	101.760	111.510	16.680	2.985	68.255	35.294	166.140	112.504
28-Jun-25	292.096	126.201	420.352	62.520	30.104	12.977	28.691	9.187	506.551	59.763
29-Jun-25	328.610	130.673	159.157	24.243	52.480	12.304	17.967	4.552	535.056	39.041
30-Jun-25	342.248	24.631	416.999	72.996	5.747	13.088	51.615	1.181	356.224	50.342

DAYS (24HRS)	Oni-Okpaku		Ishegie		Zain mast		Adun Close		Obasogie1	
	PEAK LOAD READING (kW)	PEAK REACTIVE LOAD READING (kVar)	PEAK LOAD READING (kW)	PEAK REACTIVE LOAD READING (kVar)	PEAK LOAD READING (kW)	PEAK REACTIVE LOAD READING (kVar)	PEAK LOAD READING (kW)	PEAK REACTIVE LOAD READING (kVar)	PEAK LOAD READING (kW)	PEAK REACTIVE LOAD READING (kVar)
1-Jun-25	232.173	76.917	12.936	3.847	43.775	2.633	136.841	25.478	101.085	44.431
2-Jun-25	253.724	126.620	0.249	30.514	47.992	0.991	122.813	9.138	49.403	30.641
3-Jun-25	217.348	22.299	36.677	10.358	29.971	4.585	36.318	22.747	4.957	25.187
4-Jun-25	80.718	78.516	15.536	32.255	48.175	12.985	147.649	11.704	139.127	11.379
5-Jun-25	118.515	6.731	93.182	9.885	37.789	4.498	213.092	11.640	47.509	4.977
6-Jun-25	74.352	46.179	95.411	16.977	50.278	10.257	195.469	21.493	2.862	52.667
7-Jun-25	93.669	77.380	21.356	15.065	64.769	3.860	5.754	16.182	127.059	15.613
8-Jun-25	135.833	55.485	71.531	26.090	18.277	14.432	3.089	12.152	158.705	41.567
9-Jun-25	216.750	4.827	38.027	34.696	63.396	11.678	197.709	6.441	51.847	1.433
10-Jun-25	117.587	56.338	107.584	23.579	60.981	14.753	140.505	24.396	132.205	46.824
11-Jun-25	255.927	25.265	118.617	19.558	47.808	7.634	1.240	26.362	50.132	7.026
12-Jun-25	34.540	130.081	76.771	16.358	56.552	1.551	211.916	28.420	135.955	34.901
13-Jun-25	241.386	100.121	130.695	12.613	49.103	3.758	105.163	9.495	151.004	30.700
14-Jun-25	173.267	107.062	52.906	4.998	21.379	7.774	101.569	20.909	4.188	40.502
15-Jun-25	246.400	0.840	8.470	0.189	0.650	0.816	196.538	27.692	30.503	30.336
16-Jun-25	148.905	100.370	76.146	26.338	22.411	3.246	75.017	20.243	33.914	52.432
17-Jun-25	148.632	110.182	24.743	22.057	8.632	11.325	135.723	26.816	39.456	9.715
18-Jun-25	148.152	100.313	8.849	4.542	14.848	10.307	259.486	3.407	107.964	36.258
19-Jun-25	49.271	38.254	114.902	20.740	0.493	11.613	262.487	5.564	10.518	21.151
20-Jun-25	226.773	84.230	36.020	10.935	70.428	12.450	174.545	8.424	133.320	0.833
21-Jun-25	186.688	31.684	55.193	6.536	1.762	8.380	53.930	8.012	174.508	50.157
22-Jun-25	35.726	108.304	122.796	21.964	13.863	8.743	174.187	2.519	156.931	8.034
23-Jun-25	184.681	91.697	56.353	6.327	31.336	8.765	231.176	7.875	126.832	1.692
24-Jun-25	125.756	44.962	100.404	7.804	21.999	6.055	127.307	17.195	94.345	19.321
25-Jun-25	32.853	21.336	53.282	9.249	63.451	12.660	107.744	8.477	158.475	48.315
26-Jun-25	250.754	10.087	129.854	23.558	25.192	12.430	211.265	3.706	108.832	42.642
27-Jun-25	184.952	59.983	50.404	18.995	69.264	12.370	223.543	4.764	3.621	49.754
28-Jun-25	102.868	97.175	72.963	13.648	5.782	5.133	215.256	23.154	14.488	0.416
29-Jun-25	208.807	52.958	22.421	23.774	23.509	12.780	188.011	18.569	162.177	6.251
30-Jun-25	208.791	122.805	144.521	21.851	66.735	1.840	91.658	10.428	25.776	16.048