UNIVERSITY OF CAPE COAST

HOUSEHOLDS' VALUATION OF POWER OUTAGES IN GA WEST MUNICIPALITY OF GREATER ACCRA REGION: AN APPLICATION OF A CHOICE EXPERIMENT

RICHARD AGYEKUM

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BY

RICHARD AGYEKUM

Thesis submitted to the Department of Economic Studies of the School of Economics, College of Humanities and Legal Studies, University of Cape Coast, in partial fulfillment of the requirements for the award of Master of Philosophy degree in Economics.

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DECLARATION

Candidate's Declaration

I hereby declare that this thesis is the result of my own original research and no part of it has been presented for another degree in this university or elsewhere.

Candidate's Signature……Date…….

Name: Richard Agyekum

Supervisor's Declaration

We hereby declare that the preparation and presentation of the thesis were supervised in accordance with the guidelines on supervision of thesis laid down by the University of Cape Coast.

Principal Supervisor's Signature…….Date……

Name: Dr. Godwin Kofi Vondolia

Co-Supervisor's Signature……Date……..

Name: Mr. Kwabena Nkansah Darfor

ABSTRACT

Contemporary energy sources are pivotal for socio-economic development in developing nations, offering a means to alleviate poverty. However, heavy reliance on wood poses health and socio-economic challenges. This study focuses on enhancing electricity services to address these issues, utilizing choice experiments (CE) to gauge preferences.

The research surveyed 400 households in Ga West Municipality, Greater Accra, employing mixed logit estimation to assess attributes of power outages like planned and unplanned occurrences, duration, and scope. Findings reveal households are willing to invest Gh¢ 8.51, Gh¢ 7.21, and Gh¢ 1.54 annually to reduce planned outages, unplanned disruptions, and outage duration, respectively.

Policy recommendations advocate for a comprehensive approach, prioritizing district-level improvements and allocating resources for infrastructure development and regular maintenance to mitigate disruptions. Prompt response mechanisms for unplanned outages are essential, given residents' willingness to invest Gh¢ 7.21 annually. Furthermore, prioritizing initiatives to shorten outage durations, supported by household willingness to pay Gh¢ 1.54 annually, is crucial. Investments in technology and procedures are advised to enhance service quality.

Implementing these recommendations can significantly enhance electricity service reliability, affordability, and overall quality in Ga West Municipality, ultimately improving residents' lives in the Greater Accra region

KEY WORDS

Attributes of power outages

Duration of power outage

Planned power outage

Power outages

Unplanned power outage

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DEDICATION

To my parents.

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LIST OF ACRONYMS

AGI	Association of Ghana Industries
BGS	Bulk Generation Charge
BSP	Bulk Supply Point
BST	Bulk Supply Tariff
CBA	Cost Benefit Analysis
CE	Choice Experiment
CEM	Choice Experiment Method
CMCEL	Current Monthly Cost of Electricity
CVM	Contingent Valuation Method
DCE	Discrete Choice Experiment
DSC	Distribution Service Charge
ECG	Electricity Company of Ghana
EPC	Enclave Power Company
EUT	End-user tariff
GRIDCo	Ghana Grid Company
GWh	Gigawatt hour
HEDU	Highest Educational Level of Respondents
HHMIC	Household Monthly Income
HHS	Household Size
IIA	Independence of irrelevant variables
KWh	Kilowatt hour
ML	Mixed Logit
MLE	Mixed logit estimation
MMDA	Metropolitan, Municipal and District Assemblies

MNL	Multinomial Logit
MPM	Market Price Method
MW	Megawatts
MWTP	Marginal Willingness to Pay
NEDCo	Northern Electricity Distribution Company
PURC	Utility Regulatory Commission
RCM	Replacement Cost Method
REL	Reliability of Current Power Supply
SEX	Sex of Respondent
SLT	Special Load Tariff
TICo	Takoradi International Company
TSC	Transmission Service Charge
TUC	Trade Union Congress
VRA	Volta River Authority
WAGPCo	West Africa Gas Pipeline Company
WTA	Willingness-to-accept
WTP	Willingness-to-pay

CHAPTER ONE

INTRODUCTION

In the introduction chapter of the study, topics such as the study's background, statement of the problem, purpose of the study, research questions, research hypothesis, significance of the study, delimitation, limitations, definitions of terms and the organisation of the thesis are discussed.

Background to the study

Electricity is an important resource that has an impact on every sphere of human life. Applications in the residential, social and commercial sectors all require it as a necessary component. This is especially important for developing nations that are still in the process of industrialising their economies and whose national development goals require a reliable supply of electricity *(Sasu, 2022)*. For example, the vast bulk of Ghana's activities cannot be carried out without the use of electricity in any significant capacity. Power is essential to the functioning of all economic sectors, including manufacturing, mining, and service industries. The inability to purchase this commodity will have a detrimental effect on individuals, families, companies and the country as a whole.

Numerous household activities, including cooking, cleaning, ironing, and lighting, as well as others, are dependent on the availability of power in many households. As a result of the vast majority of technical devices being powered by electricity, people have become increasingly reliant on electricity power as technological advancements have occurred *(Bell et al., 2015)*.

In the year 2015, around 4.1 million individuals were utilising Ghana's electricity, and in that same year, 10,625- gigawatt hours electricity was utilised by Ghanaians. The quantity of power absorbed is projected to more than 50% increased by the year 2020, going from 10,625 GWh in 2015 to 16,531 GWh in 2020 *(Ghana Energy Commission, 2021)*. This demonstrated that the number of people who require the use of electricity power has been steadily growing. Domestic activities are projected to account for approximately fifty percent of Ghana's total energy usage. *(ISSER, 2015; Ministry of Energy, 2017)*. These activities include lighting, ironing, cooling, heating, television, radio, and refrigeration. Consumers in the commercial and industrial sectors are accountable for the remaining fifty percent of total electricity use.

Individuals do run businesses that produce income from their households using internet access and computers, and others conduct small-scale commercial operations that require electricity, like tailoring, maize milling, and hairdressing, among others. These types of businesses require power. Electricity can have an impact on a worker's leisure time, which is an important component of the utility of the worker, because certain leisure activities might demand the utilisation of electricity energy. It is developing ever more challenging to survive without the use of electricity, particularly in urban places in which the advantages of using electricity power are much more readily accessible. Individuals of both urban and rural communities feel frustrated whenever the relevant authorities stop the delivery of electricity because of their reliance on it. This is true regardless of whether the community is urban or rural *(Adjei-Mantey, 2013)*.

Four important institutions supervise the distribution of electricity in Ghana; and theses are, the Volta River Authority (VRA), the Ghana GRID Company (GRIDCo), the Electricity Corporation of Ghana (ECG), and the subsidiary of the VRA, the Northern Electricity Distribution Company (NEDCo). Electricity is generated or produced by the VRA utilising a variety of hydro and thermal power plants. This responsibility falls under the agency's purview. Transportation and transmission of electricity from wholesale suppliers (generating businesses) to bulk clients, such as the Electricity Company of Ghana (ECG), the Northern Electricity Distribution Company (NEDCo), and the Mines, are principally the responsibility of GRIDCo. Both the Electricity Company of Ghana (ECG) and the Northern Electricity Distribution Company (NEDCo) are responsible for delivering power to end users within their respective areas of expertise. They acquire energy in bulk from the transmission organisation known as GRIDCo and then distribute it to various consumers. This category includes residences, enterprises, industries, and additional consumers. The NEDCo, a subsidiary of the VRA, is responsible for power distribution throughout the country's northern regions, including the Bono, Ahafo, and Bono east regions. The ECG is responsible for power distribution throughout the remainder of the country *(Adjei-Mantey, 2013).*

As human institutions and especially as state-owned institutions, the organisations responsible for producing and distributing energy encounter their own side of challenges. The poor management practices and laxity on the part of the employees are to blame for the unproductive distribution of energy to end users. In addition, some individuals of the general public avoid paying

energy rates by illegally connecting their homes and places of business, frequently with the assistance of personnel of ECG and NEDCo. It has become increasingly challenging for the generators, transmitters, and distributors of energy to maintain a steady and uninterrupted supply of electricity to their customers because of these and other factors *(Clark, 1998).*

This research elucidates and illuminates how power disruptions impact households and daily activities. The research adopts a choice experiment model for household decisions over how to improve electricity in our homes and communities. Households made choices based on the attributes of the good or service. For electricity service improvement, there are four attributes/characteristics identified, these attributes are planned outage, unplanned outage, duration of outage, and the geographical scope of power outage. Planned outage in a broad sense indicates the average number of planned outage occurrences experienced at the household level, whilst unplanned outage indicates the number of power outages occurring without prior notice from the power distribution companies. The duration of an outage also indicates the hours at which an outage occurs whereas the geographical scope of power outage shows the area where the power outage is restricted *(Abdullah & Mariel, 2010).*

Statement of the problem

Ghana is actively pursuing a nationwide access to electricity by 2030; as of 2020, 86% had access to electricity *(World Bank, 2022)*, while 94.7 percent urban population are on the national grid, also 90 percent of the rural population had access to electricity in 2020, an increase over the 83.9% recorded in 2019. Access to electricity is greater in urban regions than in rural

areas *(Sasu, 2023)*. Although electricity access is high in Ghana, with urban electrification at 94.7% and rural electrification at 90%, the power supply in many urban areas is unpredictable, calling into doubt the power's dependability. In order to improve the flow of energy supply and eliminate power interruptions, this study examines and estimates the marginal willingness to pay.

During a power outage, a household is assured to suffer welfare losses because they will be unable to use things that require the use of electricity. Damage has been done to many electronic home products, like televisions, refrigerators, deep freezers, and microwave ovens among others. Electric appliances may not be able to withstand the electrical shocks that can accompany frequent and unannounced power outages, which can ultimately lead to the failure of the appliances. The owners suffer a loss as a result of this, and they will have to pay additional fees to either repair or replace the affected items. Inconsistent power supply conditions can lead to losses for houses, such as the waste of food that has been stored in freezers but cannot be preserved due to a lack of electricity to run the refrigeration mechanism. In addition, thefts do occur in some households because there is either no power or the power is intermittent *(Adams et al., 2020; Taale & Kyeremeh, 2016)*.

Investing in improved generation capacity, more resilient transmission and distribution infrastructure, and enhanced utility management can lower the social costs of unstable power. However, such enhancements are costly and may be difficult to finance or cause other long-term sustainability difficulties, especially when rates are kept significantly below required levels for cost recovery *(Meles et al., 2021)*. Evaluating the costs and advantages of unstable

energy is hampered by the fact that the negative effects of power outages on consumers are not reflected clearly in market prices. It is well-known, for example, that revealed preference measures such as coping or averting costs represent only a partial accounting of these costs *(Beenstock, 1991)* for a variety of reasons including technology limitations *(Pattanayak et al., 2005)*, credit constraints *(Alpizar et al., 2020)*, or differences in the quality of those alternatives *(Orgill-Meyer et al., 2018)*. These characteristics are likely to be especially binding for energy-poor individuals with limited resources to invest in alternatives *(Beenstock, 1991)*.

The Electricity Company of Ghana (ECG) has reaffirmed its commitment to providing Ghanaians with quality, dependable and safe power supplies throughout its operating territories. Since then, the power distribution firm has asked Ghanaians to pay for electricity responsibly and to report any illegal power theft to the appropriate authorities *(GhanaWeb, 2022)*.

Ga West Municipality is one of Accra's 29 municipalities, and its communities are among those that have the most problems with power outages. Due to these power problems, ECG gave the Ga West Municipality Hospital at Amasaman, in the municipality, a 200KVA transformer on September 25, 2022. The installed transformer, which cost GHC 200,000, should give the hospital and its health care services a steady and enough supply of electricity to fix the problems caused by frequent power outages *(GhanaWeb, 2022)*.

Households make choices based on the attributes of the product or the service for service improvement in this study, three attributes of electricity reliability were identified for this study namely, planned power outages,

unplanned power outages and duration of the outages. In addition, geographical scope was also added as an attribute where the outage is restricted. As a result, the study sought to determine whether households in Ga West municipality are willing to pay an additional amount for less of planned power outage, less unplanned power outage and less duration of the outages in the communities, given that the communities in Ga West Municipality are troubled with frequent power outages. Moreover, if households are willing to invest, how much are they willing to pay on these attributes in addition to their current electricity tariffs for electricity service reliability. The price that each household is willing to pay to increase electricity energy supply will vary based on how much power outages cost the household and its inhabitants.

Purpose of the Study

The purpose of the study was to examine the marginal willingness to pay (MWTP) for the various attributes of electricity identified for service improvement using choice experiments (CE).

Objective of the study

1. Identify the geographical scope of power outages in the Ga West Municipality of Accra.
2. Estimate the Marginal willingness to pay (MWTP) for reducing planned power outages by households in Ga West Municipality of Accra.
3. Estimate the Marginal willingness to pay (MWTP) for reducing an unplanned power outage in Ga West Metropolis.
4. Estimate the Marginal willingness to pay (MWTP) for reducing the duration of power outages in Ga West Municipality of Accra.

Research Questions

1. Which geographical scope or areas are power outages restricted?
2. How much are households in Ga West Municipality of Greater Accra region willing to pay in addition to their current tariffs for reduction in planned power outages?
3. How much are households in Ga West Metropolis willing to pay in addition to their current tariff to reduce an unplanned power outage?
4. How much are households in Ga West Municipality of Greater Accra region willing to pay in addition to their current electricity tariffs for a reduction in the duration of electricity power outages?

Research Hypotheses

H_0: There is no significant effect in the geographical scope of power outages in the Ga West Municipality of Accra.

H_0: Willingness to pay GH¢ 8.51 by households in Ga West Municipality of Greater Accra region has no significant effect in reducing planned power outages.

H_0: Willingness to pay GH¢ 7.21 by households in Ga West Metropolis of Greater Accra region has no significant effect in reducing unplanned power outages.

H_0: Willingness to pay GH¢ 1.54 by households in Ga West Municipality of Greater Accra region has no significant effect in reducing duration of power outages.

Significance of the Study

In Ghana, the application of a choice experiment to the evaluation of power outages by households in the Ga West Municipality of Accra has long been recognised in the environmental sector.

The findings of this study may contribute to the existing literature on electricity power outages in Ghana. The conclusions of this study may potentially be of pedagogical value for environmental analyst and policymakers.

The results of the estimation of households' marginal willingness to pay to reduce planned power outages will reveal what households in the municipality of Ga West want and assist policymakers in resolving issues related to planned power outages.

Again, the findings on the estimation of marginal willingness to pay for reducing unplanned power outages will assist electricity providers in tariff adjustment focusing on maintenance to prevent an excessive number of unplanned power outages, thereby increasing the supply of electricity in the Ga-West Municipality of Greater Accra region.

Lastly, the findings on estimating marginal willingness to pay for reducing the duration of power outages will encourage electricity stakeholders to invest more to reduce the number of hours that power outages last for Ga West Municipality households, to enjoy a reliable electricity power supply. So, this study is significant because it contributes fresh information to the literature regarding households' valuation of power outages.

Delimitation

It was not possible to visit all of the twenty-nine municipalities in the Greater Accra Region due to financial constraints and the limited time allotted for the study that was to be carried out. Although this work was initially intended to concentrate on the Municipalities of the Greater Accra Region as a whole, it was not possible to do so.

Limitation

The main limitation of the instrument was that some respondents had difficulty selecting the best option from the choice set, necessitating many explanations of the choice sets for some respondents, which wasted a great deal of time on a single responder. Some respondents were unwilling to participate because they assumed that I had been dispatched by the government or ECG to do this research. Some households perceive no reason to engage because they will not be compensated for their participation.

Due to criminals and fraudsters, we were also barred from entering certain households. Lastly, some households were unwilling to engage because they feared that, even if they were willing to pay for improved reliability and quality of electricity power, the utility companies and the government would misappropriate the funds due to the country's and ECG's high corruption rates.

Definition of terms

The following terms are defined as applicable to the study:

Power outage: A disruption in the electrical supply. The interruption of the electrical power supply to a consumer.

Discrete choice experiment: A discrete choice experiment uses survey methods to find out how people think the different parts of a service compare in terms of value.

Mixed logit estimation: The mixed logit model is a statistical model that can be used to look at any kind of discrete choice. It gets around three major problems with the standard logit model by allowing random differences in taste between choosers, unrestricted patterns of substitution across choices, and correlations between factors that cannot be seen over time.

Willingness to pay (WTP): Willingness to pay is the highest price a customer is willing to pay for a product or service.

Attributes: A quality or characteristic that is seen as essential or defining of an individual or thing.

Planned power outage: Planned power outages are deliberate choices by electricity providers to cut power to residents and businesses.

Unplanned power outage: Unplanned power outages show how many power outages happen without the power distribution company knowing ahead of time. This happened because of a fault, danger, or electrical emergency.

Duration of power outage: Indicates any interval of one minute or more between the commencement of an interruption to a customer and the restoration of service to that customer.

Organisation of the study

This study is made up of five chapters. The first chapter talks about the study's background, which provides context for the study, explaining the need for this research and the broader issues it addresses. It also clearly defines the research problem or gap in knowledge that the study aims to address, it

outlines the specific questions the study seeks to answer. This chapter also states the overall goals and objectives of the research and discusses the importance and relevance of the study in the broader context and lastly under this chapter, it clarifies key concepts or terms used in the study. In the second chapter, a summary of the relevant literature is given, it provides the surveys existing scholarly works related to the study, both theoretical and empirical. It also explores literature on how electricity is generated and consumed and reviews research on the cost associated with electricity generation and distribution. It examines studies on how electricity is valued, both within and outside of the market. The third chapter presents the theoretical underpinnings guiding the study. It also describes the research design, data collection methods, and data analysis techniques used in the study . The fourth chapter presents the findings of the study based on the data collected and also provides an analysis and interpretation of the results, addressing the research questions. In the last chapter, policy recommendations are offered based on the study's findings and areas for suggested further research were identified that could build upon the current study's findings.

Overall, this organizational structure provides a comprehensive and systematic approach to presenting the study, starting with the background and research questions and concluding with actionable recommendations and avenue for future research.

CHAPTER TWO

LITERATURE REVIEW

Introduction

This chapter gives an introduction to the theory and design of an electricity supply system, with a focus on how it can be used in developing countries. This overview talks about how electricity is made and used in Ghana, as well as a few different ways to measure the value of an economy, energy demand and price models, and a theoretical framework.

In the last part of the chapter, a review of the research that has already been done on the topic is given. The goal of the review is to find out what has been done and said about how much power outages cost and how much people are willing to spend to improve the electricity supply, as well as what parts of the study have not yet been looked at. The only way to reach these goals is to find out what has been done and what has been said.

Overview of the Electricity Generation and Consumption in Ghana:

Electricity Generation

The main source of Ghana's electricity supply come from hydroelectricity and thermal sources *(Ghana Energy Commission, 2021)* . The amount of energy that comes from renewable sources is slowly growing as costs keep going down and people work together to diversify the sources. In 2000, about 92% of the country's electricity came from hydroelectric plants, while the other 8% came from thermal plants. Even so, the mix of energy sources in 2020 was about 36.2% hydro, 63.6% thermal, and 0.3% renewables. From 10,166 GWh in 2010 to 20,170 GWh in 2020, the total amount of energy made will have grown by an average of 7.1% per year. In

2020, a total of 20,170 GWh of electricity was made. Of this amount, 7,293 GWh came from hydro, 12,820 GWh came from thermal, and 57 GWh came from other sources *(Ghana Energy Commission, 2021)*. The generation of energy from the year 2000 through the year 2020 is detailed in Table 1 below.

Table 1: Annual Electricity Generation

Year	Generation (GWh)				Share (%)		
	Hydro	Thermal	Other Renewables	Total	Hydro	Thermal	Other Renewables
2000	6,610	614	-	7,224	92	8	-
2001	6,609	1,250	-	7,859	84	16	-
2002	5,036	2,237	-	7,273	69	31	-
2003	3,885	1,996	-	5,881	66	34	-
2004	5,280	758	-	6,038	87	13	-
2005	5,629	1,159	-	6,788	83	17	-
2006	5,619	2,811	-	8,430	67	33	-
2007	3,727	3,251	-	6,978	53	47	-
2008	6,196	2,129	-	8,325	74	26	-
2009	6,877	2,081	-	8,958	77	23	-
2010	6,995	3,171	-	10,166	69	31	-
2011	7,561	3,639	-	11,200	68	32	-
2012	8,071	3,953	-	12,024	67	33	-
2013	8,233	4,635	3	12,870	64	36	0.02
2014	8,387	4,572	4	12,963	65	35	0.03
2015	5,844	5,644	3	11,491	51	49	0.03
2016	5,561	7,435	27	13,023	43	57	0.21
2017	5,616	8,424	28	14,067	40	60	0.20
2018	6,017	10,195	33	16,246	37	63	0.20
2019	7,252	10,885	52	18,188	40	60	0.28
2020	7,293	12,820	57	20,170	36	64	0.28

Source: Ghana Energy Commission, 2021

Stylized facts about Electricity in Ghana

Electricity Export and Import:

From 2018-2023, the country's export of energy has witnessed a significant increase, which has resulted in an overall increase in the amount of electricity produced there. This has occurred as a direct consequence of the

country's provision of electrical power to the neighbouring nation of Burkina Faso. The entire amount of power that was exported in 2020, which was responsible for 25.9 percent of the total, was greater than the amount that was exported in 2019. (See figure 1). On the other hand, imports of electricity dropped significantly from 320 GWh in 2017 to 58GWh in 2020, which is a compound annual decline of 43.3 percent. By the end of the year 2020, the amount of power that will have been imported into the country will account for 0.3 percent of the total electricity that will have been generated in the country. Ghana has been in the position of being a net exporter of electricity for the past three years running, and the year 2020 was the year that the country achieved the largest amount of net export, which represents an increase of 33.8 percent over 2019 *(Ghana Energy Commission, 2021).*

Figure 1: Electricity Import and Export

Source: Ghana Energy Commission, 2021

Electricity Demand and Supply Nexus

Over the previous two decades, the peak demand for the Ghanaian electricity system has climbed by around 166%. This is the same as a growth rate of about 5 percent per year. During the same period, the ability to make electricity has grown by more than double. Installed generation capacity is 2.2% lower in 2020 than it was in 2019, when it was 5,172 MW, but peak demand is 10.2% higher in 2020 than it was in 2019, when it was 2,804 MW *(Ghana Energy Commission, 2021).*

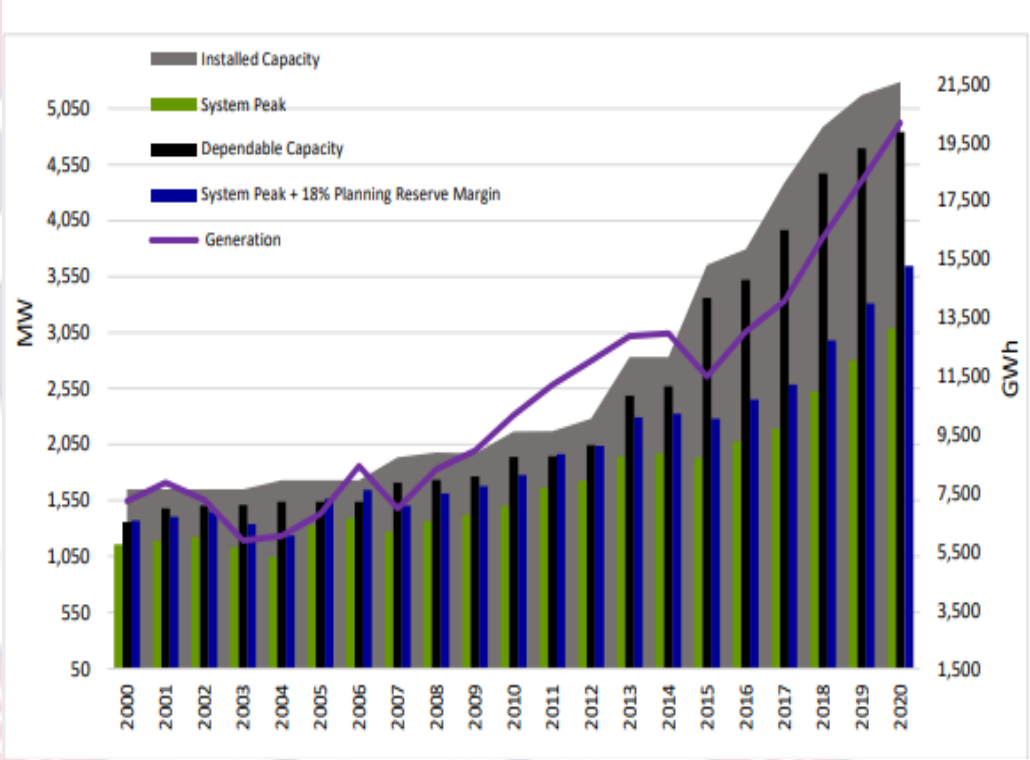

Figure 2: Trend in Installed and Dependable Capacity, Peak load, and Generation.

Source: Ghana Energy Commission, 2021

Electricity Transmitted and Losses

The overall amount of electricity that was transmitted is depicted in Figure 3, along with the transmission losses that were recorded throughout the

period. The overall quantity of electricity that was transported will have increased by around 144 percent by the year 2020, compared to what it was in the year 2000. Throughout 2019, the amount of energy that was transmitted climbed by 10.2 percent to reach its peak in 2020. In the period between the years 2000 and 2020, transmission losses increased at a rate that was equivalent to a compound annual growth rate of 7%. In the two years between 2019 and 2020, the overall transmission loss of the system increased by around 5.3%. (Figure 3). Since 2016, losses have consistently exceeded the 4.1 percent PURC threshold, with 2017 being the only exception *(Ghana Energy Commission, 2021b).*

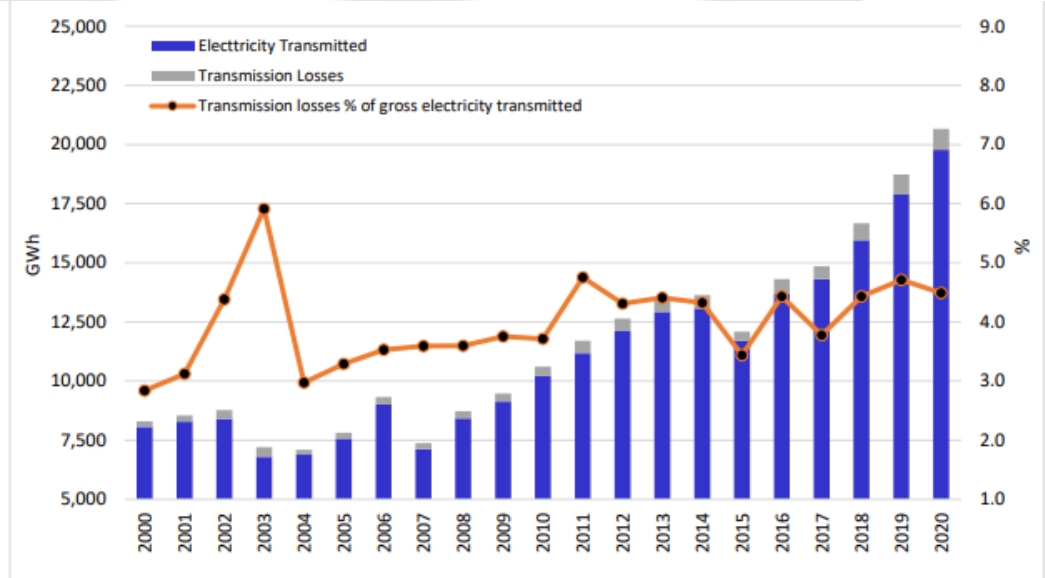

Figure 3: Electricity Transmitted and Transmission Losses

Source: Ghana Energy Commission, 2021

Electricity Purchase, Sales, and Losses by Distribution Utilities

Figure 4 shows how the Electricity Company of Ghana (ECG), the Northern Electricity Distribution Company (NEDCo), and the Enclave Power Company (EPC) buy and sell electricity. During the research period, the total number of goods bought by ECG and NEDCo grew at a rate equal to an

average annual growth rate of 6 percent for ECG and 8 percent for NEDCo. Since getting a distribution licence in 2015, EPC has grown by about 16 percent each year on average since the company started. Distribution utilities bought 14,524 GWh of electricity in 2020, compared to the 10,717 GWh they sold. The total amount of electricity sold by ECG, NEDCo, and EPC went up from 7,575 GWh, 889 GWh, and 155 GWh in 2017 to 9,333 GWh, 1,148 GWh, and 237 GWh, respectively, in 2020. ECG is the most important customer for the company because 87 percent of all sales come from them. With 11% and 2% of total sales, respectively, NEDCo and EPC are the company's second and third most valuable customers. In 2020, ECG, NEDCo, and EPC all had similar distribution losses of 3,374 GWh (88.6%), 428 GWh (11.3%), and 5 GWh (0.1%), respectively *(Ghana Energy Commission, 2021)*.

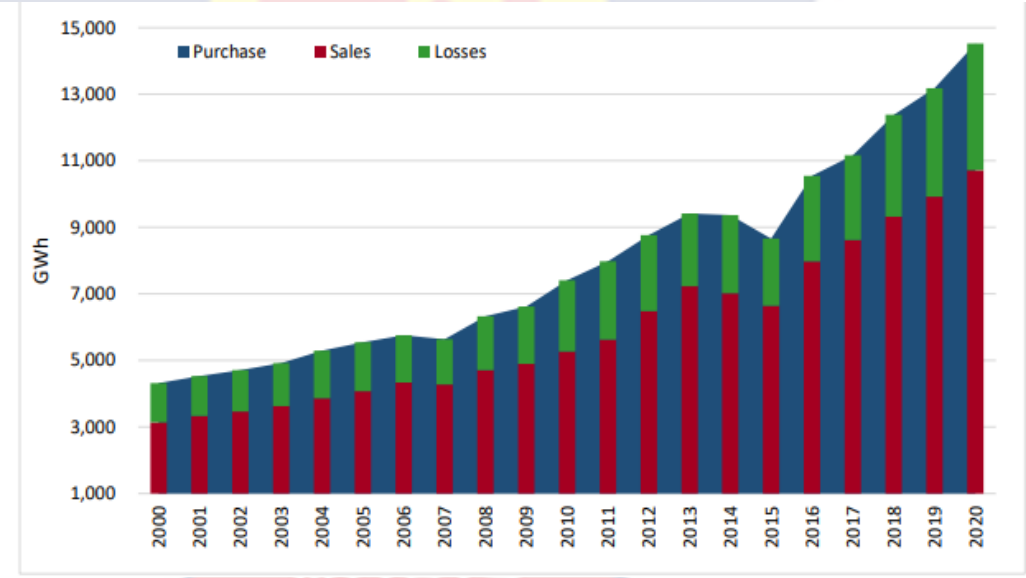

Figure 4: Electricity Purchase, Sales, and Losses

Source: Ghana Energy Commission, 2021

Electricity Consumption

Between the years 2000 and 2020, there was an increase of around 140 percent in the overall amount of power that was consumed by the various parts of the economy. Compared to 6889 GWh in the year 2000, consumption climbed by around 25 percent in the year 2003, and it increased by another 0.7 percent in the year 2015. On the other hand, total electricity consumption went up by 2.2 percent in 2004 compared to 2003, and by 17.9 percent in 2016 compared to 2015. Between 2003 and 2015, the loss was blamed on problems on the supply side, which led to a drop in overall electricity production. As a direct consequence of this loss, the total amount of electricity generation fell. Comparatively, the percentages of total power consumption accounted for by the industrial and residential sectors in 2020 were roughly 33.3 percent and 47 percent, respectively, whereas these percentages were around 34.5 percent and 46 percent in 2019 *(Ghana Energy Commission, 2021)*. The pattern of changes in energy consumption across different industries is presented in Figure 5.

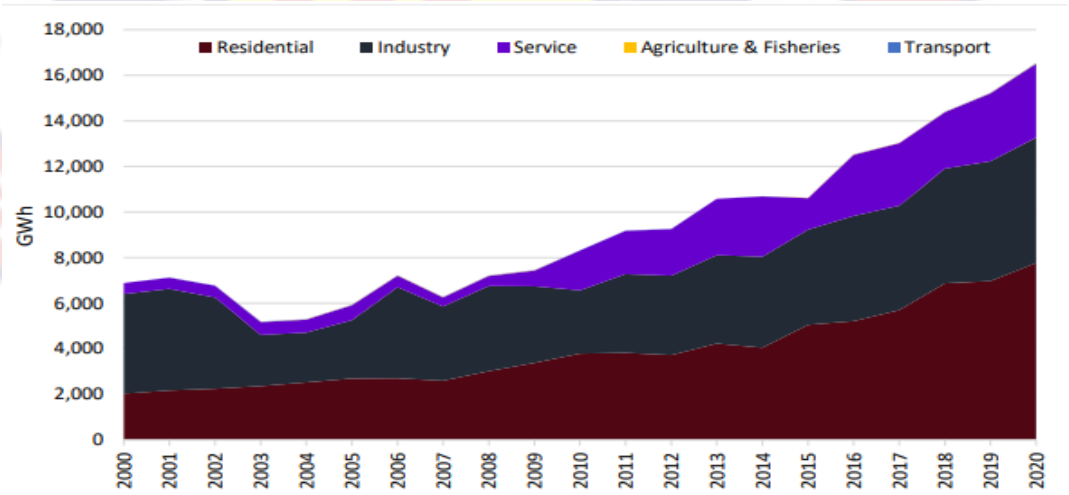

Figure 5: Electricity Consumption by Sectors

Source: Ghana Energy Commission, 2021

Consumer Population by classification

In 2020, there were a total of 5,11,000 customers. Between the years 2000 and 2020, the number of people who used ECG and NEDCo's services grew at 8.3% and 11.4%, respectively. Between 2015 and 2020, the number of customers who use EPC was being expected to grow at a 15.1% rate. In 2020, 19.9% of all customers were with NEDCo and 0.03% of all customers were with EPC. But ECG was still Ghana's biggest electricity provider, with about 80% of the country's customers. Between 2000 and 2020, the number of residential, non-residential, and Special Load Tariff (SLT) customers grew at rates of 9%, 7.5%, and 3.5%, respectively. In the year 2020, residential users comprised around 85.3% of the population, non-residential users approximately 14.6%, and SLT users approximately 0.4%, or approximately 5 million individuals *(Ghana Energy Commission, 2021)*.

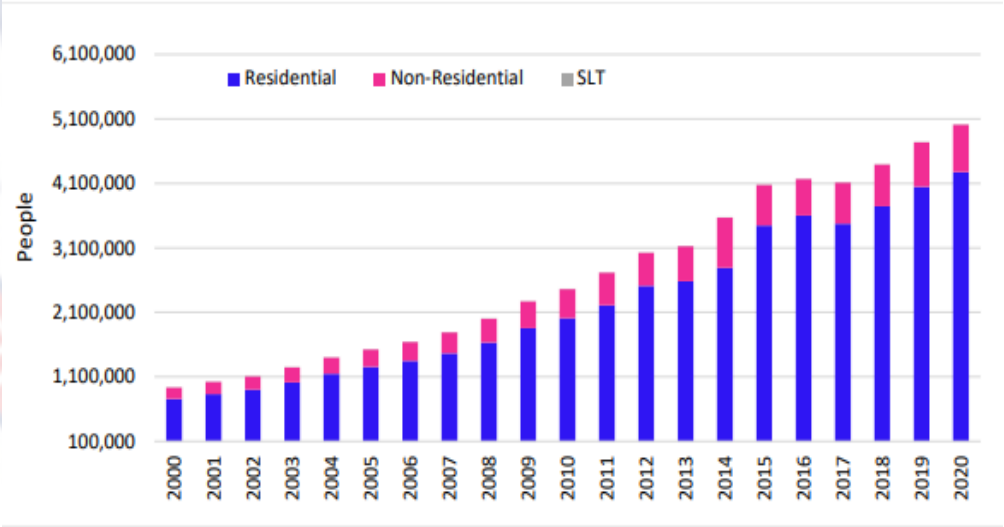

Figure 6: Consumer Population

Source: Ghana Energy Commission, 2021

Electricity tariff in Ghana

The price that people pay for electricity is the tariff. Demand theory says that the price of a good determines how much of it is bought. Most of the

time, electricity is used before payment (post-paid). With prepaid billing, people buy a certain amount of electricity before they actually use it. With postpaid billing, people use electricity and get a bill at the end of the month based on how many kilowatt hours (KWh) they used.

According to literature, there are usually three ways to price electricity. There are tariffs that stay the same, tariffs that go up, and tariffs that go down *(Adjei-Mantey, 2013; Adom, 2011).* With constant rates, people pay the same amount no matter how much KWh they use. The block tariff scheme is a way to charge consumers more as the amount of KWh they use goes up. This method encourages customers to save energy and use electricity efficiently, since smart customers would be specific about saving energy to keep their total power costs as low as possible. When block tariffs go down, the consumer pays less per kilowatt-hour of electricity used as his electricity use goes up. This system is meant to encourage people to use electricity instead of other types of energy. Since the user pays less as he uses more power, he is likely to use more KWh to take advantage of the lower prices.

The increasing block tariff scheme is more likely to be used in an economy where electricity production is low and electricity demand is high. On the other hand, the decreasing block tariff scheme is likely to be used in an economy where electricity production is high or where other forms of energy are scarce or expensive to produce.

The final tariffs that customers pay are made up of many different parts, Transmission Service Charge (TSC), Bulk Supply Tariff (BST), Bulk Generation Charge (BGC), and Distribution Service Charge (DSC). The End-user tariff (EUT) is made up of all of these things. BGC are payments made to

distribution utilities to help cover the cost of buying electricity from wholesale providers. The BST is the maximum amount that PURC allows distribution utility companies to charge consumers for purchasing capacity and energy at each Bulk Supply Point (BSP) through End-User rates. This amount is set by PURC. At Bulk Supply Points, the price of electricity is called BST. Transmission service costs (TSC) are the fees that the Transmission provider gets paid for providing transmission services. It is important to remember that the BST is equal to the sum of capacity and energy purchases from the wholesale power supply plus transmission service charges *(PURC, 2022)*. In other words, the BST is made up of both the bulk generation charges that the generating units owe and the transmission service charges. Distribution service charges (DSC) are payments made to distribution companies to cover the cost of their services. The total of the BST and the DSC is the End-User tariff (EUT) *(ISSER, 2015; Kumi, 2017)*. EUT is the price that businesses that sell goods charge the final consumer.

Industrial, commercial (non-residential), and residential users pay varying rates. The residential rate has a "lifeline" tariff for people who do not use much electricity. It started at a maximum of 100 kWh per month in 1989/90, then went down to a maximum of 50 kWh per month in 2000, and is now at a maximum of 30 kWh per month *(PURC, 2022)*.

Lifeline customers are those who use less than or equal to 30 kilowatt-hours of electricity each month. The "lifeline" consumer policy is based on the idea that energy is important for growth. So, everyone, no matter how much money they have, should have access to power. People with low incomes who

cannot pay for all of their electricity costs must still be able to use the service. So, people who use "lifeline" pay a low fixed rate as a service fee.

The PURC decides both the rate and the "lifeline" level of consumption by looking at the national minimum wage, the ability of rural consumers to pay, the price of a gallon of kerosene, and the average cost of electricity. PURC also decides who gets the "lifeline" consumption rate. The PURC looks at the national daily minimum wage when setting the lifeline level and rate, because the World Bank says that a person should not spend more than a certain percentage of their income on utilities.

Tariff Setting and Adjustment

The PURC is the group in Ghana that is in charge of changing tariffs. When necessary, they look at the tariffs, approve them, and send out changes.

Utility Service Providers such as Volta River Authority (VRA), Ghana National Gas Company (GNGC), Ghana Grid Company Limited (GRIDCo), Electricity Company of Ghana (ECG), Northern Electricity Distribution Company (NEDCo), and Enclave Power Company submitted proposals to start the tariff review process (EPC). The Commission also heard ideas from Ghana National Petroleum Company (GNPC) about expected natural gas volumes and prices based on gas supply sources (PURC, 2022).

As is usual, the PURC hold a lot of stakeholder consultations, which gives utility service providers a chance to tell the public and key interest groups, like the Association of Ghana Industries (AGI) and the Trades Union Congress (TUC) about their plans.

Tariff decisions for the years 2022 to 2025 were made after a lot of research, debate, and talking with a lot of people. The last big change to

energy prices happened in 2018, when residential customers saw a 17.5% drop and non-residential customers saw a 30% drop. Since then, key measures of the economy as a whole have gone down, especially since 2020. There are a number of things that make it harder for utilities to keep the lights on. The companies asked for an increase in rates for end users. ECG and NEDCo asked for 148% and 113% increases, respectively. VRA and GRIDCo both wanted to raise rates by 37% and 48%, respectively (PURC, 2022).

Reforms in Electricity production

There have been reforms in the production of power. VRA's responsibility was limited to power generating, while the Ghana Grid Company was given responsibility for electricity transmission (GRIDCo).

Since the 1960s, when the VRA was established and the Akosombo Dam was constructed, the VRA has been solely responsible for generating electricity. Prior to the introduction of private investors, the VRA was the sole organisation responsible for electricity generation. This was yet another sector-wide overhaul. Before initiating operations, potential private investors must submit an application to the Energy Commission and be granted the necessary licences. Beginning in the early 2000s, a number of firms entered the power producing sector, albeit in collaboration with the VRA. The Takoradi International Corporation (TICo) maintains a thermal plant alongside the VRA. 2008 was the year that the Sunon Asogli plant attained complete independence from the VRA. It is projected that power distribution will be opened up to private enterprises in the near future *(Adjei-Mantey, 2013; Miescher & Tsikata, 2009; Opam & Turkson, 2000).*

Challenges faced in Power Supply in Ghana.

In the last 10 years, Ghana has had a lot of trouble getting enough energy, which has cost the country an average of US$2.1 million per day in lost productivity *(Kumi, 2017)*. Even though installed generation capacity has more than doubled from 2,165 MW in 2010 to 5,285 MW in 2020 *(Ghana Energy Commission, 2021)*. During the same period, peak power use went from 1,506 MW to 3,010 MW. The problems with the energy supply can be traced back to a number of things, such as a high level of losses in the distribution system, which is mostly caused by old distribution equipment, and people not paying their bills. The cost of making electricity is hard for utility companies to recoup because of the way prices are set and because too much energy comes from thermal and hydro sources. Even with these problems, Ghana could reach universal access by 2030. Ghana's electricity problems need to be fixed by doing things like, but not limited to, expanding the prepaid metering system to include all public and private institutions, restructuring the tariff regime to make sure utilities can recover the cost of generation, and encouraging energy efficiency programmes *(Kumi, 2017)*.

Models of Electricity Demand and Pricing

The traditional demand theory says that the price of an item, the prices of other goods that go with it, and the consumer's income all affect demand. According to research that has been done on the subject of electricity demand, there are a few basic things that can change how much electricity is used. Among these are the price of electricity, the price of other energy sources, and the amount of money people actually have. But many studies have shown that

these are not the only things that affect energy demand. There are other things to think about.

It has been difficult to accurately measure the own-price component of electricity demand using some of the power demand models that have been developed. This is because there are three different ways to price electricity: constant rates, block tariffs that go up, and block tariffs that go down *(Adom, 2011)*. With constant tariffs, people know they will pay the same price for electricity no matter how much they use. The rising block tariff approach leads to the consumer experiencing more costs as their kWh consumption rises. This strategy encourages people to save energy and use it wisely because it is based on the idea that people will want to find ways to lower their overall electricity costs and, as a result, will be concerned about energy savings. In a price structure known as decreasing block pricing, the consumer incurs fewer costs even as his consumption of power measured in KWh increases. The fact that each of these pricing systems shows a different relationship between price and the amount of energy used makes it harder to determine how much the price affects the demand for electricity. Research has used a variety of approaches to solving this concern. Some scholars believe that average or marginal prices could serve as exogenous predictors of economic outcomes *(Adom, 2011)*. Others have suggested including marginal pricing and multiplying it by all tariff prices to get accurate numbers, while others have pushed for all important costs for a given user's usage to be combined into a single statement. Both of these approaches are intended to arrive at accurate figures.

When predicting power demand, another factor to take into consideration is the inventory of appliances and how this affects consumption.

It was anticipated that the variety and quantity of electrical appliances present in a home would affect the amount of power required. Researchers have argued that tackling this issue with discrete choice modes, sample selection tweaks, and discrete–continuous combinations would make it possible to estimate the amount of electricity consumed by each piece of equipment that is owned *(Adom, 2011).*

Non-Market Valuation:

Economic Valuation of Non-Market Goods

Non-market items are goods and services that are not part of the market, have no market or a very small market, and consumers are not forced to pay for. They possess the qualities outlined above; the vast majority of environmental goods cannot be sold on the open market. Many of these products that are favourable to the environment lack markets, which causes them to be more expensive. These few numbers show the lowest price at which buyers and sellers were willing to engage in a market transaction. At these prices, there will almost certainly be surpluses on both the production and consumption sides of the market. The economic worth of such commodities takes into account any surpluses that aren't being accounted for in addition to the price. Most things that are good for the environment do not have markets, and the few that do have prices do not reflect their full value. Putting a price on environmental products is important for their long-term success *(Perman et al., 2003).*

According to *Perman et al. (2003)*, individual decisions and preferences are the fundamental building blocks of economic value. To put it another way, what people want determines the economic value of a good,

service, or resource. Choices and concessions reveal a person's preferences more clearly than in any other way. The economic value of a good or service can be measured by how many other goods or services a person is willing to give up in exchange for that good or service.

As was said before, this could be different from the price that is offered on the market because the price that is offered on the market does not always fully reflect the economic value. Traditional research on demand shows that most customers are willing to pay more than the price of a good, especially for the first units. This means that their WTP is higher than the price that is currently being offered on the market. Use value and non-use value are the two different ways that a resource can be worth money. A resource's total economic value (TEV), which was first proposed in the middle of the eighties, is calculated by adding up all of these individual components *(Perman et al., 2003).*

Use-value is a term for the good things that happen to society when people use a resource and make money from it. For example, a community can drink from a clean river, swim in it, and go boating on it without paying for any of these things. This idea is called "use value." There are two kinds of use values: direct use values and indirect use values. The direct use-value of a resource is both the value that can be gained from directly using the services of the resource and the value that can be gained from the resource's contribution to ongoing production or consumption. Cutting down trees in forests to get wood to burn could have an immediate use value. The practical services that a resource provides to meet the needs of the market's current demand and supply can be thought of as its indirect use-value *(Perman et al.,*

2003). In the case of the forest, protecting watersheds is an example of a way that the resource can be used indirectly. When it comes to the usage of power, having sufficient light to read at night could be regarded as a direct use value, whereas maintaining adequate lighting throughout your complex at night to deter thieves and hooligans could be called an indirect use value *(Perman et al., 2003).*

The term "non-use value" refers to the value that people give to a resource more because they like it than because they use it in their daily lives. Non-use value is also the amount of money that consumers are willing to spend on a good or service even though they will not be able to use it right away or in the near future *(Perman et al. 2003)*. Non-use value includes option value, existence value, and bequest value. A person places a value on a resource in exchange for the possibility of gaining advantages in the future, and this value is known as the option value. Alternately, although the resource might not be delivering any benefits right now, it might be able to do so in the future, and because of this, people would rather keep it than get rid of it *(Perman et al., 2003).*

Existence value is the feeling of satisfaction a person can get from knowing about a resource, even if they do not even plan to use it. It is the price that people who do not use the resource are willing to pay to keep it going, even though they do not plan to use it now or in the future. This is how much people who do not use the service are willing to pay. Even if they are scared to go along the canopy walkway in Ghana's Kakum National Park, some citizens cherish the park because it is located in their own country and because it contains a canopy walkway. This is the case in Ghana, for instance. Someone

like this might be willing to shell out a significant sum of money to ensure the safety of the resource. It is speculated that the Kakum National Park appreciates the presence of this particular individual. The expense of passing down a resource to subsequent generations is referred to as the bequest value of that resource. In other words, its value is generated from the generosity of the current generation and their willingness to pass the resource on to future generations *(Perman et al., 2003).*

Non-Market Valuation Methods

According to the available research, there are two distinct methods for determining the value of nonmarket resources; these are monetary and non-monetary techniques *(Ngugi et al., 2011)*. Procedures that use money as the numéraire are referred to as monetary procedures. In other words, what is being measured is the monetary value of the goods, services, or resources that are being evaluated. On the other hand, non-monetary approaches aren't concerned with assigning a monetary value to something in the way that monetary methods are. The numéraire can take on any given value or benchmark. A willingness to pay can be disclosed, implied, or stated depending on the type of monetary approach that is used. The three most prevalent forms of monetary methods are: expressed, implied, and revealed *(Ngugi et al., 2011).*

The Market Price Method (MPM)

In this method, the total net economic benefit of a product, also called the total economic surplus, is calculated and then used to estimate how much the product is worth. In particular, the sum of the consumer surplus and the producer surplus is the same as the economic surplus as a whole. The term

"consumer surplus" refers to the value added to a product or service beyond what it cost to buy. The term "producer surplus" refers to the benefits a producer gets on top of the costs of getting a product or service to a consumer *(Brynjolfsson, 1996)*.

Surpluses are computed using the market price, this methodology is extremely dependent on the price that the commodity in question is selling for on the market. On the other hand, there are very few environmental objects that have markets and, consequently, prices. As a direct consequence of this, an appreciable proportion of non-market commodities are not considered for valuation using this approach. When it comes to products whose prices are set by the market, not everyone having the same amount of information and other inefficient market conditions do not lead to a good price. So, it is hard to ascertain what the real economic surplus is based on these prices *(Stuer et al. 2007)*.

Also, the price of the final product in many emerging economies does not take into account a wide range of inputs because the processes used to grasp the price are not very efficient. This means that the prices do not reflect the item's true value. The MPM is not a good tool for this line of enquiry because the prices that customers pay are set by the market and do not reflect the value that comes from the resource itself *(Stuer et al. 2007)*.

Expressed Willingness-to-Pay

Expressed Willingness-to-Pay is to estimate what goods or services are worth. As was already stated, non-market objects are not traded on the market, and some of them, if not all of them, may not have anything in common with any good or service that is traded on the market. So, you cannot show that you

are willing to pay for things that are not already on the market. Also, it is not always possible to assess how much people are willing to pay for a benefit by looking at how much it costs to keep resources from going to waste. This is because people's willingness to pay can change over time and be influenced by many different things. After a hypothetical situation, respondents were given a poll and asked to say whether or not they would be willing to pay for a resource. Customers may sometimes be given a lot of choices from which to choose. This information is used to compute how much people are willing to pay for a product, service, or resource that is already being used. Parts of this method, which is also called the expressed preference approach, include asking people directly how much they value non-marketable environmental services and how they would like service flows to change *(Lareau & Rae, 1989).*

This method takes into account both the use values and the non-use values of a resource. This gives an overall economic value for the product, service, or resource that is being used. According to what *Perman et al. (2003)* found, the fact that these methods have nothing to do with behaviour means that they can be used to value products and services in ways that revealed preference methods cannot. This group of valuation methods includes both the Contingent Valuation Method (also called the CVM) and the Choice Experiment Method (CEM).

Contingent Valuation Method (CVM)

The contingent valuation method is a type of stated preference methodology that is used in environmental and resource appraisal. As a result of its adaptability and capability of determining the value of passive uses, it

has emerged as one of the most common techniques for property assessment. Contingent valuation surveys are distinct from other types of surveys in that they include in-depth explanations of a fictitious valuation scenario, as well as valuation questions, payment vehicles (such as taxes), payment rules (such as the majority rule), and so on (e.g., referenda) *(Whitehead, 2012)*. Estimates of the value of environmental goods can be made in one of two ways: either by calculating preference parameters "revealed" by behaviour related to a part of the amenity, or by using information "expressed" that shows preferences for the good. In environmental economics, the expressed preference approach is called "contingent valuation" because the "value" derived from the respondent's preferences is said to "depend" on the details of the "built market" for the environmental item presented in the survey. This is because the estimated "value" based on the choices of the respondent "depends" on the details of the "constructed market" for the environmental benefit *(Carson & Hanemann, 2005)*.

In contingent valuation studies, researchers give questions aimed to elicit responses from participants that shed insight into the financial decisions they would make on a product's or service's value *(Carson, 2012)*. It is the most common way to find out non-use values, but it can also be used to unravel use values. Also, this method is the least used of the ones that do not involve the market. In a study that uses contingent value, people are asked how much they would pay for different environmental services. People are often asked if they would be willing to take a certain amount of money in exchange for a variety of services that help the environment *(Carson, 2012)*. There has been a lot of discussion around the idea that the contingent

valuation approach involves asking questions of individuals rather than observing their actual behaviour. The conceptual, empirical, and practical challenges of determining economic worth based on people's responses to hypothetical questions regarding hypothetical market conditions are hotly contested in the economics literature. This is true for all aspects of the problem, including the conceptual, empirical, and practical challenges. Researchers at CV are putting forth an effort to find solutions to these problems, but their job is not yet finished. Sake of the myriad of flaws in CV's methodology, numerous financial experts, including sociologists, psychologists, and economists, believe that CV's estimates of monetary values are not reliable (Portney, 2018).

Brief History of Choice Experiment Method:

Researchers working in a wide variety of academic fields have shown an interest in discrete choice experiments (DCEs) and other methods of a similar nature for a significant amount of time. This is probably why there has not been and was not much agreement on what the methods are, what they are called, and how they are based on theory.

Choice methods have been used by psychologists since the 1960s *(Kjaer, 2005; Louviere et al. 2010)*. In the early 1970s, they were introduced to the marketing literature, where they got a lot of attention from academic and business circles. *Green and Srinivasan (1978)* came up with the name "conjoint analysis" to describe a set of methods that were used a lot in the field of marketing and were given this name. The use of conjoint analysis has made it much easier to predict and better understand how consumers make decisions and behave when making choices. The development and use of the

conjoint analysis technique grew a lot in the second half of the 1970s and all through the 1980s.

At the same time that conjoint analysis was being developed and used, new ways of modelling discrete choices (called "disaggregated models") were reported in the economic literature, especially in the field of transportation. These models were based on what is now called "random utility theory" *(Kjær, 2005)*. Random utility theory and disaggregated models are the most common ways that choice approaches are used in the economic literature. This is because they fill in the missing link between how people act and how economists think about it. The term "conjoint analysis" is not used as much in economics literature anymore because it's important to point out that these choice procedures are well-established in economic theory (in contrast to the methods that are employed in marketing). Louviere says that the term "conjoint analysis" should be changed to something more accurate to show that the methods in question are based on the idea of "random utility" *(Louviere & Hensher, 1983)*.

Choice methods that are established in economic theory are categorized as either "choice modeling" or "choice experiments" in the body of published work in the field of environmental economics. There is currently a widespread agreement that choice techniques should be divided into three groups to reflect distinctions in theoretical assumptions, methods of analysis, and experimental methodologies *(Louviere et al., 2000; Morrison et al., 2002)*.

- Discrete choice experiments
- Contingent ranking

- Contingent rating

There are a lot of similarities between these three approaches. The fundamental design of the alternatives is the same in each of the approaches, and it is up to the respondents to pick which of the multi-attribute alternatives are mutually exclusive they prefer. In addition, if certain assumptions are made, it is possible to demonstrate that any of the three approaches is compatible with the theory of welfare economics. In the DCE, the respondents are given a certain number of options from which they must pick one to respond (two or more). It is possible to say that the data are only weakly ordered because the DCE only contains information about the favored alternative. On the other hand, contingent ranking necessitates the ranking of each alternative, and as a result, the data present a comprehensive preference order (strongly ordered). The cognitive load of a contingent ranking exercise is higher than that of a comparable discrete choice exercise because it not only contains more information about preferences but also ranks the options in a more complex order.

Louviere et al. (2000) conclude that the contingency rating task is much more difficult because respondents are expected to give each option a value that shows how much or how strongly they prefer it. Unlike contingent ranking and DCE, contingent rating allows respondents to give the same number of points to two or more options. This is called a tie, and it shows that the options are about the same. Ranking and rating data are modelled differently than DCE data because the alternatives in ranking and rating data are ordered explicitly. When studying ranking and rating data, models like the rank-ordered logit and ordered probit are used. There are some theoretical and

practical problems that could come up when ranking, and more specifically rating algorithms, are used. People may have trouble ranking or rating all of the options. Rating tasks, in particular, make it hard to make comparisons between people, and consumers' real-world decision contexts differ greatly from the hypothetical ones *(Blamey et al., 2002)*.

Blamey et al. (2002) also say that the methods differ in how well they can estimate WTP in a way that can be shown to be consistent with traditional measures of welfare change and can therefore be used as part of a cost-benefit analysis (CBA). Using the methods, it can be shown that these estimates are in line with the usual ways of measuring changes in welfare. In the economics literature of today, the DCE is the choice modelling method that is used most often, while contingent rating is rarely used.

The main benefit of the DCE, which is the simplest choice method, is that it has a low cognitive complexity. This is the degree of task complexity and difficulty that is a direct result of the experiment *(Louviere et al., 2000)*. Both the discrete choice experiment (DCE) and the dichotomous choice comparative validity method (Dichotomous choice CVM) require customers to choose items that cannot be used together. The economic ideas behind both of these approaches are based on the theory of random utility. The DCE method was changed into what it is today at the beginning of the 1980s. Louviere and Woodworth (1983) were the first to use the term "choice experiment" to describe this method, according to *lvarez-Farizo and Hanley (2002)*.

The difference between continuous and discrete variables is the source of the term "discrete choice," which is used to describe the set of possible

decisions. The word "discrete" means that the choice is discrete, which means that there is only one way to solve the problem.

Theories on Consumer Behaviour and Discrete Choice Experiment

According to the traditional theory of consumer behaviour, consumers receive direct utility from the consumption of products and services. The idea assumes that, when presented with a set of alternatives, customers will choose their most desired option to maximise utility. The conventional theory of consumer behaviour utilises the theory of demand and numerous demand factors, such as price and income, to explain consumer behaviour. *Berker (1968)* stated that variations in individual consumption that cannot be explained by income and prices are attributable to individual preferences and tastes. Consequently, to completely explain consumer behaviour, pricing, income, and taste should be viewed as the primary drivers. Numerous studies *(Auld, 1974; Michael & Becker, 1973)* have claimed that income, prices, and taste reflect only a small portion of the differences in customer demand for products and services, and hence do not fully explain consumer behaviour.

In their study on the new theory of consumer behaviour, *Michael and Becker (1973)* stated that the traditional theory of consumer behaviour is limited to market sectors where transactions are easily quantifiable in monetary terms and do not account for consumer choices that are related to non-monetary factors, such as religion, political party, life partner, etc. The study also suggested that the theories' emphasis on analysing consumer responses to monetary events made them less appealing to other social scientists, such as political scientists and sociologists, who examine individual behaviour in contexts where monetary phenomena are not common. The

problem with the classic theory of consumer behaviour, according to *Nicosia and Mayer (1976),* is its reliance on differences in tastes to explain variations in consumer behaviour, since it cannot explain how tastes and preferences are developed.

Following the studies of *Lancaster (1966), Rosen (1974), Baumol (1967),* and others, the economic theory of consumer behaviour has experienced revolutionary transformations over time. *Lancaster (1966)* provided an alternative theoretical approach based on the notion that all things have features or characteristics that customers desire, rather than the items themselves. According to Lancaster's theory of consumer behaviour, consumers make purchase decisions depending on the features of the good, as utility is derived from the good's attributes. For instance, consumers do not seek food per se, but rather the nutrients included in food. This is especially pertinent to this study because it is the most exhaustive theory that emphasises multi-attribute decision-making. Lancaster's consumer theory presents a potentially effective framework for empirical demand analysis based on survey data, in contrast to the standard model of consumer behaviour.

This study will utilise the Lancaster method to estimate the utility function of a consumer for each alternative based on the provided characteristics. Lancaster advocated utilising an experimental design to present responders with various combinations of the given features. Respondents are required to rate the options in order of preference. Based on the rankings, a consumer's utility function can be determined by this random procedure. Similar to the conventional idea of consumer behaviour, Lancaster's theory of consumer behaviour has limitations. Some academics

(Hendler, 1975; Michael & Becker, 1973; Ratchford, 1975) have described Lancaster's theory as a special case of consumer choice as opposed to a generic model of consumer behaviour.

Hendler (1975) stated that Lancaster's theory's applicability and validity are constrained by the non-negative utility assumption. In addition, he maintained that even if the marginal utility of a product is positive, certain of its attributes may be perceived negatively by the consumer. For instance, a person may favour a renewable energy source due to their preference for a clean and green environment, although other aspects of this option, such as the high price and poor service quality offered by a public company, are inconvenient. The theory's full potential can be realised, however, when the premise of non-negative utility is dropped under specified conditions. According to *Ratchford (1975),* Lancaster's method for assessing customer utility is not groundbreaking and differs only little from the methods applied by scholars in the marketing profession and other disciplines. Moreover, he asserted that proposed models of consumer behaviour in fields such as psychology, marketing, and economics are not all that dissimilar and are applied in a manner that is quite similar.

Nguyễn et al. (1991) developed the theory of consumption values using concepts from numerous disciplines, including economics, marketing, sociology, and psychology. The theory explains the motivations behind consumer purchase behaviour based on consumption ideals. The theory claims that consumer selection is a function of numerous consumption values and that customers acquire items and services with the greatest perceived value. *Nguyễn et al. (1991)* identified five consumption values that influence

consumer purchase behaviour in an attempt to answer the question, "Why do customers choose to buy or not buy a given product?" Functional, contingent, emotional, social, and epistemic is the five consumption values.

Functional value is how a consumer evaluates a product's quality and price, as well as how useful they think it is based on how it performs physically, which depends on its features. Social value is how useful a customer thinks an alternative is because it belongs to a certain social group, like a stereotyped (either positively or negatively), demographic, socioeconomic, cultural, or ethnic group. Emotional value is the perceived usefulness that a buyer gets from an option's ability to make him or her feel something. Epistemic value is how useful a consumer thinks an alternative is because of its ability to spark interest, offer something new, and meet a need for knowledge. Conditional value is the benefit a customer thinks they will get from an option based on the specific situation the person making the decision is in. Also, the idea has been used a lot to study how customers accept, adopt, and buy products that are better for the environment.

The theory of consumption value is the most dynamic and comprehensive explanation of consumer behaviour, according to *Tanrikulu (2021)*, and it provides a deeper knowledge of the consumption drivers. The theory of consumption values can assist practitioners, policymakers, and academic researchers in comprehending what motivates particular decisions and contribute to an overall comprehension of consumer choice behaviour *(Lin & Huang, 2012)*. According to *McFadden (1974)*, consumers' economic decisions are discrete, and discrete choice models are optimal for analysing

these decisions. The paradigm for choice modelling in this study is based on McFadden's random utility theory.

The theory posits that the benefit an individual obtains from using an item or service cannot be directly witnessed since it exists only in the imagination of the consumer. Nevertheless, a substantial proportion of this unobserved utility can be explained by stated preference surveys and choice trials. According to this idea, the remaining unexplained portion of the consumer's utility is characterised as random. Researchers can determine the utility consumers gain from each characteristic level relative to others using discrete choice trials. Since the 1970s, discrete choice modelling has been predominantly utilised by marketing, health, and transportation experts. In recent years, economists have utilised this method to observe customer demand for energy goods and services. Choice experiments are increasingly employed in environmental and resource economics due to the increased global interest in environmental issues and initiatives to prevent climate change.

Empirical Review:

Willingness to Pay: Electricity Service Improvement

In a number of these studies, researchers have used different criteria to judge the quality of the improved power supply. It is good to know that almost all of the studies used contingent valuation. So, this section will give a summary of empirical data about how much households are willing to pay to improve the reliability of the electricity supply.

In a survey of urban households in 42 cities across Ethiopia, *Meles et al. (2021)* use stated preference experiments to find out how much people

want better energy supplies. In the very first independent experiment, participants were given a contingent valuation (CV) scenario and asked if they were willing to pay **(WTP)** for fewer power outages at night or accept **(WTA)** money for bigger ones. The same people were then used in a test called a discrete choice experiment. The point of this experiment was to find out how the participants felt about how often, how long, and what time of day outages happened, as well as how much they valued being told ahead of time. Based on the results of the CV study, the WTP for a three-hour drop in the number of power outages at night is about 40 birr (US$1.4), while the WTA for a similar rise is 42 birr (US$1.4). The results of the choice experiment show that the average family is willing to pay 11 birrs (US$0.4) for a one-unit decrease in the number of power outages and 53 birrs (US$1.8) to avoid midday or nighttime outages instead of morning ones. A marginal WTP of 23 birrs, which is equal to $0.8, shows that households would rather know about an upcoming power outage one day in advance than one week in advance. Meles (2020) went beyond the idea of just hooking up homes to electricity to find out how much the average urban household in Ethiopia spends on defence during different times of the month when the power goes out. Using the generalised propensity score method, it was found out how much families would be willing to pay for more energy.

In Bandung, Indonesia, 1600 surveys were done as part of a discrete choice experiment. The results showed that consumers are willing to pay for a proposed improvement to the electricity supply system that is different from the status quo. *Siyaranamual et al. (2020)* did a study, and the survey found that consumers are willing to pay an amount from $1.18 to $14.49 per month,

depending on the installed capacity for electricity improvement in their communities. It costs between $4.15 and $50.64 per month to bring the number of rural areas with electricity to 100%. The marginal willingness to pay goes up in direct proportion to how long the power is out, but it is highest on weekends and in the winter *(Carlsson & Martinsson, 2008)*. *Abdullah and Mariel (2010)* used a mixed logit estimation method to look at responses from 202 electrified rural Kenyan households. They found that older people and people without jobs were less willing to pay for more reliable electricity, while larger households were more willing to pay.

Abrate et al. (2016) used logit estimation on 367 survey questionnaires from Italian households to conduct a study. They found that education is a strong predictor of willingness to deal with an outage. People with at least a high school diploma were less likely to be okay with a power outage than those with less education. According to education is a key factor in how willing people are to deal with an outage. The data show that an average Italian family spends €25.37 per kWh of lost load. Based on survey results, the value of the hypothetical lost load depends on a number of household factors, as well as the time of the hypothetical outage.

Osiolo (2017) used a Heckman two-step estimate method to estimate how much Kenyan households and businesses are willing to pay for energy (a probit model). According to the data, there is a strong link between the gender of the head of the household and WTP for increased energy independence. The declared WTP levels of families where the woman is in charge are lower than those of families where the man is in charge. *Kim et al. (2015)* made a logistic model in South Korea to determined how much trouble and money a

rolling blackout would cause in residential areas. In one of the models, income level was found to have a large effect on WTP. The study found out that low-income households were less likely to be willing to pay to avoid the "inconvenience cost" of power outages. *Ozbafli and Jenkins's (2015)* study also found that the age of the respondent is strongly linked to the loss (impact) caused by frequent outages, with older people less likely than younger people to experience the loss of utility (possibly because they have more experience).

Ghanem (2018) used a qualitative method to study the different ways people in Lebanon's urban areas have dealt with power outages, the nature and practises of the informal electricity services that have filled the gap, and how these things have affected day-to-day life. It says that the different practical ways that people use to get extra energy to their homes make the infrastructure services in the city, its neighbourhoods, and its buildings feel different. This is because households choose these solutions on their own. These effects are looked at from three different angles: the network of informal electricity providers, the new habits and behaviours of families, and the objects and artefacts that make up the energy landscape of the city.

According to Kim et al. (2019), South Korea witnessed rolling blackouts in 2011 due to a paucity of power supply infrastructure and a rapid increase in power usage. This was because there was not enough infrastructure to provide the amount of electricity that was needed. As a results of power outages, there were a lot of uncomfortable side effects in the residential sector, such as the fact that all elevators stopped working and all electrical equipment was turned off. Since then, making sure there is a steady supply of electricity has become the most important thing to do. This study looked at how much

residential customers would be willing to pay (WTP) to avoid power outages. Using the contingent valuation (CV) method, a survey was done on a total of 1,000 households in May 2018. The results showed that the average monthly WTP of households was KRW 1,522, or $1.41, which was statistically significant.

The non-monetary costs of outages were taken into account by using the stated preference method. A back-of-the-envelope calculation shows that urban families in Ethiopia who are connected to the electrical grid spend $14.8 million per month on defence and are willing to pay an extra $6.2 million per month for better electricity service. These results are based on what is thought to be the average result. The study's results show that having access to an electrical power source is not enough. It is also important to make sure that this power source is always reliable *(Meles, 2020)*.

Accordingly, research conducted in Ghana by *Amoah et al. (2017)* discovered substantial connections between WTP for improved power delivery and a variety of characteristics that are found at the household level. A probit model study done in the Greater Accra Region found that the following are positively and significantly linked to willingness to pay (WTP) for more consistent electricity delivery: gender (being male), marital status (being married), family size (having a big family), and income level (being high). *Amoah et al. (2019)*, who did a second study in the same area as the first study, found results that back up what the first study found.

Taale and Kyeremeh (2016) did similar research to find out how much people in the Cape Coast Metropolitan Area would be willing to pay for better power. A Tobit regression model was used to analyse the survey results from

950 different households. It was found that a person's annual income, level of education, marital status, and family size have a big effect on whether or not they want to pay more for better electricity services. WTP was found to be positively related to both income and education level. People with higher incomes and at least a high school education were more willing to pay for more reliable electricity than those with lower incomes or less education. They had a great relationship after they got married, and they also wanted to pay more for better electricity service. It was found that WTP had nothing to do with the number of people living in a house. But the same study showed that age, being a homeowner, and the amount of money spent each month on electricity have no effect on how much people are willing to pay to keep the power on.

Nduhuura et al. (2021) study what happens to households in Accra, Ghana, when the power goes out. The correlation and regression analyses are used in the study to find out which household factors are linked to or can be used to predict the effects of an outage on a household. It was found that power outages damaged equipment and made it harder to get food and access social services. They also made homes less safe and secure and made it harder to get food. There is a strong link between what people say about the effects of a power outage and things like their annual income and employment status, the number of times they lose power, and the size of their households.

According to the same study, having a low income, living in a large family, and being exposed to a lot of power outages are all strong predictors of reporting outage impacts. The results of this study show how important it is to take steps to either get rid of power outages completely or at least cut them

down by a lot if you want to have long-term social and economic growth in developing countries *(Nduhuura et al., 2021).* In a piece called "Are contingent valuation estimates accurate? *Amoah et al. (2019)* look into the causes of power outages in Ghana. The goals of this study are to: (1) get new estimates of how much money Ghanaian households would be willing to pay to stop power outages; and (2) add to a discussion about whether or not contingent valuation results about energy reliability are valid. The results show that people are willing to pay GHS 67 ($17) per month for a reliable energy supply. This is the same as 7 percent of the incomes of the people who answered.

In concluding the aforementioned literature analysis, it can be stated that all the research focused on willingness to pay for the improvement of electricity service in one way or another. The majority of researchers employed contingent valuation, which is susceptible to bias introduced by individuals with interests other than assuring the accuracy of the data. If respondents are advocates for or opponents of a project, they may attempt to manipulate the survey for their objectives. Other researchers used multinomial logit and probit, both of which are susceptible to prediction bias due to the misspecification of the predictive distribution of random components.

The current study used a choice experiment model whose overall goal is to estimate economic values for characteristics (or attributes) of an environmental good or service for policy analysis, where the environmental good or service has more than one characteristic. This got around the problem of contingent valuation bias. Also, the mixed logit model is used for the regression analysis in this study. This model takes into account unobserved

heterogeneity and does not show the IIA property. Another advantage is that it is useful to determine what factors impact the selection of various types of choices. Mixed logit outweighs multinomial logit, which provides unreliable forecasts because of its restrictive assumption of independent of relevant alternatives (IIA). Multinomial logit can also be used as a benchmark to show how well the mixed logit method used in this study works.

Summary of Chapter:

During a power outage, a household is guaranteed to incur financial losses due to the inability to engage in leisure activities that require electricity. Many electronic home devices, including televisions, refrigerators, deep freezers, and microwave ovens, have been harmed. Electric appliances may not be able to endure the electrical shocks caused by frequent and unexpected power outages, leading to their eventual collapse. The owners will incur additional costs to either repair or replace the afflicted products, causing them to incur a loss. Inconsistent power supply conditions can result in household losses, such as the loss of food stored in freezers but rendered unusable due to a shortage of electricity to power the refrigeration mechanism. Moreover, thefts do occur in certain homes since the power is either absent or sporadic *(Adams et al., 2020; Taale & Kyeremeh, 2016).*

This research will distinguish itself from past studies conducted on the topic of power supply by estimating the marginal willingness to pay (WTP) of households for improved electricity across three major attributes of electricity supply reliability. With the help of these attributes, which were absent from prior studies, the government should be able to determine what policies to implement and what aspects of customers' life to alter in order to increase

WTP for increased energy supply. Other studies, such as the one conducted by (Carlsson & Martinsson, 2008), are unable to identify any unique demographic variables that influence WTP apart from whether the outage was scheduled.

CHAPTER THREE

RESEARCH METHODS

Introduction

This chapter gives an overview of how the research work for this study was conducted. It gives an overview of how choice experiments were used in the study. This section also discusses the sampling and how it was chosen, as well as the requirements for survey participation and data collection. At the end of this chapter, the study discussed the econometric models and estimation methods for data analysis.

Empirical Model Specification

The empirical investigation on households' valuation of power outages in the Ga West Municipality of Accra is encapsulated by the following refined model:

$$U_{poweroutage} = \beta_0 + \beta_1 Poweroutages + \beta_2 Geoscope + \beta_3 Cost + \epsilon \quad (1)$$

$$U_{poweroutage} = \beta_0 + \beta_1 PlannedOutages + \beta_2 UnplannedOutages + \beta_3 DurationOutages + \beta_4 GeoscopeHousehold + \beta_5 GeoscopeNeighborhood + \beta_6 GeoscopeDistrict + \beta_7 Cost + \epsilon \quad (2)$$

Where $U_{poweroutage}$ represents utility derive from the consumption of power, and $Geoscope$ represents the geographical scope of Ga west municipality, cost representing the part of the costs that the power distributor wants the households to pay for improving the power outages and ϵ representing the error term. Cost is used as a control variable. Power outages can be categorised into planned power outage, unplanned power outage and duration of power outage. The geographical scope of the Ga West Municipality is

systematically explored through three distinct categories: Geoscope Household, Geoscope Neighborhood, and Geoscope District. The error term, denoted as ϵ, accommodates unobserved factors that may influence households' utility derived from power consumption. Equation 1 was remodeled to accommodate the categories power outage and geographical scope have.

Definition of Attributes and Levels

The first thing that has to be done when designing a choice experiment is to carry out research including focus groups to choose the variables that will be important. Examining the attributes, attribute levels, and attribute levels employed in earlier research as well as the significance of those attributes in the decision-making process is a good place to start. Aside from the features that are important to policy, the choice of attributes must also be based on the features that are expected to affect how respondents make decisions. With this information, focus groups will be used to identify which attributes and levels of attributes should be part of the first round of research. The goal of a focus group is to find out how many attributes and levels of attributes there are, as well as the real values that go with the attributes. The findings of the research conducted by the focus groups should, as a first step, provide information concerning plausible minimum and maximum attribute levels *(Alpizar, 2001)*

In addition to this, it is essential to determine whether or not there is a possibility of the traits' having an interactive influence on one another. To compute welfare measurements, a monetary element, such as a price or a cost, must be included. This is because prices and costs can be converted into monetary values. In such a scenario, the findings from the studies conducted

with the focus groups will reveal the most effective manner to offer a monetary attribute. Credibility is an extremely important factor, and the researcher has a responsibility to guarantee that the characteristics chosen and the amounts of those characteristics may be integrated convincingly. As a result, appropriate limits may need to be applied *(Layton and Brown (1998).*

The selection of attributes and the corresponding levels presents a challenge for customizability. This is an attempt to make the choices more realistic by tying them to the world's different levels. If it is at all possible, it would be beneficial to include an alternative that has the attribute levels necessary to describe the current situation. This would allow the other alternatives to be related to the situation as it currently stands. One possible alternative is to make some of the attributes directly related to the level. For example, the visibility levels could be set 15 percent higher or 15 percent lower than what is currently in place *(Alpizar, 2001).*

The meetings with the focus group should shed light on the best way to present and explain the task of choosing a series of options from a variety of options sets. *Layton and Brown (2000)* say that it is not always clear that making the same choice over and over is for the best. When it comes to things like recreation, it's clear that choosing one site from a list does not mean you cannot choose a different site in other situations. When it comes to public goods, however, choices that are made over and over may need more explanation in the experiment. When a choice experiment is used to test a good for the environment or a way to improve a person's health, the people taking part may not be familiar with the options.

The difficulty of a choice experiment, which can be judged by the number of choice sets and/or the number of qualities in each set, may also affect how good the answers are. In conclusion, the quality of the responses is directly related to how hard the choice experiment was. Verbal protocols, in which the person being surveyed is asked to read the survey out loud and/or to think out loud while answering, can be used to test how hard a choice experiment is. This method has been used in CVM surveys before *(Payne, 1993)*. So, the part that readers are most likely to pay attention to will be chosen, and their understanding of the experiment will be measured.

Table 2: Selected Attributes and Associated Levels

Attribute	Description	Levels
Planned Outage	Indicates the average number of planned outage occurrences experienced at the household level in a year.	5, 10, 15, 20 times
Unplanned outage	Indicate the number of outages occurring without prior notifications from the power distribution in a year.	5, 10, 15, 20, times
Duration of Outage	Indicates the hours at which an outage occurs.	40, 80, 120, 160 hours
Geographical Scope	Indicate the area where the power outage is restricted to.	Household (0), Neighbourhood (1) District (2), Whole city (3).
Cost	Additional amount per year	30, 60, 90, 120, 150, 180 Ghana cedis

Source: Author's survey, 2022

Attributes

Planned Power Outage (PPO):

Planned power outage is a continuous variable that shows the average number of planned power outages at the household level. These outages are planned because all affected households have been told about them. Those who know about a power outage before it happens are likely to lose less than those who do not know. Since the improved state requires customers to be warned before a planned outage, those who are contacted before a planned outage are likely to have a lower WTP for improved services. Upgrades to the energy supply would cost more for people who don't know about them ahead of time. *Carlsson and Martinsson (2008)* found that WTP to avoid a planned outage (which includes advance notice) is less than WTP to avoid an accidental outage (which does not include prior notification). It is expected that a negative relationship is anticipated.

Unplanned Power Outage (UPO):

Unplanned outage is a continuous variable indicating the number of power outages occurring without prior notifications from the power distribution. These are unexpected outages that occur following a fault, hazard or electrical emergency and lack of maintenance. Therefore, a negative associated is anticipated.

Duration of Power Outage (DPO):

Duration of power outage is a continuous variable that indicates any interval of one minute or more between the commencement of an interruption to a customer and the restoration of service to that customer. Therefore, it is projected that a negative association is anticipated.

Geographical Scope of Power Outage (GSPO):

Geographical scope of power outage is a dummy variable. Household is indicated by the value of 0, Neighbourhood by the value of 1, District by the value of 2 and Whole city by the value of 3. This is the area where the power outage is restricted to. Table 5 offers a summary of the attributes, their classifications, and the anticipated signals they would convey.

Table 3: Classification of Explanatory variables and their expected signs

Variables	Classification	Expected signs
Planned Outage	Continuous	-
Unplanned Outage	Continuous	-
Duration of Outage	Continuous	-
Geographical Scope of Outage (GSOT) (HH=0; NG= 1; DT= 2; WC= 3	Dummy	+/-

Source: Author's survey, 2022

Questionnaire and experimental design

The questionnaire used to collect the CE data was constructed to include environmental attributes of Ga West Municipality and other socio-economic information about the respondents. The designed questionnaire was pretested on the field to fine tune the methodology before conducting the final survey. The mode of delivery of the questionnaire was through personal interview (paper and pencil method).

Table 4: Choice Designs

Choice situation	alt1.plan_out	alt1.uplan_out	alt1.duration	alt1.geog_scope	alt1.cost	alt2.plan_out	alt2.uplan_out	alt2.duration	alt2.geog_scope	alt2.cost
1	5	5	160	0	60	15	15	80	2	120
2	10	20	160	2	90	15	10	80	1	180
3	15	15	120	2	120	10	5	40	0	90
4	20	5	40	1	30	10	15	120	3	180
5	20	5	160	3	30	10	15	80	1	150
6	5	20	40	0	60	15	10	120	2	150
7	15	15	120	1	150	5	5	40	2	30
8	5	20	40	3	90	20	10	120	0	120
9	15	10	80	0	180	5	20	160	1	30
10	10	10	120	1	150	20	20	40	3	60
11	20	15	80	2	120	5	5	160	3	90
12	10	10	80	3	180	20	20	160	0	60

Source: Author's survey, 2022

Thus, each respondent answered 12 choice scenarios questions *(Hensher et al., 2005).*

Each choice set contained 3 alternatives including a no-change option representing those that were not interested in electricity improvement or they are fine with the current situation at hand. This was done to make sure that the survey was based on how a real-world consumer would act in the market. Overall, there were five parts to the paper questionnaire. In the first part of the questionnaire, people were asked about themselves, such as their age, gender, level of education, marital status, number of children, and size of their household. In the second part of the survey, people were asked about their current electricity supply and issues related to it, such as whether they rent or own their home, the status of their electricity metre, the status of their electricity supply, how much they spend on electricity each month on average,

whether they are told ahead of time before an outage, what kind of effects an outage has, and how they feel about saving energy. The third part of the questionnaire asked about how people deal with power outages. It asked about alternative sources of energy used when the power goes out, how much people spend on those sources on average each month, how reliable the power is, and how stable the voltage or current is. The fourth part was the main choice experiment, in which respondents were given 12 sets of choices. The fifth and final part asked respondents about their current jobs and how much money they make each month. In July 2022, a small group of 25 people filled out the full questionnaire as a test to measure cognitive load and clarity. This caused some small changes to be made before the final survey was given in person during the second week of February 2022. It took three weeks to finish. Before the choice survey was given, respondents were told about the chosen attributes and their levels. Table 2 shows an example of the choices that were given to respondents.

Presenting the CE questionnaire:

Respondents in the study were introduced to the valuation research and the identity of the researcher was made known to them as well. The questionnaire included an introductory section that provided the respondents with information about the purpose of the study and also dealt with issues of confidentiality.

Data collection:

In the data collection phase for the study on households' valuation of power outages in the Ga West Municipality of Accra, a preliminary reconnaissance survey was conducted at each study site. The primary

objective of this survey was to obtain a holistic understanding of the communities, providing valuable insights to refine the study's focus. Focus group discussions were organized to gather information on attributes related to environmental services in the context of electricity evaluation. Participants were actively engaged to supplement existing literature by suggesting effective management strategies for addressing power outages in their communities. The responses and insights generated from these interactions played a pivotal role in the construction of the questionnaire tailored to the study's objectives. To ensure optimal participant comprehension, the questionnaire was administered in the local dialect. In addition to primary data collection, secondary data were sourced from relevant literature, both published and unpublished, from the Ghana statistical service ensuring a comprehensive dataset for the subsequent analysis of households' valuation of power outages.

Positivist paradigm:

The research design for the thesis on households' valuation of power outages in Ga West Municipality aligns with the positivist philosophy by emphasizing quantitative methods, structured instruments, hypothesis testing, objective measurement, generalisability, and systematic data analysis. This approach contributes to the scientific rigor and objectivity required by the positivist paradigm in research design. Positivism emphasizes the use of quantitative research methods, aligning with the study's focus on deriving numerical data to understand households' valuations of power outages. The employment of surveys, structured interviews, and statistical analyses enables

the collection of measurable and observable data, contributing to a quantitative research design.

Positivism advocates for questionnaires with standardized questions to ensure objectivity and replicability. The study, in line with positivist principles, can utilise structured instruments to gather consistent and comparable data across different households, facilitating a systematic and objective analysis. Positivism encourages hypothesis testing, where research questions are formulated as testable hypotheses. In the study, the empirical model serves as a hypothesis that can be tested using statistical methods. This approach allows for the systematic examination of relationships between variables, adhering to positivist principles.

Positivism emphasizes the importance of objectively measuring variables. The study categorizes power outages and geographical scopes into distinct, objectively defined categories (planned, unplanned, duration, household, neighborhood, district), ensuring that the variables are operationalised in an objective and measurable manner. Positivism values the generalisability of findings to broader populations. The study, by employing quantitative methods and standardised measurements, contributes to the potential generalisability of results. The findings can inform not only the Ga West Municipality but also serve as a basis for understanding similar phenomena in different regions. Positivism advocates for systematic data analysis using statistical tools. The empirical model developed in the study facilitates a systematic analysis of households' valuation of power outages, allowing for the identification of patterns, correlations, and statistical significance in the data.

Study Area:

This study centers on the Ga West Municipality, a critical administrative unit within Greater Accra, Ghana, recognized as one of the 29 Metropolitan, Municipal, and District Assemblies (MMDAs) in the region. Established in 1988 as part of a broader initiative to decentralize and modernize local governance, the Ga West Municipal Assembly holds strategic importance. The year 2004 marked a transformative period, with the Ga Municipality being divided, and Amasaman designated as the central hub of the newly formed Ga West Municipality, located at coordinates 5°35° North, 5°29' North, 0°10' West, and 0°24' West, the Municipality shares borders with Akwapim South District to the north, Ga South Municipal and Ga Central Municipal to the south, and Ga East Municipal and Accra Metropolitan Assembly to the east. Encompassing an area of about 284,088 square kilometers and comprising 412 places, the Ga West Municipality faces unique challenges, notably being severely impacted by power outages within the Greater Accra region.

As evidenced by the 2020 population and housing census, the Municipality is home to 314,299 residents, with 155,543 men and 158,754 women. Housing a total of 88,433 households, the average household size is six individuals. Remarkably, almost 98% of the population has access to energy, with a significant portion relying on prepaid meters. The decision to concentrate on the Ga West Municipality stems from its notable status as one of the worst-hit areas by power outages in the Greater Accra region, presenting a compelling case for in-depth exploration and analysis within the context of this study.

Study Area Map

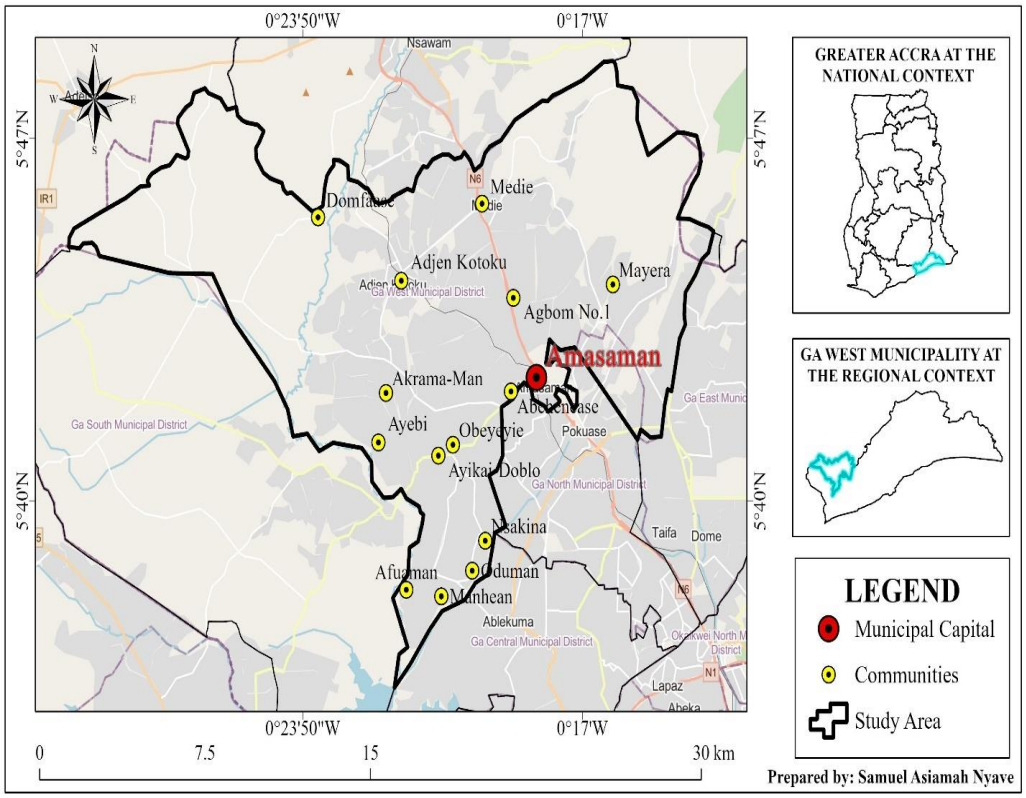

Figure 7: Overview of the Ga West Municipality of Accra

Source: Department of geography and regional planning (UCC), 2022

Sample of the study:

People from different socioeconomic backgrounds live in the Ga West metropolis, so this study used a method called "purposive sampling" to choose respondents for this survey. Purposeful sampling, which is also called judgmental, selective, or subjective sampling, is a way to choose survey participants from a community that allows the researcher use his or her own judgement. This study focused on households in the city's capital, a place where power outages happen more often, middle-income neighbourhoods, and some remote areas.

According to *Orme (2010)*, the following equation describes an acceptable sample size for a discrete choice experiment with three alternatives (two alternatives plus a "no change" option) and 12 choices per respondent:

$$n \geq \frac{500c}{ta}$$

Where $\boldsymbol{n}$ is the number of respondents, $\boldsymbol{t}$ is the number of choice sets, $\boldsymbol{a}$ is the number of alternatives excluding the no change option, and $\boldsymbol{c}$ is the highest number of attribute level. Hence the minimum number of respondents for this experiment is $n \geq \frac{500*4}{8*2}$ = 83 respondents.

With a minimum number of 83 respondents needed for each alternative, the sample size for this study is calculated as:

$$Sample\ Size\ (n) = \frac{N\left(Z\propto_{/2}\right)^2}{\left(Z\propto_{/2}\right)^2 + 4Ne^2},$$

Where N is the total household, $Z\propto_{/2}$ is the confidence level and e is the confidence interval (margin error). The study adopts a 95% confidence level, that is Z score of 1.96, a confidence interval or margin of error of 5% (0.05), and a total household size of 88,433.

Sample size (n) = $\frac{88433(1.96)^2}{(1.96)^2+4(88433)(0.05)^2} = 382.498 \approx 382$

Therefore, a sample size of three hundred and eighty-two (382) households with diverse socioeconomic backgrounds was included in the study.

Instruments:

The main instrument for the data collection is a questionnaire. A well-structured questionnaire will be administered to a sample of households within Ga west metropolis. Household heads will be the primary respondents. In the absence of the household head, however, the questionnaire will be filled by

other household members over the age of 25 years; in an exceptional situation, a respondent under the age of 25 years and living alone will also be allow to answer the questions. A hypothetical scenario of an improved electricity supply system will be created. In this scenario, power supply will be assumed to be reliable and of good quality. Reliability means the power supply is available every time and good quality means the power supply comes with the appropriate level of voltage. The hypothetical case rules out power outages to a large extent. Power outages may only occur when repair works need to be carried out and even in such cases, users of electricity who will be affected would be notified ahead of the outages and the outage will not last beyond two hours. Respondents will be asked to choose from a set of alternatives what they will be willing to pay for such an improved electricity supply system. This study used primary data from 10 communities in the Ga West metropolis: Amasaman, Abehenease, Obeyeyie, Nsakina, Manhean, Akramaman, Oduman, Afuaman, Mayera, and Adjen Kotoku. A paper questionnaire was used to collect information. Face-to-face, 400 paper questionnaires were handed out. With 400 completed questionnaires, the response rate was 100%. For this study, no rewards were given. Most people who signed up did so after hearing about the study and what it wanted to accomplish.

Ethical issues:

Ethical clearance will be, sought from the Institutional Review Board of the University of Cape Coast (UCC-IRB) to build trust in the research processes as well as participants. The researcher believes that the study participants' awareness of the institutional backing of this research will build enhance their confidence in the research. Further, the researcher will adhere to

all the four key ethical principles suggested by *Bryman (2012)* namely, no harm to participants, informed consent, protection of privacy and no deception. The researcher will ensure that all these principles are adhered to throughout the data collection, management, and analysis processes. To ensure there is no deception, all the participants will be fully informed of the nature and purpose of the research. An informed consent form will be added in the introductory session of the research instrument. This is to allow them to understand the research as well as make the choice of participating.

Confidentiality will be guaranteed by ensuring respondents that there will be no harm and deception associated with the questionnaire when they partake in it. Respondents' privacy will be assured by not making any provision for providing names or registration numbers. To reduce emotional harm, and tensions participants will be made aware that their responses represent their views and that their responses will not be linked to their academic details in any way. The survey questions do not have provisions for names or registration numbers. Confidentiality will be guaranteed by ensuring respondents that there will be no harm and deception associated with the questionnaire when they partake in it.

Data collection procedures:

Data collection will be conducted using questionnaire. The questionnaire will be self-administered as this will enable the researcher to assist respondents to understand exactly what the items meant and also to clarify possible issues respondents will find difficult to comprehend. This will be done to obtain the right responses from the respondents. The respondents would be informed that the information gathered will serve to enrich matters

for policy makers. This will be done by explaining the variables to them. Each respondent will be given up to a maximum of 30minutes to respond to all the items on the questionnaire after which the questionnaires will be collated. This may ensure 100% retrieval of the data collection instruments.

Data analysis:

After editing and coding, the data will be entered into the computer using Stata 14 software. Descriptive statistics and inferential statistical tools would be used to analyse quantitative data by using frequencies and percentages presented in tables to analyse the demographic. Means, standard deviation, and inferential statistics(regression) would be used in analysing the questions and hypothesis.

Data management:

To maintain data integrity, care will be taken with the data gathered in the field with the aid of various research instruments. Each respondent's completed questionnaire will be kept in a locker accessible to the principal investigator. The softcopy of the scores entered into Stata 14 will be stored in the researcher's Dropbox account prior to, during, and after data analysis. To protect the confidentiality of the responded instrument, these steps will be taken to prevent unauthorised access by third parties. The researcher will retain the data until the study is finally accepted by the University of Cape Coast, with the intention of making corrections while the study is under review by my supervisor and reviewers or supervisors.

Expected Outcome/Results:

The study will look into whether households who use electricity are willing to pay more to help enhance Ghana's energy delivery. The study will also help identify the attributes that influence willingness to pay for service improvement, as well as analyse the policy implications.

Model specification and Estimation Technique

In this study, respondents are assumed to make trade-offs between attributes of various sets of electricity valuation options, thus the frame of reference was made explicit to respondents via the inclusion of an array of attributes of the product; this also enables implicit prices to be estimated for attributes. The random utility model was employed for the study. The choice model (Equation 3) consists of two independent and additive parts; observable V_{ij} and unobservable ε_{ij} components *(Verbeek, 2004)*. Where U_{ij} is the utility individual j derives from choosing alternative i among various alternatives in a choice set. V_{ij} is the observable component of the individual's utility subject to the various electricity power outage attributes (Planned outage, Unplanned outage, Duration of outage, Geographical scope, and Cost). ε_{ij} is the part of a person's utility that cannot be seen or is random.

$$U_{ij} = V_{ij} + \varepsilon_{ij} \quad (3)$$

According to *Green, (2007)*, in a Conditional Logit Model, "the utility functions are conditioned on observed individual's choice invariant characteristics, Z_i and attribute of the choices which includes a price attribute necessary for the estimation of the willingness to pay for that choice X'_{ij}, as

well as a constant α_j known as the alternative specific constant (ASC) and so V_{ij} can be written as in Equation 4.

$$V_{ij} = \alpha_j + \beta'_{ij} + \delta_j Z_j \quad (4)$$

The ASC is the parameter that measures "no choice" alternative. A significant parameter/ coefficient for the ASC practically means that, some respondents have no preference for any of the choice set. Absence of this constant in the model means that no status quo option was provided or in the choice scenarios or none of the respondents were unwilling to accept or pay for one of the options provided.

This study will employ the mixed logit model since it assumes the parameter co-efficient (β) for the various attributes vary across respondents. The individual's utility is therefore specified below

$$U_{ij} = \beta'_j V_{ij} + \varepsilon_{ij} \quad (5)$$

Where U_{ij} is the utility that person i gets from choosing option j, β'_j is a vector of estimated coefficients that vary between respondents, V_{ij} a vector of the various electricity power outage attributes and ε_{ij} is the random component of the individual's utility. The utility function gives each respondent a random taste parameter β'_j based on the value of the parameter of the underlying f distribution $[f\ (\beta|\theta)]$. Mixed logit models tell you how different people's tastes and preferences are by looking at the standard deviation for each attribute coefficient.

The error terms ε_{ij} of the model is assumed to be independently distributed across utilities making the probability of individual i choosing

alternative j as given in Equation 5, and their probabilities as presented in Equation 6 where $y_i =$ the index of the choice made.

If $Prob(U_{ij} \succ U_{iq}) for\ all\ q \neq j$ (6)

$$then\ P(y_i = j) = \frac{\ell^{V_{ij}}}{\sum_{q=1}^{j_i} \ell^{V_{ij}}} \quad (7)$$

The model has an assumption that all ε_{ij} is independent across respondents. Thus, the error terms of the choice sets should not relate to each other. This property is called Independence of Irrelevant Alternatives (IIA). The conditional logit specification implies that selections of an option from the choice set must obey the `independence from irrelevant alternatives' (IIA) property. This assumption means that the relative probabilities of two alternatives being chosen from a choice set are unaffected by the introduction, or removal of other alternatives in the choice set. In other words, if an alternative in our choice set is preferred to another alternative in the choice set then introducing a third alternative with different attribute level must not change the preference or the choice for the initially preferred option irrespective of how improved the other choice set is. Therefore, whether option A or B is better should not be changed by the availability or absence of another choice option.

This assumption places some limitations to the application of conditional logit model to mimic empirical choice situation because when different options of the same product is presented to a choice maker, his choice for one of the options is surely influence by the presence or absence of other options available.

There are several possibilities for removing IIA violations and also improving the model fit. However as suggested by *Rolfe et al. (2000)* and *McConnel* and *Tseng (2000),* the inclusion of interactions between socio-economic characteristics of the choice maker and attributes of the product is a simple but important step for estimating more accurate models of choice to both improve model fit and relax the IIA assumption by introducing heterogeneity in the choice problem.

Another condition that forms the basis of the use of interaction terms in the conditional logit model that set for analysis is, by following the examples of *Walker, (2001)* where the theory of choice is extended to include the cognitive process of attitude and perception or some characteristics associated with a choice maker and his choice behaviour. According to models, *Ben-Akiva et al. (1999),* including interaction terms allow for more realistic representation of behaviour in the choice process, with a better predictive power, producing consistent and efficient estimates of the parameter, and also fill the gap between behavioural theory and discrete choice.

One common goal of discrete choice models is to measure how much people are willing to pay. Estimating how much people are willing to pay is important for making policy decisions about the price of better electricity service and its reliability. It is also a key part of economic evaluations like cost-benefit analyses and figuring out how desirable goods and services are by comparing them and ranking them *(Hanley et al., 1998; Hensher & Greene, 2005)*. The standard way to figure out how much someone is willing to pay for an attribute is to divide the coefficient of the attribute by the coefficient of the

price or cost of the attribute as in Equation 8. As a result, the willingness to pay for the level of utility U_{ij} is given as;

$$WTP = \frac{(U_{ij+1} - U_{ij})}{-\beta_n} \quad (8)$$

Where U_{ij+1} is the new level of utility, $U_{ij}$is the current level of utility and β_n represents the cost associated with the utility. The marginal willingness to pay for attribute j is given as;

$$MWTP = -\frac{\beta_j}{\beta_n} \quad (9)$$

Where β_j is the estimated coefficient for the jth attribute and β_n is the estimated coefficient for the cost attribute. This measures the various attributes of improved electricity services and their reliability that will provide information about which attributes they value the most and how much they are willing to pay.

Chapter Summary

Stated preference techniques are used to identify how much something is worth by asking people what they want in a survey. A choice experiment is a well-known way to find out what customers want and how much they are willing to pay in situations where they cannot be watched directly. Choice experiments are based on Lancaster's theory of consumer behaviour and McFadden's random utility theory. These theories say that a thing's features determine its utility and that people buy things based on their features. According to McFadden's theory, a person's benefit from consuming a good can't be seen directly, but stated preference surveys can explain it. The rest of the consumer's value is called random. A choice experiment is made up of four steps: deciding on the characteristics and their levels, designing the

experiment, making option sets for each person based on the levels of the characteristics, and choosing a sampling method.

Several qualitative methods, such as interviews, focus group discussions, expert comments, and literature reviews, were used to identified the qualities and levels of electrical service. Focus groups talked to the heads of households in Accra to find out how planned outages, unplanned outages, the length of an outage, where it happens, how much it costs, and how it affects customers' decisions.

The Random utility model will be used in this study to identify what kinds of energy goods and services people want. It assumes that the parameter co-efficient (β) for each attribute is different for each respondent and that each person's utility is given as $U_{ij} = V_{ij} + \varepsilon_{ij}$. The multinomial logit model assumes that irrelevant variables are independent. Other models, such as the multinomial probit model and the mixed logit model, can take into account the fact that people have different preferences. Many people think that the mixed logit model is more realistic and useful than the multinomial logit model.

CHAPTER FOUR

RESULTS AND DISCUSSIONS

Introduction

This chapter shows the results of the interviews and fieldwork that were done to find out how people in the Ga West Municipality of Accra feel when there is power outage. The results of the collected data on the four research questions and four study goals are shown and discussed about.

Analysis of Demographic Characteristics of Respondents

This section presents and discusses the preliminary data, which is background information about the participants in the study.

Gender of Respondents:

There were 233 respondents, constituting 58.25% of the total sample, 167 respondents, making up 41.75% of the total sample. The sum of the male and female respondents is 400, representing 100%. This section provides an overview of the gender distribution within the study, indicating that there is a slightly higher representation of males compared to females

Ages of Respondents:

This section breaks down the age distribution of the respondents, providing insights into the composition of the sample across different age groups. There were 72 respondents whose ages were less than 30 years, accounting for 18.00% of the total, 117 respondents were between the age bracket of 30 to 39 years, making up 29.25% of the total, 119 respondents were between the range 40 to 49 inclusive, representing 29.75% of the total, 63 respondents, constituting 15.75 were in the ages of 50 to 59 years and 29

respondents, contributing 7.25% were 60years and above. The sum of respondents in all age categories is 400, representing 100 % of the sample.

Marital Status of Respondents:

This section provides information on the marital status distribution of the respondents, indicating the percentage of individuals in each category. 270 respondents were married, making up 67.50% of the total, 14 respondents were co-habiting, accounting for 3.50% of the total, 85 respondents, constituting 21.25% were single and 31 respondents, representing 7.75% of the total. The sum of the respondents in all marital status categories is 400, representing 100% of the sample.

Educational level of Respondents:

This section depicts information on education level of respondents, in which 7respondents (1.75% of the total sample) reported having no formal education, 17 respondents (4.25% of the total sample) have completed basic or primary education, this represents a relatively small but slightly larger group compared to those with no formal education. 62 respondents (15.50% of the total sample) have completed Junior High School or middle school education, 145 respondents (36.25% of the total sample) have completed Senior High School education and 169 respondents (42.25% of the total sample) have tertiary education, this represents the largest group, suggesting that a significant proportion of respondents have attained higher education.

The majority of respondents have at least a Senior High School education, with a substantial number (42.25%) having tertiary education. The distribution suggests a diverse educational background among the

respondents, ranging from those with no formal education to those with tertiary qualifications.

Employment Status of Respondents:

Among the 400 respondents of the study, 309 respondents (77.25% of the total sample) are employed on a full-time basis, this represents the majority of the sample, indicating a significant number of full-time workers. 47 respondents (11.75% of the total sample) are employed on a part-time basis, while smaller than the full-time employed group, this category still represents a notable proportion of the sample. 14 respondents (3.50% of the total sample) are retired, 14 respondents (3.50% of the total sample) are students, 15 respondents (3.75% of the total sample) are unemployed and 1 respondents (0.25% of the total sample) falls into the "Others" category.

The majority of respondents are employed full-time, indicating a predominantly working sample. The diversity in employment statuses, including part-time employment, retirement, student status, and unemployment, reflects a varied representation of the workforce.

In summary, table 5 below offers a clear and concise presentation of the demographic characteristics of the respondents in terms of gender, age, marital status, educational level and employment status of respondents.

Table 5: Gender, Age, Marital status, Educational level and Employment status of Respondents.

	Frequency	Percentage (%)
Gender of respondents		
Male	233	58.25
Female	167	41.75
Total	400	100
Ages of respondents		
Less than 30 years	72	18.00
30 – 39 years	117	29.25
40 – 49 years	119	29.75
50 – 59 years	63	15.75
60 years and above	29	7.25
Total	400	100
Marital status of respondents		
Married	270	67.50
Co-habitation	14	3.50
Single	85	21.25
Separated/divorced/windowed	31	7.75
Total	400	100
Education level of respondents		
None	7	1.75
Basic/Primary education	17	4.25
JHS/Middle school education	62	15.5
Senior high school education	145	36.25
Tertiary education	169	42.25
Total	400	100
Employment status of respondents		
Employed (Full time)	309	77.25
Employed (Part time)	47	11.75
Retired	14	3.50
Student	14	3.50
Unemployed	15	3.75
Others	1	0.25
Total	400	100

Source: Field survey, 2022

Children of Respondents

Respondents were asked if they had children or not, it was revealed from table 6 that, out of the 400 respondents interviewed, 307 respondents

representing 76.75% are having children whilst 93 respondents representing 23.25% were not having children.

Table 6: Children of Respondents

Children	Frequency	Percentage (%)
Yes	307	76.75
No	93	23.25
Total	400	100.00

Source: Field survey, 2022

The household size of the Respondents:

This household size distribution provides valuable insights into the variety of household size among the surveyed population, indicating the prevalence of mid-sized households in the sample.

The majority of respondents (55.5%) have household sizes ranging from 5 to 10 members, about 29.5% of respondents have household sizes less than 5 members, a smaller proportion of respondents (13.75%) have household sizes between 11 and 15 and a very small percentage (1.25%) of respondents have household with 16 members or more, see the table 7 below:

Table 7: Household size of Respondents

Household size	Frequency	Percentage (%)
Less than 5	118	29.5
5 – 10	222	55.5
11 – 15	55	13.75
16 and above	5	1.25
Total	400	100.00

Source: Field survey, 2022

The average household size in the sample is 6.7 with standard deviation of 3.468 indicating that some variability in household sizes suggest that they are not uniform across all observations and the minimum household size for the sample is 1 and the maximum is 18, see table 8 below:

Table 8: Average household size

Variable	Obs	Mean	Std.Dev	Min	Max
Household size	400	6.7	3.468	1	18

Source: Field survey, 2022

Income level of Respondents per month:

Table 9 below provides a detailed breakdown of the monthly income levels of respondents in the thesis work. 159 respondents representing 39.75% of the total sample reported a monthly income in the range of GH¢ 1.00 to GH¢ 1,000.00, this is the largest group, indicating a significant portion of respondents have a lower monthly income. 173 respondents (43.25% of the total sample) report a monthly income in the range of GH¢ 1,001.00 to GH¢ 3,000.00, this is another category representing a substantial group with a higher monthly income compared to the first category. 25 respondents (6.25% of the total sample) report a monthly income in the range of GH¢ 3,001.00 to GH¢ 5,000.00 this is a smaller group, indicating a minority of respondents have a moderate monthly income. 8 respondents indicating 2.00% of the total sample report a monthly income in the range of GH¢ 5,001 to GH¢ 7,000.00, suggesting a minority of respondents have a higher monthly income. 4 respondents (1.00% of the total sample) report a monthly income of Gh¢ 7,001.00 and above and 31 respondents (7.75% of the total sample) either

refused to disclose their income or reported having no income. The total sample size is 400 respondents, with a percentage summing up to 100%

Table 9: Income level per month of Respondents

Income level monthly	Frequency	Percentage (%)
GH₵ 1.00 - GH₵ 1,000.00	159	39.75
GH₵ 1,001.00 - GH₵ 3,000.00	173	43.25
GH₵ 3,001.00 - GH₵ 5,000.00	25	6.25
GH₵ 5,001 - GH₵ 7,000.00	8	2.00
GH₵ 7,001 and above	4	1.00
refused/No income	31	7.75
Total	400	100.00

Source: Field survey, 2022

The majority of respondents fall into the lower income brackets, with a significant percentage reporting monthly incomes of GH₵ 1,000 or less and there is a gradual decline in the percentage of respondents as the income level increase, indicating a distribution skewed towards lower incomes. A notable portion of respondents either refused to disclose their income or reported having no income, underscoring the diversity in financial situation within the sample.

Features of Existing Electricity Supply and Associated Issues

Tenancy Status of Respondents

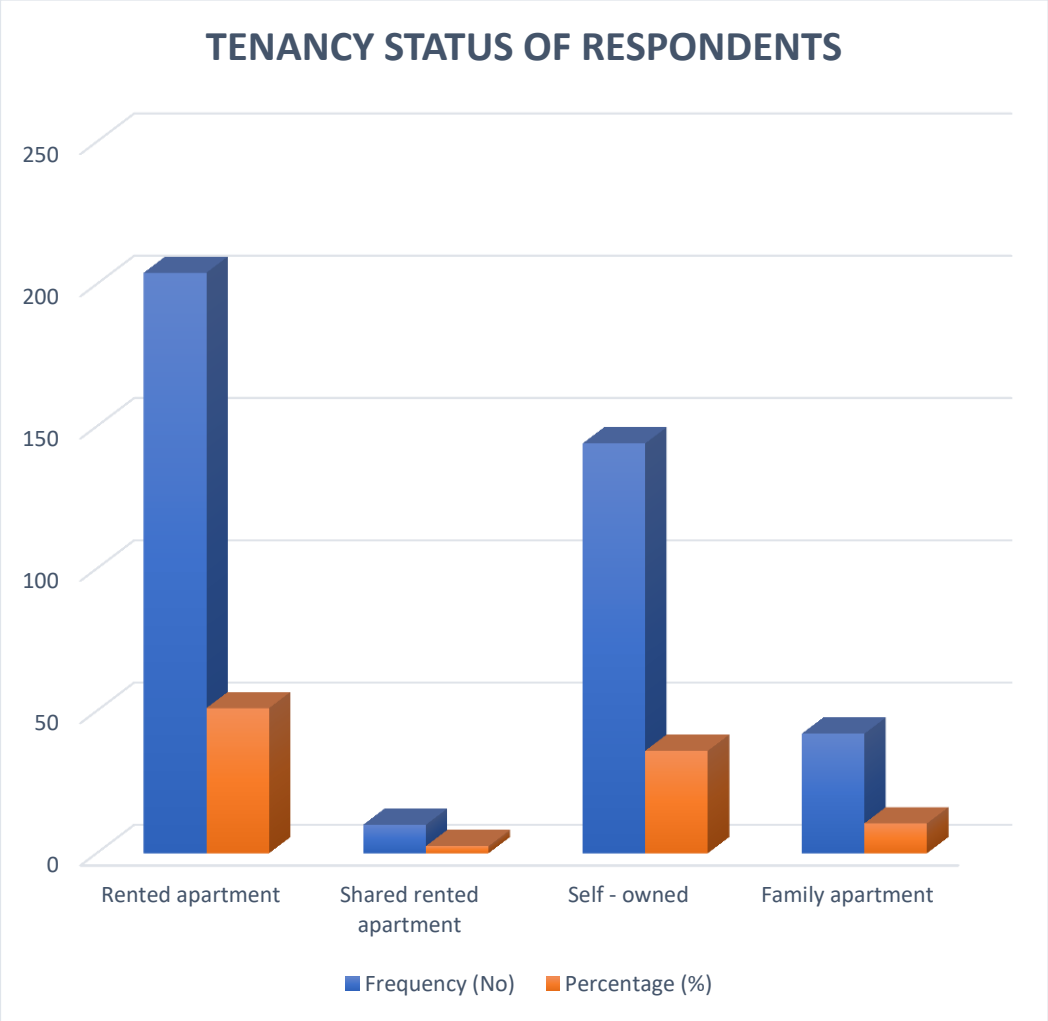

Figure 8: Tenancy Status of Respondents

Source: Field survey, 2022

All of the households selected were asked about their tenancy status whether rented, shared rented, self – owned or family apartment. Figure shows that 51% representing 204 households were rented apartments while 2.50% representing 10 households were shared rented apartments. Those who have their apartment that is self – owned was 36% representing 144 households while 10.50% representing 42 households were family apartments.

Household Electricity Meter Status

Table 10 presents households' electricity meter status during the survey

Table 10: Household Electricity Meter Status

Meter status	Frequency	Percentage (%)
Shared	179	44.75
Separate (Not shared)	221	55.25
Total	400	100.00

Source: Field survey, 2022

Table 10 shows how respondents' household electricity meter status, the survey revealed that 55.25% representing 221 households have their meter whilst 44.75% representing 179 households shared meter.

Household Electricity Supply Status

Table 11: Household Electricity Supply Status

Electricity supply status	Frequency	Percentage (%)
Postpaid	104	26.00
Pre - paid	296	74.00
Total	400	100.00

Source: Field survey, 2022

All households surveyed were asked about the supply status of their electricity, whether postpaid or prepaid. Table 11 shows that 104 households representing 26% are using postpaid whilst 296 households representing 74% are using pre-paid. This shows that the majority of the sampled survey are using pre-paid meter status.

Average Amount Spend on Electricity per month

Table 12 described the household average amount spent on electricity in a month

Table 12: Average amount spent on electricity in a month

Average Amount on Electricity	Frequency	Percentage (%)
Less than GH¢ 100.00	146	36.5
GH¢ 100.00 - GH¢ 200.00	197	49.25
GH¢ 201.00 - GH¢ 300.00	47	11.75
Above GH¢ 300.00	10	2.5
Total	400	100.00

Source: Field survey, 2022

Respondents were asked about their average amount spent on electricity every month. Table 12 revealed that 146 respondents representing 36.5% were paying for electricity tariffs less than GH¢ 100.00 for a month, 197 respondents representing 49.25 were paying an amount of GH¢ 100.00 to GH¢ 200.00 per month, 47 respondents representing 11.75% were paying an amount between GH¢ 200.00 and GH¢ 301.00 and 10 respondents representing 2.5% were paying above Gh¢ 300.00

Prior Notification Given before an Outage

Sudden Power Cuts in a Month

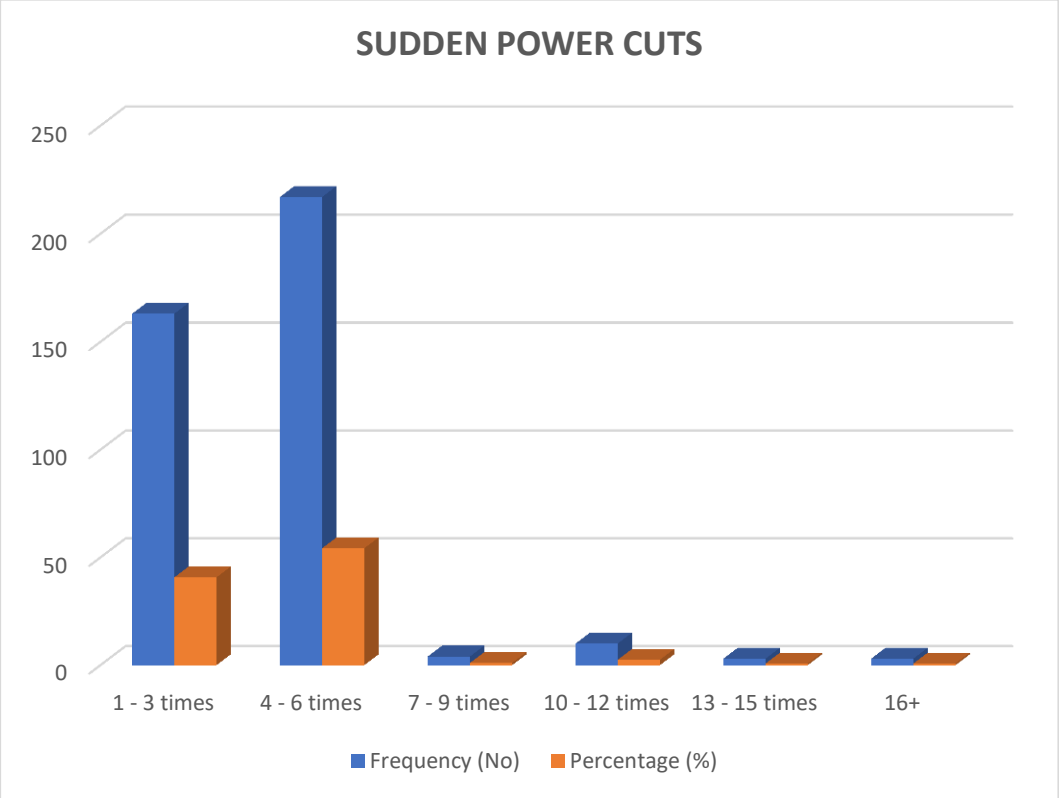

Figure 9: **Sudden Power Cuts**

Source: Field survey, 2022

All of the households were asked a month before the interview how often they had sudden power outages. Figure 9 shows that 40.75% representing 163 respondents were having 1 to 3 times sudden power cuts within a month, 54.25% representing 217 of the respondents were having a sudden power cut that ranges from 4 to 6 times in a month, a percentage representing 4 respondents were having a sudden power cuts from 7 to 9 times, 0.75% representing 3 respondents experienced 13 to 15 times sudden power cuts within a month and also 0.75% representing 3 respondents experienced 16 and more sudden power cut in a month.

Duration of Power Outages in a month

The Electricity Company of Ghana provides electricity to each of the designated residences. Yet, the clear majority of responders felt that it was difficult to predict a month of uninterrupted power. Table 13 indicates the monthly average number of households experiencing power outages for a specific number of hours.

Table 13: Duration of Power Outage

Duration of Outage	Frequency	Percentage (%)
1minutes – 59minutes	21	5.25
1hour – 4hours	151	37.75
5hours – 8hours	141	35.25
9 hours – 12 hours	45	11.25
13hours – 15hours	9	2.25
16+ hours	33	8.25
Total	400	100.00

Source: Field survey, 2022

Table 13 shows that, out of the 400 people who were sampled, 151 (37.75%) experience the most hours of outages lasting between 1 and 4 hours on days when their power supply is interrupted. This is followed by 141 (35.25%), who experience the most hours of outages lasting between 5 and 8 hours, and 33 (8.25%) who experience the most hours of outages lasting more than 15 hours in a day. For the shortest amount of time that the power was out, which was between 1 and 59 minutes, 21 people responded, which is 5.25 percent of the whole sample.

Prior Notification before an outage

Table 14: Prior Notification Before an Outage

Prior Notification	Frequency	Percentage (%)
Prior Notice Given	16	4.00
No Prior Notice Given	384	96.00
Total	400	100.00

Source: Field survey, 2022

As demonstrated in Table 14, 384 (96%) of respondents were not notified prior to power interruptions. Just 16 (4%) of the population reported receiving advance notice about power outages.

Reliability of power supply

Figure 10 shows how reliable is the power supply in households or neighborhood

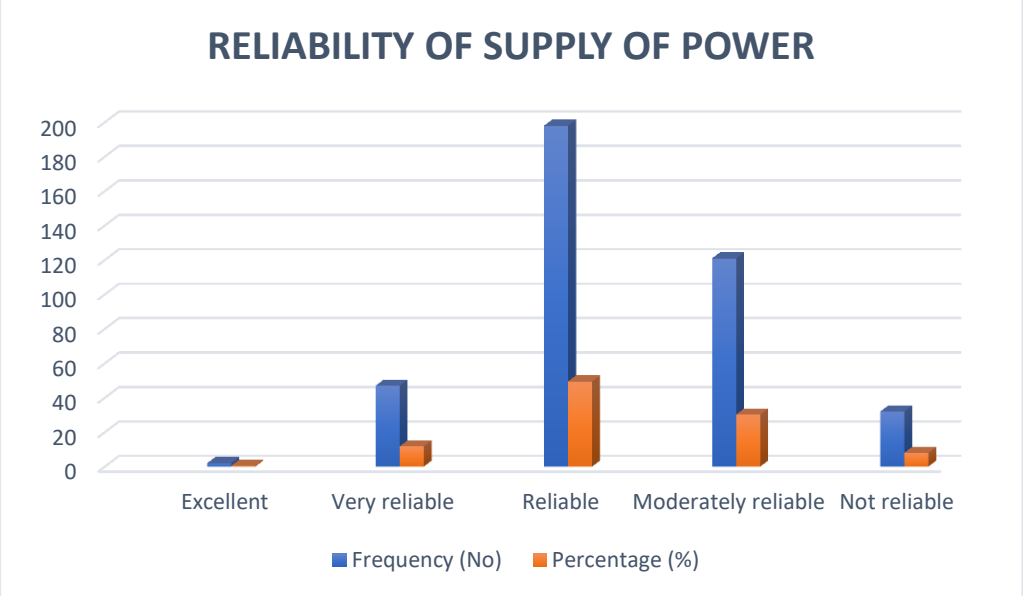

Figure 10: Reliability of Supply of Power

Source: Field survey, 2022

Additionally, households were requested to evaluate the reliability of the current electricity supply. A consistently accessible power source was deemed reliable. Figure 11 reveals that 198 respondents (49.50%) regard the reliability of the existing power supply to be reliable, while 121 (30.25%) believe it to be moderately reliable. 2 (0.50%) respondents judged the reliability of the power supply to be good, while 47 (11.75%) feel it is very reliable and 32 (8%) believe it is not at all reliable.

Econometric Results:

The results of the MNL are presented in Table 15, which demonstrates that factors such as a planned outage, an unplanned outage, the duration of the outage, and its geographical scope are all significant in comparison to its t-statistics and have the anticipated negative signals, as respondents desired fewer outages with shorter durations. As anticipated, this coefficient is negative for cost qualities, as the utility of selecting a higher level of service reliability decreases as payment increases.

Table 15: Multinomial logit model with attributes variables

Multinomial logit model

Attributes	Mean Coefficient	Robust Std. error	t – statistics	Expected sign
Constant	-1.3613	0.1050	-13.39	-
Planned Outage	-0.0553	0.0041	-14.06	-
Unplanned Outage	-0.0404	0.0041	-10.18	-
Duration of Outage	-0.0102	0.0005	-21.62	-
Geographical scope (Household)	-0.0162	0.0648	-0.25	-
Geographical scope (Neighbourhood)	-0.0560	0.0566	-0.99	-
Geographical scope (District)	-0.1860	0.0816	-2.42	-
Cost	-0.6408	0.0391	-16.81	-

Model Diagnostic	
LL(0)	-4759.188
LL(final)	-3193.566
Rho squared	0.33
Adjusted Rho squared	0.33
AIC/n	1.478
BIC/n	1.489
n (observation)	4332
r (respondents)	361
k (parameters)	8

Source: Authors Estimation, 2022

The mixed logit (ML) specification usually takes the place of the multinomial logit (MNL) model *(Louviere et al., 2000; McFadden, 1974)* when it comes to estimating choice experiments *(Petrin & Train, 2003)*. In the mixed logit model, a random term that depends on underlying parameters is added to the classical utility function of each option. This should only be done after taking into account the differences between people based on their socioeconomic status and when there is not enough information in the dataset to take into account the remaining differences. Even though there are some problems with its effects and model selection, its popularity has continued to grow *(Brownstone, 2001)*. Unlike the multinomial model, the mixed logit model lets you specify individual differences that cannot be seen. Table 16 shows an estimate of the RPM. All of the projected coefficients for the attributes are significant and have the signs expected. All of the signs of the calculated coefficients for attributes and interactions are the same as those of previous MNL models. Also, it is very important because the mean and standard deviation of random parameters have negative and positive values, respectively, when compared to the t-statistics. The small increase in the log likelihood shows that RPM fits the data better than its predecessor, MNL. RPM is a more advanced model than MNL because the random parameters

have a relatively high standard deviation. This shows that RP has a structural advantage.

Mixed Logit (ML) model

Table 16: Random parameter model (RPM)

Random Parameter Model	**Mean Coefficient**	**Robust Std. error**	**t – statistics**
Constant	-2.6723	0.2213	-12.05
Std. dev. for constant	1.9868	0.2295	9.75
Planned outage	-0.0745	0.0071	-11.38
Std. dev. for planned outage	0.0632	0.0054	9.67
Unplanned outage	-0.0631	0.0070	-10.64
Std. dev. for unplanned outage	-0.0236	0.0053	-3.13
Duration of outage	-0.0135	0.0012	-14.00
Std. dev. for duration	0.0027	0.0020	0.84
Geographical scope (hh)	0.0811	0.0641	0.96
Std. dev. for geo. (hh)	0.0050	0.0125	0.05
Geographical scope (ng)	0.0024	0.0538	0.03
Std. dev. for geo. (ng)	-0.0231	0.0163	-0.24
Geographical scope (dt)	-0.1485	0.0765	-1.42
Std. dev. for geo. (dt)	0.0145	0.0273	0.10
Cost	-0.8751	0.1078	-18.09
Planned_unplanned	0.0337	0.0067	5.08
Planned_duration	0.0022	0.0014	1.29

Planned_household	-0.2851	0.0702	-2.97
Planned_neighbourhood	0.1758	0.0759	1.92
Planned_district	0.2839	0.0947	2.43
Unplanned_duration	-0.0130	0.0013	-10.72
Unplanned_household	0.1537	0.0519	1.58
Unplanned_neighbourhood	0.4304	0.0686	4.66
Unplanned_district	0.3807	0.1069	2.71
Duration_household	-0.0405	0.0310	-0.38
Duration_neighbourhood	-0.0554	0.0364	-0.50
Duration_district	-0.1147	0.0537	-0.72
Household_neighbourhood	0.0156	0.0143	0.15
Household_district	0.0034	0.0209	0.02
Neighbourhood_district	-0.0016	0.0241	-0.01
Model Diagnostic			
LL(0)	-4759.188		
LL(final)	-2873.419		
Rho squared	0.4		
Adjusted Rho squared	0.39		
AIC/n	1.340		
BIC/n	1.385		
n (observation)	4332		
r (respondents)	361		
k (parameters)	30		

Source: Authors Estimation, 2022

Note: Std.dev for Standard deviation, hh for Household, ng for Neighbourhood, and dt for District

Table 16 indicates that the average planned outage coefficient is -0.0745 with a standard deviation of 0.0632 and a significant t-value of -11.38, indicating that respondents prefer fewer or less planned outages. Furthermore, the unplanned outage was statistically significant with a mean coefficient of -0.0631 and a standard deviation of -0.0236 compared to a t-value of -10.64, showing that consumers prefer fewer unplanned disruptions. The coefficients for duration and cost are -0.0135 and -0.8751, with a standard deviation of 0.0027 for duration. Comparing these coefficients to their corresponding t-values of -14.00 and -18.09 indicates that households prefer shorter durations with lower expenses. For geographical scopes where power outages are limited to household, neighbourhood, or district, the mean coefficients and standard deviations are 0.0811, 0.0024, and -0.1485 and 0.0050, -0.0231, and 0.0145, respectively. Comparing their relative t-values of 0.96, 0.03, and -1.42 demonstrates that households do not desire power outages to occur regardless of their location.

Research Objective One

Identify the geographical scope of power outages in the Ga West Municipality of Accra.

The last research question is to identify the geographical scope or area where power outages are restricted to.

MWTP for Geographical Scope of power outages being household

$$MWTP_{scope\_household} = -\frac{\beta_{5_{scope\_household}}}{\beta_{1_{cost}}}$$

$$MWTP_{scope\_household} = -\left(\frac{0.0811}{-0.8751}\right)$$

$$0.093 * 100 = 9.30$$

Standard Deviation for the Geographical scope of power outage being household.

$$SD_{Geo\_Household} = \frac{Standard\ deviation\ coefficient\ for\ household\ being\ geographical\ scope\ of\ power\ outage}{\beta_{1_{cost}}}$$

$$SD_{Geo\_Household} = \frac{0.0050}{-0.8751}$$

$$-0.006 * 100 = -0.60$$

MWTP for Geographical Scope_Neighbourhood

$$MWTP_{scope\_neighbourhood} = -\frac{\beta_{5_{scope\_neighbourhood}}}{\beta_{1_{cost}}}$$

$$MWTP_{scope\_neighbourhood} = -\left(\frac{0.0024}{-0.8751}\right)$$

$$0.003 * 100 = 0.30$$

Standard Deviation for the Geographical scope of power outage being Neighbourhood.

$$SD_{Geo\_Neighbourhood} = \frac{Standard\ deviation\ coefficient\ for\ neighbourhood\ being\ geographical\ scope\ of\ power\ outage}{\beta_{1_{cost}}}$$

$$SD_{Geo\_Household} = \frac{-0.0231}{-0.8751}$$

$$0.026 * 100 = 2.60$$

MWTP for Geographical Scope_District

$$MWTP_{scope\_district} = -\frac{\beta_{5_{scope\_district}}}{\beta_{1_{cost}}}$$

$$MWTP_{scope\_district} = -\left(\frac{-0.1485}{-0.8751}\right)$$

$$-0.169 * 100 = -16.90$$

Standard Deviation for the Geographical scope of power outage being District.

$$SD_{Geo\_District}$$

$$= \frac{Standard\ deviation\ coefficient\ for\ district\ being\ geographical\ scope\ of\ power\ outage}{\beta_{1_{cost}}}$$

$$SD_{Geo\_Household} = \frac{0.0145}{-0.8751}$$

$$-0.017 * 100 = -1.70$$

The final purpose was to determine which geographical area or scope electricity power is restricted to. According to the results of the regression analysis, power outages limited to Households and Neighbourhoods are not statistically significant, however, power outages limited to districts are statistically significant. In other words, residents of the Ga West Municipality do not care where the power outage is limited; they simply do not want one in their households or the neighbourhood. Households are willing to pay an additional GH¢ 16.90 per year on top of their present electricity cost to eliminate power disruptions that are confined to the district. It has a normal distribution with a mean of GH¢ 16.90 and a standard deviation of GH¢ 1.70. N(16.90, 1.70).

Research Objective Two

Estimate the marginal willingness to pay (MWTP) for reducing planned power outages by households in Ga West Municipality of Accra.

The first research question looked at how much people in Ga West Municipality of Accra would be willing to pay to reduce planned power outages in order to improve the quality of electricity service and make improvements.

Marginal Willingness to Pay (MWTP) for Planned power outage

$$MWTP_{planned\ outage} = -\frac{\beta_{2_{planned\ outage}}}{\beta_{1_{cost}}}$$

$$MWTP_{planned\ outage} = -\left(\frac{-0.0745}{-0.8751}\right)$$

$$-0.085 * 100 = -8.51$$

Standard Deviation for Planned power outage

$$SD_{planned\ outage} = \frac{Standard\ deviation\ coefficient\ for\ planned\ outage}{\beta_{1_{cost}}}$$

$$SD_{planned\ outage} = \frac{0.0632}{-0.8751}$$

$$-0.072 * 100 = -7.20$$

Households are willing to spend GH¢ 8.51 annually in addition to their current annual electricity bill for an improvement in electricity service attribute of planned power outages to reduce frequent power outages in the Ga West Municipality of Accra. It is therefore distributed normally with a mean of GH¢ 8.51 and a standard deviation of GH¢ 7.20, N(8.51, 7.20).

Research Objective Three

Estimate the marginal willingness to pay (MWTP) for reducing unplanned power outages by households in Ga West Municipality of Accra.

The next research question was to find out how much households in Ga West Municipality would be willing to pay to reduce unplanned power outages and improve the quality of electricity service.

MWTP for Unplanned outage

$$MWTP_{unplanned\ outage} = -\frac{\beta_{3_{unplanned\ outage}}}{\beta_{1_{cost}}}$$

$$MWTP_{unplanned\ outage} = -\left(\frac{-0.0631}{-0.8751}\right)$$

$$-0.072 * 100 = -7.21$$

Standard Deviation for Unplanned power outage

$$SD_{unplanned\ outage} = \frac{Standard\ deviation\ coefficient\ for\ unplanned\ outage}{\beta_{1_{cost}}}$$

$$SD_{unplanned\ outage} = \frac{-0.0236}{-0.8751}$$

$$0.027 * 100 = 2.70$$

An unplanned power outage is the number of power outages occurring without prior notifications from the power distributors. This usually occurs when there is a lack of maintenance in the electricity equipment, rotting polls, bad wires, and others. The results of this study are depicting that, households within the Ga West Municipality are willing to spend GH¢ 7.21 annually in addition to their current annual payment of electricity bills for fewer

unplanned power outages to occur, to result in improving the service of electricity within the Municipality. It is normally distributed between the mean of GH¢ 7.21 and the standard deviation of GH¢ 2.70, N(-7.21, 2.70).

Research Objective Four

Estimate the marginal willingness to pay (MWTP) for reducing the duration of power outages by households in Ga West Municipality of Accra.

The third research question is to estimate how much households in Ga West Municipality are willing to pay to cut down on the duration of power outages in order to improve and enhance electricity service.

MWTP for the Duration of a power outage

$$MWTP_{duration\ of\ outage} = -\frac{\beta_{4_{duration\ of\ outage}}}{\beta_{1_{cost}}}$$

$$MWTP_{duration\ of\ outage} = -\left(\frac{-0.0135}{-0.8751}\right)$$

$$-0.015 * 100 = -1.54$$

Standard Deviation for the Duration of power outage.

$$SD_{duration\ of\ outage}$$

$$= \frac{Standard\ deviation\ coefficient\ for\ duration\ of\ outage}{\beta_{1_{cost}}}$$

$$SD_{duration\ of\ power\ outage} = \frac{0.0027}{-0.8751}$$

$$-0.003 * 100 = -0.30$$

The duration of an outage indicates how long the power outage is going to last. Households are therefore willing to spend GH¢ 1.54 for a fewer or less duration of power outage annually in addition to what they are paying

as electricity bill in a year. This is normally distributed with a mean of GH¢ 1.54 and a standard deviation of GH¢ 0.30, N(1.54, 0.30).

Table 17: Summary of Marginal WTP and their standard deviations for the attributes

Attributes	MWTP	Standard Deviations
Planned outage	GH¢ 8.51	GH¢ 7.20
Unplanned outage	GH¢ 7.21	GH¢ 2.70
Duration of outage	GH¢ 1.54	GH¢ 0.30
Geographical scope (District)	GH¢ 16.90	GH¢ 1.70

Chapter Summary

As the first step in choosing the right attributes and how they work, it is best to use a multinomial logit model. Table 15 shows the MNL's findings, which show that things like a planned outage, an unplanned outage, the duration of the outage, and how many places it affects are important. The mixed logit model (RPM) lets you specify unobserved differences between people. The small increase in the log likelihood shows that RPM fits the data better than its predecessor, MNL. The fact that the random parameters have a pretty high standard deviation shows that RPM is a more advanced model from MNL.

Households are willing to spend GH¢ 8.51 annually in addition to their annual electricity bill for an improvement in electricity service attribute of planned power outages to reduce the frequent planned power outages. An unplanned power outage is when there is a lack of maintenance in the electricity equipment, rotting polls, bad wires, and the others and households

are willing to spend GH¢ 7.21 annually in addition to their current annual payment of electricity bill for a fewer of unplanned power outages to occur, to result in improving the service of electricity within the Municipality. Households are as well willing to spend GH¢ 1.54 for a fewer or less duration of power outage annually in addition to what they are paying as electricity bills in a year. Residents of the Ga West Municipality do not care where the power outage is limited; they simply do not want one in their households or the neighbourhood.

CHAPTER FIVE

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

This chapter gives a summary of the study. This chapter also has a conclusion, policy suggestions based on what the study found, and suggestions for further research on the subject.

Summary:

The main goal of the study is to look at the marginal willingness to pay (MWTP) for the different features of electricity that have been identified as areas for service improvement. This was be done through choice experiments (CE), in which service attributes are presented as choices and the choices made by respondents are used to calculate the marginal willingness to pay (MWTP) values. In particular, the study wanted to find out how much households would be willing to pay to cut down on planned power outages in exchange for better quality and more of them. It also wanted to find out how much households would be willing to pay to cut down on unplanned power outages in exchange for better quality and more of them, and how much they would be willing to pay to cut down on the duration of power outages in the Ga West Municipality of Accra.

The study uses a choice experiment to find out what kinds of reliable electricity service improvements people want. The four improvements mentioned above evaluated using the Mixed Logit model. The study finds that households in the Ga West Municipality of Accra are willing to pay an extra GH¢ 8.51 per year on top of what they already pay for electricity in exchange for fewer planned power outages and better electricity service. It was also revealed that, for an unplanned power outage, households within the Ga West

Municipality are willing to spend GH¢ 7.21 annually in addition to their current annual payment of electricity bill for a fewer or less of it to occur, to result in improving the service of electricity within the Municipality.

In addition, households are therefore willing to spend GH¢ 1.54 for a fewer or less duration of power outage annually in addition to what they are paying as electricity tariffs in a year. According to the results of the regression analysis, power outages limited to Households and Neighbourhoods are not statistically significant, however, power outages limited to districts are statistically significant. In other words, residents of the Ga West Municipality do not care where the power outage is limited; they simply do not want one in their households or the neighbourhood. Households are willing to pay an additional GH¢ 16.90 per year on top of their present electricity cost to eliminate power disruptions that are confined to the district.

Conclusions:

In conclusion, this thesis addressed four distinct research objectives, each focusing on estimating the marginal willingness to pay (MWTP) for specific attributes related to power outages in the Ga West Municipality of greater Accra region. The thesis provides a conclusion for each research objective as follows:

Research Objective One: Geographical Scope of Power Outages

The analysis aimed to identify the geographical scope or area where power outages are restricted. The results revealed that power outages limited to households and neighbourhoods are not statistically significant, while those limited to districts are statistically significant. Residents prioritize avoiding

power disruptions in any geographical scope, willing to pay an additional GH¢ 16.90 annually to eliminate power disruptions confined to the district.

Research Objective Two: Planned Power Outages

Households in the Ga West Municipality are willing to spend an additional GH¢ 8.51 annually to reduce planned power outages and improve electricity service. The MWTP estimate is normally distributed with a mean of GH¢ 8.51 and a standard deviation of GH¢ 7.20, highlighting the economic value residents place on minimizing frequent planned power outages.

Research Objective Three: Unplanned Power Outages

Residents are willing to spend GH¢ 7.21 annually to experience fewer unplanned power outages, showcasing the economic value placed on improving the service of electricity within the municipality. The MWTP estimate is normally distributed with a mean of GH¢ 7.21 and a standard deviation of GH¢ 2.70.

Research Objective Four: Duration of Power Outages

Households are willing to spend GH¢ 1.54 annually to reduce the duration of power outages. The MWTP estimate is normally distributed with a mean of GH¢ 1.54 and a standard deviation of GH¢ 0.30. This reflects the economic value attributed to shorter outage durations, emphasizing the importance of minimizing disruptions in daily activities.

In conclusion, the findings contribute valuable insights into the economic preferences of households in the Ga West Municipality regarding various aspects of power outages. Policymakers and electricity service

providers can use this information to guide decision-making and allocate resources effectively, ultimately improving the reliability and quality of electricity service in the region.

Policy Recommendations:

Based on the findings from this study on willingness to pay for electricity reliability improvements in Ga West Municipality of Greater Accra region, here are some policy recommendations aimed to guide policymakers, energy authorities, researchers and utility providers in implementing strategies that align with the preferences and willingness of households to pay for improved electricity services, thereby fostering economic development and enhancing the overall quality of life in the Ga West Municipality:

1. Policymakers should adopt a comprehensive approach to address power outages by considering the geographical scope. While households and neighbourhoods may not be statistically significant, districts are crucial. Develop policies that focus on district-level improvements to ensure a broader impact on electricity service reliability.
2. Allocate resources for infrastructure development to reduce planned power outages. Residents are willing to invest an additional GH¢ 8.51 annually to minimize planned outages, highlighting the economic value they place on a more reliable electricity supply. Ensure that maintenance and upgrades are conducted regularly to prevent disruptions.
3. Establish effective emergency response mechanisms to address unplanned power outages. Residents' willingness to spend GH¢ 7.21

annually signifies the importance they place on mitigating unplanned disruptions. Create a responsive system to promptly address issues such as equipment failures, rotting poles, and faulty wires.

4. Prioritize initiatives to reduce the duration of power outages. Households are willing to pay GH¢ 1.54 annually for shorter outage durations. Invest in technologies and procedures that can quickly identify and address issues, ensuring minimal disruptions and enhancing the overall quality of electricity service.

By incorporating these recommendations into policy initiatives, policymakers can work towards enhancing the reliability, affordability, and overall quality of electricity service in the Ga West Municipality, ultimately improving the lives of residents in the greater Accra region.

Limitations of the study

The primary constraint of the survey instrument was evident in some respondents struggling to discern the optimal choice from the provided options. This led to the necessity of providing detailed explanations for the choice sets to certain participants, consuming a significant amount of time per respondent. Additionally, reluctance to participate emerged among some individuals who presumed my affiliation with the government or ECG, contributing to a reluctance to engage in the research. Furthermore, a subset of households declined participation, citing a lack of compensation for their involvement.

The final limitation pertained to financial constraints, compelling the study to be confined to the Ga West Municipality of Accra instead of

encompassing the entire country, as originally intended, due to limitations in available funds.

Suggestions for future research

1. Researchers in this area should conduct additional willingness-to-pay studies on alternative electricity service attributes beyond planned power outage, unplanned power outage and duration of power outage, to provide a comprehensive understanding of household priorities for quality improvements.
2. Further research should be conducted to understand the dynamics of household preferences regarding electricity services in more depth. Explore variations in preferences across different socio-economic groups and assess the long-term impacts of improved electricity services on communities.

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APPENDICES

A: QUESTIONNAIRE

Region: Greater Accra **Municipality: Ga west**

Date of Interview…… **Questionnaire Number……..**

Introduction:

Please, I am Richard Agyekum, an MPhil Economics student at the School of Economics, University of Cape Coast. I am conducting research on the topic ***"Households' valuation of power outages in Ga West municipality of Accra: An application of a choice experiment".*** Your household's views would contribute significantly towards the understanding of how power outages affect households in this country. We would appreciate it if you could respond to the following questions. Your views are **STRICTLY PRIVATE AND CONFIDENTIAL** and shall not be passed on to another person or organization.

SECTION A: BACKGROUND INFORMATION OF RESPONDENTS

1. How old are you? _____
2. Sex:

	Please Tick (√)
Male	
Female	

3. What is your education level to date?

	Please Tick (√)
Basic/Primary	
JHS/Middle School	
SHS	
Tertiary	
None	

4. What is your marital status?

	Please tick (√)
Married	
Co - habitat	
Single	
Separated/divorce/widowed	

5. Do you have children?

	Please tick (√)
Yes	
No	

6. a. Including you, how many persons are there in your household? State the total number appropriately.

Below 5 years old	
Between 5 and 15 years old	
Between 16 and 60 years old	
Over 60 years old	

b. Please indicate household size_____

SECTION B: EXISTING ELECTRICITY SUPPLY AND ASSOCIATED ISSUES

7. How would you describe your household's tenancy status?

	Please Tick (√)
Rented apartment	
Shared rented apartment	
Self – owned	
Family apartment	

8. How would you describe your electricity meter status?

	Please Tick (√)
Shared	
Separate (If separate skip to Q11)	

9. If shared, then what is the total number of households that share this meter including your household?

Please State the number_____

10. How do you pay for electricity now that the meter is shared with other residents?

	Please Tick (√)
Part of rent	
Individual contribution	
Others (Please specify)	

11. How would you describe your household electricity supply status?

	Please Tick (√)
Postpaid	
Pre - paid	

12. How much on average does your household spend on electricity per month? Gh¢_____

PRIOR NOTIFICATION GIVEN BEFORE AN OUTAGE:

13. A month before this interview, how many times did your household experience the following:

Sudden power cuts ☐

Poor power quality ☐

14. On the average, how long did it take in each case before your electricity was restored?

State the total duration:_____

15. What usually causes the power outages?

	Please Tick (√)
A fault peculiar to this household alone (meter–spec	
A general problem for all households in the neighbo	
Do not know	
Others (Please specify	

16. Were you informed before the power outage occurred?

	Please Tick (√)
Yes	
No (if No skip to 18)	

17. If yes to 16, how did you know the power outage will occur?

	Please Tick (√)
A friend/Relative	
Radio	
Television	
Newspaper	
ECG Announcement	
Others (Please specify)	

18. Which of the following best describes how the power outage affected your household?

Type of Effect	Please Tick (√)
Work/job was affected	
Electrical gadgets/appliances, products, and activities were destroyed	
Leisure's/recreational activities	
We missed a favorite television show/ we could not watch television that day	
We missed a crucial football match	
There was a theft attempt on my household due to the darkness	
It burnt electrical fittings in parts of our rooms as a result of power outage	
The kids did not get lights to do their homework on time. That made them late for school the next day	
We could not iron or the ironing was delayed due to the power outage	
Our room(s) were very hot for us to sleep in	
We could not use our mosquito nets	
We had a late dinner due to the absence of power	
We slept outside due to the power outages	
Others (Please specify)	

19. Do you think the appropriate authorities have done enough to solve or at least deal with the problems of providing reliable and quality electricity supply?

	Please Tick (√)
Yes	
No	

ATTITUDE TOWARDS ENERGY CONSERVATION:

20. Have you heard about energy conservation?

Yes [ ], No [ ]

21. If yes to 20, how do you conserve energy? Tick all appropriate.

	Please Tick (√)
Turn our refrigerator down	
Use energy-efficient light bulbs	
Use energy-efficient appliances	
Turn off the fan when you leave a room	
Turn off your light when you leave a room	
Turn off your television when you leave a room	
Unplug devices and appliances you are not using	
Wrap or cover foods and drinks in the refrigerator	
Others (Please specify	

SECTION C: ADAPTATION TO POWER OUTAGES

22. What alternative sources of energy does your household rely on in times of power outages?

Type of Energy	Please Tick (√)
Mobile phone light	
Candle	
Kerosene lamp	
Torch/Battery lamp	
Rechargeable electric lamp	
Solar	
Standby generator	
Others ( )	

23. On the average, how much do you spend on this alternative source of power during power outages in a month? Gh¢_____

24. How would you rank the current supply of electricity to your home/neighborhood?

A. **How reliable is the power supply in your household/neighborhood?**

	Excellent	Very Reliable	Reliable	Moderately Reliable	Not Reliable
Please Tick (					

B. **How would you describe the quality of power voltage or current stable of power in your household/neighborhood?**

	Excellent	Very good	Good	Poor	Very poor
Please Tick (√)					

SECTION D: VALUATION SCENARIO OF ELECTRICITY IMPROVEMENT

This survey is concerned with your opinion about the attributes/characteristics of service improvement in this municipality. For service improvement, there are three attributes/characteristics identified, these attributes are **Planned outages, Unplanned outages, Duration of outages and Geographical scope of power outages.**

Planned Outage: this indicates the average number of planned outage occurrences experienced at the household level in a year. These are planned because they have been communicated to all affected households. As it stands now, the currently planned outages (Status quo) for a year, is **20 times**. Hence, planned outages have been categorized into these **4 levels**.

- **Level 1: 5 times per annum**
- **Level 2: 10 times per annum**
- **Level 3: 15 times per annum**
- **Level 4: 20 times per annum**

Levels 1, 2, and 3 are for improvements in planned outages in a year whilst level 4 represents the no change to the current situation.

Unplanned Outage: this refers to the number of power outages occurring without prior notifications from power distribution in a year. These outages occur unexpectedly because of a lack of maintenance. As it stands now, the number of unplanned outages in a year is **20 times per year**. Therefore, to improve upon unplanned outages, these **4 levels** have been identified.

- **Level 1: 5 times per annum**
- **Level 2: 10 times per annum**
- **Level 3: 15 times per annum**
- **Level 4: 20 times per annum**

Levels 1, 2, and 3 are for improvements on unplanned outages in a year whilst level 4 represents the no change to the current situation.

Duration of Outage indicates the hours at which outage occurs. As it stands now, the average duration of an outage that a household experience in a year is **160 hours**. Therefore, the proposed duration of outages has been categorized into these **4 levels**.

- **Level 1: 40 hours per annum**
- **Level 2: 80 hours per annum**
- **Level 3: 120 hours per annum**
- **Level 4: 160 hours per annum**

Levels 1, 2, 3 are for improvements in the duration of outages in a year whilst level 4 represents the no change to the current situation.

Geographical scope of power outages: this refers to the scope of power outage or areas where the power outage is restricted to. **The attribute**

levels are that the power outage is restricted to Household (0), Neighbourhood (1), District (2) and Whole city (3).

In addition to the three attributes identified above, there is another attribute called **cost**. Reducing the power outages will cost the power distributor, and cost refers to the parts of these costs that the distributor wants households to pay for improving the power outages. In conclusion, the cost has been categorized into these **6 levels.**

- **Level 1: Gh¢30.00 per annum**
- **Level 2: Gh¢60.00 per annum**
- **Level 3: Gh¢90.00 per annum**
- **Level 4: Gh¢120.00 per annum**
- **Level 5: Gh¢150.00 per annum**
- **Level 6: Gh¢180.00 per annum**

All these levels are an additional cost per annum for improvements of electricity power outages.

Alternatives are presented to you including the existing situation and you will be asked to choose from three options (one of these is the existing situation while the other two are alternatives for improvement in electricity service). We will change the combination of levels of the attributes and ask you to choose from the options repeatedly. **An example of a choice set:**

ATTRIBUTES	OPTION 1	OPTION 2	NO CHANGE
Planned Outages (Per year)	**5 times**	**10 times**	**20 times**
Unplanned	**10 times**	**15 times**	**20 times**

Outages (Per year)			
Duration of outages (Hours per year)	**120 hours**	**40 hours**	**160 hours**
Geographical scope	**Household**	**District**	**Whole City**
Cost (Additional amount per year)	**Gh¢ 60.00**	**Gh¢ 150.00**	**Gh¢ 0.00**
Respondents Choice (Please tick one)	☐	☐	☐

- In each of the cards like this one, you will be given the choice of making no change or selecting one of two options for improvement, which are called Option "1" and Option "2"
- The option of "No Change" remains the same on all the cards and it never involves a payment. It describes the current situation.
- However, choosing Option "1" or "2" would mean an improvement and it comes with a cost.

For example, Option "1" in this card:

- The number of planned outages has gone down from 20 times per year to 5 times per year and also unplanned outages has gone down from 20 times per year to 10 times per year with a total duration of 120 hours per year and it is restricted to households. The cost of this improvement is Gh¢ 60.00 per year.

Option "2" in this card:

- In a similar way, planned outages has reduced from 20 times per year to 10 times per year and again unplanned outages have also reduced from 20 times per year to 15 times per year, with a total duration of 80 hours per year and it is restricted to district. This improvement costs Gh¢ 150.00 per year.

Which of the three options would you prefer?

Also, pick your favourite choice from the options below:

CHOICE CARD 1

ATTRIBUTES	OPTION 1	OPTION 2	NO CHANGE
Planned Outages (Per year)	5 times	15 times	20 times
Unplanned Outages (Per year)	5 times	15 times	20 times
Duration of outages (Hours per year)	160 hours	80 hours	160 hours
Geographical scope	Household	District	Whole City
Cost (Additional amount per year)	Gh¢ 60.00	Gh¢ 120.00	Gh¢ 0.00
Respondents Choice (Please tick one)	☐	☐	☐

CHOICE CARD 2

ATTRIBUTES	OPTION 1	OPTION 2	NO CHANGE
Planned Outages (Per year)	10 times	15 times	20 times
Unplanned Outages (Per year)	20 times	10 times	20 times
Duration of outages (Hour per year)	160 hours	80 hours	160 hours
Geographical scope	District	Neighbourhood	Whole City
Cost (Additional amount per year)	Gh₵ 90.00	Gh₵ 180.00	Gh₵ 0.00
Respondents Choice (Please tick one)	☐	☐	☐

CHOICE CARD 3

ATTRIBUTES	OPTION 1	OPTION 2	NO CHANGE
Planned Outages (Per year)	15 times	10 times	20 times
Unplanned Outages (Per year)	15 times	5 times	20 times
Duration of outages (Hour per year)	120 hours	40 hours	160 hours
Geographical scope	District	Household	Whole City
Cost (Additional amount per year)	Gh₵ 120.00	Gh₵ 90.00	Gh₵ 0.00
Respondents Choice (Please tick one)	☐	☐	☐

CHOICE CARD 4

ATTRIBUTES	OPTION 1	OPTION 2	NO CHANGE
Planned Outages (Per year)	20 times	10 times	20 times
Unplanned Outages (Per year)	5 times	15 times	20 times
Duration of outages (Hour per year)	40 hours	120 hours	160 hours
Geographical scope	Neighbourhood	Whole city	Whole City
Cost (Additional amount per year)	Ghȼ 30.00	Ghȼ 180.00	Ghȼ 0.00
Respondents Choice (Please tick one)	☐	☐	☐

CHOICE CARD 5

ATTRIBUTES	OPTION 1	OPTION 2	NO CHANGE
Planned Outages (Per year)	20 times	10 times	20 times
Unplanned Outages (Per year)	5 times	15 times	20 times
Duration of outages (Hour per year)	160 hours	80 hours	160 hours
Geographical scope	Whole city	Neighbourhood	Whole City
Cost (Additional amount per year)	Ghȼ 30.00	Ghȼ 150.00	Ghȼ 0.00
Respondents Choice (Please tick one)	☐	☐	☐

CHOICE CARD 6

ATTRIBUTES	OPTION 1	OPTION 2	NO CHANGE
Planned Outages (Per year)	5 times	15 times	20 times
Unplanned Outages (Per year)	20 times	10 times	20 times
Duration of outages (Hour per year)	40 hours	120 hours	160 hours
Geographical scope	Household	District	Whole City
Cost (Additional amount per year)	Ghȼ 60.00	Ghȼ 150.00	Ghȼ 0.00
Respondents Choice (Please tick one)	☐	☐	☐

CHOICE CARD 7

ATTRIBUTES	OPTION 1	OPTION 2	NO CHANGE
Planned Outages (Per year)	15 times	5 times	20 times
Unplanned Outages (Per year)	15 times	5 times	20 times
Duration of outages (Hour per year)	120 hours	40 hours	160 hours
Geographical scope	Neighbourhood	District	Whole City
Cost (Additional amount per year)	Ghȼ 150.00	Ghȼ 30.00	Ghȼ 0.00
Respondents Choice (Please tick one)	☐	☐	☐

CHOICE CARD 8

ATTRIBUTES	OPTION 1	OPTION 2	NO CHANGE
Planned Outages (Per year)	5 times	20 times	20 times
Unplanned Outages (Per year)	20 times	10 times	20 times
Duration of outages (Hour per year)	40 hours	120 hours	160 hours
Geographical scope	Whole city	Household	Whole City
Cost (Additional amount per year)	Ghȼ 90.00	Ghȼ 120.00	Ghȼ 0.00
Respondents Choice (Please tick one)	☐	☐	☐

CHOICE CARD 9

ATTRIBUTES	OPTION 1	OPTION 2	NO CHANGE
Planned Outages (Per year)	15 times	5 times	20 times
Unplanned Outages (Per year)	10 times	20 times	20 times
Duration of outages (Hour per year)	80 hours	160 hours	160 hours
Geographical scope	Household	Neighbourhood	Whole City
Cost (Additional amount per year)	Ghȼ 180	Ghȼ 30.00	Ghȼ 0.00
Respondents Choice (Please tick one)	☐	☐	☐

CHOICE CARD 10

ATTRIBUTES	OPTION 1	OPTION 2	NO CHANGE
Planned Outages (Per year)	10 times	20 times	20 times
Unplanned Outages (Per year)	10 times	20 times	20 times
Duration of outages (Hour per year)	120 hours	40 hours	160 hours
Geographical scope	Neighbourhood	Whole city	Whole City
Cost (Additional amount per year)	Gh₵ 150.00	Gh₵ 60.00	Gh₵ 0.00
Respondents Choice (Please tick one)	☐	☐	☐

CHOICE CARD 11

ATTRIBUTES	OPTION 1	OPTION 2	NO CHANGE
Planned Outages (Per year)	20 times	5 times	20 times
Unplanned Outages (Per year)	15 times	5 times	20 times
Duration of outages (Hour per year)	80 hours	160 hours	160 hours
Geographical scope	District	Whole city	Whole City
Cost (Additional amount per year)	Gh₵ 120	Gh₵ 90.00	Gh₵ 0.00
Respondents Choice (Please tick one)	☐	☐	☐

CHOICE CARD 12

ATTRIBUTES	OPTION 1	OPTION 2	NO CHANGE
Planned Outages (Per year)	10 times	20 times	20 times
Unplanned Outages (Per year)	10 times	20 times	20 times
Duration of outages (Hour per year)	80 hours	160 hours	160 hours
Geographical scope	Whole city	Household	Whole City
Cost (Additional amount per year)	Ghȼ 180.00	Ghȼ 60.00	Ghȼ 0.00
Respondents Choice (Please tick one)	☐	☐	☐

25. Thinking about how you made your choice in the above choice cards, please indicate which of the following attributes did you take into account when you came up with your choices?

No	Attributes	Take into account	Do not take into account
1	Planned outages		
2	Unplanned outages		
3	Duration of outages		
4	Geographical scope		
5	Cost		

SECTION E: SOCIO – ECONOMIC CHARACTERISTICS

Finally, in order to provide us with a profile of the people who have participated in this survey. I'm going to ask you some questions about your work. All of the information will be kept anonymous and confidential.

26. Can you please indicate your current work status? TICK ONLY ONE

Employed (Full time)	
Employed (Part-time)	
Retired	
Student	
Unemployed	
Others( )	

27. Could you please indicate the number that best describes your total personal income per month (whether from employment, pension, state benefits, investment, or any other sources) after deduction of tax.

	Please Tick (√)
Less than Gh¢500.00	
Gh¢501.00 to Gh¢1000.00	
Gh¢1001.00 to Gh¢2000.00	
Gh¢2001.00 to Gh¢3000.00	
Gh¢3001.00 to Gh¢4000.00	
Gh¢4001.00 to Gh¢5000.00	
Gh¢5001.00 to 6000.00	
Gh¢6001.00 to Gh¢7000.00	
Gh¢7001.00 to Gh¢8000.00	
Greater than Gh¢8000.00	
Refused	

THANK YOU FOR YOUR TIME

B: ETHICAL CLEARANCE LETTER

UNIVERSITY OF CAPE COAST

INSTITUTIONAL REVIEW BOARD SECRETARIAT

TEL: 0558093143 / 0508878309
E-MAIL: irb@ucc.edu.gh
OUR REF: IRB/C3/Vol.1/0025
YOUR REF:
OMB NO: 0990-0279
IORG #: IORG0011497

8TH FEBRUARY 2023

Mr Richard Agyekum
Department of Economic Studies
University of Cape Coast

Dear Mr Agyekum,

ETHICAL CLEARANCE – ID (UCCIRB/CHLS/2022/89)

The University of Cape Coast Institutional Review Board (UCCIRB) has granted Provisional Approval for the implementation of your research on the **Households' Valuation of Power Outages in Ga West Municipality of Accra: An Application of a Choice Experiment.** This approval is valid from 8th February 2023 to 7th February 2024. You may apply for a renewal subject to the submission of all the required documents that will be prescribed by the UCCIRB.

Please note that any modification to the project must be submitted to the UCCIRB for review and approval before its implementation. You are required to submit a periodic review of the protocol to the Board and a final full review to the UCCIRB on completion of the research. The UCCIRB may observe or cause to be observed procedures and records of the research during and after implementation.

You are also required to report all serious adverse events related to this study to the UCCIRB within seven days verbally and fourteen days in writing.

Always quote the protocol identification number in all future correspondence with us in relation to this protocol.

Yours faithfully,

Kofi F. Amuquandoh

Ag. UCCIRB Administrator

ADMINISTRATOR
INSTITUTIONAL REVIEW BOARD
UNIVERSITY OF CAPE COAST

C: INTRODUCTION LETTER

UNIVERSITY OF CAPE COAST
COLLEGE OF HUMANITIES AND LEGAL STUDIES
SCHOOL OF ECONOMICS
DEPARTMENT OF ECONOMIC STUDIES

Telephone: 03321-32440/4 & 32480/3
(Direct) 0332096762
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UNIVERSITY POST OFFICE
CAPE COAST, GHANA

OUR REF: SOE/E.S/L3/V.1
YOUR REF:.....

DATE: 27TH JUNE, 2022

The Chairperson
Institutional Review Board
University of Cape Coast
Cape Coast.

Dear Sir,

ACCEPTANCE OF PROPOSAL

We formally bring to your notice that the Department is satisfied with the research proposal of Mr. Richard Agyekum, and has accordingly given the said candidate the permission to apply for ethical clearance from IRB in order to enable him to undertake data collection.

He is working on the Research Topic: **"Households' Valuation of Power Outages in selected Municipalities of Accra: An Application of a Choice Experiment".**

We count on your usual cooperation.

Thank you.

Yours faithfully,

Isaac Bentum-Ennin (Ph.D)
[Head]

D: LETTER OF CONSENT

UNIVERSITY OF CAPE COAST
COLLEGE OF HUMANITIES AND LEGAL STUDIES
SCHOOL OF ECONOMICS
DEPARTMENT OF APPLIED ECONOMICS

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E-mail: *soeappliedecons@ucc.edu.gh*

UNIVERSITY POST OFFICES
CAPE COAST, GHANA

***Our Ref*: SoE/DAE/Vondolia/ V.1/4**
***Your Ref*:**.....

JUNE 23, 2022

The Chairperson
The Institutional Review Board
University of Cape Coast
Cape Coast
Ghana

Dear Sir/Madam,

LETTER OF CONSENT

I write to formally give my approval for Mr. Richard Agyekum to be given an ethical clearance from the Institutional Review Board of the University of Cape Coast to enable him to undertake data collection some communities in Accra for a MPhil thesis on the topic ***Households' valuation of power outages in selected municipalities of Accra: An application of a choice experiment.***

Thank you for the cooperation.

Yours sincerely,

Godwin Kofi Vondolia (PhD)