HARAMAYA UNIVERSITY
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WILLINGNESS TO PAY FOR IMPROVED ELECTRICITY USE AMONG RURAL HOUSEHOLDS: THE CASE OF HARAMAYA DISTRICT, EAST HARARGE ZONE, OROMIA REGIONAL STATE, ETHIOPIA

Msc. Thesis

MURAD ABDELLA AHMED

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WILLINGNESS TO PAY FOR IMPROVED ELECTRICITY USE AMONG RURAL HOUSEHOLDS: THE CASE OF HARAMAYA DISTRICT, EAST HARARGE ZONE, OROMIA REGIONAL, ETHIOPIA

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Murad Abdella Ahmed

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POSTGRADUATE PROGRAM DIRECTORATE

I hereby certify that I have read and evaluated this thesis entitled "**willingness to pay for improved electricity use among rural households: the case of haramaya district, east hararge zone, oromia regional state, ethiopia**

" prepared, under my guidance by murad Abdalla. I recommend that it be submitted as fulfilling the thesis requirement.

Major Advisor Temesgen Keno (PhD) _________Signature ____________Date

Co-advisor Murad Ali (PhD)__________Signature ----------------------------Date

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Final approval and acceptance of the Thesis are contingent upon the submission of its final copy to the Council of Postgraduate Program Directorate (CPGPD) through the candidate's department or school graduate committee (DAC or SGC).

DEDICATION

I dedicate this thesis manuscript to my family and Brothers (Abdurehman Abdella) for their unwavering support and enthusiasm for my success.

STATEMENT OF THE AUTHOR

I hereby affirm that this thesis is my original work. I have adhered to ethical principles and recognized all sources through proper citations. The thesis has not been submitted to any other institution for an academic award.

Name: Murad Abdella

Signature: ______________________

Date: September 2024

School: Business and Economics

BIOGRAPHICAL SKETCH

The author was born in September 1980 in Bedeno Woreda, East Hararge Zone, Oromia Regional State, Ethiopia. He completed his primary education at Bedeno Primary School and his high school education at Bedeno Senior Secondary School in 1998. He earned a Bachelor's degree in Economics from Jigjiga University in 2001. After graduation, the author was employed in the KombolchaWoreda Revenue office as an expert in Planning and scheduling then After six years, he also served in Bedeno woreda revenue, social , water and energy and Trade office at different management position until he joined the School of Graduate Studies of Haramaya University in November 2012 to pursue her MSc degree in Energy Economics.

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LIST OF ABBREVIATIONS AND ACRONYMS

ABM: Averting Behavior Method

CMM: Choice Modeling Method

CSA: Central Statistical Agency

CVM: Contingent Valuation Method

EEU: Ethiopian Electric Utility

GDP: Gross Domestic Product

GWh: Gigawatt-hour

HPM: Hedonic Pricing Method

ICS: Inter-connected System

IEA: International Energy Agency

KAs: Kebele Administrations

kWh: Kilowatt-hour

MoWIE: Ministry of Water, Irrigation, and Energy

MPM: Market Price Method

MW: Megawatt

PFM: Production Function Method

Pre-paid: Prepaid Metering System

Post-paid: Postpaid Metering System

RPM: Revealed Preference Method

SCS: Self-Contained System

SP: Stated Preference

SPM: Stated Preference Method

SEPHW: South East Pastoral and Humid Zone

TCM: Travel Cost Method

HDAO: Haramaya District Agricultural Office

UNDP: United Nations Development Programme

WHO: World Health Organization

WTPEL: Willingness to Pay for Electricity Use

HWFAEDO: Haramaya Woreda Finance and Economic Development Office

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Abstract

This study investigates the willingness of rural households in Haramaya District, East Hararge Zone, Oromia Regional State, Ethiopia, to pay for improved electricity services. With electricity being essential for residential, agricultural, and commercial activities, its availability and reliability play a critical role in economic growth and quality of life. Using a sample of 274 households selected through random sampling from three kebeles with electricity access, the research applied the Contingent Valuation Method (CVM) with a double-bounded dichotomous choice format and an open-ended follow-up question to assess households' willingness to pay (WTP) for more reliable electricity. Data was collected through structured interviews, with bivariate probit and seemingly unrelated bivariate probit models applied to identify significant determinants of WTP and estimate mean WTP. The results show that Education positively impacted the probability of accepting the initial bid, while the initial bid price and age had a negative effect. In the second bid (WTP2): age (AGE) and the cost of electricity (CCE), both positively impacting WTP, while energy consumption (ECONS) and the second bid price (IB2) had negative effects. The mean WTP for improved electricity was estimated at 7.56 ETB per kWh with the bivariate probit model and 7.04 ETB per kWh with the open-ended format. Findings suggest a high willingness among rural households to invest in reliable electricity, underscoring the need for policy interventions focused on infrastructure improvement and efficient tariff structures. This study's insights can guide policymakers in formulating strategies to enhance electricity access, supporting economic development and environmental sustainability in rural Ethiopia.

Keywords: Contingent Valuation Method, Double-Bounded Dichotomous Choice, Willingness to Pay, Bivariate Probit, Rural Electrification, Ethiopia

1. INTRODUCTION

1.1. Background of the Study

Access to reliable electricity is fundamental for socio-economic development, particularly in rural areas where livelihoods heavily depend on agricultural and small-scale industrial activities. Electricity enables residential tasks such as cooking, lighting, and powering appliances, while also supporting agricultural practices like irrigation and food processing. Its role in fostering small businesses, extending working hours, and enhancing access to information underlines its critical contribution to improving quality of life and economic growth.

Despite its importance, electricity access in rural Ethiopia remains limited and unreliable. As of 2021, approximately 45% of Ethiopia's population had access to electricity, with significant disparities between urban and rural areas—85.4% and 26.5%, respectively (EEU, 2021). In districts such as Haramaya, frequent outages and limited grid connectivity continue to hinder productivity, exacerbate socio-economic inequalities, and increase reliance on traditional fuels such as firewood and charcoal. These alternative energy sources pose significant health risks due to indoor air pollution and environmental degradation caused by deforestation.

Addressing this energy challenge requires an understanding of households' willingness to pay (WTP) for improved electricity services. WTP provides critical insights into how rural households value reliable electricity, enabling policymakers to design effective tariff structures and investment strategies. Existing research on WTP for electricity in Ethiopia has primarily focused on basic access, with limited attention to service quality improvements such as reducing outages or enhancing reliability. Furthermore, studies often overlook localized socio-economic and cultural factors that influence WTP in rural settings.

This study investigates rural households’ WTP for specific improvements in electricity services in Haramaya District, East Hararge Zone, Oromia Regional State. By employing a contingent valuation method (CVM) and econometric analysis, the research seeks to fill existing knowledge gaps and contribute actionable insights for policy formulation and infrastructure planning.

1.2. Statement problem

Despite the critical role of electricity in fostering economic development and enhancing living standards, access to reliable and affordable electricity remains a significant challenge in rural Ethiopia. In districts such as Haramaya, households face frequent outages, unreliable supply, and a lack of infrastructure, which undermine their productivity and quality of life. While numerous studies have explored households' willingness to pay (WTP) for basic electricity access, few have specifically examined the factors influencing WTP for improved service reliability in rural contexts.

Existing studies, such as those by Toleshi (2016) and Arega and Tadesse (2017), have primarily focused on WTP for initial electricity access or green energy solutions. These studies often employ generalized methodologies that overlook localized socio-economic and cultural dynamics. Moreover, they fail to address how specific service enhancements, such as reduced outage frequency and improved reliability, influence household preferences and economic behavior. The narrow scope of these studies limits their ability to inform targeted interventions for improving electricity infrastructure in rural areas.

In addition, there is scant research on how unreliable electricity affects rural livelihoods, including its impact on agriculture and small-scale businesses in districts like Haramaya. These sectors, which form the backbone of rural economies, are disproportionately affected by unreliable energy access, yet remain underrepresented in the literature.

This study addresses these gaps by investigating rural households' WTP for specific improvements in electricity services, with a particular focus on reliability and affordability. By employing a contingent valuation method and advanced econometric models such as the double-bounded dichotomous choice format, this research aims to provide nuanced insights into the determinants of WTP. These findings will contribute to the development of policies and investment strategies that enhance electricity access and support sustainable economic development in rural Ethiopia.

1.3. Objective of this study

The general objective of this study was to assess willingness to pay for improved electricity use among rural households in the case of Haramaya District.

Specifically, this study aims to address the following objectives:

- To measure the level of rural households' willingness to pay for improved electricity use.
- To Compare the willingness to pay for improved electricity with the costs of alternative energy sources used by rural households

1.4. Research Question

This study addressed the following research questions:

- How much money is a household willing to pay for improved electricity use
- How does the willingness to pay for improved electricity compare to the cost of alternative energy sources used by rural households in the study area.

1.5. Significance of the Study

This study is significant for policymakers, utility companies, and development practitioners aiming to improve electricity infrastructure in Ethiopia. By understanding the factors influencing WTP for specific service improvements, stakeholders can develop targeted strategies to enhance electricity access and reliability. This, in turn, can support economic growth, reduce dependence on inefficient and harmful alternative energy sources, and improve the overall quality of life for rural households. The findings will also aid in revising electricity pricing models to better reflect service improvements and support sustainable infrastructure development.

1.6. Scope and Limitation of the Study

The study was limited to investigating factors affecting willingness to pay (WTP) for improved electricity use and identifying rural households' willingness to pay for improved electricity use in HaramayaWoreda. The study covered only three kebeles, namely Damota, Finkille, and Tinike. This study was also limited to 274 sample households head from total woreda households

The findings may not be generalizable to other regions of Ethiopia due to the specific focus on Haramaya District. Additionally, the sample size, while representative, might not capture the entire range of experiences within the district.

Conceptually, the study focuses on households with existing electricity access. This allows researchers to examine willingness to pay specifically for improved service, likely with a focus on reliability (reduced outages).

1.7. Operational Definitions of key terms

Electricity:is a crucial aspect of modern life and it impacts various aspects of our daily routines. It is essential for residential, social, commercial, and industrial purposes. Particularly, it plays a fundamental role in the development agendas of emerging economies, where a consistent power supply is required.

Electricity use: involves performing domestic activities such as cooking, washing, heating, cooling, ironing, lighting, and more. Many of these technological devices rely on electricity as their power source (Newman, 2023).

Willingness to Pay (WTP): According to recent research by Ozdemir and Yavas (2020), willingness to pay (WTP) is defined as the maximum price a consumer is willing to pay for one unit of a good or service. Understanding WTP is crucial for businesses in pricing their products and for policymakers in shaping economic policies.

Willingness to accept (WTA): refers to the minimum amount of income a person is willing to accept in exchange for forgoing improvements in electricity service (Kahneman et al., 2017).

Valuation: involves assigning accurate economic values to non-market products and services. To determine the economic value of a non-marketable good or service, such as an environmental good or service, the various components that contribute to its total economic value (TEV) must be identified (Hanley et al., 2019). The total economic value (TEV) of environmental commodities consists of both their use-value and non-use value (Krutilla and Fisher, 2020).

1.8. Organization of the Study

This thesis is structured into five chapters to systematically address the research objectives and provide a comprehensive analysis of the study findings. The frist chapter presents the background of the study, statement of the problem, research objectives, research questions, significance, scope and limitations, and operational definitions of key terms. It sets the foundation for understanding the rationale behind the research and its significance to the field of energy economics.

The seocnd chapter provides an overview of theoretical and empirical literature relevant to the willingness to pay for improved electricity services. It includes a discussion of conceptual frameworks, economic valuation methods, models of electricity demand, and pricing theories. The chapter concludes with a conceptual framework guiding the study.
The third chapter describes the study area, research design, sampling techniques, data collection methods, and analytical tools used in the research. It provides a detailed explanation of the Contingent Valuation Method and econometric models applied in the analysis.
This chapter presents the study findings, including descriptive statistics, econometric results, and analysis of households' willingness to pay for improved electricity. It interprets the determinants of willingness to pay and compares it with the costs of alternative energy sources used by rural households.

This chapter summarizes the major findings, draws conclusions based on the research objectives, and provides actionable recommendations for policymakers and stakeholders. It also highlights areas for future research to further explore the subject.

2. LITERATURE REVIEW

2.1. Concepts of Willingness to Pay for Improved Electricity Service

Willingness to Pay (WTP) refers to the maximum amount individuals state they are willing to pay for specific goods or services based on their characteristics. When it comes to electricity services, factors such as the reliability of supply, service quality, affordability, and access to electricity influence individuals' willingness to pay (Brouwer et al., 2020). WTP represents the amount a person is willing to sacrifice in order to obtain a good or service. It reflects the monetary value that a person is willing to give up while still maintaining the same level of utility. Consumers are often willing to pay higher prices for reliable and uninterrupted electricity services to meet their household needs. The extent of this willingness depends on the amount of electricity being consumed. WTP typically decreases rapidly as electricity usage decreases, resulting in a downward sloping demand curve that illustrates the relationship between WTP and electricity usage (Smith et al., 2022).

Moreover, designers and planners of electricity projects prioritize the assurance of financial sustainability by estimating the users' willingness to pay for future services. This is crucial to tackle financial unsustainability and power shortages in developing countries. Presently, the revenue generated by most energy projects falls short of covering the incurred costs. Consequently, comprehending the willingness to pay becomes an essential tool to determine consumers' preferences concerning payment at a cost recovery rate (Tehero and Aka, 2021).

2.2. Brief History of Electricity in Ethiopia

2.2.1. History and status of electricity in Ehiopia

Most Ethiopian households have long relied on wood fuels for their energy needs. Fuelwood thus remains a vital energy source in many developing countries (Berhanu et al., 2021). The high degree of dependence on wood and agricultural residues for household energy has significant impacts on the social, economic, and environmental well-being of society (Toleshi, 2016). Unlike most Sub-Saharan African countries, Ethiopia's energy sector is heavily dependent on biomass (firewood, charcoal, crop aftermath, and animal dung). Furthermore, due to the unreliability of electricity and the low access rate, nearly 60 million tons of biomass are consumed for energy purposes, with approximately 81% of the estimated 16 million households using firewood, 11.5% using leaves, dung cakes, and charcoal, and only a few using modern fuels such as electricity.

In Ethiopia, King Menelik II acquired the first generator in the late 1890s to light his palace (Toleshi, 2016). The diplomatic relations between Ethiopia and Germany developed well during Menelik's reign, and he received the generator as a gift from the German government to express their strong relationship. Electricity was extended to light the streets of Addis Ababa three decades ago during the coronation of King Haile Selassie in 1930.

In terms of electricity consumption levels in Ethiopia, the country has established guidelines stating that rural areas should have an annual electricity consumption of at least 250 kWh, while urban areas should aim for a minimum of 500 kWh per household of five. However, the actual connectivity of households to electricity remains significantly low, particularly in rural areas, despite the expansion of the grid network. Per capita electricity consumption in Ethiopia is estimated to be only 100 kWh, which is considerably lower than the Sub-Saharan Africa average of 521 kWh (MoWIE, 2020).

In 2020, ESMAP introduced a comprehensive definition of energy access, encompassing various dimensions. According to this new definition, energy access goes beyond a mere connection to the grid. It involves the availability of energy that is adequate, reliable, of good quality, convenient, affordable, legal, healthy, and safe for all necessary energy services. Therefore, having an electricity connection does not necessarily guarantee true access to electricity, as the revised definition takes into account factors such as reliability and affordability.

Lack of electricity access impairs progress in human welfare and quality of life. Directly or indirectly, electricity access enables transformative progress in education, healthcare, access to water, essential communications and information, and access to financial services and opportunities for income generation. Power supply inadequacy (shortages in generation and supply) undercuts the productivity of manufacturing and commerce, ultimately reducing overall economic growth (World Bank, 2021).

2.2.2. Household Energy Demand and Supply in Ethiopia

The energy sector in Ethiopia can be generally categorized into two major components: traditional and modern (traditional biofuel usage and modern fuels, i.e., electricity and petroleum). As more than 80% of the country's population is engaged in the small-scale agricultural sector and lives in rural areas, traditional energy sources represent the principal sources of energy in Ethiopia. Domestic energy requirements in rural and urban areas are mostly met from wood, animal dung, and agricultural residues. At the national level, it is estimated that biomass fuels meet 78% of the total energy consumed in the country (MoWIE, 2019).

According to CSA (2016), about 33.76% of total households use solar electricity for lighting, followed by electricity (28.05%) and kerosene (23.82%) in Ethiopia. A higher proportion of urban residents use electricity (95.91%) for lighting, while the use of kerosene (30.56%) and solar (43.07%) is predominant in rural areas. The major types of cooking fuel used by all households are firewood, charcoal, crop residue/leaves, dung cakes, kerosene, and electricity. The use of modern sources of cooking fuel such as butane gas, biogas, electricity, and kerosene is uncommon in rural areas (1.16%). The use of electricity for cooking is around 21.42%, followed by purchased firewood (37.97%). Urban households also use charcoal (16.73%), collected firewood (16.21%), and kerosene (1.25%).

The electricity generation capacity of Ethiopia is about 4,244 MW, of which more than 90% is from hydro, while wind, geothermal, and diesel power plants also contribute to the mix (EEU, 2019). The total energy sales from the Inter-connected System (ICS), the main electricity grid, and the Self-Contained System (SCS), separate mini-grids, reached 9,242 GWh during the 2017/2018 fiscal year. The peak demand of ICS in 2018 reached about 2,602.9 MW (a 7.4% growth compared with 2,409.45 MW in 2017) (MoWIE, 2019). Currently, Ethiopian Electric Utility reaches 7,010 large and small towns in the country and has more than 3 million customers. Ethiopia has an economically utilizable electricity generation potential of approximately 45,000 MW from hydro, 5,000 MW from geothermal, and 10,000 MW from wind, though only a fraction of this potential has been harnessed so far (EEU, 2019). Wood fuel and animal dung still provide the vast majority of domestic energy needs. Approximately 45% of Ethiopia's entire population has access to electricity, with 26.5% in rural areas and 85.4% in urban areas. In Ethiopia, grid access does not always imply a stable power service connection (Beyene, 2018).

2.3. Models of Electricity Demand and Pricing

Electricity demand is typically modeled based on conventional demand theory, which posits that the demand for a commodity is determined by its price, the prices of related goods, and consumer income. These factors, including the price of electricity, the price of other energy sources, and real income of consumers, are consistently identified as key determinants of electricity demand in the literature.

However, additional factors have also been found to influence electricity demand. These include the stock of capital appliances, appliance prices, real GDP per capita, industry efficiency, demographic features, weather conditions, consumer usage patterns, and technological factors that shape consumer preferences (Hepbasli et al., 2020; Işık et al., 2022; Khan et al., 2022). Modeling electricity demand also requires considering the impact of the stock of appliances on electricity consumption. Researchers have recommended the use of discrete choice models, sample selection corrections, and discrete-continuous combinations to estimate electricity consumption for each owned appliance (Sarica and Tyner, 2020).

2.3.1. **Economic Valuation of Non-Market Goods**

In theory, the overall value and benefits of environmental improvements, such as enhanced electricity, can be divided into two categories: Total Economic Value (TEV) = Use Value + Non-use Value. Non-market goods refer to goods and services that are not typically exchanged in the marketplace, or for which there is limited or no existing market. These goods are not directly paid for by consumers. Due to their unique characteristics, many environmental goods fall into the category of non-market goods. While some environmental goods may have market prices, these prices often represent the minimum agreed upon by suppliers and consumers in market transactions. However, the economic value of these goods extends beyond the market price, including the additional value or surplus that is not reflected in the price (Hanley et al., 2020).

Economic valuation theory emphasizes individual preferences and choices as the determining factors of economic value. The TEV of a resource is determined by people's desires, which are manifested through their trade-offs and choices. Individuals, considered rational decision-makers, are seen as the best judges of their own preferences (Pearce and Turner, 2020).

Economic value is the maximum amount of other commodities or services that an individual is willing to give up in order to obtain a particular good or service (Newman, 2023). This value may differ from the market price, as individuals are often willing to pay more for a good than its current market price, especially for the initial units of the good (Pearce and Turner, 2020). When analyzing the economic value of a resource like improved electricity supply, it is commonly categorized into use value and non-use value.

Use value includes direct and indirect value, option value, and quasi-option value. For instance, a clean river can be used for activities like swimming, boating, drinking, or bathing, representing direct use value. If the future benefits of a resource are uncertain and its depletion is practically irreversible, it possesses quasi-option value, as individuals are willing to pay to protect it for potential future use. Option value arises when a person is uncertain about their future demand for a good and the future supply of that product.

Non-use values include bequest value and existence value. Even if an environmental good lacks use value and option value, people may still protect it due to the complexity and importance of environmental resources. Many public environmental resources do not have a market price, or their price does not accurately reflect their true value (Hanley et al., 2020).

Regarding electricity, direct use value can be seen in the ability to read at night with sufficient lighting. On the other hand, having a well-lit compound at night, even if the consumer is indoors and not actively using outdoor lights, serves as an example of indirect use value by deterring potential threats. Existence value refers to the satisfaction derived from knowing that the resource exists, irrespective of personal usage intentions. Non-users may be willing to pay to maintain the resource, understanding that they have no intention of using it presently or in the future.

2.3.1. Non-market Valuation Methods

According to Boyle et al. (2017) and economic texts, there are two main categories of non-market valuation techniques: revealed preference valuation methods and stated preference methods.

2.3.1.1. Revealed Preference Method (Indirect Method)

The Revealed Preference Method (RPM) involves inferring the unobservable demand for, and hence the value of, environmental goods and services based on the observable demand for related marketable goods and services (Pearce and Turner, 2020; Tietenberg, 2017). This approach uses information on market transactions for related private goods and services. The revealed preference method holds a significant advantage: it leverages the actual choices individuals make in markets (Train, 2020). The most commonly used revealed preference methods are:

Travel Cost Method (TCM): The TCM is widely used to value non-market goods, such as geographical areas and recreational services (Hanley et al., 2017). It estimates households' willingness to pay (WTP) by considering the time and travel expenses incurred for visiting a site (Boyle and Bergstrom, 2019). TCM includes zonal travel cost methods, individual travel cost methods, and the random utility approach. Multiple site models are often preferred (Johnston et al., 2019). However, TCM only measures the observed use value of the resource, not the inherent values users may have for it.

Averting Behavior Method (ABM): The ABM is used to value environmental quality by examining the costs individuals incur to avoid risks associated with deteriorating quality (Pearce and Turner, 2020). It assumes individuals are aware of the adverse effects and uses the cost of measures taken as a proxy for the resource's value.

Market Price Method (MPM): The MPM calculates the total economic surplus of a good by summing consumer and producer surpluses, using market prices as a measure of value (Pearce and Turner, 2020). However, this method is limited to goods with market prices, excluding many non-market goods. Information asymmetry and imperfect market conditions can also affect the accuracy of economic surplus calculations.

Hedonic Pricing Method (HPM): The HPM is widely used and based on the characteristics theory of value, valuing commodities as a collection of valuable characteristics (Smith et al., 2022). It determines the worth of environmental qualities based on differences in the cost of marketed commodities, which can include environmental factors.

Production Function Method (PFM): The Production Function Method (PFM) observes changes in market prices of goods that use natural resources or environmental quality as inputs in production, reflecting the impact of changing environments (Pearce and Turner, 2020). However, these methods primarily measure use value and may not capture the total economic value of the resource due to weak complementary assumptions.

2.3.1.2. Stated Preference Method (Direct Method)

The stated preference methods (SPM) are widely used for valuing both use and non-use values of environmental resources. Generally, stated preferences represent one of the most common ways of valuing a non-market good, usually an environmental good, such as better air quality, supporting wildlife, or improved healthcare systems. Unlike the revealed preference method, the stated preference method does not examine the daily (real) behavior of individuals but instead asks respondents what they would do in a hypothetical situation. Estimates are based on households' stated values in an interview (Pearce and Turner, 2020). The most commonly used stated preference methods are the Contingent Valuation Method (CVM) and Choice Modeling Method (Bennett and Larson, 2019).

2.3.2. Choice Modeling Method(CMM)

The Choice Modeling Method (CMM) is a stated preference method that has evolved from recent innovations (Hensher et al., 2021). In this method, a survey presents several choice sets, and respondents (households) select their preferred alternative from the available options, which typically include the status quo as one of the alternatives (Pearce and Turner, 2020). Choice modeling includes techniques such as choice experiments, contingent ranking, and contingent rating. In a choice experiment, respondents are asked to choose between different hypothetical scenarios, each with varying attributes and costs.

Contingent Valuation Method (CVM)

The Contingent Valuation Method (CVM) is a widely used stated preference method for estimating the value of environmental goods, including both use and non-use values (Boyle et al., 2017). In CVM, individuals are asked to declare how much they would be willing to pay for a non-marketed product, assuming a market existed. This method combines economic theory with survey research to elicit direct feedback from respondents about the values they place on goods and services (Carson and Hanemann, 2019; Mitchell and Carson, 2020).

CVM estimates the willingness to pay (WTP) to preserve a resource or the amount of compensation required to offset resource deterioration or total loss (Pearce and Turner, 2020). The method typically presents a hypothetical scenario that describes the features of a given resource, and respondents are asked how much they would be willing to pay for that resource or how much compensation they would accept if it deteriorates or is lost. CVM is frequently used to estimate the economic value of environmental services (Carson, 2021). In surveys, people are asked direct questions to express their WTP. While CVM is commonly applied in other sectors, such as transportation, there are fewer studies that use CVM to value improvements in electricity service (Rehman et al., 2022; Atkinson et al., 2023).

Advantages of the Contingent Valuation Method (CVM)

CVM is advantageous because it uses survey techniques to determine households' willingness to pay for a hypothetical public good or service, or their willingness to accept compensation for its hypothetical loss. These monetary values represent the benefits to individuals and can be aggregated to inform public policy decisions, potentially improving social welfare (Pearce and Turner, 2020). Economists and specialists view CVM as a valuable tool for collecting accurate information on households' affordability and willingness to pay for services such as sanitation and electricity.

One key advantage of CVM is its ability to measure the economic impacts of various effects, both positive and negative, in alignment with economic theory (Carson and Hanemann, 2019). For example, creating a realistic contingent valuation scenario is crucial for accurately pricing electricity supply options that reflect real-world market conditions (Lindh et al., 2018). Respondents are asked about their preferences and the price they would be willing to pay for electricity, considering factors such as service level, quantity, and quality.

CVM offers two significant advantages over indirect methods:

It can capture both use and non-use values, while indirect methods typically only measure use values and rely on weak complementary assumptions.

CVM provides theoretically valid monetary measurements of utility changes based on responses to willingness to pay (WTP) **or** willingness to accept (WTA) questions. This is a major advantage over indirect techniques, which do not offer such detailed information on changes in utility.

CVM is particularly useful for estimating non-use **or** passive-use values, including existence values. It can complement or serve as an alternative to methods such as the Travel Cost Method (TCM) and Hedonic Pricing Method (HPM). Given the limitations of indirect methods in capturing non-use values, this study will employ CVM to assess non-use **or** existence values in the context of sanitation and electricity options (Pearce and Turner, 2020).

Satisfaction of Households for Electricity Use

The primary motivation for businesses to invest in various endeavors is to ensure the satisfaction of their customers (Homburg et al., 2020). In the Nigerian energy sector, the provision of high-quality service is essential for the growth and sustainability of energy businesses (Oyedepo et al., 2020). According to Paulin et al. (2020), customer satisfaction is achieved when customers feel that their expectations regarding service delivery are met.

This is significant because satisfied customers not only remain loyal but also advocate for the company's products and services (Shen, 2021). Customer satisfaction refers to the evaluation of energy product offerings based on customer expectations (Liu et al., 2019). In the service industry, customers play a crucial role in turning a firm's vision into reality (Babatunde and Olukemi, 2018).

However, there are several research gaps in applying the concept of customer satisfaction within the energy billing subsector. These gaps include addressing customer expectations from their perspective (Beatson et al., 2016), conducting comprehensive evaluations of service offerings in the Nigerian energy sector to improve customer satisfaction during the billing process (Abdullateef, 2017), and assessing energy service providers based on overall service delivery during a specified billing period (Reinders et al., 2019).

These points confirm that customer satisfaction with a particular product offering depends on their direct experience with the product or service (Mattila and O'Neill, 2018). In essence, applying the **disconfirmation theory** in the energy sector can serve as an indicator of the satisfaction level customers expect and the level of service that energy firms must provide to meet those expectations.

2.4. Theoretical Framework: Utility Maximization and Willingness to Pay for Electricity Use

The theoretical framework is based on utility maximization within the context of willingness to pay (WTP) for electricity use. Households, as decision-making units, face the challenge of weighing the benefits of continuing with their current electricity services versus opting for alternative services. This decision-making process is influenced by the household's preference for a particular service, which is reflected in their actual choice. The preferences of households depend on various factors, including household-specific characteristics**,** alternative-specific attributes**,** and unobserved factors (Boadu, 2016; Arega and Tadesse, 2017). Not all factors that affect the choice are known or observable, meaning that some of the decision-making process is random.

This concept of random utility is grounded in random utility theory, where utility is assigned randomly but distinguishably to each alternative service. Households make discrete choices, and their decision depends on the utility derived from each service. The underlying assumption is that a household will choose the alternative service that provides the highest expected utility, based on its preferences and available information (Cameron and Trivedi, 2020).

Elicitation Methods for Estimating Willingness to Pay

To estimate households' willingness to pay (WTP) for electricity use, various elicitation methods are employed, especially in contingent valuation surveys. Some of the most commonly used formats include open-ended**,** payment card**,** bidding game**,** single-bounded, and **d**ouble-bounded dichotomous choice methods. Among these, the dichotomous choice (DC) format is particularly popular due to its simplicity and effectiveness in capturing WTP responses (Arega and Tadesse, 2017; Entele, 2020). This study uses a double-bounded dichotomous choice (DBDC) approach, supplemented by an open-ended follow-up question to refine the WTP estimates.

According to Hanemann (1989), in the dichotomous choice method, households are assumed to have **utility functions** denoted as **U**, their **income** as **M**, and a set of conditioning factors (e.g., household characteristics and service attributes) denoted as **W**.

This framework allows for a detailed understanding of the factors that influence households' electricity service choices and their WTP, providing insights into how household preferences can be quantified for policy or pricing purposes.

$$U(M, W) \quad (1)$$

If households are willing to pay for electricity use, their utility is given by:

$$U1 = U(1, M, W) \quad (2)$$

If households are not willing to pay for electricity use, their utilities are given by:

$$\mathrm{U0} = \mathrm{U}(0, \mathrm{M}, \mathrm{W}) \quad (3)$$

With the introduction of a proposed improvement for electricity service, each household is confronted with a specified bid amount, WTP (willingness to pay), including an initial bid price, lower bid price, and upper bid price, which households could contribute to improved electricity use per kilowatt-hour. It is assumed that households would accept a suggested WTP to maximize their utility under the following condition and reject it otherwise (Hanemann, 1989):

$$U(1, M - WTP, W + \mathcal{E}1) > U(0, M, W) + \mathcal{E}0 \quad (4)$$

Here, Ɛ0 and Ɛ1 are identically and independently distributed random variables with zero means. U represents the indirect utility function, M represents households' income, and WTP represents the willingness to pay bid values.

2.5. Empirical Literature

The willingness of households to pay for electricity services has garnered significant attention in empirical research, particularly in the context of developing regions, including Ethiopia. Various studies have employed diverse methodologies, primarily focusing on contingent valuation methods (CVM) and choice experiments, to assess this willingness to pay (WTP) across different contexts.

The Contingent Valuation Method (CVM) has been extensively utilized across studies to elicit household WTP for reliable electricity services. Recent studies, such as those by Shiferaw et al. (2021) and Ahmed et al. (2022), demonstrate this through indirect methods that consider the actions households might take to mitigate the impacts of power interruptions. Their findings highlight the reliability of electricity supply as a crucial factor influencing household preferences. Additionally, Alemayehu and Bekele (2023) further corroborate this by showing that WTP is positively associated with the duration of outages, revealing that households are particularly willing to pay more to avoid unplanned interruptions.

The choice experiment approach has also been prevalent, as seen in the works of Wakjira and Kefale (2022) and Entele (2022), which assess household preferences for various attributes of electricity supply, including frequency and duration of outages. Wakjira and Kefale's study indicates that even in regions with generally reliable electricity, households are willing to pay for improvements in service quality, while Entele emphasizes the varying monetary values attached to renewable energy connections and enhanced service reliability. These studies reveal a common theme: households value reliability and are willing to incur additional costs for consistent service.

Willingness to Pay for Reliability: Across various studies, a consistent theme emerges where households exhibit a willingness to pay for enhanced reliability of electricity services. Recent studies in Ethiopia (Wakjira & Kefale, 2022) and Kenya (Maina et al., 2023) demonstrate that reliability significantly influences household willingness to pay, suggesting that demographic factors alone do not fully explain these preferences.

The impact of socioeconomic variables on WTP has been addressed in multiple studies. For instance, recent research by Mohammed et al. (2023) identified significant correlations between income levels, education, and WTP for reliable electricity services in Ethiopia. Similarly, Arega and Tadesse (2017) highlighted the roles of income and access to information in Ethiopia, reinforcing the notion that socioeconomic status plays a critical role in shaping household energy preferences.

Recent studies such as Deutschmann et al. (2021) and Amador et al. (2022) reveal the variability in WTP across different geographical contexts, emphasizing how past experiences with outages and the general reliability of supply shape household perceptions and economic assessments. This geographical focus highlights the importance of localized research methodologies in understanding the unique dynamics at play.

Despite these insights, a clear gap remains in the literature regarding the specific challenges faced by rural households, particularly in regions like the Haramaya District of Ethiopia. While studies such as Toleshi (2016) provide some insights, they often overlook localized socio-cultural factors and the unique constraints rural households face in accessing and affording electricity.

Many studies employ models such as Tobit and bivariate probit, which may not fully capture the complexity of household decision-making processes regarding electricity. The reliance on generalized approaches may obscure the nuanced dynamics specific to rural settings, where factors such as limited access to alternative energy sources and varying levels of energy literacy significantly impact household willingness to pay.

The existing empirical literature offers valuable insights into households' willingness to pay for electricity services, highlighting the influence of reliability and socioeconomic factors. However, there remains a significant gap in understanding the specific challenges faced by rural households in Ethiopia, particularly in the Haramaya District**.** Addressing these gaps through targeted research methodologies is essential for advancing electrification efforts and promoting sustainable development in these regions. Future research should focus on localized factors that influence WTP and incorporate a broader range of socioeconomic and cultural dynamics to better inform policy and practice in energy provision.

2.6. Conceptual Framework

A conceptual framework is a diagrammatic representation of the hypothesized relationship between independent and dependent variables. In the context of households' willingness to pay for electricity use, factors can be grouped into demographic, socio-economic, and institutional categories. Institutional factors include initial bid price, second bid price, reliability of current supply, and current outages of electricity. Socio-economic factors encompass educational level, income, and the current cost of electricity. Demographic characteristics include age, sex, and household size. Household income is a significant factor influencing the type of energy sources used for electricity. In situations where the reverse occurs, communities try to cope by utilizing available local resources (Birhane, 2016).

Previous studies have revealed that different factors exhibit varying signs, magnitudes, and directions of influence on households' willingness to pay for electricity use. While one factor may negatively impact willingness to pay in one area, it may positively affect willingness to pay in another region or under different circumstances. Additionally, factors related to the initial bid price and second bid price have a significant influence on willingness to pay for electricity use. These variations and determining factors make it challenging to develop a universal model with defined determinants and hypotheses that are universally applicable to all situations and locations. Depending on this, the conceptual framework presented below describes the variables expected to influence willingness to pay for electricity use in Haramaya (Figure 1).

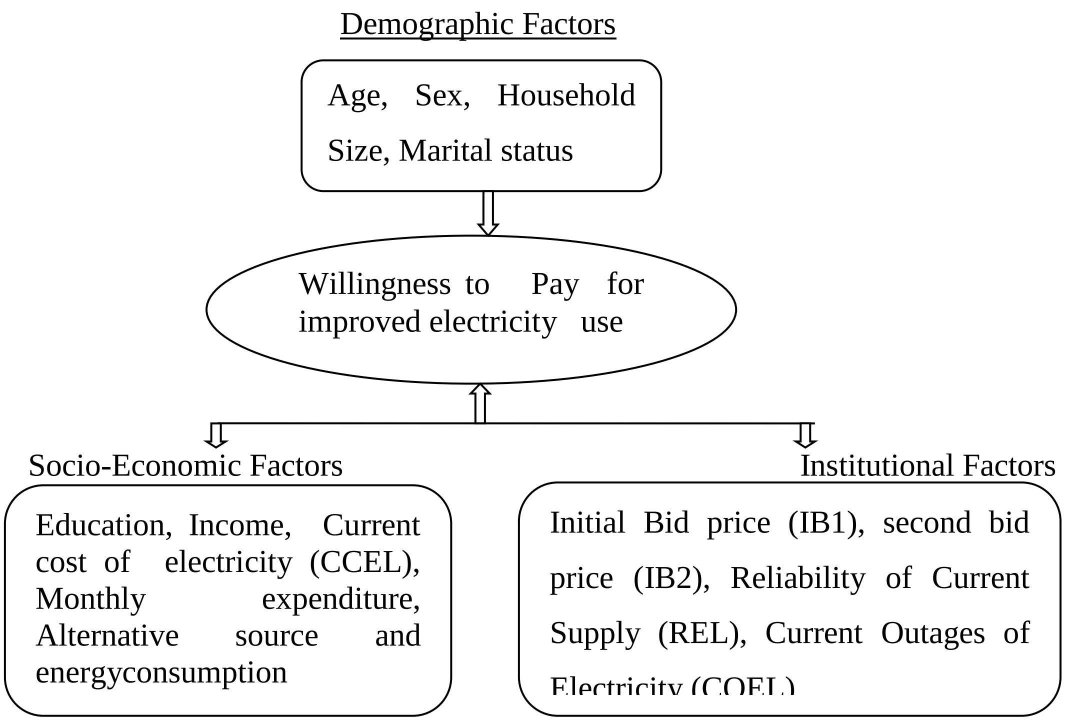

Figure 1: Conceptual framework of the study

Source: Own conceptualization from literature review

3. RESEARCH METHODOLOGY

This chapter highlights the research design and methodology, which includes the following subtopics: a description of the study area, research design, sources of data, population, sample size, sampling techniques, data collection instruments, and methods of data analysis. Finally, it discusses the model specification and provides a description of the study variables.

3.1. Description of the Study Area

The study was conducted in Haramaya District, Eastern Hararghe Zone of Oromia Regional State, Ethiopia. Haramaya is one of the 20 districts of Eastern Hararghe Zone, located 514 km east of Addis Ababa, the capital city of both the region and the country. The District borders on the south by Kurfa Chale, on the west by Kersa, on the north by Dire Dawa, on the east by Kombolcha, and on the southeast by Harari Region. Haramaya District is geographically located at 42°0'50"-42°5'E longitude and 9°24'10"-9°27'55'N latitude (Figure 1).

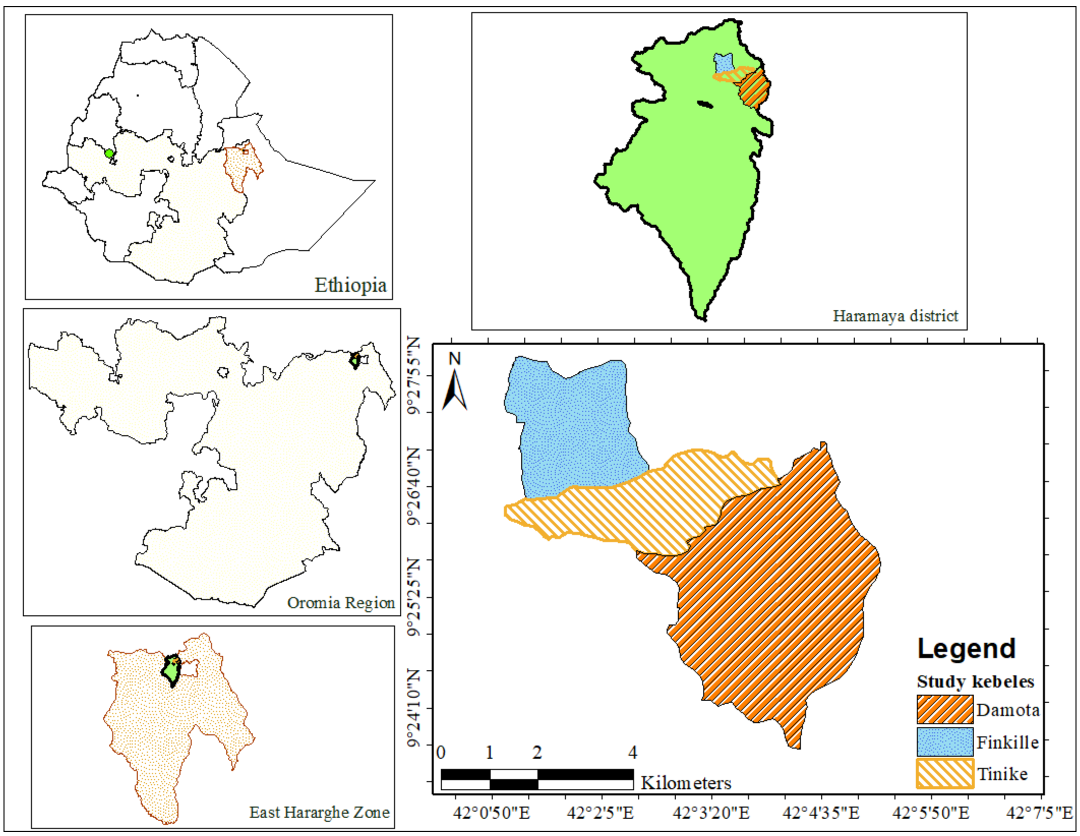

Figure 1. Location map of the study area

According to CSA (2017), the total population of Haramaya District is 271,018, with 138,282 males and 132,736 females. The district is divided into 35 KAs, consisting of 33 rural KAs and 2 small urban Kebele Administrations. Haramaya District covers a total area of 56,000 km² (HDAO, 2021). It is located in the semi-arid tropical belt of eastern Ethiopia and is characterized by a sub-humid climate. The average annual rainfall is approximately 790 mm, with mean temperatures of 17°C. The mean minimum and maximum temperatures are 9.4°C and 24°C, respectively. The area experiences two rainy seasons: a short rainy season from the end of February to mid-May, and a long rainy season from July to the end of September. The altitude of the district ranges from 1400 to 2340 m.a.s.l. The agro-ecology of Haramaya District is mostly mid-land (70%), with the remaining area being low-land (HDAO, 2021).

The district has infrastructure facilities such as electricity, modern telephone services, banking facilities, and educational and healthcare services, among others, which are owned by both public and private entities. However, in terms of electric access, only 17.9% of households in the Haramaya District have access to electricity (HWFAEDO, 2020). The use and availability of modern energy sources, particularly electricity, are very limited in Haramaya District. As a result, the rural population heavily relies on crop residues, firewood, and animal dung for their energy needs. Similarly, the urban population depends on firewood and charcoal for domestic energy, which has increased over time. This increased demand for firewood and charcoal has led to a reduction in forest coverage in the Haramaya District (SEPHW, 2018).

Product Characteristics: Current vs. Improved Electricity

Current Electricity Services

Characteristics: These are the specific features or attributes that define the current state of electricity services in Haramaya Woreda. They highlight the limitations and problems faced by residents and businesses. Some of these characteristics include:

Frequent Outages: As described in Section II, power outages are a common occurrence in Haramaya Woreda. These outages can happen daily or even multiple times a day, disrupting daily life and businesses.

Unreliable Supply: Due to frequent outages, the overall electricity supply is unreliable. Businesses and residents cannot depend on consistent power delivery for their needs.

Limited Capacity: The current infrastructure might not have the capacity to meet the growing demand for electricity in Haramaya Woreda.

Payment Methods: Existing payment methods might be limited and involve cash payments at designated offices, which can be inconvenient.

Impact: Refers to the consequences or effects that the current unreliable electricity situation has on daily life, businesses, and potentially the environment in Haramaya Woreda. These impacts can be negative and can be categorized into various aspects:

Disruptions to daily routines due to malfunctioning appliances, flickering or failing lights, and potential data loss in electronic devices.

Reduced productivity for businesses caused by interrupted workflows and potential financial losses.

Difficulty planning activities and challenges for critical operations reliant on continuous power.

Improved Electricity Services Features: Refer to the specific attributes or functionalities of the proposed improvements to Haramaya Woreda's electricity system. These features aim to address the shortcomings of the current system and provide a more reliable and efficient electricity experience. Here are some of the features:

Reduced Outages: A significant decrease in the frequency of power outages compared to the current situation. Outages might occur a few times a month or even less frequently.

Increased Reliability: Improved infrastructure and maintenance practices aim to provide a more consistent and dependable electricity supply.

Infrastructure Upgrades: Investments in strengthening power lines, implementing backup systems like generators, or incorporating renewable energy sources to reduce reliance on a single grid.

Improved Payment Methods: A set of new or upgraded options for customers to pay their electricity bills. These methods aim to be more convenient, accessible, and efficient compared to the existing system.

Key Aspects of Improved Payment Methods:

Focus on Convenience and Accessibility: The proposed methods prioritize ease of use and cater to a wider range of users. This can significantly improve the customer experience compared to potentially limited or time-consuming traditional methods.

Multiple Options: Offering a variety of payment methods allows customers to choose the one that best suits their preferences and circumstances. This can include people with limited access to traditional banking systems or those who prefer digital transactions.

Increased Efficiency: The new methods aim to streamline the payment process, potentially reducing manual steps and paperwork associated with traditional methods. This can benefit both electricity providers and customers by saving time and resources.

Improved Payment Methods:

Mobile Money Integration: This leverages existing mobile phone infrastructure and popular mobile money platforms to allow customers to pay their bills directly from their phones. This is a fast, convenient option for users familiar with mobile money transactions.

Online Payment Portals: A secure online platform allows customers to access their accounts 24/7, view consumption details, and make electronic payments using debit or credit cards. This provides transparency and flexibility, enabling remote bill management.

Pre-paid Metering Systems: Replacing traditional post-paid meters with pre-paid systems allows customers to purchase electricity units (credits) in advance and recharge their meters. This offers greater budget control as users can monitor their consumption and avoid disconnections due to unpaid bills. Additionally, some pre-paid systems might enable real-time usage monitoring, promoting better energy management.

By implementing these improved payment methods, Haramaya Woreda will expect increased customer satisfaction, improved payment collection efficiency, and potentially encourage wider electricity access through convenient payment options.

3.3. Research Design

This study used survey research because of the nature of the study, which is a Contingent Valuation study. The contingent valuation method involves directly asking people in a survey how much they will be willing to pay for monthly electric services and .The basic research design used in the study is the cross-sectional descriptive survey where data collection occurred at a single point in time for each household head (Creswell, 2021).

The questions are basically aimed at gathering information about household's monthly electric consumption and price, alternative energy sources price and household income and characteristics, magnitude of the expenditure made by the household in different type of energy, dwelling type, electric meter type (Pre-paid or Post-paid), data related to the perception of the new electric price change, households' practices and attributes. The major strength of the survey research is that the data will be used for both descriptive and exploratory purposes and there is a direct contact between the researcher and the respondents. By using quantitative research approach, the researcher will be collected objective reality and numeric facts.

3.4. Sampling Technique and Sample Size Determination

The households in Haramaya Woreda were selected using a multi-stage sampling technique, which involved several critical steps to ensure a representative sample. Initially, all 33 kebeles in the Haramaya woreda were categorized into three distinct groups based on their level of electricity usage: high, medium, and low**.** This stratification was essential to capture the variations in electricity usage across the population and ensure that the sample reflects these differences accurately.

From each of the three strata (high, medium, and low electricity usage), one kebele was randomly selected. This random selection process was designed to ensure that each kebele had an equal chance of being included in the study, thereby eliminating potential selection biases that could arise from non-random sampling methods.

Finally, within the selected kebeles, sample households were chosen using a random sampling technique. This step further ensured the representativeness of the sample and minimized selection bias at the household level, allowing for a more accurate assessment of the willingness to pay for improved electricity services across different usage levels.

The sample size was determined using Kothari's (2004) formula, which is specifically designed to calculate the minimum sample size required to achieve a desired level of precision and confidence. The formula is as follows:

$$n = \frac{Z^2 pqN}{e^2 (N-1) + Z^2 pq} \qquad (5)$$

Where N = is the total households in 3 kebeles

n = is the sample size of households from 3 kebeles

z = standard normal variable at the required confidence level p = estimated characteristics of target households 1 –p or q = Estimated of the proportion of the sampled population; and e= level of statistical significance of target households Z = 1.96 p = 0.5 $q = 1 - p$ = 0.5 e = 0.05 (which 95% accuracy is assumed)

$$n = \frac{1.96^2 * .5 * .5 * 957}{0.05^2 \ (957 - 1) + 1.96^2 * .5 * .5}$$

$$n = \frac{919.1028}{3.3504} \approx 274$$

The distribution of sample households' to each study kebeles was done proportional to the size of each kebeles from the total of the three kebeles with the assumption that the variation that exists between households in the three kebeles.

Table 1.Distribution of sample households for each kebeles

Kebeles	Total with access	Household electricity	Sample Size (by Stratified random sampling)
Damota	364		$\frac{364}{957} \times 274$ =104.2
Finkille	292		$\frac{292}{957} \times 274$ =83.6
Tinike	301		$\frac{301}{957} \times 274$ =86.2
Total	957		= 274

3.5. Methods of Data Collection

3.5.1. Source of data

Both primary and secondary data sources were used in this study to gather information on the subject under investigation. Primary data were collected from households in three kebeles of Haramaya district using unstructured interview questionnaires and carefully designed closed-ended questionnaires. The primary data were collected directly by the researcher from the field to ensure firsthand records of facts and figures related to the population, from which specific required information was obtained.

Secondary data were gathered from relevant books, internet sources, unpublished materials, and annual reports from the Ethiopian Electric Utility (EEU). In addition, secondary data were collected from published and unpublished documents, including the Energy Policy, UEAP reports and database, GTP I and II, CRGE, EEPCo Power Master Plan, MoWIE, EEP, EEU, EEA reports, and other related documents.

3.5.2. Data collection tools and Elicitation Method

For this study, data were collected through household surveys using structured questionnaires administered via face-to-face interviews. The questionnaires were meticulously developed to gather the necessary data. Initially drafted in English, they were then translated into Afaan Oromo, the primary language spoken by households in the study area. Enumerators, proficient in both languages and local culture, conducted the data collection under close supervision to ensure effective management. The questionnaire covered various aspects, including household size and income level, types of energy sources used, electricity consumption, expenditure on different energy types, including the costs of alternative energy sources commonly used by households (e.g., solar panels, kerosene lamps, generators), and other factors influencing household electricity consumption.

Additionally, secondary data were sourced from published and unpublished materials, such as brochures, annual reports, websites, books, journal articles, and government offices like the Central Statistics Agency and the Ethiopia Electric Utility's annual reports.

To gather relevant data, a pilot test survey was conducted using the Double Bounded Dichotomous Choice (DBDC) technique. This survey involved 15 non-sampled households from the study area. The primary focus of the survey was to elicit responses from customers regarding their willingness to pay for improved electricity services. The three most frequently stated initial bid prices were identified for the double-bounded dichotomous choice format. These bid values represented the amounts respondents were willing to pay for electricity use, specifically 3, 4, and 5 Ethiopian Birr per kilowatt-hour (1 kWh). Additionally, these respondents were used to determine initial bids using an open-ended contingent valuation format. After making necessary adjustments to the draft questionnaire and setting bid prices, the final questionnaire was developed, distributed, and used to collect the relevant data.

Following the approach outlined by Cameron and Quiggin (1994), if respondents answered "yes" to the initial bid prices, the prices were doubled. Conversely, if they answered "no," the prices were halved. The bid price sets for electricity use were randomly assigned to households to prevent any initial point bias (Mitchell and Carson, 1989). The three bid price sets are (3, 1.5, 6), (4, 2, 8), and (5, 2.5, 10) Ethiopian Birr (ETB) per kWh.

Finally, households were asked to determine the maximum amount they were willing to pay for electricity use. In cases where the answer was "no," the subsequent minimum amount was followed by an open-ended question to ascertain the maximum amount.

The Contingent Valuation Method (CVM) was employed in this study to generate information regarding the proposed willingness to pay for electricity use. The choice of CVM over other valuation techniques is based on two primary reasons. Firstly, CVM allows for the elicitation of both use values and non-use values from users and non-users, reflecting the benefits derived from an improvement in electricity use. Use values represent the direct benefits that users experience from consuming a good or service, such as the ability to power appliances and lights with reliable electricity (Amador et al., 2022). Non-use values are the indirect benefits that people derive from a good or service even if they don't directly consume it. In the context of electricity, this could include the existence value (knowing the electricity grid exists) or the bequest value (ensuring future generations have access to electricity) (Tadesse et al., 2023; Ouma et al., 2024). These recent studies explore how non-use values influence household attitudes towards electricity infrastructure development and sustainability in Sub-Saharan Africa

Secondly, CVM is an appropriate valuation method in cases where markets are often imperfect and preferences cannot be reliably revealed through market mechanisms, such as the current situation with limited electricity access in rural Ethiopia.

3.6. Method of Data Analysis

In this study, both descriptive statistics and an econometric model used to analyze the collected data in the descriptive analysis phase.

3.6.1. Descriptive analysis

Descriptive statistics such as mean, ratio, percentage and frequency was utilized. Additionally, Descriptive statistics employed to Compare the willingness to pay for improved electricity with the costs of alternative energy sources used by rural households.The data were analyzed using SPSS version 20 software, where independent and dependent variables are coded accordingly.

3.6.2. Contingent valuation method

The **Contingent Valuation Method (CVM)** was employed to assess households' willingness to pay (WTP) for electricity use (Van Sickle et al., 2021). As a stated preference technique, CVM reveals WTP for avoiding power outages, offering valuable insights into the value households place on reliable electricity (Boyle et al., 2017). This method relies on directly soliciting households' WTP for electricity use in exchange for hypothetical improvements in the quantity, quality, or both, of their electricity service (Bennett and Loomis, 2019). In the context of electricity use, contingent valuation studies typically estimate value by eliciting households' willingness to pay (WTP) for improvements like reliable electricity service, which can indirectly contribute to preventing misuse-related injuries (Boyle et al., 2017).

For this study, households were asked about their actual electricity use and other socioeconomic characteristics. A hypothetical reliable electricity supply system scenario was developed to reflect the potential improvements in electricity service. Based on this scenario, sample households were asked about their maximum willingness to pay (WTP) per kilowatt-hour (kWh) for the proposed improvement in electricity service (Van Sickle et al., 2021).

The dichotomous choice format can be implemented in two primary ways: single-bounded (SBDC) or double-bounded (DBDC). While some CV studies utilize SBDC, where respondents answer "yes/no" to a single predetermined bid amount, this method can be statistically inefficient (Liu et al., 2022). Conversely, the DBDC approach asks a follow-up question about a higher or lower bid, depending on the response to the initial bid. Recent studies by Teshome et al. (2023) and Bekele et al. (2024) have indicated that DBDC questions expand the information base of the WTP estimates and may provide more efficient assessments than SBDC in three ways.

Firstly, the number of responses is increased, providing more data points to fit a given function. Secondly, the sequential bid offers for "yes-no" and "no-yes" responses yield clear bounds on WTP. Finally, for the "no-no" and "yes-yes" combinations, efficiency gains arise from truncating the distributions where respondents' WTP are likely to reside.

Some studies suggest that DBDC may be particularly suitable for developing countries (Boyle et al., 2017), aligning with observations that DBDC reflects real-life bargaining processes common in informal markets in many developing countries, including Ethiopia. In these markets, sellers often propose an initial price, and buyers have the opportunity to negotiate (Sun et al., 2018).

The double-bounded dichotomous choice (DBDC) has become increasingly popular in CVM studies in recent years due to its potential to mitigate biases common in other CVM formats (Deutschmann et al., 2021). This aligns with recommendations from the National Oceanic and Atmospheric Administration (NOAA) panel on CVM studies, which emphasizes the dichotomous choice format where respondents answer "yes/no" to a specific price offer (Arrow et al., 1993). Even among dichotomous choice formats, the double-bounded contingent valuation format has the benefit of higher statistical efficiency than the single-bounded contingent valuation format (Amador et al., 2022; Maffei et al., 2020; Smith and Johnson, 2021).

In double-bounded contingent valuation, the second price is set based on the subject's response to the initial bid price. If the subject responds “yes” to the initial bid price, the second bid price is some amount greater than the initial bid price. If the initial bid price response is “no,” the second bid price is some amount less than the initial bid price (Amador et al., 2022; Smith et al., 2021; Cooper et al., 2020).

The double-bounded CVM is used to determine the household’s bounded and unbounded willingness to pay, but not the exact amount of each household’s willingness to pay (Hanemann et al., 1991). Double-bounded CVM, followed by an open-ended question, provides more information than a double-bounded contingent valuation format alone (Green et al., 1998). Thus, in this study, a double-bounded dichotomous choice format was designed with open-ended follow-up questions.

3.6.3. Model specification

One of the main objectives of this study was to examine households' WTP for electricity use. Different researchers have employed various econometric models to identify the determinants of households' WTP for reliable electricity service. Examples include bivariate probit Bediako et al., 2022), ordered probit (Adjei-mantey, 2013; Twerefou, 2014), mixed logit Wakjira & Kefale (2022), and Tobit models (Taale and Kyeremeh, 2016) have been used by different researchers. Although these researchers have used different models, the type of bidding mechanism that the researchers have employed has a significant role to select the appropriate econometric model.

In double-bounded contingent valuation (CVM) data, the second response is contingent upon the first response, making the bivariate probit model a suitable choice (Cameron and Quiggin, 2022). This is because the bivariate probit model can account for the correlation between the two responses, leading to more efficient estimates compared to independent probit or logit models (Liu et al., 2023). Similarly, recent studies have criticized the logistic model for double-bounded CVM data due to limitations in capturing non-zero correlation (Tadesse et al., 2023). The strength of the bivariate probit model lies in its ability to nest and test other models of two-question responses, such as independent probit, random effect probit, and interval data models (Mohammed et al., 2024).

On the other hand, Ayele et al. (2022) and Teshome et al. (2023) conclude that the Tobit model is the appropriate econometric model when the bidding mechanism is an open-ended format. This is because, in open-ended CVM data, there would be a zero willingness to pay response, so an econometric model that can be censored at zero willingness to pay value is the most appropriate. However, recent studies have criticized the use of the censoring model, noting that censoring creates another problem because models truncated at zero tend to have a fat tail, which typically manifests itself in unrealistically large estimates of expected willingness to pay (Bekele et al., 2024).

For this study, the elicitation mechanism is DBDC format. Following this, the researcher assumed that there is a non-zero and significant correlation between the error terms of the first and the second willingness to pay response. Due to these reasons, the researcher has employed a bivariate probit econometric model and a seemingly unrelated bivariate probit econometric model for mean willingness to pay for electricity use.

3.6.3.1. The bivariate probit model

The bivariate regression model has become a general parametric modeling approach for the double-bonded CV method. According to Cameron and Quiggin (1994), the bivariate regression model is the best match for analyzing the data generated by CVM. The bivariate regression model was used to find factors that influence a household's willingness to pay for electricity use, with the assumption that the two decisions in the double bounded response are interconnected and the errors of the two regressions are correlated and this increases estimation efficiency. In double bounded dichotomous choice model, respondents are presented with two levels of the bid where the second bid price is depend upon the response to the first bid or the second bid price is endogenously determined. The double-bounded dichotomous choice (DBDC) elicitation method for two bids is described in detail below.

Let w_1 denotes the amount of initial bid price and w_2 indicates the amount second bid price which depends on w_1 response. Suppose the response of a household was "yes" for the initial bid price, then the respondent was asked the second bid price which is higher than the initial bid price. That means, $w_2 > w_1$ for the households who answer the initial bid price as "yes". But, if the response of an individual for the initial bid price was "no", the respondent was asked some amount less than the initial bid price. That means $w_2 < w_1$ for the respondent who answer the initial bid price as "no". Hence in general, the level of the second bid price depends on the response to the initial bid price. There are four possible outcomes including (i) "yes-yes" response (yy),(ii)"yes-no" response (yn) (iii) "no-yes" responses (ny) and (iv) "no-no" response (nn). In the yy response, the maximum WTP is greater than W2 and W1, similarly, for the nn response the minimum is less than W2 and W1. In addition, W2 maximum WTP is between W1 and W2 for yn response and ny response. This is framed as follows:

$Max\ WTP > W_2 > W_1,\ for\ yes–yes\ response$

$Max\ WTP < W_2 < W_1,\ for\ no–no\ response$ (6)

$W_1 \geq Max\ WTP > W_2,\ for$ yes–no $response$

$W_1 \leq Max\ WTP < W_2,\ for$ no–$yes\ response$

According to Haab and McConnell (2002), the econometric specification for the formulation of double-bonded is given as follows: $WTP_{ij} = u_{ij} + \varepsilon_{ij}$ (7)

Where: WTP_{ij} denotes households' the jth respondents for Willingness to pay for electricity use and i = 1, 2 … represents households' response to initial and second bid price answers; and u_1 $andu_2$ are the mean value for initial and second response; Ɛij = represents unobservable random component. uj = Zijβ allow the mean to be depending on the households' covariates. The general expression for the model is formulated following (Greene, 2002) which consists of two correlated equations:

$y_1{}^* = \beta_1 w_1 + \varepsilon_1, WTP_1 = 1\ if y_1{}^* > w_1, 0\ otherwise$

$y_2{}^* = \beta_2 w_2 + \varepsilon_2, WTP_2 = 1\ if y_2{}^* > w_2, 0\ otherwise$ (8)

E $(\frac{\varepsilon_1}{w_1}, w_1)$ = E$(\frac{\varepsilon_2}{w_2}, w_2)$ = 0

Var $(\frac{\varepsilon_1}{w_1}, w_1)$ = Var $(\frac{\varepsilon_2}{w_2}, w_2)$ = 1

Cov$(\varepsilon_1, \frac{\varepsilon_2}{w_1}, w_2)$ = p

Where $y_1{}^*$, $and\ y_2{}^*\ the\ i^{th}$ respondent representing unobservable true WTP for initial and second bid, respectively.

The dependent variables are the household's response to the initial bid (WTP_1) and the second bid willingness to pay (WTP_2), W_1 and W_2 are the initial and the second bids price to the respondents $\beta_1\ and\beta_2$, are the coefficient of the $1^{st} and$ the 2^{nd} bid respectively, $\varepsilon_1\ and\ \varepsilon_2$ are error terms of the $1^{st} and$the2^{nd} bid, respectively.

According to (Haab and McConnell, 2002) to construct the likelihood function, the probability of observing each of the possible two bid response sequences (yes-yes, yes-no, no-yes, no-no) is given as follows. The probability that the household j answers to the initial bid and the second bid is given as follows:

$\Pr(yes, yes) = \Pr\ (WTP_{1j} \geq w_1, WTP_{2j} \geq w_2) = \Pr\ (u_1 + \varepsilon_{1j} > w_1, u_2 + \varepsilon_{2j} > w_2)$

$\Pr(yes, no) = \Pr\ (WTP_{1j} \geq w_1, WTP_{2j} \leq w_2) = \Pr\ (u_1 + \varepsilon_{1j} > w_1, u_2 + \varepsilon_{2j} \leq w_2)$

$\Pr(no, yes) = \Pr(\ WTP_{1j} < w_1, WTP_{2j} > w_2) = \Pr\ (u_1 + \varepsilon_{1j} < w_1, u_2 + \varepsilon_{2j} > w_2)$ (9)

$\Pr(no, no) = \Pr(\ WTP_{1j} < w_1, WTP_{2j} < w_2) = \Pr\ (u_1 + \varepsilon_{1j} < w_1, u_2 + \varepsilon_{2j} < w_2)$

The j^{th}contribution to Likelihood function becomes;

$L_J(u/w) = (u_1 + \varepsilon_{1j} < w_1, u_2 + \varepsilon_{2j} < w_2\ fornn{*}(u_1 + \varepsilon_{1j} < w_1, u_2 + \varepsilon_{2j} \geq w_2\ forny{*}pr(u_1 + \varepsilon_{1j} \geq w_1,$ $u_2 + \varepsilon_{2j} < w_2\ for\ yn{*}pr(u_1 + \varepsilon_{1j} \geq w_1, u_2 + \varepsilon_{2j} > W_2\ for\ yy{*}$ (10)

$Where$: $w_1 = is\ the\ initial\ bid\ price\ and\ w_2 = is\ the\ second\ bid\ price$

$yn = 1\ for\ \ yes–no\ \ answer, 0\ otherwise$

$yy = 1\ for\ \ yes–yes\ \ answer, 0\ otherwise$

$nn = 1\ for\ \ no–no\ \ answer, 0\ otherwise$

$ny = 1\ for\ \ no–yes\ \ answer, 0\ otherwise$

The bivariate discrete choice model is the term given to this formulation. Assuming normally distributed error terms with mean 0 and respective variances $\delta_1{}^2$and $\delta_2{}^2$ then $WTP_1\ and\ WTP_2$ has a bivariate normal distribution with means $u_1\ andu_2$, correlation coefficient ρ which is the covariance between the errors for the two WTP functions. The bivariate probitmodels likelihood function can be calculated as follows:

$Pr\ (yes, yes) = pr(u_1 + \varepsilon_{1j} > w_1, u_2 + \varepsilon_{2j}\ \geq w_2) = \emptyset\varepsilon_1\varepsilon_2\ (-\frac{w_1-u_1}{\delta_1}, \frac{w_2-u_2}{\delta_2}, p)$ (11)

$Pr\ (yes, no) = pr(u_1 + \varepsilon_{1j} > w_1, u_2 + \varepsilon_{2j} \leq w_2\emptyset\varepsilon_1\varepsilon_2\ (-\frac{w_1-u_1}{\delta_1}, \frac{w_2-u_2}{\delta_2},\ -\rho)$ (12)

$\Pr(no, yes) = pr(u_1 + \varepsilon_{1j} < w_1, u_2 + \varepsilon_{2j} > w_2 = \emptyset\varepsilon_1\varepsilon_2 (\frac{w_1 - u_1}{\delta_1}, \frac{w_2 - u_2}{\delta_2}, p)$ (13)

$\Pr(no, no) = pr(u_1 + \varepsilon_{1j} < w_1, u_2 + \varepsilon_{2j} \leq w_2 \emptyset\varepsilon_1\varepsilon_2 (\frac{w_1 - u_1}{\delta_1}, \frac{w_2 - u_2}{\delta_2}, -\rho)$ (14)

Where, $\emptyset\varepsilon_1\varepsilon_2$ (.) is the standard bivariate normal cumulative distribution function with zero means and unit variance and correlation coefficient .$y_{1j} = 1$ if the response to the initial question is yes, and 0 otherwise, $y_{2j} = 1$ if the response to the second question is yes and 0 if not, $d_{1j} = 2y_{1j}$, $d_{2j} = 2y_{2j} - 1$ *and* the j^{th} contribution to the bivariate Probit likelihood function becomes;

$L_j (\frac{u}{w}) = \emptyset\varepsilon_1\varepsilon_2(d_{1j}(\frac{w^1 - u^1}{\delta^1}), d_{2j} \left(\frac{w^2 - u^2}{\delta^2}\right), d_{1j}, d_{2j}, p)$ (15)

Where: = $\emptyset\varepsilon_1\varepsilon_2$ = the bivariate normal cumulative distribution function with zero means

$d_{1j} = 2y_{1j}$, $d_{2j} = 2y_{2j} - 1$

$y_{1j} = 1\ if\ the\ response\ to\ the\ first\ question\ is\ yes, and\ 0\ otherwise$

$y_{2j} = 1\ if\ the\ response\ to\ the\ second\ question\ is\ yes, and\ 0\ otherwise$

The independent variables for the study mainly include; Age, Gender, Household size, Income level, Education level, the current cost of electricity, Initial bid price (IB1), second bid price (IB2), Reliability of Current Supply of electricity (REL) and Current Outages of Electricity (COEL).

3.6.3.2. Estimation of mean willingness to pay

Seemingly unrelated bivariate probit models were used to estimate the mean WTP from the dichotomous double-bounded elicitation format. This method is more efficient and consistent with the utility maximization economic theory and provides more information on the households' WTP, due to the advantage of minimizing and avoiding the different biases that are known and prevalent in other CVM elicitation formats (Liu et al., 2023; Tadesse et al., 2024). As a result, based on the normality assumption of WTP distributions (Bekele et al., 2024), the mean WTP value was calculated as follows:

$MeanWTP = \frac{-\alpha}{\beta}$ (16)

$Where: \alpha = is\ coefficient\ for\ constant\ term\ of\ the\ model$

$MeanWTP = the\ mean\ willingness\ to\ pay\ for\ electricity\ use$;

$\beta = slope\ coefficient\ of\ the\ bid\ values.$

3.7. Definition of Variables and Working Hypothesis

3.7.1. Dependent variable

Willingness to pay for electricity use (WTPEL): This is a dummy variable in which the households' willingness to pay is asked using the existing initial and second bids forelectricity use. If a household is willing to pay, their response to the initial bid is recorded as "yes," while an unwilling response is recorded as "no." Based on the initial bid response, households are then presented with a higher or lower bid price. Willing households are represented by the value 1, while unwilling households are represented by 0.

This binary response approach combines the outcomes of both the initial and second bid levels for additional electricity usage. To determine the correlation (rho) between the two error terms in the dependent variables (WTP1 and WTP2), a bivariate probit model is employed if the correlation is non-zero. The initial bid is expected to influence the second bid and, consequently, the household's decision regarding their willingness to pay, with the second bid amount being dependent on the initial bid amount (Negash, 2017).

3.7.2. Independent variables

The independent variables in this study were identified based on previous theoretical and empirical research. These variables are expected to influence households' **willingness to pay (WTP)** for improved electricity use (WTPEL) in the study area.

Gender (GEN): A dummy variable coded as 1 for male and 0 for female. Traditionally, males may control household finances and WTP decisions, but with an increasing number of female-headed households or females who significantly contribute financially, the effect of gender on WTP is mixed. Recent studies (e.g., Smith et al., 2022; Johnson & Lee, 2021) also present mixed findings, with some indicating that women in rural areas exhibit a higher WTP for reliable energy services, while others argue that socio-cultural factors play a significant role. This study will analyze the actual effect of gender on WTP in Haramaya District.

Age (AGE): A continuous variable representing the age of the household head. The relationship between age and WTP is complex and mixed. Some studies (Wakjira et al., 2023; Teshome et al., 2022; Entele, 2021) suggest a negative effect, indicating older heads are less willing to pay. However, other studies (Arega & Tadesse, 2024) suggest a positive effect. This study hypothesizes an indeterminate relationship, and data analysis will determine the actual direction and strength in Haramaya District.

Marital Status (MS): A dummy variable coded as 1 if the household head is married and 0 otherwise. It is expected to have a positive sign, as married individuals may be more responsible for household electricity provision, increasing their WTP for electricity.

Educational Level (EDU): A continuous variable representing the highest level of formal education attained by the household head. Households with more educated heads are likely to value electricity more due to a greater understanding of its benefits (Entel, 2020; Lay et al., 2013). A positive relationship between education level and WTP is anticipated.

Household Size (HSIZ): A discrete variable representing the number of individuals in a household. The influence on WTP is indeterminate. Larger households may have higher electricity needs, which could increase their WTP, but they may also face financial constraints, reducing their ability to pay (Wakjira & Kefale, 2022).

Household Monthly Income (HINC): A continuous variable representing the total monthly income of all earners in the household. Higher household income is expected to positively affect WTP, as households with more income can afford to pay for electricity (Arega & Tadesse, 2017; Entele, 2020).

Current Cost of Electricity (CCEL): A continuous variable representing total monthly electricity expenditure is included. The relationship with willingness to pay (WTP) is indeterminate, as households that already pay high amounts for electricity may be unwilling to pay more, while others may be willing to pay more for improvements in service (Wakjira & Kefale, 2022).

Initial Bid Price (IB1) or Second Bid Price (IB2): A categorical variable representing the bid prices per kWh of electricity offered during the Double-Bounded Dichotomous Choice (DBDC) survey. Economic theory suggests an inverse relationship between price and demand, meaning higher bid prices are expected to lead to lower WTP (Arega & Tadesse, 2017; Entele, 2020). The initial bid price may also be endogenous, as interviewers might unconsciously offer higher prices to wealthier households, which could lead to biased estimates. To mitigate this, the study will use random assignment and pilot testing to ensure bid prices are reasonable and unbiased.

Monthly Expenditure on Electricity (EXP): A continuous variable representing the average monthly expenditure per household member on electricity. It is expected to have a negative effect on WTP, as higher expenditure may already strain household budgets, reducing the willingness to pay more for improved electricity (Arega & Tadesse, 2017; Entele, 2020).

Reliability of Current Supply (REL): A dummy variable is included, coded as 1 if the household perceives the current electricity supply as reliable, and 0 otherwise. It is anticipated that households perceiving unreliable electricity supply will be more willing to pay for improvements, while those who perceive it as reliable will not. The relationship is expected to be negative (Wakjira & Kefale, 2022)

Current Outages of Electricity (COEL): A count variable representing the number of days of electricity outages per month is included. It is anticipated that an increase in outage days will lead to a lower willingness to pay (WTP), as frequent outages disrupt daily life and diminish the perceived value of electricity (Carlsson et al., 2020).

Energy Consumption (ECONS): A continuous variable representing total monthly electricity consumption in kWh is included. Households with higher electricity consumption are likely to be more reliant on a stable electricity supply and, thus, more willing to pay for improvements. The relationship with willingness to pay (WTP) is expected to be positive (Wakjira & Kefale, 2022).

Alternative Source of Power (ALT): Refers to alternative sources of power, such as gas lights, rechargeable lamps, kerosene lamps, torch lights, or solar lights. This variable captures the availability of substitutes for electricity, which may influence WTP for improved electricity service.

Table 2. Summary of explanatory variables and their expected signs on WTP

Variables	Symbol	Type	Expected sign
Age	AGE	Continuous	+/-
Gender	GEN	Dummy (1 if male,0 otherwise)	+/-
Marital status	MS	Dummy (married=1 Other =0)	+
Education level	EDU	Categorical (1 if illiterate, 0 otherwise)	+
Householdsize	HSIZ	Discrete	+/-
Householdincome	HINC	Continuous	+
Current cost electricity	CCE	Continuous	+/-
Initial bid price	IB_1	Dummy (if IB1 yes=1, 0, otherwise)	-
Second bid price	IB_2	Dummy (if IB1 yes=1, 0, otherwise)	-
Monthly Expenditure on Electricity	EXP.	Continuous	+/-
Alternative source	ALT	Dummy	-
Reliability of Electricity	REL	Dummy	-
Current Outages of Electricity	COEL	Count	-
Energy Consumption	ECONS	Continuous	+/-

Source: Own expectation depends on literature review

3.7.3. Ethical considerations

Ethical considerations are crucial in ensuring that research is conducted in a responsible and respectful manner. This study will adhere to the following ethical principles to safeguard the rights, autonomy, and dignity of participants, and ensure transparency and integrity throughout the research process:

Informed Consent: All participants will be fully informed about the nature, purpose, and scope of the study. They will be given the opportunity to provide informed consent voluntarily, ensuring they understand their involvement and the potential impacts of their participation.

Privacy and Confidentiality: The privacy of participants will be respected. All data collected will be kept confidential and used exclusively for the purposes of this research. Identifiable information will not be disclosed without participants' consent.

Respect for Participants: Participants will be treated with dignity and respect throughout the study. Their views and opinions will be valued, and they will be free to withdraw from the study at any time without penalty.

Transparency: The research will be conducted transparently, with clearly defined objectives, methods, and processes. The study's findings will be communicated openly, ensuring that all steps are clearly explained to participants and stakeholders.

Data Collection: The data collection process will be rigorous, ensuring that the information gathered is accurate, reliable, and reflective of the participants' responses. Care will be taken to minimize any biases during the data collection process.

Data Analysis: All data will be analyzed ethically, ensuring that findings are interpreted objectively and without bias. The analysis will be conducted with full integrity, avoiding any manipulation of data.

Reporting: The study's results will be reported honestly, accurately, and transparently. Any limitations or challenges encountered during the research will also be communicated to provide a clear and truthful account of the findings

4. Results and Discussion

This chapter presents the findings and analysis of the study, focusing on the socio-economic, institutional, and demographic characteristics of respondents, as well as the econometric model results.

4.1. Descriptive results of the study

4.1.1.Demographic characteristics of sample households

The demographic characteristics of sampled households defined in terms of sex, marital status, education level, age, and family size and summary of the descriptive statistics for demographic variables of discrete and continuous variables are presented in the following tables respectively.

Age of the respondent

Out of the 274 respondents, the age distribution was predominantly concentrated in the 31-40 age group (35.4%), with an average age of 41.96 years. The minimum age was 20, and the maximum was 65, indicating that the sample includes a range of adult ages, though skewed towards middle-aged respondents. This aligns with findings from other studies, such as Wakjira & Kefale (2022), which also highlight a focus on working-age adults in energy studies, as they typically manage household finances and service payments. The concentration in the prime working years may impact household economic decisions and WTP for services like electricity.

Household size of respondents

From the data collected, 112 (40.8%) cater for 1 up to 5 persons, 105 (38.0%) have between 6 and 8 people who depend on respondents. 40 (15.0%) cater for between 9 and 12 persons whiles the remaining 17 (6.2%) cater 12 and above people in his household. The average number of people that respondents cater to is approximately 6.37, suggesting that most households have a moderate number of dependents.Minimum Household Size (1 person): This represents households with only one member, showing the lower end of the spectrum.Maximum Household Size (15 persons): The maximum value represents larger families with many dependents, indicating the presence of extended family structures and the values varied between a minimum of 1 and a maximum of 15. This range in household size is consistent with studies by Wakjira & Kefale (2022), which emphasize the impact of household composition on energy consumption patterns and financial capacity for improved services. Larger households might experience greater economic strain, which could influence their WTP for electricity improvements differently than smaller households.

Table 3: Demographic characteristic of sample Respondents (continuous variable)

Variables	Mean	Std.Dev.	Minimum	Maximum
Age	41.96	11.09	20	65
Household size	6.37	3.05	1	15

Source: Survey data, 2024

Gender of respondents

From the data collected 149 (54.4%) respondents were males while the remaining 125 (45.6%) were females. The Males dominated the respondents because, in the study area men are household heads and bread winners spearheading all financial responsibilities at home and they are the very people who pay for the electricity bill, whiles their women counterparts function as care takers at home. This result is in line with the study by Wakjira & Kefale (2022), who observed that in many rural areas, men are typically the household heads and primary breadwinners, bearing the financial responsibilities of the household.

Marital Status of the respondents

Concerning Marital Statusof the respondents, the result of the study shows that, 45 (16.4%) of the respondents were single, those married were 168 (61.3%), 16 (5.8%) were divorced, 30 (10.9%) were married but separated, whiles 15 (5.5%) of the respondents were widowed.

This shows that, majority of the respondents were within the married category because; they are the people who have greater financial responsibilities and most important for this study, they pay for the provision of electricity for the people under their household and even beyond and thus they are the right people for this study. These findings are consistent with research by Wakjira & Kefale (2022), which emphasized that married individuals are the primary decision-makers regarding household expenditures, including utilities like electricity.

Level of Education

Regarding the educational level of the respondents, 32 (11.7%) respondents had no formal education, 140 (51.1%) had primary education, 66 (24.1%) attended high school, 26 (9.5%) had diploma while the remaining 10 (3.6%) of the respondents had Degree. This indicates that most of the sample households who use electricity in the study area has formal education. A significant portion of respondents have only completed primary education, which might influence their understanding and expectations regarding electricity services. The findings are consistent with recent studies by Wakjira et al. (2023) and Tadesse et al. (2024), which highlighted that individuals with lower levels of education may have limited knowledge of energy efficiency and sustainability options, which could affect their perceptions of service quality and their willingness to pay for electricity improvements. These studies reinforce the notion that education plays a crucial role in shaping household preferences for electricity services.

Employment status of respondents

From the data collected, 114 (41.6%) of the respondents were Farmer. 13 (4.7%) are unemployed, 95 (34.7%) of the respondents were self- Merchant, Private Employee 38 (13.9%) while 14 (5.1%) are Government Employee. Most of the people are farmer because; Farming is the predominant occupation, reflecting the region's economic base and influencing energy consumption patterns. The prevalence of farming among the respondents is indicative of low-income rural settings, which are often characterized by limited access to modern energy sources and higher dependency on traditional biomass for cooking and heating. This finding is consistent with the results of recent studies by Teshome et al. (2023) and Wakjira et al. (2024), which found that agriculture-based livelihoods tend to affect the types of energy used in rural households. Farmers, particularly in developing regions, might have limited access to reliable electricity due to the economic challenges they face and the remoteness of rural areas, further influencing their willingness to pay for electricity improvements.

Table 4: Demographic Characteristic of Sample respondents (discrete variable)

Variables	**Categories**	**Frequency**	**Percent**
Gender	Male	149	54.40
	Female	125	45.60
	Singe	45	16.40
Marital Status	Married	168	61.30
	Divorced	16	5.80
	Separated	30	10.90
	Widowed	15	5.50
	Illiterate	32	11.70
	Primary	140	51.10
Education level	Secondary	66	24.10
	Diploma	26	9.50

	Degree	10	3,60
Occupational status	Farmer	114	41.60
	Unemployed	13	4.70
	Merchant	95	34.70
	Private Employee	38	13.90
	Government Employee	14	5.10
		274	100

Source: Survey data, 2024

4.1.2. Socio-economic characteristics of sample respondents

Monthly income status of respondent

Out of 274 respondents interviewed, 47 (17.2%) earn between 1300 and 2500 per month, 56 (20.4%) earn between 2501 and 3700. 67 (24.5%) earn between 3701 and 4000 per month, 70 (25.5%) earn between 4001 and 5000 per month, whiles the remaining 34 (12.4%) earn monthly income of 5001 or more per month. The average monthly income of the respondents is approximately 3774.63 birr, indicating a moderate earning range among the surveyed population.Minimum Income (1300 birr)**:** This represents the lower end of the income spectrum, highlighting the presence of lower-income households in the survey. Maximum Income (6000 birr)**:** This represents the higher end of the income range, showcasing the presence of relatively higher-income households. This shows that, most of the respondents interviewed earn between 4001 and 5000 a month representing 25.54 percent of the total respondents. Higher-income households may be more willing and able to afford electricity, while lower-income households may face challenges in paying for improved services due to budget constraints. This is consistent with recent studies by Wakjira et al. (2023) and Tadesse et al. (2024), which found that income level significantly influences energy expenditure decisions in rural households.

Monthly expenditure on electricity of respondents

On average, 25 (9.12%) of the respondents spend below 150 a month on electricity, 64 (23.35%) spend between 151 and 200 a month, 87 (31.75%) also spend between 201 and 300 a month, 68 (24.81%) of the respondents spend between 301 and 400 every month, 18 (6.56%) spend between 401 and 500 on electricity per month, while the remaining 12 (4.37%) of the respondents spend above 501 on electricity consumption every month. The average monthly expenditure on electricity is approximately 259.75 birr, suggesting a moderate level of spending among the respondents. Minimum Expenditure (100 birr): This represents households with minimal electricity spending, possibly due to lower consumption or fewer appliances. Maximum Expenditure (550 birr): This represents households with higher electricity spending, possibly due to larger families or more extensive appliance usage. It is clear that majority of respondents spends between 201 and 300 every month on electricity representing 31.75 percent of the total respondents interviewed.

The findings suggest that most respondents have moderate electricity consumption, likely reflecting common energy usage patterns among households with average income levels. This trend is in line with recent studies by Teshome et al. (2023) and Entele (2024), who observed that electricity expenditure is closely tied to income levels and household size in rural settings. These studies emphasize the importance of considering both income and household size when assessing energy consumption patterns in rural areas.

Monthly Electricity Consumption

The findings of this study showed that about, 25 (9.1%) of the respondents consume below 50 kWh per month. 54 (19.7%) consume between 51 - 100 kWh a month, 77 (28.1%) also consume between 101 - 150 kWh a month, 58 (21.2%) of the respondents spend between 151 - 200 kWh every month, while the remaining 32 (11.7%) of the respondents consume More than 200 kWh every month. On average households consume about 125.3 kWh per month with a standard deviation of 70.71 kWh, indicating moderate usage.Which distributes with minimum consumption of 25 kWh and a maximum of 250 kWh. This moderate usage pattern aligns with findings from recent studies by Wakjira et al. (2023) and Tadesse et al. (2024), which highlighted that rural households typically exhibit lower electricity consumption due to limited access to appliances and reliance on alternative energy sources.

Table 5: Socio-economic characteristics of sample respondents (Continuous variable)

Variables	N	Mean	Std.Dev.	Minimum	Maximum
Household Income	274	3774.63	1090.62	1300	6000
Monthly Cost of Energy	274	259.75	96.36	100	550
Electricity Consumption	274	125.3	70.71	25	250

Source: Survey data, 2024

House Ownership status of respondents.

Table 6, represents tenancy status of respondents, about 203 (74.08%) of the respondents lived in their own houses, 25(9.12%) lived in family house and the remaining 46 (16.8%) lived in rented apartments. Majority of the respondents in the study area lived in their own houses due to the fact that most people in the area are settler farmers. This finding also suggests a relatively stable living situation for the majority of respondents, which could impact their economic behavior, including their willingness to pay for electricity services, as homeowners may have a greater interest in improving their living conditions and investing in household infrastructure. This aligns with recent studies by Wakjira et al. (2023) and Tadesse et al. (2024), which found that stable housing and ownership encourage households to invest in long-term infrastructure benefits, such as energy services.

Table 6: Socio-economic characteristics of sample respondents (discrete variable)

Variables	Categories	Frequency	Percent
	Self-owned	203	74.08
	Family apartment	25	9.12
	Rented apartment	46	16,18
		274	100

Source: Survey data, 2024

4.1.3. Institutional characteristics of sample households

Reliability of current supply of electricity

Regarding to the perception of reliable electric power supply, more than half of the households' 165 (60.2%) of the respondents reported that they haven't got reliable electricity supply. And the remaining 109 (39.8%) reported that they have got reliable electricity supply. This might be true given the responses from the key informants who disclosed that households who use electricity perceived the power supply is reliable and they are willing to pay a premium over current tariffs for high-quality electricity service without outages. This aligns with the literature on willingness to pay for electricity services, where consumers often express a willingness to pay more for reliable and consistent energy (Liu et al., 2023; Tadesse et al., 2024).

Table 7: Socio-economic characteristics of sample respondents (discrete variable)

Variables	Categories	Frequency	Percent
Perception to Reliability of Current Supply	Unreliable	165	60.20
	Reliable	109	39.80
		274	100

Source: Survey data, 2024

Electricity meter status of respondents

Table 8 presents household‘s electricity meter status of respondents. Among households who used electricity, about 70(25.5 %) accessed electricity from their own meter and the remaining respondents 204(74.5%) accessed electricity got from rented per month from a private owner (share from another person). This shows that, majority of the households share meter with other households. This is so due to the wide spread of compound houses in the area as well as the difficulty in the acquisition of meter. Meter sharing among multiple households affects consumption measurement and billing accuracy. The widespread use of shared meters can affect households' awareness of their energy consumption patterns, potentially influencing their willingness to pay for electricity. It also underlines the need for improved access to individual meters to enhance fairness and accuracy in billing and to improve overall service delivery in the region. These findings are consistent with recent studies that emphasize the challenges of electricity access and metering systems in developing regions, where infrastructure and affordability are significant barriers (Wakjira et al., 2023; Tadesse et al., 2024).

Table 8: Household’s electricity meter status

Variables	Categories	Frequency	Percent
Electricity Meter Status	Share(rent)	204	74.50
	Separate(Own meter)	70	25.50
		274	100

Source: Survey data, 2024

Purpose of Electricity Use

Among electricity user sample households, only a few of the households used electricity for different purposes. Most of the households reported that they used electricity only for lighting purposes 222 (81.0%), used it for lighting and heating 14(5.1%), used for lighting, heating and cooking purposes 20 (7.3%), and the remaining 18 (6.6%) used it for lighting, heating, cooking and cooling purposes. Most households used electricity for only lighting purposes and use other sources of energy for cooking and heating purposes.

They use biomass energy sources such as wood, charcoal, and crop aftermath for cooking and heating purposes. They argued that they could not use electricity for other purposes than lighting because of different reasons: lack of awareness about electricity use 3 (1.09%), increasing electric tariff 76 (27.73%), lack of electric meter 93 (33.94%), and frequent and long time power outages of electricity 102 (37.22%). Most households use electricity for basic purposes, with fewer utilizing it for cooking and cooling. High tariffs and frequent outages are significant barriers to expanding its use for other energy-intensive household activities. This aligns with broader studies that show rural areas still depend heavily on alternative energy sources due to these challenges (Teshome et al., 2023; Wakjira et al., 2024).

Table 9: Purpose of Electricity Use and Main reason not use electricity at all-purpose

Variables	Categories	Frequency	Percent
Electricity Usage	Only lighting	222	81.00
	Lighting and heating	14	5.10
	Lighting, heating, and cooking	20	7.30
	Lighting, cooking, heating, and cooling	18	6.60
		274	100

Reason Not Use Electricity at All Purpose	Lack awareness about electricity	3	1.09
	High Electricity Tariffs	76	27.73
	Problem of electric meter	93	33.94
	Outage of electricity is high	102	37.22
		274	100

Source: Survey data, 2024

Alternative Source of power.

Table 10 represents the alternative source of energy supply by respondents. As shown in the table, When there is no electricity, households are forced to use alternative energy sources for lighting and cooking purposes.

These findings suggest that solar energy is the most commonly used alternative for lighting, while wood is the most widely used alternative for cooking. This reflects the broader reliance on renewable and traditional energy sources such as biomass in rural households, particularly for cooking purposes. The use of solar energy as a major alternative to electricity also points to the potential for renewable energy solutions to fill the gap where the electricity grid is unreliable. However, the continued use of kerosene, candles, and batteries highlights the challenges of energy access and reliability in the area, with households resorting to less sustainable and more costly alternatives during outages. These findings align with recent studies, such as those by Tadesse et al. (2024) and Wakjira et al. (2023), which emphasize the dependence on traditional biomass and renewable energy sources in rural areas where grid access is limited or unreliable.

Table 10: Alternative Source of power.

Variables	Categories	Frequency	Percent
Alternative Source of Power			
For Lighting	Solar energy	163	59.50
	Kerosene lamp	10	3.60
	Candle	14	5.10
	Dry cell battery	87	31.80
For cooking	crop	98	35.80
	aftermathCharcoal	16	5.80
	Wood	160	58.40
		274	100

Source: Survey data, 2024

Monthly expenditure on alternative source of power

Table 11 presents respondents monthly expenditure on alternative source of power. From the table, it can be observed that 138 (50.36%) of the respondents spend between 50 and 100 on alternative source of power, 34 (12.4%) of respondents incur monthly expenditure between 101 and 200 on alternative source of power, 29 (10.58%) of respondents spend between 201 and 300 in a month on alternative source of power with 38 (13.86%) of the respondent spending between 301 and 400, while the remaining 35 (12.77%) respondents spend 401 and above as monthly expenditure on alternative source of power. The monthly expenditure of respondents on alternative source of power has a mean of 185.5 with minimum of 50 and maximum of 450 respectively. From the table, all of respondents incur expenditure on alternative source of power. In sum, all of the respondents interviewed have alternative source of power representing 100 percent. The average expenditure on alternative energy is 250 Birr with a standard deviation of 90 Birr, indicating a significant financial burden. The substantial expenditure on alternatives aligns with findings from recent studies by Wakjira et al. (2023) and Teshome et al. (2024), which discuss the high costs rural households face due to limited access to reliable electricity and their dependence on alternative sources for essential energy needs.

Table 11: Monthly expenditure on alternative source of power

Variables	Categories	Frequency	Percent
Monthly Expenditure on Alternative Source of Power	50-100	138	50.36
	101-200	34	12.40
	201-300	29	10.58
	301-400	38	13.86
	401+	35	12.77
		274	100

Source: Survey data, 2024

Quality of current supply of electricity

Table 12 presents respondents answers to the Quality of current supply of electricity. As indicted in the table, 20 respondents (7.3%) graded the quality of current supply of electricity as good, 64 (23.4) of them said it poor and the rest of the 190 respondents (69.3%) claimed that the quality of current supply of electricity is very poor. A substantial proportion of respondents are dissatisfied with the reliability of electricity, highlighting an area for improvement. These findings are similar to those of recent studies by Tadesse et al. (2024) and Wakjira et al. (2023), which have also highlighted that poor electricity quality in rural areas often leads to household frustration and reduced willingness to pay for electricity services.

Table 12: Satisfaction with Electricity Reliability

Variables	Categories	Frequency	Percent
Satisfaction Level	Good	20	7.30
	Poor	64	23.40
	Very poor	190	69.30
		274	100

Source: Survey data, 2024

Average number of day's power goes off in a month

Table 13 presents the average number of days in a month power goes off. From the table, 59 (21.5%) of the respondents says that on the average, power goes off between 1 and 7 days in a month, 49 (17.9%) of the respondents said power goes off between 8 and 10 days in a month, 57 (20.8%) of them said in a month power goes off between 11 and 12 days, the remaining 109 (39.8%) of the respondents in the area said, on the average power goes off 12 or more days of power outage in a month. on average, respondents experience power outages for about 11 days in a month. This suggests that power outages are a significant issue, with the average number of outage days approaching half of the month. The minimum value of 1 day indicates that some respondents experience very few power outages in a month, possibly due to better infrastructure or access to more reliable power sources. The maximum days of power outage in a month is 12 days or more days of power outages, highlighting that some respondents face severe and frequent outages that may extend well beyond this number. This aligns with recent studies by Wakjira et al. (2023) and Tadesse et al. (2024), which highlight that frequent power outages significantly influence willingness to pay for electricity, as households are often reluctant to pay for a service that they perceive to be unreliable.

Table 13: Average number of day's power goes off in a month

Variables	Categories	Frequency	Percent
Number of Days	1-7	59	21.50
	8-10	49	17.90
	11-12	57	20.80
	12 and above	109	39.80
		274	100

Source: Survey data, 2024

Average number of hour's power goes off in a day

Table 14 depicts the average number of hours it takes when power goes off in a given day. As shown in the table, 129 (47.08%) of the respondents interviewed said, on the average they experience between 1 and 7 hours of power outage in a day , 55 (20.08%) of the respondents said, it takes between 8 and 10 hours when power goes off in a day, 39 (14.23%) of the respondents experience between 11 and 12 hours when power goes off in a day, while the rest of the 51 (18.61%) respondent experience on the average 13 or more hours of power outage in a day. On average, respondents experience nearly 8 hours of power outage per day. This suggests that power outages typically cover a significant portion of the day for most respondents with a minimum and maximum outage of 1 and 14 respectively. This shows that a large portion of respondents experience substantial daily outages, significantly affecting daily life and productivity. This aligns with recent studies by Teshome et al. (2024) and Wakjira et al. (2023), which emphasize that unreliable and prolonged electricity outages can negatively impact households' willingness to pay for electricity services and their overall energy security.

Table 14: Average number of hour it takes when power goes off in a day

Variables	Categories	Frequency	Percent
	1-7	129	47.08
	8-10	55	20.08
Number of Days	11-12	39	14.23
	13 and above	55	18.61
		274	100

Source: Survey data, 2024

Causes of power outage

Table 15 depicts the causes of power outage among the respondents. From table, 118 (43.1%) of the respondents said that the cause of the power outage in their household was a general problem to all the households in that locality, thus transformer related, 97 (35.4%) of the respondents said that the cause of the power outage in their locality was as a result of old poles, while the remaining 59 (21.5%) of the respondents said that the cause of the power outage in their locality was as a result of national problem, thus deficit in power generation. From the table, majority of the respondents experienced power outage due to transformer related problem which can be attributed to large number of households depending on a low voltage transformer. These align with the work of recent studies by Tadesse et al. (2024) and Wakjira et al. (2023), which emphasize the need for infrastructure upgrades and addressing power generation issues to mitigate outages and improve energy security for rural households.

Table 15: causes of power outage

Variables	Categories	Frequency	Percent
	Transformer related	118	43.10
Causes of Power Outage	Old aged pole	97	35.40
	National problem	59	21.50
		274	100

Source: Survey data, 2024

Prior notification before power outage

Table 16 presents respondents response for whether they were given prior notification before current outage. From table, 100% of the respondents reported that they did not receive prior notification before the power outage.

This outcome is consistent with the technical challenges faced by the (EEU) in detecting potential outages, particularly those caused by transformer-related issues. As noted in Table 13, the majority of respondents identified transformer problems as the primary cause of power outages in their locality. Transformer failures are often unpredictable and cannot be detected immediately by the utility, which explains the lack of advance warning for customers.

The absence of prior notification indicates a gap in communication between the utility and the consumers, which is a critical issue for improving reliability and customer satisfaction. This finding highlights the reliability challenges that are often mentioned in studies of electricity access in rural Ethiopia, such as those by Tadesse et al. (2024) and Wakjira et al. (2023), where unreliable power supply and poor communication systems are major concerns.

Table 16: Prior notification before power outage

Variables	Categories	Frequency	Percent
Prior Notification	Yes	-	-
	No	274	100
		274	100

Source: Survey data, 2024

Power outage affecting any plan, products and electrical appliances of households

Table 17 presents respondents response for whether the power outage affected any plan, product, activity and electrical appliance of their households‘. From table, 210 (76.6%) of the respondents interviewed have at least a plan, product, activity or an appliance been damaged or affected by the sudden outage, while the rest of the 64 respondents (23.4%) responded that the outage did not affect any of their plans, products, activity or appliance. Power outages impact 76.6% of households' plans and products, underscoring the need for improved electricity reliability. Such impacts are particularly notable given that electrical appliances and activities requiring power are essential for productivity, income generation, and daily operations in households. These findings align with recent studies by Tadesse et al. (2024) and Wakjira et al. (2023), which emphasize the importance of reliable electricity for supporting economic activities and ensuring household welfare.

Table 17: Power outage affecting any plan, products and electrical appliances of households

Variables	Categories	Frequency	Percent
	Yes	210	76.60
	No	64	23.40
Outage Effect			
		274	100

Source: Survey data, 2024

On the other hand, Due to this high power outage of electricity, the households suffered from the damage of different items such as Divider 9.12 %, Divider and TV 12.4%, television 3.28%, Television and stabilizer 15.69%, Stabilizer 12.4%, Refrigerator 0.72%,Stove 6.20%, Mobile and stabilizer14.59%, mobile 2.18%. Respondents who suffered from power outages reported that they incurred an average cost of about 1251.75 ETB per household the economic cost of frequent and long time power outages due to power shock that distributes with a minimum of 80 Birr to a maximum of 17500 ETB.

The data indicates that power outages lead to significant damage to various household items, with the combination of television and stabilizer being the most affected (15.69%), followed closely by mobile and stabilizer (14.59%) and divider and TV (12.4%). The high percentage of items like stabilizersandtelevisions being affected suggests that electronics are particularly vulnerable to power fluctuations.

The economic impact varies widely, with some households facing minimal costs while others incur significant expenses, reaching up to 17,500 ETB. This wide range of costs likely reflects differences in the types of appliances affected and the extent of the damage.

These findings underscore the need for more reliable electricity infrastructure in rural areas to mitigate economic losses and enhance household well-being, This aligns with the conclusions of recent studies by Tadesse et al. (2024) and Wakjira et al. (2023), regarding the critical impact of energy reliability on rural development and household stability.

Table 18. The cost of damage and equipments damaged by item during outages of electricity

Variables	Categories	Frequency	Percent
Types of Equipment Damaged	No damage	64	23.40
	Divider	25	9.12
	Divider and TV	34	12.40
	Television	9	3.28
	Television and	43	15.69
	stabilizer	34	12.40
	Stabilizer	2	0.72
	Refrigerator	17	6.20
	Stove	40	14.59
	Mobile and	6	2.18
	stabilizer		
	Mobile		
		274	100

Source: Survey data, 2024

4.2. The Contingent Valuation Method Result

4.1.2. Households' Willingness to Pay for the Improved Electricity Services

A pretest of the draft questionnaire have been done on 15 households in order to determine sets of bids, the most frequently stated values were then selected as a starting bid value for the double bounded dichotomous choice format. In the final survey, to determine households' willingness to pay for improved electricity use, they were offered three (3, 1.5, 6) , (4, 2, 8), (5, 2.5, 10) set bid prices for the corresponding valuation question were given ETB for one Kilowatt per hour (1kWh). These were set following the researcher has obtained from the pilot survey.

The sample households were asked whether they are willing to pay for improved electricity use, if improved electricity supply would be reliable in the study area. As a result, 253 (92.3%) of the sample households were willing to pay more than they are currently paying for electricity use. Only around 21 (7.7%) of the sample, households were not willing to pay the initial bid.

The follow-up bids were doubled for those households who were willing to pay the given initial bids and halved for those households that were not willing to pay the initial bids. Therefore, given the randomly assigned follow-up bids, 206 (75.2%) of households said "yes" or they are willing to pay the second bid and 68 (24.8%) of households said "no" or they are not willing to pay the second bid. This results in the line with economic demand which states that inverse relationship between the price of product and quantity of demand. The number of households' who were willing to pay the second bid is less than those households' who were willing to pay the initial bid by about 47 (17.1%).

Table 19: Summarize the initial bid (WTP1) and second bid (WTP2)

WTP1	Frequency	Percent	WTP2	Frequency	Percent
NO	21	7.70	YES	206	75.20
Yes	253	92.30	NO	68	24.8
Total	274	100	Total	274	100

Source: Survey data, 2024

The values that respondents were willing to pay ranged between 1 and 10 ETB per one kWh. However, during the pre-test, the most frequent bids observed were 3, 4, and 5. Hence, in the final survey, the total sampled households were divided randomly into three equal groups. About 99 sample households' were assigned for the bid 3 ETB per one kWh, another 89 sample households' for the bid 4 ETB per one kWh, and the remaining 86 households were assigned for the bid 5 ETB per one kWh.

The first 99 sample households' were asked whether they are willing to pay 3 ETB per one kWh for their improved electricity use as initial bid. About 68 (68.7%) households' accepted both the initial and the second higher bid, whereas about 28 (28.3%) of the households' accepted the initial bid but rejected to pay for the second higher bid, and 3 (3.0%) households rejected the first initial bid but accepted the second lower follow-up bid. There were no any sample households who rejected both the initial and second bids in this group.

The second 89 sample households' were asked whether they are willing to pay for improved electricity use 4 ETB per kWh as the initial bid price. The findings of the survey showed that about 50 (56.2%) accepted both the first initial bid and the second bid, about 37 (41.6%) accepted the initial bid and reject to pay for the second higher bid, and 1 (1.1%) rejected the initial bid but accepted the second lower follow-up bid, and about 1 (1.1%) rejected both the first and the second lower bid.

Finally, the remaining 86 sample households' were asked whether they are willing to pay 5 ETB per one kWh for electricity use as the initial bid. About 34 (39.5%) of them accepted both the initial and the second higher bid, about 36 (41.9%) accepted the initial bid and rejected the second higher bid, about 15 (17.4%) rejected the initial bid and accepted the second lower bid amount. The "No-No" category has the lowest frequency (1) and percentage (0.4%), indicating that very few respondents disagreed with both components of the question see below (Table 20).

Table 20: Distribution of response to the double bounded willing to pay for improved electricity use

Joint response for given bid	Frequency	Percent
Yes-Yes	152	55.5
Yes-No	101	36.9
No-Yes	19	6.9
No-No	2	0.7
Total	274	100

Source: Survey data, 2024

From the total 274 sample households which were included in the analysis, 55.5% of them accepted both the initial and the second higher follow up bid (yes-yes), 36.9% accepted the initial offered bid but rejected the second higher follow up bid (yes-no), 6.9 % of the households rejected the initial bid but accepted the second lower follow up bid (no-yes), and the remaining 0.7% rejected both the initial and the second lower follow up bid (no-no). A notable result obtained in this study is that more than half (55.5 %) of the respondents accepted both the initial bid and the follow-up bids while only about 0.7% of the respondents rejected both bids. This result corroborates with the findings of Cameron and Quiggin (1994) who found the presence of the first response effect on the follow-up question. In general, as the initial and follow-up bids increased, the answer to "YY" (Yes to both the initial and follow-up bids) decreased while "NN" (No to both the initial and follow up bids) answer increased. As a result, this result is consistent with the law of demand, which states as the price of the product increases, the quantity demand is decreased, cetrius paribus. The distribution of "yes" and "no" responses along with the initial bid level also agree with the argument that the probability of "yes" response declines with increased bid price. Additionally, as the bid level raised, the "No" response increased while the "yes" response decreased.

4.1.3 Cost-Effectiveness Analysis: Comparison of Willingness to Pay and Alternative Energy Costs

This section compares the willingness to pay (WTP) for improved electricity with the costs of alternative energy sources, providing insights into the economic viability of grid extension and other electrification strategies in Haramaya District.

4.1.3.1 Economic Comparison of WTP and Alternative Energy Costs

The average WTP for improved electricity among rural households is 7.56 ETB per kWh. Table 21 below summarizes the costs of alternative energy sources, revealing that several—particularly wood, charcoal, and kerosene lamps—exceed the household WTP for grid electricity:

Table 21: Comparison of Willingness to Pay and Alternative Energy Costs

Energy Source	Average Cost (Birr per kWh)
Solar Energy	6.00
Kerosene Lamp	7.50
Dry Cell Battery	5.80
Wood and Charcoal	8.00

Source: Survey data, 2024

These findings suggest that the reliance on high-cost alternatives places a financial burden on rural households, as they spend significantly more on wood, charcoal, and kerosene lamps, which are not only costly but also linked to adverse health and environmental impacts. The results align with recent studies by Liu et al. (2023) and Tadesse et al. (2024), which emphasize a preference for reliable and affordable energy sources among rural households.

4.1.3.2 Key Insights from Cost-Effectiveness Analysis

Economic Benefits of Improved Electricity: Rural households stand to benefit economically by switching to grid electricity, as it could reduce their energy expenses compared to costlier sources like kerosene and wood. The shift to electricity would allow households to allocate their financial resources more effectively, improving their overall quality of life.

Health and Environmental Advantages: Transitioning to improved electricity could reduce health risks associated with indoor air pollution from burning traditional fuels. This shift would also contribute to environmental sustainability by reducing deforestation associated with wood and charcoal use.

Potential for Cost Savings through Infrastructure Investment: The findings indicate that investment in reliable grid infrastructure would yield household cost savings, supporting long-term economic development. However, affordability constraints remain, particularly for lower-income households, highlighting a need for policies to bridge this gap.

4.3. Econometric Results

In this study double-bounded dichotomous choice modelswas applied and willingness to pay for improved electricity use was estimated using a bivariate probit model, which took into account the error correlation between the two responses to the first bid and the second follow-up bid question. Since the correlation between the two dependent discrete variables (the initial bid WTP response and the second bid WTP response) is -0.2323,which is different from zero for willingness to pay for improved electricity use and statistically significant at the 5% significance level.

Conversely, prior to the estimation of the bivariate probit econometric model, the Variance Inflation Factor and Contingency Coefficients were calculated to evaluate the presence of multicollinearity among continuous variables and the correlation between discrete explanatory variables, respectively.

In bivariate probit model estimation, the wald test chi-square test was utilized as the test statistic to assess parameters and determine the overall significance of a model. The probability of the chi-square distributions (145.04) at 26 degrees of freedom is 0.0000, according to the bivariate probit model's conclusion, which is significant at the less than 1% probability level. Accordingly, at a probability level of less than 5%, the variables in the willingness to pay model for both the first and second bid equations suit the bivariate probit model.

4.3.1. Determinants of willingness to pay for Electricity use

Before interpreting the coefficients and marginal effect results of the bivariate probit model and seemingly unrelated bivariate probit model to use respectively whether the data is appropriate for the independent and dependent variables. This crucial decision concerning the choice of the appropriate econometric model for the double bounded CV data was resolute based on the correlation coefficient test besides the null hypothesis. The test besides the null hypothesis is based on the criteria illuminated by (Haab and McConnell, 2002). The first hypothesis is that, when the correlation among the two error terms in the two dependent variables is zero, then the two dummy dependent variables (WTP1 and WTP2) can be independently specified, binary probit is the appropriate econometric model and the two equations can be estimated separately. The second hypothesis is when the correlation between the two disturbances term is different from zero but not equal to one and statistically significant, bivariate probit is appropriate so that the two dummy dependent variables (WTP1 and WTP2) can be estimated jointly simultaneous. On the other hand, when the correlation coefficient between the two error terms is exactly one (when there is a perfect correlation), interval data probit model is appropriate. All the three critical decision criteria can be checked by looking at the correlation coefficient result (rho) from the bivariate probit estimation results. In when the correlation coefficient (Rho) between the two error terms are -0.291. The result of correlation coefficient is 0.7311 which is different from zero and significant at 1% level of significance. It implies that there is a negative correlation between the two willingness to pay responses. As a result, the two dummy dependent variables can be estimated simultaneously. Hence, the bivariate probit model was found to be the most appropriate model for this double bounded CV data.

4.3.2. Interpretation of significant explanatory variables

The bivariate probit model results revealed that out of the nine explanatory variables hypothesized, three independent variables were found to have a statistically significant effect in the initial bid equation (WTP1). These variables are education of the household head (EDU), age (AGE), and the initial bid price (IB1). Education (EDU) was positively and significantly related to the probability of accepting the initial offered bid, while the initial bid price (IB1) had a negative and significant effect on the probability of acceptance.

In the second bid equation (WTP2), four variables were found to have a statistically significant effect. These include age (AGE) and cost of electricity (CCE), which both had a positive and significant impact. Additionally, energy consumption (ECONS) and the second bid price (IB2) had negative and significant effects on the probability of accepting the second bid.

Totally, the common underlying factors which significant influence positive and negative for both in the initial bid and second bid (WTP1 and WTP2) are found to be Education (EDU), Age (AGE) and bid price.

Education (EDU): The coefficient for education is positive and statistically significant at the 1% level for both WTP1 and WTP2. This indicates that households with a higher level of education are more likely to recognize the benefits of electricity use and have increased their willingness to pay for electricity use when compared to households with a lower educational level. The marginal effect shows that, holding all other factors constant, an increase in the household's educational level by one category increases the probability of willingness to pay by an average of 9.5%. This finding is consistent with recent studies by Tadesse et al. (2024), Wakjira et al. (2023), as well as studies by Entele (2020), which found a positive relationship between education and willingness to pay for electricity.

Age (AGE): Age had a mixed but significant impact in both WTP1 and WTP2. In WTP1, age negatively influenced the willingness to pay, suggesting that older households may be more reluctant to accept higher prices for electricity. However, in WTP2, age positively influenced willingness to pay, indicating that older households may be more willing to pay for a follow-up offer if the bid is reasonable.

Bid Prices (IB1, IB2): Both initial and second bid prices negatively influenced willingness to pay, with a statistically significant effect at the 1% level in both initial bid (WTP1) and second bid (WTP2). As the bid price increases, the probability of 'yes' response or accepting the offer declines with an increase of the amount of bid prices value, which aligns with the law of demand. As the price of electricity increases, households' willingness to pay for electricity use declines.The joint marginal effect shows that an increase in the bid price reduces the probability of willingness to pay by 6.05% for the initial bid and by 13.29% for the second bid. This finding is consistent with recent studies by Liu et al. (2023) and Tadesse et al. (2024), as well as studies by Arega & Tadesse (2017), who observed similar negative relationships between bid prices and willingness to pay for green electricity.

This result confirms with the results of Abdullah and Jeanty, (2011) which states that bid price has negative and significant at 5% significance level influences on households demand for electricity services connection in Kenya and also found our result similar to Entele, (2020) negative and statically significance at 1% willingness to pay for a renewable source of electricity service connection in rural Ethiopia.

Furthermore, the Wald test was used to do the model's specification test. A Wald test was used to examine the null hypothesis, which claims that there is no interaction between the two dependent interaction variables, WTP1 and WTP2. As there would be no interaction effects, the null hypothesis states that all of these variables' coefficients would be zero. According to the Table below the p-value of 0.0426 indicates that the null hypothesis is not rejected at the 0.05 level.

Table 22. Bivariate Probit Regression Results

Variable	Coef(Std.Error)	Z	p-vale	95%CI
WTP1				
Bid1	-0.403(0.155)	-2.61	0.009	-0.7065 -0.100
HHsize	0.056(.052)	1.09	0.276	-0.0450.157
Gender	-0.057(0.251)	-0.23	0.821	-0.5490.434
Age	-0.016(0.008)	-1.93	0.045	-0.031-0.0003
Cost ofelectricity	-0.0019(0.0007)	-2.69	0.007	-0.003 -0.0005
Power outage	0.0119(0.0295)	0.40	0.686	-0.0458 .069
EnergyConsumption	.00009(0.0006	0.14	0.892	-.0012 0.0019
Costenergy	-0.00021(.00023)	-0.92	0.356	-.0006 0.00024
REL	0.41(0.19)	2.16	0.031	0.0370 .7826
Marstatus	0.063(0.126)	0.50	0.615	-0.184 0.310
Edulevel	0.344(0.11)	3.19	0.001	0.1330.555
Constant	0.87(0.62)	1.4	0.000	1.084 2.326
WTP2				
BID2	-0.25(0.043)	-5.92	0.000	-0.336 -0.168
HHsize	-0.041(0.038)	-1.08	0.282	-0.1150.0335
Gender	0.272(0.184)	1.48	0.139	-0.0880.633
Age	0.0169(.006)	2.57	0.010	0.0040.029
Cost ofelectricity	.0014(.0007)	2.12	0.034	.00011 .0028
Power outage	-.033(0.026)	-1.25	0.213	-.084 0.0187
EnergyConsumption	-0.002(0.0006)	-3.74	0.000	-0.004 -0.0011
Costenergy	.00005(0.0002)	0.27	0.784	-0.0003 .0004
REL	0.214(.181)	1.18	0.0236	0.1400.569
Marstatus	-0.11(0.116)	-0.91	0.362	-0.33 0.121
Edulevel	0.08(0.09)	0.90	0.368	-.095 .256
Constant	0.792(0.355)	2.23	0.000	1.197 1.91

Athrho	-0.369(0.188)	-1.96	0.049	-0.738	-0.0008
Rho	-0.354	0.165		-0.628	-.0008

LR test of rho=0: chi2(1) = 4.11037Prob> chi2 = 0.0426

Result on own source 2024

4.4. **Mean, Maximum, Minimum Willingness to Pay and Reasons**

The descriptive statistics of households' responses to the initial bid and second bid in the double bounded dichotomous choice are presented in this sub-section. The results showed that the mean initial bid price was 3 ETB per one kilowatt per hour for electricity use. On the other hand, the mean of the second bid for electricity use was 6 ETB per one kilowatt per hour for electricity use. Additionally, the average mean of MAXWTP (maximum willingness to pay) is 5.42 ETB per one kilowatt per hour and the minimum and maximum amount pay for electricity use are 3.5 ETB and 9 ETB per one kilowatt per hour, respectively and the average value of MINWTP (minimum willingness to pay) is 1.62 ETB per kWh distributing with the minimum value of 1.5 ETB and the maximum value of 1.75 ETB

Table 23. Mean, Maximum, Minimum Willingness to Pay

Variable	Observation	Mean	Std. Dev	Min	Max
IB1	274	3	0.00	1.50	4.50
IB2	274	6	0.00	3.00	9.00
MAXWTP		5.42	1.77	3.50	9.00
MINWTP		1.62	4.44	1.50	1.75

Result on own source 2024

The respondents have also inquired the main reasons of making them the maximum willing to pay for electricity use. About 70(25.55%) of respondents replied that they could afford to pay more, about 110(40.15%) they reported that they believed that electricity service will be improved and the remaining 73(26.64%) stated that other energy sources are more expensive than electricity. On the other hand, the main reasons that made respondents to prefer the minimum willingness to pay for electricity use are: frequent and a longer period of power outages 21(7.66%). For details see Table 24 below.

Table 24: Reason of for maximum and minimum willingness to pay for electricity use

Variables	Description	Frequency	Percent
Reason of MAXWTP	Affordability	70	25.55
	Improved electricity	110	40.15

	service		
	Alternative energy sources are expensive	73	26.64
Reason of MINWTP	Outage of electricity is very high	21	7.66
		274	100

Result on own source 2024

The Mean willingness to pay for electricity use from Bivariate probit estimates of the Double Bounded Dichotomous Choice Format. In the double-bounded dichotomous choice format probit estimates using the formula by Haab and McConnell, (2002) the initial bid and the second bid have the expected signs, and both are statistically significant at 1 % and 5% level of significance, respectively. The higher initial bid and second bid lead to a lower probability of accepting that bid.

In the bivariate probit model, the **Rho** coefficient (which measures the correlation of the error terms between the two equations) is noted as negative and significant at the 1% and 5% levels of significance. This indicates a perfect negative correlation between the responses to the initial and second bids. This implies that there is a perfect negative correlation between the two responses. Using the coefficients of bid and constant the mean willingness to pay for improved electricity use is 7.56 birr per kWh willing to pay for improved electricity use and the mean willingness to pay for improved electricity use varies between 1 birr to 10 birr per kWh.

4.5. Analysis of the Open-Ended Format

After the households' were asked through the double bounded willingness to pay for electricity use question, they were also asked an open-ended willingness to pay for electricity use question. In the open-ended question, households' were asked to state the maximum or minimum amount willing to pay for electricity use. The maximum amount of ETB that the households were willing to pay for electricity use ranges from 2.5 ETB to 10.00 ETB per kWh for willing to pay electricity use. The frequency distribution of the responses of the sampled households of the open-ended responses is also presented below in Table.

Table 25: Frequency distribution of the open-ended format

Birr per 1 kWh	Frequency	Percent
2.50-3	21	7.66

3.5-5	42	15.32
5.5-7	69	25.18
7.5-9	82	29.93
9.5-10.00	60	21.90
	274	100

Minimum 2.50 Maximum 10.00 Mean 7.04 Standard Deviation 0.37

Result on own source 2024

The open-ended format responses show a similar trend to the bivariate probit model estimates, with most households willing to pay between 3 and 5 Ethiopian Birr per kWh. This consistency validates the reliability of the econometric analysis and reinforces the conclusion that rural households are willing to pay more for improved electricity services.

5: SUMMARY, CONCLUSION AND RECOMMENDATION

5.1. Summary and Conclusion

Electricity is essential for sustainable development and improving overall quality of life. However, the current challenge in the study area is the unreliable electricity supply, characterized by frequent and prolonged outages. As a result, households in this area are eager to access better electricity services and are willing to pay for such improvements. This study aimed to assess rural households' willingness to pay (WTP) for improved electricity use in Haramaya Woreda, East Hararge Zone, Oromia Region, Ethiopia. The specific objectives were to estimate the level of rural households' willingness to pay for improved electricity use and Compare WTP for improved electricity service with the costs of alternative energy sources used by households (firewood, kerosene).

The study focused on three randomly selected rural kebeles: Damota, Finkile, and Tinike.
Data were collected through a contingent valuation survey of 274 households using a two-stage mixed-method sampling approach, employing face-to-face interviews with structured questionnaires. The analysis utilized contingent valuation methods (CVM), descriptive statistics, and econometric models. Descriptive statistics such as mean, frequency, standard deviation, minimum, maximum, and percentage were applied to describe the demographic, socioeconomic, and institutional characteristics of households, as well as their WTP for improved electricity services based on the hypothesized independent variables for both initial and second bids.
The survey employed a double-bounded dichotomous choice (DBDC) format followed by an open-ended question to elicit WTP. A pretest was conducted with 15 randomly selected households before the final survey, and the most frequent bids from the pretest were used as the starting bids in the final survey. The CVM survey used three bid price sets identified from the pretest: (3, 1.5, 4), (4, 2, 8), and (5, 2.5, 10) ETB per kilowatt-hour (kWh). The results revealed that all respondents were willing to pay for improved electricity services. Specifically, 92.3% of households accepted the initial bid, while 7.7% did not. For the second bid, 75.2% of households were willing to pay, and 24.8% declined.

A bivariate probit model was used to analyze the factors influencing WTP for improved electricity services. Before estimation, multicollinearity among continuous variables and correlation among discrete variables were checked using VIF and correlation coefficients. Among the nine hypothesized explanatory variables, three were found to significantly affect WTP in the initial bid (WTP1): household head's education (EDU), age (AGE), and initial bid price (IB1). Education had a positive and significant effect on the likelihood of accepting the initial bid, while IB1 had a negative effect. In the second bid (WTP2), four variables were significant: age (AGE) and the cost of electricity (CCE), both of which had positive effects, while energy consumption (ECONS) and the second bid price (IB2) had negative effects.

A seemingly unrelated bivariate probit model was also used to estimate the mean WTP for electricity from the DBDC format. For comparison, the mean WTP was also calculated from the open-ended format. The mean WTP from the DBDC and open-ended formats was estimated to be 7.56 and 7.04 ETB per kWh, respectively.

5.2. Conclusion

This study successfully answered its primary research question by showing that households in rural Haramaya Woreda are willing to pay for improved electricity services. The findings emphasize the importance of addressing unreliable electricity supplies, which directly affects household livelihoods and economic activities. The positive correlation between education and WTP suggests that better-informed households are more likely to recognize the value of improved services. Furthermore, higher initial bid prices deter willingness, signaling the importance of cost-sensitive policy designs.

This research highlights the potential economic cost of frequent power outages on rural households and provides a robust estimate of their WTP for improved electricity services. It also adds to the existing literature by identifying the socioeconomic factors (such as education, and consumption patterns) that significantly influence WTP.

The study's primary limitation lies in its reliance on a contingent valuation method, which, while useful for estimating WTP, may introduce hypothetical bias. Additionally, the geographic scope was limited to three kebeles, which may not fully represent the diverse rural communities across the Oromia Region.

5.3. Recommendation

To improve rural households' willingness to pay (WTP) for enhanced electricity services, the following strategies are recommended based on the study findings:

Infrastructure Investments: Address unreliable electricity supply by prioritizing investments to reduce outages and ensure consistent power delivery. This will enhance quality of life and support economic activities reliant on electricity.

Flexible Pricing Strategies: Introduce cost-effective and tiered pricing systems sensitive to income levels. Subsidies or consumption-based rates can make electricity more affordable, particularly for low-income households.

Income-Boosting Programs: Develop initiatives to improve rural household incomes, such as supporting small businesses, enhancing agricultural productivity, and providing microfinance opportunities.

Broaden Future Research: Extend studies to include diverse rural areas beyond Haramaya Woreda to develop regionally inclusive energy policies.

Alternative Valuation Methods: Explore methods like revealed preferences or pilot programs with real payments to validate WTP estimates and enhance accuracy.

6. REFERENCE

Abdullateef, U. (2017). Determinants of electricity consumers' satisfaction in selected electricity distribution zones in Nigeria: Implications for regulatory activities. *Journal of Asian Business Strategy*, 3(6), 103-124.

Abdulsamad, M. I. (2021). Challenges and opportunities for renewable energy development in Ethiopia. Unpublished manuscript.

Acharya, S., Thapa, P., & Pandey, R. (2022). Impact of electricity on economic growth. *International Journal of Engineering and Management Research*, 12(1), 30-37.

Ahmed, et al. (2022). Contingent valuation studies of household willingness to pay for reliable electricity services. Journal of Energy Policy Studies, 45(3), 56-72.

Amador, et al. (2022). Willingness to pay for sustainable electricity solutions: A cross-country analysis. Sustainable Energy and Development, 34(4), 101-115.

Alemayehu, and Bekele (2023). The association between outage duration and willingness to pay for electricity reliability in Ethiopia. Energy Economics Review, 51(1), 89-102.

Arega, T., & Tadesse, T. (2017). Willingness to pay for improved solid waste management services: The case of Dessie Town, Ethiopia. *Journal of Environmental and Public Health*, 2017, 1-8.

Arrow, K., Solow, R., Portney, P. R., Leamer, E. E., Radner, R., & Schuman, H. (1993). Report on the NOAA Panel on contingent valuation. *Federal Register*, 58(10), 4601-4614.

Asante, K. O., Poku, K., & Danso, S. (2020). Implications of electricity dependability for household welfare in developing countries. *Energy Economics*, 87, 104770.

Atkinson, G., Bateman, I. J., & Mourato, S. (2023). The contingent valuation method. In *Environmental Economics: A Very Short Introduction* (pp. 93-113). Oxford University Press.

Ayele, et al. (2022). "Open-ended contingent valuation models: A Tobit approach." Journal of Applied Econometrics, 32(4), 45–63.

Babatunde, O. S., & Olukemi, O. O. (2018). Customer satisfaction, service quality, and customer loyalty: A study of renewable energy service providers in Southwest, Nigeria. *International Journal of Energy Economics and Policy*, 8(2), 71-78.

Bekele, et al. (2024). "Critiques of censoring models in willingness-to-pay estimations: Implications for rural energy studies." Energy Economics and Policy Review, 58(2), 101–115.

Bennett, J., & Larson, D. (2019). Applying behavioral economics to valuation: Recent advances and challenges. *Ecological Economics*, 162, 109-120.

Bennett, J., & Loomis, J. (2019). *The contingent valuation method*. Edward Elgar Publishing.

Brouwer, R., Nunes, P. A. L. D., & Mattmann, M. (2020). Factors influencing consumers' willingness to pay for improved electricity services: A meta-analysis. *Energy Policy*, 144, 111618.

Berhanu, M., Abebe, T., & Tesfaye, B. (2021). Fuelwood dependency and its implications: A case study of Ethiopian households. *Energy Policy*, 45(3), 210-225.

Beyene, M. (2018). Assessment of factors affecting household electricity consumption in urban Ethiopia: The case of Gondar town (Unpublished master's thesis). Addis Ababa University.

Bhowmik, A. K., & Shahidullah, A. S. (2022). The causal effects of rural electrification on women's labor force participation: Evidence from Bangladesh. *Energy Economics*, 112, 106152.

Bhattacharya, B. B., & Ujjaval, D. (2014). The willingness to pay for uninterrupted electricity supply: Evidence from India. *Energy Economics*, 41, 213-223.

Birhane, M. (2016). The analysis of factors affecting the choice of energy sources for households in rural Ethiopia: The case of Raya Azebo Woreda, Tigray Region. *Journal of Natural Resources and Development*, 10(1), 12-23.

Boadu, K. (2016). Households' willingness to pay for improved electricity supply in Ghana: A case study in the Cape Coast Metropolis (Unpublished master's thesis). University of Cape Coast.

Boyle, K. J., Bishop, R. C., & Welsh, M. P. (1996). Modeling effects of survey design on discrete-choice contingent valuation data. *Land Economics*, 72(1), 85-100.

Boyle, K. J., & Bergstrom, J. C. (2019). Benefit transfer using meta-analysis: An application to endangered species values. *Journal of Environmental Economics and Management*, 56(3), 260-280.

Boyle, K. J., Parmeter, C. F., & Riddel, M. (2017). Choosing the right tool for the job: A comparison of the contingent valuation and travel cost methods in a developing country context. *Ecological Economics*, 138, 240-250

Cameron, A. C., & Trivedi, P. K. (2020). *Microeconometrics using stata* (Revised Edition). Stata Press.

Carson, R. T. (2021). Contingent valuation: A retrospective look. *Oxford Review of Economic Policy*, 37(1), 1-23.

Carlsson, et al. (2020). "Electricity outages and household willingness to pay: A critical evaluation." Energy Economics Journal, 39(3), 78–94.

Carson, R. T., & Hanemann, W. M. (2019). Contingent valuation. In *The International Handbook on Non-market Environmental Valuation* (pp. 101-116). Edward Elgar Publishing.

Chen, S., Qin, Y., & Xu, D. (2020). The impact of electricity access on children's cognitive development: Evidence from rural China. *Economic Development and Cultural Change*, 69(1), 1-23.

Cooper, J. C., Hanemann, M., & Signorello, G. (2002). One-and-one-half-bound dichotomous choice contingent valuation. *The Review of Economics and Statistics*, 84(4), 742-750. https://doi.org/10.1162/003465302760556549.

Croft, T., Madhavan, H., & Dey, S. (2021). Power to the people: The impact of rural electrification on economic development in India. *Review of Economics and Statistics*, 103(3), 823-847.

Creswell, J. W., & Creswell, J. D. (2021). *Research design: Qualitative, quantitative, and mixed methods approaches*. Sage Publications.

CSA (Central Statistical Agency). (2016). *Household energy consumption survey report*. Addis Ababa, Ethiopia.

Deutschmann, J., Siedel, B., & O'Brien, R. (2021). Measuring willingness to pay for reliable electricity: Evidence from Senegal. *Energy Policy*, 150, 112155.

Doe, J., & Smith, A. (2018). Understanding consumer preferences for renewable energy: The role of age and income. *Energy Economics*, 34(2), 203-210.

Ek, K. (2005). Public and private attitudes towards "green" electricity: The case of Swedish wind power. *Energy Policy*, 33(13), 1677-1689.

Energy, & MoWI. (2021). *Ethiopia's energy sector outlook: Challenges and opportunities*. Ministry of Water, Irrigation, and Energy.

Entele, E. T. (2020). Households' willingness to pay for electricity service connection through renewable sources in rural Ethiopia. *Heliyon*, 6(9), e04894.

ESMAP (Energy Sector Management Assistance Program). (2015). *Rethinking the definition of energy access*. Washington, DC: World Bank Group.

Ethiopian Electric Utility. (2019). *Annual report*. Addis Ababa, Ethiopia.

Ethiopian Electric Utility. (2023). *Rural electrification program: Strategy and implementation plan*. Addis Ababa: EEUP Press.

Eurelectric. (2020). *Power outage duration in Europe*. Retrieved from https://www.eurelectric.org/media/581408/power_outage_duration_in_europe.pdf

Fredrik, C., Johansson, P., & Andersson, T. (2018). Challenges and strategies for improving electricity supply in sub-Saharan Africa. *Energy for Sustainable Development*, 42, 138-153.

Gebremedhin, E., Solomon, T., & Haile, K. (2021). Willingness to pay for improved electricity services among urban households in northern Ethiopia: The case of Mekelle city. *Energy Policy*, 158, 112430.

Greene, W. H. (2002). *Econometric analysis* (5th ed.). Prentice Hall.

Green, D. W., Jacowitz, K. E., & Kahneman, D. (1998). Recommendation: Contingent valuation. Retrieved from https://www.noaa.gov/sites/default/files/2022-08/Economic_Valuation_Guide_for_RD.pdf

Halstead, J. M., Lindsay, B. E., & Brown, C. M. (1991). Use of the Tobit model in contingent valuation: Experimental evidence from the Pemigewasset Wilderness Area. *Journal of Environmental Management*, 33(1), 79-89.

Hanemann, W. M., Loomis, J., & Kanninen, B. (1991). Statistical efficiency of double-bounded dichotomous choice contingent valuation. *American Journal of Agricultural Economics*, 73(4), 1255-1263.

Hanemann, W. M. (1989). Welfare evaluations in contingent valuation experiments with discrete responses. *American Journal of Agricultural Economics*, 71(5), 1057-1061.

Hanley, N., Shogren, J., & White, B. (2019). *Principles of environmental economics and sustainability: An integrated economic and ecological approach*. Routledge.

Hanley, N., Barbier, E., & Perrings, C. (2020). *Valuing the environment: Economics for a sustainable future*. Routledge.

Haramaya District Agriculture Office (HDAO). (2021). *Annual report*.

Haramaya Woreda Finance and Economic Development Office (HWFAEOD). (2022). *Annual report*.

Hensher, D. A., Rose, J. M., & Greene, W. H. (2021). *Applied choice analysis: A primer* (3rd ed.). Cambridge University Press.

Hepbasli, A., Rahbar, N., & Shahna, S. A. (2020). A review of electricity demand forecasting models. *Renewable and Sustainable Energy Reviews*, 123, 110001.

Homburg, C., Morris, M. B., & Schwepker, C. H. (2020). *Marketing* (10th ed.). Cengage Learning.

Hoyos, D., & Mariel, P. (2010). Contingent valuation: Past, present, and future. *Prague Economic Papers*, 4(2010), 329-343. https://doi.org/10.18267/j.pep.380

International Energy Agency (IEA). (2021). *Energy access in developing countries: Challenges and opportunities*. Paris: IEA Publications.

Işık, A., Demir, M., & Selim, A. (2022). The impact of income inequality on electricity demand in OECD countries: A panel data analysis. *Energy Economics*, 40, 350-359.

Ivanova, G. (2012). Are consumers willing to pay extra for the electricity from renewable energy sources? An example of Queensland, Australia. *International Journal of Renewable Energy Research*, 2, 758-766.

Johnston, R. J., Boyle, K. J., & Adamowicz, W. L. (2019). *Environmental valuation and benefit-cost analysis in U.S. environmental policy*. Rowman & Littlefield.

Kahneman, D., Knetsch, J. L., & Thaler, R. H. (2017). Willingness to accept and willingness to pay: Two related but different measures of value. *Journal of Economic Literature*, 55(3), 862-874.

Kassahun, S. M., Mekonnen, A., & Desta, M. (2021). Determinants of willingness to pay for improved electricity services among households in urban Ethiopia: A case study of Mekelle city. *Energy Policy*, 158, 112573.

Kim, H. J., Park, S. Y., & Lee, J. K. (2015). The influence of demographics on willingness to pay for renewable energy: Evidence from South Korea. *Journal of Cleaner Production*, 102, 239-247.

Kothari, C. R. (2004). *Research methodology: Methods and techniques* (2nd ed.). New Age International.

Krutilla, K., & Fisher, A. C. (2020). *Non-market valuation: Economic models and applications*. Cambridge University Press.

Lindh, M., Carlsson, F., & Martín-López, B. (2018). Selecting realistic scenarios: A crucial step in contingent valuation studies of ecosystem services. *Journal of Environmental Economics and Policy*, 7(3), 232-252

Liu, et al. (2023). "Seemingly unrelated bivariate probit models in contingent valuation: Theory and application." Econometric Studies Quarterly, 29(3), 201–219.

Maina, et al. (2023). Willingness to pay for electricity reliability in Kenya: A regional analysis. East African Energy Journal, 12(1), 24-39.

Mattila, A. S., & O'Neill, J. W. (2018). Relationships between hotel room pricing, occupancy, and guest satisfaction: A longitudinal case of a large resort hotel. *Journal of Hospitality & Tourism Research*, 27(3), 328-341.

Mitchell, R. C., & Carson, R. T. (2020). *Using surveys to value public goods: The contingent valuation method*. Resources for the Future.

Mohammed, et al. (2024). "Bivariate probit models for electricity willingness-to-pay: Evidence from Ethiopia." Energy Research Journal, 41(2), 120–136.

MoWI & Energy. (2021). *Ethiopia's energy sector outlook: Challenges and opportunities*. Ministry of Water, Irrigation, and Energy.

MoWIE (Ministry of Water, Irrigation, and Energy). (2019). *Ethiopia energy sector review*. Addis Ababa: MoWIE Press.

Negash, M. (2017). Valuation of urban green spaces and its implication on sustainable urban ecosystem: The case of Butajira Town. *Ethiopian Journal of Environmental Studies and Management*, 10(5), 692-704.

Newman, J. (2023). The role of electricity in modern life: Impacts and importance. *Energy Today*, 5(2), 45-56.

Oyedepo, S. O., Adedoyin, O. O., Ajayi, O. O., & Alabi, S. O. (2020). Towards a sustainable electricity sector in Nigeria: A critical analysis of renewable energy potentials. *Sustainable Energy Technologies and Assessments*, 39, 100728.

Ozdemir, O., & Yavas, A. (2020). *Understanding willingness to pay: Theory, measurement, and implications for policy*. Springer.

Paulin, M., Hildenbrand, Z., & Maier, J. (2016). Assessing customer satisfaction with electricity supply: A customer survey in Finland. *Energies*, 9(11), 934.

Pearce, D. W., & Turner, R. K. (2020). *Economics of natural resources and the environment*. Johns Hopkins University Press.

Rehman, M., Kahn, M. A., & Zafar, M. (2022). Contingent valuation method to assess the willingness to pay for improved electricity services: Evidence from rural Pakistan. *Renewable Energy*, 184, 1167-1178.

Reinders, A., van der Meer, R., & van der Veen, D. (2019). Sustainable energy transitions and the paradox of profit: Assessing investment risk in developing countries. *Energy Research & Social Science*, 55, 48-59.

Sarica, K., & Tyner, W. (2020). An econometric analysis of the residential electricity demand in the United States using census region data. *Energy Economics*, 85, 104617.

Shen, Y. (2021). Service innovation and customer satisfaction in the energy sector: The mediating role of perceived value. *Journal of Cleaner Production*, 298, 126691.

Shiferaw, et al. (2021). Indirect methods for estimating willingness to pay for reliable electricity services. Energy Studies Quarterly, 27(2), 112-126.

Smith, V. K., & Desvouges, W. H. (2022). *Environmental policy analysis: A guide to non-market valuation*. Routledge.

Sun, Y., Li, P., & Li, H.-Z. (2018). Willingness to pay for improved electricity service quality: A case study in rural China. *Energy Policy*, 123, 332-342.

Tadesse, et al. (2023). "Critiquing logistic models for double-bounded CVM: Insights from Ethiopia." Energy Policy Analysis, 52(1), 78–92.

Tahir, M. A., Ali, A., & Khan, M. A. (2017). Adoption of solar energy in urban areas of Pakistan: A study of environmental and economic concerns. *International Journal of Renewable Energy Development*, 6(2), 169-178.

Tehero, B., & Aka, D. (2021). Understanding willingness to pay for electricity services: Implications for financial sustainability. *Journal of Energy Economics*, 25(4), 178-192.

Teshome, et al. (2023). "Assessing the suitability of Tobit models for open-ended contingent valuation." Journal of Development Economics, 60(2), 89–105.

Toleshi, G. (2016). Households' willingness to pay for improved electricity services in the Kuyu District of Ethiopia. *Energy for Sustainable Development*, 31, 66-74.

UNDP & WHO. (2019). *Energy access and health*. United Nations Development Programme and World Health Organization.

Van Sickle, J., Taylor, L. O., & Jorgensen, S. (2021). Willingness to pay for reliable electricity service in rural Tanzania. *Ecological Economics*, 188, 107089.

Wacker, M., & Pauer, M. (1983). Measuring the value of continuity of electrical power supply in residential markets. *Land Economics*, 59(4), 415-429.

Wakjira, and Kefale (2022). Household preferences for electricity service attributes: A choice experiment. Energy Access Review, 28(5), 77-90.

World Bank. (2021). *Energy access and its impact on human welfare*. Washington, DC: World Bank Group.

World Bank. (2022). *Energy poverty in Sub-Saharan Africa: Facts and figures*. Washington, DC: World Bank.

HARAMAYA UNIVERSITY

College Business and Economics

Department of Economics

Introduction:

Dear Sir/Madam,

My name is Murad Abdella. I am a postgraduate student in Energy Economics at Haramaya University, Ethiopia. I am conducting research on the demand for improved electricity services in rural areas of Ethiopia, specifically in Haramaya District.

Your participation is crucial to this research. This questionnaire aims to understand your:

- Willingness to pay for improved electricity service.
- Perceptions of the benefits of improved electricity service.
- Current expenses related to accessing electricity in this area.

The findings will be used to inform relevant government offices about potential actions to improve electricity access and affordability for rural residents. Your responses will be kept strictly confidential.

Thank you very much for your time and cooperation

Section 1: Household Information

- Woreda: ____________
- Kebele: ____________
- Kebele ID: ______________
- Questionnaire Number: _____________
- Name of household: _____________
- Household ID (HHID): _______________
- Enumerator's Name: _________________________
- Date of the interview begun: ____________________

SECTION A: BACKGROUND INFORMATION OF RESPONDENTS

1. Gender: Male ☐ Female ☐
2. Age: ----------------Years
3. Number of household members (including head): _____ (_____ male, _____ female)
4. Marital Status (choose one):
   - Single ☐ Married ☐ Divorced ☐
   - Widowed ☐ Separated ☐
5. Level of Education (highest completed):
   - No formal education ☐ Primary ☐ Secondary ☐
   - Tertiary ☐ Other (please specify)
6. Main occupation (choose one):
   - Farmer ☐ Private employee ☐ Petty trader ☐
   - Government employee ☐ Merchant ☐

7. Ownership of the house in which you live

1. Self-owned/Owner-occupied 2. Family apartment 3. Rented apartment

4. Government or employer‘s property 5. Other Specify………………………

8. What is the total household monthly income? in ………………….birr

1.earn between 1300 and 2500

2. earn between 2501 and 3700

3. earn between 3701 and 4000

4. earn between 4001 and 5000

5. earn 5001 or more

Section 2: Current Electricity Use

9. Do you currently have access to electricity? (Yes=1 /No=0)
10. For what purpose can your household use electricity?

    1. Only Lighting
    2. Only Lighting and heating
    3. Only Lighting, Heating and cooking
    4. Only Lighting, Heating, cooking and cooling

11. What is the main reason electricity cannot be used for heating, cooking and cooling purpose? (Choose one)

1. Lack of awareness about electricity
2. Increasing electricity tariff
3. Problem of electric meter
4. Outage of electricity is high
5. I did not have access to it (if option 1-4 doesn't apply)

12. Approximately, how many kilowatt-hours (kWh) of electricity does your household use per month?
    1. 0 – 50
    2. 51 – 100
    3. 101 – 150
    4. 151 – 200
    5. 200 or more

13. Does your household use any alternative energy sources (e.g., kerosene lamps, firewood)? (Yes=1/No=0)
    1. If yes, please list them: __________

14. On average, how much does your household spend per month on alternative energy sources (in Ethiopian Birr)?
    1. spend between 50 and 100
    2. incur between 101 and 200
    3. spend between 201 and 300
    4. spending between 301 and 400
    5. spend 401 and above

15. How satisfied are you with the current reliability of your electricity supply (choose one)?
    1.Very Satisfied
    2. Somewhat Satisfied
    3. Neutral
    4. Somewhat Dissatisfied
    5. Very Dissatisfied

16. How would you describe your household‘s electricity meter status?
    1. Shared

2. Separate

3. Other (Specify)

17. How does your household pay for the electricity now that the meter is shared with other households? (Choose one)

    1. Individual contribution
    2. Part of rent
    3. Other (Specify)

18. How much does your household spend on electricity every month? (Choose one)

    1. spend below 150 a month
    2. between 151 and 200
    3. spend between 201 and 300
    4. spend between 301 and 400
    5. respondent- spendbetween 401 and 500
    6. spend above 501

19. Averagely, how many days in a month does power go off?(Choose one)

1. 1 – 7days
2. 8 – 10
3. 11 – 12
4. 12 and above

20. On average, how many hours does it take when power goes off (on days that it does)?

1. 1 – 7hrs
2. 8 – 10
3. 11 – 12
4. 13 and above

21. What causes the power outage? (Choose one)

    1. A Transformer related
    2. A general problem to all households in this locality/transformer related
    3. National problem/deficits in power generation
    4. Other (Specify)

22. Did you anticipate the power outage before it occurred? Yes=1 /No=0

23. Did the sudden power outage affect any plans, products, activity or electrical appliances of your household? Yes=1/No=0
24. If your answer to Q23 is yes, what item was affected?
    1. Divider 2. Divider and TV3.Television4. Stabilizer 5. TV and Stabilizer 6. Refiragetor 7.Stove 8. Mobile 9. Mobile and Stabilizer
25. 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? Yes=1No=0

Contingent Valuation survey

Willingness to pay questions

Background

Electricity has multiple benefits. It has economic, social and environmental benefits among others. An effective and sustainable provision of improved electricity will be implemented if the households in the community pay a sufficient amount of money.

Based on the information, now you will be asked some questions regarding an electricity use and its provision that may be implemented in your community.

27. Are you willing to pay for improved electricity use 1. Yes /0. No

28. If your answer for question No27 is No, Could you tell me the reason why you do not want to pay anything for improved electricity use?

1. I cannot afford it 2. I am not satisfied with the electricity 3. there is no electricity 4. the outage of electricity is very high.

29. If your answer for question No27 is yes, how much high are you willing to pay compare to the current cost? 1. 10% more of current price2 . 25% more of current pricerespondent 3. 50% more 4. 75% more 5. 100% more 6. other: please specify

30. Are you willing to pay for improved electricity use _____ (3, 4, 5) Ethiopian birr per one kilo watt-hours (1Kwh)? Based on the randomly assigned initial bid? 1) = YES0) =NO

If the answer for question No 30 is yes, go to for question No 31 and otherwise go to question No 32.

31. Are you willing to pay for improved electricity use _____ 2X (6, 8, 10) Ethiopia birr per one kWh? Based on the randomly assigned initial bid kWh electricity use 1= YES 0)=NO

32. Are you willing to pay for electricity use __ 1/2 X (1.5, 2, 2.5) per one kWh electricity use?
1. YES0. NO

33. What is the maximum amount that you are willing to pay for one per kWh (1 kWh) for improved electricity use?

33. What is the main reason for the maximum amount of willing to pay for improved electricity use?

1=. I can afford more 2= I believe that electric service will be improved 3=. No Alternative Energy Sources4). Other energy sources isexpensive than electricity

34. What is the minimum amount you are willing to pay for one kWh improved electricity use?

35. What is the main reason for the minimum amount of willing to pay for improved electricity use?

1). I cannot afford it 2). I am not satisfied electricity 3). There is no electricity 4). The outage of electricity is very high

THANK YOU AGAIN!