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SCHOOL OF GRADUATE STUDIES

HOUSEHOLDS' WILLINGNESS TO PAY FOR RELIABLE ELECTRICITY SERVICES IN KUYU WOREDA, ETHIOPIA: AN APPLICATION OF CHOICE EXPERIMENT METHOD

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ABBREVIATIONS AND ACRONMYS

ASC	Alternative Specific Constant
BT	Benefit Transfer
CBA	Cost Benefit Analysis
CE	Choice Experimental
CLG	Conditional Logit
CM	Choice Modeling
CRN	Contingent Ranking
CRT	Contingent Rating
CSA	Central Statistical Agency
CVM	Contingent Valuation Method
DCE	Discrete Choice Experiment
EEA	Ethiopian Energy Agency
EEPCO	Ethiopian Electric Power Corporation
ESMAP	Energy Sector Management Assistance Programme
FGDs	Focus Group Discussion
GOE	Government of Ethiopia
GTP	Growth and Transformation Plan
GW	Giga Watt
HPM	Hedonic Pricing Method
IIA	Independence of Irrelevant Alternatives
IID	Independently and Identically Distributed
LPG	Liquefied Petroleum Gas
MDG	Millennium Development Goal
ML	Mixed Logit
MLG	Multinomial Logit
MOFEC	Ministry of Finance and Economic Center
MW	Mega Watt
Mt	Million tons
NOAA	National Oceanic and Atmospheric Administration
OPEC	Oil Producing and Exporting Countries
PC	Paired Comparison
REF	Rural electrification fund
RPM	Random parameter model
RUT	Random Utility Theory
SP	Stated Preference
TCM	Travel Cost Method
TEV	Total Economic Value
UK	United Kingdom
USD	United States Dollar
WB	World Bank
WTA	Willingness To Accept
WTP	Willingness To Pay

ABSTRACT

Electricity is one of the essential components for development and in reducing poverty, which is one of Millennium Development Goals (MDG) for Ethiopia. Unfortunately, a major problem that confronts most of the electrified households is the irregular and unreliable supply of electricity. Mitigating these problems can contribute to household income, environmental protection and economic development.

The objective of this research is to estimates households' willingness to pay (WTP) for an improved electricity service in Kuyu woreda. These estimates rely on a cross sectional data collected from 170 Respondents through face-to-face interviews. We used the choice experiments (CE) types of valuation method. The mixed logit model was applied to estimate the respondents WTP.

In addition, we estimated, the implicit price for each service attributes. Accordingly, respondents would be willing to pay about 19cents per KWHs for reducing frequency of outages and 13cents for reducing unannounced outage that occurred during nighttime. The estimated compensating surplus showed that on average respondents are willing to contribute approximately 99cents per KWh or 19.96ETB (0.906 US$) per month per person for scenario changes from the status quo to service improvement. This is in addition to the current average monthly charge.

One important implication drawn from the study is that since households are willing to support the plan for the service improvement, government should subsequently increase the tariff to generate more electricity energy to reach more households that will improve the economic development of the nation and the sustainability of the environment.

Key words: Improved electricity service, Willingness to pay, Choice experiment, Millennium Development Goal.

CHAPTER 1

1.1 BACKGROUND OF THE STUDY

As much as air and water, human being requires energy for existence. Nowadays, modern and renewable energy such as reliable electricity can stimulate economic growth that will have beneficial spillover effects on households living in poverty and helps to insure environmental sustainability by cutting down the consumption of wood based fuels such as charcoal and firewood (Issahaku & Nkegbe, 2013).

Despite the fact that reliable electric power is decisive, in a low-income economy faces nearly 250 outages (close to 1,000 hours) a year, while high-income economy experiences only 1.5 outages (approximately 3 hours) a year . The frequency and duration of outages also vary substantially among regions. Sub-Saharan African economies have the longest outages, averaging almost 700 hours a year. While OPEC high-income economies have the shortest, averaging only about 1 hour (Doing business database, 2016).

In Ethiopia like other developing countries, electricity service is limited not only by its access but also its quality in terms of its reliability is questionable. In this country, on average, electricity outage occurs three times per day lasting for one to two hours **(EEPCO, 2014).**These frequent and longer outages have direct and indirect costs. The direct cost includes; replacement cost (cost on damaged equipment and materials such as TV, Radio, divider, electric bulb and electric wire),cost on other alternative energy sources such as fuel wood, charcoal, kerosene, candles, increase workload on woman's and children's. The indirect cost includes reduce productivity, health problem such as respiratory disease, leisure time costs, climate change (which includes increase in average temperature, or a change in rainfall patterns) etc (LaCommore and Eto, 2006).

According to Simonoff et al. (2005), there are many factors that may cause electricity outages: Crime, equipment failure, fire, Human error, operational error, natural disaster, weather, capacity shortage and etc. However, for many developing countries including Ethiopia, energy shortage leading to load- shedding and equipment failure, which is the number one factor for outage, causes and natural disaster, is also cause power interruption in Ethopia (EEPCO, 2013).

Improving access and quality of electricity service can enhance sustainable economic development and the wellbeing of the society while at the same time generating more revenue to the government that can help further development of the energy sector. However, policy makers need information on revenues that can be generated from customers once improvements are carried out since this is an important part of project evaluation.

Against this backdrop, the current study examines household's WTP to avoid unannounced power interruptions, using household survey data from Kuyu woreda of North Shewa, Oromia Regional state. The study applied the Choice Experiment (CE) method to provide new evidence about demand for improved electricity in the context of Ethiopia, using the electricity service's characteristics to value reliability.

1.2 STATEMENT OF THE PROBLEM

Electricity plays a vital part in the modern economy. Yet merely having access to power is not enough especially in developing countries like Ethiopia. The reliability of supply is also crucial. In Ethiopia, the number of outages (both technical and non-technical) is very high compared to that of developed countries. EEPCO (2014) reported that the number of outages experienced by all customers in all sectors in Ethiopia averages 1080 hours per year (equivalent to 45 days per year) , Whilst in developed countries like Netherlands and USA the average outage for low voltage consumers is 26 and 106 minutes per year, respectively (Bloemhof et al.2001).

Even if the government is investing huge amount of resources to expand and improve electricity service, the consumers are unable to get uninterrupted and good quality services yet. The electricity services are still characterized by high frequency of interruptions with long duration of outages. Long and frequent outages can damage assets (such as electronics) and inventory. Moreover, they can disrupt work by shutting down equipment and cutting off lighting, heating or internet connections, which increase an economic burden on households**(Tadele, 2012)**

In addition, when there is long and frequent power interruption, households starts to search for other energy sources for cooking as well as for lightening purposes, which increases the demand for firewood. As a result, the scarcity of firewood has become acute which leads to a continuous rise in prices, and thus increasing the economic burden on the household budget. Animal dung and crop residues are also increasingly being used for household fuel rather than being added to the soil to improve soil fertility, which causes land degradation. As the land is degraded, agricultural productivity is lowered and this in turns results in decreasing incomes and food security. As a result poor people from both rural and urban areas engage in activities that further degrade the natural resources and environment in order to obtain supplementary incomes and to sustain a living (Nebiyu,2011). .Kuyu woreda is not an exception. In 2014, the average number of outage in the woreda was 90 days per year, which is twice the average outage for the country (EEPCO, 2014).Hence, this problem cannot be solved only by the contribution of Government, the society's involvement in the sector is important as it raises Government revenue in two ways;1)Through increasing tariff that comes with the willingness of connected households to pay more for improved services.2)Through increasing electricity access for non-connected households.

The objective of this research is thus to analyze household's WTP for improved electricity services taking Kuyu Woreda of North Shewa Zone, Oromia Regional State as a case study. In this study, the key problems have been investigated and addressed by exploring the WTP values for improvement of grid-electricity services for electrified households. These values were obtained by conducting a survey in semi-urban areas, where electrified households are located.

The market values of these services or goods are important in understanding communities' values of electricity services for socio-economic improvements and for targeting the necessary policies towards vulnerable groups, on the basis of affordability and WTP values

Although the relevance of power outages problem is undeniable, the analysis of WTP values for improvement of grid-electricity services for electrified households located in the study area in particular and in Ethiopia in general are not available in terms of estimates of WTP for improved service reliability. Very few such studies have been undertaken elsewhere in the world. Thus, this study is expected to fill this gap by looking at households demand for reliable electricity services through survey data.

1.3 GENERAL OBJECTIVES

The overall objective of this study is to determine the demand for improved electricity services for electrified households.

Specific Objectives

- To evaluate households perception and attitudes towards electricity services.
- To estimate the Marginal Willingness to Pay (MWTP) and compare the importance of electricity service attributes in terms of their WTP for prioritization purposes.
- To estimate the Compensating Surplus (CS) for improved electricity services for electrified household.
- To draw implications for policies that are aimed at improving access and services of renewable energy

1.4 SIGNIFICANCE OF THE STUDY

Primarily, identifying the household's WTP for reliable electricity may helps the government for targeting the necessary policies towards the vulnerable groups, based on affordability and WTP values. In addition, the paper can be used as supplementary material for the concerned governmental policy makers as well as for the researchers' who are interested to make comprehensive study on energy sectors.

So far, there is not study that has been carried out concerning energy valuation or WTP for reliable electricity services in Ethiopia in general and in kuyu woreda in particular. In doing so, the research work will contribute to the existing limited literature for Ethiopia in this area. Moreover, the result of this study will be of interest to the regional government, and other concerned bodies in providing information forguiding policy in relation to the estimates of WTP for improved electricity service.

1.5 SCOPE OF THE STUDY

The study will be concerned with consumers' WTP for improved electricity services in Ethiopia in the case of Kuyu woreda.

CHAPTER2.LITERATURE REVIEW

2.1 ENERGY SECTOR IN ETHIOPIA

2.1.1 A Brief History and Status of Electricity in Ethiopia

Most of the peoples in sub-Saharan Africa have long relied for their energy needs on wood fuels. Fuel wood has therefore remained vital part of life in many developing countries [Arnold et al., 2003]. The very high degree of dependence on wood and agricultural residues for household energy has impacts on the social, economic and environmental well-being of society (Douglas et al. 2007).

As in most sub-Saharan countries, a marked feature of Ethiopia's energy sector is the high dependence on biomass (firewood, charcoal, crop residues and animal dung). Moreover, due to unreliability of electricity service and low access rate, nearly 60 million tons of biomass is consumed for energy purposes with about 81% of the estimated 16 million households using firewood and 11.5% of them cooking with leaves, dung cakes and charcoal and only few of them used modern fuel such as electricity. supported this aspect arguing that The birth of modern electricity in Ethiopia dates back to the late 1890‟s when King Menelik II of Ethiopia acquired the first generator to light his palace (Ibid.) only two years after his victory over Italy. The diplomatic relations between Ethiopia and Germany developed very well during the era of Menelik and he received the generator as a gift from the German government in light of expressing their good relationship **(**Hydropower, 2006).

Nearly three decades later, in connection with the coronation ceremony of King Haileselassie in 1930, the supply of electricity was extended to light the streets of Addis Ababa (EEA, online).

Since then, the Ethiopian electric energy sector has undergone through several development activities and restructuring. Today, the state-owned Ethiopian Electric Power Corporation has a monopoly power over industry and is engaged in the generation, transmission and distribution of electric power.

2.1.2 THE ENERGY SECTOR IN ETHIOPIA

Access to energy is among the key elements for the economic and social developments of Ethiopia. The energy sector in Ethiopia can be generally categorized in to two major components: traditional and modern (traditional biomass 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 live in rural areas, traditional energy sources represent the principal sources of Energy in Ethiopia.

According to study by CSA in 2014, about 71.1% of the total households use kerosene for lighting followed by firewood (15.7%) and electricity (12.9%). A higher proportion of urban residents use electricity (75.3%) for lighting, while the use of kerosene (80.1%) and firewood (18.5%) are predominant in rural areas. Major types of cooking fuel used by all households are firewood, leaves, dung cakes and kerosene.

The study by CSA at the country level, suggests that about 81.4 % of the households use firewood, around 11.5 %cook with leaves and dung cakes and only 2.4 % use kerosene for cooking. The majority of rural households use firewood (84.4 %) and few of them (12.7 %) use leaves and dung cakes. The use of modern source of cooking fuel such as butane gas, electricity and kerosene for cooking is uncommon in the rural areas (0.4 %). Use of kerosene is common in urban areas and stands at 13.8 % following firewood (65.4 %). Charcoal (7.7 %), electricity (2.4 %) and leaves (5.3 %) are also used by urban households. On the other hand, only 0.2 % of the households in rural areas are observed to use charcoal for cooking.

The total energy sales of the Interconnected System (ICS) – the main electricity grid and the Self-Contained System (SCS) – separate mini grids, stand at 3894 GWh during the 2009/2010 fiscal year. Of this, the sales in the ICS take about 98% of the total. Category-wise the domestic consumption takes the highest share at 38% seconded by the total industrial consumption (LV and HV) which is 37%.

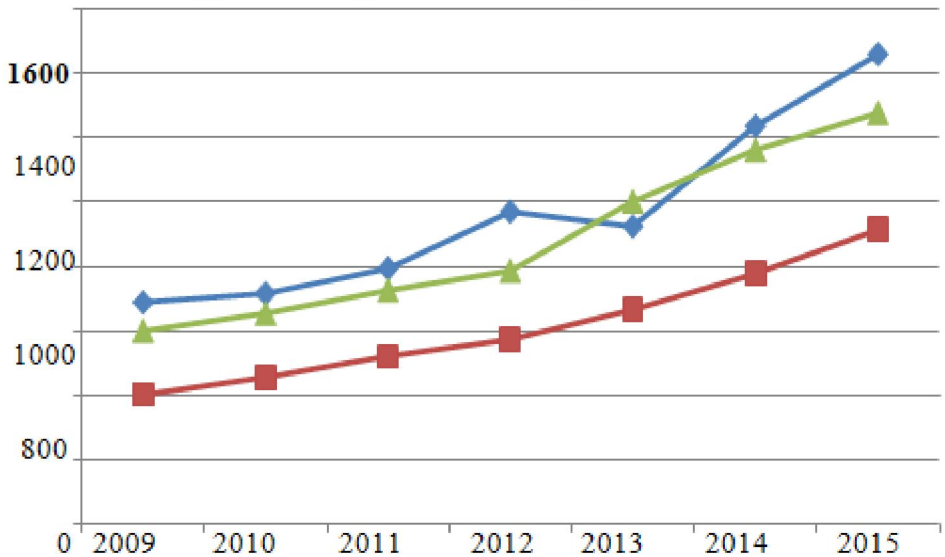
2.1.3 ELECTRICITY CONSUMPTION AND SUPPLY IN ETHIOPIA

Ethiopia has an economically exploitable electricity generation potential of more than 45,000MW from hydro, 5,000MWfrom geothermal and 10,000 MW from wind (EEPCO) though only a fraction of this potential has been harnessed so far. The vast majority of its domestic energy need had still fulfilled by wood fuel and animal dung. During 2014/15, only about 26.5percent of the population had access to electric energy **(MOFED 2015**) and even those who had the access could not get full service because the country had plagued by power outages.

2.1.4TREND IN ELECTRICITYCONSUMPTION

The Ethiopian economy has grown rapidly in recent years accompanied by increasing power consumption. According to data from EEPCO, power consumption has been increasing for all types of users (Figure2.1). For the period 2008/09–2014/15, industries havebeen, on average, the number one users of electricity in Ethiopia followed by households. Increased power consumption by households is mainly due to the augmented use of electronic household utensilsand due totherural electrification programof the government. EEPCO, 2009-2015)

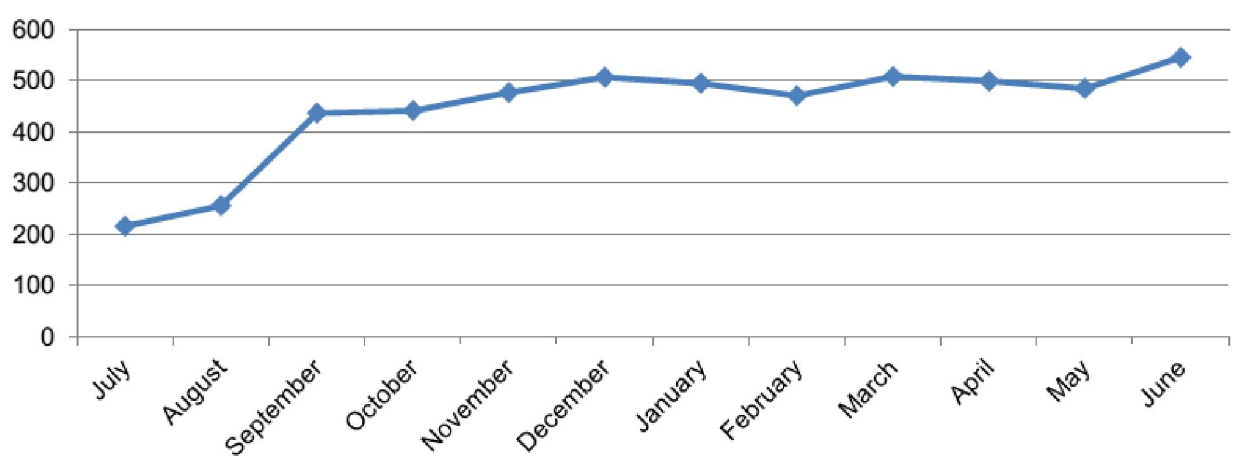
Fig 2.1 Consumption trend by all users in Ethiopia in MGW



Source: EEPCO, 2009-2015

According to EEPCO in the fiscal year 2004/15, total electricity output would be the lowest during July and August. This was due to the recorded shortage of rainfall during the belg (minor rainy season)which affected the power generation capacity as the dams had not enough water stored to be used to generate any more power until the next rainy season.

Figure2.2The monthly electric production in terms of (MGW)in2014/15



(Source: EEPCO, 2014/15)

2.1.5 STRUCTURE OF ELECTRICITY TARIFF IN ETHIOPIA

Ethiopia's average electricity tariff had been stable in nominal terms for almost fifteen years, until July 2006, when there was an increase of 22%, which took the average tariff to 0.06 USD per kWh. Since 2006, no increase has been made. The implication is that real tariff has been falling throughout these years.

Currently the real electricity price in 2015 is around 0.67ETbirr per KWh (equivalent to 0.032 US $, While, in Japan 0.15-0.20 US $/kW with subsidies. This is a government policy to ensure access to energy for the poor. However, the reality is that most of the poor have the least access to electricity and therefore the rich are the ones who are taking advantage of the subsidies. It is suggested that the rich who utilize more electricity should bear more of the costs by progressive tariffs. The GoE and EEPCO have recognized the gap between the cost and the existing tariff. EEPCO has already submitted an application to Ethiopian Electricity Agency (EEA) to raise the tariff to a system cost recover level. The objective of the tariff policy is to:

(a) Achieve full cost recovery through user charges

(b) Ensure a uniform tariff structure for all geographic regions covered by the ICS and

(c) Provide for cross-subsidies across the various customer categories in favor of low-income households.

EEPCO is able to supply electricity at an affordable rate through a social tariff built into the tariff structure. Annual tariff adjustments from EEPCO are permissible provided certain operational efficiency benchmarks are maintained or achieved. However, the prevailing practice in EEPCO appears to be working within the framework of achieving a selling price of electricity placed or suppressed to a rate equivalent to US¢6.00/kWh depending on the prevailing exchange rate.

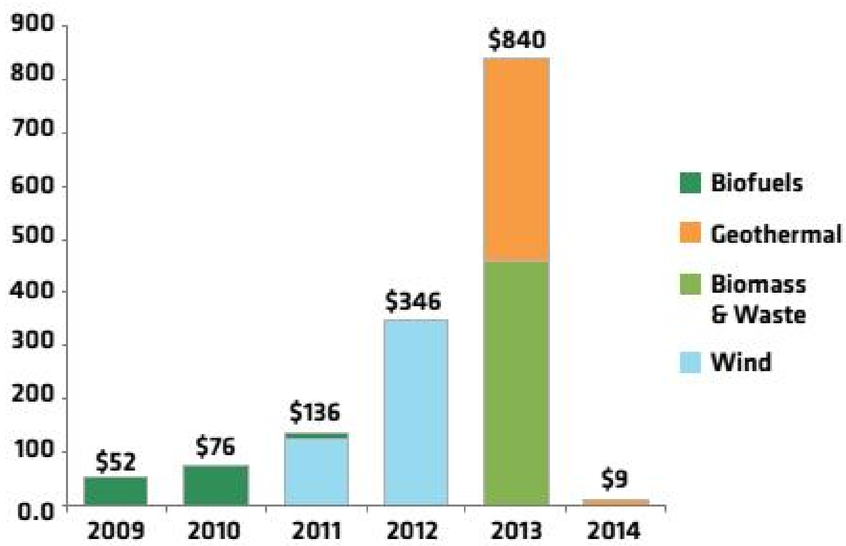
Meanwhile, EEPCO has submitted an average tariff adjustment of approximately 67 ET cents/kWh (USc 2.68) because the rate has fallen below the benchmark rate of US¢6.00/kWh due to mostly foreign exchange fluctuations. However the proposed increment will only take the average tariff to the approximate equivalent of USc 4.8/kWh which is still quite low and will not threaten the objectives of expanding electricity access to the poor. The request is under consideration by the EEA. In the meantime, EEA has advised EEPCO to review its operational efficiencies to make it easier for tariff approvals (EEPCO, 2015).

2.1.6 ANNUAL INVESTMENT IN CLEAN ENERGY

In 2030, Ethiopia's Target will be to reduce emissions by 39% (from 1.8t/person in 2010 to 1.1t in 2030). The targets would keep Ethiopia's per-capita emissions well below the global average, even as the country seeks to graduate from one the world's 'least developed' countries to middle-income status. BAU emissions reductions will come primarily from the forestry and agriculture sectors.

Ethiopia's forestry sector would go from a 55Mt source of CO_2e in 2014 to a negative 40Mt/year carbon sink under the INDC, as the country engages in a massive a forestation and reforestation effort, covering 7m hectares. Therefore, the GoE is annually investing a huge amount of money on building its existing fleet of carbon-free hydroelectric dams and on expanding clean energy sources such as geothermal, biofuels, biomass and waste and wind as Power sector emissions will remain low (5Mt/year) under either scenario, as shown below.

Fig.2.3 shows annual Government investment on clean energy from 2009-2014



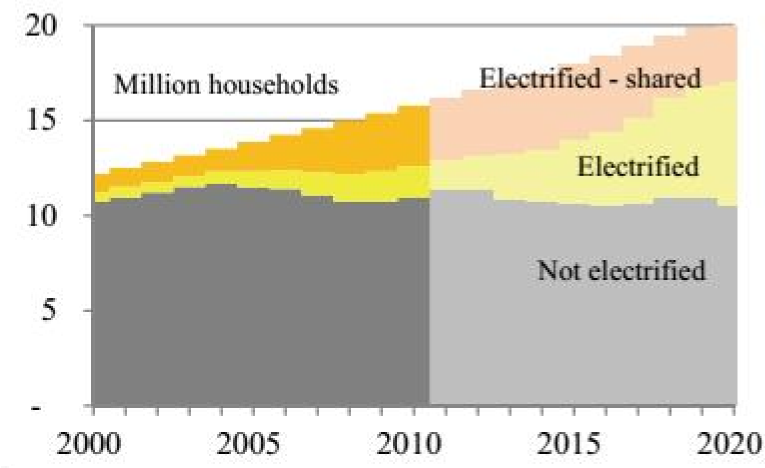
$1.5bn total cumulative investment

Source: Bloomberg New Energy Finance, 2014

2.1.7 ELECTRICITY SECTOR CONTEXT

The number of households is increasing by 2.6% annually or by 0.42 million households each year. This is in contrast to EEPCO's highest annual residential connection rate achieved in the past decade, 0.23 million, which is only about half of the growth in number of households. This means the population not being connected by EEPCO is increasing in absolute terms and only slightly declining in terms of percent connected. More than eighty percent of the population still lives in rural areas and this continues to be a challenge to increasing access to electricity from the grid. The current short-term plan (the GTP) envisages doubling the number of residential customers by 2015; however, this goal appears to be slipping – customer connection rates have slowed down in the past two years (for example, there were fewer than 100,000 new residential connections in 2014). However, even with full realization of the GTP goal and similarly very rapid connections in the succeeding five years, fifty percent of the population or ten million households, may still not be connected to EEPCO supplies (Figure 2.2)

Figure 2.4 Electrification rate in Ethiopia



Source: EEPCO, Brief Statistics (several years)

2.1.8 GOVERNMENT'S MEASURES TO MITIGATE THE POWER SHORTAGE

- ✓ In order to improve the unreliability of electricity in the country, the government of Ethiopia set short and long-term plan

***SHORT TERM*: As an immediate remedy to the power shortage, EEPCO can take the following actions:**

I. Electricity Rationing*:* EEPCOstarts rationing, though the sectors were not treated equally. The rationing varied from time to time and from sector to sector depending on the intensity of the power shortage and EEPCO favoring and disfavoring of activities. As the shortage got more serious in 2009/10, some industries, like cement, steel, and crushers, were Completely cutoff; some were allowed to work limited hours; while some industries that are believedtobekeyindustries(export-orientedsectors)weregiven special privilegein poweruse.

Overall, household consumption declined by 2.41 percent under government actual rationing scheme (GOVRAT) which is the highest decline of all the alternatives. Under this rationing scheme, the decline in consumption is the highest in almost all household types.Households,all together usingabout34percentofthetotal powersupply, wererationed with the sameintensityasthe service sector (EDRI Working Paper 006, 2011).

II. Improve operational inefficiencies

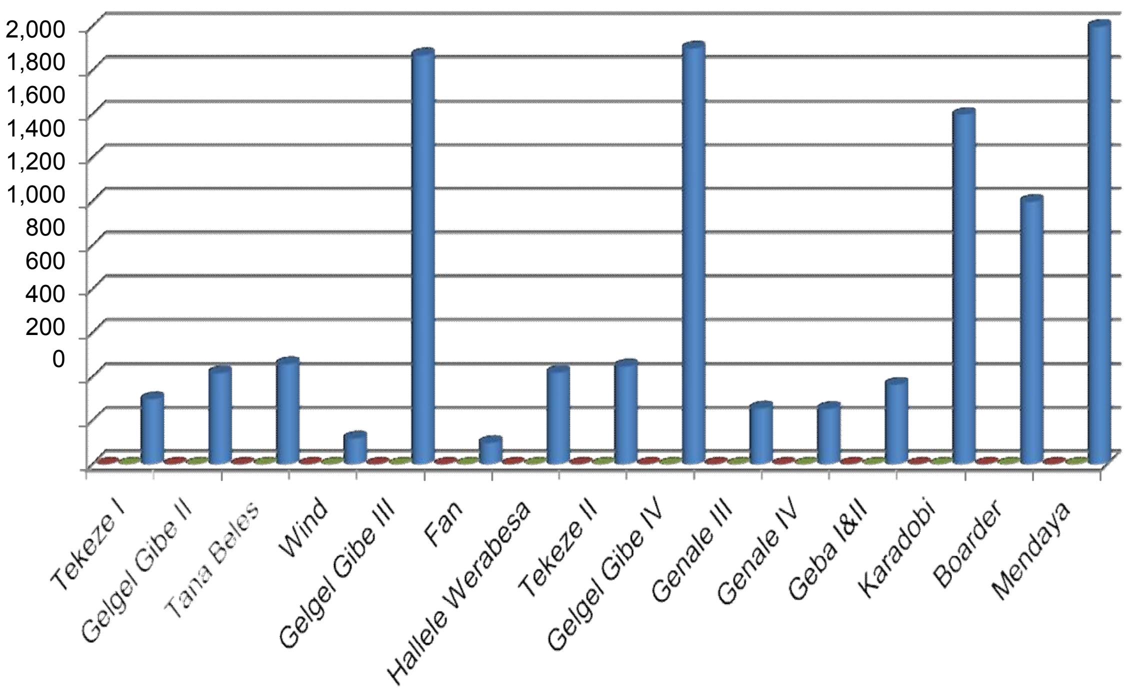
In 2013, the electricity loss in Ethiopia is about 20%, which is much higher than the international average, 12-13%. Most of the loss happens during distribution from the national grid to end users. The WB is financing projects to promote efficiency and automation of distribution.

Improving operational inefficiency include reduction in technical and non technical losses through the installation of capacitors to reduce power factor in the industrial sector and implementation of demand side management encompassing distribution of over 11 million of compact fluorescent lamps to the households. Prepaid meters are increasingly being used to improve metering, billing and collection (WB, Project Appraisal Document for a Second Electricity Access Rural Expansion Project)

LONG TERM: In order to get rid of the power shortage problem finally, and in an effort to increase reliability of electricity significantly and to speed up its access endeavor,thegovernment of Ethiopia can take the following measures.

I. An ambitious dam building program: - In addition to the three already commissioned hydroelectric generation plants in 2014/15, GilgelGibe III hydropower plant is under construction with an installed capacity of1, 870MW. Contracts for four more large dams have also been signed and their construction has already started. Moreover, there are eight more new power generation plants under project study stage. All the projects are expected to commence production within the coming five to ten years. Once completed, these dams would increase the total power generation capacity of the country by 10,500 MW from less than 2400MW in 2015(EEPCO 2015). Given this, the ever increasing domestic demand is fully satisfied and the excess to be exported to neighboring countries of Sudan, Kenya, Djibouti, and even Yemen.

Fig 2.5 shows the power generation plants that are already started and expected to start production in the next 5 years



Source: EEPCO, 2014

II. Diversification of energy Resources

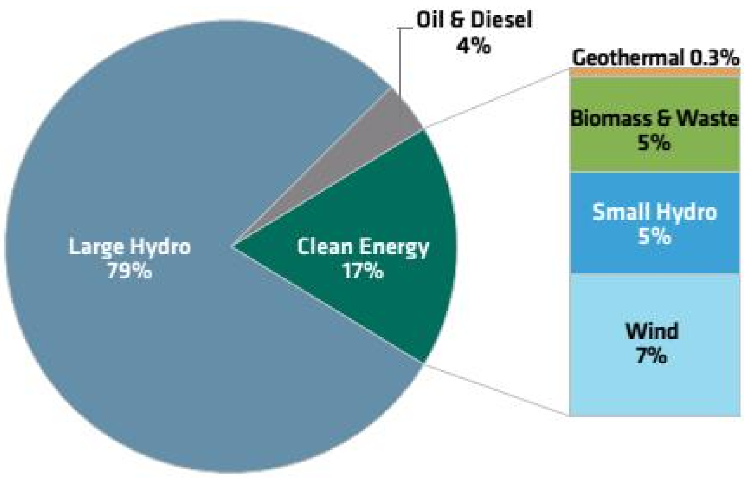
In 2010, about 86% of electricity generation is supplied by hydropower, 13% diesel and 1% geothermal. This is rational considering the facts that Ethiopia is rich in water resources and hydropower is relatively cheap. However, the rainfall in Ethiopia varies considerably from year to year and therefore, over dependence on hydropower makes the energy supply very unstable.

The instability of the energy supply brings about negative impacts on industry and the economy (EEPCO, 'Facts in Brief 2010')

The EEPCO are also recognizes the importance of the diversification of energy resources to ensure stable energy supply and is trying to develop various kinds of power plants. Thus in 2015, the GoE increases the sources of energy from three to six and decrease the percentage of electricity generation which is supplied by hydropower from (86% to 79%) and diesel and oil (from 13 to 4%) in 2015. Reduce the use of diesel generation for the off grid power supply; hence reduce operational and maintenance costs of those plants.

In 2015, the total capacity of electric generation of the country is about 2351 MW. 79% of which is from large hydropower, 17% clean energy .i.e. geothermal, biomass and waste, small hydro and wind and lastly 4% of which is from oil and diesel.

Figure 2.6 shows different energy resources in Ethiopia in 2015



Source: Bloomberg New Energy Finance, Ethiopian Electric Power Corporation, Ministry of Water, Irrigation & Energy, Ethiopian Sugar Corporation

III. Private sector involvement for the investment on energy sectors

The EEPCO is encouraging the private sector to invest in the energy sector. A study is also underway on the organizational restructuring of EEPCO to meeting the new and changing landscape in the electricity sector, where more and more private partners are involved in renewable sources of energy.

2.2 THEORETICAL REVIEW

2.2.1 VALUATION METHODS

Theoretically, the total value/ benefits of some environmental improvement such as improved electricity can be classified into two categories.

Total Economic Value = Use Value +Non-use Value.

Use value comprises direct and indirect value, which is simply "value in use", option value, and quasi-option value. For example, people use a clean river for swimming, boating, drinking or bathing. An environmental resource is said to have a quasi-option value if the future benefits it might yield are uncertain and depletion of the resource is effectively irreversible. In brief, one would be willing to pay to preserve the resource simply because it might prove valuable at some time in the future.

Option value was seen to arise when an individual was uncertain as to whether he would demand a good in some future period and was faced with uncertainty about the availability of that good.

Non-use values also comprise of bequest value and existence value. Consequently, even if a certain environmental good has neither use value nor option value, people can still protect it because they believe that all creatures have the right to exist, hence, the existence value.

Because of the complexity of environmental resources, most of the public environmental resources have no market price or their price did not show the true value of the good or service. We therefore, require non-market valuation techniques to value public environmental goods and services. In the following section, we discuss the non-market valuation techniques.

2.2.1.1 Non-market valuation techniques

Economists have developed the broad categories of non-market valuation techniques for valuing the value of public environmental resources. These valuation techniques are called revealed preference and stated preference methods. Cross cutting methods, which combines market based and non-market valuation techniques such as benefit transfer and unit day methods are used for valuing public environmental goods, such as electricity. The most widely recognized revealed preference, which includes Travel cost method and Hedonic pricing method and the stated preference valuation techniques such as Contingent valuation method and choice experiment method.

2.2.1.1.1 Revealed preference methods:

The indirect (inferential) approach (or revealed preference method) involves inferring about the unobservable demand for and hence value of the environmental goods and services based on the observable demands for the related marketable goods and services. That is, using information on market transactions for related private goods and services, economists try to infer the demand for environmental goods and services (Freeman, 1993 and Tietenberg, 2003)**.** The indirect method includes travel cost method (TCM), hedonic pricing method (HPM), averting expenditures and household production functions. The great advantage of the revealed preference methods is that it dependence on the actual behavior (Bockstael et al 2005, P.538).

2.2.1.1.2 Stated preference methods (The direct method)

The stated preference methods are the direct valuation methods used to solicit value measures by asking individuals hypothetical questions. In the stated preference techniques individuals are directly asked to state their willingness to pay (WTP) and/ or willingness to accept (WTA) compensation for change in public environmental resources from hypothetical market scenario (Frey et al. 2004, p.1).

The stated preference methods have been used for valuing both use and non-use values of environmental resources. Generally, stated preferences represents one of the most frequent way of valuing anon-market good, usually an environmental good such as better air quality, supporting wild life or an improved health care systems. Unlike reveled preference method, SP does not examine daily (real) behavior of the individuals, but asks the respondent what she/he would do in hypothetical situation. Estimates are based on the value as stated by a respondent in an interview (Scasny, 2013).

The most widely used stated preference methods are the contingent valuation method (CVM) and the choice experiment method (Bockstael et al 2005, pp.539-540).

2.2.2 THEORETICAL FOUNDATIONS OF CHOICE MODELING METHOD

Choice modeling (CM) is another SP method that can take three possible forms: Discrete Choice experiment, contingent ranking (CRN) and contingent rating (CRT). The basic designing of the alternatives is the same in each approach and the respondents must decide which of mutually exclusive multi-attribute alternatives they prefer. Furthermore, all three techniques – under the right assumptions - can be shown to be consistent with welfare economic theory. In DCE, the respondents have to choose one alternative out of a given number of alternatives (two or more).

As the DCE only contains information regarding the preferred alternative, the data should said to be weakly ordered

Contingent ranking, in contrast, requires all the alternatives to be ranked, and the data therefore provide a complete preference order (strongly ordered). While a contingent ranking exercise contains more information about preferences than a similar discrete choice exercise, it is also more cognitively demanding. The degree of task complexity in contingent rating is even higher as the respondents have to place a value characterizing the strength or degree of preference on each alternative (Louviere et al.2000).

Contingent rating (compared to contingent ranking and DCE) provides the respondent with the opportunity to rate alternatives equally (named ties) and thus to indicate indifference between alternatives. The modeling of ranking and rating data differs slightly from that of DCE data due to the stronger ordering of alternatives. Models used for ranking and rating data include the rank ordered logit and ordered probit.

The use of ranking and especially rating techniques suffers from potential theoretical and practical obstacles. These concerns include the difficulty individuals might experience ranking/rating all the alternatives; and the fact that rating tasks in particular involve difficulty in making interpersonal comparisons and departure from the choice contexts that are faced by consumers in the real world (Bennett & Blamey 2001).

Bateman et al. (2002) also argue that the methods differ in their ability to produce WTP estimates that can be shown to be consistent with the usual measures of welfare change, and which thus can be used as part of a CBA. Today the DCE is the most applied choice modeling approach in the economic literature, whereas contingent rating is hardly ever used(Boyle et al. 2001).

The DCE is the simplest of the choice techniques and thus its biggest advantage is the low cognitive complexity – the degree of task complexity and difficulty arising from the experiment (Louviere et al.2000). As mentioned earlier, the DCE is closely related to dichotomous choice CVM, as both methods involve consumers making mutually exclusive choices from a set of substitutable goods. The methods also share the same economic foundation, random utility theory.

The DCE approach in the form as it is known today was developed in the early 1980s, with Louviere & Woodworth (1983) being the first to use the term 'choice experiment' (Hanley et al. 2002). Choice experiment applications have been commonly used in marketing, psychology, and transport research, and have recently become increasingly popular in environmental valuation applications (Admowicz et al., 1998; Boxall et al., 1996; Hanley et al., 1998).

- The theoretical basis of choice Experiments (CE) are based on the fundamental building blocks: Lancaster's characteristics theory of value, and random utility theory.

2.2.2.1 The characteristics theory of value

The basic assumption in choice experiment application is that consumers derive utility from the different characteristics that a good possesses, rather than from the good per se. The characteristics associated with the commodities are thus assumed to provide services to the individual (Lancaster, 1966).

According to characteristics theory of value, the probability of choosing specific alternative service is a function of the utility linked to that same alternative. Moreover, the utility derived from each alternative is assumed to be determined by the preferences over the levels of the characteristics (goods/ services) provided by that alternatives. In the original model presented by Lancaster (1966), the goods consumed are transformed into objective characteristics, through the utility function, which is assumed to be objective and equal among all consumers. Hence, according to the characteristics theory of value, utility is a function of the services provided by the commodities. The assumption that individuals derive utility from the characteristics of a good rather than from the good itself, implies that a change in one of the characteristics (such as the price) may result in a discrete switch from one good to another will however affect the probability of choosing that specific commodity on the margin.

Hanemann, 1984 states that many of the choices made by individuals can be divided into two parts: (a) Which good/service to choose; and (b) how much to consume of the chosen good/service. The first part of the choice process represents the discrete aspect while the second part represents the continuous aspect of consumer choice. When choice experiments are applied in the valuation of on-market goods, the design of the experiment is in general carried out such that the discrete dimension of the choice situation is isolated.

2.2.2.2 Random utility theory (RUT)

Random utility theory (RUT) is the second building block. In choice experiment, where the respondent is asked to choose the most preferred among a set of alternatives, random utility theory can be used to model the choices as a function of attributes and attribute levels. According to the random utility theory, the individual is assumed to make choices based on the attributes of the alternatives with some degree of randomness. RUT says that utility derived by individuals from their choice is not directly observable, but an indirect determination of preferences is possible. The random utility theory thus, provides a link between the deterministic model outlined above and a statistical model (McFadden, 1974). In other words, under RUT it is assumed that the utility function of a good can be broken down into two parts, one deterministic or systemic (V) and one stochastic part (ε).

In this study, we used the choice experiment method. As choice, experiment method appears to have several advantages relative to CVM. First, CEs are based on attributes, they allow the researcher to value attributes as well as situational changes. Furthermore, in the case of damage to particular attribute compensating amounts of other goods (rather than compensating variation based on money) can be calculated. Second, even if both CVM and CEs are types of stated preference experiments, CVM focuses on precise scenario and attempt to gather information about respondents' choice regarding this precise scenario. In contrast, the CE approach attempt to understand respondent's preferences over the attributes of scenario rather than the specific scenario. In addition, as show below, CE overrides CV to a certain degree.

Advantages of Choice experiment over CVM method

1) Marginal values of goods are easier to measure/estimate

2) CE is more informative due to multiple choices provided for respondents

3) CE reduces response problems (‘yea-saying’, protest bids, strategic bidding)

4) Avoids embedding effects in scope test

5) Provides benefit transfer (BT) values

6) Frequent sampling allows internal consistency tests.

7) Relies less on accuracy and completeness of good description but instead on the levels of attributes of a good

7) Respondents are questioned on multiple events from possible events unlike a single event in detail (CV) Cognitive unwillingness (fatigue) due to multiple, complex choices.

9) Reduces excessive multi-co linearity problems

- According to Louviere et al.(2000), seven steps are needed to conduct a choice study:

1) Study objective is defined

2) Qualitative study is conducted

3) Data collection instrument is developed & piloted

4) Sample characteristics are defined

5) Data collection is performed

6) Model estimation is conduct

7) Policy analysis is applied.

CEs estimates WTP values based on relative changes in respondents' WTP values. The CE analyses a service improvement, where specific characteristics or attributes of the service are represented as choices and respondents' selection determines the WTP values.

Choice Experimental method comprises a number of choice sets which vary by attribute or characteristics levels and these describe the features of the good/service to be estimated.

The selection of the preferred choice is decided implicitly, by the trade-off a consumer makes among the different alternatives being offered in all given choice sets. Goods do not provide utility, but have characteristics; goods consist of numerous characteristics, some of the characteristics may be shared by at least one good; and the characteristics differ in combination and/or in separation. The attributes and number of levels and characteristics and/or features are important in constructing choice profiles (Lancaster, 1966).

Hanley et al.(1998a) noted that price is typically one of the attributes in the choices. Additionally, one of the choice sets generally includes the status quo, where this choice provides no difference in the good/service being offered. This position is a 'do nothing' scenario (Hanley et al.2001), also known as the 'business-as-usual' position, as it does not vary across the choice sets (Mogas et al.2006).

2.2.3. Use of Valuation Methods in Energy Sector

In developing countries energy is perceived as a social good, with users decide the energy mix they want to select (ESMAP , 2000b). Energy services for poor communities in developing countries are often neglected and limited to modern forms of energy sources. This results in increased use of traditional and poor forms of energy, namely firewood and charcoal, animal dung, crop residue ,leaf and etc.

By valuing the importance of modern energy services, using hypothetical approaches, such as CE, non-market values can be estimated. This is in contrast to using revealed data, where information on purchasing behavior or habits towards modern energy sources is available. A World Bank document remarked that deriving the WTP for improved services, such as energy in developing countries, using surveys, has been daunting (ESMAP 2000a).

2.3 EMPIRICAL LITERATURE REVIEW

Sabah S.M. Abdullah (2009) used both CEs and CVM method to estimate households WTP for improved electricity service in Developing country in the case of Kenya. For CVM method, the result indicates that respondents are WTP more for grid electricity services than solar power and households favored monthly connection payments over a lump sum amount. Some of the policies suggested in this paper include subsidizing the connection costs for both sources of electricity, adjusting the payment periods and restructuring the market ownership of providing rural electricity services. For CE method, mixed logit estimation had applied to identify the various socio-economic and demographic characteristics, which determine preferences in reducing power outages among a household's users.

Ozbafli(2011*)*used choice experiments (CE), contingent valuation methods (CVM) and averting expenditure (AE) method to estimate households' WTP for an improved electricity service in Turkish republic of North Cyprus. For averting expenditure, the researcher used the Tobit model, and the result indicates that, the average household's averting expenditures are 3.13 YTL/month. In the CVM section, the spike model with varying spike, varying mean and constant standard error specification results in a median WTP of 23.03 YTL per month and a mean WTP of 29.14 YTL per month. Using CE, compensating variation estimates for eliminating summer and winter outages are calculated using parameter estimates from the mixed logit (ML) model with interactions. The compensating variation is 6.65 YTL per month and 25.83 YTL per month respectively. Among the three valuation methodologies, WTP per hour un served ranges from 0.13 YTL (0.11 USD) to 1.22 YTL (1.03 USD). In order to avoid the cost of outages, households are willing to incur a 1.5%-13.5percentage increase in their monthly electricity bill.

Wacker et al., (1983) used two types of cost evaluation questions: CVM, and indirect method questions to estimate HHs willingness to pay to avoid the cost of unexpected electricity power supply in Canada. The indirect reliability worth evaluation asks that, the preparatory actions the consumers would take to avoid the costs of an unexpected electricity supply interruption. Because the costs depend on customer and interruption characteristics, in the survey the customers are asked questions on attitudes towards the service provided, the undesirability of certain interruption characteristics (e.g. time of the day, duration, frequency, etc.), as well as the preparatory actions taken to reduce the effect of an outage. In the preparatory actions section, the households are provided with a list of actions and corresponding cost estimates and are asked to choose the ones they might take in preparation for a power failure scenario. The result for the six preparatory actions used in the Canadian survey indicates that, purchase and use a candle ($0.25 per hour), an emergency lantern ($0.50 per hour), an emergency stove ($1.50 per hour), purchase or rent and use a small generator ($5.00 per hour), larger generator ($20.00 per hour). The sum of the costs of the chosen actions is a measure of the WTP of a user for alternatives to electricity and is a lower bound for the worth of reliability.

Koundouri et.al (2009) estimated WTP for construction of a wind farm in the area of Messanagros on the island of Rhodes in Greece. The study uses double bounded dichotomous choice elicitation format and found that the respondents are willing to pay a premium of Euro 8.86 in their bi-monthly electricity bills for the construction of a wind farm.

Nomura and Akai (2004) undertook a CV survey of Japanese households to estimate the WTP for renewable energy. They report that the willingness of Japanese households to pay more, in the form of a flat monthly surcharge, for renewable energy is about ¥2000 yen, which is equivalent to ($17) per month per household.

Roe et. al ,(2001) analyzes US consumers' WTP for energy related air pollution reduction using a CV survey. Results suggest that many population segments are willing to pay for decreased air emissions even if there is no alteration in fuel source. Furthermore, several groups are willing to pay significantly more when emissions reductions stem from increased reliance upon renewable fuels. The results of the survey had compared with hedonic pricing model results. While survey and hedonic results are not easily compared due to survey limitations, both point to WTP for Good Quality, Uninterrupted Power Supply. However, the survey results are likely to overstate actual WTP.

Wiser (2007) used a split-sample, dichotomous choice2 contingent valuation survey of 1574 U.S. residents to explore willingness to pay (WTP) for renewable energy under collective and voluntary payment vehicles, under government and private provision of the good. He found some evidence that, when confronted with a collective payment mechanism, respondents state a somewhat higher WTP than when voluntary payment mechanisms are used. He also found that the private provision of the good elicits a somewhat higher WTP than does government provision.

Farhar(1999) reports, using the utility market survey, that WTP for renewable energy follows a predictable pattern with an average majority of 60% willing to pay at least $5 per month more for electricity from renewable sources, 19% willing to pay at least $10 per month more, and 21% willing to pay at least $15 per month more.

Rehn (2003),using a CV survey examined the WTP for three extra services – internet energy saving advice, personal energy saving advice and an insurance service – all supplied by electricity companies in the Swedish electricity market. The average WTP for all three services is low, in fact, well below 10 SEK per quarter of the year. The same empirical material, complemented with data form one outside source, is used for the testing of six hypotheses concerning consumer behavior and WTP for extra service in the electricity market. The results show support for one of the tested hypothesis, namely, when a consumer changes electricity supplier, he changes from a higher price company to a lower price company.

Taale and Kyeremeh (2015), used Tobit model to assess households WTP for improved electricity services in Cape Coast Metropolitan Area, Ghana using 950 households survey. The finding indicates that, monthly income, prior notice on power outages, business ownership, separate meter ownership, household size and education significantly affect WTP for reliable electricity services. On the average, households were prepared to pay 44 percent (GH¢6.8) more, relative to the mean monthly electricity bill in the sample, to improve electricity services.

Markus Bliem (2009), Used choice experiment method for valuing service reliability of supply. It was carried out in Australia in 2007 using two different customer groups (households and businesses) to state their preferences for service reliability in a choice experiment. Accordingly the result from bivare probit model shows that, households have a strong preference for electricity service interruptions during the week, whereas business customers prefer interruptions, as may be expected, on weekends when their business are usually closed. Furthermore, companies prefer interruptions at night when there is less business activity.

Galina Ivanova (2012), Analyzes Queensland households' WTP extra for the Electricity from renewable energy sources. The results of a survey of Queensland households regarding their WTP for renewable energy suggest that while on average the respondents were willing to pay about $28/quarter on the top of their quarterly electricity bill to support the increase in electricity generation from renewable energy sources, there is significant heterogeneity in WTP. The heterogeneity in WTP is accounted for by estimating a latent class model. Three classes of respondents are identified using attitudinal and knowledge questions. Results indicated that there are significant differences in WTP among classes. The mean WTP in class 1 was $29 (or 12.7% of their average electricity bill), in class 2 was $13 (or 4.5% of their average electricity bill), and in class 3 was $36 (or 14.4% of their average electricity bill). Tobit analysis for each latent class indicated the importance of socio-demographic variables in respondents stated WTP for electricity generated from renewable energy.

F.Carlson and P.Martison (2005) used CVM to elicit Swedish households' WTP to avoid power outages. In the study, respondents were asked to state their WTP for avoiding nine different types of outages. Therefore, a random parameter Tobit model was applied since there is cross-sectional heterogeneity and a proportion of zero responses. Based on the estimations, they find that the WTP depends positively on the duration of the outages, and that WTP is significantly higher for unplanned outages. The overall variation in the WTP due to observed heterogeneity in housing and socioeconomic variables is small compared to the pure effects of power outages. Policy implications of those findings are discussed.

As evident from the above, most published and unpublished studies conducted in developed and developing countries have focused on incremental WTP for renewable energy. However, there is not study that has been carried out concerning energy valuation or WTP for reliable electricity services in Ethiopia. Therefore, the main aim of this study is to fill this gap by looking at households demand for improved electricity services through collected survey data. This approach is understandable given the goal of universal access to electricity and growing concerns on climate change in these countries. Therefore, estimating the benefits of service improvements together with analysis on tariff and affordability, as undertaken in this study, are relevant for policy formulation regarding future energy supply.

CHAPTER 3: DATA AND METHODOLOGY OF THE STUDY

3.1 DISCRIPTION OF THE STUDY AREA

The district found in North Shewa administrative zone of Oromiya National Regional State. It is far 156 km away from Addis Ababa. In addition, it is located at the northwestern direction on the way to Bahardar town. Geographically it is located at about $9^0$36`34`` N and $38^0$05'00"-$38^0$34'13" E with altitudinal range of 1200-2800m above sea level. Accordingly, agriculture within the area is the main means of living. Agriculture makes about 62% of the economic activities. Self employed and trade occupies about 20% and 17.7% respectively (districts agricultural and rural development office (2015). The major types of crops grown in the area are teff, sorghum, barley and pulses. Natural resources such as natural and manmade forests, woodland, bush and shrub land, grassland and plantation trees are available in the woreda.

The local population obtains almost all of their house hold utensil and construction material from forest product. Forest is everything as far as house construction, fences and furniture are concerned in the area. In this woreda, forest is the major sources of energy. Most households rely on biomass fuel rather than using electricity for both cooking and lightening purposes. Biomass fuels (wood &charcoal, animal dung and agricultural residues) are still the major sources of energy, accounting for about 80%,10% & 8% respectively. Only the remaining 2% is from electricity and kerosene. Electricity is not only limited in access but also it is unreliable in quality (**Tilahun, 2010**).

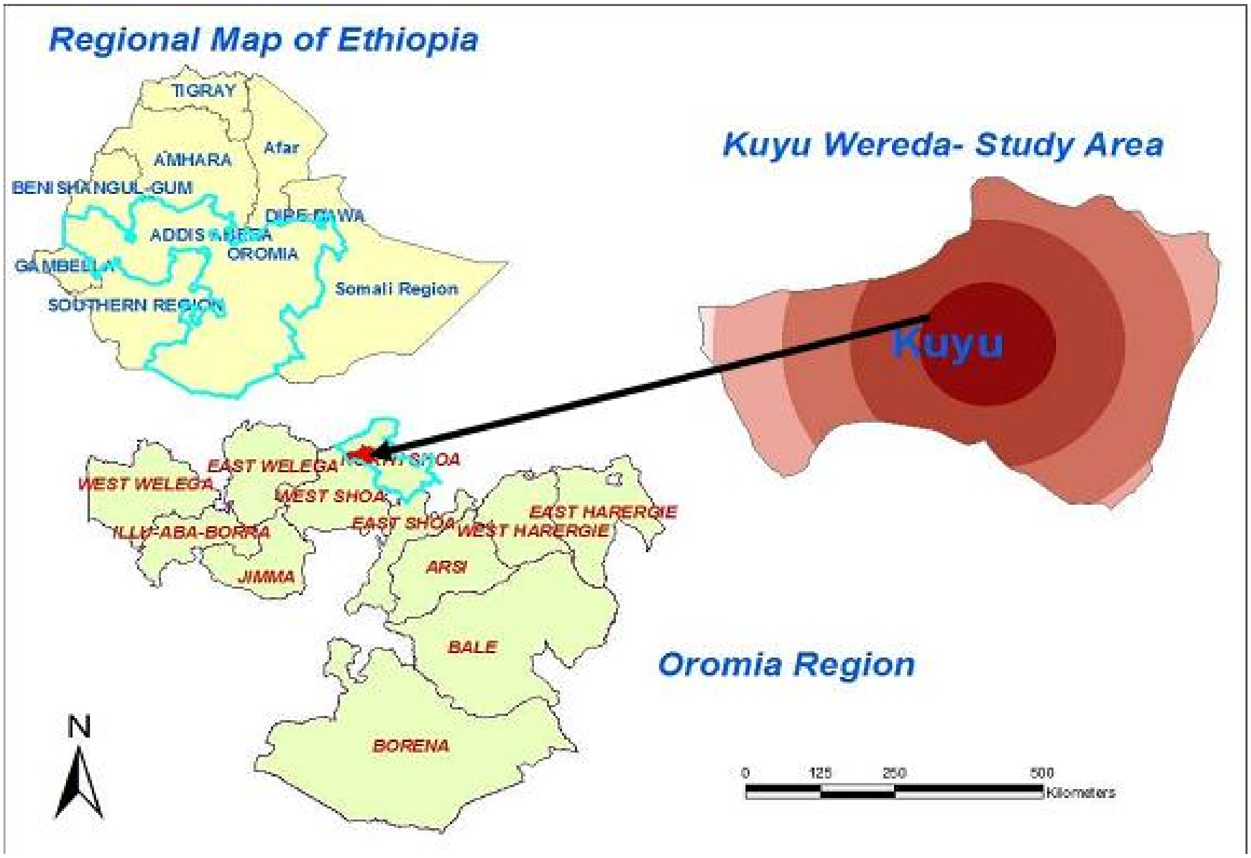


Fig3.1. Map of regional state of Ethiopia, Oromia region and study area, respectively

3.2 TYPES AND DATA SOURCES

The study was mostly relies on primary cross sectional data type for the time period 2016 that would be Choice experimental survey. The study was also use secondary data from Gebregurracha town Electricity supply office, existing documents, books, journals, reports, and other sources from sect oral offices and other relevant organizations /bureaus .

3.3 SAMPLING TECHNIQUE, STRATEGY AND SAMPLE SIZE

The objectives of the study determine the relevant population from which respondents will be sampled. The population of interest in our study is electrified households in Kuyu woreda. Sampling techniques are classified as Probability and non-probability **(Champ et al., 2003).** In non-probability sampling, each household does not have a known non-zero probability of being included in the sample, and therefore the results from the data cannot be used in making inference to the larger population. In probability sampling, each household has a known non-zero probability of being included in the sample, and the results of sample data analysis can be used in making statistical inference. Therefore, in this study, since we intend to make inferences from the sample to all electrified households in Gebregurracha town, we need to select one of the widely used probability sampling techniques.

Once the sampling technique is determined, then the sampling strategy (the method with which the households included in the sample was chosen from the population) needs to be selected.

Louviere et al. 2000 identified three types of sampling strategies: choice-based sampling (CBS); simple random sampling (SRS) and stratified random samples (STRS), .The choice-based sampling is the preferred method in collecting revealed preference data and it is not used in stated choice studies. It requires that the choice probabilities are known a priori. In the SRS, a random sample is selected from the sampling frame and each sample unit has an equal probability of being included in the sample. With the STRS, the sampling frame is divided into G mutually exclusive groups, and within each stratum, the sample units are randomly chosen.

For this study, the simple random sampling will be used and therefore all electrified households have an equal probability to be chosen. The town consists of two Kebeles and both of them are included in the survey. As only, the two kebeles are electrified. The number of households was obtained from districts agricultural and rural development office (2014), and there are about 24,484 electrified HHs live in the town kebeles. Because the current sampling theory is not exactly suitable for choice based data, most researchers using choice based data have resorted to rules of thumb in finding the minimum sample size required (Bliemer and Rose, 2005). In estimating the marginal value of attribute levels, the suggested rule of thumb (Orme, 2006) is:

$$\frac{nta}{c} > 500$$

When, n is the number of respondents, t is the number of choice sets given to each respondent, a is the number of alternatives in each choice set (excluding the status-quo or none alternative), and c is the largest number of levels in any attribute for main-effects-only designs or the largest product of levels of attributes when interactions are included. If relationships with socio-economic variables are going to be tested then the sample, size calculated with the formula above will need to be doubled (Barton,2007). However, in this study, we did not test the relationships with socio-economic variables, as it is beyond our objectives. Therefore, using the above rule of thumb, we were founds the minimum sample size required which is 170 as $510 > 500$ and satisfy the above rule of thumb.

3.4 METHODS OF DATA COLLECTION

The study shall be employ both quantitative and qualitative; choice experiment(CE) survey method of data collection to households' willingness to pay /WTP/ for improved electricity services among households' of Kuyu woreda. For choice experiment survey, different attributes, which describe reliability of electricity services, will be used and the respondents will be asked to pick the most preferred.

3.5 MODEL SPECIFICATIONS

The random utility function suggests an analysis of the probability of choosing one alternative over another. The econometric model specification relies on two further decisions: (i) the utility function specification (how the stochastic terms enter the conditional indirect utility function); and (ii) the assumption of the distribution of the error term (Hoyos, 2010). The model specifications applied for these CE study is the conditional logit model (CLM) and the Random parameter logit (RPL) models.

3.5.2 The conditional logit model

CLG is closely related to the better-known MLG model, but it derives from different behavioral assumptions and is estimated in different form. The CLG model is appropriate whenever it is reasonable to assume that individual choices among available alternatives are a function of the relevant characteristics of those alternatives, rather than the characteristics of the individual. Like MLG model, the CLG model are based on the(IID) assumption .I.e. error terms follow an extreme value distribution and are independent across alternative. Generally, if the researcher interest is to analyze the effect of characteristics of alternatives on individual choices, he/she may use CLG.

The natural model formulation would be:

$$\text{Prob } (Yi = \text{j}|x_{i1}.,x_{i2},...,x_{ij})=\text{Prob } (Yi = \text{j}|Xi)=Pij = \frac{\exp x_{ij}\beta}{\sum_{\text{j}=1}^{\text{j}} \exp x_{ij}\beta}$$

In accordance with the convention in the literature, we let j =1,2,...,J for a total of J alternatives. The model is otherwise essentially the same as the multinomial logit. In this model, the coefficients are not directly tied to the marginal effects. The marginal effects for continuous variables can be obtained by differentiating the above equation with respect to a particular xm to obtain

$\frac{\partial Pij}{\partial xim}$=[$Pij$(1(j =m)−$Pim$)]β, m=1,...,J

It is clear that through its presence in Pij andPim, every attribute set xmaffects all the probabilities. Hensher (1991) suggests that one might prefer to report elasticity's of the probabilities. The effect of attribute k of choice m on Pij would be

$\frac{\partial \ln Pj}{\partial \ln x_{mk}}$=$x_{mk}$[1(j=m) - p_{im}]β_k. Because there is no ambiguity about the scale of the probability itself, whether one should report the derivatives or the elasticity's is largely a matter of taste.

Several analysts recommend the mixed logit model or the Random parameter logit (RPL) for discrete choice modeling applications. The RPL model can overcome the limitations noted above, particularly random tastes variation (Train, 2003). Moreover, the RPL model provides a flexible, theoretical, and conceptual econometric model that can estimate any random utility model **(**McFadden and Train, 2000**).** It also provides superior insights into choice performance and welfare estimates (Sillano and de Ortúzar, 2005; Scarpa et al., 2008; Hynes et al., 2008). For these reasons, the RPL model will be used in this thesis and is discussed further in the following section.

3.5.3 Random parameter logit (RPL)

The RPL model is also referred to as the mixed logit model (ML). The model allows the coefficient of observed variables to vary randomly with a specific probabilistic distribution across individuals (Yang, 2005). In the RPL model, individual heterogeneity can be formed by varying the parameters in the population. Random parameters with the mean and variance can be modeled by assuming that the parameters conform to a multivariate normal distribution across individuals (Lee et al., 2003), as follows*:*

$$\boldsymbol{U_{ij}}= \boldsymbol{\alpha_{ij}}+\boldsymbol{f}\,(\boldsymbol{\beta_i} \backslash\, \boldsymbol{\beta_{mean}}\,,\ \boldsymbol{\beta_{std}})\boldsymbol{Z_{ij}}+ \boldsymbol{H_{ij}}$$

$$= \boldsymbol{\alpha_{ij}} + \boldsymbol{\beta_{mean}}\boldsymbol{Z_{ij}}+ \boldsymbol{\beta_{std}}\boldsymbol{Z_{ij}}+ \boldsymbol{H_{ij}}$$

$$= \boldsymbol{\alpha_{ij}} + \boldsymbol{\beta_{mean}}\boldsymbol{Z_{ij}} + \eta_{ij}+ \varepsilon_{ij}$$

Where α_{ij} denotes an alternative specific constant for individual i (i = 1… n) and alternative j(j = A, B, C). β_{mean} Is fixed parameter in the population, $\beta_{mean}Z_{ij}$ denotes observed attributes of alternatives within a choice set. β_{std} is an individual deviation parameter, which can capture a random, unconditional and unobserved type of taste heterogeneity of each random parameter (Grosjean and Kontoleon, 2009).$\beta_{std}Z_{ij}$ or $\eta_{ij}$is known as a stochastic component that reflects individual heterogeneity. The parameters η_{ij} vary in the population with density $f(\eta_{ij}\backslash\, \Omega\,)$,where Ω is the actual parameter distribution. $f(\eta_{ij}\backslash\Omega\,)$can take on different distributional forms such as normal, lognormal, uniform or triangular, counting on a different pattern of individual heterogeneity (Lee et al., 2003).ε_{ij} is a random term with the IID property across alternatives and individuals. For a given value ofη_{ij}, the conditional probability of individual I choosing alternative jin a choice set in a standard logit, is:

$$\boldsymbol{P_i}(\boldsymbol{j}/\eta_{ij}) =\frac{\boldsymbol{exp}(\boldsymbol{\alpha_{ij}} + \boldsymbol{\beta_{mean}}\boldsymbol{Z_{ij}} + \eta_{ij})}{\sum_{j=1}^{3}\boldsymbol{exp}(\boldsymbol{\alpha_{ij}} + \boldsymbol{\beta_{mean}}\boldsymbol{Z_{ij}} + \eta_{ij})}$$

However, the individual tastes are commonly unknown. Hence, it is necessary to calculate the unconditional probability generated from the equation above across all possible values of η_{ij} .This can be expressed as:

$$\boldsymbol{P_i}(\boldsymbol{j}/\eta_{ij}) =\int \frac{\boldsymbol{exp}(\boldsymbol{\alpha_{ij}} + \boldsymbol{\beta_{mean}}\boldsymbol{Z_{ij}} + \eta_{ij})}{\sum_{j=1}^{3}\boldsymbol{exp}(\boldsymbol{\alpha_{ij}} + \boldsymbol{\beta_{mean}}\boldsymbol{Z_{ij}} + \eta_{ij})} \int (\eta_{ij}\backslash\, \Omega\,)d\eta_{ij}$$

The IIA property will not be exhibited and different substitution patterns might be attained by suitable specifications of f (Hensher et al., 2005). The utility function in the RPL model estimated from the above equation can be expressed as:

$$V_{ij}=ASC_j+\beta_{mean\,j}Z_{ij}+\beta_{stdj}Z_{ij}$$

Where Z_{ij}denotes a vector of ecosystem restoration attributes of an alternative j(j = A, B, C) within the choice sets, k attributes,$\beta_{mean\,j}$ is the vector of coefficients of these attributes, β_{stdj} is the vector of standard deviation parameters or random parameter.

The experiment in this sample is unlabelled or generic where the options provided to households are unbranded. For generic or unlabelled formats, households are unable to associate the options to any specific programme, that is to say they are unable to brand the alternatives available; however they can identify the 'neither' as being the status quo. Hensher et al.2005 suggested that for an unlabelled experiment a constant term(ASC) should not be included for all the alternatives available, because they are unbranded. Therefore, for this study we did not ASC even if it captures unexplained endogeneity values held by respondents. Therefore, the utility function in the RPL can be expressed as:

$$V_{ij}=B_1Cost + B_2Frequency + B_3Duration + B_4 \text{ time of day}$$

The estimation of the choice model in this research follows the steps recommended by Hensher et al.(2005) to estimate the RPL models, with all parameters of attributes except the cost parameter initially considered as random parameters.

3.5.4. Implicit prices

In a linear statistical model, the β coefficients estimated under the MNL model can be used to estimate the rate at which respondents are willing to trade-off one attribute for another. The tradeoff estimated is known as 'part-worth', an 'implicit price', or the 'marginal willingness to pay'. They demonstrate the amounts of money respondents are willing to pay in order to receive more of the non-marketed environmental attribute:

Part-worth= - (β non-marketed attribute⁄ β monetary attribute)

Estimates of implicit prices are made on a 'ceteris paribus' basis-that is, they are estimates of the willingness to pay of respondents for an increase in the attribute of concern, given that everything else is held constant. Bennett and Blamey (2001), also pointed out that the principles applying to the determination of part-worth can also be applied to derive the willingness to tradeoff between any pairs of attributes. Hence, by division of β coefficients, the marginal rates of substitution across all the attributes, monetary and non-monetary, can be estimated. Such estimates may be useful for policy implementation of the service improvement that restore community well-being, not necessarily by the payment of financial compensation for power losses. The implicit prices are useful in that they demonstrate the trade-off between individual attributes. A comparison of the implicit prices of attributes affords some understanding of the relative importance that respondents hold for them. Based on such comparisons, policy makers are better placed to design improved service alternatives to favor those attributes, which have higher (relative) implicit prices.

3.5.5 Consumer surplus (mean WTP)

A particular strength of choice experiment according to (Alpizar et al, 2001, and Bennett et al, 2001) is its ability to generate estimates of the values of many different alternatives from the one application. Hence, from one set of choice data, the value of an array of alternative ways of reallocating resources has been estimated. This feature of choice experiment arises because it specifically investigates trade-offs between attributes. Thus, different combination of the attributes that had used to describe alternatives can be evaluated. In theory, economic welfare measures are (a) the amount of money(given or taken away) that make a person as well off as they would be before a change, or (b) the amount of money(given or taken away) that make a person as well off as they would be after a change. Depending on how the choice experiment application is designed, it is also possible to use the results to derive estimates of the compensating surplus (CS) or the equivalent surplus (ES) that results from a change in resource use. The former measures the change in income that would make an individual indifferent between the initial (lower service quality) and subsequent situations (higher service quality) assuming the individual has the right to initial utility level. This change in income reflects the individual's willingness to pay (WTP) to obtain an improvement in service quality. On the other hand, ES assumes an individual has implied rights to the subsequent utility level. Hence, it represents individuals' WTP to avoid power outages (Freeman, 1993). Based on the indirect utility functions, the compensating surplus can be illustrated as follows:

$V_0(G_i, Z_0, \mathrm{M}) = V_1(G_i, Z_1, \mathrm{M-CS})$--(3) Where M is income, Z_0 and Z_1 represents different sets of service attributes (Z_0 being usually interpreted as the set of attributes prior to a policy change), and G_i represents other marketed goods. Using the results from the mixed logit model, the CS can be estimated by employing the following equation (Adamowicz et al., 1994).

$$\mathrm{CS} = {}^{-1}/_{(\beta_m)} \{\ln (\sum \exp V_0) - \{\ln (\sum \exp V_1)\} \quad \text{--} \quad (4)$$

Where $B_m$the coefficient of the monetary attributes and is assumed that the marginal utility of income. Equation 4 allows for the valuation of multiple sites. This study considers only one woreda. Therefore, following Boxall et al., (1996) and Morrison et al., (1999), Equation 4 is reduced to

$CS = \{ {}^{-1}/_{(\beta_m)} \} (V_0 - V_1)$ --- (5) Where, V_0 and V_1 represent the initial and subsequent utility states respectively. The model also enables the estimation of welfare changes (compensating surplus) associated with an array of changes in service quality of the electricity away from the "status quo" scenario (current situation).

3.6 THE CHOICE EXPERIMENT SCENARIO

Electricity as a service consists of attributes that respondents identify and value in relation to their preferences. Choice Experiment is a suitable Stated Preference approach rather than Contingent Valuation, because respondents are able to define their preference, select suitable attributes or characteristics and choose an alternative that would maximize their satisfaction. In this study, the policy change introduced to electrified households is the service improvements by increasing reliability. Reliability characteristics or attributes of electricity service were derived from FGDs' participants, energy-related journals, and government official documents. These attributes Include: Time of days, reduced number of outages, and decreased length of outages.

It should be noted that in the electrified FGDs some participants were willing to pay extra to reduce outages or blackouts, from as little as 5birr to as much as 50bir per monthly. Additionally, the FGDs' members stated that the average numbers of blackoutsoccurring in a week ranged from 32 to 36, with an average duration of 3 to 8 hours. The attributes and their levels, description of the attributes and variable type, and their descriptions are presented in Table 3.1.

3.7 DEFINITIONS OF ATTRIBUTES AND LEVELS

Clearly, choosing the attributes to be included in the choice set is a task of crucial importance. As we try to explain in the above, we should identify Attributes and their levels based on the

FGDs and existing literature. Accordingly, the attributes included in the experiment should, in one way or another, be relevant for the policy making process. For example, Frequency of outage is one of the attribute we have identified and used in the study. There is high frequency of power interruption. Due to an overload, this in turns created due to the shortage of electricity services.

1. Frequency of outages: This refers to the average number of outages per month. It would be presented with three frequencies: ones a month, 3 times a month and 5 times a month.

2. Duration of outages*:* This shows how long on average an outage lasts. It would be presented with three durations: one hour, two hours and three hours.

3. Time of outages*:* This is the time of occurrence of the outage. It has two levels: daytime, and nighttime. Daytime refers to the time of day where there is enough daylight and one does not need to turn the lights on.

4. Additional cost: Refers to the cost that is added to the per monthly electricity bill. It has presented with four levels: 5ETB or 25cents per KWHs, 10ETB or 5cents per KWHs, 15ETB or 75cents per KWHs, 20ETB or 1ETB per KWHs.

Table 3.1: Key service attributes for improvement of grid-electricity

Attribute	Detail	Variable type	Levels	Value
Time of the day	Time of a day that outage shall be occurred	Binary	2	Day time Night-time
Frequency of outages	Frequency of outage per month	Categorical	3	1 3 5
Duration of outages		Categorical	3	1 2 3
Additional cost on monthly electricity bill	The additional cost that incurred by the consumer to get reliable electricity service	Continuous	4	5 birr 10 birr 15 birr 20 birr

3.8 EXPERIMENTAL DESIGN AND CONSTRUCTION OF CHOICE SETS

Once the number of attributes and the number of attribute levels are determined, an experimental design strategy needs to be selected. Carlson and Martins son (2003**)** described and compared some of the different design techniques used in creating the CE. One of the designs described is the Fold over design (shifting methods) which is the mirror image of the traditional orthogonal design. In addition, a fold over design defined as a systematic level change or cyclical shifting of the orthogonal design. For example, if there are two options in the choice sets (job A or job B) and the attributes have 4 levels then the fold over design (0=1, 1=2, 2=3, and 3=0) will result in a design that has a higher efficiency (Street et al. 2005).

In our case, we have four attributes, two with two levels, and three with two levels. The full factorial would yield 72 profiles (=$2^1 \times 3^2 \times 4^1$).However, it is very costly to use the full factorial. Therefore, six choice sets, which have 18 choices that satisfied Orthogonality, are generated using fold over design method**(**Louviere et al., 2000).

In the study area, the average number of electricity units consumed by households is 15 kWh per month (EEPCO, 2015). In this CE study, the average household was assumed to consume an average of 20 kWh, paying around 13 birr or 0.59 USD inclusive of all tax charges. Based on, this we assigned four-level cost structure in the experiment: 5 birr (25cents per KWh), 10birr (50 cents per KWh), 15birr (75cents per KWh) and 20birr (1birr per KWh) .There is few set of guidelines in CE construction in relation to attributes and their levels. Any choice set that dominates the experiment, in other words the choice set that is easily preferred (or avoided) by respondents, needs to be omitted. Moreover, the number of attributes and levels has to be kept modest, to avoid confusion or fatigue of the respondents. The number of choice sets created is orthogonal in nature, that is to say the choice sets are independent of each other, and is determined by the fold over design Orthogonality as it is a ‘desirable property’ (Bateman et al. 2002)**,** because it implies there is no correlation among attributes. The fold over design is an alternative to fractional factorial design and maintains the properties of fractional factorial design.

Table 3.2 shows one of a sample of choice set that was provided for the respondents.

	Service A	Service B	Current service
Frequency of outages per month	Outage three times a month	Outage ones a month	Neither Service A nor Service B: I prefer to stay with my current service
Duration of outage per/Hours	Outages for two hours	Outage for three hours	
Time of the day	Day time	Night time	
The additional cost on-monthly electricity bill	10 ETB	15 ETB	
	[ ]	[ ]	[ ]

3.9 THE DEVELOPMENT AND THE DESIGN OF THE QUESTIONNAIRE

The questionnaire consisted of Four parts; one with questions about socioeconomic characteristics and their interest in engaging in the business in the futures. This section of the questionnaire is devoted to questions seeking socio-economic data (age, sex, education status, occupation, income and so on).The second section involves the preference and perception Questionnaires. In order to examine the respondents attitudes towards current electricity service(current price, quality, improvement, the additional cost they would incurred on others fuels during the outages, estimated damage cost due to power interruption and etc). In addition, information regarding attitudes (especially general sentiments regarding the benefits electricity on the environment, on revenue of the nations, for saving the time, for facilitating the business, for providing entertainment, for providing better health and for reducing woman's workload). The third section is the choice experiment; each questionnaire was comprised of six choice sets with three alternatives in each set. Before the choice experiment exercises, the choice scenario description was presented to the respondents.

The description was about features of electricity service, about the attributes and their levels and the payment vehicle. This description could explain the attribute levels in all options. Then the choice sets were presented to them. Hence, the respondents made choices among different hypothetical improvement scenarios of electricity services. Usually this will involve stating that there are many variants to the solution just outlined and people's opinions as to which variant is best for them is a useful input to policy determination (Bennett et al., 2001). In other words, respondents are being asked to have a say in what future policy should look like.

Finally, section four is the follow up questions. These are questions comes immediately after the choice set questions to explore the motivations behind respondents' choices. In particular, these questions should be targeted at picking up any response irregularity such as: Payment vehicle protests or the respondents always choose the status quo (Alpizar et al., 2001; Bennett et al., 2001).

DATA INPUT

Once the data have been collected, they must be entered into a computer. For this study, we used Excel worksheet as a data entry program. The data was first input in wide format. Then we converted the data into the long format for statistical analysis using the reshape command. Stata12 Econometrics Software was used for estimation and analysis.

As with any data set, it is useful to start by ordering the variables in some logical way. One suggestion followed here is to present all the variables in a sequence that first describes how the data are organized (such as respondent identifier, choice set identifier), then present the independent variables from the experimental design (attribute levels) followed by the dependent variable (what option respondents chose).

The variables are:

pid: The first variable is an identification variable unique to each respondent. It will be the same for the first 18 rows, then for the next 18 rows etc.

obsid: Stata requires a variable indicating each unique choice made. This increases successively for each choice.

alt: the alternative within each choice (where alt=1 represents the first alternative, alt=2 the second alternative and alt=3 represents the alternative 3 in each choice set (service A, service B and service C respectively).

Choice set: indicates which choice was presented (there are six choices).

Choice(y): is the dependent variable, indicating respondent's choice of electricity service (service A, service B and c). These service alternatives take the value of 1 for the chosen alternative and zero for those not chosen.

The attributes in this study are a mixture of continuous and categorical dummy variables.

Additional cost: is the attribute taking the values in the dataset that correspond to the levels presented in the questionnaire. Cost was treated as a continuous but fixed variable in the regression analysis, and it was coded by taking its respective level as presented in the questionnaires.

Frequency of outages: per/month is a categorical attribute and it was coded as dummy variable taking the value 1 for daytime outage and 0 for nighttime.

Duration of outages: per/hours is also a categorical attribute and it was coded as dummy variable taking the value 1 for duration 2and 3 while zero for duration 1.

Time of the day: is a binary variable and it is commonly modeled as ordinal or dummy variable taking the value 1for night time outage and 0 for outages that can be occurs during the daytime

As socioeconomic characteristics do not vary within a choice, these should not be added into the regression model directly. Such variables could be created by simply multiplying the variables of interest. For example, if the researcher is interested in whether preferences for cost vary according to the sex of the respondent, he or she can create a variable, “cost-sex”, which is simply “cost*sex”. Nevertheless, in this study we cannot use socioeconomic variables in to analysis as it is beyond the objective of this study.

CHAPTER FOUR

EMPIRICAL RESULTS AND DISCUSSION

4.1 Outcome of Data Analysis Using Descriptive Statistics

Descriptive analysis results shows that among the sample of respondents 57% were male heads and the remaining 43% were females heads. The mean age of the respondents was 46 years. More than 43% of the respondents have no formal education. The mean monthly expenditure for the respondent was 1543ET birr. Concerning the respondent main occupations, about 43% of them engage in farming activities. The average family size of the respondents was 4.4 and the values varied between a minimum of 1 and a maximum of 10.Most of the respondent (62%) have willingness to engage in the business in the future. Among those variables used in the analysis, The variable age, monthly expenditure, family size, monthly income and total number of livestock's are in continuous form, while variables male, education, and willingness to engage in the business are dummy variable.

Table 4.1: Summary of variables used in the models

Variable	Description	means	std.dev	min	max
Male	1if head of HH is male (dummy)	0.57	.4963	0	1
Age	The age of HH head (cont)	45.98	17.59	18	85
Formal educ	1if head of HH has formal education (dummy)	0.567	.4976	0	1
Monthly exp	Monthly expenditure by HH head (cont)	1543841	.48	300	5000
Farm	1 if head of HH is engage in farming (dummy)	0.435	0.3245	0	1
Family size	Total no of family of HH head (cont)	4.3962	.2395	1	10
Income	Total per monthly income of HH head (cont)	4125	6504.4	400	60000
No of live.st	Total no of live stock owned by HH (cont)	3.018	4.998	0	20
Inter in bus	1 if HH head has willing to engage in Business (dummy)	.621	.487	0	1

Source: Own survey, 2016

Perceived benefits from grid electrification

Table 4.3 illustrates most of the respondents appreciated the benefits that are gained from grid electrification. It not only provides high quality of light for the home and education needs, but also saves time and provides more entertainment opportunities. However, some respondents disagreed that electricity services provided better healthy services and likewise few of them did concur with view that it reduced women's work load and physical effort. Moreover, 20% of the respondents were unwilling to accept that electricity provide more entertainment; facilitate starting a business and Reduce poverty.

Table 4.2: Perceived Benefits of Grid Electrification for electrified households

	Save time	Facilitates Starting a Business	Provides more Entertainment	Provides Better Health	Reduce women's work Load	Reduce poverty
Strongly Agree	38.14%	32.84%	27.93%	40.85%	40.64 %	34.23%
Agree	39.93%	36.54%	40.05%	39.04%	42.14%	38.34%
Neutral	8.110%	9.91%	11.71%	9.01%	6.31%	7.21%
Disagree	9.32%	14.91%	13.01%	6.21%	5.61%	11.21%
Strongly disagree	1.8	5.80%	7.31%	4.9%	5.31%	9.01%
Total	100%	100%	100%	100%	100%	100%

n=170 Source: Own survey, 2016

The perception of respondent on the impacts of electricity on the environment and revenue for households

Among all sampled households, around 72%of the respondents perceived that, the impact of electricity on the environment and revenue of nation would be very positive or positive, while, 9% and 15% of the respondents said that, electricity had neither positive nor negative impact on the Environment & Revenue of nations respectively. However, 19% and 11% of the respondents argue that electricity had Negative or Very negative impact on the Environment and Revenue of the nations respectively. The most reason for having negative perception were attributed to lack of awareness, confusion about the question and lack of experience.

Table 4.3 Perceived impacts of electricity on the environment and revenue for HH

What do you think about the Impact of Electricity on the Env and revenue of nation?		
Classifications	The impact of electricity on Environment	The impact of electricity on revenue
Very positive	41.44	45.95
Positive	30.63	27.03
About the same	9.01	15.32
Negative	14.41	10.81
Very negative	4.5	0.9

N=170 sources: Own survey, 2016

Current Electricity Service and Attitudes to the Electricity System for HHs

The electrified respondents' attitudes to the electricity system had summarized as follows. The power supply provided by the electric company perceived as poor or very poor by 83.79% of the respondents, 9.91% perceived as fair and the remaining 6.31 perceived as Good. In addition, 29.73% of the respondents strongly agree or agreed with the statement that their power supply had improved in the last 5 years, 11.71% is neither agree nor disagree with this statement. However, 58.55% of the respondents disagreed or strongly disagreed with this statement.

A very high percentage, 79.28%, of the respondents thought that the price of their electricity is moderate, 15.31% of the respondents argue that the price is high or very high, 5.4% of the respondents thought that the price is very low or low. If during peak periods, the utility company asked its customers to reduce their electrical consumption for a period of 2 to 4 hours, 47.75% of the respondents would be willing to reduce their electrical consumption while 26.13% of the respondents would not be willing to reduce their electrical consumption and the remaining 26.13% are argue that they may willing to reduce their electrical consumption.

Frequency versus Duration of Unplanned Interruptions for HHs

Most of the respondents (98.20%) would be strongly agree or agree with the question that says frequent short interruptions are worse than one long interruption.

Table 4.4 shows the respondents responses' towards frequency Vs duration of unplanned power interruptions.

Frequent short interruptions (30 minutes or less) are worse than one long interruption (more than 30 minutes)	Response	Percentage
-Strongly agree	69	62.16
-Agree	40	36.04
-Neutral	1	0.9
-Disagree	1	0.9
-Strongly disagree	0	0.0

Source: Own survey, 2016

Households fuels usage

Among electrified respondents, only a few of them i.e. 23.42% use electricity for both cooking and lightening purpose. While 76.58% would not use electricity for cooking purposes. Meaning that, the majority of electrified respondents use electricity only for lightening purposes and most of them use biomass fuels such as wood, charcoll, animal dung, crop residue and leave for cooking purpose. The reason why they did not use electricity for cooking purpose is due to unreliability of the service and fear of cost on monthly bill, for buying electric stoves and lack of awareness about electricity. Moreover, 38.29% of them thought that, they did not use electricity due to unreliability of the electricity services and 10.29% of them argue that they did not use electricity for cooking purpose for fear of cost while the remaining **28%** even they didn't know whether it is possible to use electricity for cooking purposes.

14.41% of the respondent use only candle for lightening during the outages,32.43% use kerosene lamp,13.51% use electric lantern(battery powered),13.51% use solar,2.7% of them use generator for lightening purpose and the remaining percent use candle & kerosene, candle & battery powed,kerosene & battery powered for lightening purpose.

Table4.5: Percentage of fuel expenditure for electrified sample

	In terms of (ETB)
Total monthly electricity expenses	31.8
Total monthly fuel expense	366.48
Total monthly electricity and fuel expense	398.28
Fuel expenditure as share of total expenditure	25.8%

Source: Own survey, 2016

Damage cost on the HHs due to frequent outage

About 81.98% respondents thought that there is different in costs paid for months with longer hours of outage and 18.02% said that there is no different in costs paid for months with longer hours of outage. In addition, 66.67% of the respondents argue that they suffered damage of appliances or equipments resulting from abnormal power release. While 33.33% of them did not suffered damage of appliances or equipments resulting from abnormal power release and for those who suffered damage, the estimated Total cost of the damage is about 17,540birr.

Preferred Interruption Time for Unplanned Outages

About 16.22% of the respondents said that outage during daytime is the most disruptive, for 39.64% of them outage which occurred at the night is the most disruptive time and for 44.14% of respondents both day and night outage time are equally disruptive.

4.2 ANALYSIS AND DISCUSSION IN CHOICE EXPERIMENT METHOD:

In this survey, choice set includes three alternatives including statuesque option so a conditional logit and mixed logit have been examined though it is the latter model, which offers a better fit and is preferred for capturing the taste preferences amongst individuals.

4.2.1 THE CONDITINAL LOGIT MODEL RESULTS

Table 4.6 shows the results of the conditional logit model, which indicates that, the attributes such as Frequency of outages, time of day(nighttime) and cost attribute is significant at 1% level of significance. In addition, the mean coefficients of the attributes such frequency of outage, time of outage (nighttime outage) and additional cost is negativeas expected. Respondents preferred fewer outages as indicated by the negative and significant signs for frequency. The negative coefficient of time of outage(nighttime) shows that the respondents do not prefers the outage that occurs during the nighttime. For the cost attribute, this coefficient is negative, because the utility of selecting an increase in service reliability decreases with higher payments. Moreover, the base case scenarios for each of these two attributes are simulated where the ratio of each attribute mean to the cost coefficient yields the implicit WTP estimates, excluding the SED interaction effects.

N/B The attribute duration of outage is insignificant. Therefore, we drop them from our models.

Table 4.6The Conditional logit model

Conditional logit model			
	Coefficient	Std.err	P-Value
Frequency of outage per monthly	-0.3212488	0.0406279	0.000
Time of outage (nighttime)	-0.2153256	0.0972576	0.027
Additional cost (per KWh)	-1.641671	0.6703137	0.000
Pseudo ρ2	0.4332		
Log likely hood	-635.10196		
NO	3060		

Source: Own survey, 2016

In this study, the existence of the IIA needs to be tested using the Haussmann test. Haussmann and McFadden (1984) developed the Haussmann test to investigate the presence of IIA. Under the IIA assumption, the removal (or addition) of any or all of the alternatives should not alter the ratio of probabilities of any two alternatives. However, the Haussmann test for conditional logit model implies that the removal of alternatives does affect the probabilities, and hence the IIA assumption does not hold (Hensher et al.2005). When the IIA is violated, the alternatives are cross-correlated, hence the CLG is biased and other model is explored to relax the IIA. One such model is the MXL or random parameter logit model (RPM), which allows for heterogeneity when the random parameter varies with the distribution.

4.2.3 THE RANDOM PARAMETER LOGIT MODEL

Table 4.8 depicts the estimations for the RPM, with the mean coefficients for attributes being significant. The signs of coefficients of all attributes are similar to the previous conditional logit model. Moreover, for the random parameters, the standard deviation are positive and highly significant at the 1% level for frequency of outage and time of day (nighttime).The significant standard deviation for those attributes reveals that, there is heterogeneity across individuals with respect to the effect of the independent variable on the alternative service chosen.

The goodness of fit, using the log-likelihood, indicates that there are high improvements in RPM than CLG model. Therefore, the MXL model is fits the data well than the CLG model. Moreover, what distinguishes MXL as an advanced model from CLG is the highly significant standard deviation of the random parameters at 1%, indicating that there is a structural advantage in mixed logit model.

Table 4.7 the random parameter model

	Random parameter model		
	Coefficient	std.err	P-Value
Frequency of outage per monthly	-0.3831775	0.487749	0.000
Time of outage (nighttime)	-0.2866101	0.1351292	0.034
Additional cost (per KWh)	-1.72608	0.487749	0.001
Standard deviation of Random Parameter			
Frequency (five times per month	0.1393567	0.0235065	0.000
Time of outage (nighttime)	1.032576	0.1735959	0.000
Pseudo ρ2	0.27		
Log likely hood	-620.80813		
NO	3060		

Source: Own survey, 2016

4.3 Welfare Analysis

The marginal WTP for a certain attribute given our assumptions about a linear income effect is the ratio of the attribute coefficient and the marginal utility of income (**Hanemann, 1984**), where the coefficients for the cost attribute is interpreted as the marginal utility of money. Table4.8 presents the marginal WTP for the attributes and 95% confidence interval. The results indicate that the highest marginal willingness to pay is for the Frequency of outage attribute as they expect that reduction in frequency of outage will reduce the extra costs, which they incur on repairing the damaged equipment during frequent outage. Next to frequency of outage attribute, the respondent is higher marginal WTP for time of outage (nighttime). The reason is they expect that decrease in outage that was occurs during the night time should reduce the extra cost they incurs on candles and kerosene. In general, respondents would be willing to pay about 19cents per KWHs for reducing frequency of outages from current to improved frequency, about 13centsfor reducing unannounced outage that occurred during nighttime

Table 4.9:Marginal WTP for Reliable electricity service in terms of Ethiopian birr.

	MWTP	Std.Err	P-Value	95% Confidence
Frequency of outages per month	.195684	.0392666	0.000	(-.2726451 ;-.1187229)
Time of outage (nighttime)	.1311625	.0717282	0.067	(-.2717472; .0094222)

Source: Own survey, 2016

Consumer surplus (mean WTP)

Consumer surplus or mean WTP:-the amount of money(given or taken away) that make a person as well off, as they would be after a change. It represents the amount of money that individuals' are willing to compensate to get improved electricity services.

Consumer surplus (mean WTP) can be calculated as:

CS = { $^{-1}/_{(\beta_m)}$ } $(V_0 - V_1)$ --- (5) Where, V_0 and V_1 represent the initial and subsequent utility states respectively. The model also enables the estimation of welfare changes (compensating surplus) associated with an array of changes in service quality of the electricity away from the "status quo" scenario (current situation).

The attribute levels that characterize of alternative electricity service improvement scenario is listed below, along with the current situation/status quo attributes:

Current ***situation/ status quo scenario***

- High frequency of outages(180 outages per month)
- There is no constant time for outage(the outage that occur every time)

Improvement scenario 1

- Frequency of outage per monthly (ones per month, three times per month and five times per month)
- There is a constant time for outages(outage occur during night time)

As explained above, those Attribute (Duration of outage) is statistically insignificant. Therefore, we can calculate the MWTP as well as mean WTP only for those attributes that are statistically significant .i.e. For Frequency of outage and Time of day (nighttime).So; we can calculate CS only for scenario 1 as follows:

Table 4.10, Estimates of Compensating Surplus (CS)

Alternative improvement scenario	WTP(birr per KWHs) MXL model	WTP (birr per month
Improvement scenario 1	0.998(0.0453USD)	19.96(0.906USD)

Source: Own survey, 2016

Estimates of compensating surplus (CS) are calculated using the above equation (Eq.5); to use this equation for estimating compensating surplus it is first necessary to calculate the utility associated with the current option and the option being considered. Using the mixed logit model, this is achieved by substituting the model coefficients and the attribute levels for the current option.

The value of the utility of the alternative option is estimated in a similar way. The compensating surplus for the change from the status quo to the new scenario is then estimated by calculating the difference between these two values, and multiplying this by the negative inverse of the coefficient for the cost attribute.

Estimates of willingness to pay for scenario 2 are presented in Table 4.12. These are the marginal estimates, showing willingness to pay for a change from the current situation. It can be seen from the estimates that, the CS for the change from the status quo to the scenario considered increases as we move towards improved electricity services. Based on mixed logit model, which has a better fit, mean WTP for scenario 1 is 99cents per KWHs, which means 19.96ETB per month and per person.

The amount of monthly WTP19.96 ETB(USD 0.906) in Ethiopia is quite low compared with those countries, e.g. Turkey 6.65YTL(5.6USD)(Ozbafli,2011) and for unplanned outages, the Swedish households were WTP 9.39SEK (0.94USD) and 223.01 SEK (25.25USD) correspondingly (Carlsson and Martinsson, 2005).Relatively low level of the mean WTP for improved electricity service in this study may be explained by lower price of electricity, low ability to pay, lack awareness about the use of electricity service, most of the consumers in low-income countries like Ethiopia used electricity only for lightening purposes. Therefore, the cost of power outages is low compared to those consumers of Swedish and Turkey etc.

The benefits derived from improvement scenario can be compared to cost of these improvement projects so that a benefit-cost analysis can be made. However, this is beyond the scope of this paper.

SOCIAL WELFARE (Aggregate mean willingness to pay)

Social welfare is the total willingness to pay by the total population in the woreda. It can be calculated by multiplying mean WTP with the total number of electrified households in Kuyu woreda as follows: Social welfare=19.96*24,484=488,700ETB per month. Generally, households in Kuyu woreda are willing to pay 488,700ETB per month in order to get improved electricity service, ceteris paribus (Own survey, 2016).Comparing this with the estimate of current monthly revenue, the revenue without improvement (the current revenue) is estimated to be 328085.5ETB per month. While if electricity services will be improved, the monthly revenue will expected to increase from the current to 816,786ETB per month

CHAPTER 5 CONCLUTION AND RECOMMONDATION

5.1 CONCLUTION

This paper measures how households' value the various electricity service attributes and testing their preferences for quality service as it is important to assess what value society places on it and hence it helps to provide information that can be used to better understand the benefits of improved electricity service and for tariff adjustment, using the choice experiment (CE) method.

In this study, each choice set consisted of three alternatives (two improved services and the current service) and each alternative had four attributes. The attributes of an electricity service included in the CE were frequency of outages, duration of outages, time of outages (nighttime) and additional cost per KWh. Approximately, none of the respondents chose the status-quo.

The conditional logit model and the random parameter logit model were used as analysis tools and their result were compared. Accordingly, the higher log-likelihood in the Random parameter model than in that of CLG model shows that the MXL model fits the data well than other model. The implicit price for each service attributes are estimated. Accordingly, respondents would be willing to pay about 19cents per KWHs for reducing frequency of outages and about 13cents for reducing unannounced outage that occurred during nighttime.

The compensating surplus estimates of the MXL results showed that respondents are willing to contribute approximately 99cents per KWh or 19.96ETB (0.906 US$) per month per person for scenario changes from the status quo to service improvement. This suggests social benefits of about 488,786ETB per month in order to get improved electricity service.

5.2 **RECOMMONDATION**

Poor quality electricity service in terms of unannounced frequent outages and long period of outages is occurring at any time is one of the critical problems facing the energy sector. This leads to losses of many sorts on the part of the customers.

Most of the loss happens during distribution from the national grid to end users. Because, EEPCO used the equipment, which has low quality. Using such types of equipments resulted in power failure. Therefore, it is recommended that, government should, invest not only on additional generation capacity but also invest heavily on transmission and distribution capacity to improve electricity supply and by subsequently increase electricity tariff with improvement in services since peoples are willing to pay for it.

The reliable electricity service will produce the desired effect of raising the living standard of the target population since electricity is necessary for running business in addition to lighting; including flourmills, bakery, barber or beauty salon, garage, small-scale industry and the like. The program is expected to change the quality of life for the better. Improving the quality of electric supply can also ensure sustainable development through reducing pressure on the environment, in line with the Green Growth policy of the nation.

Around 76.58% of the respondents reported that they did not use electricity for cooking purposes. Meaning that, the majority of electrified respondents use electricity only for lightening purposes and most of them use biomass fuels such as wood, charcoal, animal dung, crop residue and life for cooking purpose. The reason why they did not use electricity for cooking purpose may be due to unreliability of the service, fear of cost on monthly bill, for buying electric stoves and lack of awareness about the use electricity services. Therefore, we recommended that, Government should create public awareness on the uses and importance of electricity compared to other sources of energy.

In improving the quality of electricity, priority should be given to reducing frequency of outages and choosing favorable time of outage, in that order.

Further studies are recommended to make the cost- benefit analysis of improvement project so that, the benefits derived from improvement project can be compared to the costs to be incurred in providing a reliable electricity supply system such as the one used in the hypothetical case.

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APPENDIXES

QUESTIONNAIRES FOR ELECTRIFIED HHS

SELF-INTRODUCTION

My name is…………………………………and I came from Addis Ababa University and I am on the way of doing my MSc thesis on HHs willingness to pay for improved electricity service in the case of this woreda.So,I want to collect survey data related to electricity service

Dear respondent,

Your participation in the survey is voluntary. Your participation and opinions is important for the success of this study. You have been randomly selected for this independent survey. The results can be used by the Government in their evaluations of alternative electricity improvement projects, as well as in setting the appropriate tariff that reflect opportunity costs once the best alternatives are chosen. Your answers to this questionnaire will be completely confidential.

Anybody who can represent the head of your household can complete this survey. Please answer the questionnaire on behalf of all members of your household. There is no right or wrong answers-we are interested in your opinions. Your answer will be strictly confidential. We anticipated that it would take no more than 10 minutes to complete the questionnaire. Consent to participate in this study is implied by completing the questionnaire.

Thank you!

SECTION 1: SOCIO ECONOMIC CHARACTERISTICS

1. Sex: A. Male B. Female

2. Age: ------------------years

3. Your Educational Level:

A. No formal education B. Elementary school---------------

C.Secondary school-------------------- D. Technical College E.University degree

4. On the average how much do you spend in this household in a month? -------------------------------------
----

5. What is your main occupation?

A. Public (government) B.self -employed (Farm)

C.Self-employed (non-farm) D.Other (specify) ---------------------------------

6. Do you have other jobs you do besides your main occupation? If yes, what are they...?

…………………………………………………………………………

……………………………………………………………………………

7. How many individuals are in this household? ....

8. How many of them are not working? ....

Males under 15_____________

Females under 15____________

Members over 65________

9. What is the total household monthly income? I.e. The sum of incomes of all persons who are working in this household in a month ………………….birr

10. Number of livestock if applicable

11. Other valuable assets (e.g. car) _________

12. Are you willing to engage in the business in the feature?

A. Yes B. No C.Not sure

SECTION 2: PREFERENCE AND PERCEPTION QUESTIONNAIRES FOR ELECTRIFIED HHS

At present, your house is electrified and one company, namely, Ethiopian Electric Power Corporation (EEPCO), distributes the electricity. Electricity is available for 24 hours. However, there are reliability problems, such as, the present number of unannounced outages (or blackout) which 84 times per month, with a time of two hours per outage (or blackout). Accordingly, you should be incurring additional cost on other alternative energy sources such as Candle, Kerosene lamp; fuel wood, charcoll and this alternative energy have an impact on your health and the Environment. In addition, when there is electricity outage, water is not available and there is no net work for mobile as well as bank services. So, improvement is needed.

For electricity system overall what is your opinion on the following matters? Choose, the answer, which best describes your opinion for each of the Following

1. In general, the power supply provided by electric power company is

A. Very good B. Good C. Fair D. Poor E. Very poor

2. Our power supply has improved in the last 5 year

A. Strongly agree B.Agree C .Neither neither agree nor disagree (Neutral)

D.Disagree E.Strongly disagree

3. I think that the price of our electricity is

A. Very low B. Low C. Moderate D.High E .Very high

4. If during peak periods, the utility company asked its customers to reduce their electrical consumption for a period of 2 to 4 hours, would your household be willing to reduce its electrical consumption.

A. Yes B.No C.May be

5. Electricity can save time.

A. Strongly agree B.Agree C.Neither agree nor disagree (Neutral) D.Disagree E.Strongly disagree

6. Electricity can facilitate starting a business.

A. Strongly agree B.Agree C.Neither agree nor disagree (Neutral) D.Disagree E.Strongly disagree

8. Do you use electricity for cooking a. yes____________ b. NO____________

If your answer is no why? A. Not reliable____________ b. too costly_____________ c. other (specify)
____
____

8. Electricity provides more entertainment.

A. Strongly agree B.Agree C.Neither agree nor disagree (Neutral) D.Disagree E.Strongly disagree

9. Electricity provides better health.

A. Strongly agree B.Agree C.Neither agree nor disagree (Neutral) D.Disagree E.Strongly disagree

10. Electricity reduces women’s workload.

A. Strongly agree B.Agree C.Neither agree nor disagree

(Neutral) D.Disagree E.Strongly disagree

11. Electricity is necessary to reduce poverty and improve the health of citizens.

A. Strongly Agree B. agree C.neutral D.Disagree E.Strongly disagree

12. Compared to biomass fuel, the impact of using Electricity on the Environment would be:

A. Very positive B. positive C.About the same

D.negative E. Very negative

13. Compared to biomass fuel, the impact of using Electricity on the Revenue of the nation would be:

A. Very positive B. positive C.About the same

D.Very negative E.Some what negative

14. Frequent short interruptions (30 minutes or less) are worse than one long interruption (more than 30 minutes). E.g., four 30-minute interruptions in a day are worse than one 2-hour interruption.

A. Strongly agree B.Agree C.Neither agree nor disagree

(Neutral) D.Disagree E. Strongly disagree

15. Which of the following actions your households use for lightening purpose for preparations of the failures? Please choose one or more of the following.

A. Candle B.Kerosene lamp C.Electric lantern (battery powered)

D. Solar E. Others

16. Which of the following fuel types does your household use for cooking purpose? Please choose one or more of the following fuel types.

A.Eletricity B. Wood C .Animals dung

D.Lief E.Crop residue F. Others

17. Apart from electricity, how much cost you incurs on kerosene and other fuels per month in average---------------------.

18. When is an unplanned outage of uncertain duration most disruptive for your household, Daytime or Nighttime?

A. Day time B. Night time C. Both equally disruptive

D. None E.All equally disruptive F.None

19. How much does your household currently pay every month for electricity received from the electricity company...?

20, is there any different in costs paid for months with longer hours of outage?

No_______________ b. yes________________

21, Has your household ever suffered damage of appliances or equipments resulting from abnormal power release? A. yes_____________ b. no______________

22, what is the estimated cost of the damage in birr? ________________________

SECTION 3: WILLINGNESS TO PAY FOR IMPROVED ELECTRICITY SERVICES

We will now ask some questions regarding your household's willingness to pay to avoid power outages. The following characteristics and the levels each characteristic may take will define your electricity service:

1. Frequency of outages: This refers to the average number of outages per month. You will be presented with three frequencies: twice a month, 5 times a month and seven times a month.

2. Duration of outages: This shows how long on average an outage lasts. You will be presented with three durations: one hour, two hours and three hours.

3. Time of outages: This is the time of occurrence of the outage. You will be presented with two times: daytime, and nighttime. Daytime refers to the time of day where there is enough daylight and one does not need to turn the lights on to read.

In order to provide improved electricity services, the Government has to make major capital investments and cover maintenance costs of the new project. The level of investment and maintenance costs required to provide a service depends on the levels chosen for each of the attributes defined above. The Government will pay for this investment and maintenance costs by collecting money from the electricity users. For example, reducing the number of outages requires higher investment and maintenance costs and as a result, the tariff charged to the users will be higher.

We will show you 4 choice-sets one by one. In each choice set, you will be presented with two electricity service alternatives. For each alternative, we will state the frequency, duration, time and Duration of power outages. These characteristics are identical throughout the choice sets. However, their levels will be changed.

An example of a choice set is shown below. For each set, we want you to state which alternative you think is best for you and your household. Note that your choice will not affect anything other than the frequency of power outages, the duration of outages, the time of outages and your monthly electricity bill, everything else remains as it is today'

Q.1 Assuming That the Following Two Services and Your Current Service Were the Only Choices You Have, Which One Would You, Prefer

CHOISE SET ONE

	Service A	Service B	Current service
Frequency of outages per month	Outage three times a month	Outage ones a month	Neither Service A nor Service B: I prefer to stay with my current service
Duration of outages (Hours)	Outages for two hours	Outage for three hours	
Time of the day	Day time	Night time	
The additional cost on monthly electricity bill	10 ETB	15 ETB	
	[ ]	[ ]	

CHOISE SET TWO

	Service A	Service B	Current service
Frequency of outages	Outage five times a month	Outage three times a month	Neither Service A nor Service B: I prefer to stay with my current service
Duration of outages	Outages for one hour	Outage for two hours	
Time of the day	Day time	Day time	
The additional cost on monthly electricity bill	10ETB	10 ETB	
	[ ]	[ ]	

CHOISE SET THREE

	Service A	Service B	Current service
Frequency of outages per month	Outage ones a month	Outage five times a month	Neither Service A nor Service B: I prefer to stay with my current service
Duration of outages (Hours)	Outages for three hours	Outage for one hour	
Time of the day	Night time	Day time	
The additional cost on monthly electricity bill	15 ETB	10 ETB	
[ ]	[ ]	[ ]	

CHOISE SET FOUR

	Service A	Service B	Current service
Frequency of outages	Outage ones a month	Outage three times a month	Neither Service A nor Service B: I prefer to stay with my current service
Duration of outages	Outages for two hours	Outage for one hour	
Time of the day	Day time	Day time	
The additional cost on monthly electricity bill	20ETB	15 ETB	
	[ ]	[ ]	

CHOISE SET FIVE

	Service A	Service B	Current service
Frequency of outages per month	Outage three times a month	Outage five times a month	Neither Service A nor Service B: I prefer to stay with my current service
Duration of outages (Hours)	Outages for three hours	Outage for two hours	
Time of the day	Day time	Night time	
The additional cost on monthly electricity bill	10 ETB	5 ETB	
	[ ]	[ ]	

CHOISE SET SIX

	Service A	Service B	Current service
Frequency of outages	Outage five times a month	Outage ones a month	Neither Service A nor Service B: I prefer to stay with my current service
Duration of outages	Outages for one hour	Outage for three hours	
Time of the day	Day time	Night time	
The additional cost on monthly electricity bill	10 ETB	15ETB	
	[ ]	[ ]	

SECTION 4 FOLLOWUP QUESTIONARY FOR THOSE WHO CHOOSE THE CURRENT SERVICE

Q1, I notice that you responded the current service to all choice set presented for you. Did you choose that option because …

1, You are happy with the current service; the current service is good; the current service is not too bad.

2, The alternatives in the choice sets are not any different from the current service.

3, The recent electricity price increases (afraid the prices will increase more).

4, The current service is financially better.

5, Others

6. No specific reason