College Development Studies
Department of Environment and Sustainable Development

Households' willingness to pay for box type solar cooker: in selected Condominium Site residents, Addis Ababa, Ethiopia

M.A. Thesis

By

Seife T/Maryam

Advisor: Dawit Direba (PhD)

August, 2021

Addis Ababa, Ethiopia.

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A thesis submitted to Addis Ababa University College of Development Studies Department of Environment and Development for Partial Fulfillment of the Requirements for the Degree of Masters of Art (MA) in Environment and Sustainable Development

M.A. Thesis

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DECLARATION

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This is to certify that the thesis prepared by **Seife T/Maryam** entitled: **Households' Willingness to pay for box type solar cooker with a glazing wiper mechanism: in selected condominium Site residents, Addis Ababa, Ethiopia** and submitted in partial fulfillment of the requirements for Degree of Masters of Arts in Environmental and Sustainable Development, complies with the regulations of the university and meets the accepted standards with respect to originality and quality.

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Acknowledgements

First and foremost, I would like to express my heartfelt thanks to my advisor, Dr. Dawit Diriba, for his unreserved comments and advices that shaped the thesis. What is more, I thank him for his unconditional and wholehearted intellectual advices throughout the research process.

I express my sincere gratitude to my family: Mestawot Sheferaw (my mother) who put her all effort to support and encourage me to continue my education to this level, Fasil (my brother), and his wife Etatu Yohanes for your continues support, Yeshimebet and Mekdelawit (my sisters) and Surafel, Eyob, &Neway (my brothers) for all the financial support you provided to me during my study. I always owe you gratitude for no journey would be possible without having you by my side.

My sincere gratitude goes to Rediet Gebru (my wife) for all the encouragement and being there for me. Finally yet importantly, I would like to warmly acknowledge also the assistance, and technical supports of Abraham and Kefle in the journey of this study.

ABSTRACT

This examination was chiefly pointed toward assessing the tested families' ability to pay for sun oriented cooker with a coating wiper instrument in the investigation region. All the more explicitly, this examination attempted to evaluate the socio-segment attributes of the family units, gauge ability to pay for box type sunlight based cooker with a coating wiper instrument and to break down determinants of eagerness to pay. In the investigation, the technique for Contingent Valuation (CV) was utilized to direct a top to bottom meeting with 248 families who dwells in the condo locales of the chose woredas of Addis Ababa city. Probit model was utilized to investigate the deciding variables of WTP. Notwithstanding probit model, bi-variate probit model was also additionally utilized. The mean eagerness to pay was assessed to be Birr 7280 (186.7 USD) per family unit. Which is higher than the current market cost of the planned sun oriented cooker, for example normal of Birr 6500 (166.7 USD).The total WTP for the proposed is 1,442,168,000 birr, and from open finished inquiries the complete WTP was additionally figured as 1,386,700,000 birr. The exact discoveries on the determinants of WTP demonstrated that pay of the family, house status, family unit size; schooling level, female heads, hitched heads, admittance to environmentally friendly power energy data and distance from home to the closest wood and charcoal market were significantly and emphatically influencing family ability to pay for the proposed framework. Then again the offer offered, and age of the head, were found to have significant reverse relationship with eagerness to pay. A portion of the emphatically influencing factors, (for example, pay, house status, schooling, and family size) are critical to enabling choice makings.

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List of Acronyms and Abbreviations

CM	Choice Modeling
CVM	Contingent Valuation Method
CSA	Central Statistical Agency
EEPC	Ethiopian Electric Power Corporation
ENEC	Ethiopian National Energy Committee
FAO	Food and Agricultural Organization
GDP	Gross Domestic Product
GTZ	German technical cooperation /Germany word/
IEA	International Energy Agency
IHDP	Integrated Housing Development Program
KG	Kilogram
KGOE	Kilogram of oil Equivalent
KWH	Kilo Watt Hour
LPG	Liquid Petroleum Gas
MCA	Mega Calorie Equivalent to 1000 kilocalorie
MoA	Ministry of Agriculture
MoWE	Ministry of water and energy
MoRD	Ministry of Rural Development
MTOE	Metric Tons of Oil Equivalent
SPSS	Statistical Package for Social Science
TOE	Tons of Oil Equivalent
UNDP	United Nations Development
UNEP	United Nation Environment program
UNICEF	United Nations International Children Educational Fund
WTP	Willingness to Pay
WEO	World Energy Outlook
WHO	World Health Organization

CHPTER ONE

1. Introduction

1.1. Background of the Study

Over history, energy services are an essential input to economic and social development. A modern form of energy, of which electricity is part, is a prerequisite for sustainable development and overall improvement in the quality of life. Reliable electricity supply can stimulate economic growth that will have beneficial spillover effects on households living in poverty and helps to ensure environmental sustainability by cutting down the consumption of wood based fuels such as charcoal and firewood (Kuunibe, et al., 2013).

In Ethiopia, energy supply largely comes from biomass sources, which account for about 91% of total energy consumed. Biomass energy, in the form of firewood and charcoal, is largely used by households in cooking (Bryan, et al., 2018). According to the World Bank, (2018b), as at 2014, energy consumption from fossil fuel stood at 6.1%, out of which the transport sector consumed 46.8%. Energy supply for electricity in Ethiopia represents only 2% of the total energy use and is almost entirely dependent on hydro. Evidently this translates into poor electricity access, as about 70% of the Ethiopian population live without electricity. Though Ethiopia is endowed with vast energy resources such as hydro, solar, wind, geothermal, biomass, coal and natural gas (Mengistu, et al., 2015), the country has not yet been able to develop, transform and utilize these resources for optimal economic development (CSA, 2012).

Despite the huge resources allocated to the expansion of renewable electricity and supply thereof, there is huge unmet demand for electricity. Most of Ethiopian populations are not connected to the national electricity grid (especially the rural part). In Ethiopia, total demand for electricity grows at an average rate of 15–20% percent annually (Kifle, 2015). Even for the urban and peri-urban households connected to the national grid, service is not satisfactory. Ration, blackout (power outage) for long hours and intermittent supply (power goes off only to come back instantly or in a few minutes) are all too common as far as electricity service is concerned

in Ethiopia. While the ration arises from insufficient generation of electricity, intermittent electricity and outage result from technical or mechanical and management problems.

The use of solar energy for the purpose of cooking food presents a viable alternative to the use of fuel wood, kerosene, and other fuels traditionally used in Ethiopia. It is estimated that about 25% of the income of poor families is spent on cooking fuel (SCI, 2013). It will be more economical for these families to use solar cookers. While certainly solar cookers cannot entirely halt the use of combustible fuels, it can be shown that properly applied solar cooking can be used as an effective mitigation tool with regards to global climate change, deforestation, and economic debasement of the world's poorest people (Melkamu, 2013).

According to Solar Cookers International, countries with the greatest potential benefits from solar cooking include Haiti, Somalia, Ethiopia, Niger, Pakistan and the Dominican Republic, but with deforestation and growing fossil fuel scarcity this could increase dramatically. Currently it is estimated around 500 million people would benefit from solar cookers.

Solar cookers are an easy way to use less firewood and save money. Families in the developing world spend 20 – 30% of their income on fuel for cooking, yet in many places there is a much cheaper way of cooking –using the sun. Solar cooking will never fully replace traditional forms of cooking but can complement it and radically cut down on fuel costs. Solar cookers can be made out of cardboard boxes and can last for years – they are produced cheaply and sold cheaply too – making them attractive to families in the developing world. Solar cooking will never replace fully other energy methods; it is an addition to traditional cooking methods.

It appears that limited consideration has been given to the energy infrastructure transition process in urban households from commonly used fuel types, such as firewood, charcoal, gas, and animal byproduct. By ignoring the potential of renewable energy technologies to serve as supplementary and/or alternative energy carriers, opportunities to potentially alleviate the detrimental socio-economic impacts that commonly used fuel types have on urban households are missed. This also prevents the increase of energy access and more reliable energy supply, in particular for urban households, and generally in Ethiopia.

Also, much of the planned expansion in energy generation is earmarked for export to neighboring countries rather than to meet local demand. Because of this, the reliability and quality of power output will remain poor in the near future, and pointed to the need for solar power systems as an alternative, clean, safe and reliable option in the household energy mix, particularly in urban areas (SEI, 2015).

Concerning the city's energy sector, a report of the UN-Habitat on the state of Addis Ababa in 2017, indicated that residents are gradually shifting to modern sources of energy for cooking and lighting; as such, the demand for electricity keeps growing whilst supply remains inadequate. The effects of a higher electricity demand and the inadequate supply are evident in the form of frequent power outages in Addis Ababa (UN-Habitat, 2017). Also, Addis Ababa is the leader in terms of average monthly energy expenditure and its share in the overall monthly household budget from other cities of the country. Expenditure Share of Energy is about 12.05 % which implies that energy budget is significant in Addis Ababa. And kerosene is the major cooking fuel consumed by about 85 percent of the households in the city (Samuel, 2015).

Cooking, especially that of the traditional bread injera, accounts for 85% of household energy use in Addis. 6% is used to heat water and space, and an average of just 1% is used for lighting. All fuels in Addis Ababa are purchased. As income increases and urbanization continues modern fuel will become an increasingly important fuel source. Urban dwellers may be forced to take commercial fuels to meet their daily requirement (Fikre, 1995).

A progressive shift to cleaner fuels and technologies for basic energy needs is a cost-effective means of creating new development alternatives, reducing health impacts and mitigating environmental degradation. This has led to renewed optimism regarding the feasibility of programs to address household energy access in developing countries. (Schlag and Zuzarte, 2008)

Colenbrander et al., (2015) found that promoting solar energy and other low carbon energy technologies in cities is proactive and will save expenditure on consumer utility bills, governments' subsidies and save costs of investments in energy infrastructure. Moreover, metropolitan households have also been proven to be the most willing to pay for Renewable Energy Technologies (RETs) than rural residents (Soon, and Ahmad, 2015).

As private investment is a necessity to get enhanced diffusion of renewable technologies in decentralized mode, several incentives and subsidies have been promoted in the recent years as major policy instruments for attracting investments in the renewable energy sector. Unfortunately, Ethiopia has achieved no remarkable success in such approach of decentralized electrification as an alternative to traditional energy sources and complements the unreliable grid extension in the urban areas.

Therefore, an alternative renewable source of energy should be assessed not only as substitute to power supplied by the government but also to reduce costs using solar thermal energy system. The use of solar energy equipment in residential areas can play a significant part in tackling the power deficit and environmental challenges. Indeed, because of the abundance of its sunny days, the solar energy represents an important alternative for heating, cooling and ventilation.

1.2. Statement of the problem

It is expected that, the Ethiopian population will continue to grow for several decades to come. Energy demand is likely to increase even faster, and the proportion of energy supplied by hydroelectricity will also grow at the same rate. For the last several years Ethiopian Electric Power Corporation (EEPCo) the only provider of power, has faced a critical power shortage. As part of the ongoing fast economic development noted in the country, many factories had been established, adding that this had increased local demands especially in big cities like Addis Ababa for more electric power. Coupled with climate change that has resulted in irregular rain for hydroelectric power had worsened the situation. (Sharew, 2007)

Currently, the city depends mainly on the hydroelectric power as source of energy for cooling, heating, ventilation, light and many other applications. Therefore, in the absence of alternative energy sources, heavy reliance on biomass resources will result in serious long term implications and devastating consequences on the physical environment and the ecosystem at large, which Ethiopia has been experiencing since the last few decades. Similarly, there are risks associated with Ethiopia's heavy reliance on hydroelectric energy, which is variable due to a host of factors, including: trade-offs with potable, industrial, and agricultural water needs; frequent and intense droughts; the effects of siltation and sedimentation on dams and reservoirs; and international

conflicts over water rights. To cope with the effects of climate change on the energy sector the country should diversify energy production with alternative sources (Guta, and Börner, 2015)

Using solar energy equipment in residential building can play a significant part in tackling the power deficit and environmental challenges. Indeed, because of the abundance of its sunny days, the solar energy represents an important alternative for heating, cooling and ventilation. Some research works have been conducted during the last few years to study renewable energy market in Ethiopia but they focused on the geothermal energy for domestic hot water and electricity.

Due to costly technologies, renewable energy is generally provided with a higher price compared to conventional energy. But if consumers think the benefit of renewable energy worth the premium, they are likely to buy it. To make policies that can effectively increase demand of renewable electricity, it is important to know how much consumers are willing to pay for renewable electricity. This knowledge is also important for electricity companies to extract a proper premium making profits and acceptable by the public.

Expanding electricity generation from renewable energy sources is one pillar of the Ethiopian government's initiatives for building climate resilience green economy. However, there are challenges for the realization of this pillar. As FDRE (2011) identify, there is significant financial gap to finance investment on green energy. One strategy the government adopted to partly fill this capital void is cost sharing by urban community for the development and expansion of green and better electricity services.

The potential from this cost sharing scheme and the resultant welfare gains/losses however have not been sufficiently studied. More research exists on the rural consumer's willingness to pay due to a perception that they are more averse to paying for improved electricity services. Several studies were also carried out as a business viability exercise to assess the capacity and readiness of rural consumers to pay for off-grid or other alternative electricity solutions, a key factor for increasing penetration of off-grid solutions.

There are some studies (such as Mekonnen and Köhlin (2008); Gebreegziabher et al. (2010); Alem et al. (2013)) that attempted to examine household fuel choices for various fuel types in urban households of Ethiopia particularly in the capital, Addis Ababa. Moreover, there are also

studies (most recently Abdullah and Jeanty (2011); Adaman et al. (2011); Guo et al. (2014)) that were conducted in relation to the willingness to pay for improved green electricity services. Limited literature sources are available on willingness to pay for better electricity services in the industrial and urban context.

It is from this perspective that this study was imitated and it was an attempt to estimate the willingness to pay (WTP) for improved electricity services from green solar sources, and analyze how this willingness to support green energy services is related to different factors. In present case, the supply of solar cooking technology is a new commodity for Addis Ababa households and there is no market price to value such commodities. So non-market valuation techniques such as a Contingent Valuation Method (CVM) should be used assess the benefit and estimate the households WTP for a select solar cooking product.

Therefore, identifying the possible alternative energy sources for households in the condominium areas by taking the selected site was the goal of this study. It is believed that living in condominium is not only the present scenario of the city, but also it will be the main form of residency for the coming years in the city. Indeed this motivates the researcher to assess the possible small scale alternative energy sources for households in the selected area, and by thus give insight to take a sort of intervention. This study therefore, filled this gap by explore the households' willingness to pay (WTP) for box type solar cooker with a glazing wiper mechanism in Addis Ababa city selected woredas.

1.3. Objective of the study

1.3.1. General Objective

This study estimated households' willingness to pay for solar cooker with a glazing wiper mechanism in the study area.

1.3.2. Specific Objectives

Specific Objectives of this study was:

1. To assess the socio-demographic characteristics of the households.

2. To estimate households' willingness to pay for box type solar cooker.
3. To analyze determinants of households' willingness to pay for box type solar cooker.

1.4. Research questions

This study was attempted to answer the following question:

1. What is the socio-demographic characteristic of the households?
2. What is the maximum amount of birr the households' are willingness to pay for box type solar cooker?
3. What are the determinants of households' willingness to pay for box type solar cooker?

1.5. Significance of the study

The WTP that this study was induced can be used as important information to assess economic impact of renewable energy dissemination. Therefore, this study believed to be relevant for: one, the findings of this study is very useful to develop a direction for renewable energy policy. Thus, it is essential to prioritize investment projects and public value of renewable energy, and to set criteria of allocating priorities within proposed projects. Also, the measurement of the public value of renewable energy may contribute to the preparation of the basis and the direction of the policy on the change of the public perspective on renewable energy development projects.

Second, it will stimulate all involved parties or practitioners look for more effective solutions to improve public acceptance and work as the basic information of the advertisement. Finally, the study will have valuable importance for further study and add new idea to the existing knowledge in the area.

1.6. Scope of The study

Having objective of studying the household' WTP for solar cooking technology, the spatial scope of the study is delimited to the boundary of the Addis Ababa city. The unit of observation of the study is the households residing in newly constructed condominium sites in the selected woredas of Arada and Akaki Kality sub cities. The thematic scope of the study is households' WTP for a proposed solar cooking system, (i.e. box type solar cooker with a glazing wiper

mechanism), and the socio-economic determinants which affect households' decision to adopt the technology.

1.7. Ethical Considerations

Since, it is believed to be that research must be regulated by ethical norms and values, the researcher will use the following obligatory Ethical guidelines while conducting the study. This research will try to follow certain ethical standards and considerations. These include informing the participants about the purpose of research, voluntary participation, confidentiality, avoiding dependent relationship and asking for approval. In this regard, all participants will be informed about the purpose and duration of the interview. The research will be conducted after getting full willingness and consent from the participants. In addition, prior to the interviews agreement has been reached concerning confidentiality, not to expose personal information that could lead to any person experiencing danger or difficulty because of the information gathered. As a result, personal name will be made anonymous throughout the thesis.

1.8. Limitation of the study

While doing this study, some of the limitations were encountered. These were lack of quantitative information such as total number of households in the study areas; determining initial bid may involve response biases; the outbreak of Covid 19 which affected free engagement, and cooperation of households; budget and time constraint, the difficulty to cover a large number of households for the survey.

1.9. Organization of the Thesis

The research paper is organized in to five chapters. Chapter one gives a general background of the study. Chapter two reviews related literatures clarify key concepts and theories as well as clarify the conceptual framework. Chapter three presents research's methodological approach and methods of data collection instruments. Chapter four focused on data presentation and analysis. The final and the fifth chapter make brief conclusion and recommendation.

CHAPTER TWO

2. REVIEW OF RELATED LITERATURES

Introduction

Identifying relevant previous work is an essential skill in social research. The massive expansion in the volume and type of information, together with the increasing complexity of interrelated branches of knowledge, has given added importance to the need for systematic searching, and for critical appraisal and synthesized accounts of previous research (Robert, et al. 2003). This entry addresses the task of searching for relevant literature in the information age. Hence, in this section of the paper, an endeavor was made to review existing literatures and past studies related to the subject under study. In doing so, the researcher has made consideration and sharpened his idea on the existing concepts, theories, and empirical literatures relevant to the subject under study.

2.1. Theory of Environmental Resource Valuation

Hypothesis of natural asset valuation has urged financial experts because of an expanding interest for ecological merchandise and enterprises around the globe. Worth is alluded to as an adjustment in individuals' government assistance, which comes from an adjustment in the arrangement merchandise quality as well as amount improvement. This implies the estimation of an extra unit (minimal estimation) of a decent can be seen in the serious cost, if the market cost is noticeable with no significant disappointments (Perman, 2003).

By and large, there are four classes of administration that the common habitat accommodates people and their monetary exercises: contributions to creation by firms, sinks for the absorption of squanders created underway and utilization, convenience administrations to families, and life-uphold administrations (Perman, 2003).

KWAME (2013), define natural administrations as use esteem (direct use esteem and aberrant use esteem) and non-use esteem. Use esteem is a proportion of significant worth that comes from the genuine use, arranged use or conceivable utilization of a decent or administration, while,

non-use esteem emerges from the presence of the great despite the fact that the great isn't really utilized.

Yibeltal (2011) distinguished three classes of the Non-use esteem: presence esteem, Option worth and Bequest esteem. As far as he might be concerned, the Bequest esteem alludes to the fulfillment that individuals acquire from the information that characteristic asset enrichment is being saved for people in the future. Presence esteem alludes to the fulfillment that a few people get from the conservation of characteristic assets so that there stays an environment for fish, plants, and natural life, etc. It mirrors the publics' WTP to guarantee people in the future to appreciate similar ecological advantage in the years to come. Alternative worth identifies with readiness to pay to ensure the accessibility of the help for later use by the individual, and incorporates semi choice worth likewise that identifies with ability to pay to dodge an irreversible obligation to improvement currently, given the assumption for future development in information pertinent to the ramifications of advancement (Perman, 2003, refered to in Yibeltal: 2011).

The estimation of ecological products can't be resolved in the market since they are not exchanged. The trouble to decide the estimation of ecological merchandise in the market makes the non-market valuation methods more significant for natural products/administrations (Yibeltal, 2011). Presently days there are diverse valuation strategies to assess the estimation of non-advertised financial assets.

2.1.1. Revealed Preference Methods (Indirect methods)

According to Yibeltal (2011), indirect (revealed preference) method is about inferring the unobservable demand to estimate the value of environmental goods and services, based on observable demand for related marketable goods and services. It is used to indicate the demand for environmental goods and services from the information on market transaction for related item (Freeman, 1993 and Tietenberg, 2003). There are two major methods of this type: and the Hedonic Pricing Method (HPM), and the Travel Cost Method (TCM).

2.1.1.1. The Hedonic Pricing Method (HPM)

This method estimate the value of goods/services by measuring the attributes or characteristics the goods/service possesses. According to Yibeltal (2011), the main advantage of this method is that, since it is based on actual market prices, its application is straight forward and not so controversial. Though it has such advantage, the method understates economic value of environment when we try to estimate its non-use value (Carson, 2000).

2.1.1.2 The Travel Cost Method (TCM)

This method estimates the demand function of recreational site and the site's consumer surplus, which depends on information about the amount of money and time people, spent getting in to a site to infer a value for that site (Yibeltal, 2011).Measuring environmental benefits based on actual behavior has its own importance; however it is very difficult to measure non-use value using TCP (Callan and Thomas: 1996).

2.1.2. The Stated Preference Methods (Direct Methods)

This method refers to the direct expression of individuals' WTP or WTA in compensation for any change in environmental qualities, quantities or both (Yibeltal, 2011).It involves direct estimation of environmental value based on the responses of individuals to the hypothetical valuation questions and hence it does not depend on market information. This approach includes Contingent Valuation Method (CVM), Contingent Ranking (CR), Choice experiment (CE) and Conjoint Analysis(CA). From all these, the most widely used stated preference method for estimating non-market values is the Contingent Valuation Method (CVM) (Freeman, 1993). Since these direct methods such as CVM rely on surveys, they have the following advantages over revealed preference approaches (Carson, 2000).

I. They can be used to estimate a non-use value, which is not possible in other techniques.
II. They are good to measure people's policy or program references designed to changes in the quality of environmental goods.
III. They can be used for issues where there is no available market data for estimating use values.

Since it is the most widely used stated preference method, we discus only the CVM below and it is the one which was used in this study.

2.1.2.1. Contingent Valuation Method (CVM)

The technique for Contingent valuation is among the expressed inclination valuation moves toward that attempt to quantify the worth the climate by analyzing the measure of cash people's WTP or WTA in pay for any change in natural. The technique includes direct assessment of natural worth dependent on the reactions of people to the speculative valuation questions and consequently it doesn't rely upon market data (Freeman, 1993).

Unexpected valuation is a grounded technique in ecological valuation, which financial experts used to assess the worth shoppers put on non-market merchandise and enterprises. Since the 1960s business analysts have utilized unexpected valuation to esteem different natural and furthermore different sorts of merchandise (Mitchell and Carson, 1989).

Since the inspired WTP is dependent upon the specific theoretical market portrayed to the respondent, this methodology came to be called unforeseen valuation technique (Mitchell and Carson, 1989). CVM has been applied for the valuation of a wide scope of issues in a natural setting; including biodiversity, air and water quality, scene quality, untamed life preservation, woods, open air diversion and social legacy protection (Bateman and Willis, 2002).

Respondents to an unforeseen valuation review are given a sensible yet speculative situation and posed inquiries about the most extreme measure of cash that they would pay (WTP) for an improved quality from a business as usual, or the base measure of remuneration they would acknowledge (WTA) for a disintegration from a the norm (Echessah et al., 1997).

The 'yes/no' reaction to the ability to pay (WTP) questions, the offered sums (dollar esteems offered for the WTP question) and the extra data about the respondents' attributes are utilized to fit parallel reaction models, for example, logit and probit (Albertini and Cooper, 2000).

The objective of Contingent Valuation is to quantify the redressing or identical variety for the positive qualities being referred to. Appropriately, WTP is characterized as the sum cash that should be detracted from the individual's pay while keeping his/her utility consistent. Greatest WTP is the measure of cash that the purchaser will offer up to get the assistance to such an

extent that he/she is also off as he/she was without the help (Onwujekwe, 2004; Perman, 2003). **I**n this examination, CVM was applied to inspire the WTP of the family units. A dichotomous decision design, with one subsequent dichotomous-decision question and with an open-finished subsequent inquiry, was utilized to inspire the WTP.

2.1.2.2. Theoretical Framework of Willingness to Pay

Environmental valuation is the process of putting monetary values on environmental goods and services (G&S), many of which have no easily observed market prices. For examples environmental G&S include scenic views, mountain vistas, biodiversity and special species like whales, elephants, coral reefs, or plants. Environmental G&S also include many indirect processes and services, such as watersheds and water supply, forests and carbon sequestration or erosion control, ecosystem conservation, and maintenance of genetic material (Hussen, 2004).

Pearce (1993) define economic valuation as measuring benefit from environment based on the concept of willingness to pay that measure people's 'preferences' for changes in the state of their environment.

Willingness to pay is based on the concept of "Environmental valuation" which is a series of techniques that economists use to assess the economic value of market and non-market goods, including natural resources and resource services (Lipton et al., 1995). Economic value has its foundation in neoclassical welfare economics which is a branch of economics that endeavors to formulate propositions that enable us to state whether social welfare in one economic situation is greater or less than in another (ibid).

According to, Perman (2003) analytical seeking to obtain money measures of welfare changes due not to price changes but to changes in the availability of public goods or amenities, changes in the qualities of commodities, or changes in the fixed quantities of rationed goods. Simple he puts the conventional welfare measures for price changes are the compensating (C) and equivalent (E) variations, which correspond to the maximum amount an individual would be willing to pay (WTP) to secure the change or the minimum amount she/he would be willing to accept (WTA) to forgo it.

In the welfare economics concept is based on the theory of utilitarianism a commodity has economic value when users are willing to pay for it. Utilitarian's assumed that consumers make choices according to their preferences so as maximize their own satisfaction or utility. The user is assumed to be capable of assigning to every commodity or combination of commodities a number representing the amount or degree of utility associated with it (James and Lee 1971; Henderson and Quandt, 1980).

To sum up, the common idea of all these concepts is that when economists attempt to measure the benefits from improved environmental quality and of the environment but the preferences of people for an environmental good or environmental bad, but not the value. This means, we do not and cannot measure the value of life or the environment as it is. Instead, what we attempt to measure is the preferences of people for a healthier life or for a preservation of environmental amenities.

According to Albertini and Cooper (2000), the compensating variation when a person purchases an improvement in environment quality can be specified as;

$(P_{0,0}, X, Y_0) = (P_{1,1}, X, Y_0 - WTP)$……1

Where: U denotes the indirect utility function; Y_0 income; P_0, vector of prices faced by the individual; Q_0,Q_1, alternative levels of the good or quality indexes ($Q_1 > Q_0$,)indicating that Q_1refers to improved environmental quality and Q_0,unimproved one); WTP- willingness to pay; and X respondents' characteristics is a vector of individual characteristics affecting the trade-off that the individual is prepared to make between income and the improved environmental quality. This equation implies that willingness to pay depends on the initial and final level of the good in question ($Q_0$and Q_1), respondent income, prices faced by the respondent and respondent socio-economic characteristics.

2.1.3. Elicitation techniques of WTP

The CVM measures the value of environmental resource by calculating the peoples' WTP to maintain the resource or to contribute for rehabilitating the damaged resource. By doing so, people will be asked to state their WTP for a particular good or to improve a particular service or their Willingness -to -Accept (WTA) to give up a good or for deterioration in a service. In other

words, this approach involves asking individuals directly the value they attach to a particular resource and/or its characteristics. Thus, the method is able to estimate the respondent's consumer surplus for the resource and therefore the maximum amount the resource is worth to the respondent.

According to KWAME (2013), a hypothetical scenario which details out the attributes of a certain resource and its effects is created and respondents are asked in a survey how much they (or their household) will be able to pay for that resource or how much compensation they will accept should the resource deteriorate or be lost completely. This technique is called Contingent Valuation because people are asked to state their WTP based or contingent upon a specific hypothetical scenario and description of the resource.

The total value of the resource is determined by averaging respondents' values and extrapolating it across the population. This is an open ended contingent valuation format. It has been argued, however, that respondents often find it a difficult task to assign an appropriate value to the resource on their own. This often leads to a wide range of responses in a survey. In contrast to the open ended format is the close ended format of contingent valuation. This is a discrete or dichotomous choice question where respondents are presented with a value and are asked to either respond 'yes' if they would pay that amount or 'no' if otherwise. This typically mirrors the choice of consumers face in an actual market for a commodity where the good has a price and they either buy the commodity at the going price or not (KWAME, 2013).

The important element of a CV scenario is the method of asking questions respondents how much he/she is willing to pay by providing monetary amount to induces a response (Haab and Mc Connell, 2002 and Perman, 2003). Perman (2003) in his essay identified the following approaches to perform this task.

Open Ended: A CV question in which the respondent is asked to provide the interviewer with a point estimate of his or her WTP. Now days open ended CV elicitation approach less applicable due to respondents' difficulty in answering the payment question and the fact that it results in many missing values.

Bidding Game: A CV question format in which individuals are iteratively asked whether they would be willing to pay a certain amount or not. The amounts are raised (lowered) depending on whether the respondent was (was not) willing to pay the previously offered amount. The bidding stops when the iterations have converged to a point estimate of WTP. The final amount is interpreted as the respondent's WTP. This approach has its own disadvantages. First, it results in a starting point bias as the final value is systematically related to the initial bid value. Annoying or tiring respondents which causes them to answer yes or no to a stated amount in hopes of terminating the interview is another disadvantage of the bidding game approach.

Payment Cards: A CV question format in which individuals are asked to choose a WTP point estimate (or a range of estimates) from a list of values predetermined by the surveyors, and shown to the respondent on a card. The final amount chosen by the respondent can be interpreted as the respondent's WTP. This approach is also criticized on the ground that the respondents might limit their announced WTP to the values listed on the card.

Dichotomous or Discrete Choice CV: A CV question format in which respondents are asked simple yes or no questions. This approach has become the presumptive method of elicitation for CV practitioners. The other three methods have been shown to suffer from incentive compatibility problems in which survey respondents can influence potential outcomes by revealing values other than their true WTP. Thus, in this study double-bounded CVM approach were employed.

As far as the application of CVM is concerned, KWAME (2013) identified the following biases that are likely to confront the use of CVM:

I. **Starting point bias:** The starting point bias arises when the starting bid given by the interviewer goes to ultimately influence the final response given by the respondent. This bias is best minimized by varying the starting bid among the sample. This way, the interviewer is able to investigate the influence of the starting bids on the final WTP.
II. **Strategic bias:** This bias arises when respondents deliberately understate their WTP or overstate their WTA. Sometimes also, WTP may be overstated especially if the respondents are aware that they will not be asked to pay for the resource but their responses are merely being used to get a value for the resource after which the government will provide the good.

Respondents are likely to overstate their WTP if they want the good provided or may understate it if they do not want the resource provided. A discrete choice format where 'yes' or 'no' responses are required for differing amounts within the sample may minimize this bias.

III. **Hypothetical bias:** Hypothetical bias results from a poor understanding of the hypothetical scenario created from which WTP questions are asked. If respondents misunderstand the scenario or the scenario is misrepresented by the interviewer, it will lead to responses that do not match the hypothetical scenario hence biases. This can be minimized by well explaining the hypothetical scenario and avoiding any ambiguity whatsoever. Hypothetical bias may also arise because people may respond differently to hypothetical decisions compared to how they make actual decisions.

IV. **Interview and Compliance bias:** Interview bias arises from the conduct of interviewers that tend to influence the responses given by the respondents in a survey. Compliance bias arises when respondents attempt to give answers that they think may please the interviewer. These biases can be minimized by training interviewers well to adhere to the principles of conducting an effective survey.

V. **Non response bias:** Non response bias results from the fact that some sample members do not respond and yet they have values for the resource which may be different from those given by respondents. This has the tendency to bias the overall value placed on the resource.

VI. **Information bias:** Information bias arises because respondents may be asked to value attributes for which they have little or no knowledge of. This means that the information that they are given to the respondents will have substantial influence on their responses.

Even though there are the possibility of confronting various biases discussed above while using CVM, we have practical ways to reduce these biases. Compared to other methods especially revealed preference methods, the CVM has an advantage. It is flexible enough to allow for the creation of hypothetical market scenario. These hypothetical scenarios may go beyond observed market behavior and thus helps to measure existence values that are not related to the consumption of other goods (KWAME, 2013).

2.2. Energy related concepts

Usually energy is defined as a power. (EEC, 2003) defined energy as the capacity to do work or the stored ability to perform work (produce heat), and it exists in various forms, including mechanical, thermal, chemical, electrical, radiant and atomic. Energy can be also categorized as primary, secondary or delivered and end – use energy (Robert, et al 1995). The primary category refers to original sources in any fuel before it is converted to delivered energy. Primary energy is the energy that is embodied in resources, as they exist in nature. The secondary one is a gross energy, which is the produced amount of gross input of energy, and the third, useful energy or end-use, is the amount of energy effectively used by any user.

The sources of energy can be categorized as renewable and non- renewable. Sources of energy that are mostly biomass based and are available in unlimited amount in nature. Under this category come such energy sources as fuel wood, petro-plants, agricultural waste like biogas, animal dung, wind energy, water energy, tidal energy, geothermal energy, solar energy, etc. These energy sources considered as renewable. Whereas energy sources such as petroleum, coal, natural gas, nuclear power and the like are categorized as non-renewable (EPA, 2004, 2003). The non-renewable or exhaustible energy sources are available in limited amount and developed over a longer paired of time and as a result of unlimited use; such resources are likely to be exhausted any day (Aklilu, 2005).

Both commercial and traditional energy sources are vital in the study of energy consumption. Commercial energy sources refer to modern fuels that are traded to the market place and exchanged at going market price while non-commercial energy sources refer to traditional fuels that are collected by the users or by other collector who sell fuel for customer without involving any commercial type financial transaction. However, traditional fuel does not always mean non-commercial since such fuel may have been brought commercially (EE, 2003).

The traditional energy sources usually mean unprocessed fuels including wood fuel, charcoal, dried dung cakes, crop residues, leaves and other similar substances. However, wood fuel and charcoal shortage are likely to occur in many areas of the World. Because of overuse exploitation than they can be renewed especially near cities, crop residues and animal dung became more important with increasing scarcity of wood (Tsegaye, 1986). Fikre (1995), Robert (1995) and

Karekezi et al (1997) noted that charcoal is essentially a solid residue obtained after carbonization of wood in closed space hereby only a small amount of air is allowed. Many urban dwellers prefer charcoal to wood fuel for a number of reasons. It is easier to handle and produces less smoke, so that it is safer to use than wood. Moreover, due to its lack of moisture and high carbon content, charcoal contains large amounts of energy and involves shorter cooking times.

To conclude, energy, which is defined as the capacity to do work, is clearly of enormous significance to human existence. It is a central to sustainable development and poverty reduction efforts. However, it is not all an end in types of energy service; what human beings want is the services that various types and forms of energy sources provide (UNDP, 1996). It affects vitally and essentially all aspects of development. Energy important in our daily lives it simply derives from the fact that it provides Varity of essential human services. It is the means to the provision of basic needs (such as cooked food, heating, cooling and lighting), the use of appliances, transportation and communication system (such as radio, television, telephones and computers (IEA, 1999).

2.2.1. Solar Energy Systems Overview

Various attempts have also been made to look at solar energy investments in the developing world economy. In a developing economy where over-dependence on fossil fuels is surprising, solar energy remains the most attractive and effective form of electrical energy generation. Many countries have ample sunshine, such as India, Japan, Nigeria, etc. have sufficient amount of sunshine and good solar isolation that favors solar energy investments. Investment in solar energy technology is encouraged as the merits include: pollution free environment, free renewable and energy source, high reliability and low maintenance costs (Okoro, and Madueme, 2004).

Despite these restrictions, of all renewable resources, solar energy may be the most plentiful. The sun, with its by-products (wind, water, biomass, waves) provides our world with 15,000 times more energy per day than the earth currently consumes, according to Girardet (2007). While Şen (2008) estimated the amount to be 10,000 times the global annual intake, the author argues that this energy will last for up to 5×10^9 years, which is the earth's remaining life.

After approximating the total energy that the earth intercepts to about 1.8×10^{17} watts of solar energy, Pimentel (2008) also estimated this energy to be about 14,000 times the rate at which humankind produces energy from fossil fuels, nuclear, hydropower, wood and other biomass combined. Approximating the amount of sunlight that strikes the earth's atmosphere to 1.75×10^{17} watts and assuming that 60% of transmitted through the atmospheric cloud cover, Kalogirou (2009) calculated the amount of energy that reaches the earth's surface to be about 1.05×10^{17}. Converting only 1% of this energy with a 10% efficient system alone would provide us with an energy amount that is as much as four times the forecasted global energy demand for the year 2050 (Ibid.).

Generally, solar energy technologies can provide electrical generation by heat engine or photovoltaic means, day lighting, solar hot water, and space heating in active solar active and passive solar building, potable water via distillation and disinfection, space cooling by absorption or vapor-compression refrigeration, thermal solar cooking energy for cooking and high temperature process heat for industrial purpose.

These technologies are broadly characterized as either passive or active depending on the way they capture, convert and distribute sunlight. Active solar techniques use photovoltaic panels, pumps, and fans to convert sunlight into useful output. Passive solar techniques include selecting material with favorable thermal properties, designing spaces that naturally circulate air, and referencing the position of building to the sun. Active solar technologies increase the supply of energy and are considered supply side technologies, while passive solar technologies reduce the need for alternate resource and are generally considered as demand side technologies.

2.3. Conceptual Framework

The importance of examining the theoretical framework in the context of attitude theory and economic theory is to determine the decision making process. Nevertheless, understanding this framework may explain how different WTP values are decided by respondents. According to Green and Tunstall (1999), preferences and values are the foundation of CV design and the extension of the Fishbein-Ajzen model (a reasoning model which holds that beliefs determine attitudes and attitudes are known to impact the behavioral intentions) with one plausible

behavioral intention is WTP. This conceptual framework examining preferences, attitudes, and behavior is relevant to economic application of random utility theory.

This study is grounded on a set of concepts that have a bearing on key variables; cost benefit analysis of selected solar technology, willingness and ability to pay for it, potential change in solar energy demand and environmental effect of solar energy use. It begins with the concept of environmental externalities of production and consumption and the need to minimize these externalities by transiting to renewable forms of energy which have little environmental effect (Pigou, 1939).

However, as Jacobson (2006) argues along with Karekezi and Kithyoma (2003) both the environmental and economic significance of solar energy is perceived to be minimal due to predominance of low capacities and that in the absence of large subsidies, solar energy is primarily for the few. With regard to this, many studies (Gueyeet al., 2004; Cory and Coughlin, 2009; Owusu 2010) reviewed in the above literature conclude that the point of intervention is hinged on the financing models for solar energy. It also show, as in Figure 2.1, that the current models of financing for solar energy which is weighed down by initial capital upfront and low capacity

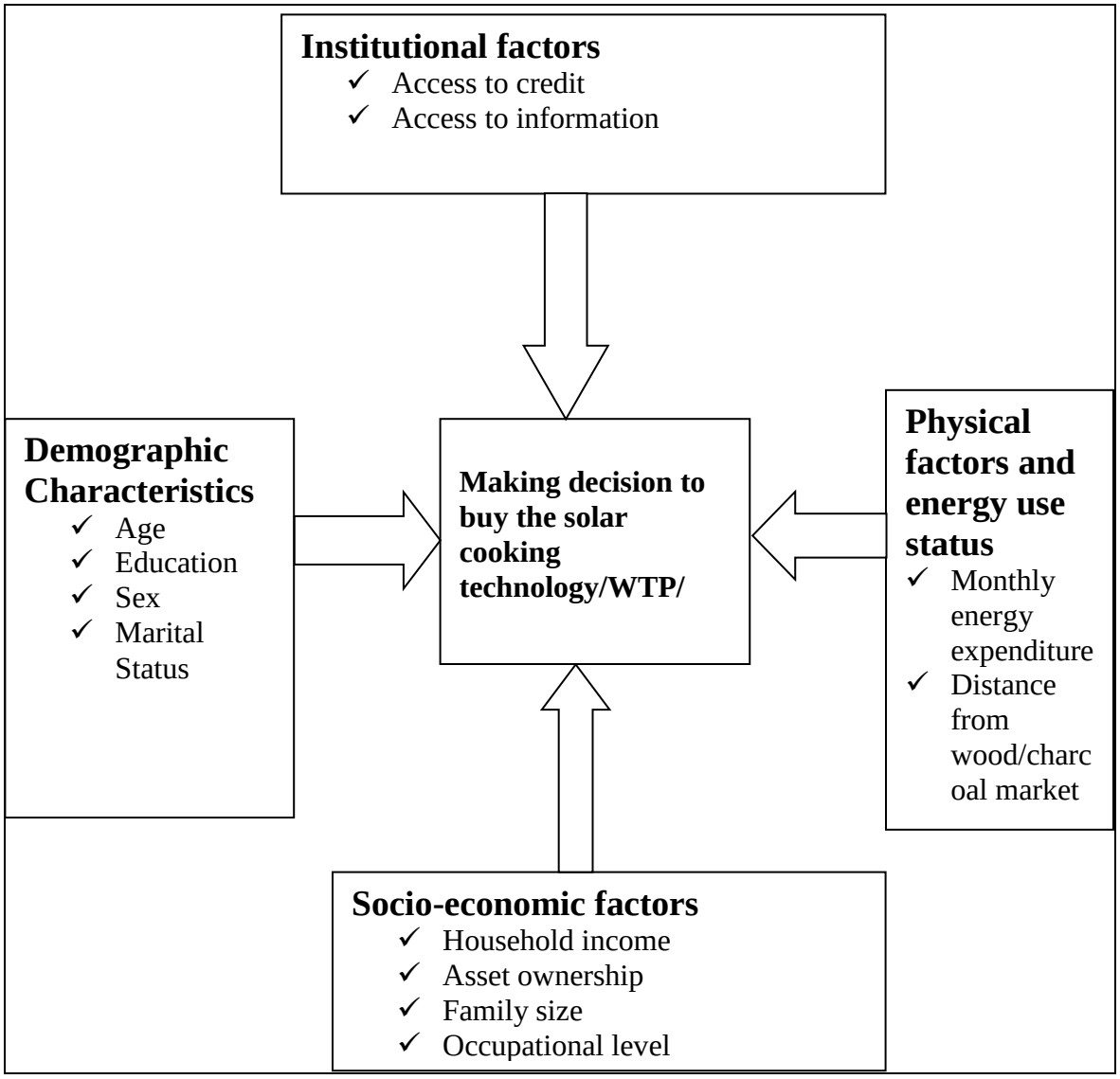


Figure 2.1.Conceptual Frame-Work for the Study

Source: Adapted and modified from Techan (2018) as he adopted from Kidane (2008) and Shiferaw and Holden (1998),

CHAPTER THREE

3. RESEARCH DESIGN AND METHODOLOGY

3.1. Description of the study area

Addis Ababa is the capital city of Ethiopia. It is located between 8°49` 55.929`` and 9° 5` 53.853`` North latitude and between 38° 38` 16.555`` and 38o 54` 19.547`` East longitudes. The city lies at the foot of Mount Entoto. From its lowest point 2,114 meters above sea level in the Eastern periphery, the city rises to over 3,000 meters in the Entoto Mountains to the North. It lies at an average altitude of 7,546 feet (2,500 meters). Its topography ranges from rolling plain to hilly areas with relatively steeper gradient and numerous rivers, stream valleys. The total area of City Administration of Addis Ababa extends over 540 Km^2 and is sub-divided into 10 sub-cities (CSA, 2007).

The lowest and the highest annual average temperatures of the city are 9.89°C and 24.64°C respectively. The annual average rainfall is 1178 mm (Dierig 1999). Addis Ababa is the home of various ethnic groups: 48.3 percent Amhara, 19.6 per cent Oromo, 17.5 per cent Gurage, 7.6 per cent Tigray, and 6.9 per cent others (Goliniet al. 2001, 128). Regarding religion, 82 per cent of the population is Orthodox Christians, 12.7 per cent Muslims, 3.9 per cent Protestants, 0.8 per cent Catholics, and 0.6 per cent followers of other religions.3 Some 93.6 per cent of the men and 79.9 per cent of the women in the city are literate (CSA and ORC Macro 2005, 35-36). The same report revealed that 68.9 per cent of the men and 44.2 per cent of the women are employed. Some 96.2 per cent of the city's households have tap water and 34.4 % own houses (Goliniet al. 2001).

Concerning the economy, the city's residents engage in diverse activities, including trade and commerce, manufacturing and industry, home makers of different types, civil administration, transport and communication, social services (education, health, etc.), hotel and catering services, and farming (agriculture, horticulture, and animal husbandry).

Addis Ababa is the diplomatic capital of Africa with more than 90 embassies and consular representatives, which makes it the fourth diplomatic center in the world. The city has been

serving as the Headquarters of the United Nations Economic Commission for Africa (UNECA) since 1988 and the former Organization of African Union (now the African Union) since 1963.

Meheret Ayenew (1999) wrote, "Addis Ababa is a fast growing urban centre that is beset with problems afflicting most cities in the developing world, including extensive poverty, joblessness, inadequate housing, severe overcrowding/congestion and undeveloped physical infrastructure." According to Dierig (1999), pollution, poverty and environmentally induced hazards are among the major problems threatening the health and life of the majority of the city's inhabitants, particularly the urban poor.

The City of Addis Ababa covers an area of 522 square kilometers (0.05 % of the Ethiopian landmass) and is comprised, according to official statistics, of an estimated 3 million inhabitants. The city is sub-divided into ten sub-cities, each of which has an average population of around 300,000 people. Population densities vary considerably among the sub-cities, with Addis Ketema and Arada showing the most densely populated neighborhoods while Bole and AkakiKality are the least densely populated sections of the city.

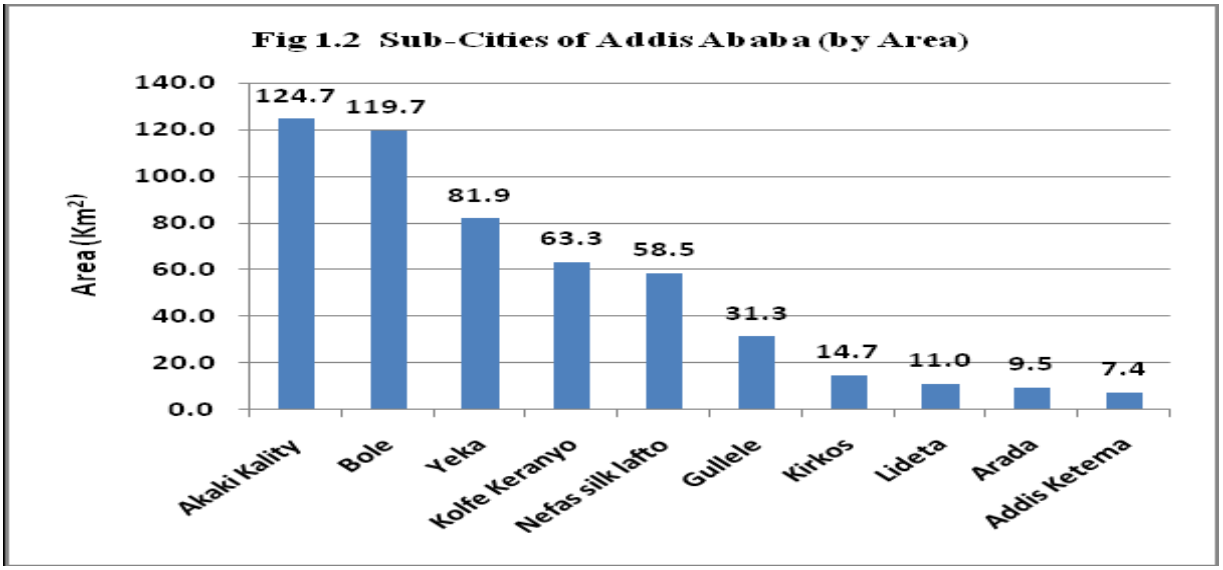


Figure 3.1. Source: Addis Ababa City Administration (2009 estimates)

Currently there are four categories of new sectors of residential developments: (a) government-initiated condominium buildings; (b) residential neighborhoods initiated by developers; (c) owner-built housing dwellings; and (d) new home activity driven by housing cooperatives.

A) Government-built Condominiums: In a struggle to resolve the severe housing shortage obvious in Addis Ababa, the government has built more than 78,000 condominium units throughout the city. Currently about two-thirds of these units are finished and residents have already started living in the condominium, with the remaining still in need numerous kinds of finishing. More condominium units are going to be built every year for the next five years as part of GTP plans.

B) Residential housing by Real Estate Developers: Residential households and neighborhoods built by real estate developers are increasing common ever since the first large-scale development was initiated by the pioneer in this sector, namely Ayat Real Estate. At present, there are other real estate developers across the city.

C) Owner-built housing construction: Housing units built by owners were by far the most common type of new residences before the beginning of government-built condominiums and real estate developers in the past decade. Though relatively restricted now, this portion of the real estate market is still active in older, more established residential neighborhoods such as Bole or Old Airport. Owner-built residences are also common in some of the outlying neighborhoods that were initially promoted by real estate developers but have subsequently attracted individual home builders.

D) Home construction by Housing Cooperatives: Cooperative housing developments are mostly, organized by group of people that share a common firm or membership, have been a long-standing feature of the residential real estate market going back to the days of the previous government. At the moment, the city administration has registered more than 500 housing cooperatives.

Regarding housing in Addis Ababa, studies conducted in the last five years conclude that only 30 % of the urban housing stock is in good or fair condition. Cities have been attempting to deliver housing for their residents, but the strategies have been unclear and the achievements limited,

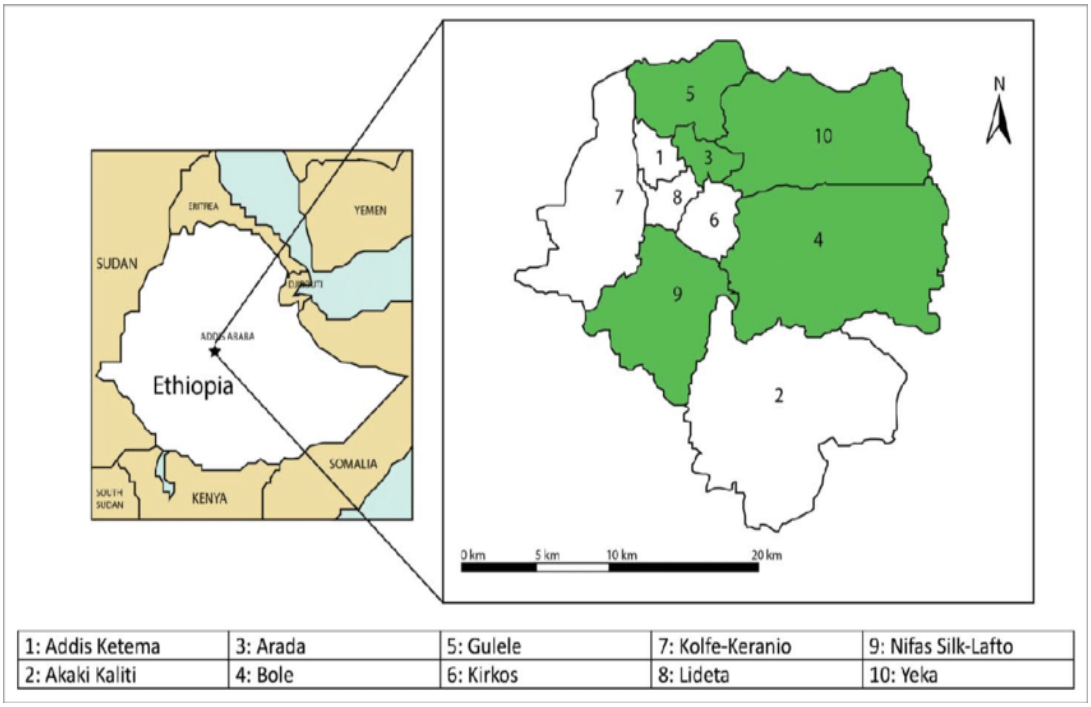
given the magnitude of the problem. Addis Ababa City Government initiated a large number of pioneering and important strategies and projects during the Sustainable Development and Poverty Reduction Program period.

These included new and innovative initiatives in integrated housing development, and Addis Ababa was taken as a laboratory for urban reform in the country (MoWUD, 2007). In order to respond to the ever-growing need for low-cost housing in the urban areas of Ethiopia, the Ministry proposed to implement an 'Integrated Housing Development Program' (MoWUD, 2006). The objective of this government-led housing program was to provide sustainable low-cost housing solutions to low- and middle-income urban dwellers in urgent need of decent dwellings (MoWUD, 2006; UN-HABITAT, 2010).

The Addis Ababa City Administration launched ambitious low-cost condominium housing projects through the Integrated Housing Development Program (IHDP) in 2006 to minimize housing backlogs, clear slums, and provide decent shelter to middle- and low income groups (Ingwan et al. 2010). By 2010 a total of 80,257 housing units had been built in Addis Ababa alone, and the model is being replicated in other cities (Wessling 2008; UN-HABITAT 2010). The condominium buildings are designed in blocks of buildings consisting of three, four, or five stores, containing one-, two-, and three-room housing units, with some blocks having four-room housing units on the upper floors and commercial space on the ground floors (Alazar and Haas 2011).

Although condominiums are supposed to provide low-cost housing for the poor and for middle-income households, they do not seem to be meeting their initial goals, as costs are so high that even many middle-income earners cannot afford the payment (Yewoinshet 2007; UN-HABITAT 2010; Ezana 2011). Moreover, even those households who are able to move to condominiums might be allocated flats on the periphery of the city, which restricts their employment opportunities and forces them to incur high transportation costs (UN-HABITAT 2010). The inability to pay the monthly mortgage and service payments forces many households to move out of their unit and rent it out (UN-HABITAT 2010).

As a result, the condominiums program may lead to a process of gentrification through which poorer people who are allocated to condominiums rent them out to better-off households. Gradually, this may lead to a situation where the urban middle class reside in and own the housing that was intended for the urban poor, who may be pushed to the suburbs, where they may not be able to find employment in the informal sector and may be unable to afford to travel to the city center for work, thus becoming even more impoverished.



1: Addis Ketema	3: Arada	5: Gulele	7: Kolfe-Keranio	9: Nifas Silk-Lafto
2: Akaki Kaliti	4: Bole	6: Kirkos	8: Lideta	10: Yeka

2-Akaki kality 3- Arada

Figure 3.2. Map showing sub-cities

The key reasons for selecting this area are: steady growth of new settlement, shortage of charcoal, kerosene and LPG, and the accompanying rise of their prices, and the sustainability challenges of energy supply due to higher dependence on firewood. Additionally, the place can be taken as a present and future model residential area for the poor across the city, and the possible alternative which is adoptable for this area will have a great potential to expand other parts of the city.

Urban centers have long been dependent on rural hinterlands for their fuel. The increasing dependence of the urban centers on rural hinterlands has a much more serious environmental consequence which has resulted in growing fuel scarcity and higher firewood prices in urban

centers, thereby undermining the livelihoods of the urban poor (Barnes et al. 2004). Similarly, Zenebe (2007) found that as urban areas develop, they depend on rural hinterlands for fuel, and this aggravates the problem of deforestation. Deforestation in contemporary times has resulted in growing fuel scarcity and higher firewood prices in urban centers.

The Akaki Kality sub city also has substantial peri urban areas. Peri-urban households living in close proximity to the forest use fuel wood as the primary energy source for cooking. Much of the original vegetation has been cleared for fire wood. Over the years, this area has experienced intense deforestation due to the activities of wood fuel poachers in the town. Trees have been cut down in order to meet the ever increasing demand for wood fuels among residents of the town.

3.2. Research Design

In this study, the researcher used the contingent valuation method to elicit the Willingness to Pay (WTP). For the electricity load assessment and willingness to pay study many researchers have used this technique. Blennow (2004) applied face to face survey method for rural electricity load assessment in Tanzania. Arega and Tadesee (2017) studied households' willingness to pay for electricity from renewable sources in urban and pre-urban areas of Ethiopia and collected the consumer data through face-to-face questionnaire based field survey. The same approach was applied by other researchers (Abdullah and Jeanty, 2011; Twerefou, 2014; Adaman, et al., 2011 and Gou, et al., 2014). To analyze the market of solar cooking system in the selected woredas of Akaki Kality, and Arada sub city, and for determining the WTP; this study followed the face-to-face data collection method.

The basic data collection instrument was an interview schedule. The researcher choose this method because he envisaged that most of the respondents could not read and/or write. Further, by administering the instrument in the local dialects, it is able to ask more probing questions and to detect and remove warm glow giving (Andreoni, 1990). It also improves the response rate and gave an opportunity to complete the data collection on time. Household heads was the primary respondents for this study.

For the purpose of this valuation scenario, a renewable energy source refers to energy from solar, from which renewable and sustainable electric energy can be generated with minimal environmental externality (Winkler, 2005). Electricity generated from such energy sources is largely clean, efficient and long-lasting, but needed financial support from the Ethiopian community. Such expansions of the generation of electricity from renewable energy sources is aimed at addressing residential energy demand as well as meeting commercial needs, and in the process minimize emissions of GHGs from household.

The new initiative introduced by the Ethiopian government is generation of electricity from large and small-scale hydropower energy sources so as to address electricity supply for all. For the best part of the last two decades, the government has been investing huge amount money for the expansion of renewable and sustainable energy. However, there are risks associated with Ethiopia's heavy reliance on hydroelectric energy, which is variable due to a host of factors, including: trade-offs with potable, industrial, and agricultural water needs; frequent and intense droughts; the effects of siltation and sedimentation on dams and reservoirs; and international conflicts over water rights. To cope with the effects of climate change on the energy sector the country should diversify energy production with alternative sources (Guta, and Börner, 2015)

In this study, an attempt was made to study how strong the willingness of the households would be to pay for improved solar electricity using the current electricity service that urban households get as a backdrop. The hypothetical electricity supply that will be presented to the households is that the city government with collaboration of private partners is planning to provide voluntary customers with solar electricity for domestic use. Electricity will be supplied without interruption. For this however, the government needs to engage in the expansion of both electricity generating structures as well as electricity transmission lines. The government will also build its technical and management capabilities for effective provision of electricity services. All of these schemes require cost sharing by the end user, such as households.

To elicit the willingness to pay for renewable and sustainable electricity by households, the payment vehicle was presented by initial bids and follow-up bids in a dichotomous set up. In this set up, households were first presented with the initial bid. The initial bid is taken from similar study undertaken by Arega, and Tadesse (2016) to measure Household willingness to pay for

green electricity in urban and peri-urban Tigray, northern Ethiopia. The data they obtained from the pilot-survey and the average electric bill data of households over the three-year period helped the researcher to design the initial bid which varies between 10–15% of the average monthly household expense for electricity. Moreover, additional feedback will be obtained from pilot-survey to have an idea about where households' ability to pay lies and refine the amount of the initial bid.

Based on this, the researchers was selected three initial bid amounts with their corresponding follow up bids and randomly assign to sample households in order to reduce starting point bias, which is the most serious problem in contingent valuation studies (Boyle et al., 1985; Kanninen, 1995; Herriges and Shogren, 1996). In the end, the process (for each initial bid) yielded three bid designs (base, which is the initial bid, and upper and lower bids, which represent the follow-up bids). Finally, based on the responses to follow up bids, households were required to decide on the maximum and minimum amount of birr they are ready to spend.

Willingness to pay data using bids were finally obtained via face-to-face interview by making use of well-trained enumerators that help obtain as much accurate as possible bid payments, thereby reducing interviewer bias (Yoo and Yang, 2001).

With this proposed electricity scheme, not only do current users benefit from effective electricity supply but the government will also generate revenue to expand electricity generation to meet current or future (unmet) demand. The proposed scheme for the expansion of electricity supply in addition would help substitute traditional fuels by less-polluting and sustainable source of energy for cooking, which also plays positive role on the climate through reducing emission of greenhouse gases. It is from this valuation perspective that this study appraises the proposed expansion of green electricity through consideration of household’s motivation and willingness for supporting the expansion of electricity generated from renewable and sustainable energy sources.

3.3. Methods of data collection

3.3.1. Focus group discussions and pretests

The questionnaire was finalized based on the results of two focus group discussions (FGD) and pretests. The first FGD was with participants from the respected Villages. The second FGD was with representatives from various government agencies. The aim of the FGDs is to test the bid prices to be used in the pretests.

3.3.2. Survey Questionnaire Development

Questionnaire based data collection is the most widely used technique in quantitative field data collection. To serve the purpose, the final questionnaire (Appendix 1) contained some specific steps. To ease the whole interview process at first the scope and objectives of the study was briefly explained to the respondents. Before introducing questions related to willingness to pay (WTP), a brief idea was given to the respondents regarding the economic and environmental advantages of the proposed system. This information helped the respondents to make informed choice of responses, which in turn helps to avoid any bias.

Before offering a product that does not yet exist in the market, it is crucial to understand how people would react to such new offering in terms of comprehension, relevance, and credibility. In addition, information on existing levels of electricity supply, problems faced due to inadequate power, current billing, socio-economic factors, approximate amounts people may be willing to pay for improved electricity services and other information are needed.

The draft questionnaire for this study was prepared based on FDG findings, community surveys, and previous survey instruments of similar studies, and other surveys in the public domain. To help on the design of the questioner and to come up with a first draft of the questionnaire we conducted a focus group discussion on March 20 and 25/ 2020.

In order to check the appropriateness, clarity and workability of the questioner, pre-test interview was conducted in the selected Woredas' of the sub cities by selecting a random sample of four households from each woredas. This process was also important in determining the bid values.

At the end of every interview, acknowledgement card was issued expressing thanks for their valuable time and cooperation, which contains interview date, interview serial number, village name and contact details of the researcher. The counterpart of each card will be kept for record. This approach offers the opportunity to track back the respondent if any clarification of the collected data is required at a later date.

3.4. Sampling technique and Sample Size Determination

The study was conducted in a selected four Woredas of the Akaki-kality and Arada sub-City of the Addis Ababa City administration. The target population for the study was the entire urban households residing in condominium houses within the city. This population is large, and is spread over a wide geographical region and it is not possible to obtain a representative sample with only one technique. Thus, it is not easy for the researcher to involve all the target population in the study due to problems related to time, finance and management of the research.

Multi-stage sampling technique was applied to select the sample households. In the first stage, sample sub cities (the primary sampling units) are selected, where one sub city from the periphery (i.e. Akaki Kality) and one sub city from the center (Arada sub city) by considering the two samples will represent the feature of the whole city. Then two woredas from Akaki Kality and two woredas of Arada sub city will be selected purposely. Then, based on stratifying the blocks in to 10/90 and 20/80, the researcher will select 25 % and 75% from each stratum respectively. Finally, sample households were selected from each stratum using systematic random sampling techniques from the list of both block numbers and house numbers.

The proportional sample size was determined based on the total sample size determined using the Yamane's formula. Yamane (1967) provides a simplified formula to calculate sample sizes. The sample size will be calculated using this formula as follows:-

$$n = \frac{N}{1 + N(e)^2}$$

Where;

n = Number of samples

N = Total population;

e = Error tolerance; Standard confidence level is 90% - 95%.

The researcher used a confidence of 95 % for a better accuracy, which give a margin error of 0.05. This level of significances is estimated by the researcher in order to manage the sample in terms of cost and time and by considering the homogeneity of respondents. As margin of error reduce the confidence level increases and the desired sample becomes too large to manage within the scope of time of study and budget at researches hand.

Currently there are totally 180,742 condominium houses in the city, where 23,979 houses are 10/90 block type, and 156,766 houses are 20/80 block type (AAHPO, 2018). Calculating the sample size using the above formula, the size of the sample for this study is:

$$n = \frac{N}{1 + N(e)^2} = \frac{180{,}742}{1 + 180{,}742(0.05)^2} = \frac{180{,}742}{1 + 180{,}742(0.0025)} = \frac{180{,}742}{1 + 451.855}$$

$$= \frac{399.11}{} \approx 399$$

Therefore, 399 households was used in this study for practical reason (randomly distribute the three bid to random samples ,i.e. 6000 birr for the first 133 HHs, 5000 birr for the next 133 HHs, and 7000 for the other 133 HHs). Then, proportional allocation of the sample was made on the basis of size. The total number of samples from each sub cities and respective woredas shown in the table below.

Block Type	**No of samples from each sub cities**							**Total No of Households**
	Arada			**Akaki Kality**				
	Woreda 10	**Woreda 9**	**Total**	**Woreda 9**	**Woreda 11**	**Total**	**%**	
10/90	-	-		49	25	74	24.6	74
20/80	57	54	111	70	45	115	75.6	226
Total	57	54	111	169	91	189	100	300

Table 3.1 No of samples from each sub cities and woredas of the study area

3.5. Empirical Model

In order to develop a realistic willingness to pay scenario, the research was presented a hypothetical market in which survey respondents are first described the good to be valued. The use of solar energy offer a promising solution towards the problems related to the health, economy, environment and energy crises to a considerable extent. Therefore, more efforts should be made in the direction of their popularization and in creating mass awareness for utilization of solar energy for cooking purposes.

The proposed solar cooking technology is a box type solar cooker with the application of wiper mechanism which was designed and fabricated in the Research Center of Bahir Dar University Institute of Technology, Ethiopia, 2018. The system was designed and fabricated in accordance to the details available in journals and previous works (Zeleke, and Sameer, 2018). Their research work describes the performance evaluation of a double-glazed box-type solar oven with three reflectors and with a vapor wiper mechanism fabricated using locally available materials.

The system has the following features (Zeleke, and Sameer, 2018):

- The water boiling time to be 53.54 minutes
- The standardized cooking power with a temperature difference of 50 ℃ was 51 W
- The payback period was estimated to be 2.4 years
- The overall daily thermal efficiency of the solar box cooker was calculated to be 31.4%
- The water boiling time from measured data was obtained to be 53.54 minutes
- The total cost of ETB 6000 (196 USD).

Then the respondents was clarified the Payment vehicle. After the payment mechanism and policy implementation rules are described the willingness to pay question was presented. We based our survey design on the prior studies that examined willingness to pay for green power ([Champ and Bishop, 2001] and [Poe et al., 2002]).

To explore willingness to pay (WTP) the dichotomous choice contingent valuation method (CVM) was applied as this technique better captures use and non-use variables. CVM is a valuation technique based on market/customer survey where respondents have the opportunity to make an informed decision on the pricing of a good or service. Rahmatian (2005) described this

method as the most suitable one for willingness to pay study as it captures the pricing options even in case of uncertainties and value a service or product that is not currently available.

Interactive choice discrete type question was asked in the first instance if the respondents are willing to pay for the proposed energy supply. Respondents who accepted the first bid was asked if they were willing to pay more than the value of the first bid. Respondents refused the first bid were offered a lower bid. Eventually an open-ended question was asked using a five different bid sets. However, it is made clear that choosing lowest bid may not be realistic, as the solar cooker operator may not make enough profit to make the project viable for long run and selecting a higher bid might be beyond their financial capability.

Despite many advantages of the CVM approach, it is often criticized for different biases. To eliminate the starting bid point bias the pre-determined (as mentioned earlier) value of ETB 5000 was applied. To deal with the strategic bias the government support to private or public-private partnership of the proposed projects was mentioned and finally to overcome the hypothetical bias respondents will be assured about the better quality service to be provided under the new renewable energy policy of Ethiopia Government.

3.5.1. Econometric Model Specification

3.5.1.1 The Probit Model Estimation

Hanemann (1984) figured out the Random Utility Model to investigate dichotomous unforeseen valuation reactions. In this examination likewise, arbitrary utility model was investigated. As per Habb& McConnell (2002) the aberrant utility capacity for respondent 'j' can be communicated as:

$V_{ij} = V_i (Y_j, X_j, \varepsilon_{ij})$ - - - - - 1

Where $Y_j = j^{th}$ respondent's income

[i]= 1 denots the last state (buying the innovation) and i=0 indicates business as usual (prior to buying of the innovation)

Xj= family's qualities and characteristics of a given decision.

εij = is the random part of a given indirect utility that is the stochastic disturbance term thought to be autonomously and indistinguishably dispersed with signify 'zero and a steady difference of σ2.

In this model respondent 'j' answers 'yes' or 'no' to a necessary installment of introductory 'offer' cost βi* for a proposed framework. Two decisions are there: stay in business as usual or buy the sunlight based cooker. Thusly the family will pick the proposed framework, if the utility with the unforeseen valuation program, net of the necessary installment, that is the underlying 'offer', surpasses utility of business as usual.

V_{1j} (Y_j-β_i*, X_j, ε1j) > V_0j (Yj, Xj, ε_0j) - - - 2

By indicating the utility capacity, it very well may be reworked as:

V_{1j} (Y_j-β_i*, X_j) +ε_{1j}> V_{0j} (Y_j, X_j) +ε_{0j} - - - 3

=$\alpha_j X_j$ +β_1 (Y_j-β_i*) +ε_{1j}>$\alpha_j X_j$+$\beta_o Y_j$+ε_{0j} - - - 4

Where α_j is a vector of boundaries and X_j is distinctive illustrative factors barring pay. As indicated by Yibeltal (2011), the key issue that the scientist may experience here is that the irregular segment of inclinations can't be known; in this way he/she can just make likelihood articulation about 'yes' or 'no' reactions for the given offer which gives a natural premise to investigate parallel reactions. In this manner the likelihood that the respondent says 'yes' is the likelihood that he/she thinks he/she is in an ideal situation from the proposed framework.

Pr. (Yes) =Pr. [V_{1j} (Y_j-β_i*, X_j) +ε_{1j}>V_{oj} (Y_j, X_j) +ε_{0j}] - - 5

Pr. (V_{1j}>V_{0j}) =Pr. [V_{1j} (Y_j-β_i*, X_j) +ε_{1j}> V_{0j} (Y_j, X_j) +ε_{0j}] - - 6

=Pr. [V_{1j} (Y_j-β_i*, X_j) - V_{0j} (Y_j, X_j)] > ε_{0j}-ε_{1j} - - - 7

=Pr [V_1j (.)- Voj (.)+ε_{1j}-ε_{0j}>0] - - - - 8

=Pr [ΔV+ή>0] - - - - - 9

Also to investigation the families' likelihood to give 'No' reaction can be evaluated as follows;

Pr. (No_j) =1-Pr. (Yes) - - - - 10

Pr. ($V_{1j}<V_{0j}$) =1-Pr. ($V_{1j}>V_{0j}$) - - - - 11

=1-Pr [$\Delta V+ \eta>0$] - - - - - 12

Where $\eta=\varepsilon_{1j}-\varepsilon_{0j}$ and letting F η (.) be a total appropriation work, and in the probit model it follows the typical total conveyance work and in the logit model Fη(.) follows the strategic total circulation work. Since both the logit and probit models give comparative boundary assesses, the decision between the two models involves numerical accommodation (Habb and McConnell, 2002, p.28)

At last, the general probit model can be given by:

T_j *=$\beta'X_j+\varepsilon_j$ - - - - - 13

Where Ti*= is inconspicuous inert variable, that is undetectable families eagerness to pay for the proposed framework. What we notice is a fake variable WTP_i which is characterized as:

WTP_j =1 if T_j*.$\geq\beta_i$*(T_j* =1, if the reaction is 'yes')

WTP_j =0 if T_j* < β_i* (T_j* =0, if the reaction is 'No')

βi*=is the underlying offer value offered to respondents εj=is the irregular mistake term which is expected to have arbitrary ordinary conveyance with signify 'zero' and basic fluctuation of σ^2.

X_j =is a vector of illustrative factors

At the point when the individual knows his/her own most extreme eagerness to pay, TI*, it is an irregular variable to the spectator with a given combined dispersion work (CDF) indicated F(Ti*/Xi ,θ),where θ is the boundary of this conveyance, which is assessed based on the reactions to the unexpected valuation overview, Ti * is the reaction of the individual and Ti* =1, if 'Yes', Ti*= 0, assuming 'No' and Xi is informative factors.

In this elicitation design the respondents are found out if they will pay the underlying 'offer' (βi *) to get the proposed framework and subsequently they replied by saying 'Yes' or 'No' , their

genuine ability to pay for the proposed framework isn't perceptible. Along these lines this 'Yes' or 'No' reactions were acquired from the shut finished study is assessed by Maximum Likelihood methodology and subsequently the Likelihood capacity can be communicated as a progression of Bernoulli trials.

$$L= \sum Tj^* \ln Fj+ (1-Tj^*) \ln (1-Fj) \text{ - - - - } 14$$

Where $Fj =F(Tj^*/Xj, \theta)$,i^{th} person's reaction likelihood and Tj^* is the fake variable demonstrating an individual decision 1 for 'Yes' and 0 for 'No' (Hanemann and Kanninen, 1998, referred to in Yibeltal (2011)). The probit model for families' inclination for the proposed framework can be communicated as:

$$WTPi=\beta_O+\beta_1 SER+ \beta_2 EDU+ \beta_3 AGOR + \beta_4 HSAT+$$

$$\beta_5 FAMS+ \beta_6 OCCR+ \beta_7 MST \beta_8 ASOC +$$

$$\beta_9 HOWN + \beta_{10} IB+ \beta_{11} INCM+ \beta_{12} MDIS +$$

$$\beta_{13} HEXPE +\varepsilon i \text{ - - - - } 15$$

Where WTPi = reaction to the 'offer' which is 1 if the reaction is 'Yes', 0 if the reaction is 'No', βi is the relapse boundary, εi is the mistake term and the illustrative factors are as characterized in the variable depiction part.

The principle targets of assessing experimental WTP model dependent on a CV review reaction is to determine focal worth (or mean) of the WTP dispersion (Hanemann, Loomis and Kanninen, 1991, referred to in Yibeltal (2011)).

The mean measure was utilized to ascertain the all out advantage of the proposed framework. Since the probit model was utilized to ascertain the mean WTP, for the shut finished single limited inquiries it tends to be characterized as follows:

$$\text{Mean WTP } =\mu= - \sigma/\beta \text{ - - - - } 16$$

Where σ=is the steady or intercept term

β= is the coefficient of the 'offer' presented to the respondent

3.5.1.2 The Bi- variate probit model Estimation

Here, families were posed two individual inquiries that has 'Yes' or 'No' reactions where the subsequent inquiry includes another offer contingent upon the main answer. After this interaction, we infer the probability capacity of the model to get the boundary appraisals of the bi-variate probit model, which takes in to think the subsequent inquiries in the twofold limited dichotomous decision. As indicated by Yibeltal (2011), by expecting the surreptitiously readiness to pay of the respondent j ($WTPj^{O}$) in the primary inquiry is between the most minimal worth ($WTPj^{L}$) and the most elevated worth ($WTPj^{H}$) and if an individual is found out if he/she will pay βq sum for a given natural great or not where q=1 if β is the initially offered sum and q=2 in the event that it is the subsequent offered. There would be four potential reactions of person

1. Indeed YES, if his/her reaction is "Yes" for both the first and the subsequent offer ($\beta_1$and β_2), $WTPj>\beta_2$, that is the most elevated readiness to pay in the brain of the respondent was among WTPH and boundlessness.

2. Indeed NO, if the people reaction is 'Yes' for the previously offer (β1) and 'No' for the subsequent offer (β_2), ($\beta_1 \leq WTPj < \beta_2$), that is the most elevated eagerness to pay is among $WTPj^{L}$ and $WTPj^{H}$.

3.NO-No,if his/her reaction is 'No' for the previously offer (β1) and 'No' for the subsequent offer (β2) ,that is the people most elevated ability to pay is among 0 and WTPjL.

4.NO-YES,if the individual reaction is 'No' for the initially offer (β_1) and 'Yes' for the subsequent offer (β_2), that is the most elevated ability to pay is among $WTPj^{L}$ and $WTPj^{0}$.

At that point the likelihood of noticing one of the conceivable two offer reactions can be composed as:

$Pr (Yes, Yes) = Pr (WTPj_1 > \beta_1, WTPj_2 > \beta_2)$ - - - 17

$Pr (Yes, No) = Pr (WTPj_1 > \beta_1, WTPj_2 < \beta_2)$ - - - 18

Pr (No, Yes) = Pr ($WTPj_1 < \beta 1$, $WTPj_2 > \beta_2$) - - - 19

Pr (No, No) = Pr ($WTPj_1 < \beta_1$, $WTPj_2 < \beta_2$) - - - 20

However, the j^{th} person's readiness to pay in twofold limited information can be given as:

$WTP_{jq} = \mu_q + U_{jq}$ - - - - - 21

Where μ_1 and μ_2 are the methods for the first and the subsequent ability to pay answers, WTP_{jq} is the j^{th} respondent's eagerness to pay and U_{jq} are mistake terms which are ordinarily dispersed with mean 0 and particular differences of σ_1^2 and σ_2^2.

Accordingly from the above conditions the j probability work becomes:

$I_{1k}(\mu/\beta) = [Pr(\mu_1 + U_{j1} > \beta_1, \mu_2 + U_{j2} > \beta_2)^{YY}] [Pr(\mu_1 + U_{j1} < \beta_1, \mu_2 + U_{j2} < \beta_2)^{NN}] [Pr(\mu_1 + U_{j1} > \beta_1, \mu_2 + U_{j2} < \beta 2)\ YN] [Pr(\mu 1 + Uj1 < \beta 1, \mu 2 + Uj2 > \beta 2)\ NY]$ - - 22

Where YY=1 for Yes-Yes reaction, 0 in any case, NY=1 for a No-Yes reaction, 0 in any case, NN=1 for a No-No reaction, 0 in any case and YN=1 for a Yes-No reaction, 0 in any case (Hanemann et al, 2001, referred to in Yibeltal (2011)).

To compute readiness to pay which is the measure of cash that makes individual detached between the underlying and the last state, and can be expressed as follows:

$= V_{1j}(Y_j - \beta_i *, X_j, \varepsilon_{1j}) = V_{0j}(Y_j, X_j, \varepsilon_{0j})$

$= \alpha_j X_j + \beta_1 (Y_j - \beta_i *) + \varepsilon_{1j} = \alpha_j X_j + \beta_0 Y_j + \varepsilon_{0j}$

$= \alpha_1 X_j + \beta (Y_1 - WTPj) + \varepsilon_{1j} = \alpha_0 X_j + \beta Y_j + \varepsilon_{0j}$

$= (\alpha_1 - \alpha_0) X_j - \beta\ WTPj + \varepsilon_{1j} - \varepsilon_{0j} = 0$

$= \alpha X_j - \beta\ WTPj + \eta = 0$ where $\eta = \varepsilon_{1j} - \varepsilon_{0j}$ and $\alpha = \alpha_1 - \alpha_0$

$= WTP_j = \alpha/\beta\ X_j + \eta/\beta$ - - - - - 23

$\sum (WTP_j) = \alpha/\beta \sum (X_j)$, expecting to be that $\sum (\eta) = 0$ - - - 24

Finally, the greatest WTP of family units' acquired from reactions of the open-finished inquiry, can be executed by the respondents can be just arrived at the midpoint of to create a gauge of mean WTP (Yibeltal, 2011), at that point communicated as:

Mean WTP =μ =ΣTi/n - - - - 25

Where n =is the example size and every T is a detailed WTP sum by studied households (FAO Corporate Document Repository, 2007)

3.5.2 Description of Explanatory Variables used in the model

Level of Education of the Head (EDU)-BEDU is a dummy variable 1 if the household obtained Basic Education, and 0 otherwise. SEDU is a dummy variable 1 if it is Secondary Education and 0 otherwise. TEDU is a dummy variable 1 if it is Tertiary Education and 0 otherwise. Education of households is expected to have positive relationship with willingness to pay for the proposed technology.

Marital status of the head (MST) - 1 if married, 0 otherwise. It is expected to have positive sign, since married people would have more interest to adopt such technology due to their more energy demand.

Respondent's family size (FAMS) - Number of family members in a household is expected to negatively associated with both initial and the follow-up bid levels

Occupational level of the respondent (OCCR) -is a dummy variable 1 for salary employment and 0 otherwise. It is expected to have positive value due to the fact that employed households need better energy sources, and have stable income than the other one.

The entries for Sex (SER) –is a dummy variable where '1' for male and '0' for female households. The sign of this variable cannot be determine since other research results shows mixed (+/-) values.

House ownership (HOWN) - 1 if household owns living house, 0 otherwise and expected to have positive relation with WTP

Availability of Source of credit (ASOC) - 1 if household has access to credit from any sources that offer credit, 0 otherwise. This variable is expected to have positive relation with WTP, because households with possible access to credit will have the ability to buy the proposed technology by taking credit.

Household's level of satisfaction with the existing energy sources (HSAT) -is a dummy variable 1 for not satisfied with the existing energy sources and 0 otherwise. This variable is expected to have negative values showing that households will have interest buy the proposed technology if their satisfaction with the current energy source is low, and vice versa.

Household's income level (IM)-is a continuous variable, and expected to have positive values, which implies households are expected to have the demand and the ability to buy the technology when their income goes higher and higher.

Age group (AGOR) - assumed to have inverse relation with the WTP, as younger respondents in Addis Ababa are more educated and are more open to accepting new technologies and services compare to their seniors.

Initial bid price offered to the respondents (IB) –it is included as an explanatory variable to determine whether households' responses were influenced by the starting bid given by the interviewer. It is a continuous variable and its sign will be known in the course of the study, and cannot be predict before the interview.

Monthly expenditure on Electricity (HEXPE) – measured by expense in Birr

Distance from wood/charcoal market (MDIS) - given in Kilometers. The opportunity cost of willingness to pay for green electricity energy is high when distance to alternative energy markets is small. This is because as the distance increases, the household incurs more for transportation and other expenses. The shorter the distance to these alternative energy sources, the lower the willingness to pay for green electricity for cooking for instance. In this regard, longer distance to alternative energy markets could effectively render these markets thin. These thin markets for alternative energy commodities could then motivate willingness to pay for green electric energy.

Table 3.2Variables Used in Regression Models and Expected Effect on WTP

Variable	Description	Expected
SER	Sex, dummy variable 1 if male,0 otherwise.	+/-
AGOR	Age of the respondents in years	-
MST	Marital status of the respondent	+/-
BEDU	Education level of the respondent ,dummy variable 1 if basic education,0 otherwise	+
SEDU	Education level of the respondent ,dummy variable 1 if secondary education,0 otherwise	+
TEDU	Education level of the respondent ,dummy variable 1 if tertiary education,0 otherwise	+
ASOC	Availability of Source of credit	+
OCC	Occupation of the respondent, dummy variable 1 if formal sector salary employment,0 otherwise	+
IM	Household average monthly income in birr	+
FAS	Family size of the respondent in number	+/-
HOW	House ownership, a proxy for wealth, dummy variable 1 if the respondents own the house,0 otherwise	+
HEXPE	Household average energy expenditure per month in birr	+/-
HSAT	Households' satisfaction with the existing service dummy variable 1 if not satisfied,0 otherwise	-
MDIS	Distance travel to get alternative energy in km	-
IB	Initial bid offered to the respondent	-

CHAPTER FOUR

4. RESULTS AND DISCUSSIONS

During the time of deigning this study, it was planned to use a total of 399 sampled households. However, due to the corona epidemic, it was possible to interview only 260 households and 248 questionnaires were analyzed. The remaining was incomplete so that excluded from the analysis. The demographic and socio-economic profile of the respondents is discussed below.

4.1. Descriptive Statistics

4.1.1. Demographic Characteristics of Respondents

The following descriptive statistics was compiled to show the age, household size, sex and marital status of respondents in terms of minimum, maximum, mean and standard deviation. Based on the result presented in the table below, the minimum age of them was 22 years, while the maximum age was 47, with the average age 32.56, and ±6 years (Standard Deviation). Additionally, concerning the family size of the household, the minimum size of the household was 1 person while the largest family has a maximum number of 9 members in the family. The average family size was found to be approximately 3 members.

Table 4.1. Demographic Characteristics of the Respondents

	N	Minimum	Maximum	Mean	Std. Deviation
Age	248	22	47	32.56	16.052
Household Size	248	1	9	2.85	1.539
Sex	248	0	1	0.36	0.41
Marital Status	248	0	1	0.62	0.56
Occupation Status	248	0	1	0.4903	0.5011

Source: Field Survey (2020)

According to the Central Statistical Agency (CSA), the average household size observed in the survey is 4.8 persons, which is similar to the average household size observed in the 1994 Census (CSA, 1999). Rural households have 4.9 persons per household and are slightly larger than urban households (4.2 persons). One-quarter of households are headed by women. Based on this, the finding on this study has shown lower average of household members among the

participant of this study. Concerning of the sex of the respondents, the result of the study revealed that it has the mean value of 0.36. Furthermore, the occupational statues of the households have 0.49 mean values.

Regarding the educational level of the respondents 43.1% of the respondents have non education, while 40.7% of the respondents were in elementary school. Only 4.0% of the respondents had Tertiary School (University/College first degree) education.

Table 4.2. Educational level of the sampled households

Items		**Frequency**	**Percentage**
Educational level	Non	107	43.1%
	Basic Education	101	40.7%
	Secondary Education	30	12.1%
	Tertiary Education(University/College first degree)	10	4.0%
Total		**248**	**100%**

Field Survey (2020)

4.1.2. Socio- economic factors

According to the study results depicted in the table below, the households' ownership status of the house has 0.73 mean values. Regarding the monthly income of the household, the surveyed households earn a minimum of birr 2800, and a maximum of Birr 8400 monthly aggregate income. The mean score of households income is birr 1953.42. Taking the average family size of 2.9, the average per capita income was Birr 673.6 per month and Birr 8083.11 per year for study area.(See table 4.3 below).

Table.4.3: House ownership and Family Income

Items	N	Minimum	Maximum	Mean	Std. Deviation
House ownership	248	0	1	0.73	0.49
Estimated monthly Family income	248	2800	8400	1953.42	914.69

Source: Field Survey (2020)

4.1.3. Institutional factor

Regarding the satisfaction of households with the existing energy sources, the study result showed it has a mean value of 0.18. The households must travel a minimum of half km and maximum of 4 km to get alternative energy sources. The average km households' travel to get alternative energy sources is about 2.11 km. The study result also shows that the availability of possible sources of credit has a mean value of 0.125.

Table 4.4: Access to Institutions based on Respondent's Opinion

Items	N	Min	Max	Mean	Std.
HH Satisfaction with the existing energy sources	248	0	1	0.18	0.32
Distance from home to the nearest market in km	248	0.5	4	2.11	2.9
Availability of sources of credit/loans	248	0	1	0.0125	0.048

Source: Field Survey (2020)

In this study, households' Willingness to pay (HWTP) binary choices for the proposed solar cooker is the dependent variable of the model. It is assumed that WTP is determined and explained by different socio economic and demographic characteristics. In the context of this study, the value that household places to get electricity services from solar energy is indirectly measured by the amount they are willing to pay (WTP) for it. The bids and socio economic and demographic variables are considered as the independent variables. The summary of variables used in the model and its description statistics is as shown below in Table 4.5.

Table 4.5 Descriptive statistics of variables used in the model

Variable	Description	Mean	Std. Dev	Min	Max
SER	Sex, dummy variable 1 if male,0 otherwise.	0.363	0.4117	0	1
AGOR	Age of the respondents in years	32.56126	16.051	22	47
MST	Marital status of the respondent	0.6242	0.56	0	1
BEDU	Education level of the respondent ,dummy variable 1 if basic education,0 otherwise	0.4814391	0.5132	0	1
SEDU	Education level of the respondent ,dummy variable 1 if secondaryducation,0 otherwise	0.2115149	0.4321	0	1
TEDU	Education level of the respondent ,dummy variable 1 if tertiary education,0 otherwise	0.2362143	0.4135	0	1
ASOC	Availability of Source of credit	0.01251	0.0483	0	1
OCC	Occupation of the respondent, dummy variable 1 if formal sector salary employment,0 otherwise	0.4085	0.4912	0	1
IM	Household monthly income	1953.14	926.48	280	840
FAS	Households' Family size	2.8547	1.5394	1	9
HOW	House ownership, dummy variable 1 if own the house,0 otherwise	0.7314563	0.4988502	0	1
HEXPE	Household average expenditure per month in birr	847.9757	336.35	101	201
HSAT	Households satisfaction of the existing energy sources, and is dummy variable 1 if not satisfied,0 otherwise	0.1813	0.3234	0	1
DTAE	Distance travel to get alternative energy in km	2.1112	2.9379	0.5	4
IB	Initial bid offered to the respondent	18.2524	5.5747	10	25

Field Survey (2020)

4.1.4. Household Energy Usage patterns

Based on the type of energy used for cocking purposes in the household, 32.7% used self-built stoves, 3.6% used stone/ fire stoves, and 46.8% of them used other types of energy. On average, more than half of the respondents 50.4% pay less than 100 birr monthly for electric consumptions while 32.7% of the households pay 100- 200 birr for electric fees for monthly consumptions.

Regarding the satisfaction of households with the current source of energy for cooking, only 46.8% were satisfied while the remaining stated as below satisfied range. Additionally, the study households prefer energy sources to have better quality (46.8%), and lower cost and be affordable (32.7%).

Table 4.6.Household Energy Usage patterns

Items		Frequency	Percentage	Mean
What type of energy do you use for cooking?	Stone/fire stove	11	4.4%	0.044
	Other Self-Built Stove	79	31.8%	0.318
	Manufactured stove	42	16.9%	0.169
	Other	116	46.8%	0.467
How much birr do you pay for your electric consumption in a month?	<100 birr	125	50.4%	0.504
	100- 200 birr	84	33.8%	0.338
	above 200 birr	39	15.7%	0.157
How do you judge your satisfaction with the existing source of energy to cooking?	very dissatisfied	9	3.6%	0.036
	Dissatisfied	81	32.7%	0.326
	partially satisfied	48	19.3%	0.19
	Satisfied	110	44.3%	0.44
	very satisfied	0	0.0%	0
Which of the following energy source you prefer mostly for cooking purposes?	fuel – wood	8	3.2%	0.03
	Electricity	91	36.7%	0.36
	Charcoal	42	16.9%	0.169
	Kerosene	107	43.1%	0.43
	Other	0	0.0%	0
Why do you prefer those sources?	Easily accessible	10	4.0%	0.04
	lower cost and affordable	76	30.6%	0.30
	more reliable	88	35.48%	0.35
	has better quality	74	29.83%	0.29
	Other	0	0.0%	0
How well do you think your knowledge is about renewable energy?	very poor	12	4.8%	0.04
	Poor	78	31.45%	0.31
	Average	62	25%	0.25
	Good	96	38.7%	0.38
	Excellent	0	0.0%	0

Source: Field Survey (2020)

4.1.5. Descriptive Analysis of WTP for the proposed Solar Cooking Stove

Households' were given three starting prices in the closed-ended dichotomous choice format. The result showed that out of the 248 households 196 (79.03%) have said that they are interested to pay an average initial bid amount. However, the remaining 52 (20.96%) said they are not interested to pay the initial bid amount. Also out of the 196 households who are ready to pay the

initial bid, 82 (33.06%) were also accepted even the higher average bid price. Meanwhile the remaining 114(45.97%) were refused to pay this higher bid amount.

Table.4.7 Households' maximum willingness to pay for the proposed solar technology

Max WTP	Number	%	Mean
0≤WTP≤ 2000	19	7.66	0.076
2000≤WTP≤4000	33	13.3	0.133
4000≤WTP≤6000	114	45.97	0.459
6000≤WTP≤8000	82	33.06	0.330
Total	248	100%	

Source: Field Survey (2020)

The study also revealed that out of 52 households who were uninterested to pay the initial bid, 33 (13.3%) of the total households were ready to pay a minimum of Birr 2000 and a maximum of Birr 4000. Meaning, they are willing to pay an average of 3500 Birr, which is a lower amount than the initial bid. The remaining 9 (4.37%) have still refused to pay even Birr 3500 which is a lower amount than the initial bid.

Furthermore, an open-ended question were asked to the households to state their maximum amount they are willing to pay for the proposed solar cooker, then a significant number of households, i.e., 196 (79.03%) assigned positive amounts and only 52 (20.96%) were given zero WTP.

4.2. Econometric results of WTP for solar Cooking Technology

4.2.1. Analysis of Determinants of Households' WTP

To research which variables impacted family units' choice to embrace the proposed sun oriented cooker, an arranged probit model relapse examination performed. Initial a test was hurried to decide if multicollinearity exists in the model. Multicollinearity exists in a model when at least two of the informative factors are exceptionally related. As per Gujarati (2006), multicollinearity is an issue in a model if the pair-wise connection coefficient is more prominent or equivalent to 0.8. From the correlation network, it very well may be seen that multicollinearity isn't a problem in this model since none of the factors have a connection coefficient of at any rate 0.8 with another variable.

As demonstrated in table 4.8 the Wald chi square that is 42.68 shows the general meaning of the Probit Model at 1% degree of importance. The pseudo R^2 is 56.74%, indicates that the logical factors fit the model by 1.15%. Nonetheless, little accentuation is put on this since 'decency of fit' isn't as significant contrasted and the measurable and financial significance of the logical factors (Wooldridge, 2010 pp. 575).

Household's Income- households' income level is significant at 1% and has a positive sign. Here income and WTP is found to have direct (positive) relationship. Households with higher income level would have both the ability and willingness to pay for improved energy sources, like the solar cooker.

The ability of income to positively influence willingness to pay, as depicted by the outcome of this study, is consistent with literature. Several studies have found a direct relationship between income and willingness to pay. Abdullah and Jeanty (2011), Abdullah and Mariel (2010) as well as Edkins (2008) all posit a direct relationship between income and willingness to pay for reliable electricity. This indicated that households with higher income have a greater ability to pay than the households with lower income. A study by Alemu (2000) and Tefera (2006) also recognizes this significant association between households 'income and WTP.

Family Size - Household size is positively associated with willingness to pay for improved energy sources and it is statistically significant at 10%. The result showed that an increase in family size increases the probability of saying 'yes' to the offered prices by about 13.10%. Solomon (2004) also found the same result. The positive impact of household size on willingness to pay in this study is in line with the work of Abdullah and Marriel (2010) and Gunatilake et al (2012)

However, it is contrary tothe findings of Akcura (2011), Quartey (2011) and Bigerna and Polinori (2011), who found a negative relationship between household size and willingness to pay. The possible reason for the negative relationship between household size and willingness to pay is that higher household size comes with it the attendant cost of providing for the basic needs of the members and as such paying for improvement in electricity may not be an immediate priority.

But, the implication of this study finding is that large household size will increase energy demand, and household heads with large family size definitely would search for alternative energy sources which are more reliable, and cheap, like the solar cooker, other factors being constant.

Educational level- the result of the probit model showed that education level of the households' is the other variable that affected WTP significantly. Also the level households' education is positively affected their WTP. One possible reason could be that literate individuals are more concerned about solar energy than illiterate one. Educated (or literate) individuals relatively know more about the significance of resources, and they are concerned more about the environmental resource. This is consistent with the findings of Tegegne, (1999) and Carlsson et al. (2004). Furthermore, the study result revealed that, if educational level of the households is increased one year, WTP will increase by 1.39%, other things being constant. This could be due to the fact that educated people have more information, interest, and tendencies to adopt new technology than uneducated people.

House ownership status (1 if household owns living house, 0 otherwise) – this variable has a positive sign and it is significant at 10%. This means, if households own their living, WTP will increase by 1.64%, other things being constant.

As stated earlier, the coefficient of house ownership has positive relation to the likelihood of saying yes to the initial bid. That is, keeping the effect of other variables constant changing ownership from 0 to 1 will increase probability of accepting the initial bid. This is because the respondents feel secure of their right to use the technology after adoption. This finding is consistent with Solomon, (2004), and Lindhjem and Navrud(2008).

Age-the value of age is statistically significant at 1% and has negative influence. This means that a one year increase in the age of the household will decrease his/her WTP by 0.49%. This result is also go in line with the study result of Du Preez, Menzies, Sale and Hosking (2012) which argued that age and awareness about environmental issues affect attitudes towards the demand and willingness to pay for energy from renewable sources.

Sex of the respondent-sex of the households is the other variable with significant impact on WTP. The variable also has a negative value which indicates among the surveyed sample households, female more interested on solar cookers than males. This result is different from the finding of Francis and Christian (2015) which was considered as insignificant. This is may be the socio-cultural reality of Ethiopia where finding the source of energy, and preparing food for the household is main responsibility of female than male. Due to this they are more in need of getting alternative, reliable and cheap source of energy such as the solar cooking technology.

Occupation-occupation of the households' has a positive value, and it affects decision of households significantly. Being an employee increases willingness to pay for improved energy sources. Most employees, especially women, do not have the luxury of time to cook every time and because they usually return home late they are motivated to have reliable, alternative power supply. Furthermore, since these groups have a permanent income, the probability of accepting an offered bid positive. The results suggest that enhancing employment activities could go a long way to improve willingness to pay for electricity supply. This finding is similar with the literatures. People who are employed tend to own and rely on electrical appliances for their personal and professional needs compared with unemployed household head (Abdullah &Jeanty, 2011).

Marital Status- the marital status of the head is the other significant variable with a positive sign. It has a significant level of 1%. This is may be due to more energy is needed in couples than single households. While the sign of the variable 'electric consumption per month has a positive and statistically significant by 10%. The central idea here is that if households consume less ,and spend little for electricity consumption per month, they will not interested to find alternative energy sources, like solar cooker.

Distance Travel for alternative energy sources-As expected, variable representing travel for alternative energy sources has a positive sign. The variable is also significant at 1%. The implication of this result is that if the distance households' needs to travel to get reliable alternative source of energy is far from their dwellings, they are more willing to adopt the proposed technology. But, this result is farther from the previous studies that show a negative

and significant relationship between the distance from market to household (Gebermariam et al., 2013; Asrat et al., 2004; Tessema and Holden, 2006).

Initial Bid- The coefficient of starting bid price is significant at 1% level of significance. But the variable has a negative sign, which indicates that initial bid and WTP have inverse relationship. Indeed, a one percent increase in the initial bid will decreased the households' WTP for the proposed energy technologies by 3.0%, other things being constant. This may indicate there is income scarcity or cash poverty. Besides, the result shows that demand for alternative energy sources, like the solar cooker, is decreased as price increases. This result is also consistent with the findings of Solomon (2004); Carlsson et al. (2004); Bin Ramlan et al. (2011); and Mousavi and Akbari, (2011). The negative influence of bid price on the willingness to pay of the respondents is also confirmed in the law of demand which stated "other things being constant demand for good decreases as the price of the good increase and vice versa"as well as other previous studies (Gebermariam et al., 2013; Shiferaw and Holden, 1998; and Ayenew and Meride, 2015).

Table 4.8Probit Model Estimates for Willingness to Pay

Explanatory Variables	Coeff.	Rob. Stan. Errs	Z	Mar. effect
BID1	-0.001	0.000	-9.27	-8.49
ASOC	-0.0426	0.0138	-3.080	-6.00
BEDU	0.5544	0.3610	1.536	1.93
SEDU	0.6132	0.3991	1.852	1.98
TEDU	0.6629	0.4102	1.911	1.99
MST	0.6761	0.5422	1.247	2.58
FAS	0.3189	0.1890	1.687	4.49
OCC	1.3098	0.4580	2.860	1.84
HOW	0.0530	0.0304	1.739	7.45
IM	2.0466	0.6948	2.946	2.88
AGOR	0.2862	0.4103	0.698	7.78
HSAT	0.2820	0.3799	0.742	4.71
DTAE	0.8246	0.4377	1.884	4.64
Constant	-7.2973	2.5133	-2.924	-
Pseudo R^2	0.5674	-	-	-
Wald chi^2	42.68	-	-	-

Source: Field Survey (2020)

To assess the bi-variate probit model, the respondents were posed two continuous inquiries so that the subsequent inquiry is dependent upon the reaction of introductory offer. For family units' who accept the starting offer, gotten some information about eagerness to pay for the higher offer (Birr 6500). For family units' who dismissed the underlying offer, we offered the lower offer (Birr 5500). In the end-product, the coefficient of connection of blunder terms of the twofold limited model (the 'rho') is discovered to be positive which shows that the arbitrary segments in the first and the subsequent reactions are decidedly related.

In the probit model, the underlying offer has negative sign which shows that when the offer offered builds the likelihood of tolerating it diminishes and is genuinely critical at 1% degree of importance. Here correspondingly, the coefficient of the subsequent offer is additionally negative and measurably critical at 1%.

As talked about before, on account of single-limited arrangement the Probit model was assessed utilizing just the originally offer. Notwithstanding, the twofold limited model was assessed utilizing both the first and the subsequent offers offered to the family units as informative factors. The exactness of the assessments of the catch term and coefficient of the offers offered to family which is estimated utilizing assessed standard blunders is one of the instruments to look at the measurable proficiency of single-limited versus twofold limited dichotomous decision question designs (Hanemann, Loomis and Kanninen, 1991: refered to in Yibeltal , 2011).

Table.4.9. Bivariate probit results for household willingness to pay

Variables	**Coef.**	**Std.Err.**	**Z-Value**
Households' WTP for initial bid,1 if 'Yes',0 otherwise			
Initial bid (in birr)	-0.0314	0.0201	-6.17
Constant	6.12761	1.521615	3.9
Households' WTP for second bid,1 if 'Yes',0 otherwise			
Second bid(in birr)	-	0.029011	-5.29
Constant	1.704317	0.731122	2.91
Athrho	7.139081	----	----
'rho'	0.764994	----	----

Source: Field Survey (2020)

The precision of the estimates of the intercept term and coefficient of the bids offered to household which is measured using estimated standard errors is one of the mechanisms to compare the statistical efficiency of single-bounded versus double-bounded dichotomous choice question formats (Hanemann, Loomis and Kanninen, 1991). As the coefficients of the bid and the intercept terms are statistically significant at 1% level for the two types of dichotomous-

choice surveys, and standard errors of these coefficients of bids and constant terms are approximately the same for both double-bounded and single-bounded models, which lead to the same t-statistics which is a measure of goodness of fit, that does not much differing in the two models. This indicates that the use of double-bounded instead of single-bounded does not increase statistical efficiency as such and thus we use the single-bounded format (the Probit model) to calculate the mean WTP of households for the proposed solar cooker.

4.2.2. Estimating mean willingness to pay from Econometric Analysis

As the coefficients of the offer and the block terms are genuinely huge at 1% level for the two sorts of dichotomous-decision reviews, and standard mistakes of these coefficients of offers and consistent terms are roughly the equivalent for both twofold limited and single-limited models, which lead to a similar t-insights which is a proportion of integrity of fit, that doesn't a lot contrasting in the two models. This shows that the utilization of twofold limited rather than single-limited doesn't increment factual proficiency all things considered and accordingly we utilize the single-limited organization (the Probit model) to compute the mean WTP of family units for the proposed sun based cooking innovation.

Assessing WTP dependent on the CV study reaction is imperative to infer the focal worth (mean) of WTP dissemination (Hanemann, Loomis and Kanninen, 1991: referred to in Yibeltal: 2011). In the Probit model, the mean WTP of families given in dichotomous decision unexpected valuation overview were determined by separating the negative of the relapse consistent (capture) by the offer coefficient.

Therefore Mean WTP =μ=-σ/β=-7.28/-0.001 =7280

Here, the households' mean WTP for the proposed technology that was obtained from the closed-ended format is Birr 7280.00, indicating that the surveyed households were willing to pay more than the current market price of the designed solar cooking stove which has a price ranges from Birr 6000-7000.

Likewise, the mean WTP for the open-ended CV survey responses of the maximum WTP reported by households is simply the average of their maximum WTP amount (Yibeltal , 2011).

$$\text{Mean WTP} = \mu = \Sigma\, Ti/n$$

Where ‘Ti’ = reported maximum WTP

‘n’ = sample size

Mean WTP =μ=1,736,000/248=7000

From the result we can understand that the mean WTP households’ given to the proposed solar cooker technology is a little bit smaller in the open-ended question than the close ended results, i.e., 7000 birr.

4.2.3. Aggregate WTP for the Proposed Solar Cooker

With respect to the estimation of government assistance utilizing WTP, total of advantage is a significant issue (Alemu, 2000). As indicated by Mitchell and Carson (1989) there are four significant issues to be considered with respect to test plan and assessing a legitimate collection of advantages: populace decision predisposition, examining outline inclination, none reaction predisposition and test determination inclination.

Irregular testing technique was utilized in this investigation utilizing a rundown of family units. Up close and personal meeting techniques was utilized and fight zero reactions were avoided from the investigation and expected dissent zeros was accounted in the assessment of the absolute total advantage of the proposed sun oriented cooker. Thus, nothing from what was a just mentioned inclination was normal, and Mean WTP was utilized as a proportion of total estimation of sun powered cooker appropriation in this examination.

The total WTP was determined by increasing the mean WTP by the absolute number of family units in the populace, as it is demonstrated below (Table 4.11). Following this, the total WTP for the proposed sunlight based cooking innovation was figured as 1,442,168,000 birr. While, from open finished inquiries the complete WTP for the proposed sunlight based cooker was likewise registered at 1,386,700,000 birr.

Table 4.11.Estimation of Total Aggregate WTP and estimated total economic value

Total households (Y)	Expected households with valid responses (Z)	Mean WTP	Aggregate Benefit(in Birr)
140,000	198,100	7280	1,442,168,000
140,000	198,100	7000	1,386,700,000

Source: Field Survey (2020)

Despite the fact that, sun oriented cooking is certainly not a novel thought. Since the primary sun based cooker was planned somewhere in the range of 1740 and 1799 (Palmer Development Group, 1997; Solar Cooking FAQ, 1999). Also, sun powered cooking expanded worldwide lately. Sunlight based cooking rivalries and displays occur every year in the USA. India has a National Solar Cooker Program that disseminated around 70 000 cookers at financed costs. The accompanying sunlight based cooking innovation request bend was developed as a perception instrument.

Sun based cookers are heat exchangers intended to utilize sun based energy during the time spent cooking. In providing the required energy, sun powered cookers can completely or incompletely swap the utilization of kindling for cooking in many agricultural nations. Self assured people have assessed that 36% of the building up world's utilization of fuel-wood could be supplanted by sunlight based ovens (Lampinen, 1994). Indeed, even fractional dependence on the sun rather than complete reliance on the woodland for cooking needs would save immense measure of fuel-wood (Ethiopia Project, 1997) however beside the expense, accommodation of utilization and certain social conditions, current sun based cookers, in the event that they are to acquire wide-scale acknowledgment, should meet got execution necessities.

In Pakistan 1780 cookers were sold at financed costs between June 1985 and June 1987, and100, 000 sun oriented cookers are utilized in China (Karekezi & Ranja, 1997). Southern African improvement here has been to some degree moderate. Despite the fact that people have been trying different things with sun based cookers for quite a while, the principal business movement started in 1993 when the Sun oven organization was dispatched (Palmer Development Group, 1997). From that point forward examinations have been led to test the practicality of various kinds of sun powered ovens (Palmer Development Group, 1997; Konttinen, 1995; Grundy and Grundy, 1999; Rodgers, 1994).

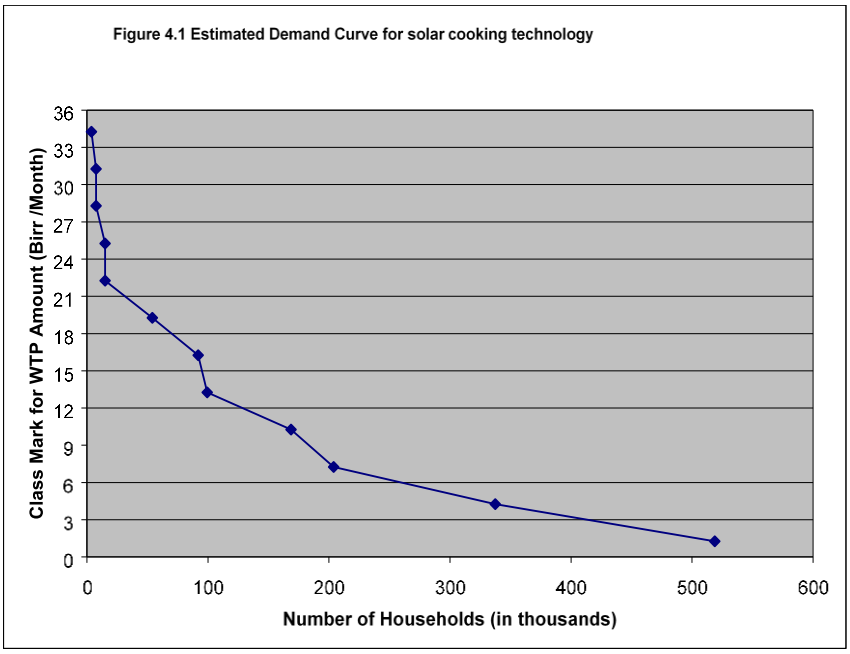


Figure 4.1 the demand curve

Lastly it is important to notice that like most normal goods, the demand curve for the proposed solar cooker is also has a negative slope (see in figure 4.1). Which implies that increase in the price of solar cooking technology would have deprecation effect on the demand, other things being constant.

CHAPTER FIVE

5. CONCLUSIONS AND RECOMMENDATIONS

5.1. Conclusions

Assessing family units' eagerness to pay for sun powered cooker with a coating wiper component was one of the destinations this paper attempted to address. All the more explicitly, this investigation attempted to evaluate the socio-segment attributes of the families, gauge eagerness to pay for box type sunlight based cooker with a coating wiper component and to break down determinants of readiness to pay.

Over the span of undertaking this examination, a Contingent Valuation Method (CVM) was utilized to lead an overview, and the analyst had the option to gather information from essential sources amounted 248 who were haphazardly chosen from the investigation zone. To meet the examination goals, bivariate probit model was utilized to assess mean WTP and distinguish deciding variables for family units' WTP. Further the inspected family units were likewise posed inquiries identified with segment and financial attributes, their energy use practices and some other general inquiries.

As the descriptive analysis showed, 54.0% of sampled households were found to be males, and 46.0% were female. Similarly, 43.1% of the sampled households were regarded as uneducated; 40.7% of them obtained basic education; and 4.0% of them got Tertiary School education.

With regarding to marital status of the households, 64.5% were married while 35.5% were unmarried. Concerning the occupation of the respondents', Unemployed and Self-employee were the largest groups among the various occupation status list containing 42.7% and 37.9% respectively.

The Probit Model outcome demonstrated that the underlying offer value, sex of respondent, Educational level, Marriage Status, Family Size, Occupation, House status and Income of the family have positive and critical impact for wiliness to pay for sun powered cooking innovation.

Out of 248 families, 196 (79.03%) were intrigued to pay a normal starting offer amount. However, the excess 52 (20.96%) said they are not intrigued to pay the underlying offer sum. Likewise out of the 196 families who are prepared to pay the underlying offer, 82 (33.06%) were

additionally acknowledged even the higher normal offer cost. Then the excess 114 (45.97%) were would not compensation this higher offer sum.

The investigation additionally uncovered that out of 52 family units who were uninterested to pay the underlying offer, 33 (13.3%) of the absolute families were prepared to pay at least Birr 2000 and a limit of Birr 4000. This means, they will pay a normal of 3500 Birr, which is a lower sum than the underlying offer. The leftover 9 (4.37%) have still would not compensation even Birr 3500 which is a lower sum than the underlying offer. Moreover, an open-finished inquiry were posed to the families to express their greatest sum they will pay for the proposed sun powered cooker, at that point a critical number of families, i.e., 196 (79.03%) allocated positive sums and just 52 (20.96%) were given zero WTP.

The experimental discoveries on the determinants of WTP showed that pay of the family unit, house status, family size, schooling level, female heads, admittance to efficient power energy data and distance from home to the closest wood and charcoal market were significantly and emphatically influencing family unit eagerness to pay for improved green power administrations. Then again the offer offered, and age of the head, were found to have significant backwards relationship with readiness to pay.

Some of the positively influencing variables (such as income, house ownership status, education, and household size) are key to empowering decision-makings. Income and information represent capacity that define ability of paying and hence their instrumental role in empowering willingness to pay decision-makings. In addition, an interesting result is the role that 'substitution effect' plays in willingness to pay decision-makings. Consistent with theory and common sense, thin markets in alternative energy (as shown by the distance to both modern and traditional alternative energy markets) will increase the willingness to pay for green electricity services.

At long last, subsequent to dissecting the shut finished inquiries, the scientist determined the mean WTP, acquired Birr 7280 for the proposed sunlight based cooking technology. This figure is more than the current cost of the planned sun oriented cooking oven which has a value scope of Birr 6000 to 7000. The total WTP for the proposed is 1,442,168,000 birr, and from open finished inquiries the complete WTP was additionally processed as 1,386,700,000 birr.

5.2. Recommendation

Based on the results of this study, I recommend a number of interventions to be put in place in the study area:

- The city government in collaboration of private actors can implement the proposed technology to satisfy the energy needs of the community.
- The government should encourage and motivate the private actors to enter in the city's energy sector and exploit this market.
- Since the current dwellers of the condominium houses are ready to pay the cost of the technology, the city government should start to think the integration of such alternative energy sources with the condominium houses that are going to build in the future.
- According to the study, being the owner of the house is directly related to the WTP for such technology. This implies that people are less willing to adopt is the house they live is rented. Therefore, the construction and distribution of condominium houses for people would make the people house owners so that willing to such technology.
- Further research is recommended particularly to assess the main challenges to adopt such alternative energy technologies in Addis Ababa context as well as its contributions to the energy usage situation in the study area.

References

- Abdella Said Shah (2003), Value of Improvements in Water Supply Reliability in Zanzibar town; Msc Thesis, Yale University, School of Forestry and Environmental Studies.
- Abdullah, S., Jeanty, P.W., 2011. Willingness to pay for renewable energy: evidence from a contingent valuation survey in Kenya. Renew. Sustain.
- Abebe, D. and Koch, S. (2011). Clean Fuel-Saving Technology Adoption in Urban Ethiopia Paper provided by Economic Research Southern Africa in its series.
- Adaman, F., Karal, N., Kumbaroglu, G., Or, I., Ozkaynak, B., Zenginobuz, U., 2011. What determines urban households' willingness to pay for CO2 emission reductions in Turkey: a contingent valuation survey.
- African Development Bank (AfDB)(2014). Energy and Power. African Development Bank Group Website. (www.afdb.org, accessed in February 2015).
- Aklilu, (2005). "Rural Electrification in Ethiopia: Opportunities and Bottlenecks".
- Alebel Bayrou, 2004. "Estimating households' affordability and willingness to pay for improved water supply services in urban areas, using contingent valuation method" (M.Sc. Thesis, Department of Economics, AAU.)
- Arega, T. and Tadesse, T. (2017), Households' willingness to pay for green electricity in urban and pre-urban Tigray, northern Ethiopia: determinants and welfare effects, Energy Policy.
- Alem, Y., Beyene, A.D., Köhlin, G., Mekonnen, A., 2013. Household Fuel Choice in Urban Ethiopia: A Random Effects Multinomial Logit Analysis. Discussion Paper Series EfD-DP13-12 Environment for Development.
- Alemu, M. and Koholin, G. (2008). Determinants of Household Fuel Choice in Major Cities in Ethiopia. Environment for Development.
- Araya Asfaw, 2012: Sustainable Household Energy for Addis Ababa, Ethiopia
- Arene, C.J. and Mbata, G.I. (2008), Determinants of Profitability and Willingness to Pay for Metropolitan Waste-Use in Urban Agriculture of the Federal Capital Territory, Abuja, Nigeria, Journal of Tropical Agriculture, Food, Environment and Extension Vol. 7(1).
- Aseffa Chaka (1998) ,Estimating Willingness To Pay for Water Supply in Addis Ababa; Msc Thesis ,Addis Ababa University, School of Economics.
- Bateman,I.J.and R.Kerry Turner.(2002) "Economic Valuation with Stated Preference Techniques", Manual .
- Bollino, C.A., 2009. The willingness to pay for renewable energy sources: the case of Italy with socio-demographic determinants.
- Bouhrim, H.; Marjani, A. (2017): On the shoreline wave energy potential and its conversion in Morocco.
- Boyle, K.J., Bishop, R.C., Welsh, M.P., 1985. Starting point bias in contingent valuation bidding games.

- Breyer et al: 2009. "Electrifying the Poor: Highly Economic Off-Grid PV Systems in Ethiopia – A Basis for Sustainable Rural Development"
- Bryman & Bell: 2003. "Business Research methods"
- Cameron, T.A., Quiggin, J., 1994. Estimation using contingent valuation data from a dichotomous choice with follow-up questionnaire. Environ. Econ. Manag. 27, 218–234.
- Carson R. (2000),"Contingent Valuation: A Users Guide", University of California, Department of Economics, San Diago, California.
- Chan, K.Y.A., Oerlemans, L.A.G., Volschenk, J., Oliver, H., 2011. Objective and subjective measures of willingness to pay for green electricity: do they measure the same? Evidence from a South African case. Technology management in the energy smart. World 11, 1–9.
- Christopher Bryan, Tadhg Macintyre, and Deirdre O'Shaea, 2018. The what, how where and when of the resilience as a dynamic, episodic, self-regulating system: A response to Hill et al.
- Colenbrander, S., Gouldson, A., Sudmant, A. H. and Papargyropoulou, E., 2015: The Economic Case for Low-carbon Development in Rapidly Growing Developing World Cities: A Case Study of Palembang, Indonesia, Energy Policy, Vol. 80.
- CSA. Welfare monitoring survey 2011: indicators on living standard, accessibility and household assets, statistical report, central statistical authority (CSA), Addis Ababa, Ethiopia. 2012.
- Dereje D. 2013. Ethiopia's Renewable Energy Power Potential and Development Opportunities: Brief Facts about Ethiopia. Ministry of Water and Energy, Addis Ababa Ethiopia.
- Duffel Lemessa (1998) Estimating Willingness To Pay for Rural Water Supply: The Case of Ada'a-Liben District (Ethiopia); Msc Thesis, Addis Ababa University, School of Economics.
- Edmond J. Keller & Edith Mukudi-Omwami(2017): Rapid urban expansion and the challenge of pro poor housing in Addis Ababa, Ethiopia, Africa Review
- Ethiopia Project. 1997. Solar Cooker Review. (Retrieved December 12, 2019 from http://www.accessone.com).
- Ethiopian Electrical Utility (EEU) (2012). Ethiopian Power System Expansion Master Plan Update (EPSEMPU).
- FAO, Corporate Documents Repository: Application of Contingent Valuation Method in Developing Countries –PDF notes http://www/fao org /DECREP/003/X8955E03.htm.
- Federal Democratic Republic of Ethiopia (FDRE), 2011. Ethiopia's Climate-Resilient Green Economy. Green economy strategy.
- Fikre Gesso, (1995). Analysis of household Energy consumption pattern, the case of Woreda 24. Addis Ababa University.
- Freeman, A.M. (1993) The Measurement of Environmental and Resource Values: Resource for the future, Washington DC.
- Gebreegziabher, Z., Oskam, A.J., Bayou, D., 2010. Urban Fuel Demand in Ethiopia, an Almost-Ideal Demand System Approach.

- GTZ, (1998). Profile of Household energy in Ethiopia. MOA/GTZ Households Energy/ Protection of Natural Resources project.
- Greene, W.H., 2003. Econometric Analysis third edition. Macmillan Publishing Co.
- Guo, B., Geng, Y., Dong, H., Liu, Y., 2016. Energy-related greenhouse gas emission features in China's energy supply region: the case of Xinjiang. Renew. Sustain.
- Guo, X., Liu, H., Mao, X., Jin, J., Chen, D., Cheng, S., 2014. Willingness to pay for renewable electricity: a contingent valuation study in Beijing, China.
- Guta, Dawit Diriba; Börner, 2015: Energy security, uncertainty, and energy resource use option in Ethiopia: A sector modeling approach
- Haab, T and McConnell, K., 1997. Referendum models and negative willingness to pay: Alternative solutions. Journal of Environmental Economics and Management.
- Haab, T.C. and K. E Mc Connell (2003), Valuing Environmental and Natural Resources: The Economic of Non- Market Valuation ,New Horizon in Environmental Economics, Printed and Bounded in Great Britain by MPG books Ltd ,Bodmin ,Cornwall.
- Hanemann, W. M. and Kanninen, B., 1999. The statistical analysis of discrete-response CV data In: Bateman, I.J and Willis, K.G. (Eds.), Valuing Environmental Preferences: Theory and Practice of Contingent Valuation Method in the US, EU, and Developing Countries. Oxford University Press, Oxford, UK.
- Hassan, M.K., Pelkonen, P. and Pappinen, A. (2014), Rural households knowlwdge and perception on bio-energy resources development: Results from a field study in Bangladesh, Applied Energy, Vol. 136, pp. 454-464.
- Herriges, J.A., Shogren, J.F., 1996. Starting point bias in dichotomous choice valuation with follow-up questioning. Environ. Econ. Manag. 30, 112–131.
- ISEI (2012) "Solar Energy Vision for Ethiopia" Opportunities for creating a Photovoltaic Industry in Ethiopia".
- Johanson, Per-Olov (1991), an Introduction to Modern Welfare Economics, Cambridge University.
- IEA (International Energy Agency). (2005): World Energy Outlook. Paris: OECD.
- Kanninen, J.B., 1995. Bias in discrete response contingent valuation. Environ. Econ. Manag. 28, 114–125.
- Karkezi and Ranja. T, (1997). Renewable Energy Technologies in Africa, London and new Jersy: Zed Books in Association with African energy Policy Research (AFREPREN) and the Stockholm Environment Institute
- Kifle M, 2015: Report on Solar Pup experience sharing and training in Lemo, Ethiopia. Nairobi Keneya, ILRI.
- Kuunibe, N., Issahaku, H., &Nkegbe, P. K. (2013). Wood based biomass fuel consumption in the Upper West Region of Ghana: Implications for environmental sustainability. Journal of Sustainable Development Studies, 3(2), 181-198.

- Lal, P. and L. Takau (2006) Economic Costs of Waste in Tonga. SPREP and the Pacific Islands Forum Secretariat.
- Lampinen, A. 1994. Reduction of deforestation by massive use of solar cookers. Technology for life, Finland. (Retrieved 20-12-2020, http://www.kaapeli.fi/tep/keitin4e.html).
- McCue, D., (2017): Enel to Build Solar Plant in Ethiopia.
- Mehari, W.(2011).Energy and economic growth in Ethiopia: Granger causality approach. Economics Department.
- Melkamu B., 2013: Constraints and opportunities of village chicken production in debsan tikara kebele at Gonder zuria woreda, north Gonder, Ethiopia.
- Mekonnen A, Gebre Egziabher Z, Kassie M, Kolin G (2009) Income alone doesn't determine adoption and choice of fuel types: evidence from households in Tigrai and major cities in Ethiopia, environment for development (EFD) policy brief.
- Mekonnen, A., Köhlin, G., 2008. Determinants of Household Fuel Choice in Major Cities in Ethiopia. Discussion Paper.
- Mengistu MG, Simane B, Eshete G, Workneh, 2015: A review on biogas technology and its contributions to sustainable rural livelihood in Ethiopia. Renew Sustain Energy.
- Ministry of Water and Energy of Ethiopia (MoWE) (2009): Energy Resources Potential of Ethiopia Energy Development, Follow-up and Expansion Department. Addis Ababa, Ethiopia.
- ____ (2011). Energy Balance of Ethiopia and Statistics for the Years 2005/6-2009/10. Addis Ababa: Ministry of Water and Energy of the Democratic Republic of Ethiopia.
- Mitchell, R.C. and R.T.Carson, (1989), Using Survey to Value Public Goods. The Contingent Valuation Method, Resource for the Future, Washington DC.
- MoFED. Growth and transformation plan (GTP) 2010/11-2014/15. ": Ministry of Finance and Economic Development (MoFED); 2010.
- Mustapa, M.; Yaakob, O.; Ahmed, Y.; Rheem, C.; Koh, K.; Adnan, F. (2017): Wave energy device and breakwater integration: A review. Renew. Sustain. Energy Rev. 77, 43–58.
- NPC. Growth and transformation plan II (GTP II) (2015/16-2019/20), national planning commission (NPC), Ethiopia. 2016
- Omar Mohammed, (1994). Household Energy and Demand Side Management in Ethiopia, Addis Ababa, Ethiopia Energy Authority.
- Perman, R, Ma, Y, Mc Gilvary, j and Common (2003),"Natural Resource and Environmental Economics, Person Education Limited, Printed and Bounded by Bell and Bain Ltd .3rd edition
- Robert L, Miller and John D, Brewer. 2003. The A-Z of Social Research. A Dictionary of Key Social Science Research Concepts. London · SAGE Publications Ltd: sage
- Samuel et al (2015). "Resource assessment and optimization study of efficient type hybrid power system for electrification of Rural District in Ethiopia".

- Schlag, N. and Zuzarte, F. (2008) Market Barriers to Clean Cooking Fuels in Sub- Saharan Africa: A Review of Literature.
- SEI-international.org, 2015.
- Sharew Anteneh Mekonnen, 2007: Solar Energy Assessment in Ethiopia: Modeling and Measurement
- Solomon Jebessa. (2004). Contingent Valuation of Multi-Purpose Tree Resources: The Case of Arsi Zone, Ethiopia. A Thesis Submitted To the School Of Graduate Studies of Addis Ababa University, Ethiopia.
- Soon, J. J. and Ahmad, S. A., (2015) Willingly or Grudgingly? A Meta-analysis on the Willingness-to-pay for Renewable Energy Use, Renewable and Sustainable Energy Reviews.
- Tegegne GebreEgziabher. (1999). Willingness to Pay for Environmental Protection: An Application of Contingent Valuation Method (CVM) in Sekota District, Northern Ethiopia. Ethiopian Journal of Agricultural Economics, 3(1).
- Tietenberg, T. (2003), Environmental and Natural Resource Economics, 6th International edition, Pearson Education, Inc.
- UN Habitat. 2017. "Condominium Housing in Ethiopia: The Integrated Housing Development Program."
- UNDP/WHO (United Nations Development Programme/World Health Organization). 2009. "The Energy Access Situation in Developing Countries: A Review Focusing on Least Developed Countries and Sub-Saharan Africa."
- Whitehead, J. C., 2006. A Practitioner's Primer on Contingent Valuation Method. In: Alberini, A. and Kahn, J.R. (Eds.), Handbook on contingent valuation, Edward Elgar Publishing Ltd, Cheltenham and Massachusetts.
- Winkler, H., 2005. Renewable energy policy in South Africa: policy options for renewable electricity. Energy Policy 33, 27–38.
- World Bank, 2018b. World Bank data: Ethiopia. Available at: https: //data .world bank .org/indicator.
- Yamane, Taro. 1967. Statistics, an Introductory Analysis, 2nd Ed., New York: Harper and Row.
- Yau, Y. (2010Willingness to pay and preferences for green housing attributes in Hong Kong. J. Green Build.
- Yibeltal Bantie Kebie, 2011. The Value Of Improved Water Supply Service In Motta Town, East Gojjam,Ethiopia.
- Yoo, S.H., Yang, H.J., 2001. Application of sample selection model to double-bounded dichotomous choice contingent valuation studies. Environ. Resource. Econ. 20, 147–163.
- Zenebe, G. (2007). 'Household Fuel Consumption and Resource Use in Rural-Urban Ethiopia', PhD Thesis, Wageningen University.

- Zeleke Ademe and Sameer Hameer, 2018: performance evaluation of a Box type solar cooker with a glazing wiper mechanism. Bahir Dar Energy Research Center, Bahir Dar Institute of Technology, Bahir Dar University, Bahir Dar, Ethiopia.
- Zografakis, N.; Sifaki, E.; Pagalou, M.; Nikitaki, G.; Psarakis, V.; Tsagarakis, K. (2010): Assessment of public acceptance and willingness to pay for renewable energy sources in Crete. Renew. Sustain. Energy.

Annex 1: Questionnaire

Hello my name is Seife T/maryam. I am conducting the research for a partial fulfillment of MA in Environment and sustainable Development at college of development study, Addis Ababa University. This study is undertaking to assess households' willingness to pay for solar cooking technology. The correct answer you have to provide is the most important factor influencing the technology producer and other concerned agents to supply. Your answer is kept confidential. During the interview if there are any questions that you would like to ask please feel free.

Thank you for your cooperation

Part I: Existing energy situation for cooking

1. How many times in a day your families cook food? _____
2. What type of energy do you use for cooking? _____
3. How much, on average, do you pay for your electric consumption per month? _____ Birr per month.
4. How do you judge your satisfaction with the existing source of energy to cooking?

l = very satisfied 2=satisfied 3= partially satisfied 4=dissatisfied 5 = Very dissatisfied

5. How far you travel to buy alternative energy (wood/charcoal) from your home? _____ Kilo meters.
6. In the last 12 months, which cook stove (s) did your household use for only preparing meals?

1= Stone/fire stove
2= Other Self-Built Stove
3= Manufactured stove
4= Other, Specify

7. Which of the following energy source you prefer mostly for cooking purposes?

1= fuel – wood 2= electricity 3=charcoal 4= kerosene 5= other (specify) ----------

7_A . Why do you prefer those sources?

l=easily accessible
2=lower cost and affordable
3=more reliable
4= has better quality
5= other (specify) ---

8. How much do you spend on the [FUEL TYPE] for this stove in the last month/in a typical month when you use the stove? ……Amount in Birr

Enter the actual amount spent, not the market value of the fuel.

9. How well do you think your knowledge is about renewable energy?

1= Very Poor 2=Poor 3=Average 4=Good 5=Excellent

PART II: Willingness to pay Questions

In this final part, I am going to present you with the cost figure for **"solar cooking system"** and I would like you to simply state if you would be willing to pay for this system, by answering "yes" or "no". Now I would like you to assume that the total cost for the production of **"Solar cooking system"** is 6000 Birr. The box type solar cooker is designed to cook for a five head family but it can cook for, say, only 80 % of the meal (other part of the meal is considered as frying based food for most Ethiopians). Considering cooking two meals per day, the heat energy produced by the solar cooker per day is 5 x 2 x 80% x 900 = 7200 kJ/day. The payback periods will be two and half years and assuming 20% efficiency for wood stoves this solar cooker can save 80,000 kg of fuel wood in ten years' time, estimated to be the life time of the cooker. The system works through this lifetime without any maintenance or running cost. Because the energy produced is from a renewable source, it also reduces the greenhouse gas emission of your home. Together with electricity from the national grid, that can satisfy all your demand. The provision of solar cooking system among other things means, good quality of energy which is safe for health and an increased amount of energy available for use.

Now, let us assume that you have an option for a private connection to such an improved energy supply scheme. You may not be required to pay initially the costs of connection to the new scheme. Instead, it will be distributed over three years in your monthly bill (The payment will be built-in the monthly electric bill). You would have to pay initial investment and running costs which will be added to your electric bill.

QUESTIONS ON WILLINGNESS TO PAY FOR THE PROPOSED SYSTEM

1. In consideration of your household's income and expenditure, are you willing to pay any amount to the proposed scheme?

1= Yes 2=No

2. If "Yes", suppose that the city government office made the proposed system available, would you be willing to pay 6000 Birr?

   1=Yes 2=No

3. If the answer to Q.25 is 'Yes', **ask the following question**. If the price of the proposed system is increased to 7000 Birr, would you be willing to pay?

   1=Yes 2=No

4. If the answer to Q.25 is 'No' **ask the following question.** If the price of the proposed system is decreased to 5000 Birr, would you be w willing to pay?

   1=Yes 2=No

5. What is the maximum price your household pays for obtaining for the proposed system?

Initial bid	Next lower bid	Next higher bid
6000 Birr	5000 Birr	7000 Birr

6. If you are not WTP, why not?
   1=It is expensive
   2=No need of adopting it presently
   3= It is not reliable
   4= It doesn't interest me
   5= The government should pay for securing ARE, not I
   6= I don't think I can afford to pay for it
   7= Other…….

7. If you are WTP, why you are willing?
   1= low cost
   2= affordable
   3= more reliable
   4= has better quality
   5= save the environment
   6= other (specify) ----------

Part III: Socio Economic Characteristics of Respondents

1. Interview Code: _____
2. Place of interview_____ (write type of the condominium)
3. Sex: O=male, l =female
4. Age of respondents_____ years
5. Educational level:

1= Non 2= Elementary School (1-6) 3=Completed High School (7-12) 4=Tertiary School (University/College first degree)

6. Are you married?

1= Yes 2=No

7. Occupation

1= Government employee 2= Self employee 3=House wife 4=Unemployed 5=Retired
6= Student 7= other, specify

8. What is your monthly family income (Birr), after taxes, from all sources? Please note that this is strictly confidential and anonymous information, only to be used for statistical purposes. ___ birr
9. Total number of people living in the house _____ People
10. Rank the following items in terms of you incurred on them monthly

l=House 2=Food 3=Transportation 4=Education 5= Electricity6=Telephone 7=Water 8=clothing
9= other (specify) ----------

11. For how many years have you lived in the area? _____ Years.
12. Do you rent or own house?

l=own 2=rented 3=other

13. Number of rooms by household unit excluding bathroom ___ rooms
14. Which asset do you own?

l =Car 1=Gold/jewelers 3=Share 4= other (specify) ----------

15. Which appliance do you have?

l= Television 2=Refrigerator 3= Stove 4=Water heater 5= Iron 6= Injeramitad 7=Washing machine

8. Microwave oven 9= other (specify) ----------

16. Does anyone in the household have a bank account at a formal/informal institution?

1= Yes 2=No

17. If you can get a loan/credit, what are the sources of credit/loans?

(Multiple responses possible)

Commercial/government bank……...1
Cooperative credit union……2
Microfinance institution…….3
Loan from city government...……4
NGO……...…5
Business firm…….6
Employer……7
Moneylender……...…8
Shop……...9
Relative/friend/neighbor……10
Mobile money services ……..…11
Iqqube…….12
Cannot get a loan/credit……..13
Other, specify…….……14