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Factors Affecting Households Adoption of Electric Mitad: the case of Debre Markos Town

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DECLARATION

I declare that this thesis is my original work and has not been presented for the award of any degree in any university.

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APPROVAL

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STATEMENT OF THE AUTHOR

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BIOGRAPHIC SKETCH

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ABBREVIATIONS/ACRONYMS

CRGE	Climate resilient green economy
CSA	Central statistical agency of Ethiopia
ECO	Energy coordination office
ECOWAS	Economic community of West African state
EREDP	Ethiopian energy studies and research center
ESMAP	Energy sector management assistance program
GACC	Global alliance for clean cook stoves
GIZ	German agency for technical co operation
HHE/PNR	Household energy protection of natural resource
IEA	International energy agency
MDGs	Millennium development goals
MOARD	Ministry of agriculture and rural development
MOWE	Ministry of water and energy
NCCSPE	Ethiopia national clean cook stove program
WHO	World health organization

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ABSTRACT

Adoption of modern cooking stoves plays a significant role in improving standard of living of urban households and in reducing adverse effects of human activities on the environment. However, household's adoption of modern cooking stove is challenged by several factors. The main objective of this study is to identify factors affecting adoption of electric mitad by urban households in Debere Markos town, Amhara Regional State of Ethiopia. The study used primary data collected from 200 sample households. The sample households were selected randomly, and systematic random sampling technique was employed to select the sample households. Mirt stove constitutes the major energy stove in baking injera, followed by electricity mitad in the study area. Only 43.5 percent of the sampled households have adopted electric mitad. The study specified the logit model to identify factors that significantly affect adoption of electric mitad at household level. Accordingly, The regression result reveals that income, family size, membership to social associations and awareness creation were found to be significant and positively correlated with the probability of Electric mitad adoption decision while availability substitute product, price of Electric mitad age and relative price of electric mitad consumption were found to be significant and negatively correlated with the probability of Electric mitad adoption decision. Furthermore, occupation, marital status and separate kitchen house were not found to be statistically significant in the study area. Policy interventions aimed to enhance adoption of electric mitad in the study area need to be diversified with emphasis on increasing household's income, promoting price regulation and awareness creation.

Keywords: Adoption, Electric mitad, Logit Model, Improved cook stove, Open-fire, household

1. INTRODUCTION

1.1. Background of the Study

Nearly half of the world's population relies on solid fuels, such as wood and charcoal, for cooking (IEA, 2014). Ensuring access to clean and efficient household cooking energy supply is the major challenge faced especially by developing countries today. Many people in developing Countries remain dependent on traditional cooking stove technologies. As of 2011, about 1.26 billion people haven't access to electricity and about 2.64 billion people rely on traditional biomass (fuel wood, charcoal, animal dung and agricultural residues) for cooking mainly in rural areas in developing countries (IEA, 2011).Cooking with traditional stove is associated with health problem, degradation of forest coverage, which aggravates climate change (Lee *et al*, 2013). Indoor air pollution due to high level of smoke, deforestation due to inefficient fuel consumption, climate change like global warming due to incomplete combustion and decrease productive opportunities for collecting fuel wood are partly attributed to the use of traditional cooking practice (Puzzolo, 2013).

Energy supply in developing countries is majorly dependent upon traditional sources including wood, charcoal, agricultural residuals and animal wastes (IEA, 2010). About fifty-six percent of the population in developing countries depends on traditional biomass and coal and cook with open three-stone fire which is associated with high level of air pollution which 38 percent of annual deaths is attributed (WHO, 2009). According to International Energy Agency (2010), in developing countries about 2.7 billion people burn biomass.

Energy supply in African countries is heavily dependent on traditional fuels like wood, agricultural residues, animal waste, charcoal and coal which accounts above 80% (GACC, 2011). Beyond this in some African countries solid fuel accounts above 95% total energy supply and largely burn with open three stone fire inefficiently which also results in negative effect on health and the environment (Tigabu, 2014).

In Sub-Saharan Africa, 68 to 90% of the population relies on biomass solid fuels (Mebratu, 2018). High reliance on traditional biomass fuels contributes a lot to human health, economic and environmental problems (Tigabu, 2014); inefficient combustion of the solid traditional biomass fuels, mainly in developing countries, emits substantial quantities of harmful air pollutants and contaminants, which have adverse effect on human health. Moreover, dependence on biomass fuels for domestic consumption is one of the major causes of deforestation in developing countries (Jan, 2011). The use of biomass in inefficient ways in developing countries increases fuel wood and charcoal demands of households.

Ethiopia's energy supply main sourced from solid fuel that accounts for above 95 % (NCCSPE, 2011). This heavy dependence and traditional utilization of biomass resources is partly leads to depletion of the country's forest resources and 4.9% of the Ethiopian burden of disease (Tigabu, 2014).Since 1970s, many improved cook stove programs have been set and encouraged by governmental and Non-Governmental Organizations in the developing part of the world (Puzzolo *et al*, 2013; Megbaru, 2018).

However, the factors of improved cooking stoves adoption and sustained use have not been yet fully examined, thus, more research helps for strengthening the understanding of which factors are highly important for securing adoption and sustained use (Klasen *et al*, 2013; Puzzolo, 2013; Mebratu, 2018) also, argued that adoption of improved cook stoves is scarce, scattered, and of differential quality. Besides, Puzzolo *et al*, (2013) in their systematic review affecting the adoption of improved cook stove, concluded that important variables like the role of socio-cultural and institutional factors are understudied and they recommend future researches to include these variables.

Given the expected household benefits, research that helps to identify factors influencing improved cook stoves adoption decisions at the household level has become examine more critical and deserves attention (Mobarak *et al*, 2012; Damte and Koch, 2011). Understanding the factors that influence household's decision to adopt improved cook stoves is crucial for creating economic, social, environmental, and health benefits and for the success of intervention programs (Lamarre-Vincent, 2011).

1.2 Statement of the Problem

Commercial energy planning is essential aspect, in economic growth and development. The developing countries nevertheless have no mitigate much of the energy problems. These countries (like Ethiopia) encounter financial, policy, institutional as well as technical and skilled man power to study and develop alternative commercial energy sources available (Tigabu, 20114).

Ethiopia is one of the least developed countries in the world. Approximately about 34% of its population lives below poverty line (UNDP, 2018). It has one of the lowest rates of access to modern energy services, whereby the energy supply is based on biomass which accounts 91.6% of Ethiopia's energy supply, waste and biomass are the country's primary energy sources, followed by oil, 6.1% and hydropower, 1.7% (OECD/IEA, 2017). Moreover, over 90% of its population depends on biomass solid fuels (Beyene *et al*., 2015). Unsustainable use of biomass results in deforestation and consequently land degradation in Ethiopia. In addition to this, incomplete combustion of biomass inside the home generates air pollution, which causes adverse health effect (Mebratu, 2018).

Commercial energy consumption in Ethiopia is crucial for its development; there is a significant uncertainty about the effects of demand-oriented policies in the utilization of commercial fuels. Such uncertainty can undermine formulation of effective energy policies due to incapability to predict the likely impacts of the changes in important variables such as, income, population size and the availability of substitute products. Also there is still an information gap that must be filled to guide the policy makers on which area or demand variables to put their efforts in order to achieve a sustainable energy use. Modern household energy consumption in Ethiopia is highly dominated by electricity and kerosene. The energy sources for cooking gradually changed since kerosene is introduced in Ethiopia (Tigabu, 2014).

Nowadays, Ethiopia is facing increasing population and urbanization, causing increasing demand for biomass fuelsby urban households in the country. In Ethiopia, urban centers highly depend on rural hinterlands for their biomass consumption (Mebratu*et al*., 2018). According to (Mebratu*et al*., 2018), urban households depend on rural areas for about 85 percent of their fuel

consumption, which is a significant cause of deforestation and forest depletion, resulting in growing fuel scarcity and higher firewood prices.

A key challenging factor for the implementation, promotion as well as diffusion of improved Cook stoves in a given country is its existing institutional infrastructure and set up (Makonese *et al*, 2006). Institutional factors such as awareness creation to households, regulation of the improved cook stoves' standard and price, financing options such as credit access and decentralizing production site are important variables that challenge the households improved cook stoves adoption decision (GIZ, 2013; Puzzolo, 2013). The price of improved cook stoves is also considered as one important factor to influence household's adoption decision. For instance, Axen (2012) argues that the price of improved stoves and households perception about the price affect household's adoption decision. Damtie and Koch (2011) also recommended that future studies should take into account the effect of price on households' technology (cook stove) adoption decision.

In Debre Markos town there are 1795, 1668 and 1479 households in kebele one, two and eight respectively among the total households of 4942 in the three kebeles. Out of the 200 respondents only 87households adopt *Electric Mitad* which is low relative to the number of respondents (Kebele Administration 2018/19 and own survey, 2019). So in order to increase the number of users by identifying the possible intervention areas of adoption of new technology this study was conducted on determinants of household's adoption decision of *Electric Mitad*.

A number of studies have been conducted to identify factors affecting household's adoption of improved Cook stove, and have come up with different findings, in which the findings vary based on study area. Therefore, their findings might not be applied in different contexts. For instance (Shen *et al*2014) concluded that many subjective and objective factors affect the adoption and sustainable use of improved Cook stoves. These factors include fuel/stove technology, household characteristics, knowledge and perception, policy and regulations, financial support, market development and government role. Beyene and Koch (2013) examined the correlation between adoption of new stoves and different socio-economic factors

in Ethiopia, and found that the price of stove, household income and household wealth all have significant effects on a household's willingness to adopt new improved stoves.

As far as the researcher's knowledge is concerned, there was no study conducted on factors affecting *Electric Mitad* adoption decision in Debre Markos town. Apart from this, all of the previous studies in Ethiopia did include only variables of household characteristics, the access to open forest, having separate kitchen house, purchase price of *Electric Mitad* and fuel wood influence in analyzing factors affecting *Electric Mitad* adoption decision. All of the previous studies in Ethiopia did not include availability of substitute products like mirt stove and the relative consumption price of Electricity to fuel-wood to bake inijera so as to identify factors affecting household's adoption of Electric mitad.

As a result, this research differs from previous studies in Ethiopia is that it includes the availability substitute products and the relative consumption price of Electric mitad in the analysis of factors affecting the households adoption of *Electric mitad*. Therefore, this study may add an original contribution to the existing find of knowledge with regard to factors affecting households *Electric Mitad* adoption decision.

Understanding factors affecting adoption of improved Cook stoves is important for the design and implementation of effective policies to enhance access to clean cooking. Therefore, this study aims to examine factors affecting household adoption of *Electric Mitad* in Urban Ethiopia, specifically in Debre Markos town.

1.2. Research question

- What are the main factors that affect household adoption of *Electric Mita*d?
- Which factor of Electric mitad adoption supports household's energy choice theory?

1.3. Objectives of the Study

The general objective of the study is to identify the factors that affect household adoption of *Electric Miitad* in Debre Markos town. Hence, the study has the following specific objectives to be addressed:

- To analyze factors affecting adoption of *Electric Mita*d at household level in Debre Markos town.
- To analyze Electric mitad adoption factors supports household's energy choice theory or not.

1.5. Scope of the Study

Geographically, this study was limited to Debre Markos Town with the sample of kebele 1 kebele 2 and kebele 8 in Amhara Regional State of Ethiopia. Conceptually, this research was limited to identifying factors affecting adoption of *Electric Mita*d at household level. Methodologically, the research employed mixed research methods. In terms of time, this research used cross-sectional data that were gathered in identifying factors affecting households' adoption of *Electric Mita*d

1.6. Significance of Study

The study will provide information on factors affecting household's adoption of *Electric Mitad* in Debre Markod town. The result of the study enables to know the significant factors affecting household's adoption decision of *Electric Mitad* in the study area.

The findings of the study may help Clean Cook stoves Program of the study area to be aware about factors which affect households *Electric Mitad* adoption decision. Since the factors that affect households '*Electric Mitad* adoption decision were investigated, the above mentioned bodies can easily identify the potentially effective intervention areas which can play crucial role for their success. Researchers who want additional investigation on factors affecting household's adoption of *Electric mitad* can use the result from this study.

1.7 Limitation of the Study

This research has been faced by certain drawbacks during the course of conducting this study. One of the difficulties that the researcher was faced, some respondents were unwilling to spend their time to fill the necessary data, and they believed sharing information leads to disclosing and may lead to negative effect on their way of life. This limitation was, however, resolved in dealing with and developing friendly relationship with and gaining trust from respondents.

1.8. Organization of the Study

Besides with the above contents, the thesis is organized as second part consist review of related theoretical, conceptual framework and empirical literature. The third part describes the methodologies employed in conducting the research. The fourth part presents the results of the data collected through the various tools described in the methodology. The final part comprises conclusions and recommendations.

2. LITRATURE REVIEW

2.1. Definition of Terms

Adoption: In this study adoption refers to the decision of households to acquire/adopt an improved cook stove and the interest to use.

Electric mitad: Here Electric mitad is an improved cook stove used to bake enijera.

Household: Here household refers to a group of people who eat together regularly and/or who sleep under the same roof together and bake enijera to feed the family.

Improved Cook stove: An improved cook stove is a stove that is more efficient and releases fewer emissions or no emission at all as compared to a traditional "three-stone" fire.

Kebele: Kebele refers to the lowest level government administrative structure in Ethiopia.

Injera: The Ethiopian staple food which is baked on circular pan

Mitad: The Amharic name of stove used to bake injera

Inefficient: Here inefficient refers to using cooking devices with low per-unit energy production and increased emissions of smoke and particulates.

Open-fire: Open-fire refers to traditional method that relies on a clay 'U' or three stones to support cooking that are highly inefficient in their use of fuel.

Slid fuels: Solid fuels refer to fuels which include biomass fuels (such as wood, crop residues, dung, charcoal) and coal.

Woreda: Woreda refers to government's administrative unit in Ethiopia which is equivalent to district.

2.2. Theoretical Literature

2.1.1. Improved Cook stoves Programs

Even though the development and the adoption of wood-burning stoves traces back, as an involvement program it was following the 1970s oil price rise. Later on, the need to rationalize the continuing reliance on biomass resource, the desire to increase deforestation and to narrow down the gap between fuel supply and demand improved cook stoves programs have given higher focus on energy efficiency (Inayat *et al*., 2012; GACC, 2011). To deal with higher oil prices, increasing deforestation, and fuel wood crisis governments, donors and nongovernmental organizations (NGOs) came up with supply-side and demand-side strategies and introduce to finance and develop stove programs. The development and distribution of improved stoves is one demand-side intermediate solution in developing countries where clean fuels like electricity are available or will be reasonable in the near future(Inyant *et al*, 2012; GACC, 2011).

Since 1970s, many better biomass cook stove programs have been introduced and encouraged by governments, donors and Non-Governmental Organizations and other for and not for-profit organizations in the developing part of the world (Puzzolo *et al.*, 2013; Gifford, 2010). Some of national improved cook stoves programs were introduced and are on implementation including programs in Guatemala, India, Indonesia, Kenya, Nepal, Papua-New Guinea, Senegal, Somalia, Sri Lanka (Gifford, 2010), Ethiopia (NCCSPE, 2011).

Now a day's many regional and global programs and motivations also have been initiated and are being implemented by GIZ, the Economic Community of West African States (ECOWAS), the East African Community (EAC), the United Nations Commission on Sustainable Development (UNCSD), the United Nation Secretary General's Advisory Group on Energy and Climate Change (AGECC), International Energy Agency (IEA) and the UN Foundation Global Alliance for Clean Cook stoves (UNGACC)(Puzzle *et al.*, 2013)

According to the report by Global Alliance for Clean Cook stoves (GACC, 2012), Africa as a region has the large number of stoves manufactured (4.8 million), 78% of which was in

Ethiopia and Kenya, while Asia manufactured about 4.3 million stoves with the lion share of China. China, Ethiopia, Kenya, Cambodia and Bangladesh were reported as the largest improved cook stoves manufacturing countries by the year 2012.

2.1.2. Improved Cook Stoves Development and Projects in Ethiopia

Ethiopia's energy supply is mostly dependent on biomass, which accounts for above 95% and in terms of sectoral consumption, household accounts for about 91.3% of the total energy users, of which biomass fuel accounts 98.5 % and also within the household sector the rural and urban household energy consumption accounts for 92 and 8% respectively (Tigabu, 2014). This highly firewood price, reduction of agricultural productivity, creates indoor air pollution (MoWE, 2012; Gebreegziabher *et al*, 2010). According to César and Ekbom (2013), between 2010 and 2030 annual fuel wood consumption will increase by 65% with large effects on forest degradation. Thus, for developing countries like Ethiopia whose energy supply is mostly dependent on biomass fuels such as wood, charcoal and agricultural residues, technical advances in energy efficiency are critical (NCCSPE, 2011; GACC, 2011).

By taking into consideration the effect of excessive and inefficient use, the Ethiopian government and other non-government organizations (mainly GIZ) have embarked on a two-pronged policy tree planting or a forestation and distribution of more efficient stove technologies (Tigabu, 2014). In the case of energy efficiency, mainly the Ethiopian Energy Studies and Research Center (EESRC) currently, Ethiopian Rural Energy Development and Massive Efforts Since 1980 develop three types of improved stove, *Mirt stove*, and *Electric stove* and improved *biomass stove* (Asefa, 2007; Gebreegziabher *et al*, 2006).

2.1.3. General Description of '*Electric Mitad*' Stove

The Electric Injera Mitadis made from steel or Aluminum sheet metal framework having a conical shaped lifting cover, short cylindrical enclosure (body), clay plate, an electric heating element, heat insulator and a support stand. The clay plate of *Electric Mitad* is made either as a single or double, circular plate having diameter ranging from 40 to 60 Cm diameter and thickness of 2.3 to 2.5 Cms. Clay plate having 58 Cms diameter is the most common.

The *Electric Mitad* design, in current use, dates back to 1960's when electric baking of Injera started with high-income groups in cities. There are currently an estimated 530,000 injera electric baking stoves, or alternatively called '*Electric mitads'* in use in Ethiopia (Jones and Diehl, 2015). It is estimated that the power consumed by existing electric mitads (3.5-6 kW per cooker)

Fig1. *Electric mitad*

2.1.4. Theories of Electric mitad adoption

The "Energy ladder" theory

The 'energy ladder' has been a commonly used concept in explaining household fuel use in developing countries. The energy ladder depicts a process by which households, as their income rises, move away from traditional fuels (e.g., biomass), first to adopt intermediate fuels (kerosene, coal), and then to use modern fuels (gas, electricity).1 In that sense, the energy ladder concept serves as a stylized extension of the typical income effect of consumer economic theory that explains how consumers substitute necessary goods and luxury goods for inferior goods, as their income rises. A subjacent assumption is that households are faced with an array of fuel choices that can be arranged according to increasing technological sophistication, and that this is reflected in household preferences.2 As a consequence, as their income increases, households shift to more sophisticated energy carriers and simultaneously give up less sophisticated alternatives.3 In this theory, the characteristics of the final technologies are implicitly associated with some features of consumer preferences that divide the fuels into necessary goods and

luxury goods. Although such hypothesis has still to be fully validated empirically, one achievement of this theory is its ability to fit well common observations of the strong income dependency of household fuel use.

Energy ladder model, considered as classic and traditional, places heavy emphasis on income (affordability) in both explaining and determining a household's energy/fuel/stove choice. This implies that the household's income is taken as the only factor that influences households fuel/stove choice decision. But, this perspective is highly criticized by a number of studies with two practical reasons (Kowsari, 2013; Puzzolo, 2013). One of the criticisms is that there are multiple significant factors in addition to income, that influence households fuel/stove choice decision.

The 'Fuel stacking' theory

Masera et al. (2000) criticized the energy ladder theory on the grounds that it cannot adequately describe the dynamics of households' fuel use. Instead, they note that fuel stacking is common in both urban and rural areas of developing countries. Fuel stacking corresponds to multiple fuel use patterns—where households choose a combination of fuels from both lower and upper levels of the ladder. Indeed, modern fuels may serve only as partial, rather than perfect substitutes for traditional fuels (van der Kroon et al. 2013, 2014). Multiple fuel use arises from several reasons, such as, occasional shortages of modern fuels (Hosier and Kipondya 1993; Kowsari and Zerriffi 2011), high cost of appliances associated with using exclusively modern fuels (Davis 1998), fluctuations of commercial fuel prices (Leach 1992) and preferences inducing households not to fully adopt modern fuels (Masera et al. 2000). The complexity of the fuel switching process thus suggests that there is a multiplicity of factors, besides income, that may affect fuel use. This led some authors to delve into more sophisticated modeling approaches.

Energy stacking household energy choice perspective overcomes the drawbacks of the energy ladder hypothesis. Energy stacking, also called fuel/stove stacking is considered as the latest and it is based on empirical evidence and is more realistic than the classic energy ladder hypothesis (Kowsari, 2013). Fuel type choice and/or stove adoption decision depends up on a

complex interaction between economic, social, cultural and environmental factors (Zuzarte, 2008).

Diffusion of innovation theory

Diffusion is a social process that occurs among people in response to learning about an innovation such as a new evidence-based approach for extending or improving health care. In its classical formulation, diffusion involves an innovation that is communicated through certain channels over time among the members of a social system. The typical dependent variable in diffusion research is time of adoption, though when complex organizations are the adopters, subsequent implementation is a more meaningful measure of change. Diffusion can be assessed among individuals such as members of Congress, organizations such as health care insurers, or larger collectivities such as cities and states. Illustrates the relationships between rates of adoption and how we characterize diffusion under different scenarios, including when innovations are introduced and do not diffuse. When time-of-adoption data are graphed cumulatively, an S-shaped curve is common, with an initial slow rate of adoption giving way to a rapidly accelerating rate, which then slows as fewer non adopters remain within the social system in question. Not all instances of diffusion play out this way, especially in policy diffusion where time to adoption can be shorter because of the occasional convergence of national attention to a problem, financial incentives, readiness for change among elected officials, motivated and organized groups, and an innovative solution that is perceived positively.

According to Rogers (2003), the Diffusion of Innovation Theory asserts that individuals and early adopters in a certain social system are able to influence attitude and behavior of others informally either to promote or hinder the acceptance of a new technology. According to this theory, improved stove technologies are more likely to spread out in a certain population if the stoves first gain acceptance among ‘early adopters.

2.1.5. Benefits of Adopting Improved Cook Stoves

As it was stated in the background of this paper, cooking and heating with solid fuels on open fires have adverse impact on health, especially women and children, households’ economy, environment and on global climate change too (GIZ, 2013; GACC, 2011; WHO, 2009).

Improved cook stove program and project implementers and coordinators including national programs, regional and global motivations, donors, non-governmental organizations and other stakeholders throughout the developing world strongly state the significant role of improved cook stoves in improving households health conditions, improving the livelihood of the poor, reduce the rate of deforestation and balance global climate change (GIZ, 2013; GACC, 2011). Global Alliance for Clean Cook stoves (GACC, 2011) and others argue that in addition to its contribution to health, economic, gender, environmental imperatives, the adoption of improved cook stoves plays critical roles United Nation Millennium Development Goals(MDGs), specifically child mortality, maternal health, gender equality, poverty eradication and environmental sustainability, to be achieved. Biomass Program in its Biomass Cook stoves Technical meeting summary report(2011)argue for the positive role that improved cook stove play such as reducing cooking related health problems , saving fuel wood and time to collect fuel wood, reducing the rate of deforestation and mitigate global climate change.

These claims on potential benefits of adopting improved cook stoves have been and are supported by many empirical case studies and experiments in developing part of the world. Case studies in developing regions such as Asia, Africa, and Latin America asserted the positive impact of adopting improved cook stoves on health, economy, the environment and others.

Africa: A study in Gambia by Jacob (2013) also found that improved Electric stoves can save fuel wood user and reduce indoor air pollution up to 90%. A study by Bwenge (2011) in Tanzania also came with evidence that in Tanzania the adoption of ICSs saved fuel wood user by about 70%; reduced women's workload, reduced the time spent to collect food from 4 hrs to 2 hrs per day; created self-employment and source of income for the producers; and reduces smoke emission.

In Eritrea Ergereman (2003), also, found that the adoption of improved biomass stoves reduces indoor air pollution, reduce concentration of smoke, fuel saving, money and time saving for acquiring fuel and less pressure on forest and energy resources, decrease greenhouse gases, skill development and job creation in the community.

Ethiopia: Assefa (2007) experimentally found that in Ethiopia improved cook stoves; particularly Electric mitad can reduce carbon monoxide (CO) concentration and particulate

materials by about 88% and 17 % respectively. A study by Gebreeziabher *et al* (2006) in Ethiopia found that assuming an average of 79 of biomass per ha, the potential reduction in deforestation amounts 1,794 ha per year. They also argue improved stoves are able to reduce land gradation in such a way that if the stoves are adopted (1) less dung will be used as fuel so more fertilizer is available, thus, fertile soil; (2) less wood consumption, thus reducing deforestation so more wood is available, in turn less dung and crop residues for fuel and; (3) less time spent for fuel wood and dung, thus, less time spent for cooking.

2.2. Empirical Literature on Factors Affecting Cook stoves Adoption

Despite the potential benefits and the efforts of national, regional and global initiatives, programs and projects the rate of improved Cooke stoves adoption has fallen behind the expectation due to different factors (Puzzolo, 2013; Berkeley Air Monitoring Group, 2012; Lewis and Pattanayak, 2012). To identify factors affecting the adoption of improved cook stoves studies have been conducted and the main findings are concluded. Puzzolo *et al* (2013), in their systematic review of enables and barriers to large-scale uptake of improved solid fuel stoves, by taking 57 case studies, found meeting users' needs, providing valued savings on fuel, meeting user expectations and ensure durability, higher socio-economic status, having kitchen house, knowledge on the relative benefits of ICs, having success with early adopters, insuring support to users in initial use, developing an efficient and reliable network of suppliers/retailers, providing financial access were among significant factors that influence the adoption of improved cook stoves. With regard to household head gender, age, family size studies have come up with different results.

Another study by Dewan *et al* (2013), examined how social marketing tools increase fuel-efficient stove adoption in China by taking in to account knowledge, attitude and interpersonal communication. The study found that the knowledge about the relative benefits of fuel efficient stoves and the disadvantages open fire, attitudinal change to use and realize the potential benefits of fuel efficient stoves and interpersonal communication are positive significant factors of fuel efficient stoves adoption. Pre and post campaign result showed significant improved cook stoves adoption percentage increment due to the increment of knowledge, attitudes, and

interpersonal communication. Post-campaign (within 1 year) 28.0% and 43.1% of those surveyed within 1 year of and 2.5 years adopted the technology.

Lewis and Pattanayak (2012) conducted a review of empirical studies with regard to factors affecting improved cook stoves adoption. Based on the review, household head education, income, household size, fuel-wood price and access to credit were found to be statistically significant positive factors that determine the adoption of improved cook stove. On the other hand, significant negative associations were found between the adoption of improved cook stoves and household head's age and socially marginalized status. A filed assessment of improved cook stoves adoption practices in Indonesia was conducted by Geary *et al* (2012).The assessment investigated that awareness of dangers of indoor air pollution, knowledge about and the availability of improved cook stoves, the built environment to install and the increase price of wood fuel as well as social networks are factors that positively affect improved cook stoves adoption decision. On the other hand, the free availability of fuel-wood was found to be one of the factors that lead to the decision not to adopt improved cook stoves.

Menon and Thandapani (2011) conducted a study to understand the adoption dynamics of improved cook stoves among people living in rural India by including variables of motivation, affordability and level of engagement in their analysis. Neighbors influence, awareness campaigns, the effect of perceived risks/benefits of improve cook stove and traditional stoves, income, education and stove design were found to be enabling factors for adoption decision. The study revealed that respondents who were recommended by their neighbors had founded to be adopters of improved cook stoves. The consumers education about the different financial instruments they can avail to purchase the cook stove so that the perceived expensiveness can be minimized.

Pine *et al* (2011) studied adoption and use of improved biomass stoves in Mexico by taking community's acceptance, household characteristics and season of adoption as explanatory variables. The study found that community acceptance of the stove, problematic experience with the traditional stoves and the compatibility of the stove with the type of fuel-wood used are statistically significant and positive factors of adoption of improved biomass stoves. From

household characteristics, the presence of adult in the household, large household size, household head's occupation (farmer) and household income and non-rainy season were found to be positive and statistically significant factors in determining the adoption of improved biomass stoves. On the other hand, rainy season, households higher valuing of open fire over the improved ones, proximity and free forest access to collect wood were found negative factors of improved biomass stoves adoption.

Inayat (2011) also conducted a study to investigate factors that make people adopt improved cook stoves in Northern Pakistan by taking into account household characteristics and source of fuel-wood. The study found household head's level of education (proxy for awareness), income, household working members and source of fuel-wood to be determinant factors of improved cook stoves adoption decision. Households not collecting wood for free were found more likely to adopt improved cook stoves in rural Pakistan. On the other hand, total household head's age, household size, landholding and open fire hazards knowledge were found statistically insignificant factors in determining improved cook stoves adoption.

Adrianzen (2009) analyzed the concerns of village technology adoption pattern and village social capital and household characteristics to identify factors affecting improved cook stoves adoption decision in Northern Peruvian Andes. The study investigated that the higher success village adoption pattern, with stronger social capital, has a significant positive effect on a household's improved cook stoves adoption decision.

From household characteristics, the household's head gender and level of education, the household's number of adults, presence of a female adult member in the household, the household's wealth and the household's participation in women and environmental clubs were found statistically significant factors to influence a household's decision of improved cook stoves adoption. Slaski and Thurber (2009) identified inherent motivation, affordability by the and compatibility/low required users engagement positive determinant factors of adoption while low motivation, low affordability and high required users engagement important obstacles of cook stoves adoption by the poor.

Troncoso et al (2007) analyzed socio-economic, cultural and environmental factors that affect improved cook stoves adoption in Mexico. While the socio-economic level, cultural acceptability and lack of free access for open forest were found to be positively correlated with the adoption of ICs, there was no correlation found between improved cook stoves adoption and educational level, awareness about the relative benefits of the stove, household head age and payment of the stove. Agarwal (1983) identified household characteristics, stoves' technical, infrastructural and cultural aspects that affect improved cook stoves adoption. Households' socio economic status, the relative benefits of stoves, extension (e.g. awareness creation) and access to credit, rational and dynamic nature of a community were identified as positive factors that affect the adoption of improved wood-burning stoves.

Africa

A recent study by Levine et al (2013) identified factors that impede the adoption of improved cook stoves in Uganda by considering variables of information, liquidity and present bias/term of payment. From the study it was found that customers' liquidity constraint, imperfect information, lack of confidence on the new stove's fuel saving performance and skepticism about the durability of the stove are important barriers of improved cook stoves adoption. The study examined the effect of a contract made for a free trial, time payments, and the right to return the stove in Kampala and Mbarara. The result showed that improved wood burning cook stoves adoption increased from 4 % to 46 % in Kampala and in Mbarara the adoption increased from 5 % to 57 %. In addition, the study found household size to be one significant factor in determining a household's improved cook stoves adoption decision.

Axen (2012) analyzed factors affecting the spread of fuel efficient cooking stoves in Northern Tanzania with the focuses of potential users' perception, financial capital, human capital, natural capital, physical capital, social capital and household head's gender. From the analysis, positive perception about the cook stoves and its price and access to credit, awareness and knowledge about the relative benefits of improved cook stoves, lack of access to wood for free and access to transport improved cook stoves and having separate kitchen were found to be enabling factors for the adoption and spread of improved cook stoves. Membership to social associations and be networked and the household head's positive interest were, also, found to be

factors that positively affect the adoption and spread of improved cook stoves in Tanzania. On the other hand, the lack of these concerns and the free access of fuel-wood were found factors that hinder the adoption and spread of improved cook stoves.

Makame (2007) investigated the influence of individual factors, stove attributes and management support in Zanzibar. From individual factors'; information the benefits, income, and level of education, from stove attributes; trial ability, observe ability, relative advantage, simplicity to use and compatibility and good program and project management and support were found to be factors that positively influence improved cook stove.

On the other hand factors for failure to adopt were found to be poor quality of the improved cook stove, high cost of stoves, poor information and education about the relative benefits of stoves. The study revealed that since the price of improved cook stove (range US$ 2.5-US$5) more than the price of tradition charcoal stove (rangeUS$1.5-US$5), households were found, tending to purchase traditional charcoal stove.

Ethiopia

In Ethiopia Damte and Kohlin (2011) investigated the determinants of improved cook stoves (Lakech, Mirt stove and Electric Mitad) in urban areas by analyzing the variables of household characteristics, stove type and ownership, substitutability of stoves and separate kitchen and it features. With regard to Mirt stove, the household heads level of education, income, separate kitchen and household head's gender (female) were found to be positive significant determinant factors of adoption decision. Other variables of substitutability of the stove and the size of children in a household were found to be insignificant in relation to *Electric Mitad* adoption.

A study by Gebreegziabher *et al* (2010) identified factors affecting urban energy transition and technology adoption in Tigray, Northern Ethiopia, with the focuses of household characteristics and price variables. Household head's age, education, family size, and income/expenditure were indicated to be positive and significant factors to determine the adoption of new cooking appliance, electric 'Mitad' and improved wood-burning stoves while prices of fuel-wood, charcoal and kerosene were found to be insignificant in determining the adoption decision.

Another study in Ethiopia was conducted by Dawit (2008) to identify factors affecting rural and urban households improved stove adoption decision 'Adea' Woreda, Oromia Regional State. From the analyzed variables of household characteristics, the stove's technical aspects and cost and financing, it was found that household income, household head's education and the stove's compatibility are positively and statistically significant factors in determining improved stove adoption decision in rural households. On the other hand, numbers of participants in fuel-wood collection and household head's age were found to be negative and statistically significant. Other variables such as family size, household head's gender, marital status, separate kitchen and access to credit were found to be statistically insignificant to influence improved stove adoption decision of households.

A study by (Mebratu, 2018) identified factors affecting household's adoption of *Electric mitad*, in woliso town oromia regional state Ethiopia, with the focuses of household characteristics and price variables. Education level of a household head, family size, income/expenditure and price of wood were indicated to be positive and significant factors to determine the adoption of *Electric Mitad* while prices electricity and sex of household head were found to be insignificant in determining the adoption decision.

2.2.1. Determinants of Improved Cook Stoves Adoption

As it was reviewed in the previous section, there are factors that can determine households improved cook stoves adoption decision. These factors are discussed.

Age: The previous studies found contradictory results with regard to the correlation between age and improved cook stoves adoption. A review by Lewis and Pattanayak (2012), household head's age was indicated to be significant negative factor that determines the adoption of improved cook stoves across studies reviewed. In contrary, Gebreegziabher *et al* (2010) found household head's age to be positive and statistically significant determinant factor of improved cook stove adoption decision. The finding of Dawit (2008) reveals that household head's age is negatively and statistically significant determinant factor of improved cook stove adoption. With regard to the influence of a household head' age on household's improved cook stoves

adoption decision, recent work of Puzzolo *et al* (2013) found inconsistency among research findings.

Therefore, based on the previous empirical works and with the assumption that older people may tend to be conservative in accepting new cooking technologies, in this study age is expected to affect the household's improved Cook Stove adoption decision negatively.

Marital status: Single women (female headed households) were found more likely to adopt improved cook stoves as compared to married women male headed counter parts (Damte & Koch, 2011; Inayat, 2011; Adrianzen, 2009). The authors argue that in patriarchal society since husband more power to make economic decisions in the household, married women's improved cook stoves purchasing decision depends up on the willingness of their spouse. Having this understanding, thus, it is expected that marital status (in favor of single) is expected to affect households' adoption of improved Cook Stove adoption decision positively.

Education: A review by Lewis and Pattanayak (2012) found that household head's education is positively and statistically significant factors that determine the adoption of improved cook stoves across studies reviewed. It is argued that educated potential households are more likely to be aware of the benefits of improved cook stoves as compared to uneducated or less educated households (Inayat, 2011; Melon, Thandapani, 2011) again claim that the consumers education about the different financial instruments they can gin to purchase the cook stove so that the perceived expensiveness can be minimized. Gebreegziabher *et al* (2010) found household head's education as positive factor in influencing improved cook stove adoption decision in Ethiopia.

This previous literature about the effect of level of education on improved cook stoves adoption decision enables one to expect a positive effect of education on households' *Electric Mitad* adoption decision in the stud area. Thus, positive and significant correlation is expected between women's literacy level and *Electric Mitad* adoption decision.

Income: The systematic review of Puzzolo *et al* (2013) found constituency among research results that higher socio-economic status is positive and significant factor in determining a household's improved cook stoves adoption decision. A review by Lewis and Pattanayak (2012) shows that income is positively and significant factor that determine the adoption of improved cook stoves across studies reviewed. Pine *et al* (2011) and Inayat (2011) shows that household income is determinant factor of households improved cook stoves adoption decision. The study investigated statistically significant positive correlation between improved cook stoves adoption and household income. The works of Damte and Koch (2011) and Dawit (2008) reveal that household income is statistically significant positive determinant factor in determining households' improved cook stove adoption decision. Having the previous literatures in this study, income is expected to affect household's adoption decision of *Electric Mitad* positively.

Family size: With regard to family size, Puzzolo *et al* (2013) found inconsistency among findings. A review by Lewis and Pattanayak (2012) found that household family size is statistically significant and positively associated with the probability of adoption of improved cook stoves across studies reviewed.

Pine *et al* (2011) found that household's family size is statistically significant factor that determines improved cook stoves adoption decision. The study revealed statistically positive correlation between improved cook stoves adoption and large family size. These authors claim that households with larger family size consume larger fuel wood as compared to households' smaller family size that results in influencing larger family size households to economize fuel wood usage. Gebreegziabher et al (2010) found that family size is positive and statistically significant factor in influencing adoption decision of improved stove. Households with large family size were found more likely to adopt improved cook stoves. Given this previous literature, it is expected that large family size positively affects households *Electric Mitad* adoption decision.

Separate kitchen: Puzzolo et al (2013) found constituency among research results that having separate kitchen is positive and statistically significant factor in determining a household's improved cook stoves adoption decision. Previous studies found separate kitchen house is a

significant factor that has positive effect on a household's improved cook stoves adoption decision (Axen, 2012; Damte & Koch, 2011). These works investigated the positive correlation between separate kitchen and improved cook stoves adoption.
Based on the existing literature, having separate kitchen is expected to have a positive effect on households' *Electric Mitad* adoption decision in the study area.

Relative price of Electricity: Mebratu, 2019 found that the price of fuel wood determines household's Electric mitad adoption decision this is because electricity and fuel wood are substitute products to bake enjera. As a result, not only the purchase price of improved stove and fuel-wood determine Electric mitad adoption decision rather the relative consumption price of Electric mitad affect households Electric mitad adoption decision.
Since the two are substitute each other as the price of Electric mitad consumption increases households shift to fuel-wood burning stoves as a result relative consumption price of Electricity is expected to have a negative effect in the study area.

Source of fuel-wood: Geary *et al* (2012) found that the free availability of fuel-wood one of the factors that lead to the decision not to adopt improved cook stoves. Source of fuel-wood is determinant factor of improved cook stoves adoption decision (Inayat, 2011). The investigation found that households not collecting wood for free were found more likely to adopt improved cook stoves. A study by Pine *et al* (2011) also found that the access to open forest is found to be negatively correlated and statistically significant with the probability of improved cook stoves adoption decision. Axen (2012) and Troncoso *et al* (2007) also investigated a positive coloration between lack of access to open forest and improved cook stove adoption and the vice versa.

Based on this empirical evidence, one can hypothesize that households that get fuel-wood with charge to be found more *Electric Mitad* adopters as compared to households that obtain fuel-wood without charge. It is assumed that for households that get wood for free, fuel-wood saving or efficient use of wood may not be their concern while fuel saving the priority for those that buy wood.

Price: price variables include the price of improved cook stoves, the price of fuel-wood, the price of kerosene and others. But for this study purpose, the influence of improved cook stoves' price on households' adoption decision is reviewed. A recent study by Levine et al (2013) found that inability of the poor to pay the cost of improved cook stoves is one of important barriers of adoption decision. Axen (2012) argues that the price of improved stoves and households' perception on the price have a significant effect on the probability of the households adoption decision. Slaski and Thurber (2009) identified that improved cook stoves' cost affordability by the poor is a positive determinant factor of adoption. The authors argue that low affordability of the cost improved cook stoves negatively affects cook stoves adoption likelihood by the poor. Makam (2007) found that the purchasing price of cook stoves is important factor in influencing a household's adoption decision of improved cook stove. The study's result shows that since the price of the improved one (ranges US$2.5- US$5) more than the price of traditional Charcoal stove (ranges US$1.5- US$3) households were found tending to purchase traditional charcoal stove.

Mebratu (2019) investigate that the price of electricity were indicated positive effect on households *Electric Mitad* adoption decision while price of fuel wood were positively affect households *Electric Mitad* adoption decision.

These previous studies give a clue to expect what the effect of *Electric Mitad* price to be on household's purchasing decision. Therefore, the price of *Electric Mitad* to have a negative effect on the households' purchasing decision while price of fuel is expected to have a positive effect in the study area.

Other factors: From the empirical literature the other factors that are found to influence the adoption decision of improve cook stoves include institutional and social factors. Makonese et al (2006) maintain that the existing institutional set up is a key factor that influences the implementation, promotion and dissemination of improved cook stoves in a certain country. These authors found that training, technology and information exchange, technology standard and decentralizing energy systems are institutional factors that influence the production, dissemination and adoption of improved cook stoves.

The works of Puzzolo e*t al* (2013) and Agarwal (1983) also found that extension services such as awareness creation and financial access to the users and the producer are positive institutional factors that influence the adoption decision of improved wood-burning stoves. Social factors are also found to be the other important variables to influence improved cook stoves adoption decision. For instance, Puzzolo *et al* (2013) and Adrianzen (2009) investigated that early adopters have a positive or negative effect on the others' likelihood of adoption. Menon and Thandapani (2011) also found that the influence of neighbors is one social factor to influence fuel efficient new cooking technologies adoption decision.

2.3. Conceptual Frameworks

Mixed methods researchers can use theory either deductively in testing and verification, or inductively as in an emerging theory or pattern (Creswell, 2003). Thus, this study was be based on three theories; Energy Ladder Theory, Energy Stacking Theory and Diffusion of Innovation Theory.

With regard to household, there are two types of household energy choice theory, energy ladder and energy stacking (Iyant *et al*, 2011). Energy ladder model, considered as classic and traditional, places heavy emphasis on income (affordability) in both explaining and determining a household's energy/fuel/stove choice. This implies that the household's income is taken as the only factor that influences households fuel/stove choice decision. But, this perspective is highly criticized by a number of studies with two practical reasons (Kowsari, 2013; Puzzolo, 2013). One of the criticisms is that there are multiple significant factors in addition to income, that influence households fuel/stove choice decision.

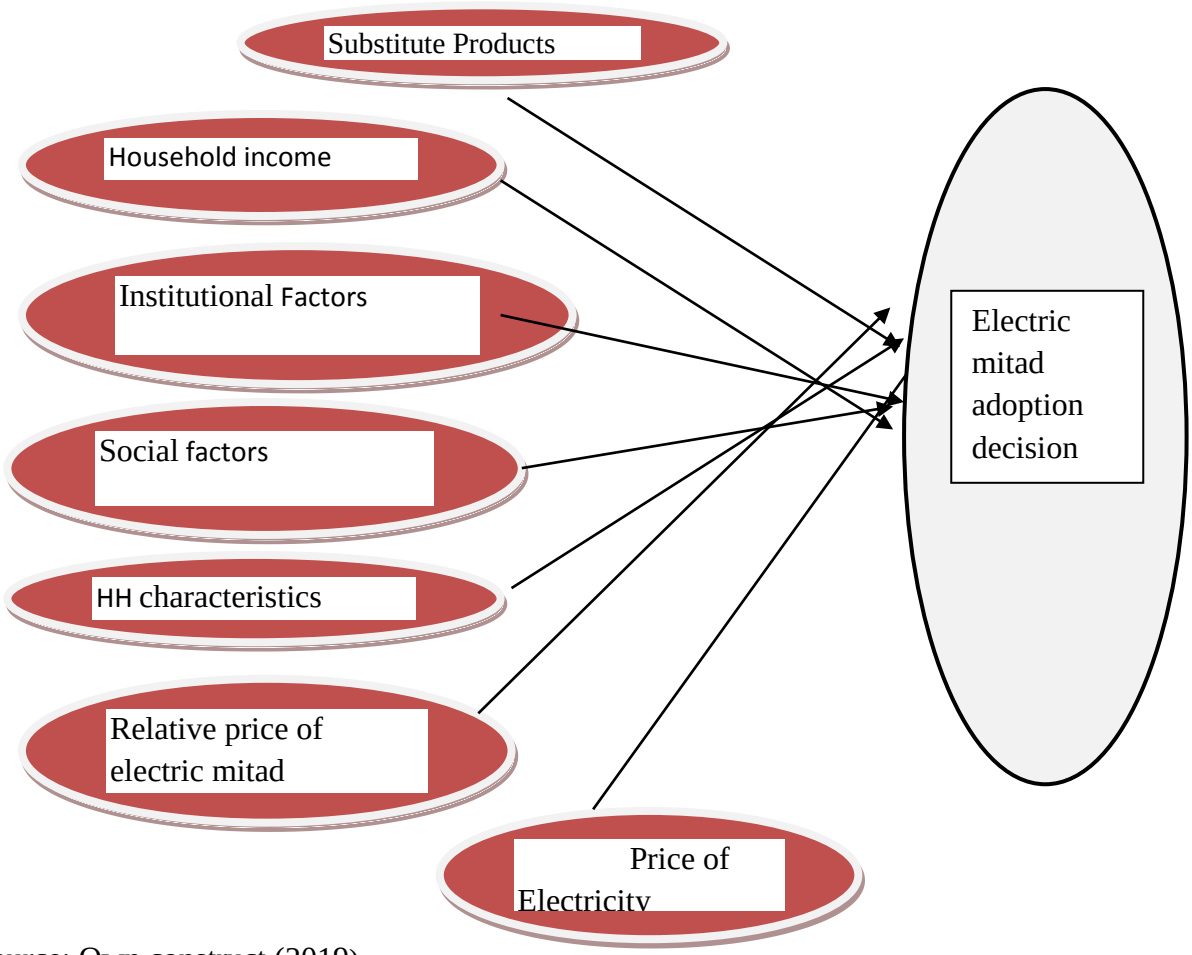
On the other hand, energy stacking household energy choice perspective overcomes the drawbacks of the energy ladder hypothesis. Energy stacking, also called fuel/stove stacking is considered as the latest and it is based on empirical evidence and is more realistic than the classic energy ladder hypothesis (Kowsari, 2013). Fuel type choice and/or stove adoption

decision depends up on a complex interaction between economic, social, cultural and environmental factors (Zuzarte, 2008).

Researchers (Takama et al, 2011) also argue that income alone does not determine adoption/ stove choice; family size, age and education are significant and matter more in determining whether or not a household adopts. As a result, the recent studies applied energy staking hypothesis and recommend that future researches should not rely excessively on the energy ladder model; for households in poor developing countries, such as those in Ethiopia, more attention to be paid other non monetary aspects besides income in the analysis (mekonnen et al, 2009).

The other theory regarding technology adoption is 'Dissemination of Innovation theory'. According to Rogers (2003), the Diffusion of Innovation Theory asserts that individuals and early adopters in a certain social system are able to influence attitude and behavior of others informally either to promote or hinder the acceptance of a new technology. According to this theory, improved stove technologies are more likely to spread out in a certain population if the stoves first gain acceptance among 'early adopters.

Based on these stated theories, the literature that the researcher has reviewed and based on the findings of the previous empirical studies on factors affecting the adoption of improved cook stoves, the following conceptual framework is developed.



Source: Own construct (2019)

3. METHODOLOGY

3.1. Description of the Study Area

Debre Markos, the capital of East Gojjam Administrative Zone is located in the north west of the capital city of the F.D.R.E. of Ethiopia, Addis Ababa, at a distance of 300Kms and 265Kms from the capital of Amhara Nation Regional State, Bahir Dar. With regards to the population composition of the town Amhara people are the predominant ones, and other nations and nationalities also dwell in the town. The Astronomical location of Debere Markos is 10°21" longitude to the north and 37°43" Latitude to the east; its elevation is estimated to be 2509 meters above sea level. During its foundation the total area was 272 hectares, but today this area increased by 23 fold and reached 6160 hectares.). Debre Markos town has temperate climate and the annual average temperature is 18.5˚C and its mean annual average rainfall is 1380mm.

Based on the 2007 national census conducted by the central statistical agency of Ethiopia (CSA), in 2012 Debre Markos has had an estimated population of 262,497, of whom 129,921 were men and 132,576 women.

3.2. Research Design and Strategy

Research design is the techniques to fulfilling research objectives and provides answers for questions. It is the plan that identifying the method and procedures for collecting and analyzing obtained information (Robert Raeside and David White, 2007). It ensures that the study would be to be effective with the problem and that it uses economical procedures. According to John A.H (2007) research design classified in to three, namely exploratory (emphasizes discover of ideas), Descriptive (concerned with determining the frequency with which an event occurs or relationship between variables) and explanatory (concerned with determining the cause and effect relationship)(Ruane, 2006).

The types of research under this study were descriptive and explanatory. The major purpose of descriptive research is description of the state of affaire as it exists at present. Then the study describes and critically asses the factors affect household's adoption of Electric Mitad in Debre Markos town. The study employed explanatory research design is that the correlation between

factors affecting households adoption decision. To achieve the objectives of the study, what factors determine household's adoption of *Electric Mitad* used both quantitative and qualitative data. Researchers typically select the quantitative approach to respond to research questions requiring numerical data, the qualitative approach for research questions requiring textural data, and the mixed methods approach for research questions requiring both numerical and textural data (Carrie, 2007). Well designed and implemented quantitative research has the advantage of making generalizations to a wider population from the sample. To enhance the generalization of findings, quantitative research approach follow standardized procedures in sample selection, instrument design, implementation and analysis (Creswell, 2003). A qualitative research approach uses strategies of inquiry including narratives, ethnographies, case studies, observations, interviews, and the findings are communicated subjectively through descriptions using words rather than numbers (Creswell, 2003).

With regard to the data sources, the researcher used both primary and secondary sources. The primary sources of this study were mothers of households and the key informants of *Electric Mitad* sealers and Woreda water office (specifically energy experts). The secondary sources were the town water office *Electric Mitad* dissemination report through energy experts, and the kebeles' household frame.

The data which the researcher used is mainly cross- sectional data .This primary data were collected from households through questionnaire. In order to collect reliable and appropriate data with manageable time, the close and open ended question were first translate in the local Amharic language.

3.3. Sample Size and Techniques

To make generalization about the whole population different sampling designs and procedures are used to get the truly representative sample (Israel, 1992). Thus, this section presents the sampling designs and procedures employed for the study.

The study selected three kebeles (kebele one, two and eight) from the total of 11 kebeles in Debre Markos town by using purposive sampling technique because of the following reasons.

1. It is a potential market for Electric mitad supplies and the presence of more condominium houses in kebele eight.

2. The previous knowledge of the researcher about the population.

The more a homogeneous population, the smaller the sample size is found to be representative (Tigabu, 2014) also selected three rural kebeles from the total of kebeles to investigate factors affecting the adoption of 'Mirt' stove in Dembecha woreda, Amhara Regional State of Ethiopia. Therefore, the findings of the study could potentially be generalized to all kebeles in the town.

The sample size for a given study should consider the time and financial constraints, minimize exposure to small sample bias, and are as representative as possible. When the response for the attributes being measured is assumed a dichotomous, the use of ***Yamane's (1967***) tables and formulas to determine sample size is more appropriate (Israel, 1992). Since the dependent variable in this study will be dichotomous, the researcher used ***Yamane's formula*** to determine the sample size for the questionnaire respondents, this is:

$$n = \frac{N}{1+N(e)\,2} = \frac{4942}{1+4942(0.07)\ \text{^}2}$$

$$n = 203.24 \approx 203$$

n=Sample size, N=Total household e= level of precision)

To determine sample size in each kebele, the researcher employed proportional sampling technique, the total samples (203) to the selected kebeles proportionally. Each kebele sample size was computed as follows:

Kebele	Household No	How to compute	Sample size
Kebele 01	1795	1795x total sample / total HH=1795x203/ 4942	74
Kebele 02	1668	1668 x total sample / total HH=1668x203/ 4942	68
Kebele 08	1479	1463 x total sample / total HH=1479x203/ 4942	61

3.4. Data Collection Instruments

Questionnaire: A structured questionnaire was prepared. The researcher was developing the questionnaire in English and translated into Amharic. The questionnaire were include information about household gender-based responsibility and fuel type and consumption, the respondent's characteristics, the presence of separate kitchen, the income of household, institutional and social factors as well as electric mitad adoption barriers.

Interview: Interviews was used to explore variables under investigation in greater detail. Semi-structured interviews were held with the key informants of Electric Mitad sellers, energy experts and kebele and natural resource management experts in their respective office. The focuses of the interviews with the key informants can be institutional factors like how, when and where the stove is disseminated and households to be informed, local forest protection, about the services and supports provided by the institution for both the producer and potential users and the most likely barriers of *Electric Mitad* adoption.

3.4.1. Data Collection Procedures

Since the study was conducted in three kebeles, three enumerators were involved in data collections that are fluent in Amharic, one to each kebele. In order to collect the true data from the respondents the enumerators took some guideline about the questions, when, where, how and to whom the questionnaire to be distributed. The questionnaire used as the basis of structured interviews, rather than self-completed, since the respondents 'may be literate and illiterate. The data was collected within one week in the morning and afternoon.

3.5. Data processing and Analyzing

The collected data were processed and analyzed. This data processing and analyzing procedure are discussed below.

3.5.1 Data Processing

To reduce incompleteness and make it useful in the analysis, the raw data was filtered. To solve the problems related with inappropriate responses, incomplete answers and other fictitious

responses, the raw data was edited, coded, grouped, tabulated and summarized with the help of STATA version.

3.5.2 Analyzing Procedures

Descriptive Statistics: The descriptive statistics of frequency, percentage, means and standard deviation was done by using the SPSS software version while econometric analysis was by STATA version in analyzing the data collected through questionnaire. The data collection through semi-structured interviews and focus group discussions were analyzed by the use of intensive textual analysis.

Econometrics: Binary logistic regression model was used. Since the dependent variable (adoption of *Electric Mitad*) is dichotomous (dummy) form, binary logistic regression was used to predict the effects of the independent variables on the dependent (outcome) variable. Logistic regression used to model the probability of a positive outcome for a binary 0 or 1 outcome variable as a function of covariates (Gujarati, 2004).

3.6 Definitions and Descriptions of Variables

The study was including variables of *Electric Mitad* adoption, household characteristics, income, price institutional and social factors. Here under these variables are defined and described.

Dependent variable: *Electric Mitad* adoption was given a value of '1' to the *Electric Mitad* adopters while '0' was assigned to non-adopter. To assess the status of *Electric Mitad* adoption by household, respondents were asked whether they purchased electric mitad or not in the form of 'Yes' or 'no' response question. Similar studies, for instance, (Inayat, 2011; Dawit, 2008) used such type of objective response and direct measure of binary dependent variable in determining the purchasing practice of *Electric Mitad*.

Independent variables: The independent variables were selected based on the existing theories and empirical studies (Puzzolo et al, 2013; Damte & Koch, 2011; Tigabu, 2014; Mebratu, 2019). The definitions of these selected explanatory variables are given below.

Age (age): Here refers to the respondent's age in years.

Sex (sex): Sex of respondents in household level

Education(edu): By level of literacy was continues variable in a maximum level of education for house hold in year.

Income (inc): total expenditure and saving of household per month

Marital status (ms): In this study marital status was a dummy which refers to the respondent's state of being single or married. A value of '1' will be given to married and '0' for single.

Family size (fs): It is the total number of persons in a household.

Separate kitchen (sepkich): It is about whether the household has separate kitchen house or not. In this study separate kitchen was a dummy valued '1' for a household that has separate kitchen and '0' for has not.

Relative price (rp): the relative consumption price of Electric mitad.

Source of wood (sw): It is about a household's main source of fuel-wood for the household. And for this study purpose, wood source that refers to whether household get fuel-wood without charge, regardless of whether they collect from open forest or self grown, or with charge, charcoal or others

Substitute product (sp): this is the availability of substitute product like Mirt Stove.

Institutional factors: Institutional factors in this study were including provision of services (e.g. awareness creation, quality control and price regulation) and supports (e.g. technical, material and financial).

Social factors: Social factors were included in this study are membership to social associations, participation in social activities, the influence of informal information exchange, the influence of early *Electric Mitad* adopters and the influence of neighbors

3.7. Model Specification

To model regressions when the dependent variable is dichotomous, taking 0 or 1 values, a probability model that has these two features is necessary: (1) as Xi increases, Pi = E(Y = 1 | X) increases but never steps outside the 0–1 interval, and (2) the relationship between Pi and Xi is nonlinear; thus, one can easily use cumulative distribution function (Gujarati, 2004). Both Logistic and Probit regression models satisfy the above two features. But, even though there is no basis in statistical theory for preferring one over the other, there are two practical advantages

of the logit model over probit model (Fox, 2010). The first one its simplicity: the equation of the logistic CDF is very simple. The second is its interpretability: the inverse linearizing transformation for the logit model is directly interpretable as log-odds, while the inverse transformation for probit does not have a direct interpretation. By taking in to consideration these advantages, the researcher preferred to use binary logistic regression model to predict the effects of independent variables on the dependent variable. Therefore, a household' *Electric mitad* adoption probability was modeled as a dichotomous variable with values 1 'if a household adopts *Electric mitad*' and 0 'otherwise'. Here the dependent variable was dichotomous, i.e. to adopt or not: thus, the independent variable Yi = 1 if the household adopt the *Electric mitad*, and *Yi* = 0 if the household do not adopt. To adopt or not to adopt in relation to independent variables can be depicted in linear probability as follow:

$$P_i = E(Y=1/X_i) = \beta_1 + \beta_2 X_i$$

Where X is the independent variable and Y=1 means the household adopts the *Electric mitad*; thus, the adoption of *Electric mitad* can be expressed as follow;

$$P_i = E(Y=1/X_i) = 1+\exp\left[1-(\beta_1+\beta_2 X_i)\right] = 1+\exp(-Z_i) \ldots\ldots\ldots\ldots (1)$$

Where Zi =. It is the cumulative logistic distribution function (CDF). Here Zi ranges from -∞ to ∞ and Pi ranges between 0 and 1; Pi is non-linearly related to Zi (i.e. Xi); thus, satisfying the two conditions required for a probability model. But, this non-linearity of Pi both in X and β's creates a problem in estimating parameters. To overcome this problem, there is a need of another equation. Here, Pi is the probability of adopting and it is given by;

$$\frac{1}{1+\exp(-Z_i)}$$

Then the (1-Pi), the probability of not adopting is,

$$(1 - P_i) = \frac{1}{1+\exp(-Z_i)}$$

Therefore, one can write:

$$\frac{P_i}{(1-P_i)} = \frac{1+\exp(Z_i)}{1+\exp(-Z_i)} \ldots\ldots\ldots\ldots (2)$$

Pi/ (1-Pi) is the odds ratio in favor of adopting the Electric mitad, i.e.; the ratio of the probability that a household will adopt the stove to the probability that it will not adopt the stove. Taking the natural log of equation (2), one can obtain;

In (pi/1-pi) = Zi = ß1+ß2Xi ……..(3)

This log of odds ratio is linear both in X's and in the parameters. Therefore, the logit model of adoption for the sample respondent households was expressed as follows; with intercept term (β0) and Xi independent variables can be equated as:

In (pi/1-pi) = ß0+ß1X1i +ß2x2i +…..ßnxni

Here, ß0 stands for the intercept term, while Xn are the hypothesized determinants of Electric mitad adoption, and ßn are the parameters to be estimated. Therefore, the model employed has the following form, with the error tem:

P (Adop) = In(pi/1-pi) = ß0 + ß1 age + ß2 ms + ß3 fs + ß4 edu +ß5 ass + ß6 sub pro + ß7 income + ß8 price + ß9 awar +ß10 sepkic +ß11Rprice+ui

3.8. Diagnostic Tests and description of variables

Before the start of complete analysis, various diagnostic tests were conducted to make the data ready for regression. Any analysis should incorporate examination of logistic regression diagnostics before reaching a final decision on model adequacy (Hosmer *et al.*, 1997).

Model-Fit test is one of the most useful tests for truly assessing model fit for binary logistic regression models (Gujarati, 2004). To assess the usefulness of the model in indicating the amount of variation in the dependent variable, R Square, described as pseudo R2- statistics (from a minimum value of 0 to a maximum of approximately 1) were tested. Since pseudo R2 was found 0.8512, the model was fitted well. In a rule of thumb p-value of 0.05 is taken as a reference in assessing the goodness-of-fit test. In this study the prob > chi2 was found to be 0.0015 which is less than 0.05 (see appendix). Thus, the model was good.

To test the correlation between variables included in the model pair-wise correlation test was run. As general rule, multi-co linearity is a problem when the correlation result is above 0.80 and below -0.80 (Stock & Watson, 2007). The coefficients of all variables were found to be above -0.5679 and below 0.6584 (see appendix). In addition, Variance Inflation Factor (VIF) and tolerance level (1/VIF) are two important measures of multi-collinearity problem (Wooldridge, 2002). According to Wooldrige, by rule of thumb, VIF value of 5 or tolerance indexes of 0.20 are used as a critical point to indicate serious multi-co linearity problem. And, the minimum and maximum VIF values for this test were found 1.07 and 1.87, respectively, with mean value of 1.36 (see appendix). Therefore, there was no severe multi-co linearity problem.

Table1. Description variables used in the logit model

Variable name	Definition	Type	Measure
Adoption	Weather a household adopt Electric mitad or not	Categorical	1 = adopter, 0 = non adopter
Age	Age of the household head	Continuous	Year
Family size	Family size of the household	Continuous	Number of persons in the household
Occupation	The employment status of the household head	Categorical	1 = employed, 0 = un employ
Educational status	The maximum educational status of the household head	Categorical	illiterate(bench mark), primary, complete, diploma degree and above
Income	The monthly income the household head	Continuous	Birr
Price	The purchase price of Electric mitad	Continuous	Birr
Relative price	The relative monthly consumption price of Electricity consumption to fuel-wood	Continuous	Birr
Separate kitchen	Weather the household have separate kitchen house or not	Categorical	1 = have separate kitchen house 0 = have not
Membership to association	Weather the household head is member of social associations or not	Categorical	1 = member, 0 = non member
Substitute product	Weather the household adopt substitute product or not		1 = adopt substitute product like Mirt stove, 0 = not

Source own construct, 2019

4. RESULT AND DISCUSION

4.1 Descriptive Statistics and Discussion

To identify the determinants of households' electric *mitad* adoption decision, a systematic sample of 203 households from the sample frame were taken from three purposively selected kebeles in Debre Markos town. From this total of sample, 200(98.5% response rate) household respondents were reached. But, the data gathered from 3 respondents were found to be incomplete. As a result, only data collected from observations were used for the analysis purpose.

4.1.1. Household Energy Consumption Pattern

The sampled households in Debre Markos town use either Electricity or fuel-wood and a mix of fuel-wood and electricity for heating and cooking. Household use Electric Mitad, Mirt stove or Open fair to bake injera table 2 shows that among the sample households in Debre Markos town 29.5 % of the households are still baking with the traditional open fair, 27% of the households are adopting Mirt stove which is better than the traditional open fair but less cleaner than electricity and 43.5 % of the households adopt Electric Mitad to bake injera.

Table2. Household's energy consumption pattern

Source of energy	Frequency	Percent	Cumulative
Open fair	59	29.5	29.5
Mirt stove	54	27	56.5
Electric mitad adoption	87	43.5	100
Total	200	100	

Source own survey, 20019

4.1.2 Status of Electric Mitad Adoption

To assess the status of Electric mitad adoption by urban households in Debre Markos town, household respondents (women) were asked whether they purchased Electric Mitad or not in the form of 'Yes' or 'no' response question. Similar studies, for instance, (Inayat, 2011; Mebratu, 2014) used such type objective response and direct measure of binary dependent variable in

determining the purchasing practice of Electric mitad. As a result, for the purpose of investigating common explanatory variables affecting households' Electric mitad adoption decision, both households who did adopt and did not adopt were included in the analysis.

Table3.Status of electric household's mitad adoption

Adoption of Electric mitad	Frequency	Percent	Cumulative
Adopter	87	43,5	43.5
Non adopter	113	56.5	100
Total	200	100	

Source own survey, 2019

As it is observed in Table 3, from the total of 200, 113 respondents (56.5 %) were found non-adopters of Electric mitad while 43.5 % are adopters. This implies the majority of the households were found to be non-adopters.

Reasons to adopt Electric mitad: To investigate the most important reasons for household's adoption of Electric mitad, only Electric mitad adopters (87 respondents) were asked. The following table shows, Electric is cleaner and convenience to use were found to be the most important reasons to adopt this improved cooking technology.

Table4. The reason for adopting Electric mitad

Items	Electric is convenience to use		Electric is quicker		Electric is cleaner	
	Frequency	Percent	Frequency	Percent	Frequency	Percent
Strongly disagree	-	-	-	-	-	-
Disagree	-	-	32	37.2	-	-
Neutral	-	-	21	24.4	-	-
Agree	48	55.8	33	38.4	25	29.1
Strongly agree	38	44.2	-	-	61	70.9
Total	86	100	86	100	86	100

Source own survey, 201

As Table 4 presents, out of 86 Electric mitad adopters, 61(70.9) strongly agreed and 25(29.1%) agreed that cleaner cooking perception of Electric mitad is important reason to adopt it. From the total of 86 adopters, 38 (44.2 %) strongly agreed and 48(55.8) agreed that convenience to use is the reason to adopt to adopt Electric mitad.

Awareness and source of information: Table 5shows that from the total of 200 surveyed women respondents, 127 (63.5 %) were found unaware of the relative benefits of Electric mitad over open fire and Mirt stove while 73 (36.5%) were found to be aware. And also, 185 (92.5 %) respondents replied that they are aware of the adverse effects of baking Injera on open-fire like eye irritation and burn while 15 (7.5 %) replied that they are unaware.

Table5. Awareness and Sources about Electric mitad adoption

Awareness and sources	Categories	Total	
		Frequency	Percent
Awareness about the benefit of Electric mitad	Yes	73	36.5
	NO	127	63.5
	Total	200	100
Awareness about adverse effect of using fuel-wood	Yes	185	92.5
	No	15	7.5
	Total	200	100.00
More accessible places to be informed about the benefit of adopting Electric mitad	Religious places	13	15.12
	Market places	28	32.56
	Meeting places	45	52.33
	Total	86	100.00
More accessible sources of information about the benefit of adopting Electric mitad	Social associations	42	48.84
	Television	44	51.16
	Total	86	100.00

Source own survey, 2019

Based on the above findings one can conclude that though majority of urban women found to be aware about the adverse effects of baking with fuel wood, the majority were unaware about therelative benefits of Electric mitad adoption. This may be because women unable access different sources of information since they spend most of their time at home to carry out their door tasks.

With regard to sources of information, as Table 5 shows, formal and informal meeting place, market place and religious places social were found to be more accessible places for 52.33% and 32.56and 15.12% of respondents, respectively. Media (television) and membership to social associations were found to be more accessible sources of information for 51.16 % and 48.86% of respondents, respectively.

From the above analysis we can infer media and social associations are found to be more accessible sources of information for urban women's at the study area. In addition meeting places and market places are identified to be more accessible sources of information for urban women. These may be because; women's exchange information when they meet in different social associations. And the accessibility of television makes women's to get information easily; the Ethiopian energy expert must address information about the benefit of adopting Electric mitad on social Medias.

4.1.3 Electric mitad Adoption and Household Characteristics

Household characteristics are those variables that explain information about the household such as respondent's gender, age, and marital status, level of education and occupation. But, for this study, household characteristics include variables of the respondent's age, marital status, literacy level, family size and household's separate kitchen ownership and occupation. These factors are explained below.

Electric mitad Adoption and Age

As it can be seen from Table 6, the minimum and maximum years of respondents are 22 and 58 while the mean and standard deviation are 32.87 and 8.2, respectively. The minimum and maximum years of the adopters are 22 and 47 while 23 and 58 years are for the non-adopters, respectively. And also, while the means for adopters and non-adopters is 31.62 and 33.65, the

standard deviations for adopters and non-adopters are 8.21 and 7.98, respectively. This finding reveals that there is mean variation between the Electric mitad adopters' and non- adopters' age. The average age of adopters is less than the average age of non adopters. This implies that the younger the age, the more likely to be Electric mitad adopter. In addition, this mean variation was found to be statistically significant with t-value = 1.89. This t-value suggests that there is significant difference between the mean age of Electric mitad adopters and non-adopters at 10% level of significance.

Table6.Electric mitad Adoption and Age

Adoption	Frequency	Mean	Sd.	Min	Max	t-value
Adopter	87	31.62	8.213	22	47	
Non adopter	113	33..655	7.979	23	58	1.89
Total	200	32.77	8.124	23	58	

Source own survey, 2019

Electric mitad Adoption and Family Size

As it can be seen from Table 7, the minimum and maximum family size is 2 and 9, respectively while the mean and standard deviation are 3.67 and 1.6, respectively. And also, the minimum and maximum family size for Electric mitad adopters were 2 person and 6personsand non-adopters were found to be the 2 person and 9 persons, respectively. The mean family size of adopters (4.89) slightly exceeds the mean family size of non-adopters (2.73) and the standard deviation of adopters (1.4389) slightly exceeds the standard deviation of no adopters (0.9566). Though there is a little bit mean difference in family size of both the adopters and non-adopters, the t-value shows that there is significant mean difference between the family size of the adopters and non-adopters at 1% level of significance.

Table7. Electric mitad Adoption and Family Size

Variable	Electric mitad adoption	Frequency	Mean	Sd.	Min	Max	t-value
Family size	Adopter	87	4.897	1.439	2	6	
	Non adopter	113	2.726	0.9566	2	9	-12.15
	Total	200	3.67	1.604	2	9	

Source own survey, 2019

Electric mitad Adoption and Marital Status

Table 8 shows that out of 200 surveyed households, 129 are married in which 77 of them are Electric mitad adopters and 52 of them are non-adopters while 71 are single in which 61 are Electric mitad adopters and 10 of them are Electric mitad non-adopters.

Table8.Electric mitad Adoption and Marital Status

Variable	Electric mitad adoption	Marital status		Total	Chi2-test p-value
		Married	Otherwise		
Marital status	Adopter	77	10	87	
	Non adopter	52	61	113	0.156
	Total	129	71		

Source own survey, 2019

These figures indicate that a greater proportion of married women are tended to adopt electric mitad as compared to non married counterparts. In addition, the chi-square statistic showed this to be statistically insignificant with P-value of 0.156. Therefore, it can be conclude that there is insignificant relationship between marital status and electric mitad adoption decision.

From this finding one can understand that married women's were more likely to adopt Electric mitad as compared to non married counterpart. One plausible explanation for this may be because of married women's get more information about the benefit of improved cook stove. This implies that non married women were found lagged behind married women to be Electric mitad adopters and it may be because of lack of information sharing with their spouse.

Electric mitad Adoption and Educational Status

As Table 9 shows, from the total of 200 respondents, 27 of them were found degree holder in which 26 of them are found to be Electric mitad adopters and of the 1 is non-adopters, 82 0f them were found diploma holder in which 44 of them are found to be Electric mitad adopters and 38 of them non adopters, 76 of them were found primary complete in which 53 of them are found to be Electric mitad adopters 23 of them non adopters and 15 are found literate in which all of them are found to be non adopters. As the educational status of a household head increase they became aware about the benefit of adopting electric mitad which means educated household heads are more likely adopt electric mitad. Therefore, it can be generalized that there is significant relationship between women literacy level and the probability of Electric mitad adoption decision.

Table9.Electric Mitad Adoption and educational status

Variable	Adoption of electric mitad	The maximum educational status of a household head					Chi2-test p-value
		Illiterate	Primary complete	Diploma	Degree &above		
Educational status	Adopter	15	53	44	1	113	0.000
	Non adopter	0	23	38	26	87	
	Total	15	76	82	27	200	

Source own survey, 2019

The chi-square statistic p-value suggests that there is significant relationship between educational status of a household head and adoption decision of Electric mitad with p-value = 0.000 at 1% level of significance. This result is consistent with the previous works of (Puzzolo et al, 2013 and Mebratu, 2018) that found educated households are more likely to adopt improved cook stove technologies as compared to households that are not educated.

Electric mitad Adoption and occupation

Table10.Shows that out of 200 surveyed households, 147 are employed in which 74 of them are Electric mitad adopters and 73 of them are non-adopters while 53 are unemployed in which 13 of them are Electric mitad adopters and 40 of them are Electric mitad non-adopters.

Table10. Electric Mitad adoption and occupation

Variable	Adoption	Employment status		Total	Chi2-test p-value
		Employed	Un employed		
Occupation	Adopter	74	13	87	
	Non adopter	73	40	113	0.15
	Total	147	53		

Source: own survey, 2019

This indicates that a greater proportion of employed women are tended to adopt electric mitad as compared to unemployed counterparts. In addition, the chi-square statistic showed this to be statistically significant with P-value of 0.15. Therefore, it can be conclude that there is insignificant relationship between occupation and electric mitad adoption decision. The chi-square statistic p-value = 0.15 suggests that there is insignificant relationship between employment status of a household head and Electric mitad adoption decision.

Electric mitad Adoption and Separate Kitchen

Table 11 shows, out of surveyed 200 household respondents, 117 of them have separate kitchen house in which 71 of them are Electric mitad adopters and 46 of them are non-adopters. On the other side, 83 have not separate kitchen in which 41 of them are found to be Electric mitad adopters and 42 of them are non-adopters.

Table11. Electric mitad adoption and Separate Kitchen

Variable	Electric mitad adoption	Presence of separate kitchen Yes	No	Chi2-test p-value
Separate kitchen house	Adopter	71	41	0.16
	Non adopter	46	42	
	Total	117	83	

Source: own survey, 2019

These imply that households that have separate kitchen house are found to be more Electric mitad adopters as compared to households that have not separate kitchen. This may be because of its fixed nature and larger in size which requires larger space. The chi-square statistic p-value = 0.156 suggests that there is insignificant relationship between presence of separate kitchen house of a household head and adoption decision of Electric mitad.

As Table 11 shows, out of 200 surveyed women, 161 (80.5) agreed that Electric mitad fixed nature is one reason for the need of separate kitchen to adopt. This implies that the nature of Electric mitad influences household's adoption decision. In addition 152(76%) of the respondents agreed that separate room has effect on Electric mitad adoption.

Table12.Reasons for the need of Separate kitchen

Response	**Separate room has effect on Electric Mitad adoption**		**Fixed nature of the stove has effect on have separate kitchen**	
	Frequency	Percent	Frequency	Percent
Strongly disagree	-	-	-	-
Disagree	7	3.5	-	-
Neutral	**25**	7.5	-	-
Agree	**152**	76.0	161	80.5
Strongly agree	**26**	13.0	39	19.5
Total	200	100	200	100

Source own survey, 2019

4.1.4 Electric mitad Adoption and Price

As it can be seen from Table 12, the minimum and maximum prices are 1500 and 2500, respectively. And also the mean and standard deviation is 2182.25 and 316.73, respectively.

Opinion on electric mitad price: As Figure 13 shows, 62.79% of the respondents stated the price of Electric mitad is expensive, 25.58 % of the respondents stated that price of Electric mitad is fair while only 11.63% of the respondents stated that price of electric mitad is cheap.

Table13.Opinion on electric mitad price

Price opinion	Frequency	Percent	Cumulative
Cheep	10	11.63	11.63
Expensive	54	62.79	74.42
Fair	22	25.58	74.42
Total	86	100.00	100.00

Source own survey, 2019

4.1.5 Electric mitad adoption and income

As it can be seen from Table 14, the minimum and maximum income of electric mitad adopters is 2500 and 31000, 2350 and 10402 for non adopters respectively. And also the mean and standard deviation is 4098.58 and 1702.60for non adopters while 11257.84 and 4868.35 for non adopters respectively.

Table14. Electric mitad Adoption and Income

Variable	Electric mitad adoption	Household head income per month					t-value
		Frequency	Mean	Sd.	Min	Max	
Income	Adopter	87	11257.84	4868.35	2500	31000	
	Non adopter	113	4098.58	1702.60	2350	10402	2.84
	Total	200	7212.86	4953.24	2350	31000	

Source own survey, 2019

This finding reveals that there is mean income variation between the Electric mitad adopters' and non- adopters'. The average income of adopters is higher than the average age of non adopters. This implies that the higher the income, the more likely to be Electric mitad adopter. In addition, this mean variation was found to be statistically significant with t-value = 2.84. This t-value suggests that there is significant difference between the average income of Electric mitad adopters and non-adopters at 1% level of significance.

4.1.6 Electric mitad Adoption and Institutional Factors

In examining institutional influence on urban households' Electric mitad adoption decision in the study area, institutional variables of denying open forest access, provision of services and supports and decentralization of Electric mitad production sites were analyzed. These institutional variables' influence on Electric mitad adoption decision is discussed below.

When series of likert-type questions/items are used to measure a single main variable or character, mean and standard deviation are more proper in analyzing the data than using of mode and median(Boone & Boone, 2012). In this study, denying access to open forest, providing services, providing supports and decentralizing Electric mitad production sites were five scale likert response questions (from 1=strongly disagree 3= neutral to 5= strongly agree) to examine institutional influence on households' Electric mitad adoption decision. As a result, the data were analyzed by using frequency and percentage.

Table15. Electric mitad Adoption and Institutional Factors

Items	Response											
	SDA		DA		Neutral		Agree		SA		Total	
	N	%	N	%	N	%	N	%	N	%	N	%
The nearby gov.t institution influence on purchase Electric Mitad.	-	-	-	-	-	-	83	41.5	117	58.5	200	100
Institutionally deny the access to forest can influence to purchase.	-	-	-	-	14	7.0	119	79.5	27	13.5	200	100
By providing service (creation awareness quality control, price regulation, government institution can affect households adoption decision	-	-	-	-	67	33.5	127	63.5	6	3.0	200	100
By providing supports institutions can affect the production and adoption of Electric Mitad	-	-	-	-	6	3.0	88	44.0	106	53.0	200	100
Decentralizing production site to users can affect Electric Mitad purchasing decision.	-	-	-	-	-	-	109	54.5	91	44.5	200	100

Source own survey, 2019

As it is observed from the above table, denying open forest access 119(79.5%), provision of services and supports 106(53.00%) of the respondents were found to be the important institutional factors that affect households Electric mitada doption decision respectively. This may be, partly, because the role of institutions in creating an enabling working environment by providing different services and supports to potential users can influence the adoption of

Electric mitad. By providing different institutional services the government or concerned bodies can expand public awareness about its benefits; the probability of adoption may be high.

The respondents reveal that institutional factor that affects the probability of Electric mitad adoption is institutional services like price regulation and quality control and denying access to open forest. Most of the key informants agreed that providing service, price regulation, support and denying access to open forest are the major institutional factors affecting the probability of household's adoption of Electric mitad.

From these findings on can understand that denying open forest access, provision of services and supports were found to be important institutional factors that affect Electric mitad adoption decision. This study came up with similar findings of Puzzolo et al (2013) and Tigabu (2014) that found denying access to open forest awareness creation and price regulation are appositive significant factors affecting households adoption of Electric mitad.

4.1.8 Electric mitad adoption and social factors

Social factors explain social relationships and networks, membership to social associations, the influence of others, the influence of neighbors', the influence of family members and other variables. But, for this study purpose the variables of membership to social associations, active participation in social activities, the influence of informal information exchange, the influences of earlier adopters and neighbors are discussed in examining social influences on Electric mitad adoption decision.

As Table 16 presents, from the total of surveyed 200 women, 66 were not found member of social associations in which 7 of them are Electric mitad adopters and 59 of them are non-adopters. On the other hand, 134 of respondents were found member of social associations in which 80 of them are Electric mitad adopters and 54 of them are non-adopters. This implies that the more a woman is member of social associations, the more likely to be Electric mitad adopter. This factor helps urban households to get information and to share some experience from being of social association's membership. The more the women participate in social association, the more likely to adopt new technologies of Electric mitad.

Table16. Electric mitad Adoption and Membership to Social Associations

Variable	Adoption of Electric mitad	Categories Yes	No	Total	Chi2-test p-value
Membership to social associations	Adopter	80	7	87	0.000
	Non adopter	54	59	113	
	Total	66	134	200	

Source: own survey, 2019

These findings imply that the more a woman is member of social associations and, the more likely to be Electric mitad adopter. This may be because of being a member to and active in participation open and increase the opportunity to contact with individuals who have different information and experience and by these social organizations there will be information exchange can influence Electric mitad purchasing decision. If a woman becomes a member of different social associations and becomes active participate, the opportunity of getting information about the benefit of Electric mitad adoption will be high. The finding of this research is similar to the works of Tigabu (2014) that found membership to social associations and be networked and Mebratu (2018) that found a woman's participation in different associations and communal activities has significant positive effect on a household's stoves adoption decision.

In this study, the influence of membership to local associations, information exchange by social associations, the influence of early adopters and neighbors were five scale likert response questions (from 1=strongly disagree 3= neutral to 5= strongly agree). As a result, the data were analyzed by using frequency and percentage.

As it can be seen from the below table, informal information exchange by social associations was found to be the most important social factor that influences Electric mitad adoption decision in the study area. In line with this, majority (50 %) of respondents strongly agreed and 41.9 % agreed that informal information exchange can influence adoption decision. This is because by social associations members may exchange their different experiences and information about the benefit of Electric mitad adoption and this communication in turn affects

Electric mitad purchasing decision. This finding is similar to the empirical studies of Dewan et al (2013) and Tigabu (2014) that found inter-personal communications and social networks are important social factors affecting households' cook stove technologies adoption decision.

Table17.Electric mitad Adoption and Influence of Social Factors

Case Processing Summary

	Response											
	SDA		DA		Neutral		Agree		SA		Total	
Items	N	%	N	%	N	%	N	%	N	%	N	%
Membership to social association can influence Electric mitad purchasing decision	-	-	-	-	22	11	57	28.5	121	60.5	200	100
By social associations there will be information exchange that can influence adoption decision	-	-	-	-	23	11.5	146	73	31	15.5	200	100
Earlier adopters of Electric mitad can influence others adoption decision	-	-	-	-	18	9.00	43	21.5	139	69.5	200	100
Neighbors can influence the others Electric mitad adoption decision	-	-	-	-	40	20.0	143	76.5	7	3.5	200	100

Source own survey, 2019

As the above table shows, social factor that affects household's Electric mitad adoption was found to be early Electric mitad adopters which majority (69.5 %) of respondents strongly agreed and 21.5 % agreed that earlier adopter of Electric mitad can influence others adoption decision. This result supports Diffusion of Innovation Theory that asserts individuals and early adopters in a certain social system are able to influence attitude and behavior of others informally either to promote or hinder the acceptance of a new technology. This result is similar to the previous works of Puzzolo et al (2013) that found households that adopted the improved

stove have a positive or negative effect on the household's likelihood of adoption. Neighbors' influence was, also, found one social factor that has influence on household's Electric mitad adoption decision.

To generalize, membership to local associations, informal information exchange, the influences of early adopters and neighbors were found social factors that affect household's Electric mitad adoption decision.

4.2. Econometric Analysis and Discussion

As discussed in chapter three, diagnostic tests of multi-co linearity, heteroskedasticity and normality were checked before applying logistic binary regression model to estimate the potential effect of each explanatory variable on the dependent variable of Electric mitad adoption decision. The results of these tests shows that no problems of sever multi-co linearity, model specification bias, normality and robust was run to solve the problem of heteroskedasticity and to get better estimations.

As Table 18 shows, the regression estimation result investigated that there are factors that have explanatory power to determine households 'Electric mitad adoption decision in the study area at 1, 5 and 10 percent level of significance. This regression result shows that Electric mitad adoption decision is positively correlated with literacy level, family size, income, membership to social associations and awareness creation. However, the result reveals that Electric mitad adoption is negatively correlated with price of electric mitad, availability of substitute products and relative consumption price of Electric mitad adoption. These correlations between technology adoption and literacy level, having separate kitchen and price support stacking and energy ladder theory in determining cook stove technologies adoption decision, respectively.

The logit model was estimated using Stata software application version 14. From the logit regression result depicted in the above table, we can observe that the explanatory variables identified in the model sufficiently explain variation in the dependent variable, which was shown by high value of Pseudo R2 (=0.8527). Moreover, probability of chi^2 is statistically significant at 5 % significance level, which indicates that all explanatory variables taken together are significant in explaining the model. Diagnostic tests were conducted, in which multico linearity problem was detected. Later, explanatory variables resulting in multi-co

linearity problem were omitted, and the final regression result is presented in Table 18 above. Therefore, the model can be valid to determine variables that significantly affect adoption of electric mitad by households in the study area.

A number of studies have shown several socio-economic factors, such as household income, education, size and age of household, time spent at home, ownership and age etc., influence household cooking and cooking stove choices. Likewise, as it is seen from Table 18, eight explanatory variables were found to be significant in affecting adoption of electric mitad in the study area. These variables are household income, age of the household head, and relative price of electricity, price of electricity, family size, awareness, and membership to associations and availability of substitute products. Furthermore, the variables came up with the expected sign.

Table18. Logistic regression result (Dependent variable adoption of electric Mitad)

Variables	Coefficient	p- value	Robust Std Error
Age	-0.0874	0.075*	0.0491
Family size	0.8897	0.003***	0.3041
Price of electric Mitad	-0.0031	0.051*	0.0016
Income	.000042	0.005***	2.84
Awareness	2.055	0.007***	0.767
Education			
Primary complete	-0.595	0.622	1.208
Diploma	-1.123	0.443	1.473
Degree and above	.83	0.523	1.298
Membership to associations	3.1229	0.049*	1.588
Substitute product	-3.147	0.029**	1.443
Occupation	.0095	0.992	0.9438
Separate kitchen	1.4723	0.127	0.9573
Marital status	-0.4377	0.607	0.8509
Relative price of Electricity	-0.6883	0.002***	0.2260
Constant	1.387	0.32	4.279

Source own survey, 2019

=10% level of significance,=5%level of significance, ***=1level of significance*

Variables that have significant explanatory power in determining the Electric mitad adoption decision are interpreted in this section.

Age: As it was expected age was found a negative significant factor that affects households' Electric mitad adoption decision. This is because higher aged individuals are not reluctant to technology change. The marginal effect for age of a household head indicates that the probability of Electric mitad adoption increases on average by 2.17 percent relatively as one year increment in the age of a household head.

The previous studies found contradictory results with regard to the correlation between age and improved cook stoves adoption. A review by Lewis and Pattanayak (2012), household head's age was indicated to be significant negative factor that determines the adoption of improved cook stoves across studies reviewed. In contrary, Gebreegziabher *et al* (2010) found household head's age to be positive and statistically significant determinant factor of improved cook stove adoption decision. The finding of Dawit (2008) reveals that household head's age is negatively and statistically significant determinant factor of improved cook stove adoption. With regard to the influence of a household head' age on household's improved cook stoves adoption decision, recent work of Puzzolo *et al* (2013) found inconsistency among research findings.

Family size: Price: As it was expected family size was found a positive significant factor that affects households' Electric mitad adoption decision. This is because households with larger family size consume larger cooking energy as compared to households' smaller family size that results in influencing larger family size households to economize their cooking energy source and make the reluctant to technology change. The marginal effect for family size indicates that the probability of Electric mitad adoption increases on average by 16.99 percent relatively as one person increment in the household family size.

This study came up with similar findings of Puzzolo et al (2013) and Gebreegziabher et al (2010) that found family size as one determinant factor that affects improved cook stoves adoption decision.

Price: As it was expected the price of Electric mitad was found a negative significant factor that affects households' Electric mitad adoption decision. This is because of the law of demand,

which states demand for a good, is a decreasing function of its price negative relationship between price of electricity and adoption of electric mitad. As the price of the good increase its demand decrease. The marginal effect for price of Electric mitad indicates that the probability of Electric mitad adoption increases on average by 8.00 percent relatively as one person increment in the price of Electric mitad.

This finding confirms household energy ladder theory which asserts that a household's socio economic status (in here the ability to pay the price of Electric mitad) determines the adoption decision.

This study came up with similar findings of Puzzolo et al (2013), Mebratu, 2018 found price as one determinant factor that affects improved cook stoves adoption decision. The result of the study also similar to the work of Tigabu, 2014 that found high affordability of the price improved cook stoves as one factor that negatively determines household's adoption decision.

Income: As it was expected households income was found a positive and significant factor affecting household's electric mitad adoption decision. The probability that a household adopt electric mitad will increase as his/her level of income increases, which confirms the energy ladder hypothesis. The marginal effect of for income, indicates that the probability of Electric mitad adoption on average increases by 0.01 percent relatively as one birr increment in the income of the household head.

This finding is consistent with most of the previous research findings. According to Malla and Timilsina (2014), the household income affects the adoption of clean fuels and cooking stoves significantly. With increase in household income, most households adopt cleaner commercial fuels to improve their living conditions. Mebratu, 2018 also found that household income has a positive and significant effect on household's adoption of electric mitad. This postulate is known as household energy ladder hypothesis in the literature of household fuel-choice. The energy ladder hypothesis states that households with lower incomes use solid biomass fuels, and households with higher incomes tend to use modern fuels.

Educational status: As it was expected, woman's educational status was found insignificant factor in that affect positively household's Electric mitad adoption decision Table 18, shows the probability that the household adopts electric mitad will increase as the wife's educational status increases. From table 18 we can clearly understand illiterate woman's are not adopt Electric mitad and for primary complete household heads it is negative but it becomes positive as educational level increases. This finding is obvious; majority of women in Ethiopia allocate most of their time to domestic activities. As a result, they need energy sources, which are convenient to them. Education equips women with the necessary knowledge how to use modern technologies as well increases their awareness about the possible negative effects associated with the use of biomass fuels.

Membership to Associations: As Table 18 shows, as it was expected membership to associations was found a positive significant factor that affects Electric mitad adoption decision. This may be because of members of social associations exchange information about their way of living and earlier adopter of *Electric Mitad* can influence the others members of social associations on *Electric Mitad* adoption decision by speaking what is the reality of using it. The marginal effect of membership to social associations indicates that the probability of Electric mitad adoption for households that are members of social association increases on average by 64.24 percent as compared to a household that are not members of social association.

This finding is consistent with most of the previous research findings. According to Puzzolo *et al* (2013) and Mebratu (2014) investigated that early adopters have a positive effect on the others' likelihood of adoption. Menon and Tigabu (2014) also found that the influence of neighbors is one social factor of improved cooking technologies adoption decision.

Awareness creation: As Table 18 shows, as it was expected awareness creation was found a positive significant factor that affects Electric mitad adoption decision. The marginal effect of awareness creation indicates that the probability of Electric mitad adoption for households that are got training increases by 45.42 percent as compared to a household that are not got training. This may be because of training makes households to be aware about the benefits of *Electric Mitad* adoption and the adverse effect of cooking with fuel wood.

This finding is consistent with most of the previous research findings. (Puzzolo e*t al* (2013), Gebregiabher, 2012 and Tigabu, 2018) found that extension services like awareness creation is a positive institutional factor that influence the adoption decision of improved stoves.

Relative price of electricity: As it is expected relative price of Electric mitad was found a negative significant factor that affects households' Electric mitad adoption decision. Households in the study area use either fuel wood or electricity to bake injera, which means the two fuels are substitutes. As a result, as price of electricity increases, households shift to the alternative energy source (such as fuel wood). Therefore, the relative price of Electricity plays an important role in influencing adoption of electric mitad. The marginal effect for relative price of Electricity indicates that the probability of Electric mitad adoption decreases by 17.05 percent relatively as one birr increment in the relative price of Electric mitad consumption.

Substitute product: As it is expected availability of substitute products like mirt stove was found a negative significant factor that affects households' Electric mitad adoption decision. This may be because of the purchase price of substitute products is low. From the law of demand, which states that keeping other things remain constant when the price of goods increase the demand for related goods increase. The marginal effect substitute product indicates that the probability of Electric mitad adoption for a households that are not adopt Mirt stove or related products increases by 65.62 percent as compared to a household that adopt substitute products.

Table19, Marginal effects after logistic regression

Variable	dy/dx	Std.err.	P>|z|	X
Age	**-.0217**	.0159	0.173	32.77
Family size	.2204	.1204	0.067	3.67
Priceof Electric mitad	-0.08	0.0005	0.100	2217.25
Income	.0001	.0001	0.053	7225.36
Awareness(*)	.4541	.1913	0.018	0.37
Membershipto associations(*)	.6424	.1755	.000	0.67
Substitute product (*)	-.656	.1987	.0001	.42
Occupation (*)	.0023	.1987	0.001	.735
Separate(*)	.3498	.2136	0.101	.585
Marital status(*)	-.107	.2012	0.595	.665
Relative Electric mitad consumption price(*)	-.171	.0824	0.039	.9897

Source own Survey, 2019

(*) dy/dx is for discrete change of dummy variable from 0 to 1

5. CONCLUSION AND RECOMMENDATION

5.1 Conclusion

This study investigated factors affecting urban household's Electric mitad adoption decision in Debre Markos town by taking 200 household respondents (women) systematically from the households frame. For the purpose of investigating factors affecting household Electric mitad adoption decision, household respondents' characteristics of age, marital status, literacy level, family size, separate kitchen, occupation, availability of substitute product, price of Electric mitad, relative price of Electric mitad, institutional and social factors were analyzed.

Mirt stove constitutes the major energy stove in baking injera, followed by electricity mitad in the study area. Only 43.5 percent of the sampled households have adopted electric mitad. Even though some households adopted electric mitad, they still use fuel wood besides electricity. This implies adoption of electric mitad does not enable households to switch completely too modern energy sources. Convenience to use and cleaner cooking were found to be the main reasons to adopt Electric mitad. With the regard to awareness, though majority of women were found to be aware of the adverse effects of baking Injera with fuel wood like eye irritation and burn, majority of women were found unaware of the relative benefits of Electric mitad.

Family size found a positive statistically significant factor affecting of households' Electric mitad adoption decision. This is because of households with larger family size consume larger fuel wood as compared to households' smaller family size that results in influencing larger family size households to economize fuel wood usage. As a result, households with large family size were found more likely to adopt improved cook stoves.

Price of Electric mitad and relative consumption price of Electric mitad were found a negative statistically significant factor of household's Electric mitad adoption decision. This study found that the probability of Electric mitad adoption decreases by one birr increment in the price of Electric mitad and relative consumption price of Electric mitad. This finding supports technology choice energy stacking theory. The availability of substitute products is a statically

significant factor decreases household's adoption of Electric mitad. This is because households adopt related products of Electric mitad when its price increases.

The study found that increase in household income increases the probability that the household adopts electric mitad (supports energy leading theory). This is because higher income households are reluctant to adopt improved technologies. However, age of the household head was found to a negative statically significant factor affecting the probability of household's adoption of Electric mitad. This is because of higher aged individuals are not reluctant to technology change

Institutional factors like awareness creation and social factors like membership to social associations were found to be statically significant factor affecting the probability of household's adoption of Electric mitad. This is because awareness creation makes households to be aware about the adverse effect of cooking with fuel wood and the relative benefit of cooking with electricity and be a member to social associations increase the opportunity to contact with individuals who have different information and experience and by these social organizations there will be information exchange which can influence Electric mitad purchasing decision (supports the diffusion model).

5.2 Recommendation

For the realization of the potential health, economic and environmental benefit of households, understanding factors affecting improved cook stoves adoption decision offer various possible insights and policy implications. So that, based on the findings of this study the possible recommendation are forwarded below.

Based on the conclusion of the study, awareness creation effort should be made and strengthened. This study reveals that substitute products like Mirt stove decreases the Electric mitad adoption. As a result, teaching households about the relative advantage of adopting Electric mitad over others must be made.

All the members of the community should encourage and motivate women to become active participants in different social associations and activities.

The government and other concerned bodies should give different subsides and make price regulation for lower income households in order to increase the number of Electric mitad users.

REFERNCES

Agarwal,B. (1983). *Diffusion of rural innovations: Some analytical issues and the case of wood-burning stoves. World Development, vol.11, No.4, PP.359-376*

Asres, WG. (2002). *Overview of Ethiopian energy status and trends in Ethiopia: Paper Presented on Energy Conference 2002, Professional Association Joint Secretariat, UNICC, Addis Ababa, 21-22 March 2002*

Assefa, Y. (2007). *Assessing environmental benefits of Mirt stoves with particular reference to indoor air pollution (carbon monoxide and suspended particulate matter) and energy conservation.*Unpublished Msc thesis, Addis Ababa University

Barnes, D., Openshaw, K., Smith, K. & van der Plas, R. (1994) .*What makes people cook with improved biomass stoves? A compressive international review of stove programs. World Bank Technical Paper, Number 242*

Berkeley, Air Monitoring Group (2012). Stove *performance inventory report. Prepared for the Global Alliance for Clean Cookstoves United Nations Foundation, October 2012*

Beyene, A. D., & Koch, S. F. (2013).*Clean fuel-saving technology adoption in urban Ethiopia. energy Economics, 36, 605-613.*Biruk, B. (2011). *Factors influencing adoption of fuel efficient Injera baking stove: The case of Agarfa District, Oromia Region, Ethiopia*Bubendorfer, A. (2011). *Adoption of effective improved cookstoves in sub-Sahara Africa:* Case study in the Arua District. Unpublished thesis, KTH School of Industrial Engineering and Management

Bwenge, N. (2011).The effects of adopting improved wood stoves on the welfare of rural women: A case of Kibaha District in Tanzania. Unpublished Thesis Van Hall Larenstein University of Applied Sciences, Netherlands

César, E. & Ekbom, A. (2013) .*Ethiopia environmental and climate change policy brief.* Sida's helpdesk for environment and climate changes

Creswell, J. W. (2003). *Research design: Qualitative, quantitative, and mixed methods approach* (2nd Ed.). Thousand Oaks, CA: Sage.

Damte, A. & Koch, S. (2011). *Clean fuel-saving technology adoption in urban Ethiopia.* Working paper 229

Dawit, G. (2011). *Energy demand in rural Ethiopia from a household perspective: A panel data analysis. The Journal of Energy and Development Volume 35, Number 2*

Dawit, W.(2008). *Fuel efficient technology adoption in Ethiopia: Evidence from improved "Mirt" stove technology: A Case in selected kebeles from "Adea" woreda. Ethiopian Journal of Economics, Volume Xvii, No 2, October 2008.*

Gebreegziabher, Z., Cornelis van Kooten, G. & van Soest,.D (2006) . *Land degradation in Ethiopia: What do stoves have to do with it?* Presentation at the International Association of Agricultural Economists Conference, Gold Coast, Australia, August 12 - 18, 2006 International Energy Agency (2010) .*Energy poverty: How to make modern energy access universal?* Special early excerpt of the World Energy Outlook 2010 for the UN General Assembly of the MDGs.

Gebreegziabher, Z., Mekonnen, A., Kassie, M., & Köhlin, G.(2010). *Urban Energy Transition and Technology Adoption:The Case of Tigrai, Northern Ethiopia. Environment for Development.*

Gujarati, D. N. (2004).*Basic Econometrics* (4th ed.). New Work, NY: The McGraw−Hill Companies

Lewis,.J & Pattanayak,S.(2012).Who *adopts improved fuels and cookstoves? A systematic review. Environmental Health Perspectives, volume 120, number 5, May 2012*

Mebratu N. (2018) Factors affecting households adoption of Electric mitad: Evidence from woliso town

Puzzolo, E., Stanistreet, D., Pope, D., Bruce, N. & Rehfuess, E. (2013).*Factors influencing the large-scale uptake by households of cleaner and more efficient household energy technologies: Systematic review*

Tigabu, A.(2014) Factors affecting households adoption of mirt stove: Evidence from Dembecha woreda.

APPENDEX-1

logit adoption age fs price income awarence i.educ ass susb occ separte ms Rprice,r

Iteration 0: log pseudolikelihood = -136.93464
Iteration 1: log pseudolikelihood = -23.313396
Iteration 2: log pseudolikelihood = -20.772872
Iteration 3: log pseudolikelihood = -20.366936
Iteration 4: log pseudolikelihood = -20.362497
Iteration 5: log pseudolikelihood = -20.362496

Logistic regression Number of obs = 200

Wald chi2(14) = 48.88

Prob > chi2 = 0.0000

Log pseudolikelihood = -20.362496 Pseudo R2 = 0.8513

| Robust

adoption | Coef. Std. Err. z P>|z| [95% Conf. Interval]

---+---

age | -.0873974 .0490596 -1.78 0.075 -.1835524 .0087576

fs | .8896515 .3041389 2.93 0.003 .2935502 1.485753

price | -.0030927 .0015827 -1.95 0.051 -.0061948 9.46e-06

income | .0004165 .0001467 2.84 0.005 .000129 .0007041

awarence | 2.055134 .7668583 2.68 0.007 .5521192 3.558148

educ |

P | -.5945838 1.207718 -0.49 0.622 -2.961667 1.772499

DA | -1.129467 1.472661 -0.77 0.443 -4.015829 1.756895

D | .829184 1.297661 0.64 0.523 -1.714186 3.372554

|

ass | 3.122946 1.588028 1.97 0.049 .0104685 6.235424

susb | -3.147049 1.44323 -2.18 0.029 -5.975728 -.3183711

```
occ |    .009476   .9437544     0.01   0.992    -1.840249    1.859201
separte |   1.462255   .9572888     1.53   0.127    -.4139971    3.338506
ms |  -.4376553   .8509136    -0.51   0.607    -2.105415    1.230105
     Rprice |  -.6882619   .2260223    -3.05   0.002    -1.131257   -.2452664
      _cons |   1.387325   4.278848     0.32   0.746    -6.999063    9.773712
------------------------------------------------------------------------------

. mfx
Marginal effects after logit
y  =  (predict)
=  .54760242
------------------------------------------------------------------------------
variable |      dy/dx    Std. Err.     z    P>|z|  [    95% C.I.   ]      X
---------+--------------------------------------------------------------------
age |  -.0216513      .01587   -1.36   0.173   -.05276  .009458     32.77
fs |   .2203969      .12042    1.83   0.067  -.015628  .456422      3.67
price |  -.0007662      .00047   -1.64   0.100   -.00168  .000147   2217.25
income |   .0001032      .00005    1.93   0.053  -1.5e-06  .000208   7225.36
awarence*|   .4540627      .19126    2.37   0.018     .0792  .828926      .37
ass*|   .6423863      .17546    3.66   0.000     .2985  .986272      .67
susb*|  -.6562262      .19868   -3.30   0.001  -1.04563 -.266818      .42
occ*|    .002348      .23399    0.01   0.992  -.456264   .46096      .735
separte*|   .3497638      .21358    1.64   0.101  -.068844  .768372      .585
ms*|  -.1071353      .20128   -0.53   0.595  -.501641  .287371      .665
  Rprice |  -.1705059      .08244   -2.07   0.039  -.332078 -.008934   .989666
------------------------------------------------------------------------------
(*) dy/dx is for discrete change of dummy variable from 0 to 1
```

. correlate adoption age fs price income awarence educ ass susb occ separte Rprice ms(obs=200

| adoption age fs price income awarence educ ass susb occ separte Rprice ms

---

adoption | 1.0000

age | -0.1605 1.0000

fs | 0.6347 -0.1258 1.0000

price | -0.3194 0.0571 -0.2425 1.0000

income | 0.6784 -0.0221 0.3586 -0.2636 1.0000

awarence | 0.4765 -0.0652 0.2422 -0.1651 0.3398 1.0000

educ | 0.7300 -0.1072 0.5116 -0.2764 0.5563 0.3433 1.0000

ass | 0.4871 0.0798 0.2805 -0.0495 0.3412 0.2295 0.4102 1.0000

susb | -0.5423 0.0679 -0.3436 0.1167 -0.3881 -0.2745 -0.4070 -0.2215 1.0000

occ | 0.2298 -0.0590 0.1523 -0.0678 0.2148 0.1551 0.0661 0.1087 -0.1088 1.0000

separte | -0.0797 0.0387 -0.0976 -0.0040 -0.1318 0.0359 -0.0689 -0.0947 0.0794 -0.1378 1.0000

Rprice | -0.5679 0.1809 -0.4188 0.1307 -0.4775 -0.1929 -0.4628 -0.2685 0.3459 -0.1727 0.1853 1.0000

ms | 0.4191 -0.1062 0.2975 -0.0764 0.3952 0.1573 0.3720 0.2127 -0.3214 0.0991 0.0326 -0.2790 1.0000

Variable	VIF	1/VIF
income	1.82	0.549421
educ	1.79	0.558916
Rprice	1.58	0.632010
fs	1.47	0.682136
price	1.33	0.750604
ass	1.27	0.787194
ms	1.26	0.793209
awarence	1.24	0.809022
occ	1.11	0.903895
age	1.07	0.931647
separte	1.07	0.936008
Mean VIF	1.36	

APPENDEX-2

Debre Markos University

College of Business and Economics

Department of Economics

Questionnaire

Objective:

Dear respondents, the purpose of this questionnaire is to gather primary data about determinants of households' adoption of *Electric Mitad*. The study is for partial fulfillment of the requirements for Masters Degree in Development Economics at Debre Markos University. I confirm you that all data will be used for academic purpose and your responses will be kept confidential.

Instructions:

No need of writing name

Where boxes are available please tick (√) in the box.

Where boxes are unavailable write the letter(s) and/or answers on the spaces provided.

Thank you for your cooperation!!!

Part I: Household Characteristics

1. Age_____ (in years)

2. Sex----------male ☐ female ☐

3. Marital Status: Married ☐ Single ☐ rced ☐

4. Occupation:

Government employed ☐ Self employed ☐ Business Person ☐

Unemployed ☐ Others……..

5. Literacy level:

Illiterate ☐ Primary school complete ☐ loma ☐

Bachelor degree ☐ Post graduate/Masters/ and above ☐

6. Family size in number

Bellow 15 year ☐ between 15 and 65 year ☐ Above 65 ☐

7. Do you have separate kitchen house?

Yes ☐ No ☐

8. Monthly income ----------in birr.

9. Do you live with your own house?

Yes ☐ No ☐

10. Do you have other fixed assets like?

Hotel and restaurant ☐ Car ☐ Rented houses ☐

Rented buildings or stores ☐ other……..

Part II: *Electric Mitad* adoption and other related issue

11. Which is the main source of energy for cooking and heating for your family?

Electric ☐ wood ☐ Charcoal ☐ Other ☐

Why do you use it……?

12. If your answer in question No 11 is Electric, which type of electric cooking stove do you use?

Electric Mitad ☐ Germany stove ☐ Local electric stove ☐ other ☐

13. Which type of Injera baking stove do you have?

a. Electric Mitad b. Mirt stove ☐ Three stone (open fire) ☐

If your answer in Question no 8 is b and/or c, is fuel wood available for free of charge for your energy consumption? Yes ☐ NO ☐

14. Do you have information about the health, economic and environmental benefits of using '*Electric stove*?

Yes No ☐

15. Are you aware of the adverse effects of traditional cook stove?

Yes ☐ No ☐

16. _____Which source of information do you think that the most likely accessible, as compared to others, for the households regarding to Electric Mitad? Choose one.

A. government bodies such as agricultural experts and health extension workers

B. media like radio and Television

C. Electric Mitad producers

D. Social associations, neighbors

E. Others _____

17. _____Which place do you think is the most accessible, as compared to others, to users (mainly mothers) to be informed about new technologies?

A. Religious places (church, mosque)

B. Market places

C. During meetings (e.g. formal, informal meetings)

D. others _____

18. Are you active participant in local associations and activities like Chairman, secretary and/or coordinator?

Yes ☐ No ☐

19. _____Did you purchase '*Electric Mitad?*

Yes ☐ No ☐

If you did purchase Electric Mitad, please state your opinion for each given reason to purchase by using 1 = strongly disagree 2 = disagree 3 = neutral 4= agree 5= strongly agree

	Reason	1	2	3	4	5
20	*Electric* is cleaner					
21	*Electric* is convenience to use					
22	*Electric* is quicker					
Separate kitchen room and adoption						
23	Separate room has effect on Electric Mitad adoption					
24	Fixed nature of the stove has effect on have separate kitchen					

25. If you didn't purchase Electric Mitad, what makes you didn't purchase it.

Presence of substitute products ☐ price effect ☐ lack of awareness ☐

26. Do you adopt Mirt Stove?

Yes ☐ No ☐

If yes why ……..?

Part III: Price of *Electric Mitad* and opinion

27. What is the price of *Electric Mitad* in your locality? _____ (in birr)

28. What would you say about its cost?

Cheap ☐ Fair ☐ Expensive ☐

29.If you adopt Electric Mitad, expected monthly payment of electric energy consumption ……..in birr if not expected monthly payment non electric (fuel wood) energy consumption----------in birr.

Please state your opinion for each given statement using the following scales: 1= strongly disagree 2= disagree 3= neutral 4= agree 5= strongly agree

	Items	1	2	3	4	5
30	The price of electric cook stove consumption is relatively high compared with non electric (fuel wood) cook stove.					
31	Relative high cost of electric mitad purchase price makes households to stay on the traditional cook stove					
32	Since electricity is cleaner households prefer their health condition rather than relative high purchase price of electric mitad					
33	The relative monthly expenditure for cooking and heating with electricity is low as compared with fuel wood cook stove					

Part IV: Institutional factors

34. Do you get any training (awareness creation) about adoption of improved cook stove

Yes ☐ No ☐

Please state your opinion for each given statement using the following scales: 1= strongly disagree 2= disagree 3= neutral 4= agree 5= strongly agree

	Items	1	2	3	4	5
35	The nearby gov.t institution influence on purchase *Electric Mitad.*					
36	Institutionally deny the access to forest can influence to use purchase.					
37	By providing service (creation awareness quality control, price regulation, government institution can affect households adoption decision					
38	By providing supports institutions can affect the production and adoption of *Electric Mitad*					

39	Decentralizing production site to users can affect Electric Mitad purchasing decision.					

No

Please state your opinion Part V: Social factors

40. Are you member of different social organizations in your locality?

Yes for each given nt using the following scales: 1= strongly disagree 2= disagree 3= neutral 4= agree 5= strongly agree

	Item	1	2	3	4	5
41	Membership in different organization in the community can affect in *Electric Mitad* adoption.					
42	By social organizations there will be information exchange that can affect *Electric Mitad* purchasing decision.					
43	Earlier adopter of *Electric Mitad* can influence the others *Electric Mitad* adoption decision by speaking what is the reality of using it.					
44	Neighbors have influence on the others Electric Mitad adoption decision.					

Part VI. Guiding questions for the Town natural resource management and energy supply experts and Electric Mitad producers

1. Do you think that the public is fully aware about the advantages of adopting 'Electric Mitad?

2. Do the concerned bodies provides supports like technical, financial, materials, training and awareness to the local 'Electric Mitad producers and potential users?

3. What do you think that barriers for the purchasing of 'Electric Mitad?

4. Do you have information from the potential users that the price of the Electric Mitad has its influence on households' decision to buy Electric Mitad?

ደብረማርቆሰዩኒቨርሲቲ

ቢዝነስእናኢኮኖሚክስኮሌጅ

ኢኮኖሚክስትምህርትክፍል

መጠይቅ

ዓላማ፡-

ወድመልስሰጭዎችየዚህመጠይቅአላማበኤሊክትሪክየእንጀራማስፊያምድጃ ‘ለመገልገል’
ተፅኖስለሚያደርጉነገሮችየመጀመሪያደረጃጭብትለመሰብሰብነዉ፡፡ይህጥናትበደብረማርቆስዩኒቨርሲቲበ
‘ዲቨሎፕመንትኢኮኖምክስ’
የማስተርስዲግሪየሚስፈልጉነገሮችለከፊልማሙያነትነዉ፡፡ሁሉምጭብጥለትምህርትዓላማእንደምጠቀምባቸዉእናመልሶቻች
ሁበምስጢርእንደሚጠበቁአረጋግጣለሁ፡፡

ትዕዛዛት፡-

⍰⍰ስምመፃፍአያስፈልግም

ሳጥኖችካሉአባክዎንከሳጥኑዉስጥ (√) ያድርጉ

⍰⍰ሳጥኖችከሌሉ፣ፊደሉን (ሎችን) እና/ወይምመልሱንበተስጠዉክፍትቦታላይይፃፉ

ስለትብብራችሁአመሰግናለሁ!!!

ክፍልአንድ፡-የቤተሰቡመገለጫዎች

1. የዕድሜ፤ ---------- (በቁጥር)

2. ፃታወንድሴት

3. የጋብቻሁኔታ፤

ያገባችያላገባችየፈታች

4. የትምርትደርጃ፤

ያልተማረችየመ[redacted]ሁለተኛደረጃ

ዲፕሎማዲ[redacted]ላይ

5. የስራሁኔታ

ስራፈላጊየመንግስተቋሙሰራተኛየግልስራ

6. ጠቅላላየቤተሰብቁጥር----------

ከ 1-15 አመትከ 1ትከ 65 አመትበላይ

7. ለብቻዉየተለየኩሽናቤትአለዎት?

አዎየለም

8. **ወርሀዊየገቢመጠንበብር**.....

9. **የሚኖሩበትቤትየራሰዎነውአዎየለም**

10. **ተጨማሪሀብት**

የቤትመኪናየተከራየቤትየቴልየተከራየመጋዘንመኖሪያህንፃ

ክፍልሁለት፡ኤልክትሪክምጣድመገልገልእናተያያዝጉዳዮች

11. ውሀለማሞቅምግብለማብሰልየሚጠቀሙበትየሀይልአቅርቦትየትኛውነው?

ሀ. ኤልክትሪክxንጨትከሰልሌሎች ----------

12. በተራቁትር 11 Þወከሆነምን Þይነትኤልክትሪክ

ሀ.ኤልክትሪክምጣድየጀርመንጃየሀገርውሰጥኤልክትሪክምድጃ

13. እንጀራለመስፋትየሚጠቀሙበትየምድጃአይነትየትኛውነው?

ሀ. ኤልክትሪክምጣድለ. Þድጃሐ. ሶሰትጉልቻ

14. ሰለኤልክትሪክምጣድየጤና፣ኢኮኖሚዊናአካባቢያዊጥቅሞችመረጃአለዎት?

አዎየለም

15. በማገዶእንጀራማስፋትስላለዉንጅዉጤቶችእዉቅናአለዎት?

አዎየለም

16. _____ከሌሎችጋርሲነፃፀርለከተማሴቶችስለኤሊክትሪክምጣድየተሻለተደራሽየመረጃምንጭየትኛዉነዉብለውያስባ ሉ?

ሀ. የመንግስትአካላትእንደግብርናባለሙዎች፣የጤናኤክስቴንሽኖች

ለ. መገናኛእንደሬድዩ

ሐ. የኤሊክትሪክምጣድአምራቾች

መ. ማህበራዊማህበራት፣ጎረቤት

ሠ. ሌሎች----------

17. _____ከሌሎችጋርሲነፃፀርለተጠቃሚዎች (በዋነኛነትእናቶች)
የስለአዳዲስቴክኖሎጅዎችመረጃለማግኘትየተሻለተደራሽቦታየትኛዉንዉብለውያስባሉ?

ሀ. የአምልኮትቦትዎች (ቤተ-ክርስቲያን፣መስጊድ)

ለ. ገበያቦታዎች

ሐ. በስብሰባዎችጊዜ (ምሳሌ፣መደበኛናመደበኛያልሆኑስብሰባዎች)

መ. ሌሎች ----------

18. በማህበራዊድርጅቶችእናተግባራትንቁተሳታፊነዎት? (በሊቀ-መንበርነት፣ፀሀፊነት፣እና/ ወይምአስተባባሪነት

አዎየለም

19. ኤልክትሪክምጣድንገዝተዋል?

አዎየለም

ኤልክትሪክምጣድንከገዙእባክዎንየሚከተሉትንመመዘኛዎችበመጠቀምለእያንዳንዱየተሰጠለመግዛትምክንያትሀሳብዎንይስጡ ፡፡ 1-በጣምአልስማማም፣ 2-አልስማማም፣ 3-ግሉል፣ 4- እስማማለሁ 5-በጣምአስማማለሁ

ተ.ቁ	ምክንያት	1	2	3	4	5
20	ኤልክትሪክምጣድንፀህነዉ					
21	ኤልክትሪክምጣድሲጠቀሙትምቹነዉ					
22	ኤልክትሪክምጣድፈጣንነዉ					
ኩሽናቤትናኤልክትሪክምጣድንመገልግል						
23	የብቻኩሽናቤትመኖርኤልክትሪክምጣድንበመግዛትዉሳኔላይተፅኖአለዉ					
24	የምርጥምድጃቃሚየመሆንተፈጥሮየብቻኩሽናእንዲኖርአንድምክንያትነዉ					

25. ኤልክትሪክምጣድካልገዙእንዳይገዙያረገወትምክንያትምንድንነው?

ተመሳሳይአማራጮችመኖራቸውየዋጋዉድነት□ውቅናስለለኝ

26. ኤልክትሪክምጣድንሊተኩየሚችሉለምሳሌምርጥምድጃንተጠቅመዋል?

አዎየለም

አዎካሉለምን……..

ክፍልሶስት፡-የኤልክትሪክምጣድዋጋናአስተያት

27. የኤልክትሪክምጣድዋጋስንትንዉ? ---------(በብር)

28. ስለዋጋዉምንይላሉ?

ርካሽተመጣጣኝዉድ

29. የኤልክትሪክምጣድከገዙወርሃዊየፍጆታኤልክትሪክመጠንበብር……. ካልተጠቀሙወርሃዊየማገዶፍጆታበብር…….

እባክዎንየሚከተሉትንመመዘኛዎችበመጠቀምለእያንዳንዱየተሰጠመግለጫሀሳብዎንይስጡ፡፡ 1 -በጣምአልስማማም፣ 2-አልስማማም፣ 3-ግሉል፣ 4- እስማማለሁ 5- በጣምአስማማለሁ

	Items	1	2	3	4	5
30	የኤልክትሪክምጣድመግዣ ዋጋ ከሌሎችምድጃዎች□ንፃርውድነው					
31	የኤልክትሪክምጣድመግዣ ዋጋ መዎደድ ሰዎች እንዳይተጠቀሙ ያደርጋቸዋል					
32	ኤልክትሪክምጣድንጹህለሆነሰዎች ከዋጋው ይልቅ ለጢናቸው ቅድምያ ይሰጣሉ					
33	የኤልክትሪክምጣድሀይል□ቅርቦት ወጭ ከማገዶ ወጭ የተሻለ ነው					

ክፍልአራት፡- ተቓማዊነገሮች

34. ስለተሻለ የምድጃአጠቃቀምስልጠናወስደዋል(ተሰጥቶዎታል)

ሀ. አዎለ. የለም

እባክዎንየሚከተሉትንመመዘኛዎችበመጠቀምለእያንዳንዱየተሰጠመግለጫሀሳብዎንይስጡ፡፡ 1 -በጣምአልስማማም፣ 2-አልስማማም፣ 3-ግሉል፣ 4- እስማማለሁ 5- በጣምአስማማለሁ

ተ.ቁ		1	2	3	4	5
35	በአቅራቢያየሚገኙመንግስትተቓማት (በጤናኤክስቴንሽንሰራተኖችበኩል) ኤልክትሪክምጣድንበመግዛትዉሳኔላይተፅኖማድረግይችላሉ					
36	በክፍትደንተደራሽነትላይተቓማዊክልከላማድረግኤልክትሪክምጣድንበመገልገልዉሳኔላይተፅኖማድረግይችላል					
37	አገልግሎቶችንበማቅረብ (ምሳሌ፣እዉቅናመፍጠር፣ጥራትንናዋጋንመቆጣጠር) ኤልክትሪክምጣድንበመገልገልዉሳኔላይተፅኖማድረግይቻላል					
38	ድጋፎችንበማቅረብ (ምሳሌ፣ቁሳዊ፣በገንዘብ፣ቴኪኒካል)					

	ኤልክትሪክምጣድንበማምረትናበመገልገልዉሳኔላይተፅኖማድረግይቻላል					
39	የማምረቻቦታንወደተጠቃሚዎችያተማከለማድረግኤልክትሪክምጣድንበመግዛትዉሳኔላይተፅኖማድረግይቻላል					

እባክዎንየሚከተሉትንመመዘኛዎችበመጠቀምለእያንዳንዱየተሰጠመግለጫሀሳብዎንይስጡ፡፡ 1 -በጣምአልስማማም፣ 2-አልስማማም፣ 3-ግሉል፣ 4- እስማማለሁ 5- በጣምአስማማለሁ

ክፍልአምስት፡- ማህበራዊነገሮች

40. በሚኖሩበትአካባቢየተለያዩማህበራዊድርጅቶችአባልነዎት

አዎየለም

እባክዎንየሚከተሉትንመመዘናዎችበመጠቀምለእያንዳንዱየተሰጠመግለጫሀሳብዎንይስጡ፡፡ 1 -በጣምአልስማማም፣ 2-አልስማማም፣ 3-ግሉል፣ 4- እስማማለሁ 5- በጣምአስማማለሁ

ተ.ቁ	ማህበራዊነገሮች	1	2	3	4	5
41	በማህበረሰቡዉስጥለተለያዩማህበራዊድርጅቶችአባልመሆንምረጥኤልክትሪክምጣድንበመግዛትዉሳኔላይተፅኖማድረግይችላል.					
42	በማህበራዊድርጅቶችየሚኖረዉየመረጃልዉዉጥኤልክትሪክምጣድንበመግዛትዉሳኔላይተፅኖማድረግይችላል.					
43	ኤልክትሪክምጣድመጠቀምያለዉንእዉነታበመናገር፣ቀድምትተገልጋዮችበሌሎችምረጥምድጃንበመግዛትዉሳኔላይተፅኖማድረግይችላሉ					
44	ጎረቤቶችየሌሎችንኤልክትሪክምጣድየመግዛትዉሳኔንተፅኖማድረግይችላሉ					