DEMAND FOR ELECTRICITY AMONG SMALL-SCALE BUSINESS ENTERPRISES IN RURAL MALAWI.

Master of Arts (Economics) Thesis

By

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DECLARATION

This thesis is my own work. Where other people's work has been used, acknowledgement has been made accordingly. I declare that it has never been submitted in any other university for similar purposes.

Candidate:…… Date:……..

CERTIFICATE OF APPROVAL

This thesis is submitted with our approval on behalf of the University of Malawi, Chancellor College, Zomba, Malawi.

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Dedication

To my beloved son, Liam Mwatama.

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ABSTRACT

Electricity is a good not yet provided in most parts of rural Malawi because ESCOM (the sole provider) argues that it cannot profitably extend its supply because of high cost of installing transformers and the weak potential demand. As a result, the main sources of energy for cooking among rural Malawian households are firewood and charcoal. Lack of alternative sources of energy such as electricity is having an environmental consequence as Malawi's forests are being depleted at an alarming rate. The study uses the contingent valuation method (CVM) to assess willingness to pay for electricity connections among small scale business owners in rural trading centers of Malawi. A Tobit model is estimated and results show that willingness to pay increases with household's annual income, expenditure on alternative sources of energy, operating a retail type of business but decreases with age of the household head. Elasticities obtained indicate that willingness to pay is inelastic with respect to income, expenditure on alternative sources of income as well as age of the household head. The significance of income in determining willingness to pay would entail that policies that will target improving income levels for the rural households would be essential if rural electrification is to be sustainable. Similarly, if rural electrification is to address environmental concerns of deforestation, complementary policies have to be pursued such as user fees or charges to deter people from overexploiting forestry resources.

Chapter 1: Introduction

1.1 Background and motivation

Electricity is a market good that is currently unavailable to most rural households and businesses because of lack of supply. In Malawi, the average household electrification rate is only 4%, one of the lowest in Africa, where the average household electrification rate is about 20% (JICA, 2004). In the rural areas, the average household electrification rate is still less than the national average, and reportedly does not even reach 1%. Provision of electricity is mainly geared towards the industrial sector and is more accessible to urban-based commercial centers, with very little investment in rural areas where most people live. NSO (2000) reported that 94 percent of Malawians use firewood and only 2 percent use electricity as their main source of energy for cooking while only 5 percent use electricity for lighting. The situation in rural areas is worse with 98 percent using firewood and only 0.004 percent using electricity for cooking and only 0.01 percent use electricity for lighting.

Access to efficient sources of energy for most citizens is limited and investment in the energy sector has stagnated over time. There is an increasing need in Malawi to invest in sustainable energy sources to arrest the environmental consequences of deforestation. The reliance on biomass energy especially fuel wood has exceeded the natural rate of forest growth. After independence in 1964, about 47 percent of Malawi was classified as forest and this has since declined to 28 percent in 2000. Currently wood demand is estimated to exceed supply by one third (GOM, 2001). Sustainable management of forest resources in Malawi is threatened by agricultural expansion and growing demand for wood energy for both domestic and industrial use, against the background of rapid population growth and pervasive poverty. Increasing access to affordable and efficient energy sources in the rural areas is one of the strategies in creating an enabling environment for achieving pro-poor growth in Malawi (GOM, 2002).

In order to improve access to electricity supplies, the government of Malawi (GOM) initiated the Rural Electrification Project (REP) in 1980. The major objective of rural electrification is to reduce poverty by creating employment opportunities through the growth of small-scale industrial activity that is grounded in agriculture and made possible with the supply of electricity. In view of this, the government of Malawi's Vision 2020, and the poverty reduction strategy paper (PRSP), identifies access to electricity by the rural people as one of its priorities for better infrastructure development.

The Government of Malawi's plans under the REP is to transform the rural economy by increasing rural access to grid and non-grid electricity. The grid option involves the extension of the distribution lines thereby expanding the distribution network to rural trading centers and public institutions such as health centers, schools, police units, immigration and custom boarder posts. Under the project remote areas which cannot be reached through distribution line extension or areas where electricity demand is low compared to distribution costs will be supplied by off-grid sources such as solar PV and mini hydros (IEP, 2001).

The implementation of the REP is carried by the Electricity Supply Corporation of Malawi (ESCOM), which are the sole generator and distributor of electricity in Malawi. One of ESCOM's objectives is to set tariffs that will ensure the financial viability of each local rural electrification project using the principles of long run marginal cost (IEP, 2001). On the supply side, the three power stations on the Shire River namely, Tedzani, Nkula and Kapichira have an installed hydro capacity of about 304 megawatts (MW), while Wovwe power plant has a capacity of 4.5 MW[1]. The demand side however shows very low levels of access to electricity by the population implying underutilization of the generated capacity. The economic implication of this underutilization is that ESCOM is failing to exploit economies of scale existing in the unserved areas such as in the rural. In 2000, ESCOM had a customer base of only 100 000 customers of which 85 percent were domestic consumers who accounted for 25

[1] It must be noted that, Tedzani is not in operation now because of a major breakdown that is being repaired.

percent of consumption. Recently, part of the excess from its ESCOM's generation capacity is supplied to some border towns of Mozambique and Zambia under the electricity export arrangements (Chirwa and Mangani, 2005).

However, the implicit question being asked by the proponents of rural electrification is whether or not the project is sustainable. In particular, policy makers are interested to know whether electricity demand in the rural area would support the requisite investment in grid extension and mini hydros. This study mainly attempts to address this question by assessing the demand for electricity among small-scale businesses in rural Malawi with a focus on hydro sources of energy.

1.2 Problem statement

The provision of electricity to rural areas derives important social and economic benefits to remote households. In the analysis of the determinants of child mortality in less developed countries, Wang (2003) finds that at the national level access to electricity has a robust effect on the reduction of child mortality and the impact was independent of income. Electricity enables communities to light their homes and schools, refrigerate their supplies and support businesses, thereby improve education standards, employment opportunities and quality of life. Similarly, Khosla (1997) argues that without substantial increases in the availability of energy and power, it is difficult to imagine how the growing numbers of the rural poor will cope with the basic problems of survival and subsistence.

In Malawi, lack of modern sources of energy hurts the poor most. According to NEC 2000, energy is a priority in their consumption bundle adding up to 7.7% of their mean per capita daily expenditure. In contrast, the non-poor allocate up to 3.6% of their per capita daily outlay on energy. On the other hand, the incidence of poverty is higher in rural areas than in urban areas where 66.5 percent of the rural population compared with 54.9 percent of urban population lives in poverty (IHS, 1998). However, the poor are victims of exclusion, pollution and price distortions. Furthermore, alternative

modern sources of energy are less accessible to rural population and the sole electricity service provider argues that it cannot profitably extend access to some rural areas due to high cost of installing transformers and the weak potential demand (IEP, 2001).

Currently, no case study has been carried out to assess the willingness to pay for electricity in rural Malawi. As a result, there is no empirical basis on which to judge the stance of the service provider in delaying rural electrification. It is therefore misleading to accept the presumption that rural households cannot afford to pay for electricity when studies elsewhere are able to show that rural households can afford to pay for investments and for services demanded by the rural households. White (1991) and Foster et al. (2000) present findings in support of this[2].

1.3 Objectives

The main objective of this study is to examine factors influencing willingness to pay for electricity services among small-scale businesses operating in rural growth centers. Specifically, the study will;

i. Assess the role of income, expenditure on alternative sources of energy and household characteristics in influencing willingness to pay for electricity.
ii. Analyze the sensitivity of willingness to pay to income, expenditure on alternative sources of energy and household characteristics.

1.4 Hypotheses

In order to achieve the foregoing objectives the following null hypotheses shall be tested:

- Willingness to pay is not responsive to changes in income, alternative sources of energy and household characteristics.

[2] A detailed discussion of these studies is presented in chapter 3.

1.5 Organization of the Thesis

The rest of the thesis is organized as follows: Chapter 2 presents an overview of energy policies in Malawi. This is followed by a review of literature both theoretical and empirical in chapter 3. Chapter 4 focuses on an econometric model specification and methodology of the study. Chapter 5 discusses results of the study while conclusions and policy recommendations as well as limitations of the study are presented in chapter 6.

Chapter 2: Overview of Energy Policies in Malawi

Efforts to electrify the rural areas under the rural electrification project were initiated by the Government of Malawi (GOM) in 1980 under ESCOM. Since then, the project has moved from Phase I to the current activities in Phase IV. It is anticipated that if each phase electrifies 54 trading centers (two in each of the 27 districts), all of the 249 trading centers not yet electrified in the country would be electrified upon the completion of 11 more phases (JICA, 2004). The criteria for administering the project in a given trading centre have been based on social and economic activities, and also forecasted electricity demands for the trading centre until 2020. However, it should be noted that the activities under the rural electrification project have moved at a very slow pace with a few trading centers connected to the national electricity grid.

MEPD (1996) notes that rural electrification project administered by ESCOM was relatively slow because ESCOM depended on commercial loans to fund the programme whose projects are largely non-commercial[3]. In 2002, the Department of Energy mobilized funding from the Japanese Government and identified 44 sites across the country for Phase IV of rural electrification at a cost of MK595 million (NEC, 2002). Additional sites for phase V have also been identified for rural electrification under the Malawi Rural Electrification Master Plan. Under the rural electrification project, the Energy Funds meet the capital cost of providing the grid at a trading centre from which business enterprises and households are expected to connect at commercial rates.

In an attempt to make the energy sector more responsive to the development needs, Malawi launched the first draft of the Integrated Energy Policy (IEP) through a public deliberation on energy issues in November 2001. The main objective of the policy is to promote socioeconomic development and to contribute to poverty

[3] Since 1996, the rural electrification programme has been under the Department of Energy implemented as part of government social development policy for poverty alleviation. The programme is funded by the Energy Fund whose main local source is the levy on fuels.

reduction through sustainable provision of equitable, efficient and affordable energy service. The policy is intended to provide a transparent and dynamic operational framework for the energy sector as well as guidelines on matters related to energy development. Issues addressed by the policy include *inter alia* access to electricity and rural electrification (IEP, 2001).

The IEP is developing on the premise that energy is a commodity in its own right, produced, stored and sold like any other economic good or service. However, public investment in infrastructure, energy production, delivery and services raises a number of cross cutting issues such as: demand, supply, pricing, legislation as well as environmental management. On the demand side, the policy emphasizes the need for modern sources of energy especially for populations previously not served. The dependency of the rural poor on inefficient traditional biomass fuels for cooking and heating is a major cause of indoor pollution and a leading cause of respiratory ailments (Wang, 2003). Lack of efficient fuels affect women more than men since they almost exclusively bear the burden of collecting, processing and utilizing biomass fuels.

On supply issues, the policy highlights the inefficiencies in the supply of electricity as one of the challenges in the implementation of rural electrification. Under the Electricity Act of 1998 which repealed the Electricity Act of 1965, Electricity Supply Commission of Malawi (ESCOM) became the Electricity Supply Corporation of Malawi, retaining the same acronym. ESCOM is the sole power utility responsible for generation, transmission and distribution of electricity. However, the electricity act of 1998 envisages new entrants in the market by establishing a National Electricity Council (NECO) responsible for licensing and regulating the power producers. Similarly, the IEP draft of January 2003 sets in motion reforms in the energy sector by addressing issues of third party access to the national power grid, pricing committee, financing and regulation of investment in alternative energy sources such as fossil fuels and solar energy. Reforms currently

taking place include concessionary transfer of ESCOM assets to private firms wishing to buy rights to transmit and distribute electricity in rural areas.

In its bid to attract private participants, the Malawi energy policy seeks to revise tariff structures so that electricity prices are based on long run marginal cost of electricity supply. Tariff restructuring would also create an enabling environment for private enterprises and competition in the power sector. Rural electrification however, needs to be given special reference in the policy. Electrification has been largely following patterns of industrialization and urbanization (IEP, 2001). Stunted industrial growth in the past decade has even slowed down progress in urban-rural spillovers. On the other hand, some of the rural areas having electricity have at least an agricultural processing plant, or are close to an urban centre (IEP, 2001).

Chapter 3: Literature Review

3.1 Theoretical Literature (General)

The measurement of willingness to pay for electricity relies critically on a reliable estimate of the demand for electricity. Demand analysis is useful for determining the distributional effects of policy interventions. For instance, equity considerations may lead to the rejection of marginal pricing when it is found that households spend a large proportion of their income on energy, or equivalently when the price elasticity of electricity is low.

Demand analysis is often used by commercial firms to assess the financial viability of a project. For electricity, the existence of demand could be assessed from observing the rural household's potential to use electricity. For instance, rural households that have vehicular batteries to operate television sets, and radios, or use paraffin for cooking or for refrigerating would more likely afford to pay for electricity if provided since the cost of running electricity consuming equipment is often higher when using non-hydro sources than hydro-sources of power (ESMAP, 2002).

Demand models are also used in the estimation of benefits or values that households place on a resource that they consume. The most common welfare index is the consumer surplus measured as the household's willingness to pay for successive units of a good. The welfare measures are used to derive the optimal tax or subsidy required when a pricing strategy is used to curtail demand (Binger and Hoffman, 1998).

Demand management is an important policy option especially when the supply of electricity is fairly limited. However, direct estimation of electricity demand parameters is not feasible because information on prices and quantity demanded is

not available especially for the rural areas[4]. Even when the price per unit of electricity is fixed centrally by the service provider, the quantity of electricity that could be demanded by rural households is not actually known. The non-availability of either quantity data or price data prevents direct estimation of demand behaviour for households demanding electricity. In such cases, other resource valuation approaches such as the contingent valuation method (CVM) or the hedonic pricing are adopted to characterize and measure demand parameters (Haab and McConnell, 2002; Whittington, 1998).

A household's demand for a commodity depends on the utility that the good generates for the household. We assume that households combine market goods and non-market goods in order to maximize utility

$$U = U(X, Q) \tag{1}$$

Where U is utility, X is a vector of market goods and Q is a vector of non-market goods such as environmental quality. The household's utility maximizing choices are constrained by resource endowments and exogenous market parameters

$$PX = M \tag{2}$$

Where P is a vector of market prices, X is a vector of market goods and M is income.

With full price information, the valuation of the commodity depends on whether or not quantity adjusts to changes in prices in the Marshallian fashion. When some $q \in Q$ is complimentary to some $X_i \in X$, the Marshallian demand functions for the market goods would be a function of prices, income and exogenously determined quantities of the non-market good (Freeman, 2003). With partial complementarity

[4] The usual assumption is that there exists a negative relationship between price and the quantity of electricity demanded.

between the market good and the non-market good, the Marshallian demand functions $X_i(P,M;Q)$ for the market good are equivalent to the Hicksian constant utility demand functions $X_i^H(P,Q;U)$ at equilibrium

$$X_i(P,M;Q) = X_i^H(P,Q;U) \quad (3)$$

When the complimentarity assumption is made, valuation of the non-market good takes the form of a change in expenditure on X that is necessary to maintain utility at its current level when Q changes. This framework of valuation is called hedonic pricing or the revealed preference method. The fundamental assumption of the hedonic approach is that consumers value goods for the bundle of characteristics that the goods possess. The non-marketed good needs to be heterogeneously distributed across the available goods, and so the prices of the goods reflect the value of the non-market good (ROA, 2002). However, we do not use hedonic pricing in this study because of imperfect markets and large transaction costs faced by rural households. In particular, it may be difficult to measure the correlation between demand for electricity when it is unavailable, and demand for some other market goods such as power using equipment that the households currently use. Instead we use a stated preference method or contingent valuation method to measure the value of the non-market good.

In a contingent valuation method, the value of the non-market good is inferred from survey data reporting household's willingness to pay (WTP) or willingness to accept compensation for a change in its quality (Freeman, 2003). When a policy change is implemented so that quantity or quality of Q improves, i.e., from Q_0 to Q_1, the CVM survey measures the compensating surplus an individual is willing to pay to enjoy the improvement i.e. remain at the same (compensated) utility level.

$$Vi(p,M,Q_0) = Vi(p,Q_1,M - WTP_i) \quad (4)$$

where Vi is indirect utility, WTP_i is individual i's stated willingness to pay, while p is the market price, M is income, Q_o is the quantity of the non market good before policy change and Q_1 is the quantity of the non market good after policy change. Equation 4 states that after the change in quantity supplied of the non-market good, an amount equivalent to the stated willingness to pay must be taken out of the individual's income.

The individual's willingness to pay for the change from Q_0 to Q_1 is formally represented by the change in expenditure required to make the individual enjoy the same level of utility as before the change in the non-market good and this is expressed as:

$$WTP_i = m(p, Q_1, U_0) - m(p, Q_0, U_0) = P\left\{X_i^H(P, Q_{1,} U_0) - X_i^H(P, Q_0, U_0)\right\} \quad (5)$$

Where the WTP_i is individual i's stated willingness to pay, while p is the market price, M is income, Q_o is the quantity of the non market good before policy change and Q_1 is the quantity of the non market good after policy change.

Equation 5 states that the change in expenditure due to the change in quantity from Q_o to Q_1 must be equal to the stated willingness to pay if utility of the household is to remain constant.

3.2 Analytical framework of a CVM study

The CVM is a survey-based method used to estimate the value of goods that have no market prices or products whose market prices are distorted through price control. A contingent study involves taking a survey through structured questionnaires asking the consumer's WTP for a hypothetical change in quality or quantity of goods or services, as well as socioeconomic characteristics believed to be covariates on WTP (Haab and McConnell, 2002).

The CVM is based on consumer demand theory. In that theory, the demand price of a good reflects the economic value of the good in the sense that the price represents an individual's willingness to pay for that good (Tiwari, 2000). Underlying the use of a CVM is the concept of property rights. Where an individual owns a good, the minimum the individual would be willing to accept as just compensation for its loss is the relevant utility measure, since this is the amount that would restore the individual to his utility before being deprived of the good. Conversely, where an individual does not own the right to a good being marketed, then the relevant measure of utility of the good to the individual is the maximum amount he or she will be willing to pay to acquire it (Garrod and Willis, 1999).

Methods of eliciting willingness to pay in a CVM study vary from one format to another depending on how the questions are presented. These include: an open ended question format, a closed ended question format, a dichotomous choice question format, bidding game question format and also a payment card format[5]. Focus will only be on the bidding game and the open ended question formats since this study used those two to elicit willingness to pay.

With an open ended question format, individuals are asked a simple question on their maximum WTP for the good offered with no value specified. For example, respondents can be asked a question such as: What is the maximum amount you would be willing to pay to connect for electricity? Where respondents have experience of purchasing other goods similar to the one in question, then the open-ended method offers a relatively easy method of eliciting WTP. The problem with this method is that, respondents may experience considerable difficulty to state how much they would be willing to pay if they have no prior experience of purchasing goods similar to the one in question (Garrod and Willis, 1999).

[5] For a detailed discussion, see Garrod and Willis (1999:134 -136).

With the bidding game format on the other hand, a set of questions are presented with a dichotomous choice of answers (yes/no). The bidding game is also called a referendum format because of the dichotomous responses that are obtained from the bidding game. In trying to obtain the WTP bids, the interviewer may present the bids in a decreasing order, the initial price being the maximum price to be paid and continues asking until the respondent answers '**yes**' indicating his maximum WTP. Alternatively, the bids may be presented in an increasing order, the initial price being the minimum price to be paid and continues asking until the respondent answers '**no**' indicating his maximum WTP (Garrod and Willis, 1999).The disadvantage with the bidding game format is that a respondent who is not sure of an appropriate answer and wants to please the interviewer may interpret the initial price as a clue to the correct bid. Because of this, it is recommended that where a bidding game format has been used to elicit WTP, the bidding game question should be followed by an open ended question (Arrow et al., 1993). This method of eliciting WTP has been used by Whittington *et al*. (1990) to estimate WTP for water services in Nigeria and Haiti.

Empirical studies have applied CVM to measure the economic value of drinking water, recreation sites , forests and cost of air pollution in both developed and developing countries. The CVM remains the most important technique with the following advantage over any other valuation technique: It can take into account non-use value, such as the utility individuals derive from the existence of an environmental good, even if they do not use it. Non-use value is divided into option value (the possibility that the person may use it in future), existence value (the person values the fact that the environmental good exists, irrespective of use), and bequest value (the person wants future generations to benefit from the good). However, the literature has also pointed out several inconsistency problems in the application of CVM (Copper and Freeman, 1991; Hanemann, 1994). The major problem with the CVM is that for a variety of reasons, respondents may not answer WTP questions accurately and thus not reveal their "true" WTP. The reasons may

include, strategic bias, starting point bias and hypothetical bias. These are discussed below.

3.2.1 Strategic Bias

Strategic bias may arise when an individual thinks that he may influence an investment or policy decision by not answering the interviewer's questions truthfully. Suppose the individual is asked how much he will be willing to pay for an environmental good. If he thinks that the donor will provide the good on condition that the responses of the individuals in the village are positive, then he will have an incentive to overstate the actual WTP. Similarly, if he believes that the good has already been provided and the purpose of the survey is to determine the amount people will pay in order to assess charges, the individual will have an incentive to understate his true WTP with the intention to free ride.

In order to reduce strategic bias, the following two steps can be taken during interviews: The first, step is to tell respondents that everybody will be required to pay the average price, that the exercise is hypothetical and urging them to give true values. The second step is to suggest to them that the survey results may indeed influence policy. However, in practice, strategic bias is not thought to be a serious problem. Most empirical results have not demonstrated the extent to which strategic bias has significantly affected CVM results (Smith, 1997).

3.2.2 Starting Point Bias

Starting point bias occurs when the stated WTP is anchored on the initial stated WTP value and this may arise from the design of the questionnaire itself. The order by which information is presented to respondents especially in a bidding game scenario can influence the final WTP amount chosen (Farrington, 2003). The starting point bias can be minimized by using an open-ended question or a payment card after the bidding game that will probe for the actual WTP and also by

providing information that will only improve the consumers' knowledge concerning the characteristics of the good being valued (Garrod and Willis, 1999).

3.2.3 Hypothetical Bias

Hypothetical bias may arise due to two possible reasons. First the respondent may not understand or correctly perceive the characteristics of the commodity being described by the interviewer. Second, it is often alleged, particularly in developing countries, that individuals do not take contingent valuation questions seriously and simply respond by giving whatever answer first comes to mind (Haneman, 1994). However, some studies have tested the statistical validity of the hypothetical bias but it was found to be insignificant (Whittington et al, 1990; Mekonnen, 2000; Tiwari, 2000).

3.3 Empirical Literature

A number of developing country studies have been conducted to quantify benefits and costs of rural electrification projects. Although different developing countries are facing different socioeconomic constraints, they share important similarities that make lessons from these studies generally applicable. Yang (2003) quantified the impact of rural investment in the power sector on rural economic development and poverty reduction in China. Six provinces with different socio economic characteristics were studied. The findings of the study highlight the importance of public investment in rural electrification programs and draw a number of general policy facts about rural electrification as outlined below.

First, Yang (2003) concluded that rural electrification is not financially viable, although there are indications that it is economically sound and socially friendly. Second, the private sector has little incentive to participate in rural electrification, hence the need for government to initiate and or invest in rural electrification

programs. Third, the main objective of rural electrification by the government should be to reduce poverty, support sustainable development in rural areas and mitigate the migration from the countryside to city. Lastly, economic development under rural electrification can be attained where priority of capital investment has been given to highly economically developed provinces. On the other hand, if the ultimate goal of the investment in rural electrification is to reduce poverty, priority should be given to the medium economically developed provinces.

Other empirical studies have focused on whether environmental services are luxuries or necessities, and whether low-income groups are relatively more willing to pay for environmental improvements than high-income groups. These are questions that Hokby and Soderqvist (2001) investigate in CVM studies conducted in Sweden by assessing the income elasticity of willingness to pay. Income elasticity in CVM studies measures the change in stated WTP for a proposed good associated with a change in income (Horowitz and McConnell, 2003). Estimates of the income elasticity in CVM studies are of interest for several reasons. Firstly, the income elasticity is widely perceived as a useful indicator of the internal validity of the responses. Lack of a positive income effect is commonly interpreted as an indication that respondents did not seriously consider their budget constraint when making hypothetical choices (Mitchell and Carson, 1989). According to Hokby and Soderqvist (2001), income elasticity of willingness to pay was found to be greater than zero but less than unity, implying that environmental services are inelastic and tend to be relatively beneficial to low-income groups.

The extent to which new energy sources are integrated into household's daily patterns of energy use is guided by a number of social, cultural and economic factors. From this point of view, it is clear that energy projects may fall short of their objectives if planners do not consider the complimentarity between rural people's capabilities and the new energy resources. Murphy (2001) observed that many projects have failed because designers have oversimplified the social and cultural relationships existing in the implementation context of the new energy

resources. Thus, adoption and dissemination of the new energy resources has to be supported by social, cultural and economic institutions.

In line with the adoption of new energy resources by households, shifting to modern sources of energy can improve the productivity of poor people in significant ways. Heltberg (2004) notes that the gender aspects of improved household energy outline cross cutting issues such as time spent by women cooking and cleaning pots could be reduced significantly. Modern energy could also allow labour to be redirected from fuel collection towards income generating activities. In addition, clean cooking fuels are important for combating the high levels of in-door air pollution encountered whenever traditional solid fuels are used for cooking.

In establishing the determinants of fuel switching, Heltberg (2004) uses the energy ladder model to analyze survey data on household energy from eight developing countries. Growing incomes in conjunction with relative fuel prices are seen as determining factors for the speed with which households fuel switch by moving up the energy ladder. The energy ladder model conceptualizes fuel switching in three distinct phases. The first phase is characterized by universal reliance on biomass. In the second phase of fuel switching, households are characterized to move to "transition" fuels such as kerosene, coal, and charcoal in response to higher incomes, urbanization and biomass scarcity. The third and final phase of fuel switching is characterized by households switching to natural gas, or electricity for cooking. However, the findings of the study show that spontaneous fuel switching does not occur to the extent often hoped. Infact, it is shown that uptake of a new cooking fuel as a household moves on the energy ladder does not necessarily displace the traditional fuels in the first phase. Instead, many households in developing countries routinely use multiple cooking fuels.

Other studies have shown that rural households are willing to shift to the use of modern sources of energy. A study by Foster et al (1998) reveals that households without electricity in rural Mexico are willing to pay for modern sources of energy.

In essence, households were willing to pay the same amount of money that they spent on alternative sources of energy to displace these sources by the modern sources of energy such as solar photovoltaic (PV) energy system. Explanatory variables such as socioeconomic, demographic and environmental conditions were included in a multinomial logit regression model. Inclusion of such variables in the regression model explains the underlying behaviour and casual relationship between consumer's willingness to pay and the socioeconomic characteristics. However, it was noted that the main reasons for demanding PV system were for electric light use and entertainment, with radio and TV sets being the appliances of choice. It is clear from the study that PV financing programs can be set up in rural Mexico to compete with conventional technologies in relatively rural areas so long as financing or leasing terms are compatible with current rural user expenses for similar services. Madubansi and Schackleton (2005) in investigating patterns of household energy use in rural South Africa also found similar results. Results indicate a changing pattern of energy use for lighting and powering entertainment appliances more specifically from dry-cell batteries and paraffin to electricity. Despite the government's policy of free basic allowance of 5-6 Kilowatts per month, cooking using fuel wood has remained the most widespread fuel in the rural settlements of South Africa and the amount used per month has not changed amidst increasing scarcity of wood in the local environment.

Literature also suggests that several economic and social factors contribute to individual's willingness to pay for services. Davis (1998) argues that changes in fuel choices occur as the availability of modern fuels improves and household incomes increase. Thus the ability to pay for the new fuel type and ownership of appliances that go with their use is strongly correlated to income. However, though income is the main determinant of demand for marketable goods, it is not necessarily the only determinant of people's willingness to pay for utilities. A contingent valuation survey by Carlsson et al, (2004) finds that willingness to pay to avoid power outages varies significantly with income but also age, geographic location, gender and also type of housing. Similarly, White (1991) notes that poor

households without good alternative supplies are often willing to pay much more than richer families with good existing supplies. Also, Foster et al. (2000) conclude that water and sewage bills in Panama are affordable to an average household beneath the poverty line at current tariff levels and for significantly higher tariffs.

In addition to this, studies on utility services such as water have shown the effect of some demographic factors on individual's willingness to pay for such services. The World Bank (1993) found effects of some variables like sex, occupation and family size on willingness to pay for water. In all the four countries studied, sex of the respondents proved to be a statistically significant determinant of willingness to pay. In Tanzania and Haiti, females were willing to pay higher amounts for access to public taps than were male respondents. This means that gender of the respondents seems to be an important determinant in household's expressed willingness to pay for improved services.

Several studies conducted in Malawi have indicated that households are willing to pay for improved services such as water. In most cases, consumers are not only willing to pay but also able to pay for the services. A study by Kwaraguza and Associates (1998) that was conducted in Mzuzu indicates that more people were willing to switch from lower level sources to higher level sources of water. It was noted that, households that were sharing other people's individual home connections and those that were using communal water points were willing to have their own connections.

An informal contingent valuation exercise that was conducted for Lilongwe and Blantyre Water Boards by Kagga and Partners (1997) revealed that a higher percentage of the households were paying MK4 to MK5 per household per month for communal water points. But the majority of these households were willing to pay at least MK7 per month (MK1.95 per cubic metre). This suggested that most consumers including the poor could afford to pay around MK2 per cubic metre, which was higher than the rate at the time. Therefore, the revealed WTP rate could

be biased towards ensuring that only few households would be denied access to piped water due to their inability to pay. The latter reflects the respondent's belief that s/he could influence the decision to supply or not to supply the good through the WTP bids.

3.4 Conclusion

The theoretical literature has analyzed approaches to resource valuation such as the direct estimation method, the revealed preference method (Hedonic pricing) and the stated preference method (CVM) for measuring willingness to pay. This study has opted to use the CVM as opposed to the other two methods mainly because of its ability to present a hypothetical market considering the fact that electricity is not yet provided in the rural. Despite problems encountered in CVM studies such as the strategic bias, starting point bias and the hypothetical bias, these can be surmounted. From our empirical findings, it is shown that households are willing to switch to the use of modern sources of energy. The energy ladder model reveals that income and fuel prices are the main determining factors for the speed at which households switch by moving up the energy ladder. Furthermore, the extent to which new energy sources are integrated into household use is determined not only by socio-economic factors such as income, but also a number of demographic factors such as age, geographic location, gender, and also type of housing. In addition to this, willingness to pay for utility services is also influenced by family size, sex and also main occupation.

In view of this, it would implicitly mean that rural households are heterogeneous in many respects including their income/wealth, attitudes and needs. From the microeconomic point of view, it is necessary to incorporate the heretegeneity aspect in our estimation since it has an effect on tastes and also has implications for policy change.

Chapter 4: Methodology of the study

4.1 Survey design

This study uses secondary data obtained from a cross-sectional survey conducted in 2002 under the JICA Rural Electrification study. For each district in Malawi, two trading centers were sampled and a structured questionnaire was used to collect data on socioeconomic characteristics of households, expenditure on alternative sources of energy, willingness to pay for electricity connection, the maximum amount households were willing to pay to connect electricity without subsidization, and affordability of monthly electricity bills. For the purposes of this study, a sample of 370 observations has been realized from the data with running a business as the main occupation of the household and also the household being not yet electrified.

In order to eliminate biases and improve reliability of the CVM, the JICA Rural Electrification study adopted guidelines laid down by National Oceanic and Atmospheric Administration (NOAA) panel. Direct interviews (face-to-face) approach was adopted in eliciting WTP[6]. Although direct interviews format is relatively expensive as compared to mail or telephone interviews, it has some advantages in that, it allows the interviewer to make some explanations that cannot be possible with mail or telephone interviews. Also, an interviewer has an opportunity to read respondents' understanding and seriousness in answering the CVM questions[7].

Given the design of the proposed rural electrification project for selected trading centers, the business owning household heads were asked their willingness to connect to electricity from the main lines that would be brought by the project to the trading centre and pay for the cost of basic wiring for a two-room shop. Cost of

[6] The NOAA Panel was a committee formed in 1989 in USA with its core objective being to investigate the reliability of CVM.
[7] See Mitchell and Carson (1989).

connection from the main power line and in-house wiring for a two-room shop including labour charges were computed at 2002 prices and summed up to MK3, 550[8]. This cost only applied to single phase connection for dwelling units or shops, but other costs were applicable for a 3 phase connection with respect to factory units or maize mills.

Elicitation of WTP was done in two steps. In the first step, the respondents were asked if they would be willing to pay for electricity connection if a power line were brought to the trading centre. For those that responded positively an iterative bidding game was presented where they had to give yes/no answers to six different costs of connection options. The options gave a hypothetical scenario of six different levels of subsidization from government and were presented in decreasing order as follows:

- Firstly, WTP for electricity connection was assessed at zero subsidy rates and this implies that the respondents are solely responsible for the cost of connection from the main power line and in-house wiring at MK3, 550.
- Secondly, WTP was assessed at a total cost of MK2, 500 entailing free connection from the main power line and no subsidy on in-house wiring costs. Overall, this implies a 30% subsidy and respondents paying 70% of the total cost.
- The third possibility required the business owning households to pay MK1, 875 providing free connection from the main power line but a 25% subsidy on in-house wiring costs. Overall, this scenario implies a 48% subsidy and respondents paying 52% of the total cost.
- The fourth situation required business owning households to pay MK1, 250 providing free connection from the main power line and 50% subsidy on in-house wiring costs. Overall, this scenario implies a 65% subsidy and respondents paying 35% of the total cost.
- The fifth situation entails a cost of MK1, 050 in which the business owning households are expected to pay the full cost connection but with a 100% of

[8] Cost of connection from the main power line was MK1, 050 and that for in-house wiring was MK2, 500.

subsidy to cover in-house wiring costs. Overall, this scenario implies 70% of the cost was offered as a subsidy and the respondents were expected to pay 30% of the total cost.

- Finally, the lowest cost situation is a free connection with a 75% subsidy on in-house wiring costs. This scenario implies a subsidy of 82% and respondents asked to pay only 18% of the total cost.

For each of the six situations presented, the respondents were to indicate either 'yes' or 'no' in order to reveal the amount they were willing to pay. Using the transitivity assumption, the first 'yes' response implied that the household was also willing to pay for the lower values.

The second step of eliciting WTP involved asking the respondents an open ended question to state their maximum willingness to pay for the cost of connection. For the purposes of this study, WTP is estimated from the open ended question.

To ensure that starting point bias is minimized in the bidding game, the JICA Rural Electrification study made use of an open-ended question after the bidding game question that probed further for the actual WTP. However, to ensure effective minimization of the starting point bias it was ideal if the sample was to be divided into two categories with equal number of respondents. From the categories, one was to be presented with a low starting point and the other with a high starting point. For low starting point respondents the amount was to be raised until the answer changes from 'yes' to 'no'. The last 'yes' has to be chosen, as the maximum amount the household is willing to pay. Similarly, for the high starting point group the amount was to be lowered and the first 'yes' to be chosen.

To ensure that hypothetical bias is minimized, the JICA Rural Electrification study employed experienced enumerators. The enumerators underwent an intensive training to ensure that they understood the questionnaire well and so could present the questions to the respondents accurately.

4.2 Implementation of the study

For the purposes of this study, both statistical and econometric methods will be employed in analyzing data using STATA SE Version 8.2. The statistical methods will be used to get a first glimpse of the distribution of the variables used in the regression by analyzing their mean values. The econometric methods will be used in estimating the willingness to pay function.

A Tobit regression model will be employed in the econometric methods from which the predicted mean willingness to pay will be obtained. The predicted mean willingness to pay is to be used to assess whether or not there is need for government to provide a subsidy for the rural electrification project. This is achieved by comparing the predicted mean WTP obtained after estimating a Tobit and the calculated cost of connection for electricity as at 2002 prices (MK3, 550). Where the predicted mean WTP obtained is greater than MK3, 550, this would mean that, on average people can afford to pay for electricity connection based on their socio-economic characteristics and therefore no need for government to provide a subsidy, otherwise the difference obtained indicates the required subsidy to be paid by government.

4.3 The econometric model for estimating WTP

The willingness to pay function could be estimated using either a Tobit regression or ordinary least squares (OLS) to predict the mean WTP. In this study, a Tobit model will be used as opposed to the OLS. This is because OLS assumes that those not willing to pay could be deemed not to participate in *demanding electricity* even if electricity were to be provided to them. This is particularly true if the WTP function takes the Cobb-Douglas or semi-log specification. Thus the OLS is a misspecification since excluding those with a WTP=0 amounts to sample selection bias, and the least squares estimators are as a result biased and inconsistent.

The general formulation of the Tobit model is given as:

$$WTP_i^* = \beta' X_i + \varepsilon_i \qquad (6)$$

Where

$$WTP_i = \begin{cases} \beta' X_i + \varepsilon_i \quad if \quad WTP_i^* > 0 \\ 0 \; if \; WTP_i^* \leq 0 \end{cases}$$

X_i is for individual *i,* a vector of explanatory factors in the regression,
β is a vector of coefficients,
WTP_i is the stated willingness to pay for the individual *i.*

The Tobit model will be estimated using maximum likelihood to generate estimators that are consistent and asymptotically normal, although these properties are highly sensitive to specification errors (Amemiya, 1973; Judge et al., 1987). The standard Tobit model may also give predictions that fall outside the domain of permissible values if the number of censored observations exceeds the uncensored observations. The consequence of the latter is that inclusion of observations for which the *WTP*=0 causes the function to swivel towards negative values, although the WTP function has a lower limit of zero.[9]

4.4 Specification of the WTP function

The WTP is specified as a function of household's annual income, expenditure on alternative sources of energy, household size, gender of the household head, the type of the business being operated, the ratio between age of the household head and the age of the business being operated, education level of the household head and also the average years of schooling for other members of the household. The dependent variable is a continuous variable capturing the stated willingness to pay for electricity connection by households.

[9] Values falling below the lower limit would not make sense although the underlying model is statistically valid.

The regression equation is given below:

$$WTP_i^* = \beta_0 + \beta_1 INCOME + \beta_2 ENERGEXP + \beta_3 HHSIZE + \beta_4 GENDERHH + \beta_5 AGEHH + \beta_6 BUSIAGE + \sum_{j=7}^{9} \beta_j BUSITYPE_{(j-6)} + \sum_{j=10}^{12} \beta_j EDUHH_{(j-9)} + \mu_i \quad (7)$$

The variables used in the regression are defined below.

WTP_i^* is stated willingness to pay measured in Malawi kwacha and is the dependent variable for the Tobit model. This is a continuous variable censored at zero if $WTP \leq 0$.

INCOME captures annual income of the household. Demand theory postulates that apart from own price, demand for a commodity is mainly determined by income. As such it is anticipated that households with higher levels of income are likely to be more willing to pay for electricity than households with lower levels of income. Thus, increases in income levels should lead to an increase in demand for electricity *ceteris paribus*, hence the expected sign for the coefficient is positive.

ENERGEXP is the expenditure on alternative sources of energy. It is hypothesized that households that spend more on alternative sources of energy would show willingness to switch to the use of electricity, than households that spend less. Thus increases in the expenditure on alternative sources of energy should lead to more willingness to pay for electricity, these being close substitutes. In addition, since alternative sources of energy are less efficient as compared to the use of electricity,

it is anticipated that households will be willing to switch to the use of electricity. The expected sign for the coefficient is positive.

HHSIZE captures the size of the household. WTP is expected to be higher in households with many people as compared to those with few people. This is due to the fact that households with more people would require more energy than those with few people. As a result larger households would be willing to have electricity as compared to smaller households. Therefore, the expected sign for the coefficient is positive.

GENDERHH is a dummy variable for sex of the household head. If household head is female, *GENDERHH* = 1, otherwise it is zero. In the rural setup, collection of firewood is mostly from natural forests and woodlands that are usually far from homes. Women bear most of the burden of collecting, processing and utilizing the firewood. Based on this, it is anticipated that women would be more willing to pay for electricity than men. The sign for the coefficient is expected to be positive.

AGEHH is a continuous variable indicating the age of the household head. The Permanent Income Hypothesis (PIH)[10] postulates that decisions made by households are determined not only by income but also by their measured longer term choice expectations. Based on this, it is hypothesized that elderly people would be less willing to make investments such as connecting electricity since their expectations are that benefits to be gained would not be enjoyed for a long time. On the other hand, elderly people are normally used to the habits of using biomass sources of energy such that switching to the use of electricity may not be obvious since they would always want to maintain their status quo. Thus older persons are expected to be less willing to pay for electricity than younger persons and the coefficient for the variable is expected to be negative.

[10] See Friedman (1957), A theory of the consumption function.

EDUHH represents the highest level of education attained by the household head. This is expressed as a dummy variable with four categories: NONE if the household head has never been to school, PRIMARY if the highest level of education attained is primary, SECONDARY if the highest level of education attained is secondary and TERTIARY if the highest level of education attained is tertiary education. The implication is that, 3 dummies will be introduced, the dummy variable taking the value of 1 for a given level of education and 0 otherwise. Education is expected to increase the household head's ability to make informed decisions thereby making rational choices. It is expected that willingness to pay will increase with an increase in the level of education, as such the expected sign for the coefficient is positive.

EDUOTHER is the average years of schooling for other members of the household. An increase in the average years of schooling by other household members may imply that other household members have better knowledge and so can influence in making decisions about the perceived benefits of rural electrification. On the other hand, this may also imply an increase in income through remittances or transfers hence improving the socioeconomic status of a household. It is expected that *EDUOTHER* will be positively related to WTP.

BUSITYPE captures the different types of business enterprises taking place in the rural trading centers. This is a categorical variable with 4 categories: retail business (RETAIL), manufacturing business (MANUF), restaurants and bars (RESTBARS), and other businesses (OTHERBU). The implication is that, 3 dummies will be introduced, the dummy variable taking the value of 1 for a given business type and 0 otherwise. It is expected that willingness to pay will be high for business types that require more energy for production such as restaurants or for entertainment as in bars. However a priori expected signs for other business types cannot be established.

BUSIAGE refers to the number of years the business has been operating. In a competitive market where there is free entry and exit, age of the small-scale

business would be an indication of survival, otherwise the business can no longer operate. This would also relate more to profitability as well as commitment the business owner has on the business. However, as to how age of the business would influence willingness to pay for electricity, this cannot be established a priori. This is because not only would age of the business matter but also the type of the business being operated as well as demographic characteristics such as the age of the business owner. As such, age of the business can either have a positive or a negative sign.

The table below gives a summary of the explanatory variables and their expected signs.

Table 1: A summary of the explanatory variables and their expected signs

Variable	**Description**	**Expected sign**
INCOME	Annual income in thousand Malawi Kwacha	Positive
ENERGEXP	Expenditure on alternative sources of energy in thousand Kwacha	Positive
HHSIZE	Size of the household	Positive
GENDERHH	Sex of the household head. *GENDER* =1 *if* female,0 otherwise	Positive
AGEHH	Age of the household head in years	Negative
EDUHH	Highest level of education attained by household head: NONE, PRIMARY, SECONDARY, TERTIARY.	Positive
EDUOTHER	Mean years of schooling for other members of the household	Positive
BUSITYPE	Different types of businesses: RETAIL, MANUF, RESTBARS, OTHERBU	Positive/ negative
BUSIAGE	Age of the business in years.	Positive/ negative

Chapter 5: Results and Discussions

The study used both statistical and econometric analysis. The statistical (descriptive) and econometric analyses were conducted using STATA SE Version 8.2.

5.1 Descriptive Statistics of the Variables in the Econometric Analysis

Table 2 below gives the summary of the measures of location and dispersion of the data for the variables that have been used in the econometric analysis to estimate equation 7. These are the variables that have been hypothesized that they determine willingness to pay for electricity.

Table 2: Descriptive statistics of the variables in the Econometric analysis

Variable	Mean	Std deviation	Min	Max
Stated Willingness to pay in Thousand Kwacha (WTP_i^*)	6.184	5.749	0	30
Annual income in Thousand Kwacha (*INCOME*)	113.44	160.38	2.1	1055
Annual energy expenditure in Thousand Kwacha (*ENERGEXP*)	10.622	16.682	0	243
Household size (*HHSIZE*)	5.941	2.805	1	20
Dummy = 1 if sex of household head is female, = 0 otherwise(*GENDERHH*)	0.078	0.268	0	1
Age of the household head in years (*AGEHH*)	37.029	11.422	19	75
Age of the business in years (*BUSIAGE*)	8.166	7.558	1	52
Average years of schooling other household members (*EDUOTHER*)	3.834	2.179	0	12
Dummy=1 for primary education (PRIMARY)	0.668	0.471	0	1
Dummy=1 for secondary (SECONDARY)	0.241	0.428	0	1
Dummy=1 for tertiary education (TERTIARY)	0.008	0.089	0	1
Dummy=1 for never been to school (NONE)	0.083	0.276	0	1
Dummy=1 for retail business (*RETAIL*)	0.623	0.485	0	1
Dummy=1for manufacturing (*MANUF*)	0.025	0.156	0	1
Dummy=1 for restaurants and bars (*RESTBAR*)	0.147	0.303	0	1
Dummy = 1 for other businesses (*OTHERBU*)	0.205	0.403	0	1

Source: JICA rural electrification survey, 2002

Note: For all categorical variables, mean is the proportion of those respondents with dummy value of 1.

The statistics show that about 8% of the respondents were female against 92% male. On average, the respondents were 37 years old. The statistics also reveal that the majority of the respondents (about 62%) were in retail type of business, while those operating restaurants and bars were only about 15% and the least being those in manufacturing with a percentage of about 3%. The businesses have a mean age of 8 years and this would imply that most of the respondents started their business in around 1984. In terms of education of the household head, the highest level of education attained was primary with 67% of the respondents attaining primary school education, against 24% attaining secondary school education and the least being those attaining tertiary education (0.8%). The average household size is 6 and the households had an average annual expenditure of about MK11, 000 on alternative sources of energy. The table also reveals that the respondents have a mean annual income of MK113, 000 and the mean willingness to pay for electricity connection was MK6, 000. The maximum stated WTP was MK30, 000 with the minimum WTP of zero[11].

5.2 Econometric Analysis of the Variables

This section presents the regression results and the elasticities obtained from the Tobit model. The stated willingness to pay amount for electricity connection (WTP) was modeled as a function of the explanatory variables in equation 7.

Several variables were hypothesized to influence WTP as presented in equation 7. A correlation analysis between these variables was conducted in order to identify key variables with relatively strong inter-dependences. Mycoo (2005) notes that collinearity between independent variables can substantially affect the results of regression analysis so these must be noted and accounted for. On the other hand,

[11] From the sample, 30 respondents were not willing to pay as such, their stated WTP was zero, against 340 respondents that were willing to pay. For those that responded positively, the stated mean WTP was MK6, 700.

Gujarati (2003) suggest that collinearity only becomes a serious problem if the pair-wise or zero-order correlation coefficient between two regressors is in excess of 0.8.

After conducting a pair-wise correlation test between education level of the household head (*EDUHH*) and the average number of years of schooling for other members of the household (*EDUOTHER*), collinearity of equal to 0.8416 was found between these two variables and this was statistically significant at 5% level. This could be explained by the fact that education level of the household head is likely to have an influence on the level of education attained by other members of the household. Thus, an educated household head is likely to have its members go further in education than a non-educated household head.

Inclusion of the variable average years of schooling for other members of the household (*EDUOTHER*) consistently produced unstable results in that most of the variables in the regression were not statistically significant. As such the variable had to be omitted from the model and in the end, a parsimonious model was obtained after controlling for the variable (*EDUOTHER)*. Results for the model are presented in Table 3 below:

Table 3: Estimation results for the Tobit model

Variable	Coefficient	Standard error	t-statistic	Elasticities
INTERCEPT	3.929	3.929	2.16	
INCOME	0.005	0.002	2.20 [b]	0.093
ENERGEXP	0.046	0.021	2.23 [b]	0.084
HHISZE	0.188	0.120	1.57	0.189
GENDERHH	-2.131	1.226	-1.74 [c]	-0.028**
AGEHH	-0.070	0.033	-2.13 [b]	-0.439
BUSIAGE	0.064	0.064	1.34	0.088
RETAIL	1.558	1.559	2.09 [b]	0.163**
MANUF	-0.264	-0.264	-0.13	-0.001
RESTBARS	1.467	1.467	1.30	0.026
PRIMARY	1.044	1.044	0.90	0.118
SECONDARY	1.101	1.101	0.85	0.045
TERTIARY	-4.040	-4.040	-1.05	-0.006

Notes:
The t-statistics are based on robust standard errors.
Superscripts *a*, *b* and c indicate significance at 1%, 5% and 10% level, respectively.
** Interpretation of the elasticity for *GENDERHH* and *RETAIL* may not offer any significant meaning since the variables are discrete in nature.

Wald X^2 = 40.33 Pseudo R^2 = 0.0178
N = 370 Prob > chi = 0.0001

Predicted mean willingness to pay after Tobit ***= 2.275*** [12]

Obs. summary: 30 *left-censored observations at WTP <=0*
340 *uncensored observations*

The results in Table 3 show that all the coefficients have the expected signs except for gender of the household head. The observation summary shows that 340 respondents had a positive willingness to pay while as 30 respondents were not willing to pay and their willingness to pay has been censored at zero. Household's income, expenditure on alternative sources of energy, gender of the household head, age of the household head and also operating a retail type of business are found to be significant at 5% level of significance. The results are discussed below:

[12] The mean willingness to pay is measured in thousand Malawi Kwacha which equal toMK2 2 75.

Income

The statistical significance and positive sign for income means that WTP for electricity increases with an increase in the level of income. Thus households with higher levels of income would be willing to pay more for electricity connections than households with lower levels of income. In line to this, Davis (1998) argues that the ability to pay for new fuel types is strongly correlated with income in that changes in fuel choices occur as the households income increase. Furthermore, a study by Heltberg (2004) on fuel switching found similar results in that income is one of the determining factors for the speed with which households switch to the use of modern sources of energy. The income elasticity is calculated to be 0.093 implying that a one percent increase in income will lead to an increase in WTP to pay by approximately 0.1%. The positive income elasticity could indicate that the respondents seriously considered their budget constraint when they were making hypothetical choices as suggested by Mitchell and Carson (1989). With an income elasticity of less than unity, it means household incomes must increase substantially for rural households with small-scale businesses to be willing to pay more for electricity connections.

Expenditure on alternative sources of energy

The statistical significance and positive sign for *ENERGEXP* means households are willing to switch to the use of electricity and that WTP for electricity connection increase with an increase in expenditure on alternative sources of energy. Thus households that have a higher expenditure on alternative sources of energy are likely to switch faster to the use of electricity than households that spend less. A study by Foster et al. (1998) in rural Mexico also found that the amount households spend on alternative sources of energy significantly determines their willingness to pay for modern sources of energy. In this respect, it is businesses with substantial expenditures on alternative sources of energy that would be willing to switch to electricity much faster than other businesses. In particular, restaurants and bars were

found to have a significantly higher expenditure on alternative sources of energy than any other business as it is shown in Appendix 3. In addition, the use of alternative sources of energy is generally considered to be less efficient as compared to the use of electricity.

However, there is a possibility that the main reason for switching to the use of electricity may not be for cooking *per se*, rather rural households may demand electricity for other reasons such as entertainment or lighting. The Findings by NSO (2000) reveal that in urban Malawi where electricity is accessible, 94 percent of the households use firewood and only 2 percent use electricity as their main source of energy for cooking (NSO, 2000). In support of this argument, a study on household patterns use conducted in rural South Africa by Madubansi and Schackleton (2005) found that households pattern of energy use changed with regard to lighting and powering entertainment from dry-cell batteries and paraffin to electricity. However, despite government's policy of free basic allowance of 5-6 Kilowatts per month, cooking using fuel wood has remained the most widespread fuel and the amount used per month has not changed amidst increasing scarcity of wood in the local environment. Heltberg (2004) presents similar findings in investigating fuel switching in 8 developing countries. The findings show that switching to the use of modern sources of energy does not always displace traditional fuels as evidence emerging is showing that many households in developing countries routinely use multiple cooking fuels.

The elasticity for *ENERGEXP* is 0.084 implying that, a unit percent increase in the expenditure on alternative sources of energy will lead to an increase in WTP by approximately 0.1%.

Gender of the household head

Gender of the household head is statistically significant only at 10% significance level. The negative sign for gender of the household head (*GENDERHH*) indicates

that being female, willingness to pay for electricity will be lower than being male. However, this is contrary to the hypothesis that women are likely to be more willing to pay than men. Could this be a paradox? Even if this outcome is statistically significant, our a priori expectation cannot be completely discarded because the outcome would possibly be as a result of women representation in the sample. The descriptive statistics in Table 3 indicate that, only 8% of the respondents were female against 92% male. On the other hand, the GEMINI study reveals that in Malawi, 34% of Micro and Small Enterprises (MSE) are owned by women (ECI & NSO, 2000). Based on this, it can be argued that women were under represented in the sample such that the responses obtained are mainly for male headed households.

Furthermore, a two-sample t-test for comparing mean willingness to pay between female and male headed households fails to reject the null hypothesis of equal mean willingness to pay across gender at 5% significance level[13]. Although this is statistically significant at 10% level, this outcome cannot be used in this respect. A 10% significance level entails a wider confidence interval such that the results may not be reliable.

Age of the household head

The statistical significance and negative sign for *AGEHH* means that WTP for electricity connection decreases with aging. This finding is consistent with a priori that *AGEHH* should have a negative sign. Thus older people would be less willing to pay less electricity connection as compared to younger people. Elasticity for *AGEHH* is -0.439 implying that a unit percent increase in age will lead to a decline

[13] **Results for the two-sample t-test for comparison of two means**;

Ho: meanWTP(female) – meanWTP(male) = diff = 0

Ha: diff ≠ 0

MeanWTP if female= 4.2965 , Mean WTP if male= 6.3445

t-statistic=1.8476, p(t-statistic > |t|) = 0.0655

We therefore fail to reject the null hypothesis and conclude that the mean WTP for female and male are not statistically different.

in WTP by 0.44%. In comparing the values of the elasticities from the results, *AGEHH* has the largest elasticity in absolute terms. This would indicate that WTP is more responsive to age of the household head than any other variable in the regression.

Retail type of business

The significance and positive sign for the *RETAIL* means that, willingness to pay for electricity connection is higher for those in retail type of business than any other business. A calculation of the mean willingness to pay by business type in Appendix 3 also shows that mean WTP is the highest in retail type of business than in any other business. This finding may not be surprising since the descriptive statistics in Table 3 show that over half of the respondents (62%) were in retail type of business indicating that retail type of business could be an easier business to start and operate for rural households comparing to any other type of business.

5.3 Predicted Mean willingness to pay

A mean willingness to pay of MK2, 275 was predicted after estimating the Tobit regression. This is the amount that the average respondent would be willing to pay towards the total cost of connection. This amount is below the calculated total cost of connection equivalent to MK3, 550 (at 2002 prices). After factoring in inflation, the mean willingness to pay amounts to MK4, 985 in the year 2006 while the calculated total cost of connection amounts MK6, 650[14]. However this finding does not necessarily imply that rural electrification is not sustainable, rather, that respondents may not afford some of the elements of investment that come with rural electrification because of the household's prevailing socioeconomic status. Table 4 below gives the predicted mean willingness to pay by the type of business. It is evident that predicted mean willingness to pay is highest for the retail type of

[14] Figures for inflation were obtained from the Reserve Bank of Malawi website: www.rbm.mw.
1 USD = MK140.00 as of July, 2006.

business with restaurants and bars being second. This corresponds to the results obtained that being in retail type of business, willingness to pay is higher than any other type of business. The latter relates to the hypothesis that businesses with substantial expenditures on alternative sources of energy such as restaurants and bars will be willing to switch to the use of electricity much faster than any other type of business[15].

Table 4: Predicted mean willingness to pay by type of business in thousand Malawi Kwacha

Type of business	**Predicted mean WTP for electricity connection (MK '000)**
RETAIL	2.9
MANUFACTURING	1.3
RESTAURANTS AND BARS	2.8
OTHER BUSINESSES	2.1

5.4 Summary of findings

Results show that willingness to pay for electricity increases with an increase in the level of income and also expenditure on alternative sources of energy. On the other hand, willingness to pay for electricity is found to decrease with age of the household head. However, education level of the household head, household size and age of the business are found not to significantly determine an individual's willingness to pay for electricity. The elasticities obtained show that willingness to pay for electricity is inelastic to changes in income, expenditure on alternative sources of energy and also age of the household head. Although the results show that willingness to pay for electricity will be lower for being female than male, two

[15] It should be noted that while as the predicted mean willingness to pay after estimating a Tobit is highest for the retail type of business, the mean expenditure on alternative sources of energy is highest for restaurants and bars as shown in Appendix 3.

sample t-test results for comparison of two means indicate that the mean willingness to pay for female and male are not statistically different.

Chapter 6: Conclusions and Recommendations

The study employed a contingent valuation method (CVM) to estimate willingness to pay for electricity using a Tobit model. Specifically, the study wanted to assess the role of income, expenditure on alternative sources of energy and households' characteristics in influencing willingness to pay for electricity. In addition, the study wanted to analyze the sensitivity of willingness to pay to income, expenditure on alternative sources of energy and household characteristics. Results show that household's income, amount spent on alternative sources of energy, gender of the household head, age of the household head and also operating a retail type of business are important factors in determining willingness to pay for electricity connection.

From the elasticities obtained, willingness to pay with respect to income is found to be inelastic[16]. This finding may be explained by the fact that the commodity in question has not yet been supplied, as such, households lack comparable experience for them to make adjustments. The significance of income in determining willingness to pay would entail that policies that will target improving income levels for the rural households would be essential if rural electrification is to be sustainable. In this respect, provisions of credit schemes would be vital in increasing profitability of the businesses which will eventually translate into higher income levels.

The results for the Tobit model also indicate that willingness to pay with respect to expenditure on alternative sources of energy is inelastic. This finding implies that as expenditure on alternative sources of energy increase, the speed of adjustment or the pace at which households would switch to the use of electricity is slow. Thus, despite the provision of electricity in the rural, households would continue using alternative sources of energy as long as these are in supply. This indicates that areas with open access biomass fuels and where household incomes are low would be

[16] This finding is not surprising since willingness to pay studies rarely find income to be elastic.

unrealistic targets for rural electrification both in the short and medium run unless complimentary policies are pursued. In this regard, even if people revealed their willingness to pay for electricity connections, the problem of deforestation would not be solved unless there were economic incentives such as user fees or charges that will deter people from overexploiting forestry resources.

The predicted mean willingness to pay after estimating a Tobit is found to be less than the calculated total cost of connection implying that an average household in the rural Malawi cannot afford to pay for the cost of connection at the market price because of the household's prevailing socioeconomic status. For policy considerations, this calls for subsidization of capital expenditures from government if rural electrification is considered to be a development priority. Despite the arguments that may be there against subsidies, the relevance of the subsidy here would be to support an investment that could trigger development in rural areas and help the Programme recoup both the costs of investment in the long run. The latter relates to the other finding of the study that income must increase substantially for WTP to increase.

From the six different levels of subsidization that were presented in an iterative bidding game format, the most appropriate subsidy scenario to implement would be that of asking respondents to pay the full cost of connection on in house wiring and getting a free connection from the main power lines[17]. Implicitly, a subsidy equivalent to 30 percent of the total cost of connection is required to ensure that an average household is able to pay for the cost of connection at the market price.

While as subsidization enables more people to have to access to electricity, there is need to provide a strategy that will ensure that the subsidy is withdrawn in the long run because this will reduce costs incurred in rural electrification projects. Due to

[17] A mean willingness to pay of Mk2 275 approximates to the second cost of connection option of Mk 2 500. The suggested subsidy policy scenario applies to this cost of connection option.

the existence of complimentarities in the economy, an appropriate strategy would be to develop other infrastructures such as roads, schools and hospitals among other things that will compliment the provision of electricity. Investments in the energy sector together with other sectors of the economy will eventually bring development thereby making rural households productive. As households become productive, it would mean an improvement in their living standards entailing that they may no longer require a subsidy since there is an increase in the level of income.

Nevertheless the results obtained show that CVM studies can be used for planning and decision making in the continuing efforts to provide sustainable energy sources such as electricity in Malawi. However, caution has to be taken before generalizing the results to specific districts in Malawi. This is in recognition of the fact that different geographic areas are at different development stages and would differ in factors that influence household willingness to pay for electricity.

Limitations

The study has attempted to assess whether or not rural electrification is sustainable by estimating willingness to pay to connect to electricity. The problem with the thesis is that it inherits weaknesses of the data source, a survey designed and undertaken by JICA in 2002. There are potential small-scale business activities that would be stimulated by electricity supply but which are considered in the survey like welding. Furthermore, the focus of the study has mainly been on connection costs and installation. It would be imperative for future research on rural electrification to incorporate issues pertaining to the affordability or ability to pay for the monthly bills if designed policies on rural electrification projects are to be realistic.

The rural electrification project in Malawi mainly plans to transform the rural economy by increasing rural access to grid and non grid electricity. Where demand for electricity is low compared to the distribution costs, electricity will be supplied

by off-grid sources of energy such as solar PV and mini hydros. However due to unavailability of data on off-grid sources of energy, this study has not been able to assess the demand for electricity for non grid options. A more comprehensive study would be required to also investigate the demand for electricity under the non grid options. This will increase our understanding on factors that affect willingness to pay for electricity in general.

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APPENDICES

Appendix 1: Estimation results for the Tobit model

Variable	Coefficient	Standard error	t-stats	P-Value> |t|	95% confidence interval	
INTERCEPT	3.929	3.929	2.16	0.031	0.352	3.321
INCOME	0.005	0.002	2.20	0.029	0.001	0.009
ENERGEXP	0.046	0.021	2.23	0.026	0.005	0.087
HHISZE	0.188	0.120	1.57	0.118	-0.048	0.425
GENDERHH	-2.131	1.226	-1.74	0.083	-4.542	0.280
AGEHH	-0.070	0.033	-2.13	0.033	-0.135	-0.005
BUSIAGE	0.064	0.064	1.34	0.180	-0.029	0.158
RETAIL	1.558	1.559	2.09	0.037	0.093	3.025
MANUF	-0.264	-0.264	-0.13	0.899	-4.375	3.846
RESTBARS	1.467	1.467	1.30	0.194	-0.751	3.684
PRIMARY	1.044	1.044	0.90	0.368	-1.233	3.321
SECONDARY	1.101	1.101	0.85	0.395	-1.444	3.647
TERTIARY	-4.040	-4.040	-1.05	0.294	-11.62	3.521

Appendix 2: Estimation results for the Elasticities

Variable	**Elasticity (ey/ex)**	**Std error**	**z-stats**	**P-Value >|z|**	**95% confidence interval**		***X***
INCOME	0.093	0.042	2.18	0.029	0.009	0.176	112.835
ENERGEXP	0.084	0.038	2.21	0.027	0.009	0.159	10.737
HHISZE	0.189	0.121	1.57	0.118	-0.048	0.427	5.938
GENDERHH	-0.028	0.016	-1.74	0.084	-0.060	0.004	0.078
AGEHH	-0.439	0.207	-2.13	0.034	-0.845	-0.033	37.002
BUSIAGE	0.088	0.066	1.34	0.181	-0.041	0.218	8.154
RETAIL	0.163	0.079	2.09	0.038	0.009	0.318	0.619
MANUF	-0.001	0.009	-0.13	0.899	-0.018	0.016	0.024
RESTBARS	0.026	0.021	1.30	0.195	-0.014	0.067	0.108
PRIMARY	0.118	0.131	0.90	0.368	-0.138	0.374	0.665
SECONDARY	0.045	0.053	0.85	0.395	-0.059	0.150	0.243
TERTIARY	-0.006	0.005	-1.05	0.294	-0.016	0.005	0.008

Appendix 3:Mean expenditure on alternative sources of energy and mean WTP by type of business, in thousand Malawi kwacha.

Type of business	**Mean willingness to pay for electricity connection (MK '000)**	**Mean expenditure on Alternative sources of energy (MK '000)**
RETAIL	5.6	825.0
MANUFACTURING	3.0	533.4
RESTAURANTS AND BARS	5.5	1192.3
OTHER BUSINESSES	4.4	1036.2